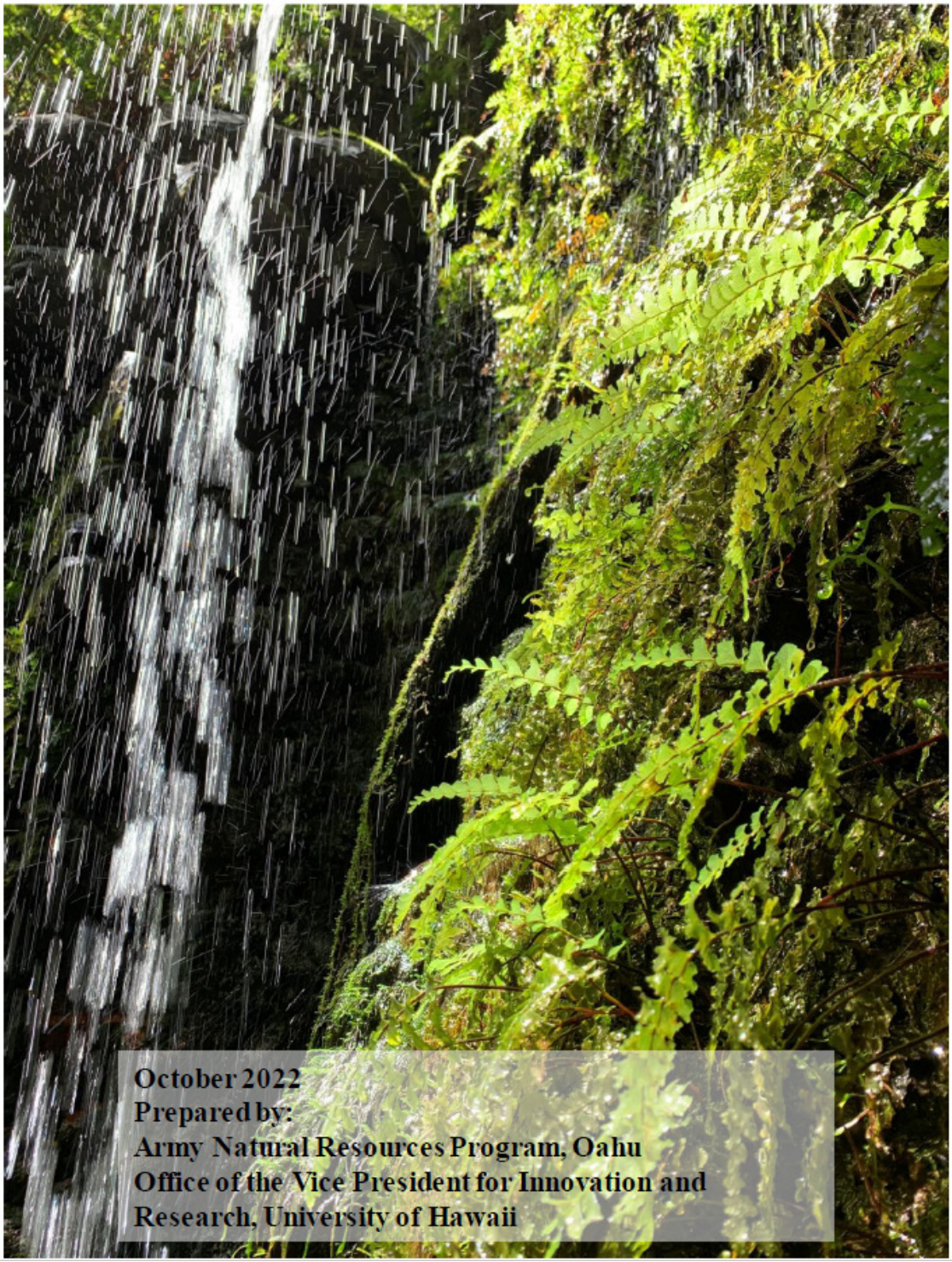
2022 Status Report for the Makua and Oahu Implementation Plans



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*Cover photo: *Asplenium unilaterale* next to a waterfall in Schofield Barracks East Range captured during damselfly surveys conducted this year.

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EXECUTIVE SUMMARY

The Army Natural Resources Program on Oahu (ANRPO) has over 50 personnel on staff, comprised of management and administrative support staff, biologists and technical experts, three resource management crews, one vegetation restoration crew, 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 to the University of Hawaii. Staff levels in Fiscal Year (FY) 2022 were up from FY 2021. For FY 2022, ANRPO received a total of $5,872,548 to implement Makua Implementation Plan (MIP) projects and Tier 1 projects from the Oahu Implementation Plan (OIP). This included funding for unexploded ordnance escort, technical expertise, biological assessment preparation, rodent control supplies, plant propagation services, and greenhouse lease rent. As in FY 2021, for FY 2022, ANRPO did not receive funding for OIP Tier 2 and Tier 3 projects, as there was no training conducted that could impact the species at 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 (Year 18) and OIP (Year 15). The period covered in this report is July 1, 2021 to June 30, 2022.

Hawaiian diacritics are not used in this document except in some appendices, to simplify formatting. Please refer to Appendix ES-1, *Spelling of Hawaiian Words*.

ANRPO 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, snails, birds and insects 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 via email with file link (see Appendix ES-2 for a tutorial on how to use this database).

ANRPO is reporting on the eighteenth year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the fifteenth 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, 75 pair of Oahu elepaio, and six extant Koolau *Achatinella* species. Since finalizing the OIP, two additional species requiring stabilization were added: *Drosophila montgomeryi* and *Drosophila substenoptera*. Of the OIP plants, management activities are conducted for eleven taxa present in the Schofield Barracks West Range Action Area and in the Kahuku Training Area. In 2022, ANRPO did not receive funding to support the remaining 12 OIP plant taxa and the six Koolau *Achatinella* species due to the lack of Army training impacts to these taxa in the Kawailoa Training Area. The MIP and OIP also require the Army to minimize the threat of alien species introductions on training areas by conducting surveys of Army landing zones and roads for invasive plants, preventing their spread, eradicating newly found incipient invasive plants, and controlling weeds around rare taxa populations.

The Army contracted the Army Corps of Engineers, Engineering Research and Development Center, Construction Engineering Research Laboratory to complete an updated Programmatic Biological Assessment (PBA) for the Army to enter into formal consultation for all Oahu training ranges (including

Makua Military Reservation). A draft of this document was submitted to the U.S. Fish and Wildlife Service (USFWS) in August 2021. It includes an analysis of the potential impacts from Army training 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 PBA, while in previous consultations it had been kept separate. This approach allows the Army to present a combined analysis of impacts to Oahu's endangered species. Comments were received on the draft PBA and USFWS and the Army are meeting regularly to determine the best way to address these. Management requirements will be determined through the consultation process and outlined in the BO to be issued upon completion of this process.

PANDEMIC EFFECTS ON PROGRAM

ANRPO continued to respond rapidly and effectively to the various COVID-19 orders and guidelines, from both the State of Hawaii and the Department of Defense. Regular work continued in accordance with State, DOD, and CDC guidance, with emphasis on staff safety. Periodic telework continues for some staff to reduce crowding in office spaces.

INFRASTRUCTURE

The only infrastructure improvement at the Army's natural resource baseyard was in the greenhouse. This year circulation fans were installed in order to moderate summer temperatures.

PROGRAM STAFFING AND STRUCTURE

Over the course of this reporting period, ANRPO has maintained staffing levels projected for its cooperative agreement with the Army. While some positions are currently vacant, current staffing levels are sufficient to implement the tasks from the Cooperative Agreement and positions are being back-filled as rapidly as possible. The ANRPO organizational chart is included in Appendix ES-3.

LANDOWNER/AGENCY COOPERATIVE AGREEMENTS AND PARTNERSHIPS

The Army could not meet its MIP and OIP goals without the cooperation of public and private landowners and agencies. ANRPO 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. was renewed during this reporting period (expiring July 2025). The four-year license agreement with the Honolulu Board of Water Supply expired in November 2014 but this agreement contains a "perpetual right of entry to maintain" clause. Although this clause exists, it is still important for this agreement to be renewed. Lastly, the 3-year right of entry agreement for Gill Ewa Lands expired in May 2019 and also needs to be renewed. The Army must utilize the Army Corps of Engineers (ACOE) Real Estate Division to enter into and renew real estate agreements. The ACOE office has experienced high staff turnover over the last 5 years, which has complicated agreement renewal efforts. Currently, ACOE staffing is stable and pending renewals will be reinitiated. The Army also continues to work cooperatively under a Memorandum of Understanding (MOU) with the U.S. Navy.

In July 2011, an MOU was signed between the Army and the State of Hawaii, Department of Land and Natural Resources (DLNR) for the use of DLNR lands to meet MIP and OIP goals. Currently, the Army holds seven State of Hawaii permits for ANRPO work on Oahu, including a Natural Area Reserves Special Use Permit, a Threatened and Endangered Plant Species Permit, an Invertebrate Permit, a Forest Reserve (NARS) Access Permit, a Conservation District Use Permit, a State Parks Permit, and a Protected Wildlife Permit. Last year, a combined permit that covers invertebrates, rare plants and NARS was issued that covers these areas until June of 2023. In addition, special permits were acquired for drone

plant monitoring and rodent control at Kaena Point. The Army and the State finalized a lease for ANRPO's use of the DLNR Nike site mid-elevation greenhouse and associated facilities. This lease negotiation has been in the works for approximately 10 years, thus it is a major milestone. This lease was effective 1 Oct 2021 and allows for four consecutive extension years through 30 Sept 2026.

ANRPO joined the Hawaii Conservation Alliance steering committee this year. ANRPO Program Managers and the UH Extension Professor are active in committee meetings and look forward to assisting with HCA initiatives. ANRPO continues to provide and receive support from partner agencies including the Oahu Invasive Species Committee (OISC), Oahu Plant Extinction Prevention Program (OPEPP), State DLNR Native Ecosystems Protection and Management Program (NEPM), Hawaii Invertebrate Program, 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, and the Hawaii Rare Plant Restoration Group. Highlights of Army natural resource partnership work over this report year included cooperation in wildfire response, aerial surveys for highly invasive species and pathogens, rare snail enclosure construction and maintenance, and numerous habitat improvements for endangered plants and animals. Unfortunately, staff exchange projects with partners are still limited due to COVID-19 concerns.

OUTREACH PROGRAM

The ANRPO 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 exhibits at community events, internships, and the production of publications and other media materials.

During this reporting period, hundreds of military members were trained during the Environmental Compliance Officer's course and the Range Safety Officer/Officer-in-charge briefings. These presentations are 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.

With the decline in COVID positivity rates and the support of a part-time Americorps intern, ANRPO's outreach program resumed offering monthly volunteer trips. Volunteers included individual community members from across Oahu and community organizations, such as schools and non-profit organizations. Volunteers contributed 2,511 hours in the field and 520 hours at the ANRPO baseyard. Outreach staff led 50 volunteer trips and facilitated 16 additional opportunities for volunteers to assist natural resource staff with conservation field projects. In addition, the program hosted 7 interns during this reporting period. Many former interns return to work for ANRPO after college graduation. See Chapter 2 – Environmental Outreach for more details.

SPECIES AT RISK

An analysis of species at risk (SAR) from Army land was produced this year and it is included in this report (Appendix ES-4). It is important for the Army to understand the presence, distribution and extent of SARs and incorporate natural resource management to benefit these taxa into the Integrated Natural Resources Management Plan (INRMP). Understanding the presence of SARs on installations also aids in anticipating how the Army, through implementation of beneficial management actions, can aid in precluding the need for these species to undergo federal listing. A list of SARs is included in the appendix in tables for plants, birds, insects and snails. A total of 127 SAR have been identified so far. This includes, 97 plant, 4 bird and 26 insect SAR. The snail SAR analysis is still a work in progress. In

addition, comprehensive species lists for plants, insects and birds found on Army training lands were compiled and are included as Appendices ES-5, 6 and 7, respectively.

MANAGEMENT UNIT (MU) PROTECTION

MU protection continued during this reporting period through: 1) ungulate control/fencing efforts; 2) aggressive weed control, including control of incipient invasive species and early detection surveys; 3) continued expansion of active habitat restoration effort through the outplanting of common natives; 4) rodent control technique refinement and implementation; and 5) control of invasive slugs around susceptible rare plant sites. Summaries of these program areas are included below.

UNGULATE PROGRAM

During this report period, ANRPO replaced or repaired 2,857 meters of fencing, with most of this work occurring at the Opaeula/Helemano MU in the Kawailoa Training Area. A small fence enclosure was constructed at Dillingham Military Reservation to protect stream habitat for *Megalagrion xanthomelas.* Ungulates breached six MUs during this reporting period and all fences have been or are in the process of being restored to their ungulate free state. Most of the breaches involved small numbers of pigs or goats and were resolved quickly (see Chapter 1 – Ungulate Control Program). Monitoring intervals are suitable for detecting any ungulates that breach fence boundaries and response is efficient. In addition, ungulate removal continues within Lihue, the largest MU, and within the Makua Valley perimeter fence which protects the MUs in the valley not otherwise encircled by an ungulate exclosure. During this reporting period, unexploded ordnance (UXO) was removed, allowing for access again to the lower elevation portions of the Ohikilolo MU. For more details about ANRPO ungulate control, see Chapter 1 – Ungulate Control Program.

VEGETATION MANAGEMENT PROGRAM

In this reporting period, ANRPO spent 12,566 hours controlling weeds across 465 ha. The number of hours substantially increased since last year and even surpassed pre-COVID levels, which was likely due to staff resuming regular camp trips and completing more volunteer trips. Incipient weed eradication and suppression efforts accounted for 389 ha (84% of total area controlled). Staff spent 2,826 (22% of total effort) hours on Incipient Control Area (ICA) management and conducted 597 visits to 242 ICAs. Five ICAs were declared eradicated over the reporting period, for a total of 70 eradications over the last 16 years. However, 10 new ICAs were created. General habitat weed control efforts covered 76 ha (16% of total area controlled). ANRPO conducted control in Weed Control Areas (WCAs) for a total of 9,741 hours (78% of total effort) over 1,001 visits at 182 WCAs. WCA effort increased and area treated decreased this year. Unexploded ordnance (UXO) has been addressed in MMR so the Lower Makua portion of the Ohikilolo MU is open again for vegetation management. Access for vegetation management in Lihue MU is still restricted to small fenced areas and managed sites which have been cleared of UXO.

ANRPO conducted 150 road, landing zone, campsite and weed transect surveys to detect and prevent the spread of any newly introduced invasive species. ANRPO submitted 8 non-native plant samples to Bishop Museum; one of these, *Salvia hispanica* is a new island record. Highlights are covered in Chapter 3 – Vegetation Management.

To date, ANRPO has completed a total of 26 Ecosystem Restoration Management Unit Plans (ERMUPs) for the highest priority and largest MUs. During this reporting period, the ERMUPs for several MUs were

revised (Ekahanui, Kaena, Kaluakauila, Koloa, Ohikilolo (Lower Makua), and Pualii). All are included in this year's report (see Appendices 3-1 to 3-6).

VEGETATION RESTORATION

Complementary to weed control efforts, additive active restoration work expanded during this reporting period. The total number of outplants was 12.8% higher than last year's number, and the area over which outplanting was conducted was over double last year. Again, there was an emphasis on outplanting rather than using seed sows, divisions and transplants. In 14 MUs, across 5.4 ha, 13,131 common native plants were planted to enhance recovery of native habitat, provide additional host plants for rare snails, rare *Drosophila* flies, and rare *Megalagrion* damselflies, and to help stabilize habitat for rare plants. The Makaleha West MU was an area of focus this year along with Kahanahaiki and Kaluaa and Waieli MUs. Common native seed collection efforts focused on 74 taxa for planned restoration projects, for seed production sites, and for seed broadcast trials. See Chapter 3 – Vegetation Management, for more information on habitat restoration efforts.

RODENT CONTROL PROGRAM

ANRPO conducts rodent control in MUs by maintaining trapping grids 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, particularly Oahu elepaio. During this reporting period, ANRPO maintained 35 year-round rodent control areas consisting of 1,575 A24 traps. Additionally, ANRPO is working to transition rodent activity monitoring methods at some sites from tracking tunnels to game cameras in order to reduce labor required. First, pairing of both methods must be implemented in order to adapt the rodent activity goals for the game camera method. Over this reporting period, ANRPO has also been working to address CO_2 leakage challenges on A24 traps. In the interim, A24 traps are being serviced every four months beginning in October 2022 compared to the former maintenance regime which was on a six month interval. This increases required labor to maintain rodent control grids. In addition, after observing increased seed/fruit predation by rodents, ANRPO expanded rat control efforts and methods at Pualii to better protect *Hesperomannia oahuensis*. This year, ANRPO also field-tested AT-220 traps manufactured by NZ Auto Traps for which real time trap catch and status data can be accessed remotely. This trap is designed to control rats and other non-target predators that have been complicating rodent activity monitoring. Working out an effective long term bait that attracts multiple species is a high priority for next year. The ANRPO rodent control program continues to make considerable contributions in this area of conservation tool development for the State of Hawaii. See Chapter 8 – Rodent Control for details on these projects.

ALIEN INVERTEBRATE AND FOREST PEST CONTROL AND RESEARCH PROGRAM

During this reporting period, the Alien Invertebrate and Forest Pest Control Program focused on rosy wolf snail (*Euglandina rosea*), slugs, ants, ROD, and the coconut rhinoceros beetle (CRB) (*Oryctes rhinoceros*). ANRPO conducts slug control at 49 rare plant population reference sites for 11 species susceptible to slug predation. The total area over which slugs are being controlled using molluscicide is 5.2 ha. During this report year, the Honolulu Board of Water Supply approved to ANRPO's request to apply slug bait in Makaha MUs in order to protect rare plant populations. Prior to the application of slug bait in Makaha, *Achatinella* surveys must be completed, thus ANRPO is focusing on completing these surveys.

ANRPO continues to cooperate with other agencies in control and detection efforts for island-wide forest pest threats, including ROD, CRB and LFA on Oahu. ANRPO staff support early detection efforts for ROD by assisting partners with restricted airspace access for twice a year helicopter surveys. No samples were submitted by ANRPO this report year, but staff continue look for potential damage incidentally during other field work.

During this report year, CRB range dramatically expanded across the island; this expansion is also associated with a large increase in trap catches and damage to palms. CRB is now regularly found in traps on Wheeler and Schofield. Last year, CRB was detected at MMR, close to Range Control. Despite a variety of management efforts including the deployment of additional panel traps, the management of green waste on site, and the removal of coconut palms, CRB continue to be detected at Makua. This year, staff monitored panel traps deployed on remote access roads and trails to monitor for CRB in natural areas; unfortunately, beetles were detected at most of these traps. ANRPO participates in a working group developing a CRB response strategy for native areas, in particular for native loulu palms (*Pritchardia*), and as part of this, contributed to research efforts to determine the potential impact of CRB to loulu and other potential host taxa. The likely spread of CRB into *Pritchardia kaalae* populations is ANRPO's greatest concern at this time, and efforts are underway to support propagule storage and seed storage testing. The rapid expansion of CRB on Oahu increases concern that CRB will be transported to outer islands. *Pritchardia kaalae* living collections may need to be established elsewhere in the continental U.S. as an extreme safety net.

LFA have not been detected during ANRPO surveillance of new Army plantings and Army plant-holding facilities. In 2015, the Army established an official Garrison policy aimed at preventing LFA from establishing on Army-controlled lands. 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 MUs or at important points of entry like greenhouses and landing zones. This year, a dense population of yellow crazy ants was detected at the Kahanahaiki snail enclosure site. The impacts of these ants on *Achatinella mustelina* are not clear at this time and methods for control in a forest setting are limited. Thus, ANRPO is in discussions with partners about treatment options.

MONITORING PROGRAM

The ANRPO monitoring program conducted several projects associated with vegetation and habitat monitoring, as well as projects informing rare species and target weed taxa management efforts. During this reporting period, staff:

- Conducted and analyzed vegetation community monitoring for Kamaili, Pahole, and Ohikilolo MUs and analyzed data for Kahanahaiki MU (monitoring conducted last report year). Results for all but Ohikilolo can be found in Appendices 3-11, 3-12, and 3-13. Ohikilolo results will be presented next year;
- Monitored and analyzed native shrub cover change at Ohikilolo Lower MU (results in Appendix 3-15);
- Monitored and analyzed vegetation change at the Giant Ohia restoration site at Makaha MU (results in Appendix 3-14);
- Completed and analyzed data from snail enclosure vegetation monitoring for the new Kahanahaiki and Kaala enclosures and the Palikea North enclosure (results in Appendices 5-2, 5-3, and 5-5); and
- Continued developing drone utilization protocols to capture photos documenting rare plants and change over time.

FIRE MANAGEMENT

This year, three fires occurred on Army training lands in the Waianae Mountains on Oahu. The first fire started on June 2, 2022 above the Schofield Barracks (SB) Impact Area from Army training. The second fire started at Makua Military Reservation on June 13, 2022 and impacted the Ohikilolo and Ohikilolo Lower MUs. The third fire started on August 19, 2022 at Koiahi Ridge, also in Makua Military Reservation. The cause for both of the Makua fires was undetermined but Army activities were not occurring at the time. Detailed fire reports are included as appendices to this report.

The fire at SB burned a total of 22.7 acres, of which 14.8 acres were elepaio critical habitat. This exceeds the Army's 3.7 acre per year allowance for impacting elepaio critical habitat. In addition, the SB fire burned the margins of two elepaio territories which were occupied by two elepaio pairs and two hatching elepaio. In total, this fire caused the 'take' of six endangered elepaio birds. The fire burned, primarily, non-native forest dominated by *Eucalyptus* on the dividing ridge between the north and south Pulee gulches. See Appendix ES-8.

The June fire in Makua burned 96 acres and severly impacted two populations of endangered plants, *Hibiscus brackenridgei* subsp. *mokuleianus* and *Tetramolopium filiforme*. Post-fire survey teams estimate that at least 25% of the *Hibiscus* will not recover and ~25% of plants at the *Tetramolopium* population will not recover. See Appendix ES-9, a detailed fire report for this June 2022 Makua fire.

The August fire in Makua burned 133 acres total, of which ~10% was native forest or shrubland. While no occurrences of endangered plants, animals or critical habitat burned, the fire came within 100 m of four listed plant taxa; *Lobelia niihauensis*, *Korthalsella degeneri*, *Neraudia angulata* and *Melanthera tenuifolia*. See Appendix ES-10, a detailed fire report for this June 2022 Makua fire.

RARE PLANT PROGRAM

The current status of MIP and OIP rare plant taxa are presented in Tables 1 and 2. These tables include: current status (with totals not including seedlings), last year's population numbers (not including seedlings), and the number of plants in the original IPs for comparison for each Manage for Stability (MFS) Population Unit (PU). Genetic storage and threat protection status from ungulates is also summarized for each PU. Ungulate control is expressed by the percentage of mature plants in a PU that have the threat controlled. For more specific details regarding ungulate threat control refer to the Threat Control Summary Report (Appendix 4-2). The number of PUs that have reached numeric stabilization goals is included.

As of the end of this reporting period, 41 of 99 MIP PUs (41%) and 9 of 31 (29%) PUs for OIP Tier 1 plant species are at or above the stabilization goal for the minimum number of reproducing plants. All data tables are included on the CDs distributed to IT members. During this reporting period, ANRPO outplanted 1,503 individuals of 15 species of MIP and OIP taxa. In the last year, ANRPO made 821 observations at *in situ* and outplanting sites. Two new five-year plans were prepared covering *Geniostoma cyrtandrae* and *Gouania vitifolia*. These are included as Appendices 4-4 and 4-5. In addition, the five-year plans for *Cyanea grimesiana* subsp *obatae* and *Pritchardia kaalae* were updated.

Genetic storage goals for each PU may be met in one of the following ways: at least 50 seeds each from 50 founders stored in the seed lab; or at least three clones each in micro-propagation or living collection from 50 individuals. If there are fewer than 50 founders for a PU, genetic storage is required from all available founders. For example for a population with 50 total founders, if there are at least 50 seeds from five founders, or at least three clones in propagation from five founders, 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 unique genetic storage requirements. Therefore, PUs with population sizes of zero and a genetic storage requirement of "n/a (reintroduction)" denote reintroductions with no wild plants and thus no storage requirements. 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. For research highlights, living collection status updates, and rare plant reintroductions, please refer to Chapter 4- Rare Plant Highlights.

Table 1: MIP Plants Executive Summary

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 41 of 99

= 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 2021	# 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	2	53	0%	0%	No	
		Kahanahaiki to Keawapilau	0	0	0	0	1	8	0%	100%	No	
		Makaha	6	6	0	0	7	75	61%	100%	No	
		Makua	4	4	0	0	4	15	33%	100%	No	
		Alectryon macrococcus var. macrococcus Total:	12	12	0	0	14	151				0 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	226	167	59	0	192	20	70%	100%	Yes	
		Kahanahaiki and Pahole	433	285	148	0	363	276	96%	100%	Yes	
		Makaha and Waianae Kai	112	107	5	5	146	12	57%	94%	Yes	
		Cenchrus agrimonioides var. agrimonioides Total:	771	559	212	5	701	308				3 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	47	21	26	0	53	0	60%	100%	No	
		North branch of South Ekahanui	98	60	38	0	109	5	100%	100%	No	
		Pahole to West Makaleha	125	63	62	0	140	46	88%	100%	No	
		Palikea (South Palawai)	685	662	23	2	919	63	71%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	955	806	149	2	1221	114				1 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	91	59	32	0	125	66	82%	100%	No	
		Makaha and Waianae Kai	21	19	2	0	29	4	56%	100%	No	
		Pahole	246	81	165	0	206	114	100%	100%	Yes	
		Cyanea longiflora Total:	358	159	199	0	360	184				1 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	153	18	135	0	251	152	100%	100%	No	
		Kaluaa	85	0	85	0	28	0	N/A	0%	No	
		Makaha	71	58	13	0	114	0	N/A	100%	Yes	
		Palikea	296	19	277	0	326	0	N/A	100%	No	
		Cyanea superba subsp. superba Total:	605	95	510	0	719	152				1 of 4

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 41 of 99

= 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 2021	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	74	29	45	12	52	97	72%	100%	No	
		Kawaiiki (Koolaus)	21	2	19	1	21	50	0%	0%	No	
		Opaeula (Koolaus)	108	34	74	11	84	26	29%	100%	No	
		Pahole to West Makaleha	2437	635	1802	74	1629	300	100%	100%	Yes	
		Cyrtandra dentata Total:	2640	700	1940	98	1786	473				1 of 4
Delissea waianaeensis	100											
		Ekahanui	125	68	57	0	107	58	100%	100%	No	
		Kahanahaiki to Keawapilau	143	109	34	0	74	34	79%	100%	Yes	
		Kaluaa	291	165	126	0	270	44	100%	100%	Yes	
		Manuwai	40	36	4	0	48	0	N/A	100%	No	
		Delissea waianaeensis Total:	599	378	221	0	499	136				2 of 4
Dubautia herbstobatae	50											
		Makaha	215	21	194	0	215	0	72%	86%	No	
		Ohikilolo Makai	48	48	0	0	60	700	22%	100%	No	
		Ohikilolo Mauka	139	125	14	0	123	1300	60%	100%	Yes	
		Dubautia herbstobatae Total:	402	194	208	0	398	2000				1 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	1	1	0	0	9	26	81%	0%	No	
		Kaena	1154	880	274	0	1154	300	100%	0%	Yes	
		Makua	66	66	0	0	67	40	94%	100%	Yes	
		Puaakanoa	133	133	0	0	148	157	62%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1354	1080	274	0	1378	523				3 of 4
Euphorbia herbstii	25											
		Kaluaa	44	17	27	0	49	0	N/A	100%	No	
		Kapuna to Pahole	100	71	29	2	120	170	46%	100%	Yes	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Euphorbia herbstii Total:	144	88	56	2	169	170				1 of 3
Flueggea neowawraea	50											
		Kahanahaiki to Kapuna	59	9	50	0	65	32	29%	100%	No	
		Makaha	28	12	16	0	29	4	45%	75%	No	
		Manuwai	1	0	1	0	1	0	N/A	100%	No	
		Ohikilolo	1	1	0	0	1	3	50%	100%	No	
		Flueggea neowawraea Total:	89	22	67	0	96	39				0 of 4

Table 1 (continued)**.**

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 41 of 99

= 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 2021	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Gouania vitifolia	50											
		Keaau	55	5	50	0	57	0	94%	100%	No	
		Gouania vitifolia Total:	55	5	50	0	57	0				0 of 1
Hesperomannia oahuensis	75											
		Haleauau	20	0	20	0	9	0	0%	100%	No	
		Makaha	40	14	26	0	52	13	0%	100%	No	
		Pahole NAR	1	1	0	0	2	8	N/A	100%	No	
		Pualii	32	23	9	0	42	0	N/A	100%	No	
		Hesperomannia oahuensis Total:	93	38	55	0	105	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	99	57	42	16	85	4	83%	0%	Yes	
		Keaau	132	59	73	9	79	0	100%	100%	Yes	
		Makua	59	30	29	0	169	7	80%	100%	No	
		Manuwai	138	38	100	0	76	0	N/A	100%	No	
		Hibiscus brackenridgei subsp. mokuleianus Total:	428	184	244	25	409	11				2 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	98	41	57	4	148	60	86%	95%	No	
		Central Makaleha and West Branch of East Makaleha	9	6	3	0	16	47	82%	0%	No	
		Kahanahaiki to Pahole	74	46	28	0	69	161	100%	100%	No	
		Makaha to Ohikilolo	209	93	116	0	275	0	N/A	100%	Yes	
		Kadua degeneri subsp. degeneri Total:	390	186	204	4	508	268				1 of 4
Kadua parvula	50											
		Ekahanui	145	123	22	3	181	0	N/A	100%	Yes	
		Halona	173	38	135	0	173	64	100%	45%	No	
		Ohikilolo	97	79	18	0	100	66	100%	100%	Yes	
		Kadua parvula Total:	415	240	175	3	454	130				2 of 3
Melanthera tenuifolia	50											
		Kamaileunu and Waianae Kai	1061	815	246	274	1061	880	4%	0%	Yes	
		Mt. Kaala NAR	155	131	24	0	155	250	0%	100%	Yes	
		Ohikilolo	581	570	11	0	581	2009	8%	100%	Yes	
		Melanthera tenuifolia Total:	1797	1516	281	274	1797	3139				3 of 3

Table 1: (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 41 of 99

= 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 2021	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Neraudia angulata	100											
		Kaluakauila	38	19	19	0	37	0	N/A	100%	No	
		Makua	124	44	80	0	49	29	40%	100%	No	
		Manuwai	86	18	68	0	92	12	43%	100%	No	
		Waianae Kai Mauka	13	11	2	0	13	46	41%	100%	No	
		Neraudia angulata Total:	261	92	169	0	191	87				0 of 4
Nototrichium humile	25											
		Kaluakauila	107	43	64	0	110	200	39%	100%	Yes	
		Makua (south side)	53	50	3	0	53	138	0%	100%	Yes	
		Manuwai	102	101	1	0	104	0	N/A	100%	Yes	
		Waianae Kai	188	53	135	0	188	200	24%	92%	Yes	
		Nototrichium humile Total:	450	247	203	0	455	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	0%	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	8	1	7	0	8	33	84%	100%	No	
		Konahuanui	41	36	5	3	42	0	0%	100%	No	
		North Mohiakea	138	63	75	0	71	30	62%	100%	Yes	
		Ohikilolo	0	0	0	0	1	14	82%	0%	No	
		Plantago princeps var. princeps Total:	187	100	87	3	122	77				1 of 4
Pritchardia kaalae	25											
		Makaleha to Manuwai	125	122	3	0	134	141	0%	2%	Yes	
		Ohikilolo	1102	161	941	477	1442	473	2%	100%	Yes	
		Ohikilolo East and West Makaleha	281	27	254	0	276	75	N/A	100%	Yes	
		Pritchardia kaalae Total:	1508	310	1198	477	1852	689				3 of 3
Sanicula mariversa	100											
		Kamaileunu	213	31	182	1	213	26	100%	100%	No	
		Keaau	16	14	2	0	3	141	68%	100%	No	
		Ohikilolo	127	12	115	0	142	162	34%	100%	No	
		Sanicula mariversa Total:	356	57	299	1	358	329				0 of 3

Table 1: (continued)

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 41 of 99

= 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 2021	# 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	134	123	11	20	132	55	100%	100%	Yes	
		Kaluanui	110	46	64	0	136	0	N/A	100%	No	
		Pahole	111	67	44	0	146	3	100%	100%	Yes	
		South Ekahanui	183	151	32	60	223	85	95%	100%	Yes	
		Schiedea kaalae Total:	538	387	151	80	637	143				3 of 4
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	200	186	14	0	171	65	82%	100%	Yes	
		Kapuna-Keawapilau Ridge	79	67	12	15	175	4	100%	100%	Yes	
		Makaha	174	174	0	0	102	0	N/A	100%	Yes	
		Schiedea nuttallii Total:	453	427	26	15	448	69				3 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	529	306	223	8	878	90	100%	100%	Yes	
		Keawapilau to West Makaleha	88	38	50	20	98	36	100%	100%	No	
		Makaha	325	203	122	2	263	0	N/A	100%	Yes	
		Schiedea obovata Total:	942	547	395	30	1239	126				2 of 3
Tetramolopium filiforme	50											
		Kalena	62	35	27	0	42	0	18%	100%	No	
		Ohikilolo	3290	2322	968	20	3327	2500	12%	100%	Yes	
		Puhawai	0	0	0	0	0	12	80%	0%	No	
		Waianae Kai	21	21	0	0	21	22	0%	0%	No	
		Tetramolopium filiforme Total:	3373	2378	995	20	3390	2534				1 of 4
Viola chamissoniana subsp. chamissoniana	50											
		Halona	55	49	6	0	17	3	18%	78%	No	
		Makaha	124	25	99	3	71	50	44%	100%	No	
		Ohikilolo	232	182	50	0	232	0	6%	100%	Yes	
		Puu Kumakalii	77	73	4	0	44	20	18%	0%	Yes	
		Viola chamissoniana subsp. chamissoniana Total:	488	329	159	3	364	73				2 of 4

Table 2: OIP Plants Executive Summary

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 9 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 2021	# 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	104	77	27	3	133	44	86%	100%	Yes	
		Kaawa to Puulu	199	39	160	0	196	124	9%	67%	No	
		Kahanahaiki	103	73	30	1	112	0	100%	100%	Yes	
		Makaha Makai	147	81	66	0	147	100	72%	72%	Yes	
		Abutilon sandwicense Total:	553	270	283	4	588	268				3 of 4
Cyanea acuminata	50											
		Helemano-Punaluu Summit Ridge to North Kaukonahua	325	23	302	0	325	72	100%	0%	No	
		Kaluanui and Maakua	249	126	123	52	249	0	0%	100%	Yes	
		Makaleha to Mohiakea	303	210	93	0	284	118	22%	100%	Yes	
		Cyanea acuminata Total:	877	359	518	52	858	190				2 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	64	40	24	0	125	76	3%	58%	No	
		Opaeula to Helemano	29	22	7	0	29	13	0%	45%	No	
		Poamoho	39	20	19	0	39	12	5%	0%	No	
		Cyanea koolauensis Total:	132	82	50	0	193	101				0 of 3
Eugenia koolauensis	50											
		Kaunala	27	6	21	0	54	141	62%	83%	No	
		Oio	4	3	1	1	8	74	77%	67%	No	
		Pahipahialua	3	2	1	21	24	291	56%	100%	No	
		Eugenia koolauensis Total:	34	11	23	22	86	506				0 of 3
Gardenia mannii	50											
		Haleauau	121	37	84	0	125	2	50%	100%	No	
		Helemano and Poamoho	23	23	0	0	23	18	48%	4%	No	
		Lower Peahinaia	29	9	20	0	56	46	58%	56%	No	
		Gardenia mannii Total:	173	69	104	0	204	66				0 of 3
Geniostoma cyrtandrae	50											
		East Makaleha to North Mohiakea	217	207	10	0	228	100	16%	86%	Yes	
		Koloa	3	2	1	0	7	0	N/A	100%	No	
		Geniostoma cyrtandrae Total:	220	209	11	0	235	100				1 of 2

Table 2 (continued).

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 9 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 2021	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
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
Phyllostegia hirsuta	100											
		Haleauau to Mohiakea	16	12	4	0	19	18	48%	100%	No	
		Koloa	18	15	3	1	21	0	70%	87%	No	
		Puu Palikea	46	7	39	0	8	0	N/A	100%	No	
		Phyllostegia hirsuta Total:	80	34	46	1	48	18				0 of 3
Phyllostegia mollis	100											
		Ekahanui	6	2	4	0	1	35	100%	100%	No	
		Kaluaa	25	20	5	0	24	49	100%	100%	No	
		Pualii	0	0	0	0	0	0	100%	100%	No	
		Phyllostegia mollis Total:	31	22	9	0	25	84				0 of 3
Schiedea trinervis	50											
		Kalena to East Makaleha	766	415	351	487	767	376	100%	92%	Yes	
		Schiedea trinervis Total:	766	415	351	487	767	376				1 of 1
Stenogyne kanehoana	100											
		Haleauau	18	0	18	0	18	1	100%	0%	No	
		Kaluaa	14	5	9	0	16	79	100%	100%	No	
		Makaha	0	0	0	0	0	0	N/A	100%	No	
		Stenogyne kanehoana Total:	32	5	27	0	34	80				0 of 3

Achatinella mustelina Management

During this reporting period, ANRPO 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 predator-resistant enclosures; and 5) translocating snails into snail enclosures. ANRPO collaborates and coordinates regularly with the State of Hawaii's Snail Extinction Prevention Program. Table 3 summarizes management status of *A. mustelina*, which is the only rare snail taxon in the MIP and OIP Tier 1. This report does not include other OIP rare snail taxa, because they are Tier 2 or 3 taxa. Populations of *A. mustelina* were genetically assigned to one of six ESUs. The IP goal is to achieve 300 total snails across all age classes in each of eight managed populations within the six ESUs. Four of the eight managed field populations have over 300 snails; this is one more than last year. It is important to note that as more enclosures come online and wild snails are translocated into the enclosures, the number of snails reported only represents a fraction of the snails present. The detection rate varies depending on the vegetation height and density. Snail counts within the

enclosures capture only those snails visible to the observer; this is estimated to vary between 10-25%, thus numbers presented are a conservative underestimate. Dips in snail counts are more concerning if paired with evidence of predation in ground shell plots. Also, as snails from ESU D1 and D2 have been translocated into the Puu Hapapa snail enclosure, the ESU is now reported simply as D, where previously they were reported separately. This combination reduces the number of managed populations from 8 to 7 to reach the >300 goal.

Table 3: Summary of IP Rare Snail Management. Numbers reflect highest counts of observed snails for the report year.

Achatinella mustelina ESU	Population	Highest Number of Snails observed in ESU	Avg # Snails Counted in Enclosures based on quarterly counts	Enclosure Location
A	Kahanahaiki	356	104 (Kahanahaiki) 96 (Pahole)	Kahanahaiki (new)/Pahole
B1	Ohikilolo	324	110	Makaleha West
B2	East Makaleha	535		Makaleha West
C	Lower Kaala NAR & Schofield Barracks West Range	268	25	Kaala
D	Central Kaluaa to Schofield Barracks South Range to Makaha	562	507	Hapapa
E	Ekahanui	127	102	Palikea North
F	Puu Palikea	228	89	Palikea South

Note: Extrapolated estimates are based on conservative 25% detection rate. Detection rates differ between enclosures and can be as low as 10%.

During this reporting period, ANRPO continued to maintain the Kaala, Kahanahaiki, Makaleha West, Palikea North, Palikea South, and Puu Hapapa snail enclosures. The snail population in the Puu Hapapa enclosure continues to increase, instilling confidence in the strategy of predator resistant enclosure management for tree snail conservation. At Makaleha West and Palikea North translocated snails were placed into smaller temporary enclosures within the predator proof fences to allow for close monitoring and to concentrate snails in the most suitable current habitat within these larger fences. At the temporary enclosure for Palikea North, the vegetation recovered to the extent that snails are now being found moving out of the temporary enclosure on their own. Translocations into the two new enclosures at Kahanahaiki (ESU-A) and Kaala (ESU-C) were conducted during this reporting period. At Kahanahaiki the old snail enclosure was searched five times at night and all *Psidium cattleianum* trees were cut down to carefully search the canopy for *A. mustelina.* A total of 238 snails were found and translocated into the new Kahanahaiki enclosure. At Kaala, a small trial translocation was conducted into the snail enclosure, because of concerns about the large elevation increase between the source population and the enclosure location. This trial translocation was successful and over the next reporting period ANRPO will move more snails into the enclosure. ANRPO and partners monitor population trends for *A. mustelina* within the Kaala, Kahanahaiki (new), Makaleha West, Puu Hapapa, Palikea South, and Palikea North enclosures using timed-count monitoring. Also, the State (including SEPP) is actively restoring and managing threats at the Pahole snail enclosure.

ANRPO have been able to get ahead of the rat challenges experienced during the 2021 reporting period. Success in this area is a result of proactive rat control using multiple methods. This year, yellow crazy ants (YCA) have emerged as a new potential threat to tree snails. A YCA outbreak occurred within the new Kahanahaiki snail enclosure. ANRPO is determining the predation threat to tree snails and assessing

available control methods. For more information on rare snail management, see Chapter 5 – *Achatinella mustelina* Management.

RARE VERTEBRATE MANAGEMENT

Currently, ANRPO manages two species of rare vertebrates: the Oahu elepaio (*Chasiempis ibidis*) and the opeapea, or Hawaiian hoary bat (*Lasiurus cinereus semotus*). Management consists of active predator control for the Oahu elepaio and surveying for opeapea at Army installations across Oahu. Staff conduct spot surveys for bats roosting in trees that need to be pruned or removed at Army installations during the bat pupping season each year.

In the 2021 breeding season, ANRPO controlled rats to protect 120 pairs of Oahu elepaio at five management sites, exceeding the required 75 pairs for species management in the Oahu BO. The increase in protected pairs since last year is in part due to the inclusion of pairs protected within the large-scale rat grid in Makaha. At managed sites, predator control is conducted using A24 automatic traps. This year, access was restored to Makua Valley following the removal of UXO. For the first time since 2017, Oahu elepaio surveys resumed. Seven elepaio were observed, including three breeding pairs, which were protected by an A24 trapping grid. Predator control was installed to protect these pairs.

This year, survey efforts again focused on abundance surveys in and around managed areas in the Waianae Mountains. Results so far, compared to 2010 surveys, show a 263% increase in Oahu elepaio abundance in the Waianae Mountains. For more information, see the Chapter 6 - Rare Vertebrate Management and Chapter 8 – Rodent Management.

This year one wildfire burned forested habitat above the Schofield Barracks firebreak road. The fire affected elepaio critical habitat and two occupied elepaio territories. The Army exceeded its take allowance for elepaio and impacted more critical habitat that allowed by the Army's Biological Opinion. Details about this fire can be found in Appendix ES-8.

Endangered waterbird surveys are conducted annually and after flooding events. During this reporting period, the ephemeral wetland and Dillingham Army Airfield was flooded for three months, between Feb and May. During this time, Hawaiian stilt, moorhen and coot were all observed in addition to some other migratory waterfowl. Three gallinule chicks were observed during this flooded period. In addition three Hawaiian stilts were observed twice on Schofield Barracks in September, foraging in grassy fields."

In previous years, the Hawaiian hoary bat was detected flying over all Army installations on Oahu by monitoring via listening stations. In early September 2015, an official U.S. Army Garrison, Hawaii 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 tree removal 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 ANRPO must survey for roosting bats within trees slated for removal/pruning. During this performance period, ANRPO and a contractor conducted 9 bat surveys over a total of 9 hours (not including travel time). A total of 102 trees were screened for bats during the summer of 2022. This represents a dramatic decrease since last year due to budget cuts and delays in funding availability, resulting in reduced funding for tree trimming and associated bat surveys. For more information, see the Chapter 6 - Rare Vertebrate Management.

RARE INSECT MANAGEMENT

During this reporting period, ANRPO: 1) conducted regular monitoring of known *Drosophila* populations designated as 'manage for stability'; 2) outplanted *Drosophila* host trees; 3) collaborated with partners at

the State's Invertebrate Conservation Program (ICP) on *Drosophila*; 4) worked with the ICP on *Megalagrion xanthomelas* translocations and threat management at Tripler Army Medical Center (TAMC) and DMR; 5) conducted surveys for *Megalagrion* on SBE; and 6) facilitated surveys by SERDP grant researchers Dr Rosemary Gillespie and Dr. Thomas Roderick. Surveys for *Hylaeus* were not conducted this report year. All activities are summarized in Chapter 7 – Rare Insect Management.

Monitoring allows ANRPO to track fluctuations in *Drosophila* numbers and attempt to determine abundance patterns. This year monitoring frequency transitioned from monthly to quarterly. Winter and spring 2022 saw a general increase in most common and rare species with the expected population spikes in spring. *Drosophila montgomeryi* numbers dropped off since spring of 2021; none were seen in North Kaluaa or Palikea, though the Central Kaluaa site had a large number of observed adults in spring of 2022. At Palikea, both endangered species (*D. substenoptera* and *D. hemipeza*) saw an increase in observed individuals over the previous year's observations, including the highest ever recorded number of *Drosophila hemipeza* at Palikea. Host tree outplanting this year occurred for *Drosophila montgomeryi* at the Ekahanui, Kaluaa and Puu Hapapa sites (204 *Urera glabra*). Additional *Drosophila* habitat management efforts to provide more shade and improve general habitat quality were accomplished this year through outplantings of other common native plant taxa at 'manage for stability' *Drosophila* sites. Surveys near suitable hosts continue at training ranges to obtain a thorough picture of endangered *Drosophila* distribution at Army training ranges for use in the upcoming Programmatic Endangered Species Act, Section 7 Consultation.

Under the Army's Integrated Natural Resources Management Plan (INRMP), ANRPO continued to monitor and control threats to the *Megalagrion xanthomelas* population at TAMC. ANRPO staff continue to assist the State's ICPm with releases of lab-reared *M. xanthomelas* at a small spring-fed stream at Dillingham Military Reservation (DMR) between April and September 2022. There was a break in releases between June 2021 and April 2022 in order to determine if the population would sustain naturally. In December 2021, the DMR stream flooded which caused sedimentation of the release site. Artificial ponds were created in order to restore suitable damselfly breeding habitat and to prepare the site for more lab releases. In April 2022, damselfly releases resumed. As of the end of this reporting period, 1,914 adult damselflies had been released at DMR. In addition, the TAMC population was augmented with 5,255 damselflies total between June 2021-June 2022. Wild-born damselflies were observed at DMR, though the success of the augmentation effort is still not certain. Again this year, similar to last year, wild individuals were observed along the drainage ditch around the Tripler cooling plant but very few were seen at the stream location.

Lastly, ANRPO conducted surveys for endangered Hawaiian damselflies at Schofield Barracks East Range in order to complete needed information for the Draft Oahu Training Areas Biological Assessment.

RESEARCH PROJECTS

During this reporting period, ANRPO funded, supported and/or co-authored the following significant scientific publications.

- Murphy, L.B. et al. 2022. The disconnect between short- and long-term population projections for plant reintroductions. Frontiers in Conservation Science, doi: 10.3389/fcosc.2021.81.4863. The Army Natural Resources Manager is co-author on this study. The publication is included as Appendix ES-11.

- Barton, K.E. et al. 2021. Hawaii Forest Review, synthesizing the ecology, evolution and conservation of a model system. Perspectives in Plant Ecology, Evolution and Systematics, 52 (2021) 125631. This paper is included as Appendix ES-12.

- Rosemary Gillespie and George Roderick from UC Berkeley were awarded a grant from the SERDP program to study invasion pathways and early detection using cutting edge eDNA technology. Researchers involved are experts in native Hawaiian spiders and have already collected some new species of spiders from Army study sites. This project will be ongoing for the next five years.

- Nerfa, L. et al. 2022. Removal of non-native trees fosters but alone is insufficient for forest regeneration in Hawaii. Forest Ecology and Management, 571 (2022) 120267. This paper is also included as Appendix ES-13.

- Three papers were published by the Vertebrate Introductions and Novel Ecosystems (VINE) research group which investigates various aspects of the ecology of non-native bird species interacting with Hawaiian forest systems. These publications are not included as appendices but literature citations are below.

    - Millikin, P.W., S.B. Case and C.E. Tarwater. 2021. Pollination and nectar larceny by birds and bees in novel forest of the Hawaiian Islands. Journal of Pollination Ecology, 29(15), pp 189-203.

    - Wilcox, R.G. and C. E. Tarwater. 2022. Space use patterns and the extent of complementarity across scales in introduced seed dispersers. Biological Invasions, https://doi.org/10.1007/s10530-0220-02786-7.

    - Case, S.B. et al. 2022. Introduced galliforms as seed predators and dispersers in Hawaiian Forests. Biological Invasions https://doi.org/10.1007/s10530-022-02830-6.

- ANRPO-annually funds graduate assistantships (GAs).
    - Two GAs were completed: 1) Thomas Chapin/Nicole Hynson studied the cultivation mycorrhizal associates of two Hawaiian orchids. 2) Samantha Shizuru/Creighton Litton studied the phenology of *Chromolaena odoratum*.
    - Three new GAs were awarded. 1) *Dubautia herbstobatae* breeding biology 2) Oahu elepaio nest predation 3) Mapping invasive weeds using high-resolution aerial images. Funding for the last two projects was continued for a second year.

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CHAPTER 1: UNGULATE MANAGEMENT

Threat control efforts for ungulates are summarized for each Management Unit (MU) or non-MU land division within this chapter. Notable projects such as large fence replacement projects and fence construction from the 2021-2022 reporting year are discussed in the *Project Highlights* section of this chapter. Ungulate control data is presented with minimal discussion in the *Summary of Ungulate Removal Efforts* section. Future fence repair and ungulate removal projects for this upcoming year are discussed in the *Future Projects* section below.

1.1 PROJECT HIGHLIGHTS

1.1.1 Summary of Repair & Construction Efforts

Table 1: Ungulate Fence Check and Construction Inventory Summary: summary of fence repair projects during the 2021-2022 reporting period.

Fence Code	Fence Name	IP Management Unit	Fence Length (m)	Distance Repaired (m)	Reason for repair/construction
ANU-A	Manuwai Perimeter	Manuwai	4560.00	4.00	Tree fall. Tree was removed off the fence. No other damage to fence.
ANU-B	Manuwai Interior	Manuwai	1060.00	10.00	Section of fence constantly being damaged by heavy stream flow and boulders. Replaced damaged section with hypalon barrier.
DMR-A	DMR MegXan	DMR No MU	130.00	123.00	Fence constructed to protect a population of *Megalagrion xanthomelas.*
KAH-A	Kahanahaiki MU Subunit I Perimeter	Kahanahaiki	3050.00	6.00	Tree fall. Tree was removed off the fence. No other damage to fence.
KAL-A	Kaluaa/Waieli Section A (Perimeter)	Kaluaa and Waieli	4780.00	93.00	Small piglets were able to breach the fence through the smaller squares at the bottom of the fence. Reinforced problematic sections with fickle wire.
KAL-D	Kaluaa/Waieli Section between II and III	Kaluaa and Waieli	610.00	1.00	Interior fence within Kaluaa / Waieli MU. Repaired small holes along the bottom of the fence line.
KEA-B	Keaau Hibiscus	Keaau Hibiscus	895.00	47.50	Added additional panels to existing fence to raise the overall height of the fence to deter goats from hopping over.
KLO-A	Opaeula Lower I	Opaeula Lower	1560.00	2.50	Tree fall. Tree was removed off the fence. No other damage to fence.
KLO-G	Opaeula/Helemano	Helemano	5960.00	1654.00	Replaced and repaired rust damaged sections of fence and a strategic ladder along the fence line that was damaged during heavy rainstorm January 2021.
KTA-C	Kaunala	Kaunala	600.00	1.00	Repaired small damage to the skirting along the bottom of the fence.
KTA-D	Kaleleiki	Kaleleiki	355.00	2.00	Repaired small damage to the skirting along the bottom of the fence.
LEH-C	Three Points	Makaleha West	644.00	18.00	Fence line had been compromised due to pig pressure and erosion. Lowered the fence closer to ground to prevent pigs from burrowing underneath.
LIH-A	Kamaohanui	Lihue	1360.00	0.80	Repaired small holes along the bottom of the fence. No other damage to the fence.
LIH-B	Cyprus-Firebreak	Lihue	1610.00	5.00	Repaired small holes along the bottom of the fence. No other damage to the fence.
LIH-C	Firebreak Road	Lihue	3980.00	3.00	Tree fall. Tree was removed off the fence. No other damage to fence.
LIH-D	Kalena-Kaala ridge	Lihue	4960.00	1.00	Repaired small holes along the bottom of the fence. No other damage to the fence.
MAK-C	Makaha Subunit I	Makaha I	2520.00	650.50	Small piglets were able to breach the fence through the smaller squares at the bottom of the fence. Installed fickle wire along to bottom to block entry.
MAK-D	Makaha Subunit II (Mauka and Makai)	Makaha II	2750.00	2.00	Repaired small holes along the bottom of the fence. No other damage to the fence.
MAK-E	Kamaili (Mauka and Makai)	Kamaili	1160.00	11.00	Repaired sections damaged from rock fall. No other damage to the fence.

Table 1 (continued).

Fence Code	Fence Name	IP Management Unit	Fence Length (m)	Distance Repaired (m)	Reason for repair/construction
MMR-A	Kaluakauila	Kaluakauila	3150.00	23.00	Repaired sections damaged from rock fall. Fence sections to the south are damaged by rust. ANRPO staff plan to replace those sections in the future.
MMR-B	Ohikilolo Section A and B	Ohikilolo	7190.00	151.00	Repaired sections damaged from erosion.
MMR-K	MMR Perimeter (West Makaleha)	MMR No MU	983.00	3.00	Repaired small holes along the bottom of the fence from pig pressure. ANRPO staff will continue to repair the fence as needed.
MMR-L	MMR Perimeter (Kahanahaiki-Kaluakauila)	MMR No MU	3223.00	6.00	Tree fall. Tree was removed off the fence. No other damage to fence.
MMR-M	MMR Perimeter (Kaluakauila to Farrington Highway)	MMR No MU	860.00	0.45	Wires holding push gates closed constantly need to be replaced after hunters cut them to gain access into Makua.
PAH-A	Pahole Section A	Pahole	3370.00	0.10	Repaired small holes along the bottom of the fence. No other damage to the fence.
PAK-A	Palikea Subunit I	Palikea	1620.00	12.50	Certain sections of skirting along the bottom line became loose. ANRPO staff anchored it flush to the ground.
PAK-B	CyaGriOba PU fence	Palikea	350.00	10.00	Replaced rust damaged section along the fence.
PUA-A	North Pualii	Pualii North	1730.00	4.00	Tree fall. Tree was removed off the fence. No other damage to fence.
WAI-C	Waianae Kai Slot Gulch	Waianae Kai	130.00	2.00	Repaired sections damaged from rock fall.
				TOTAL 2857.35	

As represented in Table 1, in total, approximately 2,857 meters of fencing was replaced or repaired during the reporting year, primarily due to environmental damage. The documented damages and repairs were consistent with past years, and were similarly related to weather events. Staff will continue to monitor and replace damaged fence as needed over time. One notable exception was the addition of the new Dillingham Military Reservation (DMR) fence constructed in-house by ANRPO staff with assistance from Division of Forestry and Wildlife Staff (DOFAW)

1.1.2 Summary of Fencing Efforts

- **DMR Fence Project:** The Army Natural Resources Program on Oahu (ANRPO) constructed an ungulate exclusion fence in the Dillingham Military Reservation. The exclusion fence is approximately 130 meters and encompasses the flattest part of a spring-fed streamlet that is habitat for a population of *Megalagrion xanthomelas*. The DMR ungulate exclusion fence is constructed of cattle panels with a layer of fickle fence along the bottom to exclude ungulates from disturbing the breeding habitat within the unit. Fence construction was completed on November 30, 2021.

Figure 1: Map of the completed fence unit at the DMR.

- **Opaeula/Helemano:** ANRPO secured funding to replace portions of the existing MU fence in Opaeula/Helemano (Figure 2). This MU fence is exposed to the harsh wind and rain conditions on the summit of the Northern Koolaus. Exposed to the constant barrage of wind, sections of fence in this region typically only last 6-8 years. Staff delineated the sections to be replaced and the contract was put out for bid in winter of 2021. The contract was awarded to Pono Pacific LLC in January 2022 and replacement of rust damaged sections began immediately. Work was completed on March 10, 2022. In total, 1,654 meters of hog wire fence were replaced with cattle panel type fencing. In addition to the contract work completed this report year, on May 25, 2022, ANRPO staff also repaired a strategic ladder that was damaged during the heavy rains of March 2021. This strategic ladder is an essential component of the fence line as it will aid staff in safely conducting quarterly fence checks. ANRPO staff will continue to monitor the condition of the fence and address the smaller patches of damaged fence as needed.

Figure 2: Map of Opaeula/Helemano replacement project.

- **Kaluaa/Waieli:** In recent years heavy pig pressure along the outside of the Kaluaa and Waieli MU has been observed by ANRPO staff. Three times in the past 8 years pigs have been observed inside of the unit. It was suspected that the fence was being breached from the north where there is constant pressure from pigs, so in January 2020 staff began installing fickle wire along the bottom of the fence to prevent small pigs from entering. Fence work slowed down during COVID pandemic, but staff finally completed reinforcing the north side of the unit on March 13, 2022. A few months prior, in November 2021, Hawaii Department of Land and Natural Resources (DLNR) staff observed piglets crossing in and out of the fence through the small squares along the bottom, on the south side of the unit. Fence material was flown up to the area where pigs were observed and ANRPO staff will be installing fickle wire along the southern section of the fence this upcoming year.

- **Makaha Subunit I:** In response to piglets breaching the fence in early 2020, ANRPO staff began installing fickle in areas along the bottom portion of the fence to prevent small pigs from entering the unit. Fence and ungulate control work slowed down during the COVID pandemic and on March 10, 2022 staff completed reinforcing the fence. Approximately 1400 meters of the 85-acre unit was fortified with fickle, most of which are sections with heavy pig sign. Fickle work began at the top of the ridge on eastern side of the unit, continued down around the bottom, and up the

western side of the unit to where the fence connects with partner organization Waianae Mountain Watershed Partnership's (WMWP) perimeter fence. In addition to incidental observations from field teams working inside of the unit staff will continue to monitor the fence line for any pig incursion. There have been no pig incursions this year.

Figure 3: Fickle wire (black mesh) attached to the bottom of cattle panel fence.

- **Manuwai MU:** In previous years, a section of an interior fence crossing the gulch bottom between Manuwai sub-unit I and II was damaged by heavy stream flow which pushed boulders down the gulch. On May 13, 2022, ANRPO staff constructed a hypalon barrier to allow boulders and heavy water flow to pass through during rain events. The hypalon will be monitored after heavy rain events to ensure it settles back in an orientation that prevents pigs from entering.

Figure 4: Hypalon barrier in Manuwai

1.1.3 Summary of Ungulate Removal Efforts

- **Kapuna MU**: In May 2022, a pig was observed in Kapuna Upper Subunit IV. Fence checks did not identify any obvious holes or breaches, so it remains uncertain how the pigs got in. In response, snaring and trapping operations were initiated. One pig was captured in a trap on June 06, 2022, near the same area the pig had been spotted the month prior. No additional ungulate sign was detected during a follow up check. Kapuna MU is currently ungulate free.

- **Keaau MU**: In July 2021 goat sign was observed on the inside of the unit. In response, snaring operations were initiated and a fence check revealed a few low spots along the fence line. It is possible that goats were able to jump over at these low spots. Two goats were caught in traps in August 2021 and ANRPO staff addressed the low spots in September 2021 by attaching additional fence panels to the top of the existing fence. No other goat sign has been detected.

- **Makaleha West (3-points):** During the previous reporting period (July 2020-June 2021), heavy pig sign was observed near the trailhead and around the first fence crossing leading into the unit. To mitigate impacts to the fence, staff installed a live trap near the trailhead. It was successful at reducing pig pressure near the trailhead in catching one mature boar, one sow, and three babies but pressure along the fence persisted. Therefore, this reporting year, ANRPO staff relocated the live trap to an area just outside of the fence, where ungulate pressure was observed via trail cameras and incidental observations from field crews. Two mature boars and one sow were captured. Trail cameras verify that there are still piglets in the area who may have become trap shy. To reduce the potential of piglets breaching the fence staff blocked the possible entry ways into the unit which had become exposed by pigs digging at the bottom of the fence. ANRPO staff will continue to monitor the area in the coming year. Makaleha West remains ungulate free.

- **Makua Military Reservation (MMR)**: ANRPO had initiated an endeavor to reduce pig numbers in MMR in 2014. Traps are used in this area since hunting with dogs is not permitted (due to UXO presence). Initial snaring efforts started with the upper reaches of the valley above the cliffs and have slowly expanded to include the area within the former impact area, below the cliffs. Due to UXO policy changes, staff were prohibited from entering until the UXO were removed (detonated) by Army EOD. UXO were removed in January 2022 and ungulate control began again. Both cameras and traps were installed in MMR in March 2022. Unfortunately, during these efforts, two additional UXO were discovered; now staff are limited to control work to areas outside of the detonation zone for these UXO (300m). Requests have been made for the detonation of these two remaining UXO in January 2023. No pigs were caught during this report year. Plans for ungulate removal in Makua Valley will be covered more in the Future Projects section of this chapter.

- **Ohikilolo MU**: Goats are occasionally able to breach the fence on Ohikilolo ridge at MMR; however, ANRPO staff have not been able to detect where the breaches have occurred. Several sections of the fence have had extra panels attached along the top to raise the fence height and deter goats from jumping over. Additionally, the substrate which the fence is built upon is loose dirt and rock, highly susceptible to erosion, thus compromising the integrity of the fence in some areas. Erosion has been a continual issue along this fence line and ANRPO will continue to repair compromised sections as needed as well as looking into alternative solutions to halt erosion. To prevent goats from reaching the priority areas, where most managed rare taxa are located, ANRPO staff have conducted snaring along the fence line from Red Dirt Puu to the Ohikilolo cabin. Four goats were removed from the Ohikilolo MU fence area over the past reporting period. ANRPO plans to check the traps quarterly and determine where the goats are breaching the ridge fence on Ohikilolo.

Figure 5: Ohikilolo Ridge looking east. Makua Valley is located to the left of the fence. Erosion spots are to the right of the fence on the south facing slope.

Figure 6: Erosion along Ohikilolo fence line. Facing east. Makua Valley is to the left of the fence and Makaha Valley is to the right.

- **Palikea MU:** In January 2022 the gate leading into the unit was accidently left open. At the same time pig sign was also observed inside of the unit. Snaring operations began soon after, and one pig was caught in a trap January 31, 2022. Fence checks did not identify any obvious holes or breaches; therefore, it is believed that this pig got in when the gate was left open. Several different organizations and hikers pass through the gate, but ANRPO will communicate with partner organizations to keep the gate shut when entering and exiting the unit. No other pig sign has been detected.

- **Pahipahialua:** On March 29 2022, while conducting a quarterly fence check at the Pahipahialua management unit ANRPO staff observed heavy pig damage on the inside of the unit. The fence check turned up no possible entry ways as to how the pig may have breached the fence. A thorough follow up check inside of the 370-meter unit to scout for the pig also did not yield any results. It was presumed that the pig had found its way back out of the fence. No ungulate sign has been reported since. ANRPO staff will look into reinforcing the fence with fickle wire to prevent any future incursions.

1.2 OIP/MIP MANAGEMENT UNIT FENCE STATUS

The MU status tables below show the current status of all completed fence units, organized by MU. The tables identify fence construction status, whether it is ungulate free, acreage protected versus acreage proposed in the Implementation Plan, and the year the fence was completed. The number of Manage for Stability Population Units (MFS) protected is also identified for each fence. 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 (if there are any ungulates inside) to each fence unit. Table 2 includes units that protect species outlined in the Makua Implementation Plan (MIP) and Table 3 has information for those units that protect species outlined in the Oahu Implementation Plan (OIP).

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	5			Complete and ungulate free.	None
	Kahanahaiki II	Yes	Yes	30/30	2013						Complete and ungulate free.	None
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002	6		2			Complete and ungulate free.	None
Opaeula Lower	Opaeula Lower	Yes	Yes	26/26	2011	2		3	1		Complete and ungulate free.	None
Ohikilolo	Ohikilolo	Yes	No	3885/574	2002	13	1	4			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, 30 goats have been able to breach the fence. One goat removed in past reporting year. Sections of the fence were replaced in 2014 and 2016.	Pig/Goat
Ohikilolo Lower	Ohikilolo Lower	Yes	No	70/70	2000	3					This strategic fence is complete.	Pig
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 (DLNR)												
Ekahanui	Ekahanui I	Yes	Yes	44/44	2001	6	1	2		1	Completed by the Nature Conservancy of Hawaii (TNCH). Staff and partner organizations have observed an increase in goat pressure along the fence this past year. Staff will monitor and address any breaches or low spots along the fence line should incursions happen.	Goat
	Ekahanui II	Yes	Yes	165/159	2009						Complete and ungulate free.	Goat
Haili to Kealia	Haili to Kealia	No	-	-	-	1					As per DLNR Division of Forestry and Wildlife staff 'no fence needed'. Pigs are considered low risk in this MU	None
Kaena	Kaena	Partial	-	-	-	1					There is a predator proof fence installed by State but it only protects a portion of the *Euphorbia celastroides* var. *kaenana* plants. Pigs considered a low risk in this MU. However continual rat and mice damage throughout the dry seasons have detrimental effects on plants. Staff will look to implanting seasonal rat control to mitigate damage.	Rat
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999	6	1	2	1		Completed by TNCH and ungulate free.	None

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		
Kaluaa/Waieli	Kaluaa/Waieli II	Yes	Yes	25/17	2006						Completed by TNCH.	None
	Kaluaa/Waieli III	Yes	Yes	43/11	2010						Complete and ungulate free.	None
Keaau	Keaau II	Yes	Yes	8/33	2014	2					Complete and ungulate free. DLNR requested to reduce the size of original proposed MU fence.	None
	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 ANRPO staff.	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	224/224	1998	14	1				Complete and ungulate free.	None
Palikea	Palikea I	Yes	Yes	25/21	2008	1	1	1	2		A pig breached the fence this year but staff were able to remove it.	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	No	342/224	2007						One pig breached the fence this year but staff were able to remove it.	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 the Kamaili unit due to the continuous rock fall damage and threat to personnel. Fence not being maintained.	Pig/Goat
Makaleha West	Makaleha West	Yes	Yes	11/11	2001	5					All PU fences are complete and pig free. The 3-points fence was expanded in 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	No	85/96	2007	8	1				Complete and ungulate free	None
	Makaha II	Yes	Yes	16/66	2013	5		1			Complete and ungulate free.	None

Table 3: OIP Management Status

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Completed	# MFS PUs					Notes	Current Threats
						MIP		OIP				
						P	I	P	I	V		
ARMY LEASED AND MANAGED LANDS												
Kaala-Army	Kaala	Yes	Yes	183/183	2008			4	1		Strategic fences complete. Three pigs were caught in 2014, the first since 2010 but no sign observed since. New fence extension completed in August 2018.	None
Kaunala	Kaunala	Yes	Yes	5/5	2006			1			Complete and ungulate free.	None
Lihue	Lihue	Yes	No	1800/980	2012	3	1	6	3		Completed. Encompasses six PU fences and the original three proposed fence units. A total of 548 pigs have been removed to date. There are very few pigs left in unit. FLIR Survey conducted. See discussion below	Pig
Oio	Oio	Yes	Yes	3/3	2006			1			Complete and ungulate free.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	271/271	2001/ 2007			1			Complete and ungulate free.	None
Opaeula Lower	Opaeula Lower	Yes	Yes	16/16	2011	1		1	1		Complete and ungulate free.	None
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006			1			Complete and ungulate free.	None
South Kaukonahua	South Kaukonahua I	No	No	0/95	TBD			1			The Tier 1 taxa *Hesperomannia swezeyi* occurs within this MU. DLNR is proposing to build a larger unit encompassing this proposed fence.	Pig
Tripler *MegXan* Fence	Tripler Army Medical Center (AMC)	Yes	Yes	.23/.23	2021						Complete and ungulate free.	None
Dillingham *MegXan* Fence	Dillingham Military Reservation (DMR)	Ýes	Yes	.03/.03	2021						Complete and ungulate free.	None
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 of Manuwai is subject to pig traffic from Lihue, which is unlikely but possible.	None

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Completed	# MFS PUs					Notes	Current Threats
						MIP		OIP				
						P	I	P	I	V		
North Kaukonahua	North Kaukonahua	Yes	Yes	31/31	2017			1			Site is included within the larger Poamoho Natural Area Reserve (NAR) fence. Fence is complete and ungulate free.	None
Poamoho	Poamoho Lower II	Yes	Yes	5/5	2014			1			Site is included within the larger Poamoho NAR fence.	None
	Poamoho Pond	Yes	Yes	18/18	2014						Site is included in the larger Poamoho NAR fence.	None
Waimano	Waimano	Yes	Yes	4/4	2011						Complete and ungulate free. Transferred management of fence over to OPEPP. ANRPO assists the OPEPP staff with all repairs and replacement of fence.	None
North Pualii	North Pualii	Yes	Yes	25/25	2006	1		1	1		Completed by TNCH. 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	176/160	2012			4			Complete and ungulate free.	None
KAMEHAMEHA SCHOOLS												
Waiawa	Waiawa I	No	No	0/136	TBD						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	TBD						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 OPEPP.	None
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

1.3 FUTURE PROJECTS

1.3.1 2022 – 2023 Fencing Projections

- **Pualii MU:** A section of fence that crosses the gulch bottom in the Pualii MU has been repeatedly damaged by debris and boulders carried by heavy stream flow during periods of heavy rain. This upcoming year ANRPO staff plan to install a hypalon barrier to allow the pass through of these debris and boulders when the stream is flowing heavily and also serve as an effective ungulate barrier during the dry season.

- **Palikea:** Sections of skirting along the southern side of the Palikea MU fence are becoming loose due to erosion and pig pressure. Skirting is an essential barrier, as it prevents pigs from rooting underneath the fence and potentially breaching the unit. ANRPO staff have already begun to re-anchor the skirting and will continue to address problematic sections this upcoming year.

- **Lehua Makanoe Bog:** Located on the summit in the northern Koolaus, north of the Opaeula / Helemano MU this 340-meter fence is constantly exposed to the harsh inclement weather associated with this region. Because of this the fence develops rust and eventually deteriorates to nothing. Currently sections of original hog wire fence and cattle panel fixes remain, but the rust is detrimental and eventually the fence will need to be replaced. This upcoming year ANRPO staff plan to replace the entire fence with new cattle panels. This project will be completed in-house.

- **Kaluakauila:** A section of the original Kaluakauila fence exhibiting rust damage has gotten worse over the years. Specifically, the sections constructed with hog wire are rusting away faster than the sections constructed with panel. Approximately 300 meters of fence will need to be replaced and ANRPO staff are planning to replace the damaged sections this upcoming year.

1.3.2 2022 -2023 Future Ungulate Management Plans

- **Makua Military Reservation Ungulate Control Plans:** ANRPO managers met in March 2022 to discuss future management plans for pig control in Makua Military Reservation (MMR). Mangers agreed to initiate large scale pig control for the next two years (2022-2024). This approach will utilize two survey techniques to get an estimated population abundance: 1) aerial UAV surveys and DIFS grids (density intensity for feral swine). Aerial UAV surveys will use thermal imagery to detect pigs from the air more about this method will be covered below. 2) DIFS method uses motion activated game cameras spaced out in a 5 kilometer grid system to detect where the pigs are within the valley and the size of the herds. Given threat of UXO in Makua it will not be feasible to deploy cameras in some of the areas. Ungulate control methods will include an arsenal of live trapping including the Pig Brig and the use of PAG (Pneumatic Air Guns) and high-powered firearms. The details of implementation are still being developed. ANRPO plans to begin implementation in the winter of 2022 with the goal in mind to protect rare plant species and native forest already established in the valley in addition to reducing pig pressure in those areas that may become future reintroduction sites. Progress will be reported in next year's report.

- **Lihue MU:** Complete ungulate removal of the Lihue Management Unit has been an ongoing project since completion of the fence. FLIR surveys conducted in January 2022 located three pigs inside of the unit. Given the limitations and different variables when conducting the survey ANRPO predicts that there may be more than three pigs inside of Lihue. The danger of unexploited ordinances (UXO) throughout the unit restricts ungulate control to trails that have

been cleared by EOD. Baiting techniques along the trails and live trapping along the road will be conducted this year and results will be reported in the next reporting year.

1.3.3 New Tool Development

- **KIA thermal survey:** ANRPO contracted the company KIA Hawaii (KIA) from Maui to conduct forward looking infrared (FLIR) aerial surveys of Makua valley (3,884 acres) and Lihue (1,834 acres) in January 2022. Personnel from KIA came to Oahu with an electro-optical thermal device that detects far-infrared energy. Video is collected while the areas are traversed with a helicopter. The video is then processed post-flight and animals detected are mapped with the paired GIS track logs. KIA was able to detect 13 pigs and 14 goats in Makua valley. All goats seen were on Ohikilolo Ridge outside the fence. All pigs were seen in the center of the valley in the open grass and shrub areas. In Lihue 9 pigs were seen. Two were inside of the fence unit and the others were outside the fence. As in Makua, pigs were detected in the open areas where their heat signature was visible to the FLIR unit. The survey occurred early in the morning on January 18 in Makua and January 19 at Lihue. FLIR is best utilized in the early hours of the day when the temperature difference between targets and the surrounding environment is greatest. Video recorded was processed by KIA made into a report that will aid ANRPO in future ungulate management decisions (Appendix 1-1). The overall cost of the contract was $8,727 or $1.50 per acre. Below are the benefits and drawbacks of using the survey. Key points to highlight in the drawbacks section is the safe altitude a helicopter can fly above the canopy in addition to its maneuverability with challenging terrain. These limitations leave a margin for error when surveying. To solve for this ANRPO has purchased an UAV Autel EVO2 640 Dual drone which will be talked about more in depth below.

  Benefits of the survey include:

  - Rapid landscape scale animal detection (5,718 acres completed in two-three hours of flying)
  - GIS location information to inform future control and decision making.
  - Possible trend analysis with repeated survey operations.

  Drawbacks include:

  - Cost of helicopter operations and contracting.
  - Delay in target number and location information until video processing is complete.
  - Inability to fly low and maneuver into restrictive terrain.
  - Inability to detect animals in dense cover or behind terrain (behind ridges or in deep gulches)

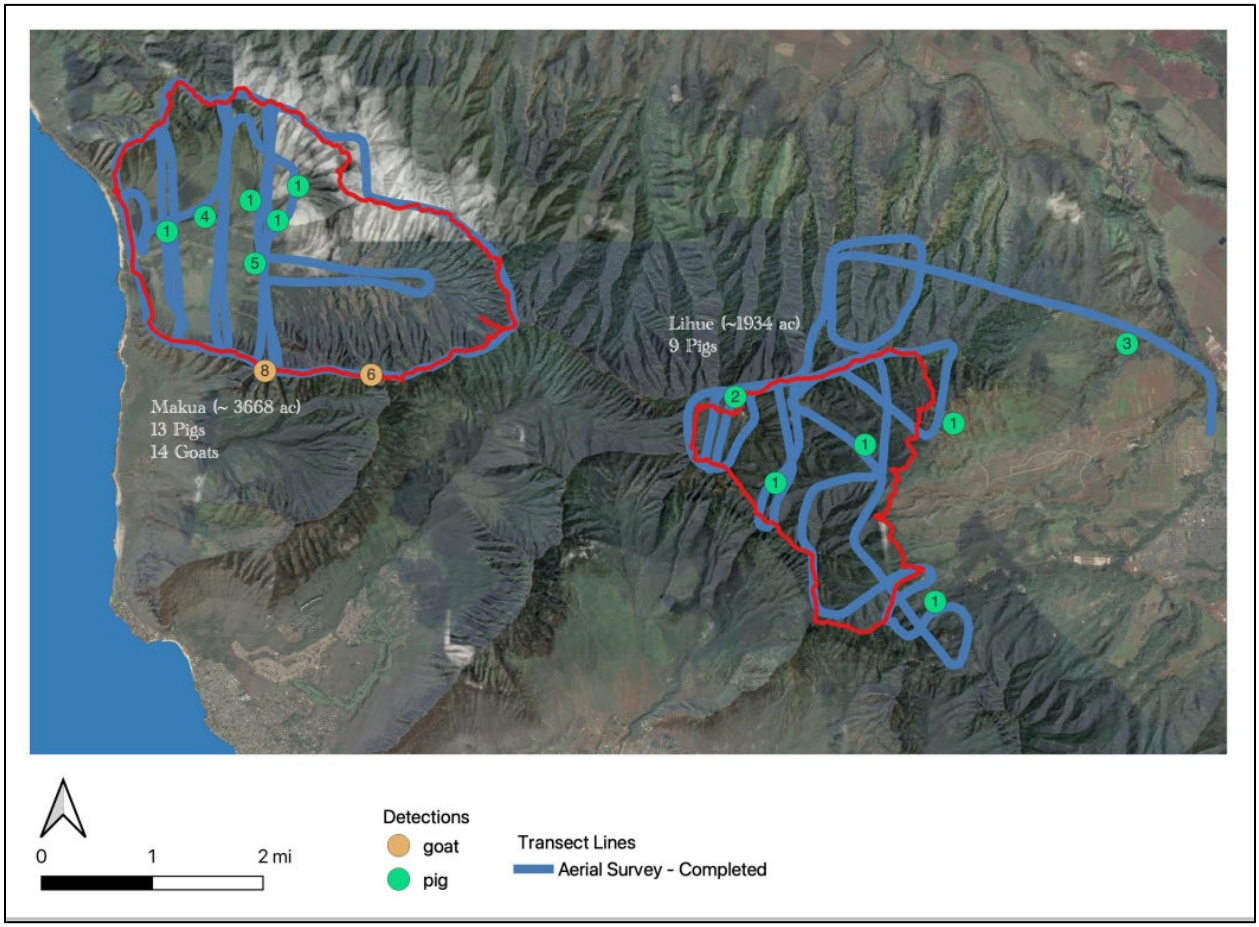

Figure 7: FLIR flight paths and animals detected by KAI in January 2022

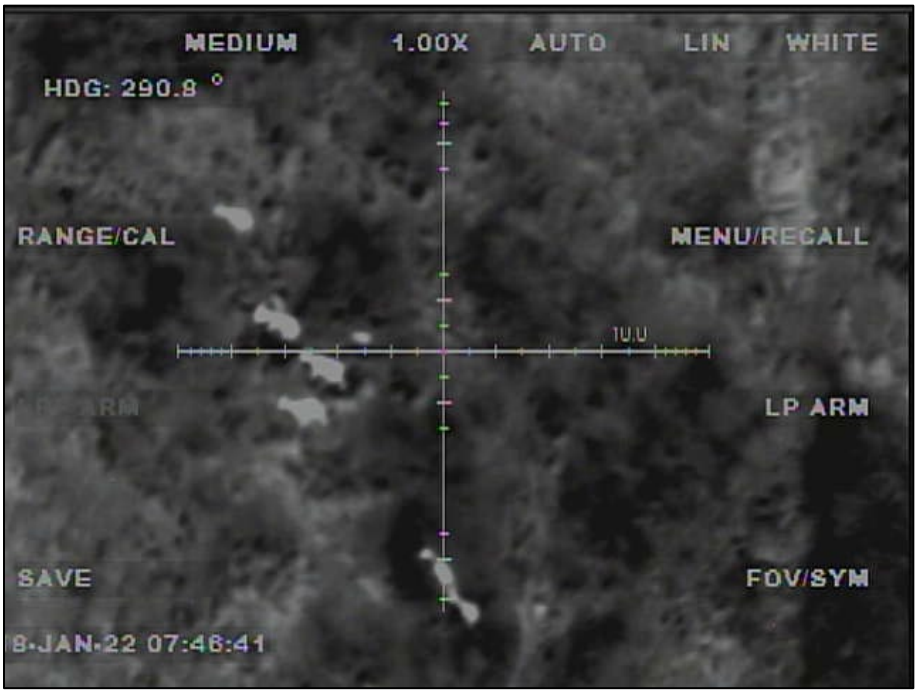

Figure 8: FLIR image captured by KIA Hawaii of six goats outside the fence on Ohikilolo ridge

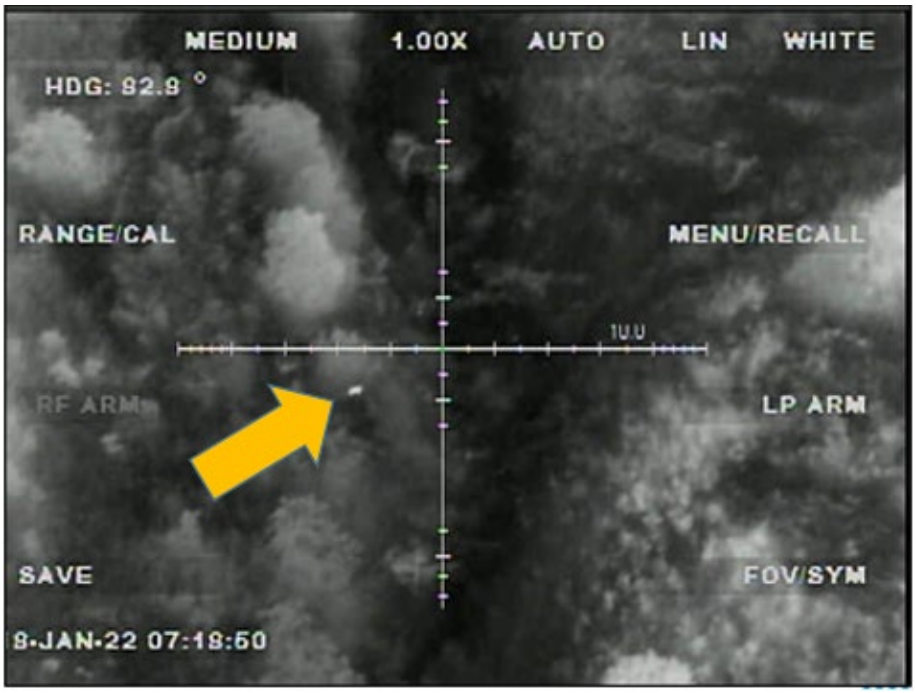

Figure 9: FLIR image captured by KIA Hawaii of one pig in the Lihue

- **UAV Autel EVO2 640 Dual:** ANRPO recently purchased a new drone with a dual thermal camera with capabilities to spot animals due to the temperature difference between them and the surrounding environment. ANRPO staff look forward to deploying this technology to assist in ungulate control and are working to overcome hurdles in getting permission to fly the drone on Army lands but will be conducting flights on state lands in the next year. To develop better

surveying skills staff will look for opportunities to test drone at the next off-site ungulate incursion to assist in response and consider flying the drone outside of management areas.

We see clear advantages to using this unit over technologies used in helicopters:

- Operations will be much cheaper than using helicopters and a contractor to conduct surveys
- Drones can fly lower and slower than helicopters without the disturbance
- Drones can navigate tight gulches to look into areas the helicopters cannot access
- Detections will be immediately determined (does not require video post processing)

Disadvantages include:

- Inability to do landscape scale survey, as was done using FLIR
- As with FLIR, inability to detect animals in dense cover or behind terrain (behind ridges or in deep gulches)
- Requesting access and permission to fly drones on Army lands is an ongoing timely process.

- **Pig Brig:** ANRPO has procured two Pig Brig traps and are looking to deploy these as a new trapping tool to assist in ungulate control. The Pig Brig is a light weight, transportable, circular, self-resetting live trap made of rope weaved into a net like system. Pigs in the surrounding area are habituated to the trap location by first pre baiting the trap site. When the trap is set, the net has been dropped, and the necessary components are tensioned correctly. Pigs will root underneath the net and get caught on the inside of the circle. These traps should assist in the removal of multiple pigs. There are terrain limitations on where the trap can be set as the area needs to be relatively flat. As multiple pigs are targeted the trap also requires a larger amount of feed and water than the smaller box and corral traps. In addition, because the trap is a net it can easily be vandalized. With these considerations in mind, staff will work to deploy the traps in appropriate areas. ANRPO will look to use this trap to reduce numbers outside of fences as well as target animals that gain access to fenced units. Details of implementing in management units when there are pig incursions are still be planned out. Areas to be considered for deployment in the next year include Lihue, West Makaleha, and Makua.

Figure 10: Example of the Pig Brig.

CHAPTER 2: ENVIRONMENTAL OUTREACH

The Army Natural Resources Program on Oahu (ANRPO) 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;
- Managing an active volunteer program which assists staff in meeting Implementation Plan (IP) goals, particularly by conducting field actions; and
- Hiring and training interns to provide natural resource management experience for up and coming conservationists and to assist staff in meeting IP goals.

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

2.1 VOLUNTEER PROGRAM

Outreach staff maintained a volunteer database of over 2,000 individuals for the past 10 years. This report year, duplicate or inactive volunteer records in the database were removed. ANRPO now maintains a database of 597 active volunteers and 68 of these joined as new volunteers this year.

Figure 1: Volunteers from the Army Directorate of Public Works, engineering branch, take in the views after a long day of controlling invasive strawberry guava (*Psidium cattleianum*) in Kahanahaiki.

With the decline in COVID positivity rates and the addition of an AmeriCorps intern to assist with staffing volunteer trips, ANRPO resumed offering monthly volunteer trips this report year. The majority of volunteer service trips included individual community members from across Oahu. In addition, numerous organized community groups volunteered with ANRPO and accomplished mutually beneficial goals, experiencing important connections to place and educational opportunities while providing important assistance with natural resource management actions. Community groups participated in 20% of the volunteer trips this report year and included a wide range of individuals, including staff from the Department of Education (DOE) Hawaiian language immersion program, participants in summer school programs, and even a group of civilian engineers (Figure 1). The list below includes community groups that volunteered with ANRPO this report year:

- Malama Learning Center, staff/interns
- Kupu, Conservation Leadership Development Program, members
- Waianae High School, Hawaiian Studies Program, students
- Waianae High School, Marine Science Program, students (2 days)
- Le Jardin, teaching staff
- Ka Papahana Kaiapuni (DOE Hawaiian language immersion program), staff
- PALS/PLACES Hawaii (Leeward coast summer program), participants
- Kokua Hawaii Foundation, staff/docents
- Directorate of Public Works, Engineering Branch
- Punahou School, Kuaihelani Learning Center and Outdoor Education Program

The table below (Table 1) compares volunteer participation for report year 2022 with that of previous years, distinguishing between volunteer efforts spent in the field and around the Army Natural Resources Program baseyards.

Table 1: ANRPO volunteer participation from 2010 to 2022.

Reporting Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Worksite**	Total Volunteer Hours at Baseyard ***
2022	**2,511**	**714.25**	**519.50**
2021	916	280.75	210.5
2020	2,490.5	578	562
2019	4,634	1,207.75	456.25
2018	4,168	1,356	413
2017	3,397.5	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 worksite, and gear cleaning time at end of day*

***Includes actual time spent weeding, planting, etc.*

****Includes propagule processing, nursery maintenance, gear preparation, GIS data entry, outreach support and maintenance of interpretive native gardens*

+*Shorter reporting year, spanning nine (9) months*

Outreach staff led a total of 50 volunteer trips and facilitated 16 additional opportunities for volunteers to assist natural resource staff with conservation field projects. These supplemental projects varied depending on volunteer abilities and program needs and are included in the summary of volunteer field actions in Table 2.

Volunteer efforts focused mainly within the Kaala, Kahanahaiki, Makala West, and Kaluaa Management Units during the 2022 report year (Figure 2). Of the 95 volunteer field actions listed in Table 2, over 62% supported weed control goals (17% incipient and 45% general ecosystem). There was a notable increase in volunteer support for stabilization of rare snail taxa; 29% of volunteer field actions included assistance with snail monitoring, predator detection and maintenance of snail enclosures. The remaining 9% of volunteer field actions provided assistance with slug control, fence and trail maintenance, and surveys.

Four volunteers regularly supported activities at the ANRPO baseyard, including projects in the seed conservation lab, weed control and maintenance in the native Hawaiian interpretive garden, and GIS related support.

Figure 2: ANRPO Volunteers assist with natural resource management actions in a variety of management units across the Waianae range, including (clockwise from top left): Kaluaa; Kahanahaiki; Makaleha West; and Kaala.

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

Table 2: Volunteer field actions for report year 2022.

Management Unit	Type of Project	Number of Field Actions
Kaala	Incipient weed control	10
	Ecosystem weed control in WCAs	6
	Monitor-timed count (*Achatinella*)	3
	Monitor (tracking tunnels)	2
	Reintroduction (*Achatinella*), photography	1
	Predator control (A24s)	1
	Euglandina rosea exclosure maintenance	6
	Trail maintenance	1
Kahanahaiki	Ecosystem weed control in WCAs	13
	Euglandina rosea exclosure maintenance	3
	Monitor-timed count (*Achatinella*)	1
Makaleha West	Ecosystem weed control in WCAs	14
	Euglandina rosea exclosure maintenance	3
	Monitor-timed count (*Achatinella*)	1
	Monitor-ground shell plot (*Achatinella*)	1
	Monitor (tracking tunnels)	1
	Slug control	1
	Incipient weed control	1
	Outplanting	1
Kaluaa and Waieli	Ecosystem weed control in WCAs	8
	Monitor-timed count (*Achatinella*)	1
	Monitor-ground shell plot (*Achatinella*)	1
	Alien Control (Jackson's Chameleons)	1
Palikea	Incipient weed control	5
	Euglandina rosea exclosure maintenance	2
	Ecosystem weed control in WCAs	2
Makaha	Ecosystem weed control in WCAs	2
Lihue	Survey	1
	Slug Control	1
MMR No MU	Monitor/Maintenance (fence)	1

2.2 INTERNSHIPS AND MENTOR PROGRAMS

Outreach staff recruited and hired seven individuals for internship positions during this report year, including six ANRPO summer internships and one 11-month AmeriCorps internship. One individual from this group continued on with the program as a full-time Natural Resource Management Technician.

- *ANRPO Summer Internship*
  Outreach staff, with assistance from the Rare Snail Conservation Biologist and a Natural Resource Field Team Leader, scored 25 applications, interviewed nine applicants, and awarded six individuals with paid summer internships with ANRPO. Interns were placed with each field team, the animal program, the vegetation restoration program, and the greenhouse and seed lab. Outreach staff and field crews planned and implemented a four-day orientation session for the summer interns, consisting of new hire training modules and educational field activities at various management units, as shown in Figure 3. The 2022 summer internship lasted for 12 weeks.

Figure 3: Four of the ANRPO summer interns join the Native Plant Restoration Biologist at Kahanahaiki, as part of orientation week, to begin learning important natural resource management strategies and skills.

- *AmeriCorps/Kupu/Conservation Leadership Development Program (CLDP)*
  ANRPO served as a host site for one AmeriCorps member from Kupu's CLDP program. Outreach staff, with assistance from the Propagule Management Biologist, scored 32 applications, interviewed two applicants, and awarded one individual the opportunity to work as a part time (20 hours/week) CLDP member with the ANRPO outreach program and field teams. The CLDP member worked a total of 900 hours from late September 2021 to mid-August 2022. During this report year, this CLDP member joined the program as a full-time, temporary Vegetation Restoration Technician.

During this report year, four former ANRPO summer interns joined the program as full-time staff including three from the 2021 cohort and one from the 2020 cohort. These four individuals filled the following ANRPO positions: Natural Resource Management Technician (two positions), Vegetation Restoration Technician, and Propagule Conservation Technician.

2.3 EDUCATIONAL MATERIALS

Educational materials were developed and presented on natural resource issues specific to Makua and Oahu Implementation Plan taxa and their habitats. Materials ranged from virtual presentations for college and high school students to digital publications and educational signs. The following list highlights new or adapted educational materials:

Presentations

- University of Hawaii at Manoa, Natural Resources and Environmental Management (NREM)

- Introduction to NREM class, updated virtual presentation on ANRPO management, careers in conservation, and internship and volunteer opportunities.
- Weekly Lecture Series, virtual presentation on "ANRPO Applied Research Needs 2021-2022."

- Hawaii Youth Sustainability Challenge
  Virtual workshop video recording presenting two conservation challenges to high school students and teachers, including: "Greenhouse Guardians: Stop the Invasion" (a challenge to test and identify material to keep invasive slugs and snails out of plants in the greenhouse) and "Pigs for Conservation" (a challenge to determine whether pigs can be used to help detect and remove invasive *Crocosmia x crocosmiiflora* from the forest).
- Watersheds and Native Forest Preservation
  Virtual presentation on native forest plants, seed storage and tour of ANRPO seed lab.
- Range Safety Officer/Officer in Charge (RSO/OIC) Natural Resources Brief
  Updated presentation to include current vehicle wash rack information and volunteer program contacts and produced pre-recorded video of ANRPO staff giving brief to ensure consistency of delivery, maximize audience reach, and increase efficency.
- Makua Military Area Natural Resources Brief for soldiers and marines
  Updated presentation to include pre-recorded video of ANRPO staff presenting relevant information.

Publications

- Ecosystem Management Program Bulletin 2022
  An annual newsletter highlighting achievements made by the Army Environmental Division's Conservation Branch on Oahu and Hawaii Island (Figure 4), posted online at www.issuu.com/oanrp

Figure 4: Outreach staff produced the Ecosystem Management Program Bulletin 2022, featuring an article on surveys that indicate Oahu elepaio populations are expanding into new territories in the Waianae Mountain range, in response to ANRPO predator control efforts.

Educational Signs

- Snail Enclosure Signs (Figure 5)
  - Kaala Snail enclosure
    An aluminum sign installed on the locked gate on the fence outside the Kaala snail enclosure to discourage hikers from entering the snail enclosure area.
  - Snail Enclosure Adhesive Sign/Sticker
    A large sticker adhered to the walls of snail enclosures to discourage people from standing or climbing on the structure, to protect the integrity of the predator barriers.

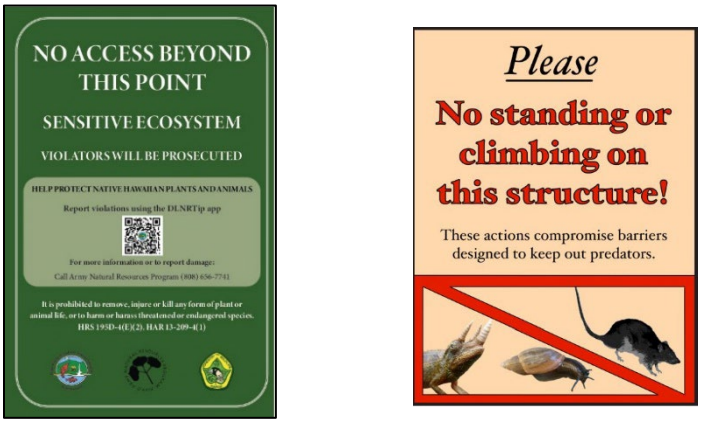

Figure 5. Outreach staff produced aluminum signs and adhesive stickers to discourage entry and damage to the *Achatinella* snail enclosures on the Waianae mountain range.

- Army Beach Sign
  An aluminum sign installed at Mokuleia Beach (a.k.a. Army Beach) to inform beach goers of natural resources in the area and to discourage behavior that could have negative impacts on native vegetation and wildlife (Figure 6).

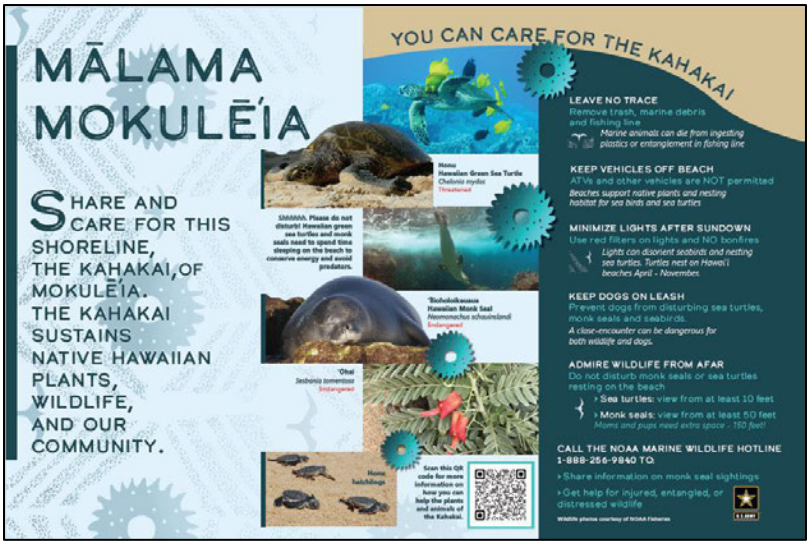

Figure 6: Outreach staff produced an interpretive sign to provide natural history information and advise ways to minimize negative impacts at Mokuleia Beach (a.k.a. Army Beach), in response to an increase in Hawaiian green sea turtle nesting activity.

2.4 OUTREACH EVENTS

ANRPO disseminated information on natural resources specific to Army training lands through public outreach opportunities. This report year, ANRPO staff participated in 16 general community outreach events with students and staff from elementary schools, high schools, university classes, along with conservation organizations and military families. An interest in establishing native gardens on campus initiated several outreach opportunities with administration and resource staff from elementary schools. In addition, an exhibit booth at the annual Schofield Fun Fest & Earth Day Festival provided ANRPO with an opportunity to share natural resource information with the military community.

These outreach activities are summarized in Table 3 and Figure 7 below.

- Total number of people served during community outreach events: 597

Table 3: Outreach events for 2022.

Event	Format	Attendance	Audience
University of Hawaii at Manoa, Introduction to Natural Resources and Environmental Management Class	virtual presentation	38	higher education
University of Hawaii at Manoa, Transformational Research Experiences Class	virtual presentation and in-person	20	
University of Hawaii at Manoa, Natural Resources and Environmental Management, Weekly Lecture Series	virtual presentation	34	
Hawaii Youth Sustainability Challenge	virtual workshop	30	K-12 schools (not on military bases)
Watersheds and Native Forest Preservation Studies, Waianae High School	ANRPO Virtual seed lab tour	29	
Kupu Environmental Education Leaders Host Site Visit	ANRPO Seed lab, nursery and interpretive garden tour	7	
Native Garden Development (Kalaheo High School Teachers)	planting demonstration	3	
School Garden Planning (Leilehua DOE Complex Resource Teachers)	virtual presentation	3	
Hawaii Trail and Mountain Club (HTMC) Trail Clearing Support	community service	20	natural resource professionals and conservation community
Kupu - Hawaii Youth Conservation Corps Host Site Workshop	virtual meeting	30	
Chromolaena Outreach Working Group	virtual meeting	9	
Conservation Dogs of Hawaii Trail Access Support	community service	3	

Table 3 (continued).

Event	Format	Attendance	Audience
Schofield Barracks Fun Festival and Earth Day Celebration	exhibit	350	military community
ANRPO Interpretive Garden, Seed Conservation Lab and Nursery Visit (Wheeler Middle, Wheeler Elementary, and Daniel K. Inouye Elementary Teachers)	tour	8	
Campus Garden Scoping and Planning (Wheeler Middle, Wheeler Elementary, and Daniel K. Inouye Elementary School)	tour	7	
Native Garden Development (Wheeler Middle, Wheeler Elementary, and Daniel K. Inouye Elementary School)	planting demonstration	6	
Total Number in Attendance			**597**

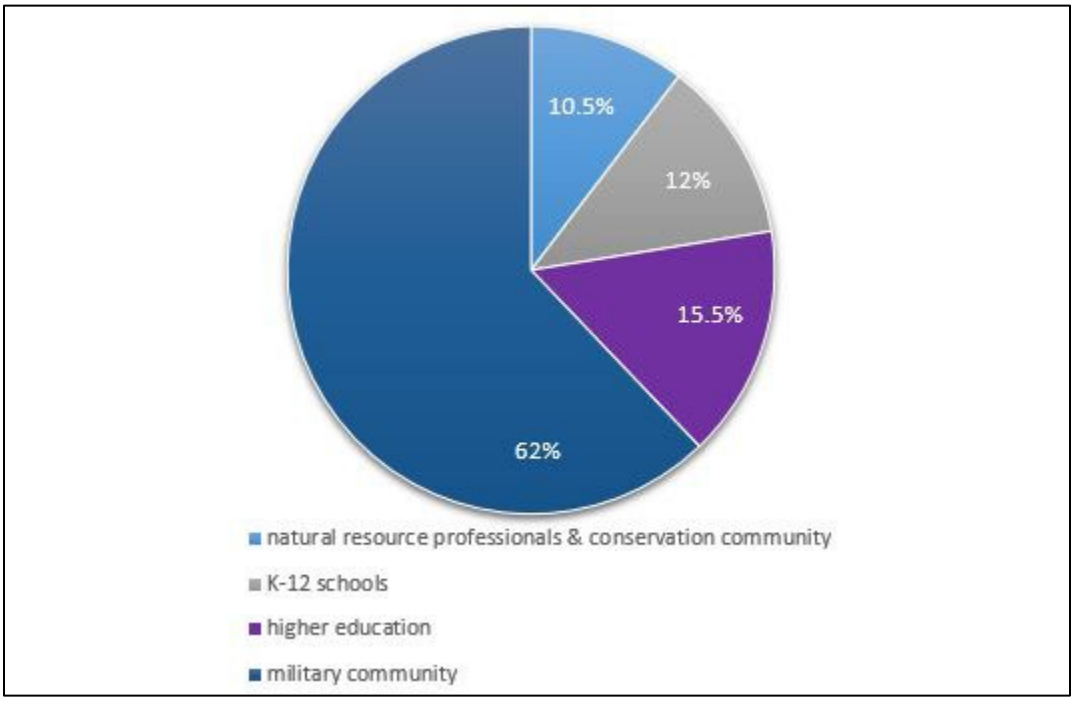

Figure 7: Target audience at 2022 outreach events.
Military community represents outreach to military families and schools at Schofield Barracks.

Troop outreach frequency increased to 60 presentations this year, in large part due to improvements in the delivery of the natural resource briefs. The natural resource section of both the Makua Military Reservation (MMR) brief and the Range Safety Officer/Officer in Charge (RSO/OIC) brief were transformed into pre-recorded presentations given by ANRPO staff. These updates provided greater flexibility for units to schedule briefs and also ensured consistency in the delivery of natural resource concerns.

These troop outreach events are summarized in Table 4 below.

Table 4: Troop Outreach in 2022.

Event	Format	Briefings
Makua Military Reservation Briefings	Pre-recorded presentation	18
Range Safety Officer/Officer-in-Charge Briefings (RSO/OIC) (3x monthly)	Pre-recorded presentation	36
Environmental Compliance Officer (ECO) Trainings	Virtual presentation	6

2.5 CONTRIBUTIONS TO CONFERENCES AND WORKSHOPS

ANRPO staff contributed to outreach by presenting research findings at various academic conferences and workshops. The table below (Table 5) summarizes contributions to conferences and workshops in the 2022 report year.

Table 5: Contributions to Conferences and Workshops in 2022.

Presentation Title	Format	Venue	Date	Author*
Devil to pay: detection and ten years of management of *Chromolaena odorata* (Devil Weed) in Hawaii	Virtual presentation	California Invasive Plant Council (Cal-IPC)	2021-10-17	**Jane Beachy**
History of ANRPO's rodent control efforts and current practices on Oahu, Hawaii	Virtual presentation	Mauritius Predator Control Workshop-Organized by Ebony Forest Reserve	2022-03-16	**Troy Levinson, Tyler Bogardus**
Control of specific invasive tree species across managed native forested areas on Oahu: Evaluating the results and what next for management?	Virtual presentation	University of Hawaii, CTAHR – Invasive Pest Mini-Conference	2022-03-23	**Melissa Valdez**
Twenty-Five Years of Rare Plant Management on Oahu	Virtual presentation	Center for Plant Conservation – National Meeting	2022-05-04	**Tim Chambers**
Intensive Vegetation Management	Virtual presentation	Restoration & Weed Workshop	2022-05-05	**Melissa Valdez, Christopher Lum, Petelo Maosi**
Leveling up the Weed Spreadsheet	Virtual presentation and discussion	Restoration & Weed Workshop	2022-05-05	**Jane Beachy, Clay Trauernicht**
Monitoring the Phenology of *Chromolaena odorata* to Inform Management of an Incipient and Highly Invasive Species in Hawai'i	Virtual presentation	Hawaii Conservation Conference	2022-05-20	**Samantha Shizuru**

**ANRPO authors in bold font*

2.6 PUBLIC RELATIONS AND PUBLICATIONS

ANRPO was featured in peer reviewed online journals, online news articles, printed publications and local televised news coverage this report year. In addition, the USAG-HI Facebook page featured several posts highlighting ANRPO staff and the natural resource work that was accomplished this year. Staff coordinated published media with USAG-HI Public Affairs Office. The table below (Table 6) provides a summary of media and publications relating to ANRPO management in report year 2022.

Table 6: Media coverage and publications in 2022.

Title	Author	Publication	Date	Format
ANRPO & UH: A cooperative stewardship in natural resources and environmental management	Noelo	Noelo https://research.hawaii.edu/noelo/anpro-and-uh/	2021-07-13	online news article
Hawaii's Youth Plant Seeds of Sustainability in Annual Environmental Program	Mindy Pennybacker	Honolulu Star-Advertiser https://www.staradvertiser.com/2021/08/22/hawaii-news/hawaiis-youth-plant-seeds-of-sustainability-in-annual-environmental-program/	2021-08-22	online news article
Hawaii's forest review: Synthesizing the ecology, evolution, and conservation of a model system	Barton, K., Westerband, A., Ostertag, R., Stacy, E., Winter, K., Drake, D., Fortini, L., Litton, C., Cordell, S., Krushelnycky, P., **Kawelo, K.**, Feliciano, K., Bennett, G., Knight, T.	Perspectives in Plant Ecology, Evolution and Systematics, Volume 52 https://www.sciencedirect.com/science/article/pii/S1433831921000433?via%3Dih	2021-10-01	online journal article
Saving Hawai'i's Endemic Plants, One Seed at a Time	Cynthia Wessendorf	Hawaiibusiness.com https://www.hawaiibusiness.com/saving-plants-hawaii-army-seed-lab-endemic-endangered/	2021-10-13	online news article
Saving Hawai'i's Endemic Plants	Cynthia Wessendorf	Hawaii Business Magazine	2021-10-13	printed magazine article
Plant 'smoothie' limits ohia rust in endemic plant	Mark Ladao	Honolulu Star-Advertiser https://www.staradvertiser.com/2021/10/18/hawaii-news/plant-smoothie-limits-ohia-rust-in-endemic-plant/	2021-10-18	online news article
At this unique seed lab, the Army is saving Oahu's endangered plants	Hawaii News Now	Hawaii News Now https://www.hawaiinewsnow.com/2022/01/06/this-unique-seed-lab-army-is-saving-oahus-endangered-plants	2022-01-05	televised news coverage
The Disconnect Between Short- and Long-Term Population Projections for Plant Reintroductions	Bialic-Murphy, L., Knight, T., **Kawelo, K.**, Gaoue, O.	Frontiers in Conservation Science https://www.frontiersin.org/articles/10.3389/fcosc.2021.814863	2022-01-17	online journal article

2.7 VOLUNTEER RECOGNITION

Each year, outreach staff nominates eligible volunteers for the President's Volunteer Service Award. Nominations for this reporting year included volunteer service from 01 July 2021 - 30 June 2022. A total of four individuals listed below in Table 7 volunteered over 100 hours with ANRPO within this report year. These volunteers will be honored with certificates signed by the President of the United States and commemorative pins.

Table 7: 2022 President's Volunteer Service Awardees.

Award Level	Name	Hours of Service in 2021-2022
Bronze	Kathleen Altz	155.25
Bronze	Roy Kikuta	220.75
Bronze	David Danzeiser	227.50
Silver	Elaine Mahoney	339.25

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

2.8 GRANTS

ANRPO was awarded $5,930.76 from the 2021 National Public Lands Day Department of Defense Legacy Grant to support volunteer efforts to control invasive weeds within the native forest of Kaala at Schofield Barracks West Range. Outreach staff hosted a two-day volunteer camping trip (Figure 8) focused on kahili ginger (*Hedychium gardnerianum*) and Florida blackberry (*Rubus argutus*) control within the fenced management unit.

The funds were used to purchase volunteer tools including gloves, pruners, and handsaws, along with camping gear to support future volunteer camping trips.

Figure 8: The National Public Land's Day 2021 volunteer day was featured on the National Environmental Education Website.

CHAPTER 3: VEGETATION MANAGEMENT

Highlights of vegetation management work and notable projects from the 2021-2022 report year are discussed here. Chapter sections include a general weed control program summary, an incipient plant control summary, a habitat/ecosystem weed control summary, highlights from weed early detection surveys, notes on inter-agency collaboration, a vegetation monitoring update, Army training range weed highlights, and a restoration effort summary.

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 the majority of Army Natural Resources Program on Oahu (ANRPO) MUs. 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; ANRPO modifies these plans as needed and can provide the most current versions on request. This year, the Ekahanui, Kaena, Kaluakauila, Koloa, Ohikilolo (Lower Makua), and Pualii ERMUPs were revised, and are included as Appendices 3-1 to 3-6.

3.1 WEED CONTROL EFFORT 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 diversity of habitat types, vegetation types, and weed levels encompassed in the MUs, these Implementation Plan objectives should be treated as guidelines and adapted to each MU as management begins. Please see the 2010-2011 MIP and OIP Annual Report for a discussion of adaptive changes to these goals. The ERMUPs for each MU detail specific goals and monitoring expectations for each MU.

Weed Control Effort Summary.

ANRPO weed control efforts are divided into three primary categories:

- Incipient control efforts, which are tracked in Incipient Control Areas (ICAs),
- Broad ecosystem control efforts, which are tracked in Weed Control Areas (WCAs), and
- Early detection surveys.

This year, ANRPO spent 12,566 hours controlling weeds across approximately 465.4 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. The hours/ha metric gives a sense of weed control intensity.

Figure 1: Staff thoroughly weeding as part of regularly scheduled maintenance in a restoration site.

Table 1: Summary Statistics for Weed Control.

Report Year	Effort (hours)	Area (ha)	Hours/ha
2021-2022	12,566	465.4	27.0
2020-2021	10,937	462.6	23.6
2019-2020	8,651	445.2	19.4
2018-2019	11,457	642.6	17.8
2017-2018	10,399	528.2	19.7
2016-2017	9,309	593.9	15.7
2015-2016	8,447	539.5	15.7
2014-2015 (9 months)	4,654	325.9	14.3
2013-2014	7,600	286.5	26.5
2012-2013	6,968	267.7	26.0
2011-2012	5,860	275.7	21.3
2010-2011	5,778	259.0	22.3

This year, weed control intensity hrs/ha increased and the total area treated increased from the 2020 to 2021report year. This was likely due to staff resuming regular camp trips and completing more volunteer trips.

Complementing control efforts, ANRPO 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, SBS, and SBW. Results of these surveys are discussed in section 3.7 below.

3.2 INCIPIENT PLANT CONTROL SUMMARY

All weed control geared towards eradication or containment of a particular invasive weed is tracked via ICAs. Staff use the Hawaii Pacific Weed Risk Assessment (HPWRA) website to gauge the risk a species poses and species distribution data from the Bishop Museum and ANRPO vegetation monitoring results to determine whether it should be targeted for eradication. Each ICA is a species-specific and geographically defined area using Geographic Information System (GIS) data, topography maps, and field notes. One infestation may be divided into several ICAs or one ICA, depending on infestation size, topographical features, and land ownership. Some ICA species are incipient island-wide and are a priority for ICA management whenever found. Others are locally incipient to the MU, but widespread elsewhere. Those not located within or adjacent to an MU were selected for control either because they occur on an Army training range (for example, *Rhodomyrtus tomentosa* in SBE) or are particularly invasive (*Pterolepis glomerata* in Manuwai).

The goals, strategies, and techniques used vary between ICAs, depending on target taxon biology, size of infestation, known effective control techniques, access, terrain, and surrounding vegetation. The management objectives of an ICA are:

- Total eradication: ICAs checked consistently with no mature plants observed for 10 years (unless there is clear evidence of a shorter seed bank longevity like *Ehrharta stipoides*); or
- Manageable containment and spread prevention of incipient plants on Army training areas and in or near MUs.

Many ICAs are 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 are quite large and require multiple days to cover the entire area. Typically, ICAs are checked consistently until eradication has been achieved and staff is reasonably confident there is no remaining seed bank. Staff visitation rates vary depending on the biology of target taxon, infestation size, and if there are any mature plants present or not. For example, *E. stipoides*, must be visited at least quarterly, as this cryptic grass grows and matures very quickly. However, ICAs that have initially low numbers or a strong downward trend in total number of plants found per visit or no mature plants ever recorded and are slow to mature can be checked less frequently, i.e., once or twice per year. In certain cases, at ICAs with no mature plants (species-dependent) and small infestation numbers, eradication can be shortened to five years.

For some ICAs, eradication can be improbable for multiple reasons including a constant high number of plants, restricted access that does not allow for consistent monitoring or control, the infestation area's size or terrain make it unmanageable, or a substantial amount of staff time to survey/control. Instead of eradication, the goal for these ICAs is to contain and manage the incipient species to that location. One example of this type of ICA is *Cenchrus setaceus* at Lower Ohikilolo, which is problematic as the infestation is split between Army and Private land. ANRPO can only control *C. setaceus* on Army land, so the goal for this ICA is to manage the spread within Army land to decrease the likelihood of this plant species spreading further into the Makua Military Reservation (MMR). ANRPO continues to evaluate the status of each ICA to determine eradication goals and modify control strategies if needed.

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 ANRPO 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 Implementation Plan (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.

ANRPO currently controls 54 taxa in 294 ICAs. Of the total 465.4 ha controlled, ICA efforts covered 388.9 ha. This year, staff spent 2,826 hours on ICA management, conducted 597 visits to 47 taxa in 242 ICAs, achieved eradication at five ICAs, and created 10 new ICAs. This is slightly higher effort spent and area covered for incipient weeds than the 2021 reporting period (Table 2). ICA work accounted for 84% of the total area weeded and 22% 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	# of ICAs Controlled	Visits	Effort (hours)	Area (ha)	Hours/ha
2021-2022	241	597	2,826	388.9	7.3
2020-2021	257	651	2,287	347.4	6.6
2020-2019	226	531	2,203	361.7	6.0
2018-2019	262	667	3,158	525.0	6.0
2017-2018	234	674	2,645	381.9	6.9
2016-2017	233	662	2,573	467.3	5.5
2015-2016	175	539	2,452	388.1	6.3
2014-2015 (9 months)	147	333	1,537	245.6	6.2
2013-2012	157	389	1,754	196.4	8.9
2012-2013	152	311	1,369	184.3	7.4
2011-2012	115	260	1,661	219.3	7.6
2010-2011	130	281	666	164.0	4.1

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 consistently monitor a site. Each year, staff note new locations of known priority species or discover entirely new taxa. While dispersal via Army training or ANRPO management accounts for some of the new ICAs, some spread is likely due to recreational use, non-native animals, and weather events. Occasionally, if a species or site is determined to no longer be eradicable, the ICA is made ‘Inactive’ or ‘Discontinued’ and/or addressed as a target taxon 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 no target plants were found at 125 out of 241 ICAs checked. In addition, staff were able to confidently declare eradication at 5 ICAs this year (Table 3), for a total of 70 eradications in ANRPO’s history. Ten new ICAs were created this report year (Table 4). The suspected vectors for each ICA are listed in Table 4. The new ICAs are alarming as most are established by staff unintentionally using contaminated gear (tabis, field clothes, packs, etc.), which can be determined by examining the Daily Roster that lists where each staff is located every work day and level of staff visitation frequency to those sites. ANRPO plans to re-evaluate sanitation protocols in order to improve decontamination and invasive plant material spread.

Table 3: ICAs Eradicated in 2022.

Taxon	MU	ICA Code	Comments
Ehrharta stipoides	Ekahanui	Ekahanui-EhrSti-01	No plants found for 3 years (seeds persist 1.5 years) at both sites.
	Kahanahaiki	MMR-EhrSti-09	
Rubus argutus	Ohikilolo	MMR-RubArg-07	Only 1 immature observed in 2018. No plants have been seen since.
Setaria palmifolia	Pahole	Pahole-SetPal-01	No plants seen for 10 years.
Verbesina enceliodes	East Makaleha No MU	EMakalehaNoMU-VerEnc-02	No plants seen for 10 years.

Figure 2: Staff surprised by the *Anredera cordifolia* clump that was uncovered from the ground.

This year ANRPO re-evaluated *Chromolaena odorata* management in KTA. Previously the goal for this incipient species was eradication but ANRPO instead will focus efforts on limiting the spread of *C. odorata* by military training and ANRPO staff. ANRPO hopes to accomplish this by surveying and controlling 10-m on each side of all drivable roads and targeting hotspots within buffer, while limiting staff interactions with heavily infested sites, which will decrease the likelihood of tracking *C. odorata* into MUs with rare taxa. Staff will continue to control smaller outlier ICAs that are close to rare resources or Army infrastructures. Continued control efforts are important to contain the spread from KTA prior to future biocontrol release. *Chromolaena odorata* control in SBW and other MUs will remain. Changes to

total effort and area change are reflected in the latter quarters of the 2022 report year. Additionally, results from the awarded graduate assistantship project on "Monitoring Phenology of *Chromolaena odorata* to Inform Management of an Incipient and Highly Invasive Species in Hawaii" by Samantha Shizuru (Appendix 3-7), suggests that *C. odorata* has a strong flowering and seeding season from late fall to spring. Thus, ANRPO has modified sweeps and control during the summer in these areas to avoid flowering season and exposure to *C. odorata* seeds, which can easily hide on gear and field clothes. Additionally, controlling *C. odorata* in the summer will reduce plant density prior to the flowering season.

Table 4: New ICAs Established in 2022.

Taxon	MU	ICA Code	Vector Comments
Andropogon glomeratus var. *pumila*	SBE No MU	SBE-AndGlo-01	Army/road maintenance. Previously undetected.
	Central Makaleha No MU	CMakalehaNoMU-AndGlo-01	
Anredera cordifolia	Kaluakauila	MMR-AnrCor-01	Staff/partners/recreation/unknown.
Chromolaena odorata	Kahanahaiki	MMR-ChrOdo-01	Staff. Found around managed rare plant taxa.
	Kawaiiki No MU	KLOA-ChrOdo-02	Recreation/unknown.
Elephantopus mollis	Kapuna Upper	KapunaUpper-EleMol-01	Staff/partners/recreation/unknown. Discovered along main access trail.
	Makaleha West	MakalehaWest-EleMol-01	Staff/partners/recreation/unknown. Discovered along main access trail.
Ehrharta stipoides	Ekahanui	Ekahanui-EhrSti-03	Staff. Discovered along fenceline where staff frequent often.
Schizachyrium condensatum	SBE No MU	SBE-SchCon-09	Army/road maintenance.
Setaria palmifolia	Kahanahaiki	MMR-SetPal-03	Staff. Found near work site visited frequently.

ANRPO continues to re-evaluate all ICAs according to updated distribution, numbers, etc. Both *Angiopteris evecta* and *Sphaeropteris cooperi* are problematic tree ferns, which are widely distributed throughout the Koolau and Waianae Mountain ranges. Spores from mature plants are air dispersed, making the likelihood of identifying and controlling immature ferns consistently within the same area improbable. Constant replenishment of spores from sources outside MUs, where ANRPO controls, makes the goal of eradication unrealistic. However, controlling mature plants is effective as both tree fern species take at least 3 years to mature to reducing habitat impacts. In 2020 report Year, the Kapuna Upper MU *S. cooperi* ICAs were re-designated as a 'Target taxon'. Staff target *S. cooperi* around IP species. Next report year, all *S. cooperi* ICAs across all MUs will also become target taxa. ICAs for *A. evecta* will also follow the same designation and control known hotspots along the gulches in MUs every 2-3 years.

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 ANRPO database (supplied on CD) and are recommended for review by the Implementation Team (IT).

3.2.1 2022 ICA Effort by Select Target Taxa

Three taxa accounted for 74% (257.8 ha) of all treated area: *C. odorata*, *S. condensatum* and *S. palustre*. Three taxa accounted for 62% (1,744 hrs) of all treatment efforts. The taxa highlighted in this section all reported ≥ 10% of Total ICA Effort. The 2020-2021 effort 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. 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.

Taxon: *Chromolaena odorata*. Please see the 2011 Year End Report, Appendix 1-2 to view the original draft management plan for *C. odorata*, and section 3.5 of the 2019 Year End report for a discussion of recent strategy.

List of MUs with active ICAs: Aimuu No MU, Kaiwikoele to Elehaha No MU, Kahana No MU, Kahanahaiki, Kahuku Laie No MU, Kamaili, Kaluaa No MU, Kawaiiki No MU, KTA No MU, Makaha I, Makaha No MU, Manuwai, Oahu North Central No MU, Pahole, SBE No MU, SBW No MU and Waimea No MU.

2021-2022 Highlights:

- Total 2022 Control: 1,147 hrs; 207.2 ha; 161 visits; accounted for 41% of time spent on ICA work, and 53% of all ICA area controlled. Most effort was spent on 200-m buffer surveys for Kahanahaiki, Kaluaa No MU, and Makaha I.
- Total 2021 Control: 1,118 hrs; 189.7 ha; 162 visits; accounted for 49% of time spent on ICA work, and 55% of all ICA area controlled.
- Total 55 ICAs, 53 of which were visited this year.
- Largest infested area, KTA, continues to report increasing high numbers in Alpha and Bravo Ranges.
  - Staff checked 29 out of 32 ICAs; and 6 ICAs reported no plants observed.
  - A total 402 effort hours over 69 visits were reported.
  - Since the KTA infestation continues to grow, ANRPO has switched the goal of "eradication" to "containment" for *C. odorata* by focusing efforts along roads (buffered at least 10 m on each side), buildings, gravel piles, and known military training/bivouac areas.
  - ANRPO continued to contract OISC to conduct work across half of the KTA infestation; see OISC's progress reports in Appendices 3-8 and 3-9. For next year, OISC's involvement in KTA will prioritize public outreach and assisting with control in the main motocross areas.
- Second largest infested area, SBW No MU.
  - Staff checked 7 out of 7 ICAs; and 4 ICAs still reported no plants observed.
  - A total of 435 effort hours over 36 visits were reported.
  - SBWNoMU-ChrOdo-01 and SBWNoMU-ChrOdo-04 continue to be the largest infested ICAs and most time spent for staff. Both ICAs were sprayed aerially, and from the ground.
- A second ICA (KLOA-ChrOdo-02) was found along the Drum Road at the Kamehameha Schools gate. This section of the road is along privately owned land and will be checked only during road surveys or opportunistically.
- One new ICA (KaluaaNoMU-ChrOdo-02) along the SBS road was found by staff.
  - This initial introduction vector of *C. odorata* is unknown as this road is frequently used by staff, partnerships, and Army personnel. However, likely spread may be from road maintenance.
  - Staff conducted the 200-m buffer. No *C. odorata* plants were found during that survey.
- One new ICA (MMR-ChrOdo-01) was created at Kahanahaiki.
  - One mature plant was found in an area frequented by staff. Staff have completed the 200-m buffer and no additional plants have been found since.

- Kaala Rd ICAs: No plants have been observed in the CMakalehaNoMU-01 ICA since 2018 or the CMakalehaNoMU-02 ICA since 2019. At EMakalehaNoMU-ChrOdo-03, numbers continue to decline.
- No additional plants have been found in the Kamaili ICAs (Kamaili-ChrOdo-01 and Kamaili-ChrOdo-02) since 2018, when they was first discovered, or in the buffer surveys.
- No plants have been observed at the SBE ICA (SBE-ChrOdo-01) since 2015, or the Manuwai ICA (Manuwai-ChrOdo-01) since 2017.
- The KaluaaNoMU-ChrOdo-01 ICA along the SBS access trail reports low numbers of *C. odorata*. Fifteen immature plants were treated this report year. However, no mature plants have been observed at this ICA since 2018.
- Staff continue to work with OISC, the Hawaii Department of Agriculture, the U.S. Forest Service, the State Division of Forestry and Wildlife, and Biosecurity Queensland to pursue a biocontrol. Staff shipped immature *C. odorata* plants to HDOA on Hawaii Island in preparation for host specificity testing. A successful biocontrol agent is critical to island-wide suppression and control of *C. odorata*.
- ANRPO participates in the *C. odorata* Working Group, which is managed by OISC. This group focuses on outreach, building support for control efforts and biocontrol, and mobilizing volunteer groups to check public trails.
- Staff will be completing a study on the efficacy of five organic herbicides on *C. odorata*. Results of this study will be discussed in the 2022-2023 report year.

Figure 3: Graduate assistant, Samantha Shizuru, recording phenology data for her study on "Monitoring Phenology of *Chromolaena odorata* to Inform Management of an Incipient and Highly Invasive Species in Hawaii".

Taxon: *Schizachyrium condensatum*

List of MUs with active ICAs: Manuwai, SBE No MU, and SBW No MU.

2021-2022 Highlights:

- Total 2022 Control: 326 hrs; 40.1 ha; 30 visits; accounted for 12% of time spent on ICA work, and 10% of all ICA area controlled.
- Total 2021 Control: 75 hrs; 48.9 ha; 10 visits; accounted for 3% of time spent on ICA work, and 14% of all ICA area controlled.
- Total 10 ICAs, 10 of which were visited this year. One new ICA (SBE-SchCon-09) was established.
- The largest and oldest infestation, SBE: The majority of taxon effort (93%) was spent here.
  - Staff checked 7 out of 7 ICAs; and all ICAs reported plants observed.
  - The core infestation is located in one large ICA (SBE-SchCon-02) along Centerline Road, and a smaller population is located in another ICA in the ER-2 training range to the north ICAs.
  - A significant increase in effort spent is due to more staff completing ICA checks per visit.
  - The smaller ICAs are outliers located along the Pineapple Junction Road and have low numbers of plants; four of these ICAs reported $\leq$ 3plants.
- No plants have been observed since 2019 at the SBWNoMU-SchCon-01 ICA, which is located on the live-fire training range in the Radiologically Controlled Area and only accessed during cold range weeks.
- Only one mature *S. condensatum* was found and treated this report year at the Manuwai ICA (Manuwai-SchCon-01).

Taxon: *Sphagnum palustre*

List of MUs with active ICAs: Kaala Army and Kaala NAR.

2021-2022 Highlights:

- Total 2022 Control: 272 hrs; 3.4 ha; 22 visits; accounted for 10% of time spent on ICA work, and 1% of all ICA area controlled. Majority of Total Control accounted for the buffer surveys that are scheduled every 2-3 years to re-delineate the ICA boundaries.
- Total 2021 Control: 76 hrs; 1.2 ha; 21 visits; accounted for 3% of time spent on ICA work, and 3% of all ICA area controlled.
- Total 9 ICAs at Kaala MU, 9 of which were visited this year. No new ICAs were established.
- Only 1 ICA (Kaala-SphPal-08) reported no *S. palustre* this year.
- Staff are not reporting large patches across all ICAs except at Kaala-SphPal-05 and Kaala-SphPal-10.
- Staff are observing small, isolated *S. palustre* further off the trails.
- Kaala-SphPal-03 is relatively large in size and the vegetation can be dense, making it extremely difficult to detect every single *S. palustre* sprig.
  - Staff continue to find patches sporadic throughout.
  - A new small patch was found just outside the ICA during the buffer survey. The ICA has been expanded.
- ANRPO will continue to control these ICAs; however, may reduce frequency of checks for most of these ICAs (except the Radio tower) since there is a steady decline in *S. palustre*.
- Staff will also maintain established trails, i.e., clear brush, flag trees, and consider boardwalk-type structures to improve the transect trail across muddy sections, which could reduce the chances of *S. palustre* spreading further in the MU.

Table 5: 2022 ICAs Controlled by IP Management Unit

MU	Total # of ICAs checked	ICA Species	Comments
Aimuu No MU	1 of 2	*C. odorata*	AimuuNoMU-ChrOdo-08 is on private land and not checked by ANRPO. KTA-ChrOdo-22 has trails that cross unto AimuuNoMU-ChrOdo-10 (private land) and were surveyed this year.
Ekahanui	3 of 3	*E. stipoides*	Ekahanui-EhrSti-01 was eradicated as the last plant observed there was in 2019. Ekahanui-EhrSti-03, located by the '*Cenchrus* bumpout', is a new ICA.
Helemano South No MU	1 of 1	*Leptospermum scoparium*	ANRPO has been controlling this ICA since 2007 as it is near *Gardnia manii* plants. It is swept annually. This is a lower priority action, not in a MU, and takes an entire day to sweep. ANRPO will likely reduce more efforts here and possibly coordinate with the Koolau Mountain Watershed Partnership to control *L. scoparium* as it overlaps their own work sites.
Kaala Army	18 of 23	*A. evecta*, *Anthoxanthum odoratum*, *C. crocosmiifolia*, *Diplazium esculentum*, *Juncus effusus*, *P. glomerata*, *S. palmifolia*, *S. palustre*	All these ICAs are relatively small in area and can be checked in one day. Volunteers assist with a few *J. effusus* and *C. crocosmiifolia* ICAs. The *A. evecta* ICA will be discontinued. *C. crocosmiifolia* is problematic as manual control is the only method, which is time consuming and ineffective. ANRPO will re-evaluate control measures to determine a more effective management plan. The *P. glomerata* and *S. palmifolia* ICAs have not had plants for a few years, which is promising. *S. palustre* continues to be found but in small, isolated patches.
Kaala NAR	11 of 12	*C. crocosmiifolia*, *Diplazium esculentum*, *Juncus effusus*, *P. glomerata*, *S. palustre*	All these ICAs are relatively small in area and can be checked in one day. Staff continue to collaborate with NEPM on checking these ICAs.
Kahanahaiki	17 of 20	*Acacia mearnsii*, *A. evecta*, *C. odorata*, *E. stipoides*, *Macfadyena unguis-cati*, *P. glomerata*, *S. palmifolia*	There is a steady decline in all *E. stipoides* ICAs. One, MMR-EhrSti-09, was eradicated. No plants have been observed at the *C. odorata* ICA since it was first discovered earlier this report year. No *M. unguis-cati* has been seen since ICA. ANRPO will designate *A. mearnsii* and *A. evecta* as target taxa not ICAs as there are too many sources constantly infiltrating the MU from the outside to allow for eradication. Staff will continue to target these in the fenced MU, especially near rare taxa. One out of the four *P. glomerata* ICAs reported plants, but numbers continue to decline.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Kahuku-Laie No MU	1 of 1	*C. odorata*	Staff only found one plant in the last three years. This ICA encompasses a large cliff adjacent to the road which makes doing an entire sweep of the ICA improbable. Staff attempt to binocular survey cliffs but do not find much.
Kawaikoele to Elehaha No MU	2 of 2	*C. odorata*, *R. tomentosa*	The *C. odorata* ICA was expanded, but the extent of the population was never determined. Staff conducted stream surveys and found mature plants further away from this ICA. However, this ICA is on private land and is not ANRPO responsibility, so the ICA was reduced back to its original size and information about this infestation was shared with the landowner. The *R. tomentosa* ICA has shown a decrease in plants since 2017.
Kaluaa and Waieli	9 of 10	*A. evecta*, *Blechnopsis orientalis*, *Casuarina equisetifolia*, *Dovyalis hebecarpa*, *E. stipoides*, *Solanum capsicoides*	The *A. evecta* will be discontinued as an ICA. *C. equisetifolia* continues to have no plants and is scheduled to be eradicated by 2024. Few plants have been observed at the *B. orientalis*, *D. hebecarpa* and *S. capsicoides* ICAs. The *E. stipoides* has low numbers, however, was recently expanded as plants were found just outside the ICA.
Kaluaa No MU	4 of 4	*Clusia rosea*, *Morella faya*, *C. odorata*	One new *C. odorata* ICA was found along the SBS road, which is concerning as it was likely spread by contaminated range maintenance gear. The *C. rosea* ICA will be 'Discontinued' as this taxon is unfeasible to treat as an ICA. Staff will target this taxon in the MU whenever seen. The *M. faya* ICA will remain, however may be re-evaluated to reduce checks as one 1 plant has been seen since 2018.
Kaluakauila	1 of 1	*A. cordifolia*	This is a new ICA. *A. cordifolia* was known in the area but did not pose a threat. However, this vine is problematic as it grows densely in the canopy and can produce large and heavy corms that can weigh down native tree branches. It has a high HPWRA of 20 and has been spreading through the MU.
Kamaili	2 of 2	*C. odorata*	Both *C. odorata* ICAs have had no plants observed for over 3 years. Only a total of 3 immature plants for both ICAs have been found. Staff will continue to check these ICAs on an annual check schedule, but may consider eradiation in 2025 for both ICAs.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Kapuna Upper	4 of 14	*A. evecta*, *E. stipoides*, *E. mollis*, *Neonotonia wightii*, *P. glomerata*, *S. palmifolia*	ANRPO collaborates with NEPM on ICA control. Again, the *A. evecta* ICAs will become discontinued as this species cannot be feasibly eradicated or controlled. Staff will continue to target this taxon when working in this MU and should control any *A. evecta* near rare taxa. Staff will control known hotspots or gulches every 2-3 years focusing on mature *A. evecta*. The *E. mollis* is a new ICA. *E. mollis* is a common trail weed in the Koolaus, but not well-established in the Waianaes.
Kawaihapai No MU	1 of 1	*Rubus argutus*	Staff continue to observe no *R. argutus* on the Kuaokala Road since 2013. This ICA can be eradicated in 2023.
Kawaiiki No MU	2 of 2	*C. odorata*, *L. scoparium*	Staff control *L. scoparium* during annual Army LZ surveys. Few plants have been found. A new *C. odorata* ICA was established at Kamehameha School's access gate and will be checked annually during road surveys.
Kawainui No MU	1 of 1	*Chelonanthus acutangulus*	Since 2016, numbers of *C. acutangulus* found fluctuates from each quarterly check as staff have used different treatment methods, i.e., handpull, clip&drip w/20% Garlon4 ultra-application, pre-emergent application following hand-pull, and foliar spray w/glyphosate/pre-emergent/imazypyr cocktail. The most effective mixture seems to be the foliar spray w/glyphosate/pre-emergent/imazypyr cocktail as it gave the longest suppression than the other methods. Constant *C. acutangulus* numbers also suggests that this species has a strong seed viability.
Keaau No MU	1 of 1	*C. setaceus*	Staff are limited to controlling *C. setaceus* found along the fenceline. Staff spend most effort on surveying the Keaau side to document number of plants. There are a few hundred plants, however herbicide is not allowed on Keaau side of the fenceline as it is privately owned and plants are inaccessible as they are growing on the edge of the eroded ridge or on the cliffs below. ANRPO will contact the landowner again to determine if herbicides are still not permitted. An aerial spray would be the most effective treatment.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Kihakapu No MU	1 of 1	*P. glomerata*	This ICA is from the Lower Kaala NAR Road. This spot is checked during the annual road survey as it is a lower priority ICA and difficult to access (dependent on road drivability).
Koloa	1 of 1	*Hedychium coronarium*	This ICA includes a large portion outside of the Koloa MU fence enclosure and steep areas. Staff focus on control inside the fence annually. ANRPO plans to re-map boundaries of where *H. coronaium* have been found to better inform control efforts.
KTA No MU	40 of 40	*Acacia mangium*, *C. setaceus*, *C. odorata*, , *Miscanthus floridulus*, *Senecio madagascarensis*	Staff spend most effort on *C. odorata*. KTA-ChrOdo-31 status change to 'Inactive' due to steep terrain and no observations of *C. odorata* for over 2 years. The *A. mangium* ICAs continue to have low numbers. The *M. umbellata* ICAs are large and are densely vegetated, making checks extremely difficult to spot plants. Staff will need to re-evaluate control strategies to determine the most effective method. ANRPO is considering discontinuing the *M. floridulus* ICA as plants have not been seen since 2019 on a cliff during an aerial spray. Also, this ICA is in the core *C. odorata* ICA, which makes it difficult to prevent staff exposure to flowering *C. odorata*. Only 1 mature plant in 2017 was found at the *S. madagascarensis* ICA.
Lihue	4 of 5	*Dietes iridioides*, *Erythrina poeppigiana*, *P. glomerata*, *S. capsicoides*	Both *D. iridioides* and *P. glomerata* ICAs are located on the Nalus LZ, which is surveyed quarterly. Only 1 immature *D. iridioides* was ever found and the *P. glomerata* ICA has a steady decline in numbers. The *E. poeppigiana* ICAs report low numbers, however much of these ICAs are in UXO areas, which restricts staff's ability to thoroughly survey the area. ANRPO will reduce the frequency of checks for *S. capsicoides* as only 1 mature plant was found in 2017.
Makaha I	3 of 3	*C. odorata*, *E. stipoides*, *P. glomerata*	No *C. odorata* has been observed since it was established in 2021. The 200-m buffer was completed and no other *C. odorata* was found. No plants have been found at the *E. stipoides* ICA since 2019 and it will likely be eradicated by next year. Staff continue to report low numbers of *P. glomerata* in this ICA.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Makaha II	3 of 4	*M. faya*, *P. glomerata*, *S. palmifolia*	Only a few *M. faya* plants were reported by staff in 2022. Both *P. glomerata* ICAs have a constant amount, which is probably due to the inability to suppress the seed bank with a pre-emergent. *Setaria palmifolia* has not been observed since 2017, so checks can be less frequent.
Makaha No MU	3 of 5	*A. evecta*, *C. odorata*, *E. stipoides*, *L. scoparium*, *P. glomerata*	The *A. evecta* ICA will be discontinued and become a target taxon. Staff continue to find low numbers of *C. odorata*. No plants were observed in the *E. stipoides* since June 2019 and it will be eradicated next year. ANRPO continues to collaborate with WMWP on *L. scoparium*. Few plants have been found in walkable areas. Rappelling to control the remaining *L. scoparium* may be needed but this is a lower priority ICA to complete.
Makaleha Central No MU	5 of 6	*A. glomeratus* var. *pumila*, *C. odorata*, *P. glomerata*	The *A. glomeratus* var. *pumila* ICA was established this report year. Only1 mature plant has been found. The *C. odorata* ICAs have low numbers and are steadily declining. Both *P. glomerata* ICAs have sporadic upticks in numbers, but on a steady decline.
Makaleha East	2 of 4	*J. effusus*, *P. glomerata*, *S. palmifolia*	Both *J. effusus* and *S. palmifolia* located at the top of the Dupont Trail continue to have low numbers. The *P. glomerata* at culvert 69 has not had any plants since 2017. The EastMakaleha-PteGlo-02 is hard to access and is only checked when staff visit the area for other actions. The State has agreed to assist in checking this ICA.
Makaleha East No MU	3 of 4	*C. odorata*, *C. crocosmiifolia*, *P. glomerata*	Staff continue to report low numbers of *C. odorata*. The culvert 59 *C. crocosmiifolia* continues to have a steady number of plants. Only few *P. glomerata* were reported and numbers are steadily declining.
Makaleha West	3 of 4	*E. stipoides*, *E. mollis*, *P. glomerata*	No plants have been found since 2019 at the *E. stipoides* ICA and will considered to be eradicated next year. Both *P. glomerata* ICAs reported low numbers. The *E. mollis* ICA is new. Only 1 immature was recorded.
Makaleha West No MU	1 of 1	*P. glomerata*	The numbers of *P. glomerata* are consistently high at this ICA, which is not in a fenced area and has ungulates present. ANRPO will re-evaluate management of *P. glomerata* here as staff only monitor the *Alectryon macrococcus* var. *macrococcus* trees, which have since all died.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Manuwai	9 of 9	*Caesalpinia decapetala*, *C. odorata*, *D. iridioides*, *P. glomerata*, *S. condensatum*	The last *C. decapetala* plant was found in 2014 and the ICA can be declared eradicated by 2024. The *C. odorata* continues to have no plants. The *D. iridioides* ICA has been problematic as numbers have been consistently high. Fortunately, this taxon seems to be limited to this site, but control seems to be ineffective. ANRPO will investigate new control measures. Staff report a sporadic number of *P. glomerata* in the largest ICA but it is declining overall. The other *P. glomerata* ICAs continue to have low numbers. Only 1 mature *S. condensatum* was reported this year.
MMR No MU	2 of 2	*D. intortum*, *R. argutus*	The *D. intortum* was recently re-established as an ANRPO ICA from NEPM. Only 1 plant was observed in 2020. Staff still report *R. argutus*, but numbers have drastically declined over the years.
Nanakuli No MU	1 of 1	*C. crocosmiifolia*	No *C. crocosmiifolia* was reported this year and this ICA will continue to be checked by the Outreach program as it is easily accessible for volunteers.
Oahu North Central No MU	1 of 1	*C. odorata*	Staff continue to check the ICA just off of the Poamoho access road quarterly and report small number of plants. However, ungulate presence here remains high as it is in the ranch area, so the spread outside of the ICA is high. There is a known population of *C. odorata* that was found in the pastureland actively grazed by cattle. This was found during a 200-m buffer survey and the State and landowner were notified.
Ohikilolo	9 of 9	*Cirsium vulgare*, *E. stipoides*, *P. glomerata*, *R. argutus*, *Sideroxylon persimile*	Staff continue to report zero *Cirsium vulgare* plants and can be considered eradicated by year 2025 if none are found. The largest *E. stipoides* ICA has a constant high number of plants. This ICA is difficult as *E. stipoides* is cryptic and easily missed. Both *P. glomerata* ICAs at Ohikilolo the "Ctenitis PriKaa" site and Camp LZ have recorded zero plants for over 4 years. The last *R. argutus* found at the ICA Ohikilolo DZ was in 2019 and will be eradicated next year. The Ohikilolo gate *R. argutus* was eradicated this year. The *R. argutus* Red dirt Puu will be 'Discontinued' as it is extremely steep and too dangerous for staff to continue to check. The *S. persimile* ICA is in Makua and will be 'Discontinued' as only 1 mature plant was ever found.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Ohikilolo Lower	2 of 2	*C. setaceus*, *Tithonia diversifolia*	There is a consistent number of *C. setaceus* plants found, but consistent aerial sprays are effective on managing this population. Staff will likely increase aerial control to 2-3 times a year to aggressively manage the core population. No plants at the *T. diversifolia* ICA have been observed since it was established in 2021.
Opaeula	3 of 9	*A. evecta*, *Rhynchospora caduca*, *S. palmifolia*	All *A. evecta*, *R. caduca*, and *S. palmifolia* ICAs will be discontinued as these taxa are more widespread now and consistent control is unfeasible due to weather conditions. Staff should always target these species whenever found.
Opaeula Lower	4 of 4	*R. caduca*, *S. palmifolia*	The fenceline and weatherport *R. caduca* ICAs have a constant influx of plants. ANRPO may need to re-evaluate control strategy as controlling these ICAs is also suppressing natives from re-establishing to compete with *R. caduca*. Numbers in the *S. palmifolia* are relatively low and continue to decline.
Pahole	18 of 18	*A. evecta*, *Axonopus compressus*, *C. odorata*, *Dicliptera chinensis*, *E. mollis*, *P. glomerata*, *R. tomentosa*, *S. palmifolia*, *Tecoma capensis*	Again, *A. evecta* will be discontinued as an ICA species. Staff will continue to target whenever found. Few plants have been found in the *A. compressus* ICA. No plants have been observed in the *D. chinensis* and *R. tomentosa* ICAs and they will be declared eradicated after one more check with no plants. Only a few plants have been reported for both *E. mollis* ICAs over the past couple of years. The *S. palmifolia* has been eradicated. Last *T. capensis* reported by staff was 2018, so current control will continue.
Palikea	12 of 12	*Arthrostemma ciliatum*, *C. crocosmiifolia*, *D. chinensis*, *P. glomerata*, *S. palmifolia*	No plants have been observed in the *A. ciliatum* ICA since it was created in 2019, so frequency of checks will decrease. All *C. crocosmiifolia* ICAs report high constant numbers. This taxon is difficult as staff are limited to manual control. There is no approved effective treatment method available now. ANRPO will investigate new control methods. Staff report low numbers of *D. chinensis*. No *P. glomerata* has been seen at the fenceline and North Palikea Snail Enclosure for over three years. The Cabin DZ *P. glomeratus* had only 1 mature plant in 2021. Three of the four *S. palmifolia* ICAs reported no plants.

Table 5 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Poamoho No MU	1 of 3	*A. evecta*, *L. scoparium*	All *A. evecta*, *L. scoparium* ICAs will be discontinued as consistent control is unfeasible due to weather conditions. Staff should always target these species whenever found.
SBE No MU	18 of 19	*Alstonia macrophylla*, *A. glomeratus* var. *pumila*, *C. odorata*, *Heterotheca grandiflora*, *R. tomentosa*, *S. condensatum*, *Smilax bona-nox*, *Vitex trifolia*	The majority of time spent by staff is geared towards *S. condensatum* and *R. tomentosa*. ICAs for both species have constant steady numbers as these areas are large and often get regularly mowed. *A. macrophylla* is a lower priority and has not been completed since 2016, so will likely be 'Discontinued', but still targeted when found. The *A. glomeratus* var. *pumila* ICA was created this year with only 1 mature reported. The last *C. odorata* was observed in 2015. The *S. bona-nox* and *V. trifolia* ICAs are a lower priority and report low numbers, so the frequency of checks will be reduced. The two remaining H. grandiflora ICAs will be considered eradicated by 2024 as the last plants found at these sites was in 2014.
SBW No MU	9 of 11	*C. odorata*, *Ilex cassine*, *S. condensatum*	Staff spend the majority of total effort controlling *C. odorata*. Two of the seven ICAs are large infestations that are power sprayed and aerial sprayed. The *I. cassine* ICA will be 'Discontinued' as staff have no access to this ICA due to UXO presence. No *S. condensatum* plants have been reported since 2019, so this ICA is trending towards eradicated.
Waieli No MU	1 of 1	*M. faya*	The last observation of *M. faya* was in 2012 when it was established. This ICA may be considered eradicated next year.
Waimanalo to Kaaikukai No MU	3 of 3	*C. crocosmiifolia*, *S. palmifolia*	All *C. crocosmiifolia* ICAs along the access trail to Palikea MU report relatively low numbers and are checked by Outreach and volunteers. The *S. palmifolia* last recorded plants in 2020.
Total: 241 of 294 ICAs checked			

3.3 HABITAT WEED CONTROL SUMMARY

Ecosystem control efforts are tracked in Weed Control Areas (WCAs) and 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 Manuwai, the entire MU has been divided into WCAs. Each WCA is prioritized, and goals are set based on a variety of factors including:

- The presence of MIP/OIP rare taxa,
- The potential for future rare taxa reintroductions,
- The integrity of native forest,
- The level of invasive species presence, and
- The high fire threat.

The 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 *L. scoparium* just outside Koloa), 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 ANRPO database. Visitation rates are scheduled for each action. ANRPO 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 hope 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. All MUs are managed by an assigned field team. The team is responsible for the bulk of weed control efforts. Other factors which contribute to overall effort in an MU include targeted canopy or single species sweeps not focused on IP taxa (carried out by either the assigned field team or weed-project focused Vegetation Restoration team), active volunteer projects (led by the Outreach team), and active restoration projects incorporating aggressive weed control coupled with native taxa restoration. These three factors are included in Table 6 and provide some insight into the levels of effort spent at various MUs. Note that all sites listed have restoration projects, which shows the labor-intensive nature of this type of task.

Table 6: Summary Statistics for WCAs.

Report Year	Visits	Effort (hours)	Area (ha)	Hours/ha
2021-2022	1,001	9,741	75.7	128.6
2020-2021	1,028	8,650	115.2	75.1
2020-2019	863	6,448	83.5	77.2
2018-2019	956	8,299	117.6	70.6
2017-2018	951	7,753	146.3	53.0
2016-2017	727	6,736	126.6	53.2
2015-2016	713	5,995	151.3	39.6
2014-2015 (9 months)*	352	3,117	80.4	38.8
2013-2014	526	5,846	90	64.96
2012-2013	532	5,620	83.4	67.39
2011-2012	443	4,199	57	73.67
2010-2011	409	5,123	*	
2009-2010	353	3,256	*	
2008-2009	267	2,652	*	

*Data not comparable

Figure 4: Staff making neat bundles of weeds to add to a larger slash pile in Palikea.

This year, WCA efforts covered 75.7 ha. Staff spent 9,741 hours over 1,001 visits at 182 WCAs. WCA work accounted for 16% of the total area controlled and 78% 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 12 months each. Area data from 2008 through 2011 was not collected as accurately as current practices and is not presented for comparison.

Total effort significantly increased from last year due to the increase in staff time and camp trips. However, the total area weeded decreased from last year due to the completion of new restoration sites and the Kahanahaiki snail enclosure in 2021 report year and staff focusing on existing sites. One restoration site "Ii nui" in Makaleha West, was completed at the beginning of the 2022 report year. Staff effort was intensive to complete the chipping of slash piles before the deadline for flying the chipper out of the MU, thereby increasing staff time reported with no increase in area weeded.

All MUs which received $\geq$ 150 hours of effort this report year are summarized in Table 6. Most of these MUs are large, host multiple rare IP taxa, contain large swaths of native forest, and are readily accessible; these include Ekahanui, Kaala Army, Kahanahaiki, Kaluaa and Waieli, Kapuna Upper, Koloa, Lihue, Makaha I, Ohikilolo, Pahole, and Palikea. Two MUs on the list are in severely degraded habitat and host one or two IP taxa; these include Keaau Hibiscus and Ohikilolo Lower. Both are dominated by alien grasses. Maintaining fuel levels around the rare taxa at these MUs is a high priority and requires consistent, large inputs of time.

Table 7: Management Units which received ≥ 150 hours of total effort

IP Management Unit	# of MFS Plant Population Reference Sites that received weed control	Hours	Visits	Area Weeded (ha)	Targeted Canopy or Single Taxa Sweeps Conducted?	Volunteer Projects Present?	Restoration Project On-going?
Kahanahaiki	24 of 34	1,535	159	11.91	Yes	Yes	Yes
Makaleha West	3 of 8	999	73	1.87	Yes	Yes	Yes
Palikea	8 of 8	990	109	4.30	Yes	Yes	Yes
Ohikilolo Upper*	9 of 62	862	58	3.83	Yes	No	Yes
Kaluaa & Waieli	16 of 19	632	67	2.63	Yes	Yes	Yes
Makaha I	12 of 21	601	68	4.98	Yes	Yes	Yes
Pahole	16 of 41	601	64	4.56	Yes	Yes	Yes
Kaala Army*	4 of 43	448	43	8.40	Yes	Yes	Yes
Opaeula Lower	3 of 3	414	24	0.88	Yes	No	Yes
Ekahanui	14 of 17	376	41	1.54	No	No	Yes
Keaau Hibiscus	3 of 3	291	26	1.02	Yes	No	Yes
Lihue	6 of 26	288	22	3.11	No	No	No
Kapuna Upper	12 of 23	285	32	1.49	No	No	Yes
Makaha II	7 of 8	246	28	1.37	No	No	Yes
Ohikilolo Lower	3 of 4	233	19	3.34	Yes	No	Yes
Manuwai*	12 of 20	201	25	1.23	No	No	No
Koloa	2 of 18	183	10	1.61	Yes	No	Yes

Not all rare plant Manage for Stability (MFS) *in situ* populations receive weed control, as the weed threat is low for some populations; this includes populations in the following MUs: Kaala Army, Koloa, Ohikilolo Upper, Pahole, and Lihue. The majority of weed control around MFS taxa is focused on reintroduction sites, which are scheduled for consistent visits at least once or twice a year. Additionally, some MUs that have a high number of MFS populations, like Ohikilolo, are only accessible via rope (noted * in Table 7). The total number of MFS populations that received weed control are reported in Table 6 above.

- Volunteer work trips were still reduced as compared to pre-COVID report years. However, volunteer trips have steadily increased through the 2022 report year.
- Targeted sweeps for priority weed species typically cover large areas and contribute to MU-wide habitat protection but are of secondary priority to rare taxa site management. At some MUs and for some slow-maturing priority weeds, target sweeps are not scheduled annually, but at some less frequent interval.
- Access to Manuwai was improved by establishing two new LZs; one on private land off of Farrington Highway and one on the "west side" of the MU; as the access road conditions are variable and permission through private land to the LKNAR has been difficult. Staff also built a camp site near the new "west side" LZ to allow camp trips near work sites in Manuwai.

- Restoration projects typically require large amounts of effort, particularly during initial weed clearing. As restoration sites mature, weed effort gradually declines. This year, no new restoration sites were established. Staff spent a lot of effort maintaining weed levels in existing restoration sites.
- Weed maintenance at infrastructure, including roads, trails, base yards, and greenhouses is important to reduce weed spread and facilitate easy access to work sites. Main trails and roads this year were cleared.

Figure 5: Staff demonstrating careful weeding near native plants.

In the ANRPO database, specific reports can be generated that detail the amount of time spent in each WCA, the plant species controlled, and the techniques used. These database reports, as well as the ERMUPs, provide a more detailed look into each MU and each WCA. It can be difficult to compare effort spent between WCAs or MUs and to judge whether the effort spent was sufficient to improve habitat quality. Since goals for each site vary, estimating the effort needed for each WCA is very challenging.

Control efforts for all MU are summarized in Table 8. The table lists all MUs where WCA control was conducted in the past year. Note that some WCAs specifically track weed control along fencelines and trails. These infrastructure WCAs generally encompass an entire MU, overlapping other WCAs, and explain why the total WCA area is double the MU area. Data from the 2020-2021 report is included for reference. This year's data is in bold and shaded. For each year, the total actual area weeded is reported. The number of separate weeding trips is recorded as the 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 ANRPO has made over the years.

Table 8: MU WCA Weed Control Summary, Report Year 2021 to 2022.

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Alaiheihe No MU	N/A	N/A	11.35	**0**	**0**	**0**	4.80	1	20	This area includes the Lower Kaala NAR access road and is weeded only if necessary.
DMR No MU	1	N/A	4.06	**0.06**	**2**	**24**	0.02	1	2	This MU is a small, fenced enclosure for *Megalagrion xanthomelas*. Weed control here is limited to thinning canopy and understory to increase light levels ideal for *M. xanthomelas*.
Ekahanui	10	87.50	181.15	**1.54**	**41**	**376**	2.15	47	290	Efforts in this large, highly degraded MU were centered on rare taxa locations, restoration sites, and grass/fuel control.
Haili to Kealia I	2	7.91	1.13	**0.29**	**13**	**94**	0.13	7	55	Staff target woody weeds and grasses around the *Hibiscus brackenridgii* subsp. *mokuleianus in situ* and reintroduced plants.
Haili to Kealia No MU	N/A	343.18	31.42	**0.03 (267 m²)**	**1**	**2**	0	0	0	Staff control weeds along the access trail to Haili to Kealia MU as needed.
Honolulu East No MU	N/A	N/A	2.43	**2.43**	**3**	**12**	2.16	7	12	Greenhouse staff conduct regular maintenance throughout the year around rare plant living collections at Koko Crater Botanical Garden.
Huliwai	1	0.1	0.20	**0.13**	**4**	**21**	0	0	0	This MU is centered on an *Abutilon sandwicense* population located in a small, fenced enclosure. Weed control is usually coupled with rare plant monitoring.
Huliwai No MU	4	N/A	9.53	**0.08**	**3**	**19**	0.05 *(532 m²)*	2	16	Staff conduct grass control around a *Cenchrus agrimonioides* var. *agrimonioides* site and along the ridge access trail to the site.
Kaala Army	4	49.02	125.59	**8.4**	**43**	**448**	8.50	40	519	*Hedychium gardnerianum* and *P. cattleianum* are primary weed targets at Kaala. Staff continued to control weeds around rare plant reintroduction sites and along fencelines.
Kaala NAR	2	20.03	24.65	**0.52**	**11**	**24**	0.28	5	84	Staff maintain grasses at the shelter/campsite and along the boardwalk trail. Staff also focus efforts on the Kaala snail enclosure and rare IP taxa sites.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaena	1	10.06	3.28	**0.21**	**2**	**11**	0.28	3	26	Staff targeted grasses and woody weeds around the central and eastern portions of the *Euphorbia celastroides* var. *kaenana* population outside the State's predator proof fence.
Kaena East of Alau	1	14.51	1.20	**0.19**	**2**	**11**	0.50	2	10	Staff focus on reducing grassy fuels around the small *E. celastroides* var. *kaenana* site, including the access trail.
Kahanahaiki	10	37.70	82.77	**11.91**	**159**	**1,535**	24.62	184	1,711	Staff continue to control weeds at rare plant sites, rare snail enclosures, restoration sites, and along trails and fencelines.
Kaiwikoele to Elehaha NoMU	5	N/A	34.17	**0**	**0**	**0**	0.83	1	9	Staff target *L. scoparium* to reduce potential ingress into neighboring Koloa. Since *L. scoparium* can be controlled manually, it is a target during rainy weather at the summit and is a low priority for completion.
Kaleleiki	1	0.12	0.80	**0.02 (244 m²)**	**1**	**1**	0.03 *(313 m²)*	3	10	This *Eugenia koolauensis* population has been heavily impacted by the *Austropuccinia* rust, and weed control is a low priority until new options for *E. koolauensis* management are discovered. Staff weed around some of the remaining *E. koolauensis* and along the fenceline as needed.
Kaluaa and Waieli	11	80.97	164.10	**2.63**	**67**	**632**	15.46	62	429	Work increased at several rare plant and insect sites and increased at the Hapapa Snail Enclosure. Total effort increased due to intensive weed control in existing rare plant and restoration zones to prepare for outplanting season.
Kaluaa No MU	1	N/A	14.88	**1.21**	**3**	**6**	0.74	3	5	Staff spray the invasive grass *S. palmifolia* along the access trail and weed in a small TNC-built enclosure which contains some rare taxa.
Kaluaa No MU	1	N/A	14.88	**1.21**	**3**	**6**	0.74	3	5	Staff spray the invasive grass *S. palmifolia* along the access trail and weed in a small TNC-built enclosure which contains some rare taxa.
Kaluanui No MU	6	N/A	209.57	**0.04 (486 m²)**	**2**	**26**	0.02 *(172 m²)*	1	12	Staff weed the around the *Schiedea kaalae* outplants. This action is combined with rare planting outplanting or monitoring.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kamaileunu No MU	N/A	N/A	3.88	**0.03 (388 m²)**	**3**	**25**	0.11	4	33	Staff maintain the LZ, DZ, campsite, and trail to facilitate access to the Kamaili fences. Staff continue to control the *M. hibiscifolia* stand adjacent to the LZ.
Kamaili	5	2.57	3.92	**0.87**	**13**	**103**	0.75	7	51	This MU is divided into mauka and makai fences. In both fences, staff continue to work around rare plant locations and native forest patches, weed restoration sites, control grasses, and remove weeds along fencelines. This year, staff completed more camp trips and spent time clearing the *N. angulata* reintroduction site.
Kapuna Upper	11	172.35	507.69	**1.49**	**32**	**285**	2.07	30	189	Most of the effort in this MU is focused on rare plant sites and along the Keawapilau ridge. Staff have been aggressively removing *P. cattleinum* and *S. terebinthifolius* between the *C. longliflora* and *S. nuttallii* reintroduction zones to create more habitat for future outplantings. This year, staff spent more time intensely weeding this restoration site to prepare for outplanting season.
Kawainui No MU	9	N/A	113.06	**0**	**0**	**0**	0.22	1	3	This area overlaps Kaiwikoele to Elehaha NoMU. Staff target *L. scoparium* to reduce potential ingress into adjacent Koloa MU and is a good rainy-day activity at the summit.
Keaau and Makaha	1	1.19	0.18	**0**	**0**	**0**	0.006 *(63 m²)*	1	1	This WCA contains a small population of *Sanicula mariversa*, which can be difficult to access. Weeding usually happens when coupled with rare plant monitoring.
Keaau Hibiscus	2	N/A	7.35	**1.02**	**26**	**291**	1.14	24	213	All weeding effort focuses around *in situ* and reintroduced *H. brackenridgei* subsp. *mokuleianus*, reintroduced *Gouania vitifolia*, common native outplantings, and along the trails and fenceline. Fuels reduction is a high priority. This year, staff created a new fuel break along the fenceline in areas that would be highly susceptible for fire to move and burn in the unit.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Keaau No MU	N/A	N/A	0.73	**0**	**0**	**0**	0.62	5	9	Regular maintenance is conducted along the access trail to the MU and LZ as needed. Both grasses and woody weeds are targeted.
Koloa	9	71.54	72.95	**1.61**	**10**	**183**	3.17	27	343	Located at the summit of the Koolau Mountains, weather poses a major challenge to conducting effective weed control. Staff focus weeding efforts around reintroduction zones and sweeping for target taxa throughout the MU. This year, staff released the *P. cattleianum* biocontrol, *Tectacoccus* in the MU.
KTA No MU	N/A	N/A	3.53	**0.79**	**3**	**7.50**	0.40	1	3	Staff spray out any leftover mixed herbicide from controlling a nearby *C. odorata* hotspot with a power sprayer along the Bravo Road.
Kuaokala No MU	N/A	N/A	0.83	**0**	**0**	**0**	0.05 *(536 m²)*	1	1	Staff control grass along the access trail as needed.
Lihue	12	711.92	1439.46	**3.11**	**22**	**288**	3.27	16	226	Much of all effort is around four rare taxa sites, particularly the 'Olopua' and 'Hame' fences, and maintaining trails.
Makaha I	10	34.20	71.20	**4.98**	**68**	**601**	5.07	68	499	Staff weed consistently throughout the year in rare plant and restoration sites and conduct grass control. All rodent control trails are also cleared throughout the year. There was an increase in total effort due to the expansion of an existing restoration site.
Makaha II	7	26.69	14.73	**1.37**	**28**	**246**	0.71	18	128	Staff prioritize weed control in rare plant sites and along fencelines. This year, the total area weeded, and effort increased due to field teams completing multiple camp trips, which allowed for conducting more weed control.
Makaha No MU	N/A	N/A	12.70	**0**	**0**	**0**	0.00036 *(3.60 m²)*	1	0.15	These WCAs are for trail and road maintenance outside of the fence enclosure, as needed.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaleha Central No MU	2	N/A	0.19	**0.10**	**1**	**1.50**	0.01 *(113 m²)*	1	4	Staff concentrate weed control around the remaining *in situ Kadua degeneri* var. *degeneri* population when monitored.
Makaleha East West Branch	2	1.14	1.23	**0.01 (65.60 m²)**	**1**	**1.50**	0.001 *(18 m²)*	1	1	Staff concentrate weed control around the remaining *in situ K. degeneri* var. *degeneri* population when monitored.
Makaleha West	7	38.05	8.89	**1.87**	**73**	**999**	2.85	53	466	This MU has three fences, two adjacent and one widely separated to the north. Staff weed around rare plant taxa, restoration sites, and in/around the snail enclosure. There was a significant increase in total effort this year due to staff clearing the remaining stands of dense *P. cattleianum* for the 'Ii nui' restoration site.
Makaleha West No MU	N/A	N/A	0.36	**0.06**	**3**	**7**	0.13	2	4	Staff maintain the trail to the MU by clearing weeds and spraying invasive grasses as needed.
Manuwai	12	122.49	254.74	**1.23**	**25**	**201**	1.00	23	105	Much of Manuwai is highly degraded forest in steep terrain. Staff focus weed efforts around reintroduction sites and along trails and fences. This year, access was greatly improved due to the newly established LZ and campsite on the west side to facilitate more work in this MU. A new *H. brackenridgei* subsp. *mokuleianus* reintroduction site was created. The total effort increased due to staff conducting more camp trips.
Manuwai No MU	N/A	N/A	4.17	**0**	**0**	**0**	0.1 *(808 m²)*	1	1	Staff control grasses along the western access trail and fenceline as needed.
MMR No MU	N/A	N/A	24.13	**0.12**	**4**	**5**	0	0	0	Weed control is mainly conducted along the Re-Veg section of the road and MMR and Kahanahaiki fencelines as needed.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Moanalua No MU	1	N/A	88.95	**0**	**0**	**0**	0.05	2	13	Staff focus on controlling *L. leucocephala* and grasses along the Tripler fenceline of *M. xanthomelas* enclosure as needed.
Nanakuli No MU	N/A	N/A	6.01	**0**	**0**	**0**	2.9	3	52	This leeward facing bowl stretches between the Palikea and Palikea IV MUs. *S. cooperi* is targeted to decrease spore sources that blow into the Palikea MU. This is on a bi-annual schedule.
Oahu North Central No MU	N/A	N/A	0.06	**0**	**0**	**0**	0.01 *(95.0 m²)*	1	2	Staff maintain weeds around both old and new rare plant living collections at Wahiawa Botanical Garden.
Ohikilolo	14	232.79	155.29	**3.83**	**58**	**862**	4.06	52	499	The Lower Makua portion of the MU was closed the majority of the year due to UXO issues. UXO has been cleared along main trails and staff access and effort should increase. Most work reported here occurred in the Ohikilolo Ridge portion of the MU. Staff continue to focus on rare taxa sites, native forest patches, grass control, restoration projects, sweeps for *Clidemia hirta*, and ridgeline control of *S. terebinthifolius*. This year, there was an increase in total effort hours due to more scheduled camp trips than last year.
Ohikilolo Lower	3	28.75	4.62	**3.34**	**19**	**233**	3.14	25	215	All work at this MU is focused around three rare plant sites. The goal of weed control is to reduce fuels while increasing native vegetation cover. Unfortunately, the *H. brackenridgei* subsp. *mokuleianus* patch was severely burned this year. ANRPO will re-evaluate weed control and restoration actions here.
Opaeula Lower	4	10.15	14.02	**0.88**	**24**	**414**	2.07	29	285	Staff conduct weed control at the *in situ C. dentata* and *G. mannii* reintroduction sites and restoration areas. Staff also control weeds along the fence and trails. There was an increase in total effort hours due to more scheduled camp trips.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Pahole	14	88.02	193.65	**4.56**	**64**	**479**	4.36	65	702	Staff prioritize effort at rare plant sites. In the back of gulch 3 and the 'Bill Garnett' site, ANRPO and the State have been increasing weed control efforts to improve overall native habitat. Trail and fence maintenance is also regularly completed.
Pahole No MU	N/A	N/A	24.28	**7.26**	**6**	**21**	6.09	11	65	Staff control weeds along the Pahole road, around the Nike greenhouse and LZ, along the beginning of the Kahanahaiki-Pahole access trail, on the access trail to the main Pahole gulch, and around the *C. agrimonioides* var. *agrimonioides* site near the Pahole-Kahanahaiki crossover.
Palawai No MU	N/A	N/A	5.97	**0.01 (142 m²)**	**2**	**1**	1.27	1	12	This area immediately abuts the Palikea MU. Since *S. cooperi* numbers have declined due to the success of past efforts, the area will be treated every other year.
Palikea	4	9.95	22.14	**4.30**	**109**	**991**	3.97	134	1,118	Staff continue to focus on maintaining restoration sites, rare taxa sites, in/around the snail enclosures, grass control, and rodent control trail/fence maintenance.
Puaakanoa	1	10.70	2.21	**0.48**	**9**	**28**	0.30	7	29	This region is steep, rocky, and at risk for fire. Staff focus directly in *E. celastroides* var. *kaenana* sites and along the trail and fenceline.
Pualii North	1	7.99	10.98	**0.56**	**10**	**66**	0.54	9	31	Staff focused weed control around rare plants and along the fenceline. The *H. oahuensis* plants, which are located on the ridge and close to the top of the MU, were prioritized for weed control.
SBE No MU	N/A	N/A	4.22	**0.08**	**3**	**5**	0.20	1	2	Staff control weeds around East Base to reduce the potential for staff and volunteers to act as vectors.

Table 8 (continued).

Management Unit	Total IP taxa	MU area (ha)	Total WCA area (ha)	2022 Report Year			2021 Report Year			Comments
				Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
SBW No MU	N/A	N/A	2.62	**0.98**	**8**	**13**	1.10	9	34	Staff continued to regularly maintain weeds at West Base to reduce the potential for staff to act as vectors. Staff spent most weed control effort at the Kahua Living Collection site.
Waianae Kai	4	3.66	1.14	**0.002 (16 m²)**	**1**	**1**	0.38	5	10	The majority of effort at this MU was spent clearing weeds around wild *Nototrichium humile* in two small fences.
Waianae Kai No MU	N/A	N/A	3.85	**0**	**0**	**0**	0.07	1	1	Staff clear the main access trail to Slot Gulch as needed.
Waimanalo to Kaaikukai No MU	1	N/A	12.71	**0.47**	**2**	**2**	0.63	3	4	Staff control invasive grasses along the access trail to Palikea. Staff also weed around the *K. parvula* outplants along the trail.
Waimea No MU	N/A	N/A	0.27	**0**	**0**	**0**	0.27	2	13	The rare plant living collections at Waimea Valley are weeded as needed.
TOTAL	N/A	N/A	4064.83	**75.70**	**1,001**	**9,741**	115.14	1,028	8,650	Total effort increased (1,091 hrs) this year due to the lift of COVID restrictions, which allowed for more camp and volunteer trips.

3.4 INTER-AGENCY COLLABORATION

Invasive species management can be incredibly daunting, as the number of weeds rarely diminishes, and new species discoveries add to an ever-mounting list of challenges. Similarly, much remains to be learned about restoration techniques. Collaboration is critical in achieving progress. ANRPO supports, and is supported by, a variety of partner agencies and researchers in addressing weed control and restoration issues. Notable partners and researchers include, but are not limited to, the alphabetical list below. In addition, ANRPO participates in discussions with and replies to inquiries from a variety of other members of the invasive plant and restoration community, including watershed partnerships and invasive species committees, the Nature Conservancy of Hawaii, State and County Agencies, other Federal Agencies and other branches of the Armed Forces.

- Bishop Museum. Plant samples were submitted to and identified by the Bishop Museum Herbarium staff. Noteworthy finds are discussed in Section 3.7.
- Board of Water Supply (BWS). BWS reviews ANRPO 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.
- Department of Defense (DOD) Strategic Environmental Research and Development Program (SERDP). A SERDP proposal from UH and UC Berkley focused on the use of eDNA to track the presence and spread of invasive alien taxa was funded. ANRPO are coordinating logistics and helping to guide priorities with the researchers involved in this study.
- DOD (ESTCP). Staff provided technical assistance for an ESTCP proposal from Applied Research Associates, intended to explore plant identification from unmanned vehicle imagery. Unfortunately, this proposal was not awarded.
- Federal Aviation Administration (FAA), Kaala facility. Staff informally share information on invasive plants found within the FAA facility on the summit of Kaala, and along the Kaala access road, with FAA and road maintenance personnel.
- Hawaii Agricultural Research Center (HARC). This year, staff continued to assist HARC with their project to develop fungus-resistant *Acacia koa* stock for the Waianae Mountains, which may then be used by staff for restoration projects.
- Hawaii Department of Agriculture (HDOA). This year, staff continued working with HDOA on the development of a biocontrol for *C. odorata*.
- Hawaii Vertebrate Introductions and Novel Ecosystems (VINE) Project. ANRPO continues to support VINE researchers by providing access to field sites and input on new project ideas. This year, VINE projects finished a first phases of their project and continue to focus on interactions between birds and plants. These studies have implications for weed control and restoration projects.
- Hawaiian Electric Company (HECO). ANRPO maintains a positive working relationship with HECO staff. HECO accesses parts of Army training ranges to maintain their infrastructure. They continue to be aware of range sanitation requirements.
- Honolulu Botanical Gardens. ANRPO manages rare taxa living collection sites at Koko Crater Botanic Garden and Wahiawa Botanic Garden. This work includes vegetation maintenance.
- Koolau Mountains Watershed Partnership (KMWP). The U.S. Army Garrison, Hawaii is an active member of the partnership. Cooperative work with partners still was a challenge due to COVID restrictions, so ANRPO did not work with KMWP in 2022 report year.

- Oahu Invasive Species Committee (OISC). ANRPO serves on the OISC steering committee and attends all committee meetings. ANRPO continues to collaborate with OISC on a variety of *C. odorata* issues, including sharing information about newly discovered infestations, contracting OISC to conduct control at KTA, surveying steep slopes with gigapan imagery, collaborating on overall management strategy, and pursuing a biocontrol.
- University of Hawaii (UH). OVPRI continues to fund graduate assistantships (GAs) of UH affiliates conducting research relevant to ANRPO goals.
    - Two GAs were funded in January 2021, and three were funded in June 2021; two of these GAs are studying vegetation management related topics. Both January 2021 GAs have completed their projects.
    - Results from GA study "Monitoring the Phenology of *Chromolaena odorata* to Inform Management of an Incipient and Highly Invasive Species in Hawaii" has help to better guide the timing of control efforts and lay the groundwork for monitoring the eventual impacts of a biocontrol release.
    - One of the June 2021 GAs is training artificial intelligence to identify *A. evecta* from high resolution aerial imagery, has been extended another year to complete the full analysis.
- State of Hawaii: Dept. of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), Native Ecosystems Protection and Management (NEPM).
    - The Army's Readiness and Environmental Protection Integration (REPI) funds were awarded for Kaluakauila fuel control and Lower Kaala NAR Road maintenance. ANRPO conducted site visits to both sites. ANRPO assisted with developing proposed work plans for Kaluakauila to ensure these complemented ANRPO actions in this MU.
    - ANRPO staff collaborated with NEPM to control *A. evecta* spotted below the Nike Site, in a gulch between the Re-veg Road and Kuaokala Road. A few *A. evecta* were found and treated. This work collaboration is important to building good relationships with State programs, who work in the same areas, and exchange knowledge of effective control techniques.
- U.S. Forest Service (USFS). Staff assisted Forest Service staff with access and logistical support for the Forest Inventory and Analysis (FIA) project. This national program provides assessments of forests across the nation and monitors change over time. FIA plots are located at KLOA, KTA, MMR, and SBE.
- USDA/US Forest Service, Institute of Pacific Islands Forestry. This year, staff continued working with USDA on the development of a biocontrol for *C. odorata*. The gall fly population is being reared at the facility.
    - A new temporary Biocontrol technician in June 2022 to work at the biocontrol facility at Volcano, Hawaii, to prep materials and plants for upcoming host-specificity testing of the gall fly biocontrol.
    - *Chromolaena odorata* plants sent from ANRPO were potted and maintained at the Volcano facility for rearing gall flies.
    - The Biocontrol technician established a colony of gall flies.
    - Staff sent two batches of native plants for host-specificity testing.
- Waianae Mountains Watershed Partnership (WMWP). The U.S. Army Garrison, Hawaii is a member of the partnership.
- Waimea Valley. ANRPO manages two rare taxa living collection sites at Waimea maintenance.

Figure 6: ANRPO staff visiting the USDA/U.S. Forestry Service biocontrol testing facility at Volcano Hawaii Island.

- This year, staff participated in the ninth annual Oahu Natural Areas Weed Control and Restoration Workshop, held virtually on May 5, 2022. The interagency group Priority Oahu Native Ecosystems (Priority ONE) organizes and hosts this annual workshop. It is a valuable way to share information, data, and control techniques among local agencies conducting weed control management and habitat restoration work. Few staff were on the planning committee this year and helped to structure and put on the event; see agenda in Appendix 3-10. The workshop highlighted restoration projects included new restoration techniques, and lessons learned. Participants also discussed the weed matrix value and determining updating and sharing. In addition to serving on the planning committee, ANRPO staff also presented at the conference.

3.5 VEGETATION MONITORING

During this reporting period, vegetation monitoring analysis was completed for Kahanahaiki, Kamaili and Pahole MUs; Makaha Giant Ohia restoration site; Ohikilolo Lower WCAs; and the Kahanahaiki, Kaala, and Palikea North snail enclosures. Results of these monitoring efforts are included in Appendices 3-11 to 3-15, 5-2, 5-3, and 5-5. The results of these studies will be used to modify weed control and restoration plans. Vegetation monitoring was also completed at Ohikilolo MU, and results will be reported next year. In the coming year, staff plan to continue scheduled monitoring at Kapuna Upper and Palikea MUs; Palikea IPA treated *M. faya* trees; Ohikilolo Lower WCAs; and Palikea North, 3 Points, and Kahanahaiki snail enclosures.

3.6 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, ANRPO staff 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

- ANRPO conducts presentations for Army troops, contractors and other active military personnel providing information on how training and maintenance actions can impact natural resources on Army training lands. See Chapter 2, Environmental Outreach, for more information.
- ANRPO prepared and updated the natural resource section of the Officer in Charge/Range Safety Officer (OIC/RSO) briefs, which are held three times per 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. Last year staff discovered range staff who presented the brief had a shift in responsibilities and was no longer presenting the material. After reviewing the brief currently being delivered to soldiers ANRPO found the message to be unclear and inconsistent. The number of soldiers that have been briefed in through this new presentation is unclear to ANRPO at this time. In response staff worked with Range Division to deliver and record the OIC/RSO brief to ensure consistent and effective delivery of the required materials. ANRPO will monitor these briefs on a more consistent basis to ensure that the brief is being delivered properly.
- ANRPO staff present a one-hour brief at the Environmental Compliance Officer (ECO) training which occurs six times per year. This class is for enlisted personnel and contractors that work on Army training lands. After receiving this training, the ECO becomes the Environmental POC for his/her unit. The course has shifted to 100% virtual, due to pandemic limitations. The Natural Resource Brief was delivered at all six of these classes.
- Prior to any training at Makua Military Reservation (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 wildfires. Last year, ANRPO recorded our staff presenting this brief via MS Teams. This has provided flexibility for the trainer and consistent and effective delivery of natural resource training material. This year, a total of 18 MMR briefings were conducted; a total of 436 soldiers were in attendance.
- The Environmental Division hosts 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, one of these quarterly meetings was hosted at the Natural Resources baseyard to showcase the seed laboratory, greenhouse and interpretive garden. In addition, measures taken to minimize invasive species spread were showcased.

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

- Following the discovery of Coconut Rhinoceros Beetle (CRB) in Makua Valley traps, ANRPO cut all coconut trees around MMR range control. ITAM assisted with green waste removal. This course of action was developed in partnership with ANRPO and the State of Hawaii CRB Response Team. For detailed information on CRB see Chapter 9, Alien Invertebrate Control.

Figure 7: Coconuts removed by gate of MMR range control Oct. 2021.

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 and again in 2019 and 2021, but the new policy has not yet been signed. The updates would generalize the purpose of the policy which was originally put in place to prevent the spread of *C. odorata* from Kahuku Training Area (KTA) to other Army lands on Oahu. The updates would expand the background to more broadly include invasive plants spread via training.
- The Central Vehicle Wash Facility (CVWF) on Schofield Barracks, SBE Wash Rack, and KTA Wash Rack were operational for all of this year. No major maintenance issues were reported and minor ones were repaired promptly. Each individual wash rack is available for use on specific days out of the year. The availability of each wash rack this year was, CVWF 274 days, SBE Wash rack 264 Days, and the KTA Wash Rack 264 days.
- Analysis of RFMSS (the range scheduling program) data on wash rack use is encouraging, with large utilization increases this year for all three Oahu wash rack facilities. The days utilized are tracked by the wash rack operations contractor (not the unit), and thus realistically reflect facility usage. The usage of each wash rack this year was, CVWF 254 days, SBE Wash rack 36 Days, lastly the KTA Wash Rack 140 days. The total number of days that wash rack facilities were utilized during this reporting period was 430 as compared to the prior year number of 399.

Wash Rack Sediment Disposal

- Three years ago, the Federal Natural Resource Manager stepped down as the Contracting Officer Representative (COR) for operation of Army wash racks. ANRPO is still involved in reporting issues

seen by users to ensure the wash racks remain fully functional. Staff are also involved in the planning and execution of wash rack sediment cleaning, which occurs annually. ANRPO has secure sites where sediment is deposited and monitored for invasive species germination. Each wash rack has sediment bays where the vast majority of dirt and debris accumulates. The removal of the sediment from the two large sediment bays at the Central Vehicle Wash Facility on Schofield Barracks occurred October 2021. The sediment was deposited at the landfill on Area X. ANRPO coned off the deposit and monitored the sediment for germination of invasive species. No species of concern were detected over the course of 6 months. In the future ANRPO will no longer be surveying the sediment dumps. After years of surveying these dump sites no significant pest plant species have been found. Sediment is stored in large bays that are shaded from the sun and are consistently flooded with water for a year. Staff believe those conditions are enough to destroy any seeds that may wash into those bays allowing for safe disposal of sediment. (Vidal, D.B)

Figure 8: CVWF sediment deposit; October 2021.

PTA

- Staff continue to coordinate with CEMML staff at Pohakuloa Training Area (PTA) on Hawaii Island to share notable weed finds in range areas. As soldiers often train at both PTA and Oahu ranges, there is a risk of weeds spreading between the islands. Sharing information on notable invasive species allows crews to be aware of potential new threats.

KTA

- No new high priority incipient invasive weed sites were found on KTA this year though *C. odorata* continues to spread across range. This highlights the importance of cleaning gear and vehicles before leaving KTA, the omnipresent and intractable problem of preventing trespassing, and the extremely invasive nature of *C. odorata*.
- Staff continue to note examples of trespassing and encroachment at KTA, such as motocross riders and hunters using the area during the week (motocross use is only allowed on weekends) and outside of the designated motocross park. This continues to be a major challenge with regards to minimizing the spread of *C. odorata* in and around KTA. Staff will continue to discuss this issue with OISC and DOFAW. There are no easy solutions.

KLOA

- The KMWP has a conservation license that requires some coordination with ANRPO and with Range Division Hawaii for helicopter operations. This conservation license allows KMWP access to conduct ecosystem management in Kawailoa Training Area (KLOA).

- Army training still occurs on Basilian Drop Zone (DZ) located along Drum Road on privately owned ranch land. ANRPO will continue to survey this site if the DZ is used for Army training. ANRPO staff conducted a Pre-Brief with Range and land owners to get a better understanding of what is used by military units when training in this area. Staff also did a follow up survey in all areas where training had been conducted.

MMR

- A 2022 fire in the MMR burned into a known *C. setaceus* population; these invasive plants thrive after burns and may lead to increase fire risk in this area in the future. ANRPO will conduct aerial surveys and sprays.

SBE

- Staff continue to maintain cones, rope, and signs around select *S. condensatum* hotspots to prevent accidental mowing of this highly invasive grass by maintenance crews at Schofield Barracks East Range (SBE). While the system is imperfect, it is an important tool for communicating with other range users.
- Two gates were installed in SBE that restrict access to the ER12 training area and critical Oahu Elepaio habitat. There are four ICAs on the road that drives through ER12, two of which were created in 2022. These gates drastically reduce the amount of traffic through the area by Military units and will mitigate spread of the incipient weeds found there.
- Staff continue to take note and report unfettered access to SBE by trespassing motocross riders. Despite a new gate being installed at the California St. entrance to SBE, motocross riders have still been spotted within SBE, making the task of reducing the spread of the incipient species on range difficult and increasing the risk of new invasive species being introduced to the range.

SBW

- No ranges at Schofield Barracks West Range (SBW) have been closed to training due to *C. odorata* presence, but there are several signed areas outside and adjacent to ranges with *C. odorata* infestations. Troops should not be training in these signed areas. At OP X-Ray, ‘no mowing’ signs and cones are in place. Troops may train in this area but should not drive down the dirt road along its edge. Range Control helps with enforcement. ANRPO staff monitor installed signs and maintain them as needed.

SBS

- A new *C. odorata* ICA was created near the water tower in SBS near the “IED 1” area. A plant was found roadside and was likely spread through contaminated vehicles or equipment accessing the area. Two hundred meter buffer surveys were conducted but no other plants were found. Staff will monitor this area closely to prevent further spread.

3.7 WEED SURVEY UPDATES: NEW FINDS

Staff conducted surveys along roads and helicopter landing zones (LZs) used by both natural resource staff and the Army. All surveys which include drivable roads may vary year to year, and thus are tracked and stored using mapping software.

See Table 9 for a summary of all surveys conducted this year. Several inaugural surveys were completed this year. Survey WT-Ohikilolo-01 was completed as a replacement for survey for WT-MMR-04, which has not been completed since 2006. This was done advantageously as ANRPO staff were accessing Koiahi for the first time in several years. Two new LZs were created and surveyed this year, LZ-Manuwai-165 and LZ-Gordan-226; both are used to access the Manuwai MU.

Table 9: Summary of Surveys Conducted.

Survey Type	Description	# Surveys Conducted this Year
Road Survey	All drivable roads on Army Training Ranges were surveyed (total 482 km). MU access roads are surveyed annually or every other year. Several roads were not scheduled for this year.	21 surveys on 21 roads
LZ Survey	Actively used Army LZs are surveyed once per year. ANRPO LZs are surveyed only if used within a given quarter.	88 surveys on 43 LZs
Transect Survey	Surveys are conducted annually along high use access trails to MUs, selected MU fencelines, and high-traffic trails inside MUs.	16 surveys on 16 weed transects
Camp/Other Survey	Surveys are conducted at staff campsites and other potential locations of introduction, such as wash rack sediment disposal sites, gravel/fill piles, baseyards, and other staging locations. Survey frequency varies based on location and frequency of use.	25 surveys at 12 sites

Survey sites are depicted in Figure 9. Locations of LZ and camp/other survey sites surveyed this year are depicted as points and tallow lines. Incidental observations of target taxa or unusual/new species, or those made by staff during the course of regular work or on personal time, are identified as stars. Surveys along roads and transects are portrayed as lines.

Survey data is tracked in the ANRPO database. Each year, the list of new weed species on each survey is reviewed. Noteworthy species are discussed in Table 10. While most of these species are not considered to be ecosystem altering, they often favor disturbed habitats and can spread along fencelines and trails. To prevent the introduction of these species into the MUs, management of vegetation on ANRPO-used LZs and some drop zones (DZs) is a priority. This includes controlling select invasive weeds, as well as preventative maintenance 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 fieldwork are referenced as “incidental” in the table. ANRPO contracted the Bishop Museum to identify unknown species. This year, a total of 8 alien taxa submissions were sent to Bishop Museum for identification or to document new locales for select taxa. Only the *Chromolaena odorata* incidental find has become an incipient control areas (ICAs). This year there are three new *C. odorata* ICAs to report, one of which was found incidentally while conducting other fieldwork. A new *Andropogon glomeratus* ICA was created this year, this time on Schofield Barracks East Range. This follows a sighting and ICA creation for the same species just last year on Kaala Road.

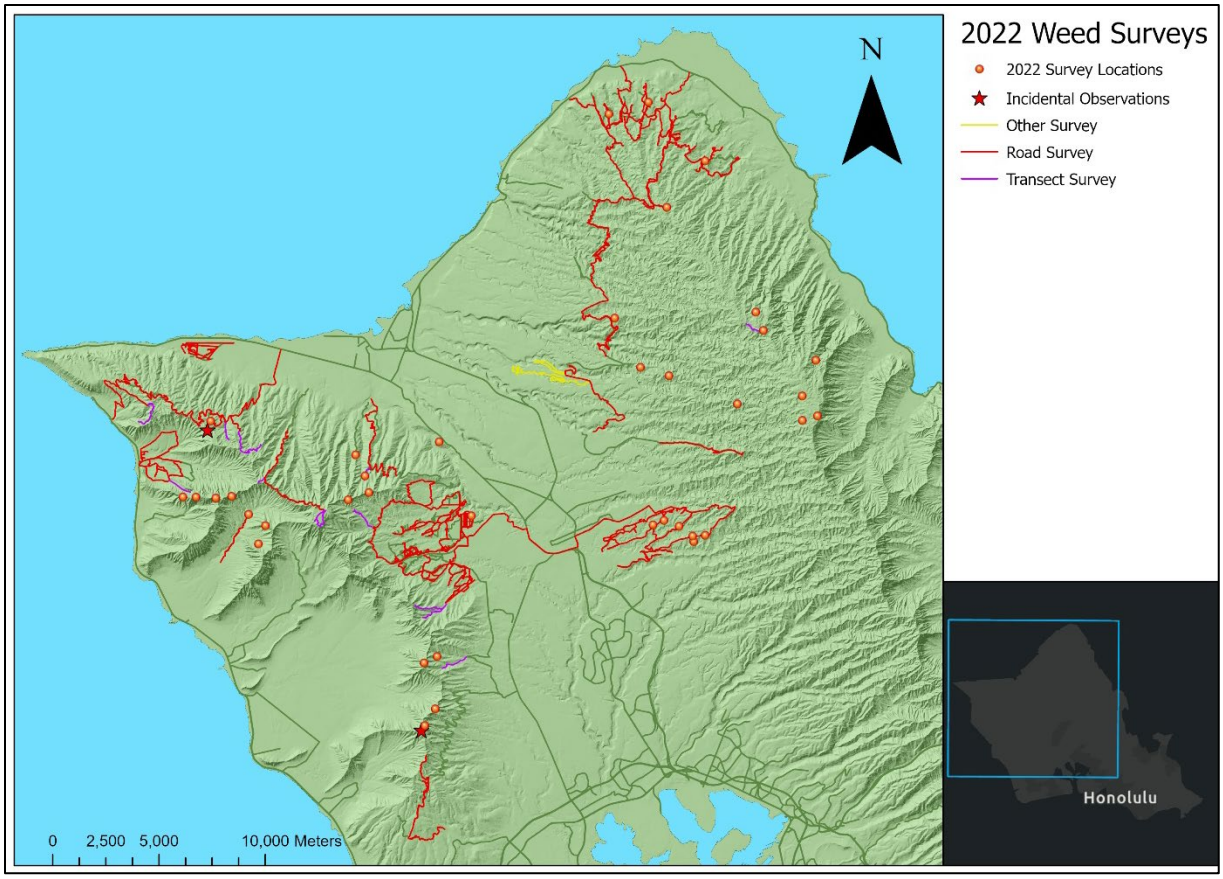

Figure 9: Map of surveys conducted in 2022.

Table 10: Summary of Noteworthy Alien Taxa Found on Surveys from 2022 report year.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-SBE-01** East Range Road to Schofield Waikane trailhead	*Andropogon glomeratus*	Staff found 1 mature plant along the roadside in SBE and was submitted to the Bishop Museum Herbarium (USArmy565) to confirm the identification. The known populations of *A. glomeratus* were on Midway Atoll, Hawaii Island, Oahu's Halawa valley, and Pali Hwy, but it is not widespread. This grass poses two problems: has a potentially high fire load and is found on a military training area that is used heavily by soldiers. ANRPO has prioritized control for *A. glomeratus* to reduce continual spread. A new ICA, SBE-AndGlo-01 was established.
Road	**RS-DMR-01** Dillingham Roads	*Tribulus terrestris*	This was the first time this plant has been recorded by ANRPO staff. T*ribulus terrestris* has a WRA score of 11 (high risk). It has been historically introduced outside of its natural range, has shown that it can naturalize readily, prolifically produces burs bearing seeds and is easily dispersed by animals. However, *T. terrestris* is naturalized to Hawaii, so no incipient control area has been designated for it.

Table 10 (continued).

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-Kaala-01** Kaala Road	*Cardiospermum grandiflorum*	*Cardiospermum grandiflorum* is naturalized in Hawaii but has now been observed most recently on Kaala Road. With a WRA of 18, staff will monitor this plant closely in hopes to mitigate its spread to Kaala, which is one of the most intact native forests in the Waianae mountains. *Cardiospermum grandiflorum* is a threat to the Makaleha gulches as well due to the suitable habitat. No ICAs have been created for this plant because of its naturalized status, but staff will consider action if this plant continues to spread.
Multiple Surveys	**RS-KLOA-08** Kawailoa Drum Road **RS-SBS-02** South Range Roads (Southern Portions)	*Chromolaena odorata*	*Chromolaena odorata* has been seen previously on both of these surveys. Kawailoa Drum Road has a *C. odorata* ICA a few miles north from this new site. The South Range Roads are adjacent the second largest infestation of *C. odorata* on Oahu. These sightings, while disappointing, are not surprising. The spread to these new areas could be attributed to maintenance crews using contaminated gear/equipment to maintain roads or ANRPO/Military vehicles. ICAs have been created for both sightings. A 200-m buffer surveys was completed for the South Range plant and no other *C. odorata* was found.
Multiple Surveys	**OS-Kaala-01** Kaala shelter/campsite **RS-Kaala-01** Kaala Road **RS-KLOA-08** Kawailoa Drum Road	*Plantago rugelii*	This plant was first noted in 2019-2020 report year when it was confirmed to be *P. rugelii* by the Bishop Museum Herbarium, who noted it was a new state record. *Plantago rugelii* looks similar to *P. major* and may have been misidentified in the past by staff. These sightings confirm populations of this plant are much more widespread than previously thought. This species is not of concern and there are no plans for control.
Incidental	**Palikea** Fern Gully Restoration Site	*Salvia hispanica*	While conducting regular weed control in the restoration site, staff noticed this uncommon weed near a regular lunch spot. Staff determined it to be *Salvia hispanica* (Chia) and submitted it to Bishop Museum Herbarium for confirmation (USArmy562). This is a new island record, but this species has a low WRA score of 1. ANRPO determined that a previous staff member who enjoyed Chia seeds often at lunch is the cause of this previously unseen weed in the MU. All plants found will be removed, but will not be creating ICAs to manage this species.
Incidental	**Kahanahaiki** Generals Restoration site	*Chromalaena odorata*	Staff conducting general weeding near managed rare outplants found one mature *C. odorata*. The 200-m buffer surveys were conducted shortly after to determine the extent of the infestation. Nothing was found over the three-day survey period. An ICA was created (MMR-ChrOdo-01) and will be checked quarterly. This incident follows shortly after last year's spotting of a *C. odorata* in Pahole MU 400-m away. This Kahanahaiki plant is believed to be a direct result of poor scheduling, and at the time the programs lack of dedicated gear for *C. odorata* work which has since been rectified. ANRPO is looking to continue to improve their sanitation practices to reduce these incidents.

Figure 10: Close up of *Tribulus terrestris*.

Figure 11: *Cardiospermum grandiflorum* choking out a forest.

3.8 RESTORATION ACTIONS UPDATE

3.8.1. Management Unit (MU) Summaries

Restoration actions continued in high priority Weed Control Areas (WCAs) this year. Restoration activities aim to complement weed control efforts in areas with high weed recruitment, restore connectivity and structure to native forest patches, and replace vegetation following removal of dense patches of alien species. ANRPO's restoration efforts require dedicated project planning and follow-through. Many projects are started with the goal of removing all alien vegetation from a defined site within a WCA and replacing it with native plants via active restoration. Active restoration is defined as aided recovery via outplanting, seed sows, divisions, and transplants that complement weed control efforts. Conversely, passive restoration is defined as only the removal of environmental stressors, in this case weeds, allowing the existing native seed bank to repopulate the area. Frequent weed control is often required right after non-native canopy removal, but effort declines as native plant cover increases. There are, however, other restoration actions that are initiated with very specific goals in mind, including: increasing native habitat around a specific rare plant population, creating vegetative fuel breaks for fires, or establishing plants that support endangered *Drosophila* spp., *Achatinella* spp., or *Megalagrion* spp.

Restoration actions are tracked within WCAs, as two types: 1) outplantings; and 2) seed sows, divisions, and transplants (SDTs). 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). Outplanting area and SDT area are recorded separately and areas may overlap. A summary of restoration actions for each MU in 2022 is presented in Table 11. Locations of each MU can be identified using the map in Figure 12.

Reporting of common outplants started in 2016 and has since grown to fit the needs of active restoration (Figure 13). This year, ANRPO outplanted a total of 13,131 common native plants, which is a 12.8% increase from 2021 report year. Since ANRPO's restoration strategy has switched over the years towards more groundcover species, Figure 14 shows the distribution of groundcovers versus trees, shrubs, and other forms. In general, groundcovers planted more densely help to achieve goals of restoration by reducing the available area for weeds to germinate, retaining more moisture in the soil by shading the ground, resulting in more favorable conditions for outplanted tree species to establish.

This year, restoration efforts continued to focus mainly on outplanting rather than SDTs. Outplanting restoration area increased by 27%. This increase can be attributed to starting a large project in Makaleha West MU in addition to However, staff have worked on some novel methods for SDTs as well, and those SDT efforts are clearly represented in the increased area. SDT area increased to 5,379 m^2 in 2022, a 132% increase compared to last year (Figure 15). This increase may look large, but SDT area still falls far short of the 2019 report year's total of 13,019 m^2. As staff continue to trial effective uses for SDTs, anticipate these numbers to fluctuate dramatically year to year.

In this report, MUs with the most notable restoration projects have their own maps with detailed descriptions of actions performed in this year (Figure 16-24 and Tables 12-18). All other MUs with restoration efforts this year, are summarized in Table 16 and will not have individual maps. All taxa are listed by their six letter code; a full scientific name can be found using Table 20 at the end of the section.

Table 11: Summary of 2022 Restoration Actions by MU

MU	Total # Outplants	Total Outplant Area (m²)	SDT Total Area (m²)
Ekahanui	967	1,880	-
Kahanahaiki	1,968	3,845	2,415
Kaluaa and Waieli	1,374	8,224	-
Kaluakauila	329	1,025	-
Kamaili	282	711	-
Kapuna Upper	829	271	243
Keaau Hibiscus	590	1,308	-
Makaha I	449	1,252	498
Makaha II	267	443	-
Makaleha West	1,627	2,343	942
Ohikilolo	507	575	-
Ohikilolo Lower	523	1,178	-
Opaeula Lower	336	501	777
Palikea	3,083	5,207	504
Total:	13,131	28,763	5,379

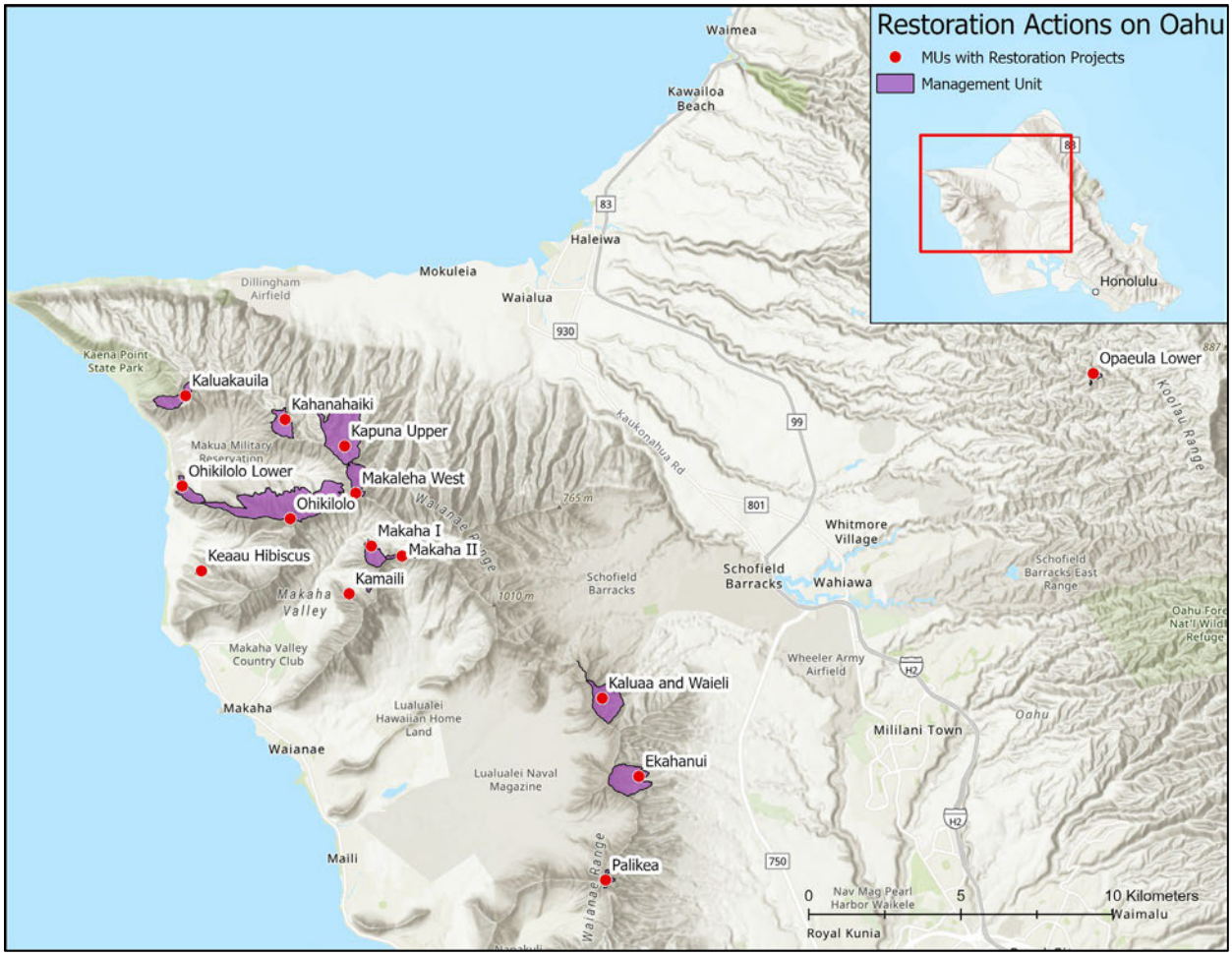

Figure 12: Map of ANRPO restoration sites by MU across Oahu in Report Year 2022

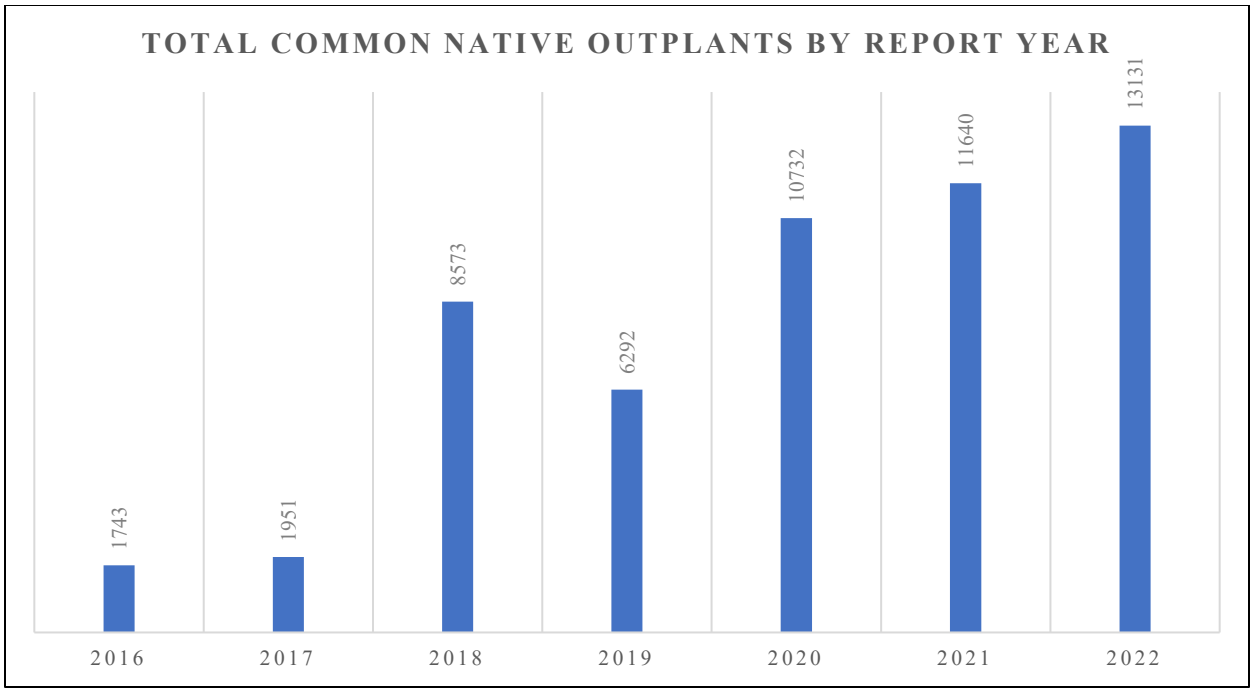

Figure 13: Total number of outplants each report year since 2016

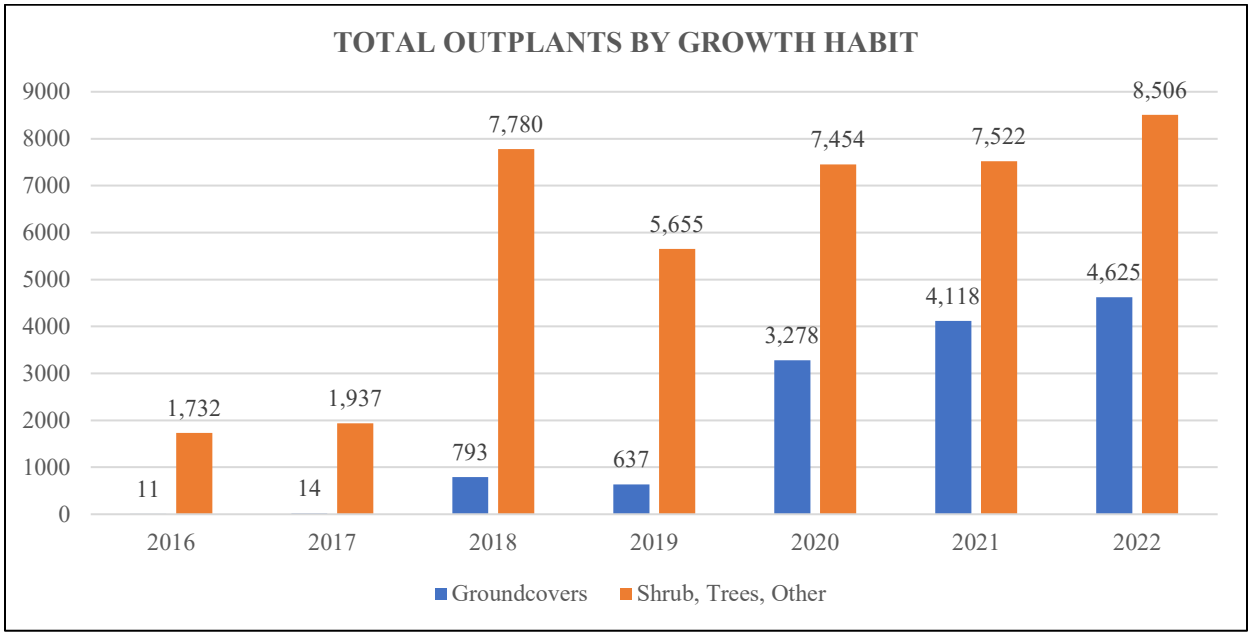

Figure 14: Total number of outplants by growth habit each report year since 2016. Groundcovers are defined as species that typically do not grow taller than 1m from ground level.

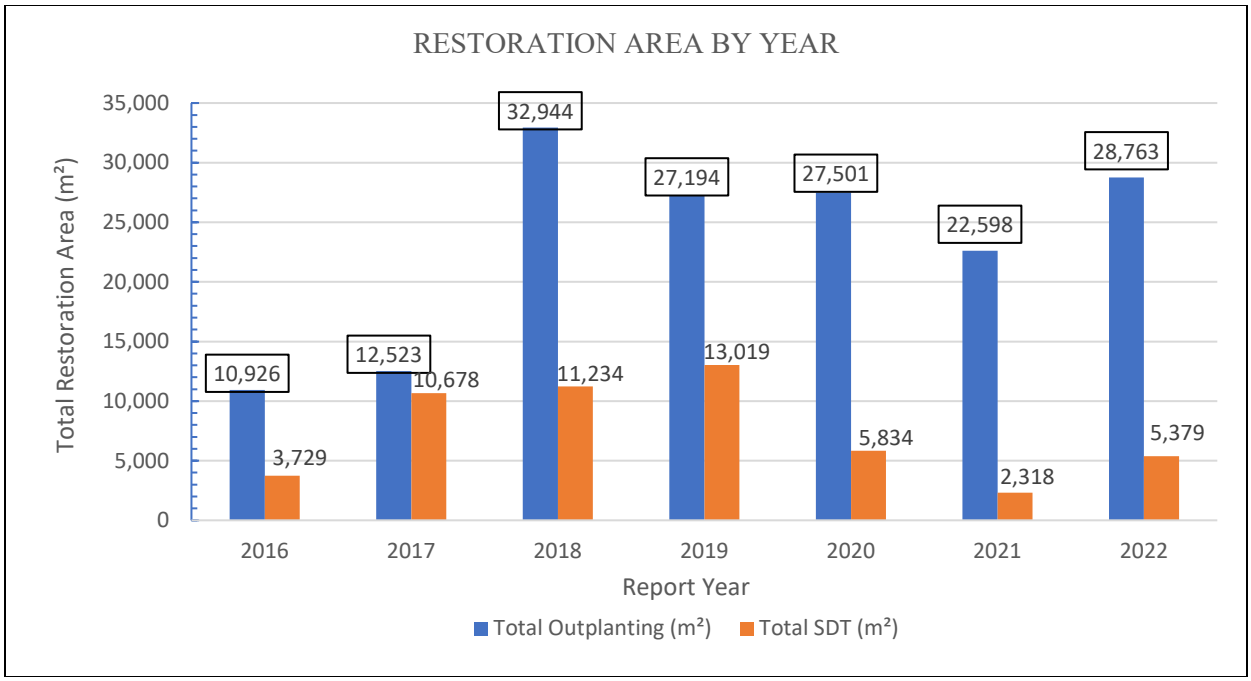

Figure 15: Total outplant area and SDT area each report year since 2016

Ekahanui

Figure 16: Map of 2022 Restoration Actions in Ekahanui MU

Table 12: Summary of 2022 Restoration Actions in Ekahanui MU

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration, Drosophila Stabilization - Outplanting	967	1,880	AcaKoa, CarWah, CeoBru, CleKak, DiaSan, DodVis, KadCor, MicSpe, MicStr, PsyHat, PsyMar, RumAlb, SanFreFre, SapOah, UreGla
Outplanting happened in three WCAs of Ekahanui this year. In Ekahanui-05 at the "2D site," 170 plants were used primarily to increase *Drosophila* spp. breeding habitat. Future outplantings here will expand out of the current area into adjacent sites that need more improvement. In Ekahanui-13, "Bump Out," staff continued to remove *Psidium cattleianum* and replace it with an array of native canopy and understory plants. In total 422 plants were planted in the "Bump Out." Lastly in Ekahanui-14, 375 outplants were used in an effort to slow erosion of the slope above the *Abutilon sandwicensis* EKA-C population.			

Kahanahaiki

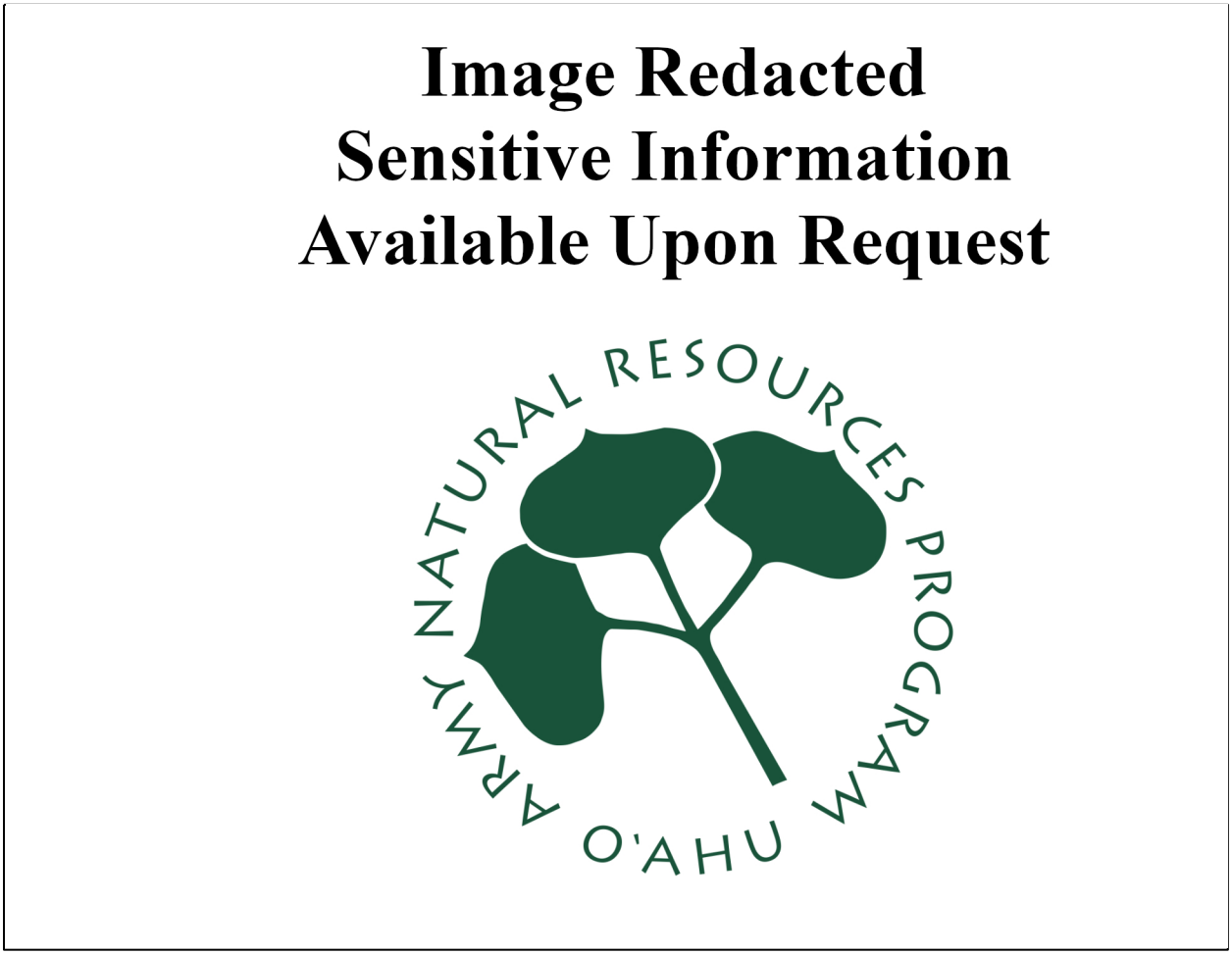

Figure 17: Map of 2022 Restoration Actions in Kahanahaiki MU

Table 13: Summary of 2022 Restoration Actions in Kahanahaiki MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	1,505	3,204	AcaKoa, AlySte, AntPla, AspKau, CarMey, CarWah, CeoBru, CeoUmb, ChaObo, ChaTom, CypHyp, DiaSan, DodVis, EraGra, HibArn, KadAff, MetPol, MetTre, MicStr, MyrLes, OstAnt, PitGla, PolOah, PsyMar, PsyOdo
This year MU restoration outplanting occurred in 7 WCAs throughout Kahanahaiki. In Kahanahaiki-03, "Schobo Baggins" received mainly trees with a few groundcovers as teams continued to fill gaps in the lower bowls. The area has filled in nicely with AcaKoa, so it will not receive any additional outplants next season, but teams will continue to weed and monitor progress. In Kahanahaiki-04, "The Shire" and "Aunty Desma's" both received outplants of trees species in hopes of creating more canopy in the area. Again, teams will continue weed efforts but will take a break on outplanting in this area until existing trees become more established. In Kahanahaiki-08, the "Thunder Dome" was established and received a mix of groundcovers and tree species totaling 353 plants. This area joins together the CyaSupSup MMR-J outplanting with Maile Flats as restoration efforts aim to connect more native areas. In Kahanahaiki-09, the area adjacent to the new snail enclosure was also opportunistically cleared of large weedy canopy while the chipper was present. Staff outplanted 296 plants in the area to restore native vegetation. In Kahanahaiki-10, "Tacky-10," staff outplanted 147 trees in the eastern section of the restoration area with the intention of creating canopy. Next season, outplanting will focus on the western section, across the gulch. In Kahanahaiki-15, "Plane Crash Site," staff outplanted AcaKoa, DodVis, and OstAnt to stabilize the slope and hopefully reduce the amount of invasive grasses in the area. Lastly in Kahanahaiki-16, "Schweppe's Extension," staff outplanted a small number of trees to fill in gaps left behind by senescing *Pipturus albidus* plants.			
Achatinella stabilization-Outplanting	463	642	AntPla, CeoBru, DodVis, HibArn, IleAno, KadAff, MetPol, MicStr, MyrLes, PlaSan, PsyMar
Outplanting continued inside the new Kahanahaiki snail enclosure, expanding revegetation efforts from last year. Because the snail enclosure already featured a fair number of mature *MetPol* and *Nestegis sandwicensis*, staff added other snail host trees and groundcovers to fill the space. Even without seedsows or outplanting, *Scaevola gaudichaudiana* has naturally recruited and plants look healthy enough to persist without additional help. Because of this, staff found the number of projected outplants inside the enclosure too large, choosing not to use a few during the restoration effort. As these outplants fill in, staff will monitor carefully and adjust plans for future outplantings as needed. Currently it is not projected to need any future inputs.			
MU restoration-SDT	3983 seeds, 10 divisions, 5 transplants	2,415	AntPla(2,950 seeds), DiaSan(613 seeds), DooKun(5 transplants), MicStr(10 divisions), PlaSan(170 seeds), SapOah(250 seeds)
As part of our expanding efforts in SDTs, this year teams tried various techniques and species in hopes of accelerating the restoration process. In Kahanahaiki-03 "Schobo Baggins" restoration area, 290 grams of AntPla fruit, estimated at 2,950 seeds, were scattered. In Kahanahaiki-04, "Aunty Barbs" restoration area, 170 fruit of PlaSan were scattered across the area. In Kahanahaiki-06, 250 cleaned and soaked SapOah seeds were sown at a depth of about 2cm. In Kahanahaiki-10 "Tacky-10", ten divisions of MicStr and five transplants of DooKun were moved from crowded spots across the gulch into more open locations in hopes of establishing new colonies. Lastly, in Kahanahaiki-16, 39.62 grams of DiaSan fruits, estimated at 613 seeds, were scattered in the "Schweppes Extension".			

Kaluaa and Waieli

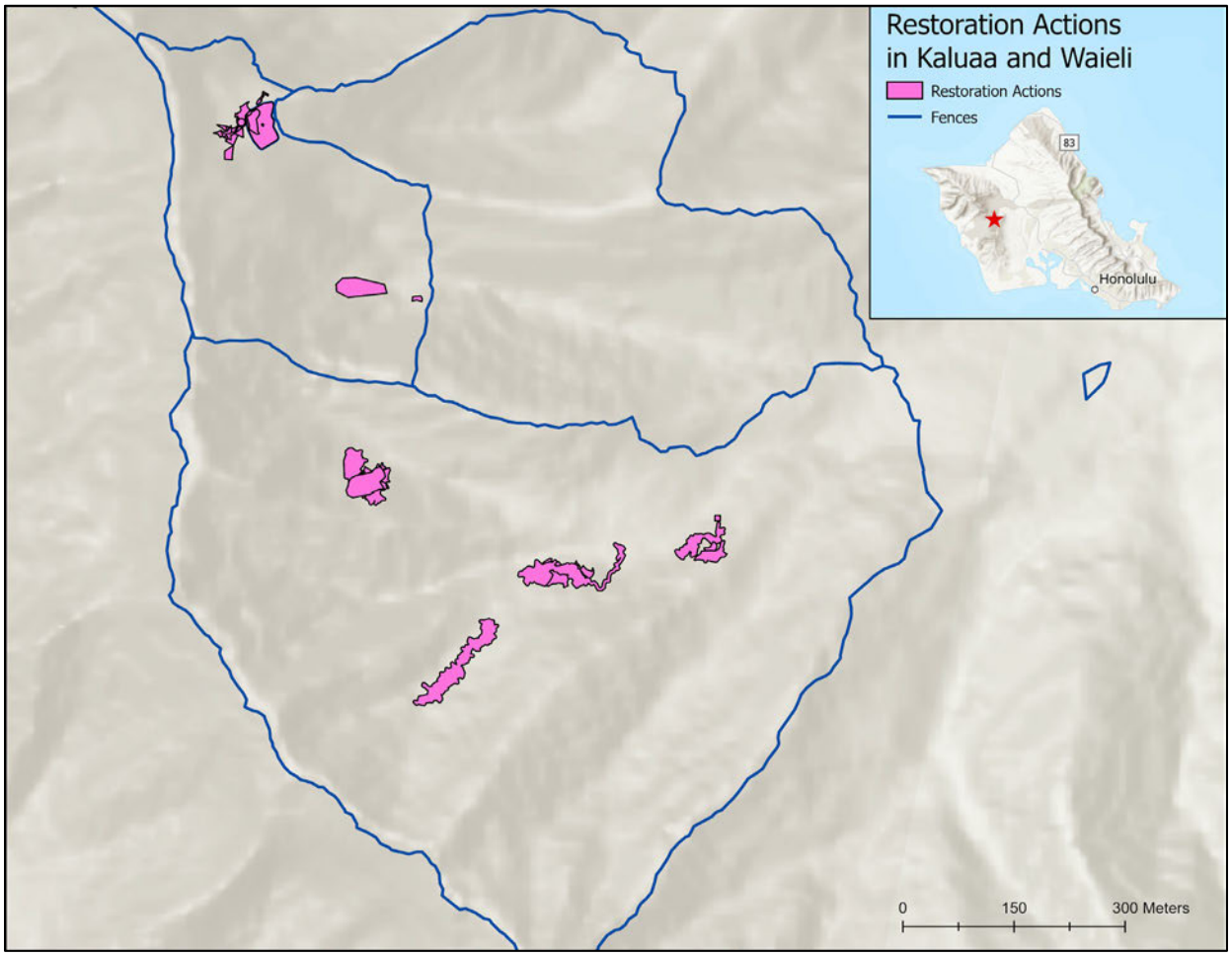

Figure 18: Map of 2022 Restoration Actions in Kaluaa and Waieli MU.

Table 14: Summary of 2022 Restoration Actions in Kaluaa and Waieli MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - Outplanting	1,243	5,420	AcaKoa, CarWah, CeoBru, CopLon, DiaSan, DodVis, HibArn, KadAff, MicSpe, MicStr, PitCon, PitGla, PsyHat, PsyMar, SanFre, UreGla
MU Restoration occurred in three WCAs this year. In KaluaaandWaieli-02, staff outplanted 25 plants in and around the Hapapa enclosure. In KaluaaandWaieli-06, 291 plants were used to continue to improve habitat around the *Cyanea grimesiana* subsp. *obatae* KAL-D population. In KaluaaandWaieli-08, 927 plants were used to buffer the DelWai KAL-C and CyaSupSup KAL-A populations.			
Drosophila stabilization-Outplanting	131	2,838	UreGla, MicSpe
Restoration for *Drosophila* stabilization occurred in two WCAs in Kaluaa and Waieli. In KaluaaandWaieli-08, 49 UreGla were planted at the bottom of Gulch 1. Two efforts occurred in KaluaaandWaieli-02 around the Hapapa weatherport totalling 57 UreGla and 25 MicSpe.			

Kapuna Upper

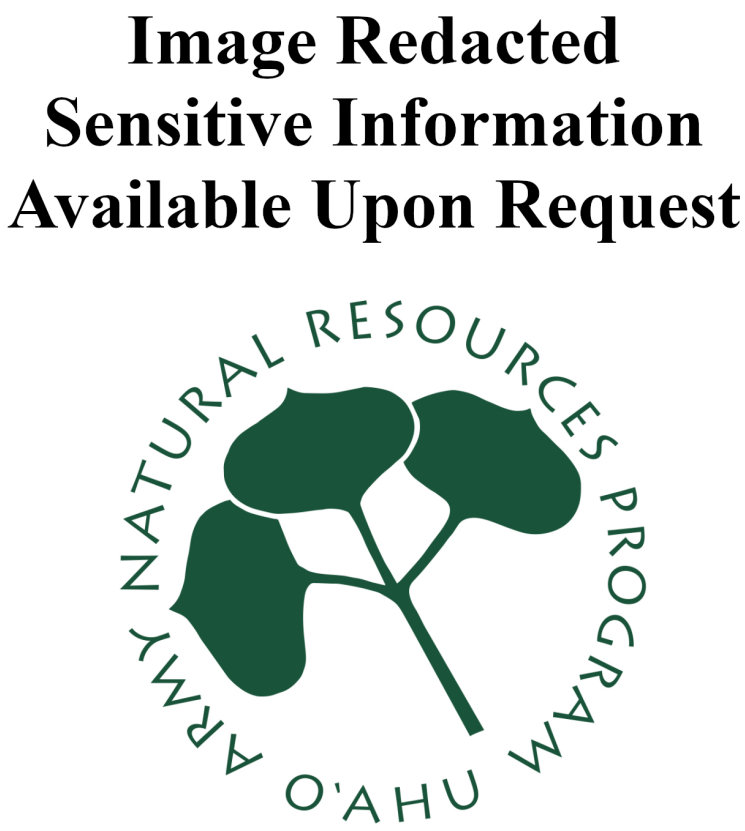

Figure 19: Map of 2022 Restoration Actions in Kapuna Upper MU.

Table 15: Summary of 2022 Restoration Actions in Kapuna Upper MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - Outplanting	829	271	AcaKoa, AntPla, AspKau, CarWah, CeoBru, ChaObo, ChaTom, CibCha, CopFol, CopLon, DodVis, DooKun, GahBee, KadAff, MetPol, MicStr, PsyMar
This year work continued in the KapunaUpper-03 restoration area along Keawapilau ridge between *Cyanea longiflora* PIL-C/F and *Schiedea nuttallii* PIL-B populations. Removal of *Psidium cattleianum*, *Grevillea robusta*, and *Schinus terebinthifoius* continued and was replaced with native trees as well as groundcovers. The area is progressing nicely and teams plan to keep expanding this restoration area in future years.			
MU restoration - SDT	250 seeds	243	SapOah(250 seeds)
Within the same restoration area, 250 seeds of *S. oahuensis* collected from Kahanahaiki were sown. Seeds were treated prior to sowing by removing the flesh of the fruit, and then soaking the seeds for ten days. Seeds were pressed into the soil to ensure good soil surface contact when sowing			

Makaleha West

Image Redacted
Sensitive Information
Available Upon Request

Figure 20: Map of 2022 Restoration Actions in Makaleha West MU.

Figure 21: *C. polystachyos* being deployed through a Nerf Super Soaker on 07/29/21.

Figure 22: *C. polystachyos* trial plot at Makaleha West on 04/19/22.

Table 16: Summary of 2022 Restoration Actions in Makaleha West MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	1,627	2,343	AcaKoa, AlySte, AntPla, CarMey, CarWah, CeoBru, ChaObo, CheTom, Cibcha, CleKak, CopFol, CopLon, CypHyp, DiaSan, DodVis, DooKun, IleAno, KadAff, MetMac, MetPol, MicStr, MyrLes, PipAlb, PsyMar, SadCya, ScaMol, SopChr, SyzSan
Restoration efforts occurred in two WCAs. In MakalehaWest-02, staff continued to plant the "Okazu Bowl" to buffer rare plant populations of *Delissea waianaeensis*, *Cyanea longiflora* and *Cyrtandra dentata*. In MakalehaWest-04, the restoration area now called "Ii Nui" was outplanted after being cleared during the summer of 2021. Of the 1,627 outplants this year, 1,384 went into this new restoration site and more will be needed next season to fill in spots as staff monitor the success of the site.			
MU restoration – SDT	256,245 seeds	942	AntPla(4,185 seeds), PitGla(60 seeds), CypPol(252,000 seeds)
This year, staff trialed CypPol as a novel ground cover. As an indigenous sedge, with high seed fecundity, this species was selected to compete with surrounding weeds in freshly disturbed spots like the newly opened restoration site. Seeds were first wild collected, then cleaned and weighed for count, then applied with tackifier through a Nerf Super Soaker water gun to help with even distribution and soil contact. To measure success, a 5m x 5m plot was divided into nine transects and monitored using point intercept methods every 50 cm. In total, 171 points were taken, and after nine months 46.8% of those points had CypPol. In comparison, 0 of 171 points in the adjacent control plot had CypPol after the same time period. This demonstrates the ability to deploy seeds through this method and that those seeds have the ability to germinate and persist, creating a native ground cover in a relatively short amount of time. Though this experiment was run on relatively flat ground and the application method may not be necessary in such context, it could be used for steeper slopes facing erosion concerns.			

Ohikilolo Lower

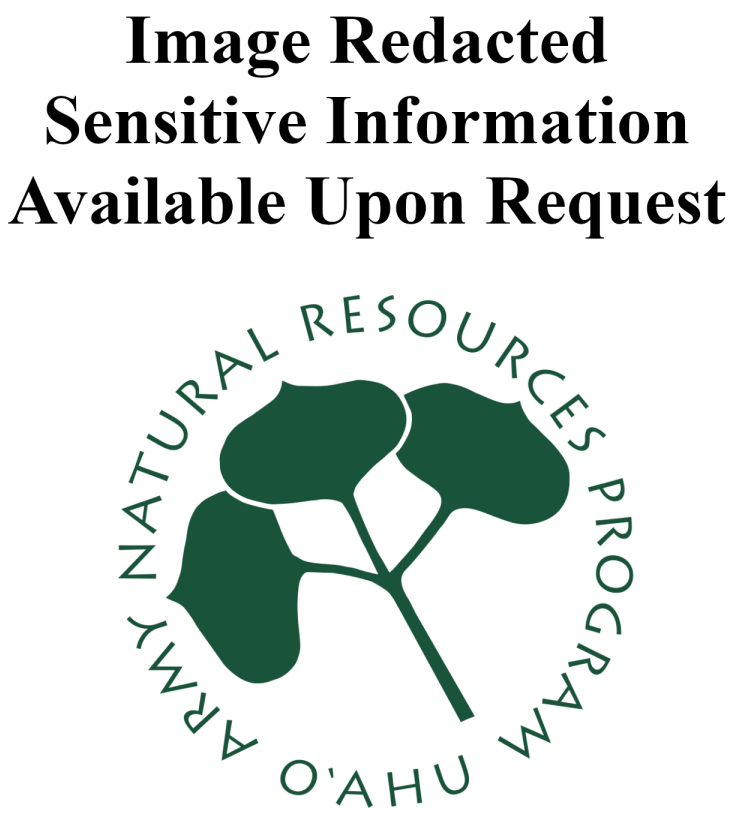

Figure 23: Map of 2022 Restoration Actions in Lower Ohikilolo MU.

Table 17: Summary of 2022 Restoration Actions in Lower Ohikilolo MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	523	1,178	CheOah, DodVis, EraVar, ErySan, SidFal
Restoration continued in LowerOhikilolo-02 "Upper Akoko patch" and staff planted 276 plants this year. Conditions were a little wetter following a large rain event, so hopefully this batch of plants establishes better than previous years in the same spot. In LowerOhikilolo-03 "Hibiscus Patch" staff planted 247 plants, mostly near the cliff bands to provide a couple hours of shade in the morning. Unfortunately, a fire in June of 2022 burned through this area, likely killing most of the new outplants from this season along with other outplants from years past.			

Palikea

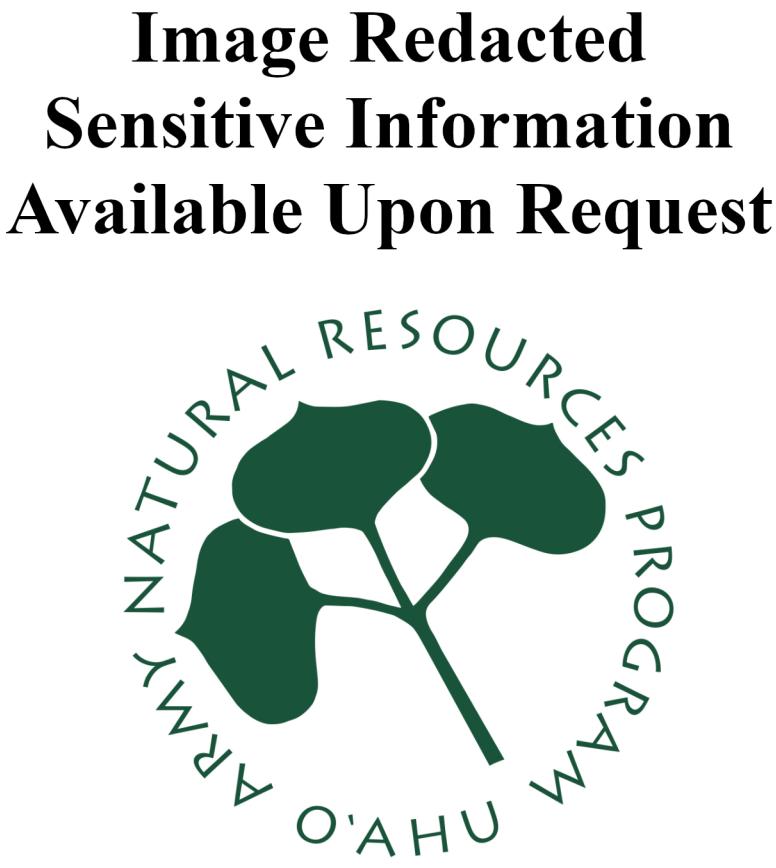

Figure 24: Map of 2022 Restoration Actions in Palikea MU.

Table 18: Summary of 2022 Restoration Actions in Palikea MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - Outplanting	2931	3,998	AcaKoa, AlySte, AntPla, CarWah, CeoBru, CheTri, CleKak, CopLon, CypPol, CyrWai. DiaSan. DooKun. ElaBif, EraGra, FreArb, KadAff, KadCor, LuzHaw, MetPol, MicSpe, MicStr, MyrLes, NepCor, PanNep, PerSan, PipAlb, PolOah, PsyHat, PsyMar, RumAlb, SadCya, ScaGau, UreGla
This season, MU restoration occurred in six WCAs across Palikea. Palikea-01, "The Meadows" added a mix of MicStr and DiaSan to buffer the ScaGau production plot. Palikea-02 "Erosion Scar" added 118 plants to fill in gaps that were not already colonized by native vegetation. Palikea-03 "Slope of Hope" restoration added 458 plants, a mixture of groundcovers and small trees, to stabilize the soil in this steep and crumbly area. The soil is so loose that plants are having difficulty establishing and it may take a few more brute force efforts like this to eventually turn it around. Palikea-06, "Fern Gully" received an addition of 451 plants this year, a mix of ferns, groundcovers, and trees, as staff continue to expand the borders of this site. Palikea-08, "Ieie site" has filled in nicely since last year. The PipAlb in the area looks great after a very successful seed sow. Tree species were planted in the shade of these plants, as staff expect PipAlb to senesce in a few years based on anecdotal evidence from other sites. As PipAlb thins, already having trees established in the ground will hopefully provide a smooth transition to long-term native vegetation. Groundcovers like EraGra and DiaSan have also done well, producing some of the biggest specimens around and plenty of seed for the native seed bank in addition to collections for future projects. Palikea-09 "Koa site" received 375 plants, the majority being groundcovers, to fill in gaps and help stabilize some of the soil there.			
Snail Stabilization - Outplanting	152	1,209	AntPla, CheTri, FreArb, MetPol, MyrLes, PsyHat, PsyMar, SadCya
Palikea-11, "Palikea North snail enclosure" received 152 plants this year. These outplantings focused on *A. mustelina* host trees and other associated species that will continue to fill in the canopy. The snail enclosure is now full of plants, and there may not be a need to add more in the future as long as the snail populations are doing well.			
MU restoration – SDT	78,579 seeds	504	CopLon(10,170 seeds), PitCon(41 seeds), PipAlb(68,368 seeds)
This year, SDT efforts in Palikea occurred in two WCAs. In Palikea-02 "Erosion Scar," staff dispersed 565 grams of CopLon fruit, estimated to be 10,170 seeds. These fruits were collected from outplanted individuals in Palikea North Snail Enclosure. Two other seedsow efforts occurred in Palikea-08 "Ieie site". One effort scattered 185 grams of PipAlb, estimated to be 68,368 seeds and the other effort sowed 41 partially germinated seeds of PitCon. The PipAlb seed sow has shown success very early as seeds sown in July of 2021 have already matured and produced seed of their own. Good soil and favorable weather likely contributed to early success.			

Figure 25: Staff sowing seeds of *C. longifolia* at Palikea-02

Other 2022 Restoration Efforts

Table 19: 2022 Restoration Efforts in other MUs (no maps)

MU	Restoration Action	# of plants	Area(m²)	Taxa
Kaluakauila	MU restoration - Outplanting	329	595	CheOah, DioSan, DodVis, HibArn, OstAnt, PluZey
In Kaluakauila-02, 329 plants were outplanted on the slope by the catchment. Establishment here has been difficult due to very low precipitation. Plants from previous seasons are hanging on, but slow to add new growth.				
Kamaili	MU restoration - Outplanting	282	150	DodVis, ErySan, MicStr, PluZey, SapOah
In Kamaili-02, 282 plants were planted to buffer around the *Neraudia angulata* MAK-D population in the Makai fence.				
Keaau	MU restoration – Outplanting	590	1,308	CheOah, DodVis, ErySan, SapOah, SidFal, PsyOdo
This year, restoration occurred in two areas, but both fall into the same WCA of KeaauHibiscus-01. "The Wilds" and the "GouVit Bowl" both received plants to buffer their respective rare plant populations. Previous years' outplantings look good but establishment of canopy species is a slow process.				
Makaha I	MU restoration - Outplanting	449	607	AcaKoa, AntPla, CarWah, CopLon, DiaSan, DodVis, DooKun, EraAtr, EraGra, KadAff, MetPol, MicStr, SapOah
In Makaha I, a few small efforts in three WCAs totaled 449 outplants. Makaha-02 "Radagast" received 76 plants to buffer the edges. Makaha-05 received 148 plants in the "SchObo MAK-D Augmentation" as staff attempt to slowly replace *P. cattleianum* with native vegetation. Finally, Makaha-09 "Fangorn" received 225 plants, a mix of trees, shrubs, and groundcovers.				
Makaha I	MU restoration – SDT	770 seeds	498	AlySte(323 seeds), PlaSan(447 seeds)
SDT efforts in Makaha I consisted of 3 efforts along Camp Ridge restoration sites, "Radagast" and "Giant Ohia." Two efforts scattered AlySte totaling 323 seeds, and one effort scattered PlaSan totaling 447 seeds.				
Makaha II	MU restoration - Outplanting	267	127	AcaKoa, AntPla, CarWah, CopLon, DiaSan, DooKun, KadAff, MetPol, MicStr, PsyMar
In Makaha II, two WCAs received common native outplants in 2022. Makaha-10 "SchNut Corner" added 106 plants to continue buffering the *Schiedea nutallii* population. Makaha-14 added 161 plants to continue buffering the *S. obovata* MAK-E population.				
Ohikilolo	MU restoration - Outplanting	507	922	AcaKoa, AntPla, AlySte, CarWah, DiaSan, DodVis, KadAff, MetPol, MetTre, MyrLes, SadCya
This year, outplants were used in a few different areas of Ohikilolo-13. "LanCam gulch" received 311 plants as staff try to replace weeds like *Erigeron karvinskianus*. In the "Pteralyxia patch" plants were used to reduce erosion along the fenceline. Lastly, near the cabin, plants were used to continue replacing non-native vegetation.				
Opaeula Lower	MU restoration – Outplanting	336	922	AntPla, CheTri, CibMen, CleKak, IleAno, MetPol, ScaGau, WikOah
In Opaeula Lower, "Frog Pond," staff planted 336 plants and continued to expand the buffers around the *Gardenia mannii* OPA-A and *Cyrtandra dentata* OPA-F sites. Restoration will continue in this MU next year as staff continue to remove stands of *P. cattleianum*.				
Opaeula Lower	MU restoration – SDT	10,200	777	CleKak
Staff smeared 6 fruits of CleKak onto nurse logs around the *Gardenia mannii* area. Based on previous seed counts, averaging 1,700 seeds per fruit, it is estimated 10,200 seeds were spread.				

3.8.2 Future Restoration Efforts

If ANRPO is to meet IP recommended goals of 50% native vegetation cover across MUs, active restoration is necessary. However, the number of simultaneous restoration projects are limited by the amount of maintenance weeding that can be done and the capacity for producing propagules.

When initiating a new project (Figure 26), site selection is dependent upon the site's proximity to IP taxa or existing native vegetation. Typically, active restoration projects are in WCAs that have presented challenges with weed control in the past and require more than just passive effort. After initial clearing and planting are completed, a 'continuation phase' consisting of frequent and aggressive weed control follows as weeds inevitably colonize unoccupied gaps in vegetation. In this phase, it is important to evaluate the progress of existing common native outplants, to give staff the opportunity to fill in gaps with supplemental outplantings as needed. Continued weed management in the 'maintenance phase' is critical in staving off weed incursions until the site is stable and restoration plantings and/or SDTs are established. Because restoration areas are so variable in location and vegetation composition, estimates for the duration of the maintenance phase are also highly variable. When weeding can occur on a limited basis, for example, two times per year or less, restoration projects should be considered complete. Sites can then be evaluated for use in rare plant reintroduction. Regardless of use, efforts still contribute towards MU vegetation IP goals.

ANRPO plans to increase SDT efforts, especially regarding seed sows, as the program has hit the upper limit of production based on current greenhouse space and staffing. Seed sows, if successful, can possibly alleviate some of the space constraints in the greenhouse. In past years, ANRPO has planted seed orchards of common native taxa and continues to harvest from them in anticipation of greater seed needs. ANRPO is currently exploring various techniques, new species options, and revising protocols to increase program capacity for seed sows in the future. Seed sow candidates must demonstrate the ability to germinate readily at relatively high rates and persist through early life stages in order to be considered worthwhile, as this is where most mortality occurs. Species like *Bidens torta*, *Pipturus albidus*, and *Cyperus polystachyos* have successfully established in preliminary trials and show a lot of promise in restoration. ANRPO is working on further quantifying the success of these species and others, via the metric of vegetation cover, in competing with and slowing the incursion of invasive plants. Other benefits, though harder to quantify, could also be an ability to stabilize soil, reduce erosion, and create more hospitable microclimates for successional natives.

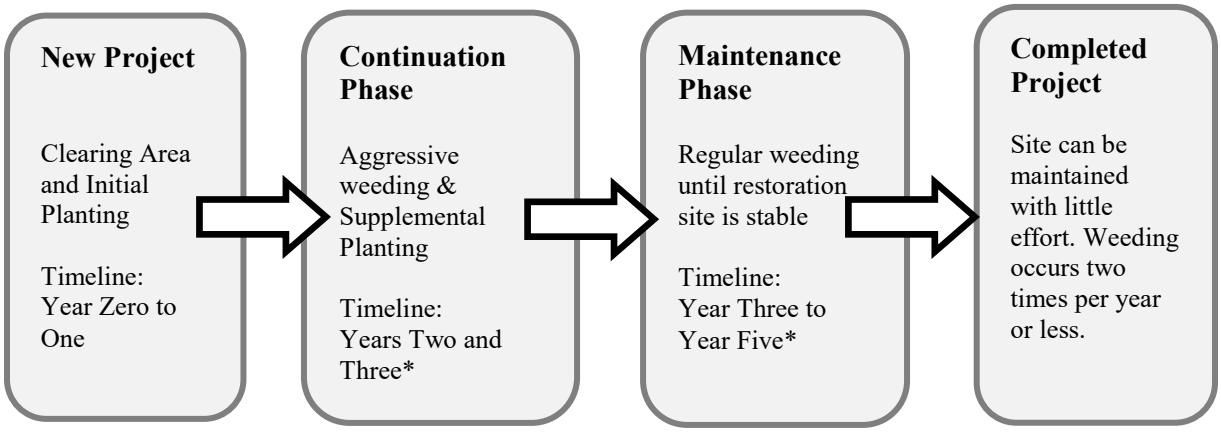

Figure 26: Flow chart the phases of active restoration. *Timelines may vary depending on vegetation composition.

Due to space limitations in the greenhouse, ANRPO's outplanting efforts are forecasted to be reduced in coming years. Outplants will likely be reduced from around 13,000 to 8,000 to accommodate additional living collections. Therefore, seedsows and natural recruitment will play a vital role in restoration moving forward. ANRPO plans to use this opportunity to focus more heavily on identifying the factors that limit the success of seedsows and natural recruitment. Available outplants will be used to start new projects as they are still necessary in that phase, but seedsows will likely play an important role in the continuation phases of projects replacing supplemental outplants.

3.8.3 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 to 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 to guide plant material transfer until species specific genetic research is available to delineate empirical seed zones.

ANRPO 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 Rapid Ohia Death (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, Hawaii Rare Plant Restoration Group population reference codes, and by incorporating local expert knowledge (pers. comm., M. Keir). The map includes 14 distinct zones (Figure 27). ANRPO 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.

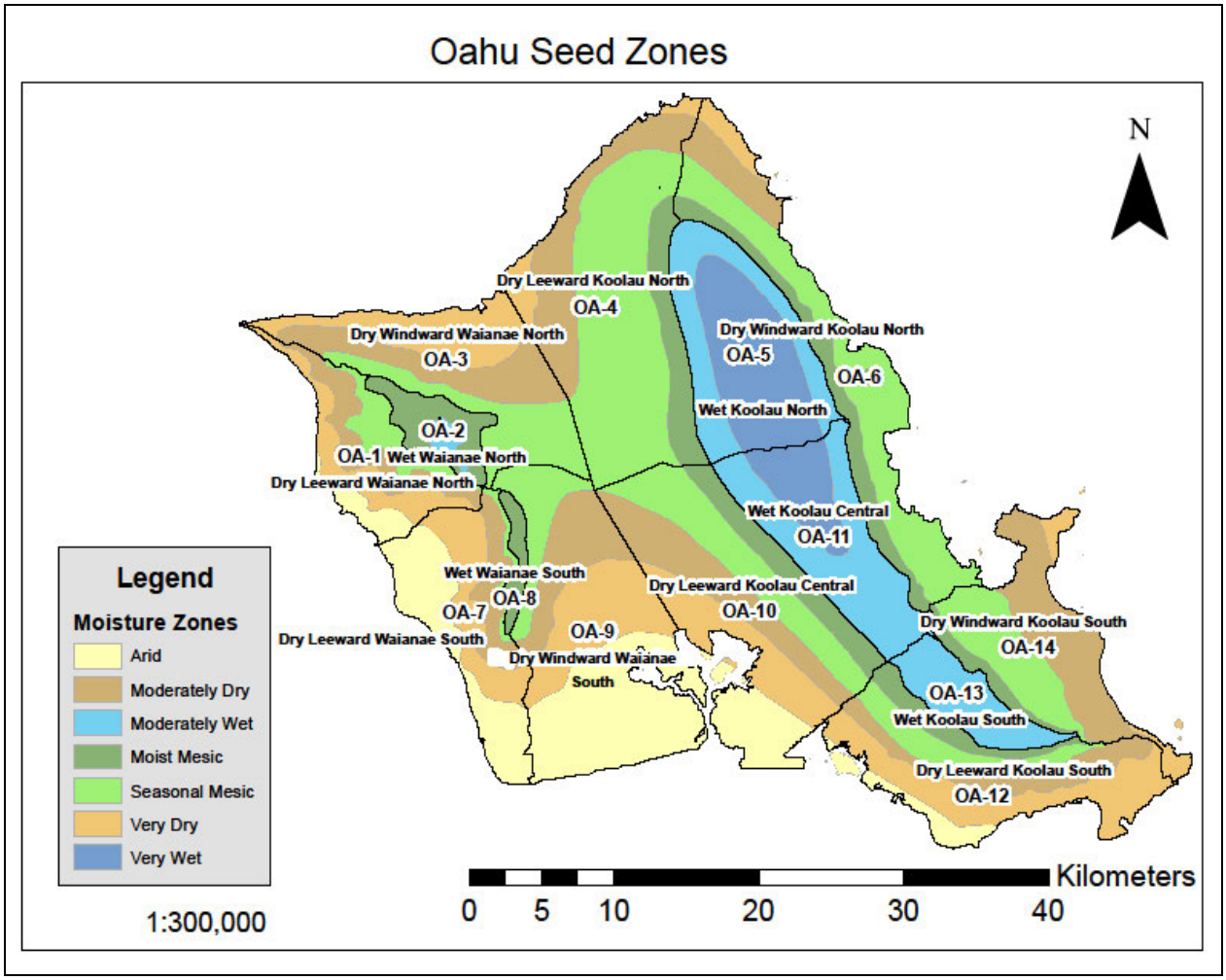

Figure 27: Map of Oahu Seed Zones (Laukahi Hawaii Plant Conservation Network, 2021)

Efforts in this report year continued to target seed collections 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 and were amended in 2022 Report year to total 74 species (Table 20). This list includes species commonly used in ANRPO restoration outplantings and direct seeding operations, as well as species not used in past actions, but which exhibit traits beneficial to ANRPO restoration goals. Common native seed collections are processed and curated in the ANRPO 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 if successful protocols for seed (S) and vegetative (V) propagation are being used or if propagation protocols are unknown (No). Some seed accessions are bulk collections if we know of a large amount of diverse seed available. All bulk collections have more than ten founders represented within each accession. Other, less available, seeds are counted along maternal lines so that each maternal line is an individual accession.

Table 20: Summary of taxa for ANRPO restoration projects.

Taxa	Six Letter Code	Family	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions Collected in 2022	Seed Zones Represented
Abutilon incanum	AbuInc	Malvaceae	Yes	S	11,339	7	5	OA-1
Acacia koa	AcaKoa	Fabaceae	Yes	S	48,485	82	29	OA-1,2,5,8
Alyxia stellate	AlySte	Apocynaceae	Yes[e]	S	693	14	2	OA-2,8
Antidesma platyphyllum	AntPla	Phyllanthaceae	Yes[e]	S,V	2,239	21	4	OA-2
Asplenium kaulfussii [a]	AspKau	Aspleniaceae	Yes[d]	S	NA	4	1	OA-2
Bidens cervicata	BidCer	Asteraceae	Yes	S	334	1	0	OA-1
Bidens torta	BidTor	Asteraceae	Yes	S,V	672,659	47	16	OA-1,2,8
Canavalia galeata	CanGal	Fabaceae	Yes	S	16	7	4	OA-1,2
Carex meyenii [a]	CarMey	Cyperaceae	Yes	S	21,460	7	2	OA-2
Carex wahuensis	CarWah	Cyperaceae	Yes	S	332,000	24	4	OA-1,2,8
Ceodes brunoniana	CeoBru	Nyctaginaceae	No	S,V	513	3	1	OA-8
Ceodes umbellifera	CeoUmb	Nyctaginaceae	No	S,V	0	0	0	----------
Charpentiera obovate	ChaObo	Amaranthaceae	Yes	S	6,361	9	4	OA-2
Charpentiera tomentosa	ChaTom	Amaranthaceae	Yes	S	22,112	19	11	OA-2
Cheirodendron trigynum	CheTri	Araliaceae	Yes	S	53,251	20	5	OA-5,8
Chenopodium oahuense	CheOah	Chenopodiaceae	Yes	S	8,643,195	23	4	OA-1,3,8
Cibotium chamissoi[a]	CibCha	Dicksoniaceae	Yes[d]	S	NA	10	3	OA-2,5
Cibotium menziesii	CibMey	Dicksoniaceae	Yes[d]	S	NA	4	1	OA-5
Clermontia kakeana	CleKak	Campanulaceae	Yes	S	141,344	12	1	OA-2,8,5
Clermontia persicifolia	ClePer	Campanulaceae	Yes	S	14,096	8	3	OA-2,5,8
Coprosma foliosa[a]	CopFol	Rubiaceae	Yes	S	1,045	7	4	OA-2
Coprosma longifolia	CopLon	Rubiaceae	Yes	S	80,856	64	6	OA-2,8
Cyperus hillebrandii var. *hillbrandii* [a]	CypHil	Cyperaceae	Unknown	No	0	0	0	----------
Cyperus polystachyos [a]	CypPol	Cyperaceae	Yes	Yes	315,175	7	4	OA-2,8
Deparia prolifera[a]	DepPro	Athyriaceae	Unknown[b]	V	NA	2	0	OA-2
Dianella sandwicensis	DiaSan	Xanthorrhoeaceae	Yes	S,V	103,207	20	5	OA-2,8
Diplazium sandwichianum [a]	DipSan	Athyriaceae	Unknown[b]	No	NA	3	1	OA-8

Table 20 (continued).

Taxa	Six Letter Code	Family	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions Collected in 2022	Seed Zones Represented
Dodonaea viscosa	DodVis	Sapindaceae	Yes	S	394,613	116	16	OA-1,2,3,8
Doodia kunthiana[a]	DooKun	Blechnaceae	Yes[d]	S	NA	8	3	OA-2,8
Eragrostis atropioides	EraAtr	Poaceae	Unknown	S	NA	0	0	----------
Eragrostis grandis	EraGra	Poaceae	Yes	S	113,314	26	11	OA-2,8
Eragrostis variabilis	EraVar	Poaceae	Yes	S	17,931	3	1	OA-3
Erythrina sandwicensis	ErySan	Fabaceae	Yes	S	100,645	40	8	OA-1,3
Freycinetia arborea [a]	FreArb	Pandanaceae	Yes	S	975,283	20	9	OA-2,8
Gahnia beecheyi [a]	GahBee	Cyperaceae	Yes	No[c]	16,921	7	1	OA-2,8
Geniostoma kaalae	GenKaa	Loganiaceae	Yes	S	1,315	2	2	OA-8
Gossypium tomentosa	GosTom	Malvaceae	Yes	S	0	0	0	----------
Gynochthodes trimera	GynTri	Rubiaceae	Yes	S	73	3	2	OA-8
Hibiscus arnottianus subsp. *arnottianus*	HibArn	Malvanceae	Yes	S,V	5,383	6	2	OA-2
Ilex anomala	IleAno	Aquifoliaceae	Yes	S	88,933	28	16	OA-2,5,8
Kadua acuminata	KadAcu	Rubiaceae	Yes	S	9,812	2	2	----------
Kadua affinis	KadAff	Rubiaceae	Yes	S	110,958	55	5	OA-2,8
Kadua cordata	KadCor	Rubiaceae	Unknown	No	11,181	1	1	OA-8
Luzula hawaiiensis	LuzHaw	Juncaceae	Yes	S,V	920	3	1	OA-2,8
Machaerina angustifolia [a]	MacAng	Cyperaceae	Yes	No	0	0	0	----------
Melicope oahuensis [a]	MelOah	Rutaceae	Unknown	No	0	5	3	OA-5
Metrosideros macropus	MetMac	Myrtaceae	Yes	S	31,440	3	0	OA-2
Metrosideros polymorpha	MetPol	Myrtaceae	Yes	S	7,317,357	350	31	OA-1,2,5,8
Metrosideros tremuloides	MetTre	Myrtaceae	Yes	S	2,674,830	95	8	OA-2
Microlepia speluncae [a]	MicSpe	Dennstaedtiaceae	Yes[d]	S,V	NA	7	1	OA-2,8
Microlepia strigosa var. *strigosa*	MicStr	Dennstaedtiaceae	Yes[d]	V,S	NA	17	8	OA-1,2,8
Myoporum sandwicense	MyoSan	Scrophulariaceae	Yes	S,V	14,376	160	0	OA-1,3
Myrsine lessertiana	MyrLes	Primulaceae	Yes	S	1,270	10	6	OA-2,8

Table 20 (continued).

Taxa	Six Letter Code	Family	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions Collected in 2022	Seed Zones Represented
Nephrolepis cordifolia	NepCor	Nephrolepidaceae	Unknown	S,V	NA	0	0	----------
Nephrolepis exaltata subsp. *hawaiiensis* [a]	NepExa	Nephrolepidaceae	Unknown	No	NA	0	0	----------
Nestegis sandwicensis	NesSan	Oleaceae	Yes	S,V	297	6	3	OA-2
Osteomeles anthyllidifolia	OstAnt	Rosaceae	Yes	S	1,718	6	0	OA-1,2
Panicum nephelophilum	PanNep	Poaceae	Unknown	S	1,702	4	0	OA-2,8
Perrottetia sandwicensis	PerSan	Dipentodontaceae	Yes	S,V	2,326	7	0	OA-8
Pipturus albidus	PipAlb	Urticaceae	Yes	S,V	373,194	10	1	OA-2,8
Pittosporum conferiflorum	PipCon	Pittosporaceae	Yes	S	1,287	10	4	OA-8
Pittosporum glabrum	PitGla	Pittosporaceae	Yes	S	4,248	34	19	OA-2,5,8
Planchonella sandwicensis	PlaSan	Sapotaceae	No	S	0	0	2	OA-2,8
Plumbago zeylanica	PluZey	Plumbaginaceae	Unknown	V	0	0	0	----------
Polyscias sandwicensis [a]	PolSan	Araliaceae	Yes	S	4,999	2	0	OA-1
Polyscias oahuensis	PolOah	Araliaceae	Yes	S	1,133	7	4	OA-2,8
Psychotria hathewayii	PsyHat	Rubiaceae	Yes	S	1,443	19	4	OA-2,8
Psychotria mariniana	PsyMar	Rubiaceae	Yes	S	561	8	2	OA-2,5,8
Psydrax odorata [a]	PsyOdo	Rubiaceae	Yes	S	95	2	2	OA-1,2
Pteris excelsa [a]	PteExc	Pteridaceae	Yes[d]	S	NA	1	1	OA-8
Rockia sandwicensis	RocSan	Nyctaginaceae	No	S,V	0	0	1	----------
Rumex albescens	RumAlb	Polygonaceae	Yes	S	43,736	10	4	OA-8
Sadleria cyatheoides	SadCya	Blechnaceae	Yes[d]	S	NA	6	3	OA-2,5,8
Santalum spp.[a]	SanSpp	Santalaceae	Yes	S	4,246	17	9	OA-1,2,8
Sapindus oahuensis	SapOah	Sapindaceae	Unknown	S	3,765	18	4	OA-1,2,8
Scaevola gaudichaudii [a]	ScaGaud	Goodeniaceae	Yes	S	0	0	0	----------
Scaevola gaudichaudiana	ScaGau	Goodeniaceae	Yes	S,V	1,746	14	10	OA-2,5,8
Scaevola taccada	ScaTac	Goodeniaceae	Yes	S,V	0	0	0	----------

Table 20 (continued).

Taxa	Six Letter Code	Family	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions Collected in 2022	Seed Zones Represented
Sida fallax [a]	SidFal	Malvaceae	Yes	S,V	31,567	23	8	OA-1,2,3,8
Sophora chrysophylla	SopChr	Fabaceae	Yes	S	5,466	22	3	OA-1,2
Syzygium sandwicense	SyzSan	Myrtaceae	Unknown	S	0	0	4	----------
Urera glabra	UreGla	Urticaceae	Yes	S,V	10,354	10	0	OA-8
Waltheria indica	WalInd	Malvaceae	Yes	S	20,061	7	4	OA-1,3
Wikstroemia oahuensis	WikOah	Thymelaeaceae	Yes	S	2,963	15	10	OA-5,8

[a] Native species targets for future restoration efforts
[b] Research underway to develop seed storage protocols
[c] Research underway to develop propagation protocols
[d] Short to medium term storage is possible, research ongoing to determine longevity in storage
[e] Short lived in storage

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CHAPTER 4: RARE PLANT MANAGEMENT

4.1 PROJECT HIGHLIGHTS

During this reporting period, the Army Natural Resources Program on Oahu (ANRPO) outplanted a total of 1,503 rare plants representing 15 Makua Implementation Plan (MIP) and Oahu Implementation Plan (OIP) taxa at 26 Manage for Stability (MFS) reintroduction sites. In the last year, ANRPO made 821 observations at *in situ* sites and outplanting sites of Implementation Plan (IP) taxa. In this chapter, a summary of this year's highlights is included, along with discussion of the Taxon Status, Threat Control, and Genetic Storage Summaries. Lastly, five-year management plans for *Gouania vitifolia* and *Geniostoma cyrtandrae* and updated management plans for *Pritchardia kaalae* and *Cyanea grimesiana* subsp. *obatae* are presented. Some of this year's highlights include:

- This report year the second outplanting for *Viola chamissoniana* subsp. *chamissoniana* was attempted in the Halona MFS Population Unit (PU) at PAK-A, north of the Palikea Stairs site on upper slopes above "Fern Gully" restoration site Forty-four plants were planted representing three founders from the *in situ* Population Reference Site (PRS), HAL-B.
- Staff expanded the *Delissea waianaeensis* MMR-A reintroduction in the Kahanahaiki to Keawapilau PU. The outplanting was conducted to augment three *D. waianaeensis* plants that recruited and matured on the ridge between the Shire and Aunty Barb's restoration sites in Kahanahaiki over the last three years. This outplanting also marks the second time ANRPO has established a rare plant outplanting in an intentionally restored forest site.
- On June 13, 2022 a fire was reported at Makua Military Reservation south of the south fire break road between the Hibiscus Patch and Koiahi gulch. The fire burned roughly 96 acres and impacted two *Hibiscus brackenridgei* subsp. *mokuleianus* sites, the *in situ* MMR-A site and the associated augmentation, MMR-F. In addition, the fire also impacted the *Tetramolopium filiforme* MMR-H site within the Genetic Storage (GS) Ohikilolo PU. As a direct result of the fire, the *H. brackenridgei* ssp. *mokuleianus* MMR-F site declined by 47%; however the *in situ* site, MMR-A, increased by four mature plants and seven immature plants, likely due to better detection as result of the fire and more time spent searching the area. Staff observed an estimated 100-150 plants at *T. filiforme* MMR-H that succumbed as a direct result of fire impact, through direct burn or desiccation from radiant heat. Based on post fire monitoring efforts, staff estimated that 25-30% of the plants on site were killed as a direct result of the fire (roughly 250 plants); however, staff also observed an estimated 1,060 (848 mature and 212 immature plants) just outside of the fire footprint, which exceeds estimates from the last current complete census conducted in 2004. See Appendix ES-09 for further details.
- In late June 2022 the staff observed heavy damage on *Euphorbia celastroides* var. *kaenana* resembling both rat and pig damage. On July 13th, the Orange team returned to the site to conduct a complete census to better understand the extent of the damage on site. Based on the census it is estimated that 30-50% of plants on site were damaged to some extent. On August 4th seven game cameras were installed to document animal activity. The cameras took 10,000 image and the vast majority were images triggered by wind; however, the majority of nighttime images showed rat and mice activity on plants. It is clear, especially with this visual evidence, that rats (and potentially mice as well) are causing significant damage to plants by gnawing stems. To minimize further rodent damage on site, a rat grid including 40 A24 traps and 40 Victor traps was established across the site on both State Park and NAR properties. Pig sign was observed throughout the site, including pig scat, crushed stems from pig bite, pig bedding areas, and whole plants dug out. No pig activity was captured on camera, but game cameras remain on site and we will monitor imagery for continued pig activity.

- Nine large trees of *Flueggea neowawraea* representing six founders were planted at Koko Crater Botanical Garden throughout the Hawaiian section in a variety of conditions. Prior to planting, the trees were injected with a systemic insecticide using the Arborjet system to protect against the black twig borer. The trees were recently observed flushing out with new growth and little to no twig borer damage, but were also observed with heavy leaf damage from the rose beetle. The trees were treated with imidacloprid and will continue to be monitored each month.
- As *F. neowawraea* declines across the state, there may be a need for mixing plant founders in the future to obtain viable seed and increase genetic diversity of propagules for reintroduction. Opportunistic cross pollinations of *F. neowawraea* were successful in the greenhouse utilizing female founders from the Big Island and pollen from Oahu founders. Resulting seeds and seedlings will be made available to PEPP for outplantings on the Big Island. Seed viability testing is underway and has already produced five seedlings. The Big Island founders will continue to be grown in the greenhouse and more crosses will be made as material becomes available.
- *Gouania vitifolia* plants at Kahua *inter situ* site continue to produce abundant flowers and fruit. Seed Collections have reached an all-time high, and rare plant staff were able to make seed collections in excess of 50 viable seeds from 47 founders representing the Keaau PU. Staff were able to make large bulk collections, in excess of conservation need, to use in developing processing protocols and for storage and longevity research. Seeds are orthodox with a current recollection interval ≥15 years with the potential to store much longer. Over the next 12 months, based on growth potential of plants on site, we expect to have genetic storage goals complete for over 50 founders. Once genetic storage goals are satisfied for 50 or more founders, we will keep production in place to supply seed to Lyon Arboretum for storage and use, and for potential inter-island restoration efforts utilizing Oahu seed stock.
- Horticulture staff with assistance from other natural resources staff expanded inter-situ holdings of *Eugenia koolauensis, Nototrichium humile* and *Neraudia angulata* at Koko Crater. The plants will serve as genetic storage for the greenhouse should founders from the living collection be lost.
- *Eugenia koolauensis* plantings were initiated at Wahiawa Botanic Gardens and Waimea Botanic Gardens, in addition to the plantings at Koko Crater. The plantings were restricted to PUs, with the Wahiawa Botanic Gardens plants representing the Pahipahialua PU and the Waimea Botanic Gardens plants representing the Kaunala PU. Irrigation was installed at both sites to increase survival of the plants. The plantings will be utilized for genetic storage and seed production, once storage protocols are established for *E. koolauensis*.
- *Nototrichium humile* were planted at Wahiawa Botanic Gardens and Waimea Botanic Gardens in addition to the plantings at Koko Crater. The plantings were restricted to PUs, with two disparate sites at Waimea representing the Kaluakauila and Mikilua PUs and the Wahiawa site representing the Punapohaku PU. Irrigation was installed at both sites to increase the survival of the plants. The plantings will be utilized for genetic storage and seed production.
- Two individuals of *Sicyos macrophyllus* representing a lone founder from the Keamuku Maneuver Area at Pohakuloa Training Area are being grown in the greenhouse until staff at Pohakuloa Training Area can assume care of the plants.
- The *Hesperomannia oahuensis* reintroduction site in Pualii North MU had many individuals with high flower sets, some with over 50+ flowering heads and/or buds per tree. Seed collection efforts were extremely successful this year, as staff were able to collect 452 filled seed based on the initial "press" test, compared to 109 filled seed collected last year. The vast majority of collected fruit were unmanipulated or "open pollinated" versus "hand pollinated", an indication that these plants are receiving pollinator services. However, caches of *H. oahuensis* fruit were discovered

on site in the 2021 reporting year, which led us to believe the rats were caching mature fruits, while leaving very little fruit materials behind for successful collections of filled seed or natural recruitment. Ten game cameras were staged throughout the site for the second year running to observe animal-flower interactions. Rats were observed extracting nectar from the *H. oahuensis* flowers, nibbling on fruits, and snatching entire fruit off the mother plants. Amakihi (*Chlorodrepanis virens*), Apapane (*Himatione sanguinea*), Oahu Elepaio (*Chasiempis ibidis),* Red-Vented Bulbul (*Pycnonotus cafer*), and Red-Whiskered Bulbul (*Pycnonotus jocosus*) were sighted interacting with *H. oahuensis* buds and flowers. A full analysis of video images captured has not yet been completed, and we will report out on findings once analyzed. Due to the high presence of foraging rats, a new A24 grid system was implemented within a two-acre area, and an additional 13 A24 traps were added in and around the population, bringing the total number of A24 traps to 25. In April 2022, the first D50 treatment took place. There was a total of four treatments, two applications of 15 lbs. of D50 per treatment that took place in April and June. See chapter eight, Rodent Management, for more information on D50 treatments.

- In April 2022, ANRPO Seed lab received the first collection of *Gunnera petaloidea* from Kaala since 2003. Field teams collected mature fruit from two separate individuals, with a total of 2,617 seed. Seed lab staff sowed initial germination tests and set up research collections where seeds are stored under three different storage conditions and will be pulled for future viability testing. This taxon is recognized as a SAR (Species at Risk) and stored seed is available for future restoration efforts.
- Currently 76 *Dubautia herbstobatae* founders meet genetic storage goals. This represents a 57% increase since the 2020-2021 reporting year. Efforts have been made over the last few year to transition *D. herbstobatae* founders from greenhouse living collection to micropropagation. Currently 18 founders meet genetic storage goals in micropropagation, a 33% increase since last reporting year. In addition, an in-ground collection of this taxon was establish at ANRPO's West Base facility as a supplement to plantings at the University of Hawaii at Manoa campus in support of Sunyoung Park's PhD research to investigate low seed fill and self-incompatibility in *D. herbstobatae.*

4.2 POPULATION UNIT STATUS SUMMARY

In the last year, there have been changes in the numbers of mature plants at 84 of the 131 MFS PUs managed by ANRPO. Forty-two MFS PUs showed a decline in mature plants, while 42 showed an increase, and 47 PUs showed no change. This represents an increase of sixteen PUs that showed an increase in mature plants as compared to last year. Table 1 and 2 show the PUs where a change was observed in the last reporting period. The difference in the number of mature plants reported last year and this year is given (ΔMat), with the percent change observed at each (% Change Mat). In addition, this table includes, as reference, the difference in the total number of plants reported last year and this year (ΔPop.), along with the percent change observed at each (% Change Pop.). In some cases the total number of mature plants may show a decline, but not the total number of plants. Most of the largest changes are due to variations at outplanting sites; when more plants are added, numerous plants in the same cohort mature at similar times, or are observed to have died at the same time. Population Units that are in **bold text** are wild *in situ* PUs that have not been augmented through outplanting. Therefore, the changes in the total number of plants are due to natural recruitment, the death of known plants, or new counts from recent monitoring efforts. The majority of increases in mature plants occurred in PUs that have been augmented with outplants, with some exceptions.

Efforts to monitor cliff dwelling species continued this year and a thorough monitoring at *Plantago princeps* var. *princeps* SBW-A in the North Mohiakea PU in Lihue revealed a significant increase in plant

numbers in both the mature and immature age classes. Mature plants increased by 35 plants and immature plants by 32 plants. It is possible that more plants were observed this year, as staff may have expanded the area rappelled beyond what was surveyed in previous monitoring events. Similarly, *V. chamissoniana* subsp. *chamissoniana* plants increased at the Puu Kumakalii PU. In both cases significant genetic storage collections were made in both PUs. Seed from 18 founders of *P. princeps* var. *princeps* was collected and cuttings were taken from from 32 *V. chamissoniana* subsp. *chamissoniana* founders. An increase of 411 mature plants was observed at the *T. filiforme* Ohikilolo PU, however, the overall population declined slightly.

Plant numbers increased at three of the four *Cyrtandra denata* MFS PUs, Pahole to West Makaleha, Kahanahaiki, and Opaeula, by 31%, 33%, and 27% respectively. DOFAW and ANRPO cooperatively monitored *G. vitifolia* at the *in situ* Population Reference Site (PRS) KEA-A. Four mature and three immature plants were observed this past year as compared to two mature plants observed during the post fire census in 2018. Moving forward ANRPO will support DOFAW efforts to augment the remaining wild plants at this site. Other encouraging population increases observed in the 2022 reporting year include *Cyanea longiflora* PAH-A *(in situ*), where the mature age class increased by 23. This population continues to grow as a result of effective threat control. Although, many of the increases observed over the last year are the result of more plants being added to reintroduction sites across taxa and PU, in some case increases are the result of successful recruitment. *Hibiscus brackenridgei* subsp. *mokuleianus* at KEA-C (Reintro) saw an increase of 62 plants in the immature age class, of which 30 are F1 recruits. While many of our *Phyllostegia mollis* reintroductions have failed through time, EKA-D has been sustained entirely through recruitment since 2019. The site currently supports two mature plants and four immatures, an increase of one mature plant since last reporting year.

The past year has been marked by drought conditions and as a result declines in population numbers were observed for multiple taxa, across multiple PUs. However, in some case declines in plant numbers are directly associated with unpredictable, destructive events, such as fire in Makua impacting both *T. filiforme* and *H. brackenridgei* subsp. *mokuleianus*, and cryptic destruction of plants caused by invasive animal species like that observed at Kaena with *E. celastroides* var. *kaenana*. Declines observed at the *Kadua degeneri* subsp. *degeneri* Alaiheihe and Manuwai PU, *Schiedea nutallii* Kapuna-Keawapilau PU, *Schiedea kaalae* Pahole PU, *Neraudia angulata* Kaluakauila PU, *Cenchrus agrimonioides* var. *agrimonioides* Makaha and Waianae Kai PU, and *Schiedea obovata* Kahanahaiki to Pahole PU are all likely associated with drought conditions as drought stressed plants have been observed in all of these PUs. *Schiedea obovata* in the Kahanahaiki to Pahole PU experienced a decline of 47 mature plants and an overall population decline of 444 plants, yet at the MMR-G reintroduction 49% of the remaining mature plants and 87% of immature plants are recruits and the PU still meets stabilization goals for mature plants. Another steep decline was observed in the *Cyanea grimesiana* subsp. *obatae* Palikea (South Palawai) PU. This decline is primarily due to losses observed at the PAK-C reintroduction. Prior to January 2022, the last complete census conducted at the site took place in winter 2018. Over this period, the mature age class declined by 252 plants or 31%, however, recruitment of additional plants is occurring within the reintroduction footprint and observations of recruited seedlings and immature plants have been reported in other areas of the Palikea Management Unit (MU) - in the Palikea South Snail Enclosure, the Banyan Breezeway restoration area, and within the *Phyllostegia hirsuta* PAK-A reintroduction - which would suggest animals are actively dispersing fruits and seeds. Twenty-three F1 immature plants were observed at the reintroduction during the last complete census, and casual observations since then would suggest that recruitment continues to expand with at least one F1 recruit transitioning to the mature age class.

Efforts were made in the past year to census all *Eugenia koolauensis* MFS PUs and the largest Genetic Storage (GS) PUs, all of which have not been monitored since 2015. As expected, declines in plant numbers were observed at all PUs monitored, however, plants in both the immature and mature age class still persist at all sites, with many of the immature plants showing minimal sign of the *Austropuccinia psidii* rust and a few remaining mature plants observed with healthy new growth. Mature plants at the

Kaleleiki (GS) PU experienced a reduction of six mature plants and an overall population declined of 64% and the Kaunala PU fell by 67% with a loss of nine mature plants. A decline of 84% was observed at Pahipahialua with a loss of 16 mature plants, and the smallest decline was noted at the Oio PU (29%) with a loss of only 3 mature plants. However, these numbers are outstanding considering that at the outset of the *A. psidii* invasion ANRPO did not expect that any plants would survive the next 5-10 years. Given these observations, it may be warranted to investigate potential resistance to the rust in wild immature plants or in F1 plants recruiting at the established living collection at Koko Crater Botanical Garden. During these monitoring events cuttings of 13 new founders were sampled and deposited with ANRPO horticulture staff as potential additions to the living collection.

Currently, 50 of the 131 MFS PUs meet stabilization requirements for mature plants, an increase of 3 PU compared to last reporting year (ANRPO 2021a). In the coming year ANRPO will continue to prioritize monitoring of cliff dwelling species with particular focus on *T. filiforme* and *Melanthera tenuifolia*. Monitoring priority will also be given to PU that have not been surveyed in last five years or longer. Additionally, we will collaborate with DOFAW to monitor *Alectryon macrococcus* var. *macrococcus* No Management PUs to sample propagules for Oahu's last remaining wild individuals to add to ANRPO's living collection for this taxon. Outplanting efforts are planned for *C. grimesiana* subsp. *obatae*, *C. longiflora*, *Cyanea superba* subsp. *superba*, *C. denata*, *D. waianaeensis, Euphorbia herbstii*, *Hesperomannia oahuensis*, *K. degeneri* subsp. *degeneri*, *Kadua parvula*, *Geniostoma cyrtandrae*, *Neraudia angulata*, *S. nuttallii*, *S. obovata*, and *V. chamissoniana* subsp. *chamissoniana* at MFS PUs that currently do not meet stabilization goals for mature plants, or will likely fall below goals in the near future. Propagation efforts are under way to build greenhouse living collections of *Phyllostegia kaalaensis*, *P. mollis* and *Stenogyne kanehoana* for the purpose of propagating plant materials for the establishment of new reintroductions for these taxa. The ANRPO Rare Plant Program is working with the Amend and Hynson Laboratories at the University of Hawaii at Manoa to develop field strategies for the use of endophytic fungi to protect Hawaiian native mint species from the impacts of powdery mildew at reintroduction sites.

Table 1: MFS PUs sorted by greatest to least % Change Mat (decrease). Bold PUs have only wild plants. ΔMAT= the difference in mature plants between 2020 and 2021. %Change MAT= percent change observed in mature plants. ΔPop= the difference in total plant numbers between 2021 and 2022. %Change Pop= percent change observed in total plant numbers. *Population Unit Name= PU meets stabilization goals for mature plants

Plan	TaxonCode	PopulationUnitName	Δ Mat	% Change Mat	Δ Pop.	% Change Pop.
MIP	PlaPriPri	Ohikilolo	-1	-100.00	-1	-100.00
MIP	**EupCelKae**	**East of Alau**	-8	-88.89	-8	-88.89
OIP	**EugKoo**	**Pahipahialua**	-16	-88.89	-124	-83.78
MIP	HibBraMok	Makua	-61	-67.03	-110	-65.09
OIP	**CyaKoo**	**Kaipapau, Koloa and Kawainui**	-73	-64.60	-61	-48.80
OIP	**EugKoo**	**Kaunala**	-9	-60.00	-54	-66.67
MIP	HesOah	Pahole NAR	-1	-50.00	-1	-50.00
OIP	**EugKoo**	**Oio**	-3	-50.00	-3	-37.50
MIP	NerAng	Kaluakauila	-18	-48.65	-4	-9.52
MIP	KadDegDeg	Alaiheihe and Manuwai	-32	-43.84	-51	-33.33
OIP	PhyHir	Haleauau to Mohiakea	-5	-29.41	-3	-15.79

Table 1 (continued).

Plan	TaxonCode	PopulationUnitName	Δ Mat	% Change Mat	Δ Pop.	% Change Pop.
MIP	CyaGriOba	Palikea (South Palawai)*	-255	-27.81	-232	-25.24
MIP	SchNut	Kapuna-Keawapilau Ridge*	-21	-23.86	-81	-46.29
MIP	SchKaa	Pahole*	-19	-22.09	-35	-23.97
MIP	**KadDegDeg**	**Kahanahaiki to Pahole**	-12	-20.69	-36	-32.73
MIP	**DubHer**	**Ohikilolo Makai**	-12	-20.00	-12	-20.00
MIP	CyaGriOba	Kaluaa	-5	-19.23	-6	-11.32
MIP	HesOah	Pualii	-5	-17.86	-10	-23.81
MIP	CenAgrAgr	Makaha and Waianae Kai*	-22	-17.05	-29	-19.86
MIP	DelWai	Manuwai	-7	-16.28	-8	-16.67
MIP	**AleMacMac**	**Makaha**	-1	-14.29	-1	-14.29
MIP	**KadDegDeg**	**Central Makaleha and West Branch of East Makaleha**	-1	-14.29	-7	-43.75
MIP	**SchObo**	**Kahanahaiki to Pahole***	-47	-13.31	-444	-45.26
MIP	CyaLong	Kapuna to West Makaleha	-9	-13.24	-34	-27.20
MIP	DelWai	Kaluaa*	-24	-12.70	21	7.78
OIP	AbuSan	Ekahanui and Huliwai*	-11	-12.50	-26	-19.55
OIP	PhyHir	Puu Palikea	-1	-12.50	38	475.00
MIP	CyaSupSup	Kahanahaiki	-2	-10.00	-98	-39.04
MIP	CyaLong	Makaha and Waianae Kai	-2	-9.52	-8	-27.59
MIP	KadPar	Ekahanui*	-12	-8.89	-33	-18.23
OIP	GarMan	Haleauau	-3	-7.50	-4	-3.20
MIP	SchKaa	South Ekahanui	-11	-6.79	9	3.85
MIP	SchKaa	Kaluaa and Waieli	-7	-5.38	22	16.67
MIP	HibBraMok	Keaau	-3	-4.84	62	78.48
OIP	PhyMol	Kaluaa	-1	-4.76	1	4.17
MIP	KadPar	Ohikilolo*	-3	-3.66	-6	-5.83
MIP	NotHum	Manuwai*	-3	-2.88	-2	-1.92

Table 1 (continued).

Plan	TaxonCode	PopulationUnitName	Δ Mat	% Change Mat	Δ Pop.	% Change Pop.
MIP	CenAgrAgr	Central Ekahanui*	-4	-2.34	31	15.90
MIP	NerAng	Makua	-1	-2.22	75	153.06
OIP	GenCyr	East Makaleha to North Mohiakea*	-4	-1.90	-11	-4.82
MIP	**PriKaa**	**Makaleha to Manuwai***	-1	-0.81	-9	-6.72
OIP	SchTri	Kalena to East Makaleha*	-1	-0.24	109	9.53

Table 2: MFS PUs sorted by greatest to least % Change Mat (increase). Bold PUs have only wild plants. ΔMAT= the difference in mature plants between 2021 and 2022. %Change MAT= percent change observed in mature plants. ΔPop= the difference in total plant numbers between 2021 and 2022. %Change Pop= percent change observed in total plant numbers. *Population Unit Name= PU meets stabilization goals for mature plants

Plan	TaxonCode	PopulationUnitName	Δ Mature	% Change Mature	Δ Pop.	% Change Pop.
MIP	SchKaa	Kaluanui	39	557.14	-26	-19.12
MIP	VioChaCha	Halona	38	345.45	38	223.53
MIP	SchObo	Makaha*	132	185.92	57	21.11
MIP	GouVit	Keaau	3	150.00	-2	-3.51
MIP	NerAng	Makaha	17	141.67	30	125.00
MIP	**PlaPriPri**	**North Mohiakea***	35	125.00	67	94.37
MIP	**CyrDen**	**Kahanahaiki**	16	123.08	28	48.28
OIP	GenCyr	Koloa	1	100.00	-4	-57.14
OIP	PhyMol	Ekahanui	1	100.00	3	100.00
MIP	SchNut	Makaha*	81	87.10	72	70.59
MIP	KadDegDeg	Makaha to Ohikilolo*	41	78.85	-66	-24.00
MIP	FluNeo	Makaha	5	71.43	-1	-3.45
MIP	**VioChaCha**	**Puu Kumakalii***	29	65.91	33	75.00
MIP	DelWai	Kahanahaiki to Keawapilau*	37	51.39	66	85.71
MIP	CyaSupSup	Makaha	19	48.72	-43	-37.72
MIP	HibBraMok	Manuwai	12	46.15	62	81.58
MIP	CyaGriOba	Pahole to West Makaleha	19	43.18	-15	-10.71
MIP	CyaLong	Pahole*	24	42.11	40	19.42
MIP	EupHer	Kaluaa	5	41.67	-5	-10.20

Table 2 (continued).

Plan	TaxonCode	PopulationUnitName	Δ Mature	% Change Mature	Δ Pop.	% Change Pop.
MIP	DelWai	Ekahanui	19	38.78	18	16.82
MIP	PriKaa	Ohikilolo East and West Makaleha	7	35.00	5	1.81
MIP	**TetFil**	**Kalena**	9	34.62	20	47.62
MIP	SchNut	Kahanahaiki to Pahole*	44	30.99	29	16.96
MIP	NerAng	Manuwai	4	28.57	-6	-6.52
MIP	HesOah	Makaha	3	27.27	-12	-23.08
MIP	**TetFil**	**Ohikilolo***	411	21.51	-37	-1.11
MIP	**CyrDen**	**Pahole to West Makaleha***	111	21.18	772	44.39
MIP	HibBraMok	Haili to Kawaiu*	9	18.75	29	33.72
MIP	**CyrDen**	**Opaeula (Koolaus)**	5	17.24	32	36.78
MIP	PriKaa	Ohikilolo*	22	15.83	63	4.16
MIP	**DubHer**	**Ohikilolo Mauka***	16	14.68	16	13.01
MIP	**PlaPriPri**	**Konahuanui**	4	12.50	1	2.33
MIP	CenAgrAgr	Kahanahaiki and Pahole*	31	12.20	70	19.28
MIP	**NotHum**	**Kaluakauila***	4	10.26	-3	-2.73
OIP	**AbuSan**	**Kaawa to Puulu**	3	8.33	3	1.53
OIP	**CyaAcu**	**Makaleha to Mohiakea***	15	7.69	19	6.69
OIP	AbuSan	Kahanahaiki*	4	5.80	-8	-7.14
MIP	CyaSupSup	Palikea	1	5.56	-30	-9.20
MIP	**SchObo**	**Keawapilau to West Makaleha**	2	5.56	-44	-28.95
MIP	EupHer	Kapuna to Pahole*	2	2.90	-18	-15.00
MIP	**EupCelKae**	**Makua***	1	1.54	-1	-1.49

The Population Unit Status Summary for each IP taxon is included as Appendix 4-1. The example shown below (Table 3), displays the management designation, the original MIP or OIP population total, last year's reported total and the current status of the wild and outplanted plants for each PU. The PUs are grouped by location inside the MIP or OIP Action Area (AA) (In) and outside of AAs (Out). Definitions for each field are given below.

Table 3: Example of a Population Unit Status Summary using *Cenchrus agrimonioides* var. *agrimonioides*

Population Unit Status - Makua Implementation Plan

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides Target # of Matures: 50 # MFS PU Met Goal: 3 of 3

Population Unit Name	Management Designation	Total Mature Original IP	Total Imm Original IP	Total Seedling Original IP	Total Mature 2021	Total Immature 2021	Total Seedling 2021	**Total Mature Current**	**Total Immature Current**	**Total Seedling Current**	Wild Mature Current	Wild Immature Current	Wild Seedling Current	Outplanted Mature Current	Outplanted Immature Current	Outplanted Seedling Current	PU LastObs Date	Population Trend Notes
Kahanahaiki and Pahole	Manage for stability	210	66	0	254	109	0	**285**	**148**	**0**	55	12	0	230	136	0	2022-05-23	More plants were added to the outplanting site
Kuaokala	Genetic Storage				1	3	0	**0**	**0**	**0**	0	0	0	0	0	0	2022-06-15	Thorough monitoring in the last year showed a decline
	In Total:	210	66	0	255	112	0	**285**	**148**	**0**	55	12	0	230	136	0		

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides Target # of Matures: 50 # MFS PU Met Goal: 3 of 3

Population Unit Name	Management Designation	Total Mature Original IP	Total Imm Original IP	Total Seedling Original IP	Total Mature 2021	Total Immature 2021	Total Seedling 2021	**Total Mature Current**	**Total Immature Current**	**Total Seedling Current**	Wild Mature Current	Wild Immature Current	Wild Seedling Current	Outplanted Mature Current	Outplanted Immature Current	Outplanted Seedling Current	PU LastObs Date	Population Trend Notes
Central Ekahanui	Manage for stability	20	0	0	171	21	3	**167**	**59**	**0**	65	2	0	102	57	0	2022-03-16	More plants were added to the outplanting site
Makaha and Waianae Kai	Manage for stability	9	3	0	129	17	0	**107**	**5**	**5**	6	0	5	101	5	0	2021-09-28	Thorough monitoring in the last year showed a decline
South Huliwai	Genetic Storage	27	0	0	42	2	0	**32**	**5**	**0**	32	5	0	0	0	0	2021-07-13	Thorough monitoring in the last year showed a decline in mature plants
	Out Total:	56	3	0	342	40	3	**306**	**69**	**5**	103	7	5	203	62	0		
	Total for Taxon:	266	69	0	597	152	3	**591**	**217**	**5**	158	19	5	433	198	0		

***Population Unit Name*:** Groupings of Population Reference Sites. Only PUs designated to be 'Manage for Stability' (MFS), 'Manage Reintroduction for Stability/Storage,' or 'Genetic Storage' (GS) are shown in the table. Other PUs with 'No Management' designations are not managed and will not be reported. In the ANRPO database, "No Management" PUs may be shown by not checking the "Exclude No Management" box on the report menu.

***Management Designation*:** For PUs with naturally occurring (*in situ*) plants remaining, the designation is either 'Manage for Stability' or 'Genetic Storage'. Some MFS PUs will be augmented with outplantings to reach stability goals. When reintroductions alone will be used to reach stability, the designation is 'Manage Reintroduction for Stability.' When a reintroduction will be used for producing propagules for genetic storage, the designation is 'Manage Reintroduction for Storage'.

***Total Original IP Mature, Immature, Seedling*:** These first three columns display the original population numbers as noted in the first IP reports of MIP (2005) and OIP (2008). When no numbers are displayed, the PU was not known at the time of the IPs

***Total Mature, Immature and Seedling (Year)*:** This displays the **SUM** of the number of *wild and outplanted* mature, immature plants and seedlings from the previous year's report. These numbers should be compared to those in the next three columns to see the change observed over the last year.

***Total Current Mature, Immature, Seedling*:** The **SUM** of the *current* numbers of *wild and outplanted* individuals in each PU. This number will be used to determine if each PU has reached stability goals. These three columns can be compared with the previous columns to see the change observed over the last year.

***Wild Current Mature, Immature, Seedling*:** This set of three columns display the most up to date population estimates of the wild (in situ) plants in each PU. These numbers are generated from ANRPO monitoring data, data from the Oahu Plant Extinction Prevention Program (OPEPP) and Oahu NARS staff. The estimates may have changed from last year if estimates were revised after new monitoring data was taken or if the PUs have been split or merged since the last reporting period. The most recent estimate is used for all PUs, but some have not been monitored in several years. Several PUs have not been visited yet by ANRPO and no plants are listed in the population estimates. As these sites are monitored, estimates will be revised.

***Outplanted Current Mature, Immature, Seedling*:** The last set of three columns display the numbers of individuals ANRPO and partner agencies have outplanted into each PU. This includes augmentations of in situ sites, reintroductions into nearby sites and introductions into new areas.

***PU LastObs Date*:** Last Observation Date of the most recent Population Reference Site observed within a PU. Where thorough monitoring was done, the estimates were updated. Note, there are sites that may have been observed more recently, but since a complete monitoring was not done, these observations are not reflected in the table.

***Population Trend Notes*:** Comments on the general population trend of each PU is given here. This may include notes on whether the PU was monitored in the last year, a brief discussion of the changes in population numbers from the previous estimates, and some explanation of whether the change is due to new plants being discovered in the same site, a new site being found, reintroductions or augmentations that increased the numbers, or fluctuations in the numbers of wild plants. In some cases where the numbers have not changed, staff monitored the PU and observed no change. When the PU has not been monitored, the same estimate from the previous year is repeated.

4.3 THREAT CONTROL SUMMARY

The Threat Control Summary for each Implementation Plan (IP) taxon is included in Appendix 4-2. An example shown below (Table 4) summarizes the threat (ungulates, rodents, weeds, slugs, and fire) status

at each PU for every IP taxa. “Yes,” “No,” or “Partial” is used to indicate the level of threat management. Additionally, “Partial” management includes a percentage based upon the number of mature plants being protected.

Table 4: Example of a Threat Control Summary using *Cenchrus agrimonioides* var. *agrimonioides*

Threat Control Summary Makua Implementation Plan

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides

PopulationUnitName	ManagementDesignation	# Mature Plants	Ungulates Managed	Weeds Managed	Rats Managed	Slugs Managed	Fire Managed
Kahanahaiki and Pahole	Manage for stability	285	Yes	Partial 100%	Partial 78%	No	No
Kuaokala	Genetic Storage	0	No	No	No	No	No

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides

PopulationUnitName	ManagementDesignation	# Mature Plants	Ungulates Managed	Weeds Managed	Rats Managed	Slugs Managed	Fire Managed
Central Ekahanui	Manage for stability	167	Yes	Partial 99%	Yes	No	No
Makaha and Waianae Kai	Manage for stability	71	Partial 92%	Partial 100%	Partial 92%	Partial 85%	No
South Huliwai	Genetic Storage	32	No	Partial 100%	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Ungulate Managed = Culmination of Cattle, Goats, and Pig threats
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial%=Percent of mature plants in Population Unit that have threat controlled
Partial 100%= All PopRefSites within Population Unit have threat partially controlled
Partial 0%= Threat partially controlled, but no mature plants

***Population Unit Name*:** Groupings of Population Reference Sites. Only PUs designated to be ‘Manage for Stability’ (MFS), ‘Manage Reintroduction for Stability/Storage,’ or ‘Genetic Storage’ (GS) are shown in the table.

***Management Designation*:** Designations for PUs with ongoing management are listed. Population Units that are MFS are the first priority for complete threat control. PUs that are managed in order to secure genetic storage collections receive the management needed for collection (ungulate and rodent control) as a priority but may be a lower priority for other threat control.

 # *Mature Plants*: Number of Mature Plants within the Population Unit.

***Threat Columns*:** The six most common threats are listed in the next columns. To indicate if the threat is noted at each PU, a shaded box is used. If the threat is not present at that PU, it is not shaded.

Threat control is defined as:

- Yes = All sites within the PU have the threat controlled
- No = All sites within the PU have no threat control
- Partial X%= Percent of mature plants in Population Unit that have threat controlled
- Partial 100%= All PopRefSites within Population Unit have threat partially controlled
- Partial (with no %) = All PopRefSites within Population Unit have threat partially controlled and only immature plants have been observed.

***Ungulates*:** This threat is indicated if pigs, goats or cattle have been observed at any sites within the PU. This threat is controlled (Yes) if a fence has been completed and all ungulates removed from the site. Most PUs are threatened by pigs, but others are threatened by goats and cattle as well. The same type of fence is used to control for all three types of ungulates on Oahu. Partial indicates that the threat is controlled for some but not all plants in the PU or if there is a sustained incursion of ungulates into a previously ungulate free fence.

***Weeds*:** This threat is indicated at all PUs for all IP taxa. This threat is controlled if weed control has been conducted within a 50m radial buffer around IP Taxa sites for each PU. If only some of the sites have had weed control, 'Partial' is used.

***Rats*:** This threat is indicated for any PUs where damage from rodents has been confirmed by ANRPO staff. This includes fruit predation and damage to stems or any part of the plant. The threat is controlled if the PU is protected in an active rat control area. For some taxa, rats are not known to be a threat, but the sites are within rat control areas for other taxa so the threat is considered controlled. In these cases, the box is not shaded but control is 'Yes' or 'Partial.' Partial indicates that the threat is fully controlled over part of the PU.

***Slugs*:** This threat is indicated for several IP taxa as confirmed by ANRPO staff. Currently, slug control is conducted using Ferroxx AQ produced by Neudorff, the manufacturer of Sluggo. Like Sluggo, Ferroxx AQ contains iron phosphate as the active ingredient (AI) but at a 3% concentration instead of Sluggo's 1%. Unlike many molluscicides, which contain metaldehyde or methocarb, iron phosphate is not a contact poison thereby reducing risk to non-target animals. Iron phosphate is non-toxic to birds, humans and other mammals as well as earthworms and insects. Ingestion by slugs or snails, even in small amounts, will cause them to cease feeding, providing immediate protection to plants, though the animal may not die for six days. Environmental risk is low as iron phosphate breaks down completely and is a natural component of soils.

***Fire*:** This threat is indicated for PUs that occur on Army lands within the high fire threat area of the Makua AA, and some PUs within the Schofield West Range AA and Kahuku Training Area that have been threatened by fire within the last ten years. Similarly, PUs that are not on Army land were included if there is a history of fires in that area. This includes PUs: below the Honouliuli Contour Trail; in the gulches above Waialua where the 2007 fire burned including Puulu, Kihakapu, Palikea, Kaimuhole, Alaiheihe, Manuwai, Kaomoku iki, Kaomoku nui and Kaawa; and in the Puu Palikea areas that were threatened by the Nanakuli fire in 2016 and the Keaau fire in 2018. Threat control conducted by ANRPO includes removing fuel from the area with pesticides, marking the site with Seibert Stakes for water drops, and installing fuel-breaks in fallow agricultural areas along roads. In addition, ANRPO supports City and County, State, and Federal wildland firefighting efforts and organizes and facilitates the use of Army Wildland Fire Crew and aviation assets in support of these efforts as justified under the MIP and OIP. 'Partial' means that the threat has been partially controlled to the whole PU, not that some plants are fully

protected. Firebreaks and other control measures only partially block the threat of fire which could make it into the PU from other unprotected directions.

Weed control continues at most MUs, and is a threat to all taxa in all PUs. See Chapter 3 for more detailed description of weeding efforts and long-term plans. The weed control status was determined by overlaying weed control efforts with IP taxa population sites in GIS. A 50m radial buffer around IP taxa sites was created. If weed control efforts covered the entire buffer for a particular population reference code, it was counted as full management, and assigned a 'Yes.' If only a part of the buffer was weeded, it was assigned 'Partial". Of the 131 MFS PUs, 112 received 'Partial' weed control status, same as the previous year (ANRPO 2021b). Of the 112 PUs assigned 'Partial' weed control status, 80 received weed control for ≥ 50% of mature plants in the PU. This represents no change from last reporting year. MFS PUs are prioritized for weed control over GS PUs. In MFS PUs, reintroduction PRSs are prioritized over wild or *in situ* PRSs, given that wild sites are often more sensitive to human impacts associated with weed control or are located on terrain where it is difficult to control, like in cliff habitat.

Rodents are considered a potential threat to most IP taxa, as they consume fruit, as well as damage stems and seedlings of plants. The rodent control status was determined by overlaying rodent control efforts with IP taxa population sites in GIS. A 25m radial buffer around IP taxa sites was created. If rodent control efforts covered the entire buffer for a particular population reference code, it was counted as full management, and assigned a 'Yes.' If only a part of the buffer was controlled, it was assigned 'Partial". Rodent 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, except when they benefit from inclusion within MU-scale trap grids. 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 21 of the 39 taxa in the MIP and OIP. Of the total MFS PUs where rats are considered a threat, they are partially or fully controlled at 65% of MFS PUs. This is an increase of 12% from the previous year (ANRPO 2021b). Partial and full control was attained at 29 (41%) and 17 (24%) MFS PUs respectively. Control is considered "Full" for a PU when all PRSs within that PU have an individual trap grid or fall within a larger grid. "Partial" control refers to PUs in which one or more PRSs do not have an individual trap grid or do not fall within a larger grid system. Rodent threat management is almost exclusively Goodnature A24 automatic resetting traps which improves time efficiency and control of rats around rare taxa (see Chapter 8 for more discussion on rodent control).

Ungulate threat control and fence repairs are ongoing, and all areas known to be free of ungulates are listed as "Yes." Population Units (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 all ungulates have been removed. Of the 126 MFS PUs where ungulates are listed as a threat to management taxa, 119 MFS PUs currently have either partial or full control. This represents an increase of 5 PUs compared to last year (ANRPO 2021b). Partial and full control was attained at 43 (34%) and 76 (60%) MFS PUs respectively. In the event of an ungulate incursion into a fence unit where ungulates were cleared, the control designation will remain as "Full" unless the incursion is significant, involving large numbers of animals or persists for an extended period of time. In this case, the control designation will change to "Partial" until animals are cleared from the fence unit. There was no pig damage observed to ANRPO management taxa during this period.

Slugs are a threat to seedling survival and recruitment of many native plants. They are noted as a threat to 25 of 39 MIP and OIP taxa and are currently partially or fully controlled at 42% of MFS PUs for those taxa, which is a 12% increase from the previous year (ANRPO 2021b). Of the 83 MFS PUs, 29 (35%) received partial and six (7%) full control. Increases in slug control are the result of program efforts, initiated last reporting year, to expand slug control in our management units. Increases in slug control will be observed into the next reporting year as well. Slug control is considered "Full" for a PU when all PRSs

within that PU receive treatments for slugs. “Partial” control refers to PUs in which one or more PRSs do not receive slug control treatments. Decisions on where to initiate control are based on site accessibility, slug impacts to 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 (see Chapter 9 for more discussion of slug control).

4.4 GENETIC STORAGE SUMMARY

The Genetic Storage Summary for each IP taxon is included in Appendix 4-3. An example table is provided below (Table 8). Every year, ANRPO collects propagules from IP taxa for *ex situ* genetic storage. Storage goals were pre-determined in the MIP and OIP. In general, each wild plant (up to 50 plants from each PU) needs either 50 viable seeds (as estimated at the time of collection) or three ex-plants (plants held in tissue culture) or a living collection of three plants in the nursery. The Genetic Storage Summary tables report 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 55 PUs out of 226 that reached their storage goal, representing 1,076 founder plants and 29 taxa (Table 5). There was an increase of 5 PUs meeting storage goals since last reporting year, and an additional 24 founder plants in the category of “goals met” as compared to the previous year (ANRPO 2021c). Among PUs where goals are not 100% complete, there has been progress with an additional 1,271 founder plants in 169 PU partially represented. This increase is due in part to efforts to generate seed for *Gouania vitifolia* from the Keaau PU planted at Kahua *inter situ* site. Forty-seven founders from *G. vitifolia* KEA-A have ≥50 estimated viable seed stored, as compared to forty-three founders seen last year. In addition, *Hibiscus brackenridgei* subsp. *mokuleianus*, *Kadua degeneri* subsp. *degeneri*, and *Plantago princeps* var. *princeps* all saw an increase of founders with ≥ 50 viable seed stored. This can be attributed to the collection efforts made by ANRPO field crews. Also, as *Tetramolopium filiforme* MMR-G founders flower in the greenhouse horticulture staff continue to hand pollinate to increase the number of filled seed that will count towards our genetic storage goals.

Table 5: Summary statistics indicating progress during the 2022 reporting year in genetic storage collections. There are 226 PUs that require *ex situ* representation via seed banking, tissue culture, or living collections in the Army Nursery.

Genetic Storage Summary Statistics	2021	2022
Number of PUs with 100% Genetic storage	50 (1,052 founders)	55 (1,076 founders)
MIP and MIP/OIP Overlap PUs with 100% Genetic Storage	34	38
OIP PU with 100% Genetic Storage	16	17
Average PU Genetic Storage Completion	43%	46%
PU with No Founder Representation in Genetic Storage	55	55
PU with ≥90% Genetic Storage Complete	54	58
PU with ≥50% Genetic Storage Complete	99	111
Total Founders with 100% Genetic Storage	2181	2351

Table 6. A summary of the living collections for founders meeting genetic storage goals by species. The total number of potential founders for each species is listed in the 5th column from left for reference.

Species	Founders w/ >3 in Nursery 2021	Founders w/ >3 in Nursery 2022	Change in founders w/ >3 in Nursery	Total Number of Potential Founders
Alectryon macrococcus var. *macrococcus*	11	15	4	30
Cenchrus agrimonioides var. *agrimonioides*	36	50	14	310
Dubautia herbstobatae	28	75	47	512
Eugenia koolauensis	130	113	-17	144
Flueggea neowawraea	14	17	3	43
Gardenia mannii	16	30	14	69
Hibiscus brackenridgei subsp. *mokuleianus*	97	117	20	174
Melanthera tenuifolia	3	11	8	1756
Neraudia angulata	42	37	-5	136
Nototrichium humile	50	118	68	561
Schiedea nuttallii	33	32	-1	57
Viola chamissoniana subsp. *chamissoniana*	21	34	13	407

ANRPO maintains living collections in the nursery for the plants listed above in Table 6. Following the installation of fans in the greenhouse to circulate air within and move hot air out, living collection founders meeting the goal of three or more replicates per founder generally increased with three exceptions, *Eugenia koolauensis, Neraudia angulata* and *Schiedea nuttallii*. The loss of founders meeting goals for *E. koolauensis* can be explained by the outplanting at Wahiawa Botanical Gardens. Founders from the Pahipahialua PU were outplanted in November of 2021. Most of the plants selected for this outplanting were propagated five or more years ago by Horticulture staff and were severely pot bound and prone to drying out. Horticulture staff had begun propagation before the outplanting and will replace plants to meet goals by the next YER. The decline in the number of *Neraudia angulata* founders that meet goals of three plants in living collection can only be explained by the prevalence of greenhouse pests on *N. angulata* and the general decline of health of older plants in the living collection. Horticulture staff will focus on propagating remaining living collection stock to bring the number of founders meeting goals up. The loss of a single founder of *S. nuttallii* can be directly tied to rat activity at ANRPO's Pahole nursery; a rat ate through the irrigation line of an entire row of *S. nuttallii* this past summer, causing the loss of a founder. Efforts will be made to recollect the founder from reintroduced plants at various locations.

Increases in founders meeting genetic storage goals for *Alectryon macrococcus* var. *macrococcus, Cenchrus agrimonioides* var. *agrimonioides, Flueggea neowawraea, Gardenia mannii, Hibiscus brackenridgei* subsp. *mokuleianus* and *Nototrichium humile* can all be attributed to increased efforts by horticulture staff to increase production to meet genetic storage goals. Of note; following a decline in *N. humile* founders in the greenhouse living collection in 2021, Horticulture staff were able to collect

propagules from the planting at Koko Crater Botanic Gardens to bring lost founders back into the living collection. In addition, Horticulture staff focused on propagating founders with less than 3 plants in the living collection, resulting in a large increase of founders of *N. humile* meeting genetic storage goals.

Increases in founders meeting genetic storage goals for *Dubautia herbstobatae* and *Viola chamissoniana* subsp. *chamissoniana* can be directly tied to increased monitoring and collection efforts in 2021-2022 by staff.

Table 7: Micropropagation Summary

Species	Founders in Microprop 2021	Founders in Microprop 2022	Change in founders in Microprop
Dubautia herbstobatae	12	18	6
Melanthera tenuifolia	5	7	2
Schiedea nuttallii	2	11	9
Viola chamissoniana subsp. *chamissoniana*	20	30	10

Since successfully transitioning founders of *Phyllostegia hirsuta, Phyllostegia mollis* and *Schiedea kaalae* from greenhouse living collection to micropropagation, Horticulture staff have been steadily increasing representation of founders for the species listed above (Table 7). The 2021-2022 reporting year was no different and representation in micropropagation increased, thanks to both collection efforts in the field and propagation efforts in the nursery. Horticulture staff will continue to increase founder representation for the species listed above until genetic storage goals are complete as founders become available.

Table 8: Example of a Genetic Storage Summary using *Cenchrus agrimonioides* var. *agrimonioides*

Genetic Storage Summary Makua Implementation Plan

Population Unit Name	Management Designation	# of Potential Founders			Partial Storage Status				Storage Goals				Storage Goals Met	
		Current Mature	Current Imm.	Dead and Repres.	# Plants >= 10 in SeedLab	# Plants >= 10 Est Viable in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants >= 50 in SeedLab	# Plants >= 50 Est. Viable in SeedLab	# Plants >=3 in Microprop	# Plants >=3 Army Nursery	# Plants that Met Goal	% Completed Genetic Storage Requirement
Action Area: In														
Cenchrus agrimonioides var. agrimonioides														
Kahanahaiki and Pahole	Manage for stability	55	12	65	85	70	0	0	62	39	0	0	48	96%
Kuaokala	Genetic Storage	0	0	1	0	0	0	1	0	0	0	1	1	100%
Action Area: Out														
Cenchrus agrimonioides var. agrimonioides														
Central Ekahanui	Manage for stability	65	2	50	80	47	0	50	40	10	0	29	35	70%
Makaha and Waianae Kai	Manage for stability	6	0	8	9	5	0	9	4	0	0	8	8	57%
South Huliwai	Genetic Storage	32	5	28	44	34	0	33	26	10	0	12	19	38%

Total Current Mature	Total Current Imm.	Total Dead and Repres.	Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=10 Est Vaible Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants w/ >=50 Seeds in SeedLab	Total # Plants w/ >=50 Est Viable Seeds in SeedLab	Total # Plants w/ >=3 in Microprop	Total # Plants w/ >=3 Army Nursery	Total # Plants that Met Goal
158	19	152	218	156	0	93	132	59	0	50	111

***Number (#) of Potential Founders*:** These first three columns list the current number of live *in situ* immature and mature plants in each PU. These plants have been collected from already or may be collected from in the future. The number of dead plants from which collections were made in the past is also included to show the total number of plants that could potentially be represented in genetic storage for each PU since collections began. Immature plants are included as founders for all taxa, but they can only serve as founders for some. For example, for *Hibiscus brackenridgei* subsp. *mokuleianus*, cuttings can be taken from immature plants for propagation. In comparison, for *Sanicula mariversa*, cuttings cannot be taken and seed is the only propagule appropriate for genetic storage. Therefore, including immature plants in the number of potential founders for *S. mariversa* gives an over-estimate. The 'Manage reintroduction for stability/storage' PUs have no potential founders. The genetic storage status of the founder stock used for these reintroductions is listed under the source PU.

***Partial Storage Status*:** To meet the IP genetic storage goal for each PU for taxa with seed storage as the preferred genetic storage method, at least 50 seeds must be stored from 50 plants. The number of seeds needed for each plant (50) accounts for the original viability (Estimate Viability) of seed collections. In order to show intermediate progress, this column displays the number individual plants that have collections of >10 seeds in storage. For taxa where vegetative collections will be used to meet storage goals, a minimum of three clones per plant in either the Lyon Micropropagation Lab, the Army nurseries or the State's Pahole Mid-Elevation Nursery is required to meet stability goals. Plants with one or more representatives in either the Lyon Micropropagation Lab or a nursery are considered to partially meet storage goals. The number of plants that have met this goal at each location is displayed.

 # *Plants that Met Goal*: This column displays the total number of plants in each PU that have met the IP genetic storage goals. As discussed above, a plant is considered to meet the storage goal if it has 50 seeds in storage or three clones in micropropagation or three in a nursery. For some PUs, the number of founders has increased in the last year; therefore, it is feasible that staff could be farther from reaching collection goals than last year. Also, as seeds age in storage, plants are outplanted, or ex-plants contaminated, this number will drop. In other PUs where collections have been happening for many years, the number of founders represented in genetic storage may exceed the number of plants currently extant in each PU. In some cases, plants that are being grown for reintroductions are also being counted for genetic storage. These plants will eventually leave the greenhouse and the genetic storage goals will be met by retaining clones of all available founders or by securing seeds in storage. This column does not show the total number of seeds in storage; in some cases thousands of seeds have been collected from one plant. For the first time this year, collections that have expired in the seed bank have been removed from the inventory and are not reflected here as represented. These collections have been flagged for *in situ* seed dispersal as collections have aged past adequate genetic representation of founder lines without high levels of artificial selection.

***% Completed Genetic Storage Requirement*:** Describes the percent of Founder Plants that have met Genetic Storage goals. 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 it is listed in the tables is 10%.

4.5 FIVE YEAR RARE PLANT MANAGEMENT PLANS

Five-year rare plant management plans for *G. vitifolia* and *Geniostoma cyrtandrae* and updated plans for *C. grimesiana* subsp. *obatae* and *Pritchardia kaalae* are presented in Appendices 4-4, 4-5, 4-6, and 4-7 respectively. Updated five-year management plans will be abbreviated compared to the original document and will only include sections with new information or sections that are relevant to the current management discussion. Table 9 below outlines a timeline for the completion of five-year plans for taxa without completed plans and for updates to plans that have expired. This timeline could change depending on the specific management needs of each ANRPO IP taxa.

Table 9: Timeline for the completion of five-year management plans and updates to expired plans

Species	IP	5 year Management or Genetic Storage Plan Date Completed	Future Expected Completion Date	Expected Update
Abutilon sandwicense	OIP	2012		2026
Alectryon macrococcus var. *macrococcus*	MIP		2025	
Cenchrus agrimonoides var. *agrimonoides*	MIP	2020		2030
Cyanea acuminata	OIP		2024	
Cyanea grimesiana subsp. *obatae*	MIP	2009		2022
Cyanea longiflora	MIP	2017		2028
Cyanea superba subsp. *superba*	MIP	2009/2015		2027
Cyrtandra dentata	MIP	2021		2030
Delissea waianaeensis	MIP	2009		2023
Dubautia herbstobatae	MIP	2021		2030
Eugenia koolauensis	OIP	2010/2014		2029
Euphorbia celastroides var. *kaenana*	MIP	2010		2025
Euphorbia herbstii	MIP	2014		2027
Flueggea neowawraea	MIP	2010		2025
Gardenia mannii	OIP	2013		2027
Gouania vitifolia	MIP		2022	
Hesperomannia oahuensis	MIP	2010		2024
Hibiscus brackenridgei subsp. *mokuleianus*	MIP	2010		2023
Kadua degeneri subsp. *degeneri*	MIP	2019		2029
Kadua parvula	MIP	2019		2030
Geniostoma cyrtandrae	OIP		2022	
Melanthera tenuifolia	MIP		2023	
Neraudia angulata	MIP	2013		2026
Nototrichium humile	MIP	2013		2027

Table 9 (continued).

Species	IP	5 year Management or Genetic Storage Plan Date Completed	Future Expected Completion Date	Expected Update
Phyllostegia hirsuta	OIP	2012		2026
Phyllostegia kaalaensis	MIP		2023	
Phyllostegia mollis	OIP	2010		2024
Plantago princeps var. *princeps*	MIP	2016		2028
Pritchardia kaalae	MIP	2009		2022
Sanicula mariversa	MIP	2014		2028
Schiedea kaalae	MIP	2011		2026
Schiedea nuttallii	MIP	2018		2029
Schiedea obovata	MIP	2018		2029
Schiedea trinervis	OIP		2025	
Stenogyne kanehoana	OIP		2024	
Tetramolopium filiforme	MIP	2016		2028
Viola chamissoniana subsp. *chamissoniana*	MIP	2020		2030

These management plans are intended to include all pertinent species information for stabilization, serve as a planning document and as an updated educational reference for ANRPO staff. In many cases, data or information is still being gathered and these plans will continue to be updated between scheduled revisions. For taxa for which threats are so severe that *in situ* management options are currently not feasible, Five-Year Genetic Storage Plans will replace Five Year Management Plans. A brief description of each section is given here:

- ***Species Description*:** The first section provides an overview of each taxon. The IP stability requirements are given, followed by a taxon description, biology, distribution, population trends, and habitat.
- ***Reproductive Biology Table*:** This information was summarized by ANRPO based on best available data from the MIP, OIP, USFWS 5-year Status Updates, ANRPO field observations and other published research. Phenology is primarily based on observations in the ANRPO rare plant database. The suspected pollinator is based on casual observations, pollinator syndromes as reported in the MIP and OIP, or other published literature. The information on seeds is from data collected at the Army seed lab and from collaborative research with the Harold L. Lyon Arboretum.
- ***Known Distribution & Historic Collections Table*:** This information was selected from Bishop Museum specimen records and collections listed in published research, the Hawaii Biodiversity and Mapping Program and other collectors' notes.
- ***Species Occurrence Maps*:** These maps display historic and current locations, MUs, landmarks and any other useful geographic data for each taxon. Other features may be used on public documents to obscure locations of rare elements.

- ***Population Units*:** A summary of the PUs for each taxon is provided with current management designations, action areas, and management units.
- ***Habitat Characteristics and Associated Species*:** These tables summarize habitat data taken using the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form. The data is meant to provide an assessment of the current habitat for the in situ and outplanting sites. Temperature and rainfall estimates are also included for each site when available.
- ***Pictures*:** These photos document habitat, habit, floral morphology and variation, and include many age classes and stages of maturing fruit and seed. They serve as a reference for field staff making collections and searching for seedlings.
- ***Taxonomic Background*:** This section provides information pertaining to the history of the taxonomy of the species.
- ***Population Structure & Trends*:** Data from monitoring the population structure for each species is presented with a plan to establish or maintain population structure at levels that will sustain stability goals. A review of population estimates for each PU is displayed in a table. Estimates come from the MIP, OIP, USFWS 5-year Status Updates and ANRPO field observations. In most cases, these estimates cannot be used to represent a population trend.
- ***Outplanting Considerations*:** This section discusses considerations related to outplanting rare plant taxa, such as concerns regarding unwanted hybridization with closely related taxa or other potential hybridization relationships and climate variables to consider when selecting outplanting sites. Climate Range Maps developed by Dr. Fortini (USGS) and related discussions are included in this section.
- ***Reintroduction Plan*:** A standardized table is used to display the reintroduction plans for each PU. Every outplanting site in each PU is displayed showing the number of plants to be established, the PU stock and number of founders to be used, and type and size of propagule (immature plants, seeds, etc.). Comments focus on details of propagation and planting strategies.
- ***Monitoring Plan*:** This section outlines the overall monitoring strategy for the species and monitoring frequencies for both MFS and GS PUs are established.
- ***Threats & Stabilization Goals Update*:** For each PU, the status of compliance with all stability goals is displayed in this table. All required MFS PUs are listed for each taxon. 'YES', 'NO' or 'PARTIAL' are used to represent compliance with each stability goal. For population targets, whether or not each PU has enough mature plants is displayed, followed by an estimate on whether a stable population structure is present. The major threats are listed separately for each PU. The boxes are shaded to display whether each threat is present at each PU. A dark shade identifies PUs where the threat is present and the lighter boxes where the threat is not applicable. The corresponding status of threat control is listed as 'YES', 'NO' or 'PARTIAL' for each PU. A summary of the status of genetic storage collections is displayed in the last column.
- ***Genetic Storage Section*:** This section provides an overview of propagation and genetic storage issues. A standardized table is used to display information recorded for each taxon's PUs where applicable. The plan for genetic storage is displayed and discussed. In most cases, seed storage is the preferred genetic storage technique; it is the most cost-effective method, requires the least amount of maintenance once established, and captures the largest amount of genetic variability. For taxa that do not produce enough mature seed for collection and testing storage conditions, micropropagation is considered the next best genetic storage technique. The maintenance of this storage method is continual, but requires much less resources and personnel than establishing a living collection in the nursery or a garden. For those taxa that do not produce storable seed and cannot be established in micropropagation, a living collection of plants in the nursery or an inter

situ site is the last preferred genetic storage option. In most cases, current research is ongoing to determine the most applicable method. For species with substantial seed storage data, a schedule may be proposed for how frequently seed bank collections will need to be refreshed to maintain genetic storage goals. This schedule is based only on storage potential for the species; other factors such as threats and plant health must be factored into this schedule to create a revised collection plan. Therefore, the frequency of refresher collections will constantly be adjusted to reflect the most current storage data. The re-collection interval is set prior to the time period in storage where a decrease in viability is detected. For example, *Delissea waianaeensis* shows no decrease in viability after ten years. ANRPO would not have to re-collect prior to ten years as the number of viable seeds in storage would not have yet begun to decrease. The re-collection interval will be 10 years or greater (10+ yrs). If viability declines when stored collections are tested at year 15, the interval will be set between 10 and 15 years. Further research may then be conducted to determine what specific yearly interval is most appropriate. The status of seed storage research is also displayed and discussed. Collaborative research with the USDA National Center for Genetic Resources Preservation (NCGRP) and Lyon Arboretum Seedlab is ongoing.

- ***Management Discussion & 5-Year Action Plan*:** A summary of the management approach, overall strategy, and important actions for each taxon. This section displays the schedule of actions for each PU. All management is planned by 'MIP or OIP Year' and the corresponding calendar dates are listed. This table can be used to schedule the actions proposed for each species into the ANRPO scheduling database. Comments in this section focus on details of certain actions or explain the phasing or timeline in some PUs

4.6 LITERATURE CITED

ANRPO. 2021a. Appendix 4-1 Taxa Status Summary in Status Report for the Makua and Oahu Implementation Plans.

ANRPO. 2021b. Appendix 4-2 Threat Control Summary in Status Report for the Makua and Oahu Implementation Plans.

ANRPO. 2021c. Appendix 4-3 Genetic Storage Summary in Status Report for the Makua and Oahu Implementation Plans.

CHAPTER 5: *ACHATINELLA MUSTELINA* MANAGEMENT

5.1 BACKGROUND

In this chapter, *Achatinella mustelina* management by the Army Natural Resources Program on Oahu (ANRPO) is reported for July 2021-June 2022. *Achatinella mustelina* across the Waianae Mountain range are divided into Evolutionary Significant Units (ESUs) based on genetic differences and are each managed separately. There are a total of seven managed populations within the six ESUs (Figure 1). ESU-B has two managed populations because of its large geographic spread. ESU-D. The Makua Implementation Plan (MIP) set a goal of 300 snails in each of the seven 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. This chapter starts with a summary status of *A. mustelina* management in regards to IP goals and general threat control information, which is followed by a summary status of each ESU.

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Figure 1: Map of eight ESUs, current and historic *A. mustelina* sites, and snail enclosure locations.

5.1.1 Threat Control

In PRSs designated as Manage for Stability (MFS) threats such as predators, ungulates, and weeds are controlled. Predators include rats, rosy wolf snails (*Euglandina rosea* and *Euglandina* sp.), and Jackson's chameleons (*Trioceros jacksonii xantholophus*). Tables in this chapter show the Threat Control Summary

for each MFS PRS and the current status of fence construction and removal of ungulates from Management Units (MUs), as well as the status of weed, rat, rosy wolf snails, and Jackson's chameleon's 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 MUs and weeds are a threat to all taxa in all PUs. See Chapter 3 for a more detailed description of weeding efforts and long-term plans. For wild PRSs weed control status was determined by overlaying weed control efforts with *A. mustelina* population reference sites in GIS. A 50 meter radius 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.' If none of the buffer was weeded, it was assigned a 'No.' Although weeds were not completely removed, all snail enclosures were listed as 'Yes' as weed control was implemented within the enclosure. Vegetation monitoring at the enclosures provides specific data on native habitat vs. weed density.

Rats are considered a potential threat to all PRSs, as they are known to prey on native snails. Rat control continued around many PRSs in the last year, in large grids around entire MUs and in smaller grids targeting individual populations. In all ESUs rat control is ongoing. See ESU tables in each section for the threat control status at individual PRSs. Much of the rat threat management has included the addition of more Goodnature A24 automatic resetting traps (A24s) which improves time efficiency and control of rats. The snail enclosure wall includes a barrier to prevent rats from climbing over the wall. The vegetation surrounding the enclosure is cleared to create a buffer to prevent rats from jumping from trees over the wall.

There is no effective control for rosy wolf snails or Jackson's chameleons. At the snail enclosures, these predators are excluded from the enclosures by physical barriers and quarterly visual searches are conducted; therefore, the threat control is 'Yes' and quarterly sweeps for predators are conducted at all enclosures. At all wild populations there is no threat control; therefore, they are listed as 'No.'

5.1.2 Progress Towards MIP Goals

ANRPO continues to make progress toward MIP goals. At four of the seven managed populations in the ESUs, the goal of 300 snails is met (Table 1) based on timed count observations. In three other ESUs (C, E, F) the number of counted snails are approaching the goal of 300 and given that the detection rate during Timed Count Monitoring (TCM; see below for methods) is not 100%, the number of snails at each site are likely greater than what was counted. Depending on the vegetation density, weather, time of day, and observers, detection rates can be as low as 10-25%. Previously, the reported numbers were based off the most recent data collection, but going forward, to take into account the variations in detectability due the listed factors, the highest counted number of snails within the report year will be reported as well as the average count for the quarterly timed counts at the enclosures. The highest number, while still considered an underestimate of the population, will give us a better representation of the population size and is based off the highest number of snails counted throughout the year and/or large-scale translocations. The reported average number of snails will take into account weather and most importantly observer error. Inconsistency in observers largely accounts for low counts.

Table 1: Recent counts of ESU MFS populations and snail enclosure status based on data from July 2021-June 2022 reporting year.

ESU	Highest # Snails Observed in ESU	Average # Snails Counted in Enclosures based on Quarterly Counts	Enclosure Location
A	356[1]	104 (Kahanahaiki) 96 (Pahole)	Kahanahaiki/Pahole
B1	324[2]	110	3 Points (Makaleha West)
B2	535		
C	268	25	Kaala
D	562	507	Hapapa
E	127	102	Palikea North
F	228	89	Palikea South

[1] Count includes TCM from Pahole and total translocations from Kahanahaiki
[2] The majority of snails in the 3 Points enclosure came from B1

At MFS PRSs snails are monitored on a regular basis using Timed Count Monitoring (TCM) and also Ground Shell Plot (GSP) surveys where terrain is accessible. 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 specific area for a specified number of person-hours. This ensures that data is comparable across surveys. At the enclosures, TCM is conducted quarterly, while wild managed PRSs are monitored every one to two years during the day or night depending on the location. TCM data represents a subsample of the population, as not all snails are detectable at any one time. Currently, TCM occurs either at night and/or day depending on the enclosure. For GSP surveys, the ground is searched within a designated plot and all shells are collected and counted. GSPs give an indication of mortality rates. This method also ensures comparable data across surveys and is used to assess trends in mortality.

5.2 ESU-A

Figure 2: *Achatinella mustelina* from ESU-A.

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Figure 3: Map of ESU-A. The red box shows an enlarged view of the old and new Kahanahaiki snail enclosures.

5.2.1 Management History and Population Trends

ESU-A span parts of Kahanahaiki Gulch and Pahole Natural Area Reserve (Figure 3). Two snail enclosure sites (Kahanahaiki and Pahole) are designated as MFS (Table 2) and the remaining PRSs are No Management (NM) (see ANRPO 2017 for a list of No Management sites). The Kahanahaiki and Pahole enclosures combined have at least 356 (includes translocated snails into Kahanahaiki enclosure and TCM data at Pahole) snails (actual population size is likely higher due to detection rate being less than 100%) and almost all the NM PRS snails have been moved into one of the two snail enclosures. The old snail enclosure at Kahanahaiki is no longer in use and all snails have been moved to the new enclosure. ANRPO manages the snail enclosure at Kahanahaiki (MMR-P), and the State of Hawaii's Department of Land and Natural Resources' Snail Extinction Prevention Program (SEPP) manages the Pahole snail enclosure (PAH-B).

Rosy wolf snails are assumed to be ubiquitous across the habitat and quarterly sweeps are conducted inside the enclosure to ensure that they have not breached the enclosure walls. Four rat tracking tunnels and four A24s have been installed inside the Kahanahaiki enclosure and have been maintained at six month intervals in the past but will checked at four month intervals going forward. The enclosure lies within the larger Kahanahaiki A24 grid. Jackson's chameleons are not common in this area.

Table 2: ESU-A population structure and threat control summary for MFS PRSs. The count reported is the highest count observed for the report year.

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-P	Manage for stability	102	2022-03-28	71	8	23	0	Yes	Yes	Yes	Yes	Yes
New Kahanahaiki Snail Enclosure												
PAH-B	Manage for stability	118	2022-01-04	54	41	23	0	Yes	Yes	Yes	Yes	No
Pahole Exclosure												
	ESU Total:	220		125	49	46	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.

MMR-A Old Kahanahaiki Enclosure NM-PRS: After a rat breach was detected inside the enclosure, ANRPO began translocating snails from the old enclosure to the new enclosure. A total of five translocation events took place and a total of 238 snails have been removed from the old enclosure. All *Psidium cattleianum* trees inside the enclosure were cut down and thoroughly searched for snails. The enclosure will continue to be searched quarterly for any remaining snails and will be maintained until at least March 2023. If no snails are found at that time, we will deconstruct the enclosure. See Appendix 5-1 Kahanahaiki Translocation Plan for complete protocol and monitoring plans.

Table 3: Translocations from the old enclosure (MMR-A) into the new enclosure (MMR-P).

Reintro Destination Site	Reintro Date	Reintro Origin Sites	Origin Coll. Date	Reintro Origin Lab	Reintro Sml	Reintro Med	Reintro Lrg
AchMus.MMR-P	New Kahanahaiki Snail Enclosure						
	2022-06-20	AchMus.MMR-A	2022-06-20		1	1	2
	2022-04-26	AchMus.MMR-A	2022-04-26		6	2	3
	2022-03-29	AchMus.MMR-A	2022-03-29		5	0	2
	2022-03-28	AchMus.MMR-A	2022-03-28		34	15	45
	2022-03-07	AchMus.MMR-A	2022-03-07		28	23	71
	AchMus.MMR-P Total:	5 Reintro Events		Total Snails Reintro:	74	41	123

MMR-P New Kahanahaiki Enclosure PRS: The newly constructed enclosure at Kahanahaiki is the focus of ANRPO's management within ESU-A. A total of 238 were collected from the old enclosure over five visits and all snails were introduced within a designated area in the enclosure (see Appendix 5-1 Kahanahaiki Translocation plan). Monitoring of the *A. mustelina* population within the enclosure occurs quarterly, and includes TCM and GSP monitoring. Table 4 reports the night counts for this report year in both the old enclosure (noted by the *) and the new enclosure after snails were introduced. Although counting the same population, since this is a new habitat, snails are utilizing the new enclosure differently which may affect the counts. Snails were initially released in three *Nestegis sandwicensis* trees but over time snails have moved to the surrounding trees. Figure 4 shows the population trend in the new enclosure since re-introduction. Although it appears that the population is decreasing, the downward trend is likely due to movement of the snails into higher (less visible) canopy and into the surrounding trees. Snails have been found outside the enclosure or on the wall. Vegetation from outplantings are already starting to fill the enclosure. See Appendix 5-2 for the Kahanahaiki snail enclosure vegetation monitoring results.

Table 4: TCM data for this report year. Observations can fluctuate due to various reasons. Counts done during the dryer summer months tend to be the lowest. The * indicates observations while snails were in the old enclosure.

Kahanahaiki Snail Enclosure								
	Night TCM				Ground Shells			
Date	Small	Medium	Large	Total	Small	Medium	Large	Total
*9/20/2021	13	21	82	116	4	1	6	11
*12/20/2021	12	24	96	132	5	1	13	19
3/28/2022	23	8	71	102				0
4/25/2022	14	10	75	99	1		2	3
6/20/2022	8	7	55	70	1		1	2
Average				104	Total ground shells			35

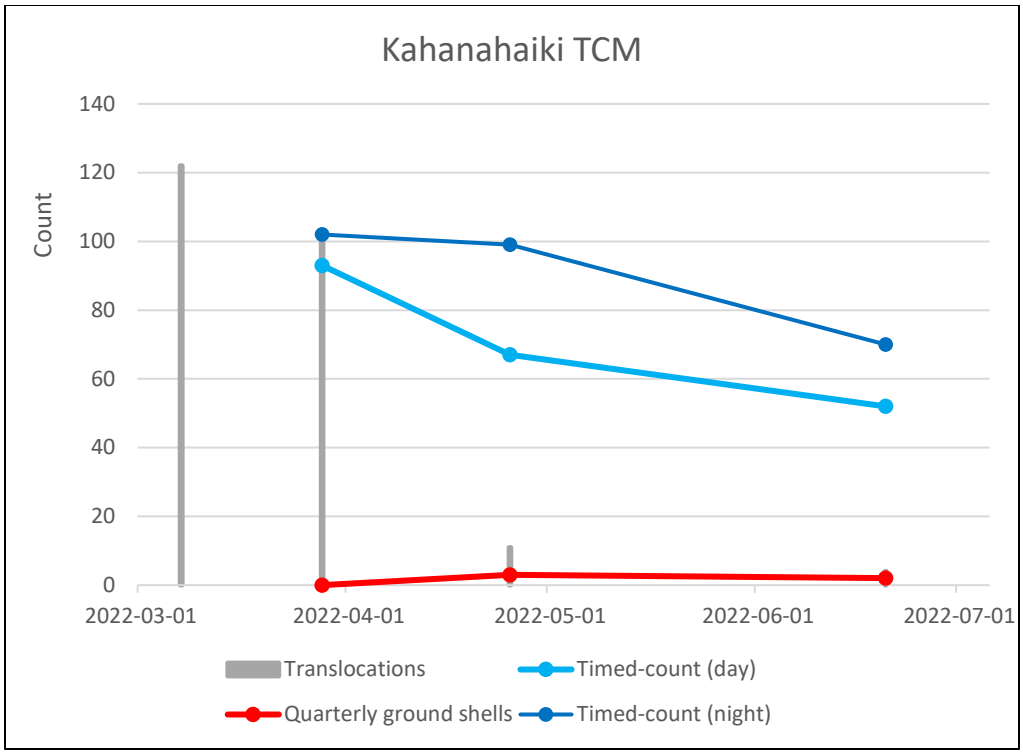

Figure 4: Quarterly timed-count monitoring (TCM) and ground shell counts for *A. mustelina* in the new Kahanahaiki snail enclosure from March 2022-June 2022, with numbers of snails translocated into the enclosure over time.

PAH-B Pahole Enclosure PRS: The enclosure at Pahole is the focus of SEPP's management in this area. Monitoring results of *A. mustelina* in the PAH-B enclosure population are shown below in Figure 5. Construction of a new enclosure which surrounded the old enclosure was completed in March 2019. The old enclosure was deconstructed in July 2021 after the new enclosure area was cleared of rosy wolf snails.

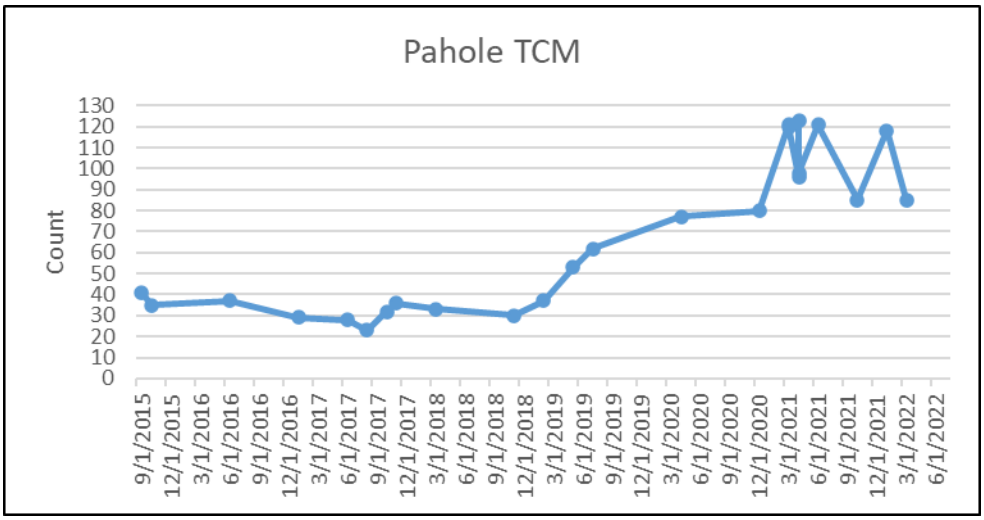

Figure 5: Day timed-count monitoring (TCM) conducted by SEPP for *A. mustelina* in the Pahole snail enclosure since 2015. Counts are done for a duration of 3-person hours. Data is collected by SEPP and shared with ANRPO.

5.2.2 Future Management

ANRPO will continue to work according to the monitoring plan which includes both day and night surveys (Table 5) for MMR-P. The old enclosure will be searched on a quarterly basis and any remaining snails will be moved to the new enclosure. Threat control will continue inside and around the existing enclosures, including tracking tunnels and A24s for rats, and quarterly searches for rosy wolf snails and Jackson's chameleons. Weed control and habitat improvements will continue cautiously to ensure there are no impacts on the snails at the enclosure. An invasion of *Anoplolepis gracillipes* (yellow crazy ants) have been detected inside the enclosure and is being monitored closely until an effective treatment can be found (see Chapter 9).

Table 5: ESU-A Monitoring Plan for MFS PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-A Kahanahaiki Enclosure	Snail collections	Quarterly	2022, 2023	Searches for remaining snails will continue on a quarterly basis until March 2023, at which time, if no snails are found, the enclosure wall will be deconstructed and removed from the forest.
MMR-P New Kahanahaiki enclosure	TCM	Quarterly	All	Conduct night TCM of entire enclosure with 2 personnel 1 hour each, for 2 person-hours total.
	GSP	Quarterly	All	Search the ground within a designated plot.

5.3 ESU-B

Figure 6: *Achatinella mustelina* from ESU-B.

ESU-B covers a large geographic area and is 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. ESU-B2 includes the gulches spanning West, Central, and East Makaleha. Management of ESU-B2 is focused at the 3 Points snail enclosure in Makaleha West.

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Figure 7: Map of ESU-B1 and the 3 Points snail enclosure 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) (Figure 7 and Table 6). A combined total of 324 snails were observed during the most recent TCM at these PRSs. All other PRSs are designated NM. In June 2021 a total of 48 snails were collected from MMR-E and MMR-F and moved into the 3 Points enclosure along with snails from ESU-B2 to increase the genetic diversity of the population within the enclosure and to preserve B1 genes in the event of a population decline at Ohikilolo.

The Ohikilolo MU remains unique in that rosy wolf snails and Jackson's chameleons have never been recorded in the area. 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 Ohikilolo Mauka	Manage for stability	22 *	2022-06-16	13	6	3	0	Yes	Partial	Yes	No	No
MMR-F Ohikilolo Makai	Manage for stability	302 *	2022-06-15	152	82	68	0	Yes	Partial	Yes	No	No
	ESU Total:	324		165	88	71	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.

MMR-E Ohikilolo Mauka PRS: The population was monitored in June 2022 and a total of 22 snails were counted. This count is one year after a subset of snails were collected and translocated to the 3 Points snail enclosure. There is a slight decline in the trend line partly due to the collection of snails from this population, however, it may also be due to observer bias. The lack of consistency in number of observers and surveyed area may also be affecting the trend line.

MMR-F Ohikilolo Makai PRS: The population was monitored in June 2022 and 302 snails were counted (Figure 8). This count is one year after a subset of snails were collected and translocated to the 3 Points snail enclosure. One snail was translocated into the Makai patch from MMR-Q prior to the TCM. The trend line shows an increase in the population since 2020.

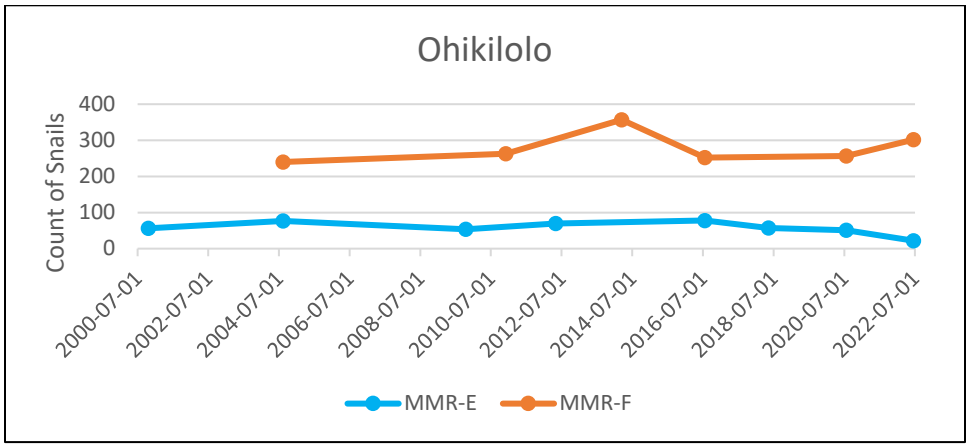

Figure 8: Timed counts of MMR-E and MMR-F during the day.

MMR-Q Koiahi Big Myrles spot NM-PRS: A single snail was found by staff during the course of other field work and translocated to MMR-F. A survey will need to be conducted to determine the extent of the population.

5.3.2 ESU-B1 Future Management

ANRPO will continue monitoring as indicated below (Table 7). Searches for rosy wolf snails and Jackson's chameleons during other work will also continue. Staff is conducting restoration at MMR-E and MMR-F which will hopefully lead to improved habitat for snails. Staff work carefully in the area to minimize impact to snails.

Table 7: ESU-B1 monitoring plan for PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-E Ohikilolo Mauka	TCM	Every 2 years	2024	Eight person-hours day survey with binoculars
	GSP	Annual	all	Search the ground within the marked plot.
MMR-F Ohikilolo Makai	TCM	Every 2 years	2024	46 person-hours day TCM with binoculars
	GSP	Annual	all	Search the ground within the marked plot.
MMR-Q Koiahi	Survey	N/A	2023	Survey the area to determine extant of population.

5.3.3 ESU-B2 Management History and Population Trends

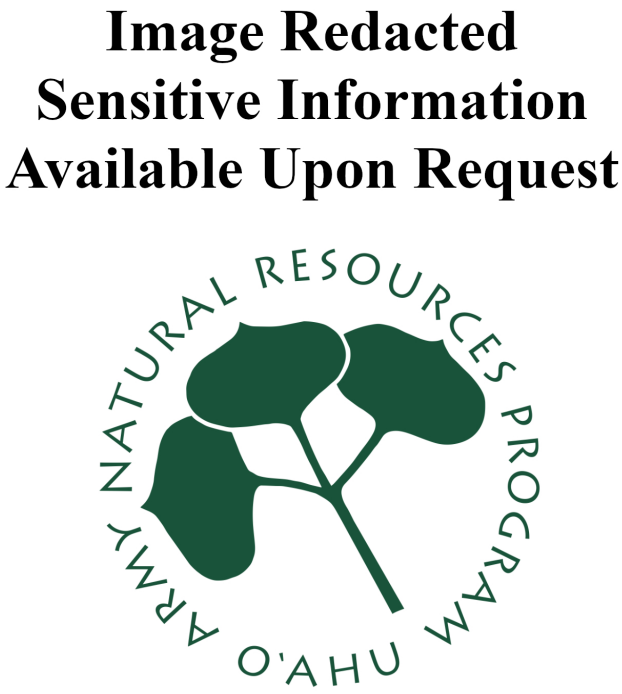

Figure 9: Map of the ESU-B2 range with the 3 Points enclosure. Although some populations may be closer to the Kaala snail enclosure, Kaala does not contain any B2 snails.

There are three MFS PRSs within ESU-B2: two located below the Kaala Road, LEH-C (Culvert 69) and LEH-D (Culvert 73); and LEH-N (the 3 Points snail enclosure) in Makaleha West (Table 8). Together these PRSs have 535 observed snails. Snails have been collected and translocated to the 3 Points enclosure from LEH-C, LEH-D, the NM-PRSs (See ANRPO 2020 for list of collection sites and numbers), and most recently KAO-B. Currently rats are controlled with A24s at LEH-C along the ridge crest, at LEH-D and at the 3 Points snail enclosure. While rosy wolf snails are assumed present throughout ESU-B2, Jackson's chameleons have not been observed.

Table 8: ESU-B2 population structure and threat control summary for MFS PRSs. The recorded count for LEH-N is the highest count observed between July 2021-June 2022.

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	277 *	2020-08-28	224	48	5	0	No	No	Yes	No	No
East Branch of East Makaleha (culvert 69)												
LEH-D	Manage for stability	93 *	2020-11-04	79	10	4	0	No	No	Yes	No	No
East Branch of East Makaleha (culvert 73)												
LEH-N	Manage for stability	165	2022-01-03	82	47	36	0	Yes	Yes	Yes	Yes	Yes
three points enclosure												
	ESU Total:	535		385	105	45	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.

LEH-C East Branch of East Makaleha Culvert 69 PRS: The last monitoring of this population was conducted by ANRPO staff in 2020 and 277 snails were observed. This count was done after the 2019 translocation to 3 Points and the 277 snails represent the remaining population. 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. Given the difficult logistics for the current survey protocol using rappel, a survey plot will be selected that does not require rappel but will result in fewer observed snails due to the smaller area surveyed.

LEH-D East Branch of East Makaleha Culvert 73 PRS: This area is also very steep with a predominant *Dicranopteris linearis* understory and thus is determined to be inappropriate for GSP monitoring. TCM will be performed annually. The last monitoring of the population occurred in November 2020 and a total of 93 snails were observed (Figure 10). This count was done after the 2019 translocation to 3 Points and the 93 snails represent the remaining population.

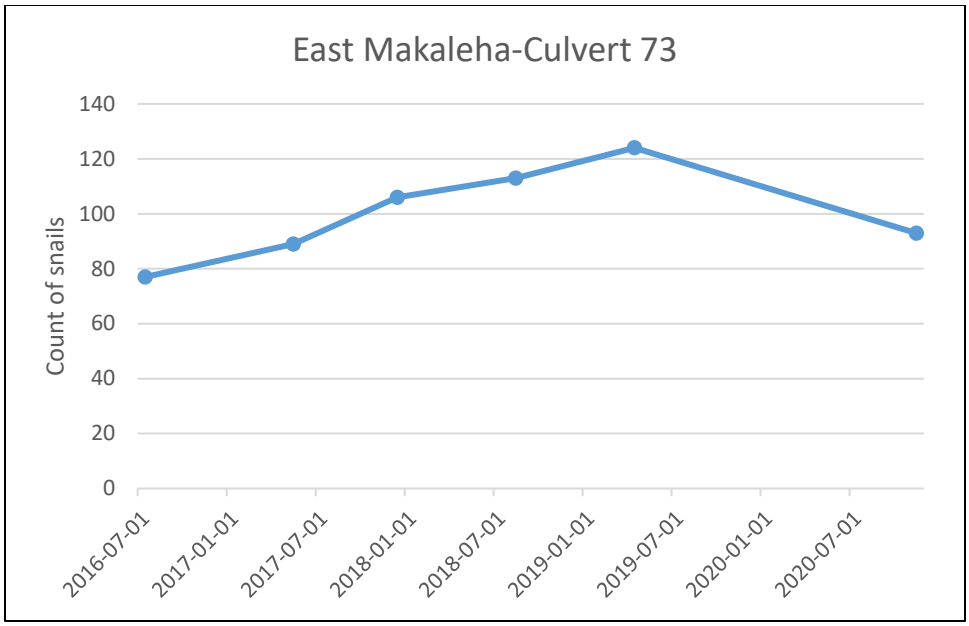

Figure 10: Timed counts during the day at LEH-D. The trend line shows a decrease due to the translocation in 2019.

LEH-N 3 Points Snail enclosure PRS: Since November 2019, 510 snails have been translocated into a temporary enclosure within the larger enclosure. The last translocation occurred in July 2021 with ten snails from KAO-B. Monitoring has shown that the population remains stable with minimal ground shells found (Figure 11). Although a total of 510 snails have been reintroduced into the enclosure, the highest number of snails counted for this report year was only 165. On average, 110 snails are counted (Table 9) which is ~20% of the total population that was released into the enclosure. The tall canopy within the enclosure likely affects detection rates. Understory vegetation is slowly filling in but is still not dense enough to support the population and snails are likely moving up higher into the canopy. The temporary enclosure is no longer being used to contain snails within one area. Although the temp walls are still standing, no electric barrier prevents snails from crossing. The temp walls will be deconstructed and removed and survey area expanded in October 2022.

Table 9: TCM data for the report year. The highest count recorded was 165 snails and average number of snails counted is 110. A total of 10 ground shells were found throughout the year. Ground shell recovery is low due to pooling and muddy conditions after a large rain event causing shells to be buried under the mud. Ground shells are likely higher than what is reported.

3 Points Snail Enclosure								
	Night TCM				Ground Shells			
Date	Small	Medium	Large	Total	Small	Medium	Large	Total
7/28/2021	22	18	57	97				0
10/25/2021	6	18	41	65	1		3	4
1/3/2022	36	47	82	165	2		1	3
5/16/2022	34	36	42	112		1	2	3
Average				110	Total ground shells			10

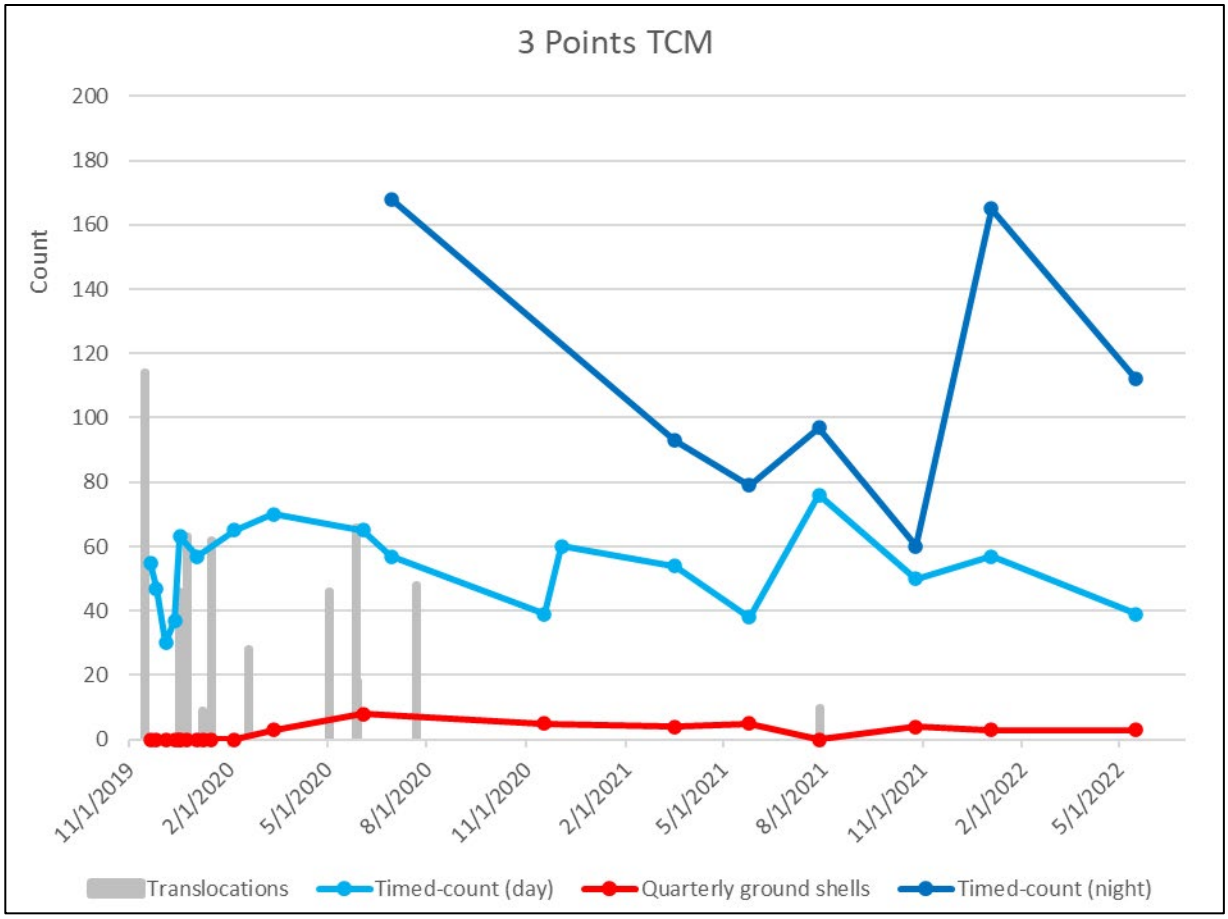

Figure 11: Timed-count monitoring (TCM) and ground shell counts for *A. mustelina* at 3 Points Snail Enclosure (LEH-N) since November 2019, with numbers of snails translocated into the enclosure over time.

KAO-B East of Dupont Trail site NM-PRS: Due to the steepness of the site, it was difficult to make a threat assessment and determine the extent of this population. Genetic samples from this population indicated that they belong to ESU-B2 and would therefore be moved into the 3 Points snail enclosure. In July 2021, ten individuals were translocated to the 3 Points enclosure to increase the genetic diversity within the enclosure. The site will be surveyed opportunistically and if at any time it is determine that the population is threatened, translocations to 3 Points will be considered.

5.3.4 ESU-B2 Future Management

Translocations to the 3 Points snail enclosure ended in 2021 with a total of 510 snails reintroduced into the enclosure. Native habitat restoration will continue inside the enclosure and native ground cover will be increased to reduce pooling in the enclosure after large rain events.

ANPRO will re-assess the management status for LEH-C and LEH-D and consider designating as NM and monitoring less frequently when the goal of 300 counted snails for the ESU has been met inside the 3 Points enclosure.

ANRPO will conduct monitoring as outlined below (Table 10).

Table 10: ESU-B2 Monitoring Plan for MFS PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
LEH-C East Culvert 69	TCM	Every 2 years	2022, 2024	Conduct night TCM for 2 person-hours along the ridge.
LEH-D East Culvert 73	TCM	Every 2 years	2022, 2024	Conduct day TCM for 4 person-hours.
LEH-N 3 Points	TCM	Quarterly	All	Conduct day/night TCM within temporary enclosure for 2-person hours
	GSP	Quarterly	All	Search the ground of entire temporary enclosure.

5.4 ESU-C

Figure 12: *Achatinella mustelina* from ESU-C.

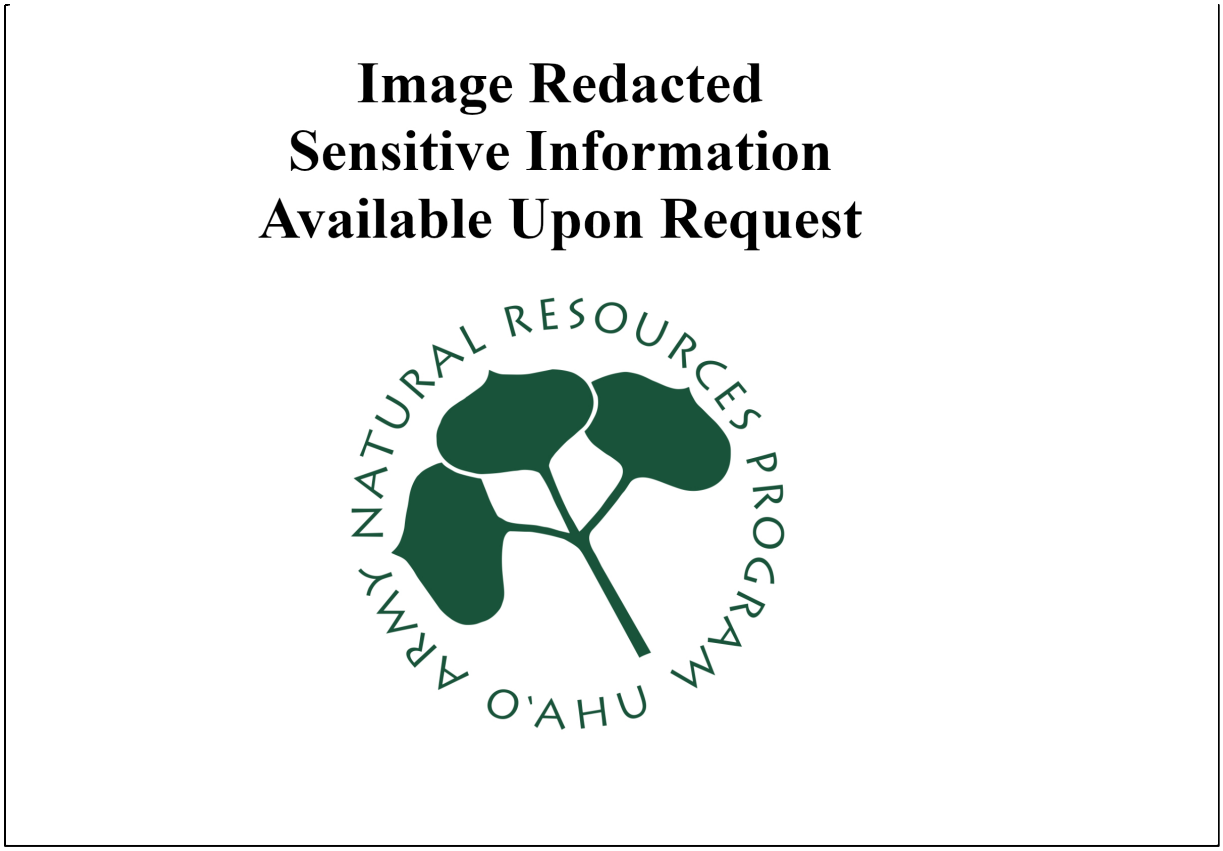

Figure 13: Map of ESU-C with the location of the new Kaala snail enclosure.

5.4.1 ESU-C Management History and Population Trends

ESU-C includes Schofield Barracks West Range, Alaiheihe, Manuwai, and Palikea Gulches. (Figure 13). There are two MFS PRSs within ESU-C: SBW-W (Skeet Pass) and ALA-A (Kaala snail enclosure) (Table 11). There are several NM PRSs that had been re-surveyed in 2020 and any snails found were translocated to SBW-W (this occurred prior to the snail enclosure completion). ANRPO conducts rat control at SBW-W and at the Kaala snail enclosure. Rosy wolf snails are present across the ESU. Jackson's chameleons are not often seen across Lihue MU, however, they are present although their distribution is not well known.

Table 11: ESU-C population structure and threat control summary. The 268 snails counted at SBW-W in December 2020 represents the population before translocations to the Kaala enclosure. Therefore the snails in the Kaala enclsoure is a subset of the population at SBW-W and the ESU-C population is more accurately represented by the 268 snails counted.

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: C	**Schofield Barracks West Range, Alaiheihe and Palikea Gulches**											
ALA-A	Manage for stability	34	2021-11-17	34	0	0	0	Yes	Yes	Yes	Yes	Yes
Kaala Snail Enclosure												
SBW-W	Manage for stability	268*	2020-12-19	156	84	28	0	Partial	No	Yes	No	No
Skeet Pass												
	ESU Total:	302		190	84	28	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.

SBW-W Skeet Pass PRS: The population was last monitored in December 2020 and a total of 268 snails were counted, many of which occurred on steep slopes. Staff collected a total of 101 snails from the slopes of Skeet Pass in November 2021 to be introduced into the Kaala enclosure. Staff will continue collections from the slopes and monitor the remaining population on the ridge in November 2022.

ALA-A Kaala Snail Enclosure: A total of 101 snails (1S, 100L) were collected and introduced into the enclosure. Snails are monitored on a quarterly basis and have been seen dispersing from the release site. Babies are observed, an indication that the population is growing. Table 12 shows the snail observations since release. The habitat prior to construction was already considered good snail habitat and outplanting was not required. See Appendix 5-3 for the Kaala snail enclosure vegetation monitoring results.

Table 12: TCM data for Nov 2021-May 2022. On average 25 snails were counted per visit, which is 25% of the total population released into the enclosure.

Kaala Snail Enclosure								
	Night TCM				Ground Shells			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
11/8/2021			23	23				0
11/17/2021			34	34				0
11/29/2021			20	20				0
12/27/2021			28	28			2	2
1/24/2022	1		17	18	1			1
2/28/2022	4		22	26			4	4
5/23/2022	7	1	19	27			1	1
Average				**25**	**Total ground shells**			**8**

5.4.2 ESU-C Future Management

Given the initial success of translocations into the Kaala enclosure, ANRPO will attempt to collect another 200 snails for release at the enclosure. An effort will be made to collect snails from the slopes of Skeet Pass on rappel and leaving as many snails along the ridge as possible. Monitoring of wild snails along the ridge will continue.

Table 13: ESU-C Monitoring Plans.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
SBW-W Skeet Pass PRS	TCM	every 2 years	2022, 2024	Conduct night TCM for 9.25 person-hours
ALA-A Kaala Snail Enclosure	TCM	Quarterly, Day/Night count	All	Conduct search within release site and surrounding area for 2 person-hours.
ALA-A Kaala Snail Enclosure	GSP	Quarterly	All	Collect and remove all ground shells from plot

5.5 ESU-D

Figure 14: *Achatinella mustelina* from ESU-D.

ESU-D covers a large geographic area and in the past had been divided into three units: the Kaluaa area including Hapapa (D1), Makaha (D2), and the Lihue area. Since all snails in ESU-D have been consolidated to the Puu Hapapa enclosure, the ESU will now simply be reported as D but the designations D1 and D2 will still be used in this report to distinguish the geographic area. The only MFS PRS in ESU D is the Puu Hapapa snail enclosure.

5.5.1 ESU-D1 Management History and Population Trends

Image Redacted
Sensitive Information
Available Upon Request

Figure 15: Map of ESU-D1.

There is one MFS PRS at KAL-G (Puu Hapapa Snail Enclosure) (Figure 15 and Table 14). 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 movement and genetic communication of snails across the enclosure. Weed control is ongoing. Staff will continue to opportunistically survey the 12 NM PRSs, and if any are found, translocate snails into the Puu Hapapa Snail Enclosure. Threats are abundant outside of the enclosure, with rosy wolf snails and Jackson's chameleons.

Table 14: ESU-D1 Population Structure and Threat Control Summary. The * indicates that historically snails were collected from the population but no snails are currently being translocated out of the enclosure.

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	562 *	2021-09-13	429	101	32	0	Yes	Yes	Yes	Yes	Yes
Puu Hapapa snail enclosure												
	ESU Total:	562		429	101	32	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.

KAL-G Puu Hapapa Snail Enclosure PRS: During TCM, 562 snails were observed in September 2021 and the average number of snails counted was 507 (Table 15). The trend line shows a slight decline in observed snails which is likely due to a lack of consistency in observers each quarter. Though subsequent counts have been variable, the population appears to remain stable (Figure 16). Staff will continue to monitor for any indications of high mortality. The habitat continues to improve and the snails were observed spreading out into new vegetation as outplanted native trees grow larger. A total of 1 snail was translocated to Hapapa over the last year from ELI-A.

Table 15: TCM data for the reporting period. The highest count was in September 2021 with 562 and the average number of snails counted is 507. The count for Quarter 4 was not completed due to time restraints.

Puu Hapapa Snail Enclosure								
	Night TCM				Ground Shells			
Date	Small	Medium	Large	Total	Small	Medium	Large	Total
9/13/2021	32	101	429	562	29	8	6	43
*No Quarter 4 Count done								0
3/14/2022	99	109	254	462	23	6	16	45
6/6/2022	73	96	328	497	36	11	14	61
Average				507	Total ground shells			149

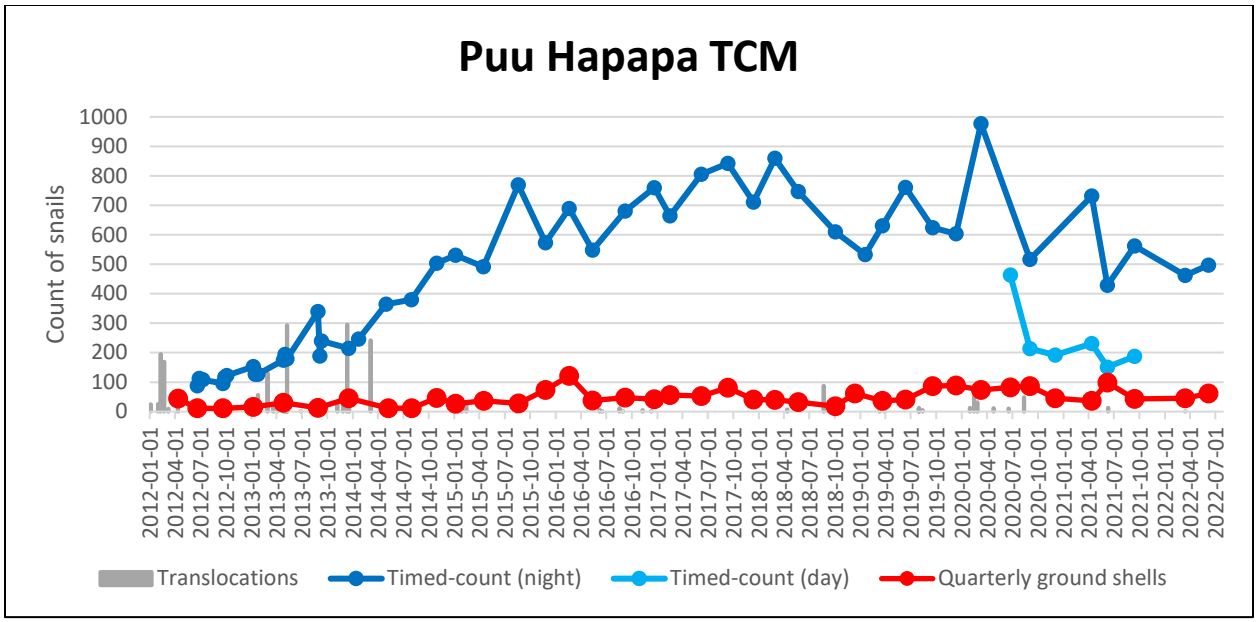

Figure 16: Timed-counts and ground shell counts for *A. mustelina* in the Puu Hapapa snail enclosure from June 2012 to June 2021, with numbers of snails translocated into the enclosure over time.

ELI-A South Waieli Gulch North Branch NM-PRS: A single snail was found in *Megathyrsus maximus* by staff during a fence check. The snail was collected and released into the Puu Hapapa enclosure.

No Management PRSs: The 12 NM PRS are not monitored regularly. With a high abundance of threats, these sites will likely continue to decline. ANRPO staff translocate any snails opportunistically seen at NM PRSs into the Hapapa enclosure.

5.5.2 ESU-D1 Future Management

ANRPO staff will continue monitoring KAL-G (Puu Hapapa Snail Enclosure) (Table 16). Threat control will continue around the existing enclosure, including tracking tunnels and A24s for rats, and searches for rosy wolf snails and Jackson's chameleons. Weed control and habitat improvements will continue in the enclosure. Habitat improvements will also continue in the area surrounding the enclosure. The enclosure is showing signs of aging and erosion which could potentially allow predators to breach the structure. ANRPO is plans to re-building the structure.

Table 16: 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 in sampling areas with 4 personnel for 8 person-hours total.
	GSP	Quarterly	All	Search the ground within the two marked plots.

5.5.3 ESU-D2 Management History and Population Trends

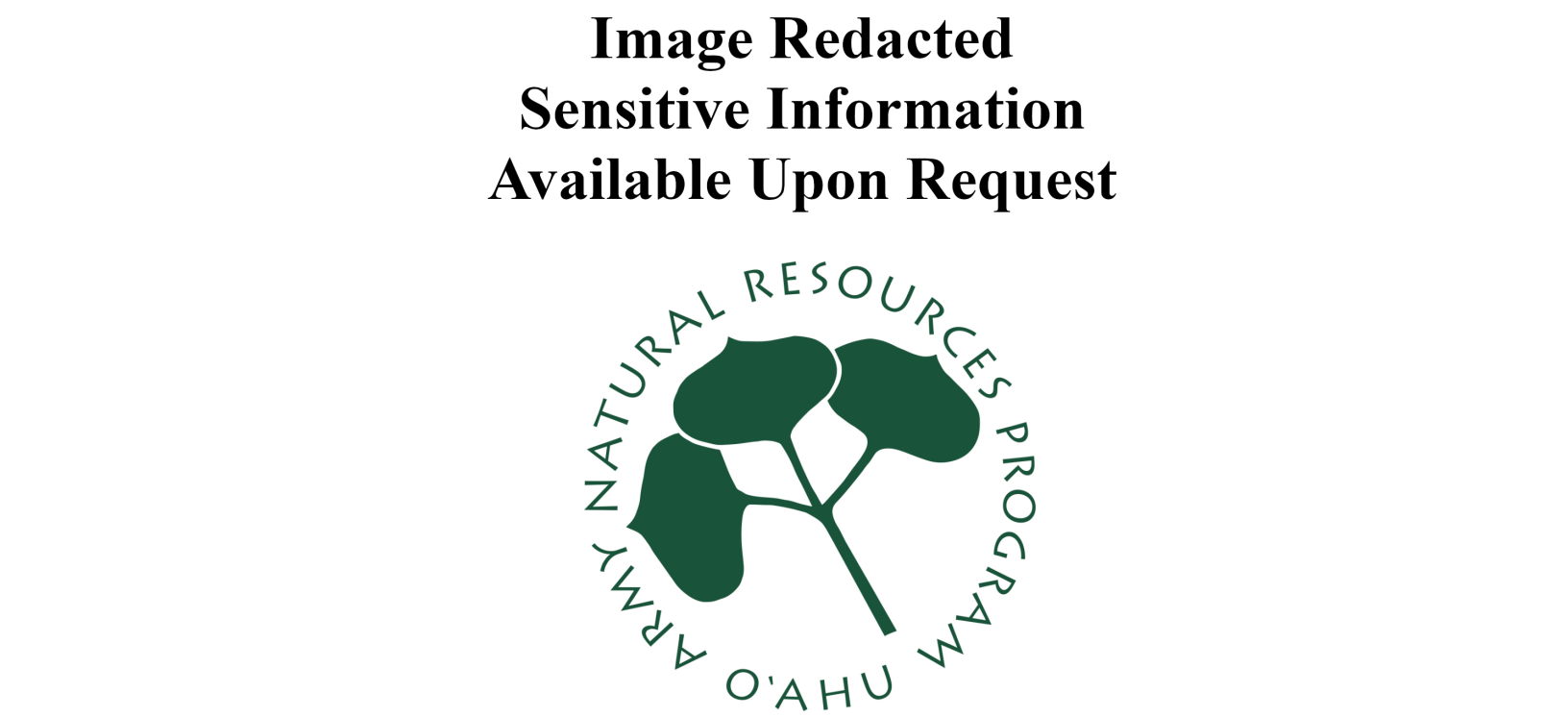

Figure 17: Map of ESU-D2 and the Hapapa snail enclosure. Due to the lack of flat terrain in Makaha, snails were translocated to the Hapapa snail enclosure.

Monitoring of snails in ESU-D2 (Makaha) have shown a steady decline over the years. Therefore translocations of all snails in walkable/accessible areas to the Puu Hapapa snail enclosure have begun. ESU-D2 is now considered No Management. No snails were collected from Makaha in the last report year.

MAK-G Upper Makaha NM-PRS: Staff surveyed the area on ropes in December 2021. A total of eleven snails were counted, eight on the ridge and three on the slopes. Further surveys are required to determine the extent of this population and threat levels.

5.5.4 ESU-D2 Future Management

ANRPO staff will continue surveys to determine the extent of MAK-F and MAK-G (Table 17). Both sites are on steep terrain and are not very accessible, staff on rappel is required for surveying. ANRPO will continue to explore higher elevation areas in the next year to determine numbers. Threat control is not feasible due to the steep terrain. ANRPO will continue to visit Makaha opportunistically to collect snails and move them to Puu Hapapa.

Table 17: ESU-D2 Monitoring Plans.

PRS	Monitoring Type	Comments
MAK-F Waianae Kai	Scope	Conduct day survey on ropes to determine the extent of remaining population
MAK-G Upper Makaha	Scope	Conduct day survey on ropes to determine the extent of remaining population

5.6 ESU-E

Figure 18: *Achatinella mustelina* from ESU-E.

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Sensitive Information
Available Upon Request

Figure 19: Map of ESU-E. Snails are actively being translocated to the Palikea North enclosure (highlighted in red box). Although it is located within ESU-F, the enclosure has been designated for ESU-E snails.

5.6.1 ESU- E Management History and Population Trends

ESU-E spans two separate geographic areas in Ekahanui and Huliwai (Figure 19). A sharp decline in snail numbers at Ekahanui were observed and plans were made with the IT in 2015 to translocate snails to a permanent ESU-E dedicated enclosure at Palikea since Ekahanui did not have a site with flat terrain suitable for constructing an enclosure and attempts to manage the population in Ekahanui had failed (see OANRP 2019 for ESU-E management history).

All lab reared ESU-E snails have been translocated into the Palikea North enclosure and remaining wild snails are collected and translocated as they are found. The Palikea North snail enclosure is now the only MFS PRS for ESU-E (Table 18) and all other sites are NM.

Table 18: ESU-E Population Structure and Threat Control Summary. The recorded observation is the highest number of snails counted at night within the report year.

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**											
PAK-T	Manage for stability	127	2022-01-31	80	20	27	0	Yes	Yes	Partial	Yes	Yes
ESU-E snails in Palikea North Enclosure												
	ESU Total:	127		80	20	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.

EKA-G Cenagr site: This site was previously considered a historic snail population and the use of Ferroxx AQ for rare plant protection has been utilized here as it is the biggest rare plant site in Ekahanui. However, after seeing a snail, staff have discontinued the use of Ferroxx AQ and are currently working to survey/clear the site of snails using the Slug Control Area survey protocol (see Appendix 5-4) before resuming use of Ferroxx AQ. A total of 13 snails have been collected from the site on three separate occasions; all were translocated to the Palikea North Snail Enclosure.

Table 19: Snail collections from EKA-G.

Reintro Destination Site		Reintro Date	Reintro Origin Sites	Origin Coll. Date	Reintro Origin Lab	Reintro Sml	Reintro Med	Reintro Lrg
AchMus.PAK-T	**ESU-E snails in Palikea North Enclosure**							
		2022-05-26	AchMus.EKA-G	2022-05-25			2	6
		2022-05-11	AchMus.EKA-G	2022-05-10			4	
		2022-04-13	AchMus.EKA-G	2022-04-11			1	
	AchMus.PAK-T Total:	**3**	**Reintro Events**	**Total Snails Reintro:**			7	6

PAK-T Palikea North Enclosure: A total of 347 snails have been reintroduced into the temporary snail enclosure since December 2018, including both wild snails from Ekahanui/Huliwai and snails from the SEPP captive rearing facility. The average number of snails observed during the timed-counts is 102 (Table 20). The population remains stable (Figure 20) and snails are no longer restricted to the temporary enclosure. The duration of TCM was increased by 30 minutes to include a search of the surrounding vegetation around the temp enclosure to include these escapees in monitoring efforts. The temp enclosure will be deconstructed in September 2022 and survey area will be marked with flagging. See Appendix 5-5 for the Palikea North snail enclosure vegetation monitoring results.

Table 20: TCM data for July 2021-June 2022. The highest number of snails observed was 127 snails and the average number of snails is 102.

Palikea North Snail Enclosure								
	Night TCM				Ground Shells			
Date	Small	Medium	Large	Total	Small	Medium	Large	Total
9/28/2021	16	24	54	94	2		4	6
11/22/2021	14	20	60	94	3		2	5
1/31/2022	27	20	80	127		1	2	3
4/20/2022	8	22	61	91	5	4	5	14
Average				102	Total ground shells			28

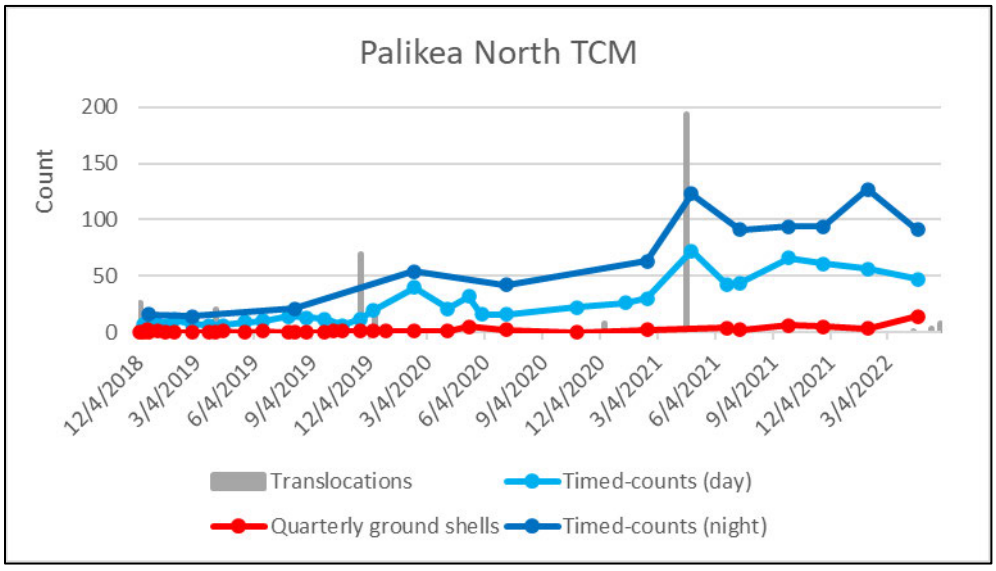

Figure 20: Timed-count monitoring (TCM) and ground shell counts for *A. mustelina* in the Palikea North temporary snail enclosure from December 2018 to June 2021, with numbers of snails translocated into the enclosure over time. The population remains stable and ground shells remain low.

5.6.2 ESU-E Future Management Plans

NM PRSs at ESU-E will be visited again opportunistically to collect any remaining snails.

Monitoring of the snail population in the Palikea North temporary enclosure will occur quarterly and a night survey will be conducted annually (Table 21).

Table 21: ESU-E Monitoring Plan for MFS PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
PAK-T Palikea North temporary enclosure	TCM	Quarterly	all	Conduct day TCM within temporary enclosure for 1 person-hour and the vegetation surrounding the temp enclosure for 1 person-hour. Total survey is 2 person-hours.
	TCM	Annually	all	Conduct night TCM within temporary enclosure for 1 person-hour and the vegetation surrounding the temp enclosure for 1 person-hour. Total survey is 2 person-hours.
	GSP	Quarterly	all	Search entire temporary enclosure for ground shells

5.7 ESU-F

Figure 21: *Achatinella mustelina* from ESU-F.

Image Redacted
Sensitive Information
Available Upon Request

Figure 22: Map of ESU-F. The Palikea South Enclosure houses snails from ESU-F. The red box shows a zoomed in view of both the Palikea South and Palikea North enclosures. Although located within ESU-F, the Palikea North enclosure houses ESU-E snails.

5.7.1 Management History and Population Trends

ESU-F extends from Mauna Kapu to Palawai. There is one MFS PRS in ESU-F (the Palikea South snail enclosure) (Figure 22) which includes 228 observed snails (Table 22) and all other sites have been designated NM. All PRSs in the Palikea fence are within the large rat control grid. Only three Jackson's chameleons have been observed within the MU thus far but larger numbers have been observed along Palehua Road.

Table 22: ESU-F Population Structure and Threat Control Summary. The number of snails recorded here is from June 2021 and was conducted during a night count of the entire enclosure.

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-P	Manage for stability	228	2021-06-22	174	32	22	0	Yes	Yes	Yes	Yes	Yes
Palikea snail exclosure												
	ESU Total:	228		174	32	22	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.

PAK-P Palikea South Enclosure PRS: TCM is conducted during the day on a quarterly basis (Figure 23) within two designated plots. The highest number of snails observed in the last year was 105 and the average number of snails seen is 89 (Table 23). Once a year, a night TCM is performed for 4-person hours covering the entire enclosure; in June 2021 staff counted 228 *A. mustelina*. The trend line shows a slight decline but this may be due to the vegetation growth in the enclosure. The increased vegetation density resulted in some areas becoming harder to survey and many of the snails in those areas were not counted. The Q2 TCM was not completed due to time constraints and will be completed in the beginning of Q3. ANRPO plans to re-build the enclosure in the near future. The structure is aging and could potentially allow predators to breach its walls.

Table 23: The highest number of snails counted in the last year within the two plots

Palikea South Snail Enclosure								
	Day TCM				Ground Shells			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
8/31/2021	22	18	57	97			3	3
11/22/2021	6	18	41	65			4	4
1/31/2022	11	17	77	105		2	5	7
*No Quarter 2 count done								0
Average				**89**	**Total ground shells**			**14**

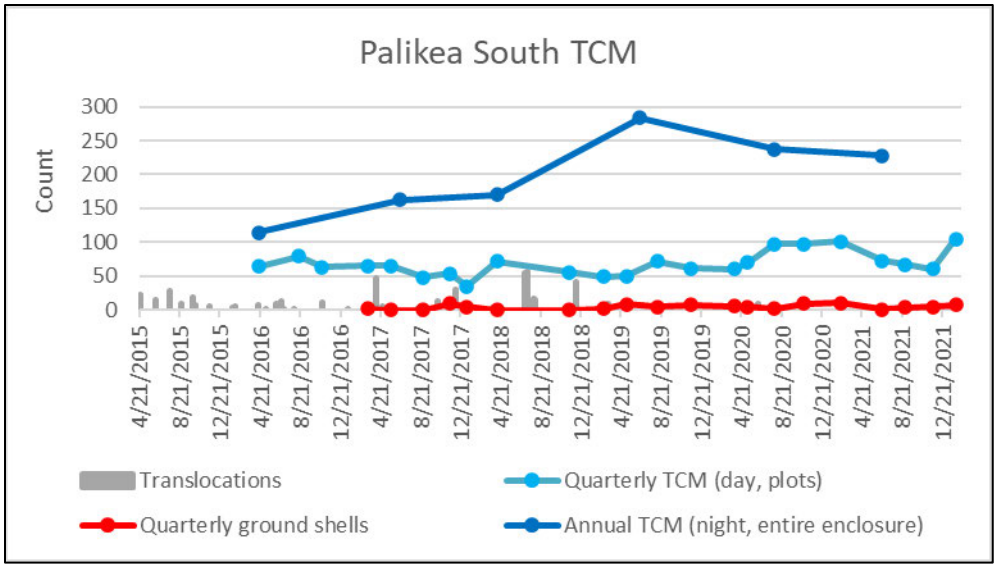

Figure 23: Quarterly and annual timed-counts and quarterly ground shell counts for *A. mustelina* in Palikea South snail enclosure from April 2016 to January 2022, with numbers of snails translocated into the enclosure over time since April 2015. Note: Snail detection is much greater at night than during the day, and the entire enclosure is searched at night, but only subsampled in plots during the day.

5.7.2 ESU-F Future Management

ANRPO will continue monitoring and managing as described in Table 24. As mentioned earlier, small snail populations are still occasionally found in the Palikea MU and are translocated to the enclosure. Threat control will continue in the MU, including quarterly tracking tunnels for rats, and searches for rosy wolf snails and Jackson's chameleons focused around the snail enclosures. Weed control and habitat improvements will continue cautiously in known snail habitat to ensure there are no impacts to the snails especially near and within the enclosure walls. Habitat restoration across the MU will improve the habitat for NM PRSs. Sites will be surveyed during the day and night for snails before conducting aggressive weed control.

Table 24: ESU-F Monitoring Plan for MFS PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
PAK-P Palikea Enclosure	TCM	quarterly	all	Conduct day TCM in sampling plots for 4 person-hours.
	GSP	quarterly	al	Search two marked plots for all ground shells
	TCM	annual	all	Conduct night TCM across entire enclosure

5.8 LITERATURE CITED

ANRPO. 2017. Chapter 5: *Achatinella* Species Management *in* 2017 Status Report for the Makua and Oahu Implementation Plans.

ANRPO. 2019 Chapter 5: *Achatinella* Species Management *in* 2019 Status Report for the Makua and Oahu Implementation Plans.

ANRPO. 2020. Chapter 5: *Achatinella* Species Management *in* 2020 Status Report for the Makua and Oahu Implementation Plans.

CHAPTER 6: RARE VERTEBRATE MANAGEMENT

The Army Natural Resources Program on Oahu (ANRPO) manages or monitors two vertebrate species, the Hawaiian Monarch Flycatcher (Oahu Elepaio) and the Hawaiian Hoary Bat (Opeapea). Results of our management efforts for Oahu Elepaio and Opeapea are presented below.

6.1 OIP ELEPAIO MANAGEMENT 2022

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 (USFWS 2003), ANRPO is required to conduct threat control for a minimum of 75 Oahu Elepaio pairs. On-site management is required to be conducted 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. Staff currently conducts rodent control at SBW (Lihue), Ekahanui Gulch in the Honouliuli Forest Reserve, Moanalua Valley, Palehua (Gill Ewa Lands), Makaha Valley, Makua Valley, and Palikea in the Honouliuli Forest Reserve.

Beginning December 2019, in consultation with the Implementation Team (IT), ANRPO shifted to a new monitoring strategy in the Waianae Mountains. The new monitoring strategy currently focuses on surveys of Management Units (MUs) and drainages with suitable habitat throughout the Waianae Mountains. The results of these ongoing surveys will be compared to surveys conducted from 2004-2010 and will provide an updated population estimate for the species across the Waianae range. These surveys will also be an indicator of the impact of decades of ANRPO management for Oahu Elepaio, as managed populations may act as sources for Oahu Elepaio dispersal elsewhere. In order to visit all areas at least once that were surveyed from 2004-2010, as well as areas never before surveyed, completion of these surveys will take multiple years. Completion of these surveys is scheduled for December 2023.

In addition to surveys, a select group of Oahu Elepaio pairs within the Honouliuli Forest Reserve at the Ekahanui and Huliwai gulches will be monitored to identify which factors influence Elepaio nesting success by comparing nesting success and nest-site characteristics between areas with rodent control and areas without. Unusual breeding trends and behaviors will also be documented. This five-year field study will help identify management actions that are beneficial to the population growth and expansion of the species, which ANRPO will use in the planning and implementation of Oahu Elepaio recovery. Pairs monitored at Ekahanui are within the ANRPO management unit and have benefited from years of either seasonal or year-round rodent control through various methods. Most recently, a large-scale Goodnature auto-resetting (A-24) trapping grid has been operational year-round since 2017, helping to minimize the threat of rats during the breeding season. Recent surveys have revealed a dramatic increase in Oahu Elepaio at Ekahanui and its surrounding gulches. One of these gulches, Huliwai, is approximately 700 meters to the north and has never had any management conducted there. For five years, ANRPO will compare breeding success at these two sites. Recently, ANRPO made the decision to have direct involvement with University of Hawaii students and researchers by funding graduate assistantship positions. For the 2022 breeding season, UH Manoa graduate student, Nikki Preston, assisted with monitoring and collecting nesting data at Honouliuli Forest Reserve for her research project focusing on comparing Oahu Elepaio nesting success between areas with and without rodent control. For her project motion sensor cameras were deployed to monitor the progress of active nests and help determine causes of nest failure.

ANRPO will also continue to conduct rodent control for a minimum of 75 pairs at five management units. To ensure territories with rodent control contain an Oahu Elepaio pair, each year a survey of managed areas will be conducted at the beginning of each breeding season.

This chapter summarizes the results of the Oahu Elepaio surveys in the Waianae Mountains thus far. Also included are the results of the first year of monitoring Elepaio pairs at Ekahanui and Huliwai. 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

6.1.2.1 Rodent Control

This past year all Elepaio populations relied on Goodnature auto-resetting (A-24) trapping lines and grids for protection against predation from rodents. These traps are able to provide year-round protection from rodents and require rebaiting every six months. Beginning in October 2022 we will be transitioning to a four month rebaiting interval due to gas retention issues found in aging A-24 traps (see Rodent Management Chapter 8). In SBW, ANRPO was not able to conduct an aerial broadcast of Diphacinone-50 prior to the breeding season. Rodent control was conducted with the use of A24 trap lines traversing through approximately 27 territories with Elepaio pairs in Mohiakea and Banana gulches. The number of pairs is based on recent surveys and previous monitoring observations. Four other MUs continue to be protected with the use of A-24 traps. Oahu Elepaio at Ekahanui, Palehua, Palikea, and Makaha Valley benefit from large-scale A-24 trapping grids. In 2022, approximately 55 pairs were managed at Ekahanui, 14 pairs at Palehua, seven pairs at Palikea, and six pairs at Makaha. Difficult terrain and wide-spread territories at Moanalua Valley do not allow for the use of large-scale grids, so nine A-24 traps are placed within each individual territory. Nine paired territories were managed via these smaller-scale trapping grids this year at Moanalua, the only population in the Koolau Mountains. In total, ANRPO provided rodent control for approximately 120 Oahu Elepaio pairs in 2022.

Figure 1: Rare Insect Biologist, Tommy Russell, with an adult Oahu Elepaio at Palehua. *Photo by Storey Welch*

6.1.2.2 Surveys

Surveys for Oahu Elepaio continued throughout the Waianae Mountain range, primarily in valleys and drainages in the northern half of the range. Surveys were conducted between late summer and early winter so that they wouldn't coincide with the breeding season. As with the previous two years of surveys there continues to be a significant increase in Oahu Elepaio observed compared with the 2004-2010 surveys. The majority of the surveys completed in the last year actually occurred in areas not included in the previous surveys. These include drainages or gulches that make up the Mokuleia Forest Reserve and Kaala Natural Area Reserve. While these areas do have a small handful of prior Elepaio observations, thorough surveys were never conducted. This, along with a large Elepaio population at the SBW management unit in such close proximity, made surveying at these areas a priority to document any expansion of the species. ANRPO staff was also able to access Makua Valley for the first time since 2017. For the results of the latest survey in Makua see *6.2 MIP Elepaio Management 2022*. The results of all the latest surveys and current Oahu Elepaio abundance are compiled below and are presented in two ways. First, Table 1 lists locations or drainages where surveys were completed from 2004-2010, in comparison with recent surveys completed from 2016-2022. It is important to note that this is just a partial list of locations surveyed in the past and updated surveys at more locations in the Waianae Mountains are currently ongoing or are scheduled to be re-surveyed soon. Also displayed in the table are the number of Oahu Elepaio pairs and single males detected during each survey period, as well as the total population for that period. Second, maps display the current abundance and distribution of Oahu Elepaio in the surveyed drainages and current management units that are listed in Table 1. The maps also show the areas recently surveyed by ANRPO staff and the pairs or single birds detected within them. Oahu Elepaio found during the surveys are split into two groups: managed and unmanaged. Managed represents pairs or single birds found within an area of active rodent control, where unmanaged birds are found in areas without it.

Figure 2: A view of Oahu's north shore and Alaiheihe Gulch. The first survey of this drainage found 20 Elepaio.

Table 1: Comparison of surveys completed in 2010 and the latest surveys completed by ANRPO staff. Locations listed geographically from north to south.

Oahu Elepaio Abundance in the Waianae Mountains

Location	No. of Pairs	No. of Single Males	Previous Survey	No. of Pairs	No. of Single Males	Latest Survey
Makua Valley	2	2	**2010**	3	1	**2022**
Makaleha West	–	–	–	0	0	**2022**
Makaleha East *	–	–	–	2	1	**2022**
Kaumokuiki Gulch	–	–	–	3	0	**2022**
Manuwai Gulch	–	–	–	14	1	**2020**
Alaiheihe Gulch	–	–	–	8	4	**2022**
Kaimuhole Gulch	–	–	–	1	0	**2022**
Palikea Gulch	–	–	–	2	1	**2022**
Kihakapu Gulch	–	–	–	2	0	**2022**
Puule Gulch	–	–	–	2	1	**2022**
Makaha Valley	5	13	**2009**	13	9	**2021**
Waianae Kai Forest Reserve	0	4	**2009**	0	0	**2022**
Schofield Pulee	1	3	**2010**	16	2	**2020**
Schofield North Haleauau	12	1	**2010**	28	5	**2019**
Schofield Central Haleauau	15	11	**2010**	30	3	**2016**
Schofield South Haleauau	1	1	**2010**	7	0	**2020**
Schofield North Mohiakea	8	2	**2010**	13	0	**2020**
Schofield South Mohiakea	5	2	**2010**	30	1	**2020**
Waieli Gulch	0	0	**2006**	0	0	**2021**
Kaluaa Gulch	1	5	**2006**	17	1	**2020**
Maunauna Gulch	0	0	**2006**	2	1	**2021**
Manuwaielelu Gulch	0	1	**2006**	8	0	**2020**
Huliwai Gulch	0	5	**2006**	20	1	**2020**
Ekahanui North	1	3	**2009**	27	2	**2021**
Ekahanui Central+South	37	8	**2009**	59	2	**2019**
Puumaialau Gulch	0	0	**2006**	9	2	**2020**
Pohakea Gulch	0	0	**2006**	4	1	**2020**
Pualii Gulch	0	1	**2006**	1	0	**2020**
Napepeiaoolelo Gulch	0	0	**2006**	0	0	**2020**
Palawai Gulch (Palikea)	0	6	**2006**	13	1	**2020**
Kaaikukai Gulch	1	2	**2009**	6	1	**2020**
Manuwaikaale Gulch	1	1	**2010**	2	0	**2020**
Namoopuna Gulch	1	2	**2010**	0	0	**2020**
Kaloi Gulch (Palehua)	15	4	**2010**	16	2	**2020**
Total	**106**	**77**		**358**	**43**	
Total Population	**289**			**759**		

*Survey Incomplete

Makaleha

Image Redacted
Sensitive Information
Available Upon Request

Figure 3: Map of Oahu Elepaio abundance and distribution at Makaleha East and West drainages.

Makaleha is an area that includes three large drainages in the Mokuleia Forest Reserve. The bottoms of these drainages, where Elepaio prefer to establish territories, are challenging to access and had never been surveyed until now. All areas of suitable habitat that were reasonably accessible were surveyed at both Makaleha West and the east fork of Makaleha East. The Makaleha East drainage was the first to be surveyed, accessible from Kaala Road and walking down to approximately 800 feet elevation. Five Elepaio were observed, which included two pairs and one single male. The upper portion of Makaleha West was also surveyed, but no Elepaio were observed. Less attractive habitat and a greater distance from the management unit at SBW likely contribute to the lack of birds in both drainages. The west fork of East Makaleha and Central Makaleha drainages are expected to be completed by the end of this year.

Kaumokuiki to Kaimuhole

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Available Upon Request

Figure 4: Map of Oahu Elepaio abundance and distribution at the Kaala Natural Area Reserve.

The drainages of Kaumokuiki, Manuwai, Alaiheihe, Kaimuhole, and Palikea are all part of the Kaala Natural Area Reserve. As with the Mokuleia Forest Reserve, this is another area that has never been surveyed for Oahu Elepaio. That also goes for Kihakapu and Puulu gulches, which are on adjacent private land. ANRPO staff have been managing other resources in several of these drainages for over two decades, but Elepaio observations have been scarce until recent years. With the increasing population at SBW to the south these drainages seemed ideal for Elepaio to expand into. This was precisely the case as the results of the surveys are extremely encouraging. Kaumokuiki, one of the smaller surveyed gulches, had three Elepaio pairs. In Manuwai, 14 pairs and one single male were detected. Alaiheihe Gulch had eight pairs and four single males, while the extremely limited amount of suitable habitat in Kaimuhole was still able to support one Elepaio pair. Palikea Gulch had two pairs and one single male, Kihakapu had two pairs, and in Puulu Gulch another two pairs and one single male were found. Unsurprisingly, the drainages with suitable habitat and that are closest in proximity to the SBW MU are documenting the most Elepaio detections. Further west, the numbers significantly begin to decrease. Years of successful breeding at SBW appears to have had a spillover effect into these gulches helping to repopulate areas where Oahu Elepaio have been scarce for decades.

Makaha

Figure 5: Map of updated (2021) Oahu Elepaio abundance and distribution in Makaha Valley.

Makaha Valley was once an Oahu Elepaio management unit and from 2005-2009 multiple pairs on the north side of the valley and within the Subunit I MU benefited from rodent control and were monitored for breeding activity. Eventually, the decision was made to discontinue all management for Oahu Elepaio and focus efforts elsewhere. The valley's remote location, poor breeding success, and lack of expansion of the population proved to be of little benefit for both the species and ANRPO. In the final year of management the population was known to be 23 birds, which included five pairs and 13 single males. Only two pairs had territories within the Subunit I MU. After ten days of surveying in fall 2021 those numbers were almost completely reversed with 13 pairs and nine single males observed, totaling 35 Elepaio. Breeding pairs were either seen at the very back of narrow gulches on the north side of the valley or within the Makaha Subunit I MU. In 2018, an A-24 trapping grid was installed inside the Subunit I fence to protect rare plants and snails. This seems to have had a positive effect on the Elepaio population with six pairs now known to have territories within the rodent control grid. This lead to the decision to include Makaha Subunit I as a management unit for Oahu Elepaio and add the six known pairs to the 2022 total for managed pairs. Overall, it is great to see population growth in Makaha Valley, as well as lots of suitable habitat for which the species will hopefully be able to expand into.

Waianae Kai Forest Reserve

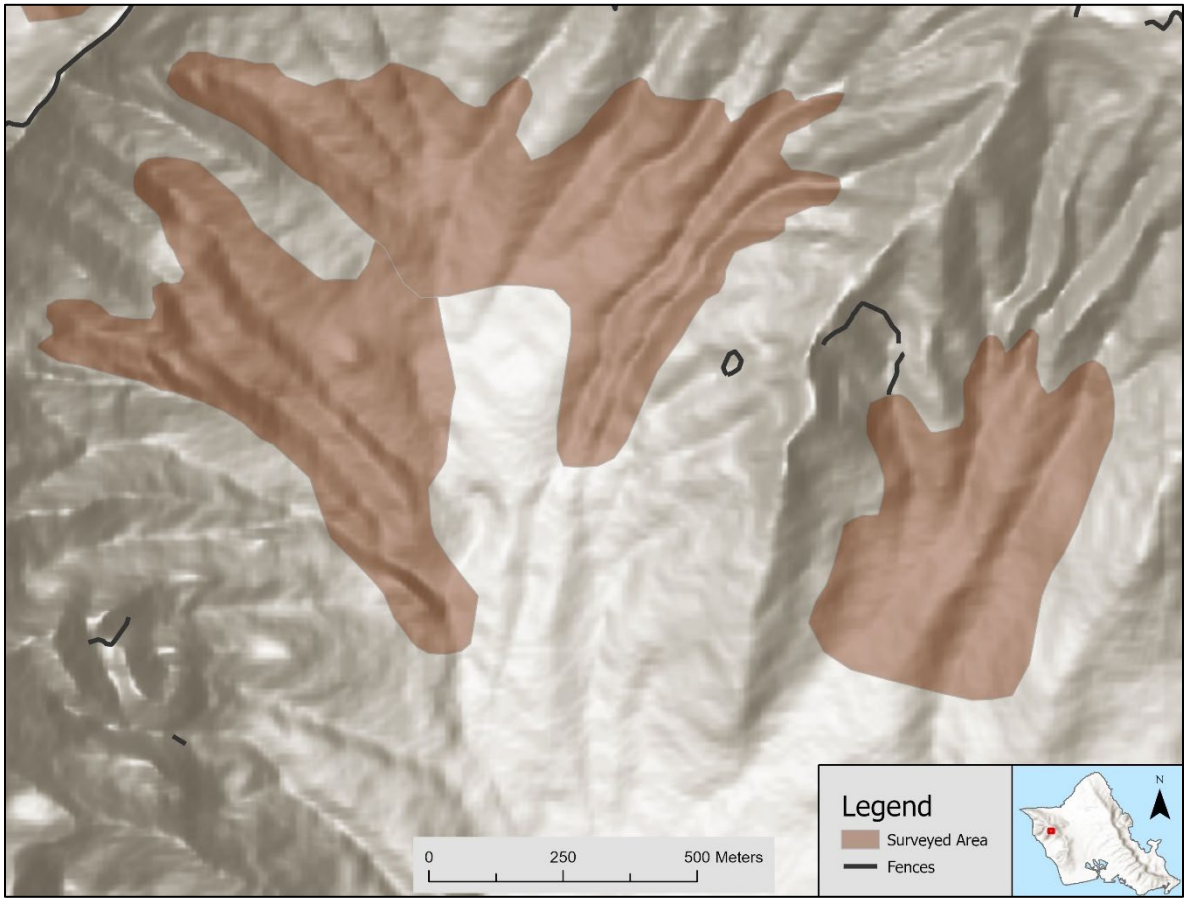

Figure 6: Map of surveyed area in 2022 at the Waianae Kai Forest Reserve.

Waianae Kai is not an area known for a high abundance of Oahu Elepaio. Two pairs and three single males were observed in 1997 in the upper areas of North Kumaipo Gulch, a large assortment of drainages in the western most region of the Forest Reserve. Twelve years later a survey revealed only four single males. This year, after surveying North and South Kumaipo, along with Hiu Gulch, not a trace of Oahu Elepaio was found. More gulches to the east make up the Forest Reserve, but they lack the proper elevation and suitable habitat that would sustain an Elepaio population. Therefore, surveys of those drainages will not take place at this time. Small pockets of adequate habitat do still exist in the very backs of some of these gulches, and with stable populations not far away at SBW and Makaha it's possible a small handful of pairs could one day establish territories in the Forest Reserve.

North Kaukonahua- Schofield Barracks East Range

Figure 7: Map of *Megalagrion* and Oahu Elepaio observed in North Kaukonahua.

On March 9-10, 2022 ANRPO conducted a two-day survey for federally listed damselflies in the South Kaukonahua Drainage, SBE (Figure 7). (See Chapter 7: Rare Insect Management for details.) Three survey teams divided up on each of the two days to cover 100% of walkable stream from the eastern edge of the Action Area to the Cannon Dam at 1,200ft elevation. Survey teams were delivered by helicopter to temporary landing zones nearest a team's assigned stream section. In addition to the damselfly survey, groups were briefed in avian resources including Oahu Elepaio, Iiwi, and Apapane. On March 9, the survey team in the southernmost tributary detected an Elepaio at 1,500' elevation. The bird called several times from the ridge south of the stream. The team did not get a visual of the bird, but there was an experienced observer on the team and he reported that there was no question that it was and Elepaio call. ANRPO is aware of previous reports of Elepaio from the lower elevations of Kipapa gulch. Kipapa is just south of the drainage where the bird was detected and staff are hopeful that there are still a number of Elepaio in the area. ANRPO will work to survey the area in the next couple years.

6.1.2.3 Monitoring

The first year of a five-year monitoring study comparing Oahu Elepaio nesting success between areas with and without rodent control began with the 2022 breeding season at Ekahanui and Huliwai. The results of this study will help guide Oahu Elepaio recovery efforts by understanding the current impact rodents have on Elepaio nesting success, effectiveness of long-term threat control, observing changes in breeding season trends, and documenting unusual nesting behaviors and nest-site characteristics. Prior to the breeding season it was presumed that Elepaio within the Ekahanui MU would have higher nesting success due to the presence of rodent control over a long period of time. Huliwai would be expected to have a higher rate of nest failures with an absence of protection from predators. Surprisingly, the first year of monitoring did not yield these results. Throughout the breeding season, 19 Elepaio pairs at Ekahanui and 18 at Huliwai were monitored weekly. A total of 29 nests were found at Ekahanui and 19 at Huliwai. Twenty-two of these nests at Ekahanui and 13 at Huliwai became active, meaning an egg or nestling was known to be within the nest. At Ekahanui, 11 (50%) of those nests were successful and produced 12 fledglings. Three fledglings were also observed in family groups where a nest had not previously been found. Huliwai had nine (69%) successful nests that produced 11 fledglings. Another seven fledglings were found in family groups. In total, 15 fledglings were found at Ekahanui and 18 at Huliwai. The aforementioned data is also displayed below in Figure 8. It is worth noting that since 2011 successful active nests at Ekahanui averaged 54% in years prior to and after ANRPO adopted the use of A-24 traps. While the cause of nest failures at both sites is largely unknown, UH graduate student Nikki Preston installed motion sensor game cameras at 25 nests between the two sites. She is currently examining thousands of images attempting to uncover the cause for some of those failures. Unfortunately, at least two active nests at Ekahanui were discovered to have been predated by rats at night. Lastly, the heights of all nests at both sites were measured with a handheld laser measuring tool. It is presumed that nests would be higher at Huliwai with the belief that rats are more abundant at this site and pairs will be more inclined to build nests further away from predators. With year-round rodent control at Ekahanui it is thought that Elepaio may nest lower in the tree canopy, as the threat of rodents is diminished. The first year of data shows that the average nest height at Ekahanui was 7.51 meters, with Huliwai slightly higher at 8.55 meters.

Keeping in mind that this is only one year of monitoring data, the results seem to indicate that without rodent control Huliwai was able to have a successful nesting season. The number of Elepaio increased steadily for years in Huliwai and the other gulches north of Ekahanui, presumably due to the nesting success within the MU enabling it to serve as a source population. The question became whether or not these newly forming populations would be able to successfully breed without the suppression of rats. Data from this year appears to indicate that successful breeding is indeed possible. At Ekahanui, factors contributing to a similar number of successful nests and a higher number of failures could come from any number of possibilities. One factor may be the deterioration of the A-24 trapping grid at Ekahanui. The MU has seen consecutive years of near 50% failure rate of its 306 A-24 traps. The result of this high percentage failure rate may leave some pairs with little to no rodent control within the actual territories. ANRPO continues to try and resolve this issue, while looking for alternative methods to reduce rodents in the field. An effort was also made to compare rodent density at both sites with the use of tracking tunnels. Unfortunately, in many instances feral cats in both gulches ate the bait before rodents were able to enter the tunnels, making it difficult to estimate rat activity. ANRPO deployed traps to eliminate feral cats, as well as modified tracking tunnels to exclude unwanted target animals.

Figure 8: 2022 Nest and fledgling data from Ekahanui and Huliwai.

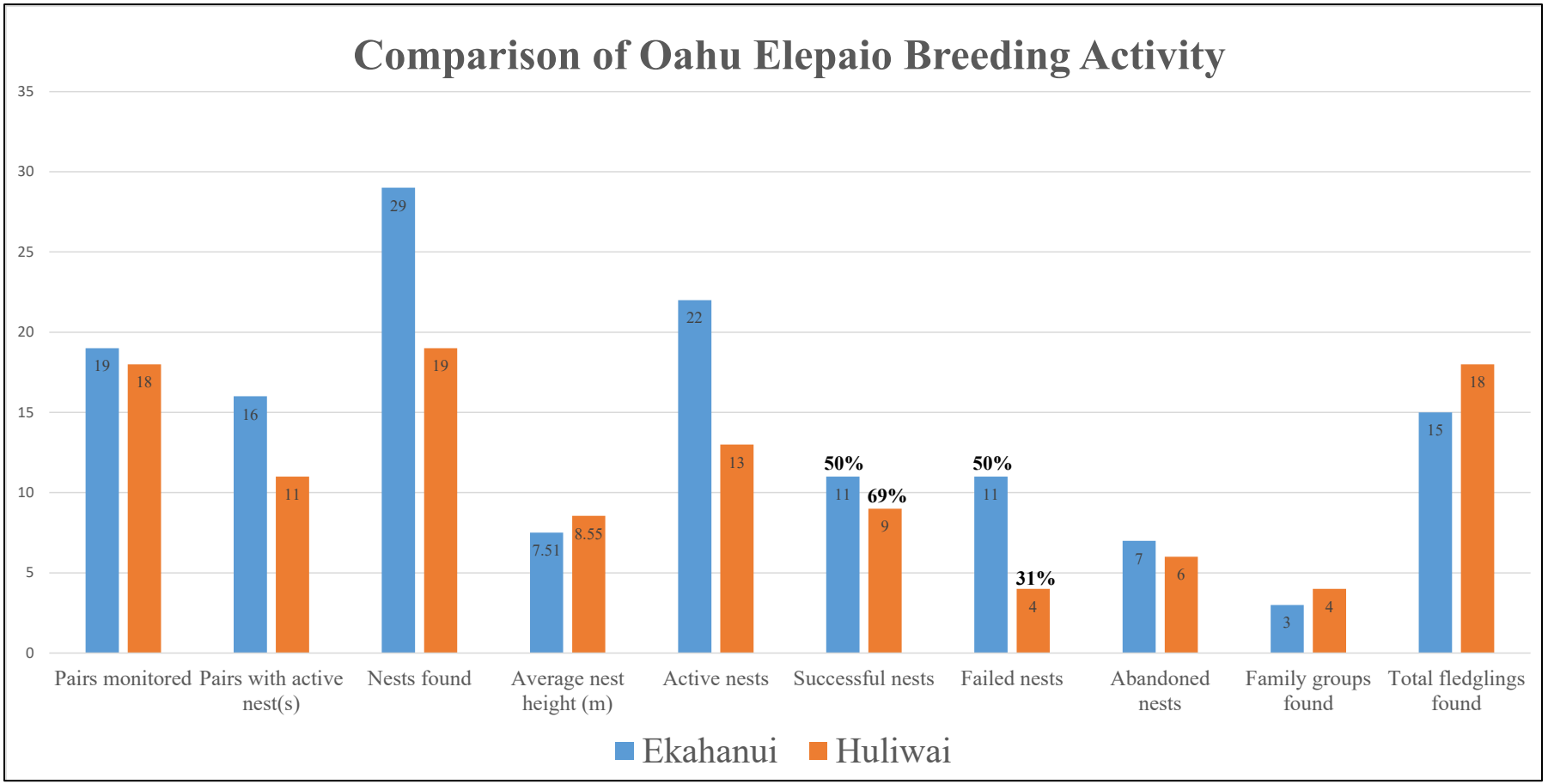

Figure 9: A subadult Elepaio pair takes advantage of an unused Warbling white-eye nest in Huliwai. This unusual, yet time saving technique proved successful and produced the pair's first fledgling. *Photo by Nikki Preston*

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Available Upon Request

Figure 10: Map of territories monitored at Ekahanui and Huliwai

6.1.3 OIP Summary 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.*

[One fresh 155mm artillery projectile was identified above the firebreak road in September 2021]

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*.

[There was one fire in June-July 2022 above the fire break which impacted Elepaio territories. The Army notified the DOD coordinator with the USFWS Pacific Islands Office and in addition the Army kept him up-to-date with new information]

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: 808/783-9556). If the B.P Bishop Museum does not wish to accession the specimens, the permittee should contact the Service's Division of Law Enforcement in Honolulu, Hawaii (telephone: 808/541-2681; fax: 808/541- 3062) for instructions on disposition*.

[One adult Oahu Elepaio specimen was collected by ANRPO staff on July 21, 2022 inside the Makaha MU. The cause of death is unknown. The specimen was delivered to the Bishop Museum]

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

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

[This report documents all of the above requirements]

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. Details of control activities are available in the ANRPO Database provided to partners annually]

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 10: Even with a large-scale trapping grid tree-climbing rats remain a significant threat to Oahu Elepaio at Ekahanui. This black rat (*Rattus rattus*) was able to make its way to an Elepaio nest and prey on the nestlings inside. *Photo by Nikki Preston*

6.2 MIP ELEPAIO MANAGEMENT 2022

6.2.1 Background

The initial Biological Opinion (BO) that triggered the development of the Makua Implementation Plan (MIP) was issued in 1999 (USFWS 1999). At that time, the Oahu Elepaio was not listed as an endangered species, but the 1999 BO did include recommendations related to Oahu Elepaio. These included conducting complete surveys of the Makua Action Area (AA) for Oahu Elepaio presence, monitoring of all known Oahu 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 (USFWS 2004), the USFWS issued another BO that covered newly designated critical habitat within the Makua AA for plants and Oahu Elepaio. This BO outlined additional requirements related to this critical habitat. The most recent BO issued in 2007 required the protection of all Oahu 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.

Figure 11: ANRPO is back managing Oahu Elepaio in Makua Valley. Two A-24 trapping grids are now operational with the latest survey resulting in three pairs and one single male.

Makua

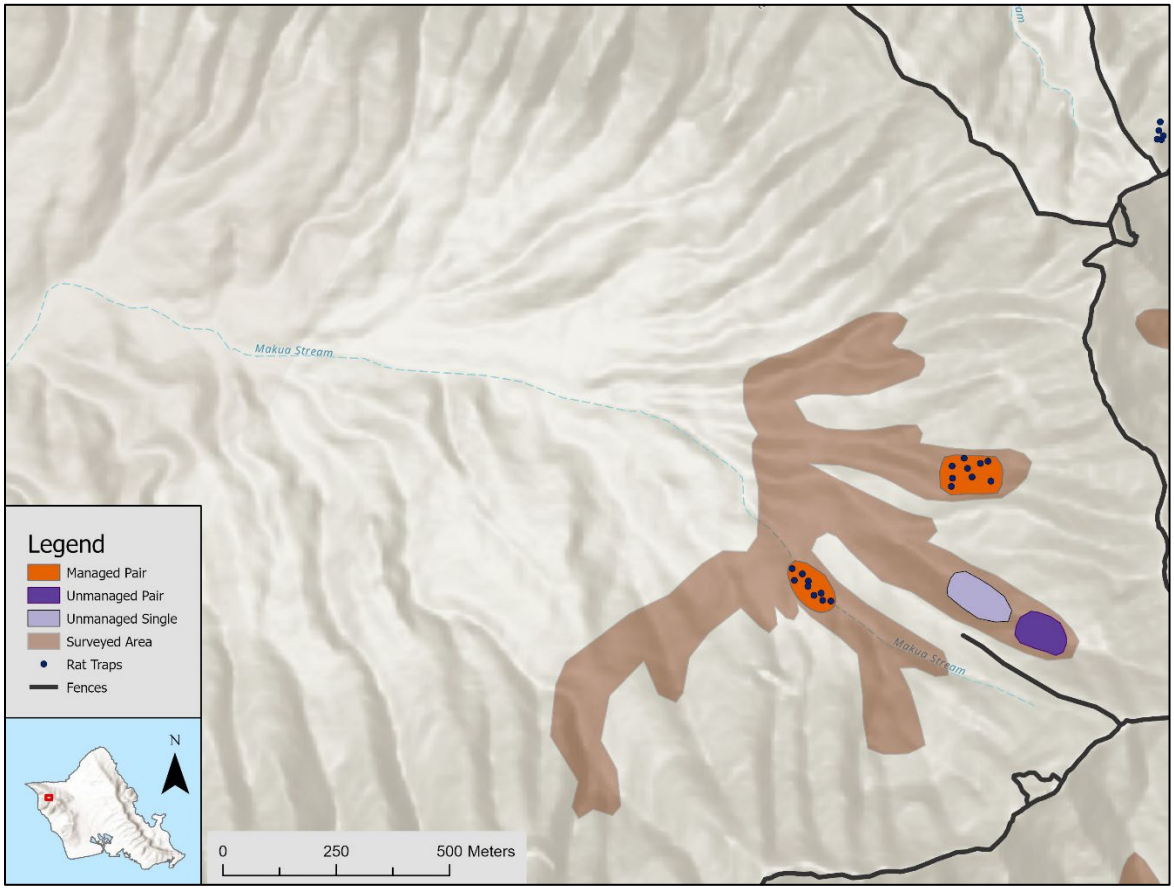

Figure 12: Map of updated (2022) Oahu Elepaio abundance and distribution at Makua Valley.

6.2.2 MIP Management Actions 2022

For the first time since 2017 staff were able to access Makua Valley on September 30, 2021 for the purpose of locating new and previously known UXO that would be disposed of shortly after. This would allow ANRPO to continuing conservation efforts that had been suspended for many years due to safety concerns. During the trip staff observed two occupied Elepaio territories. One with a subadult pair and another with a single adult male. This is the first time a pair had been seen in Makua Valley since 2009. Staff later returned in late March 2022 to continue surveying for Elepaio and to set up an A-24 trapping grid consisting of nine traps in the subadult pair territory found earlier in September. During this survey another subadult pair was discovered. This second pair also had an active nest with nestlings. This is the first time a nest had been found in Makua in 13 years. In mid-July staff returned for a two night camping trip to complete an assortment of actions. A second A-24 trapping grid was installed to protect the subadult pair earlier found with an active nest. Unfortunately, too much time had passed to tell if their nest was successful in fledgling the nestlings. After completion of the trapping grid a third pair was discovered. This time the pair consisted of two adult Elepaio. Altogether, this is the most pairs ANRPO have observed in the past two decades. Also present was the same single male observed back in September. This leaves the current known population of Makua Valley at seven Elepaio. After finally being able to return to Makua Valley it is extremely encouraging to see such an increase in the Elepaio population, as well as active breeding taking place. Another trip to Makua is scheduled for November 2022. The goal will be to install a third A-24 trapping grid and hopefully discover that the remaining single male Elepaio has paired up with a mate.

6.3 FEDERALLY LISTED WATERBIRD MANAGEMENT 2022

6.3.1 Background

During periods of heavy rainfall, Dillingham Military Reservation (DMR) has the potential for flooding within a California Grass Meadow in the P1 training area, map below. This transformation from open grassy field to ephemeral pond attracts three species of federally listed waterbirds that include the Hawaiian Stilt *(Himantopus mexicanus knudseni)*, Hawaiian Coot *(Fulica alai*), and Hawaiian Gallinule *(Gallinula chloropus sandvicensis)*. Rather than conducting regularly scheduled surveys throughout the year, ANRPO staff monitor the training area after heavy rainfall events. If any federally listed waterbirds are observed the Army is notified that closure of the area is needed while ANRPO staff monitor for nesting activity for the remainder of the flooding period.

Additionally, ANRPO tracks incidental observations of endangered waterbirds. The Hawaiian Stilt has been observed at Aliamanu Military Reservation (AMR) due to its close proximity to wetlands located offsite. There are no wetlands at AMR though grassy fields do flood in heavy rainfall events. Hawaiian Stilts have also been observed at Schofield Barracks. In 2016, two Hawaiian Stilts were observed in the catchment basin for the Central Vehicle Wash Facility. This basin captures water from the paved surfaces of the facility during heavy rainfall events. Also, in September 2022, three Stilts were observed near the Natural Resources baseyard and in a neighborhood nearby. On both occasions they were foraging in unflooded grassy fields.

Image Redacted
Sensitive Information
Available Upon Request

Figure 13: Location of California Grass Ponding Area

6.3.2 Federally Listed Waterbird Management Summary

After heavy rains on Oahu in early December 2021, ANRPO staff first observed flooding at South California Grass Meadow on January 6, 2022. Both Hawaiian Coot and Hawaiian Gallinule were observed in the flooded area. On February 3, 2022, an Army vehicle was observed stuck in the pond. The unit was using the water feature to practice vehicle rescue and recovery. ANRPO immediately informed Range Control and they counseled the soldiers and the activity ended. ANRPO recommended closing the P1 training area for the duration of the flooded period. Monitoring of the pond continued and on March 3, 2022 a pair of adult Hawaiian Gallinule were spotted with three chicks at the edge of a small grassy island at the east end of the pond. The last observation of standing water was on April 28, 2022. Since January, all three federally listed waterbirds were observed at the area during multiple visits. On May 11, 2022, ANRPO monitored the area for a final time and observed no standing water or waterbirds. Range Control was informed that the area could be re-opened for training use.

Due to the increase in incidental observations and use of the DMR meadow, ANRPO will create a new database to track observation data for these waterbirds. Until now data had been tracked via spreadsheets. The database will allow for analysis and reporting.

Figure 14: Flooding at Dillingham Military Reservation lasted for five months and attracted federally listed Hawaiian waterbirds like this Hawaiian Gallinule that nested here at the pond. In the distance, an Army unit practices vehicle rescue and recovery.

6.4 OPEAPEA MANAGEMENT 2022

6.4.1 Background

ANRPO 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), MMR and Schofield Barracks Military Reservation (SBMR). The 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 Opeapea. Acoustic monitoring confirmed the presence of Opeapea on all Oahu Training Areas, 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.).

6.4.2 Opeapea Management Summary

The Army continues to abide by a tree cutting moratorium during the Opeapea pupping season from 1 June to 15 September. The USFWS provided these parameters to minimize impacts to roosting bat pups through an informal consultation. Refer to ANRPO (2016) for further details on the restrictions. This is a difficult situation as Federal contracts for grounds maintenance are executed using year-end funding just before the summer bat pupping season. Typically, this makes it impractical to get all tree trimming and removal projects completed prior to 1 June. To ensure the completion of these contracts and cover any emergency tree removal actions, thermal surveys are conducted prior to any tree trimming or removal activities during the pupping season. All surveys are performed prior to sunrise on the morning of the scheduled tree trimming. During the 2022 pupping season there were nine requests for bat pup surveys. All were conducted by a contractor, Tree Solutions and Environmental Consulting Services. The contractor has had training and past experience in bat pup surveys. The contractor employed the use of a FLIR Scout III thermal imager to conduct its surveys. Table 2 shows the results of the nine surveys conducted by the contractor. All totaled, approximately nine hours were spent conducting these surveys (not including transportation time) in 102 trees. No bats were observed during these surveys.

The Opeapea Acoustic/Thermal Survey summary table below shows the total number of roosting bat surveys throughout the 2022 pupping season. From the left, column 1 shows the date of each survey. Column 2 lists the surveyor, 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: Fort Shafter Military Reservation (FSMR), Red Hill Mauka (RHM), and Wheeler Army Airfield (WAAF). Finally, columns 8-20 present the different species of trees that were surveyed.

Table 2: 2022 Opeapea Acoustic/Thermal Survey Summary. This table lists surveys by date and details the number of trees by species.

Date	Surveyor	Thermal or Acoustic Survey	Time	Bat Detected (T/A)	Wildlife Detected	Army Installation	*Cocos nucifera*	*Dypsis lutescens*	*Enterolobium cyclocarpum*	*Fraxinus uhdei*	*Phoenix dactylifra*	*Roystonea regia*	*Samanea saman*
8-Jun	TSECS	Thermal	05:00-06:00	No	Yes	RHM			1				
9-Jun	TSECS	Thermal	05:00-06:00	No	Yes	RHM			1				
10-Jun	TSECS	Thermal	05:00-06:00	No	Yes	RHM			1				
15-Jun	TSECS	Thermal	05:00-06:00	No	Yes	RHM							1
14-Jul	TSECS	Thermal	06:00-07:00	No	Yes	WAAF	7	2					
14-Jul	TSECS	Thermal	06:00-07:00	No	Yes	WAAF				1			
14-Jul	TSECS	Thermal	06:00-07:00	No	Yes	WAAF							4
20-Jul	TSECS	Thermal	06:00-07:00	No	No	FSMR					1		
26-Jul	TSECS	Thermal	05:30-06:30	No	No	FSMR						83	

6.5 Literature Cited

U.S. Fish and Wildlife Service. 2004. Reinitiation of the 1999 Biological Opinion of the USFWS for Routine Military Training at Makua Military Reservation Island of Oahu. 190 Pages http://manoa.hawaii.edu/hpicesu/DPW/BO/2004BO_edited.pdf

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CHAPTER 7: RARE INSECT MANAGEMENT

This chapter covers management of the four endangered insects known from Army lands on Oahu: the pomace flies *Drosophila montgomeryi*, *D. obatai*, *D. substenoptera*, and the damselfly *Megalagrion xanthomelas*. Reviews of the past year's actions and trends are presented for all four species. There are endangered bees (*Hylaeus facilis*, *H. kuakea*, and *H. mana*) known from sites adjacent to Army lands or ANRPO management units (MUs) on state land, but they are not currently known from within the action area; no surveys or management were conducted for them this past year beyond occasional checks of artificial nests, which were not utilized by *Hylaeus* sp.

7.1 *DROSOPHILA* MANAGEMENT

7.1.1 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. ANRPO work on *Drosophila* began in March 2013, focusing on monitoring known populations, surveying for new ones, and restoring habitat. Winter and spring 2022 saw a general increase in most common and rare species with the expected population spikes in spring. *Drosophila montgomeryi* numbers dropped off since spring of 2021; none were seen in N. Kaluaa or Palikea, except for Central Kaluaa which had many observed adults in spring of 2022. At Palikea both endangered species (*D. substenoptera* and *D. hemipeza*) saw an increase in observed individuals over the previous year's observations including the highest recorded number of *Drosophila hemipeza* at Palikea.

7.1.2 SURVEY METHODS

Many species of Hawaiian *Drosophila*, including the picture wing group to which all of the endangered species belong, are readily attracted to bait 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 4-12 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, since numbers fluctuate through the day. This number is compiled by adding the maximum observed at each discrete group of bait sponges at any one time, on the assumption (based on observations of recognizable individuals) that the same individual flies may move between sponges within a group but are unlikely to be seen at two different groups.

Known, significant populations of *D. montgomeryi* at Kaluaa Management Unit (MU) and *D. substenoptera* at Palikea MU, where flies occur relatively consistently, are monitored quarterly in order to determine approximate population trends through the year. Until recently these populations were monitored monthly. Due to the time expended and utility of this data it was determined to conduct monitoring on a longer interval. For *D. montgomeryi*, Pualii (designated as a management site for *D. montgomeryi*) and Waianae Kai (the largest population but unmanaged) were designated to be monitored quarterly; however, due to apparent loss of the population at Pualii due to a loss of the host plant, and

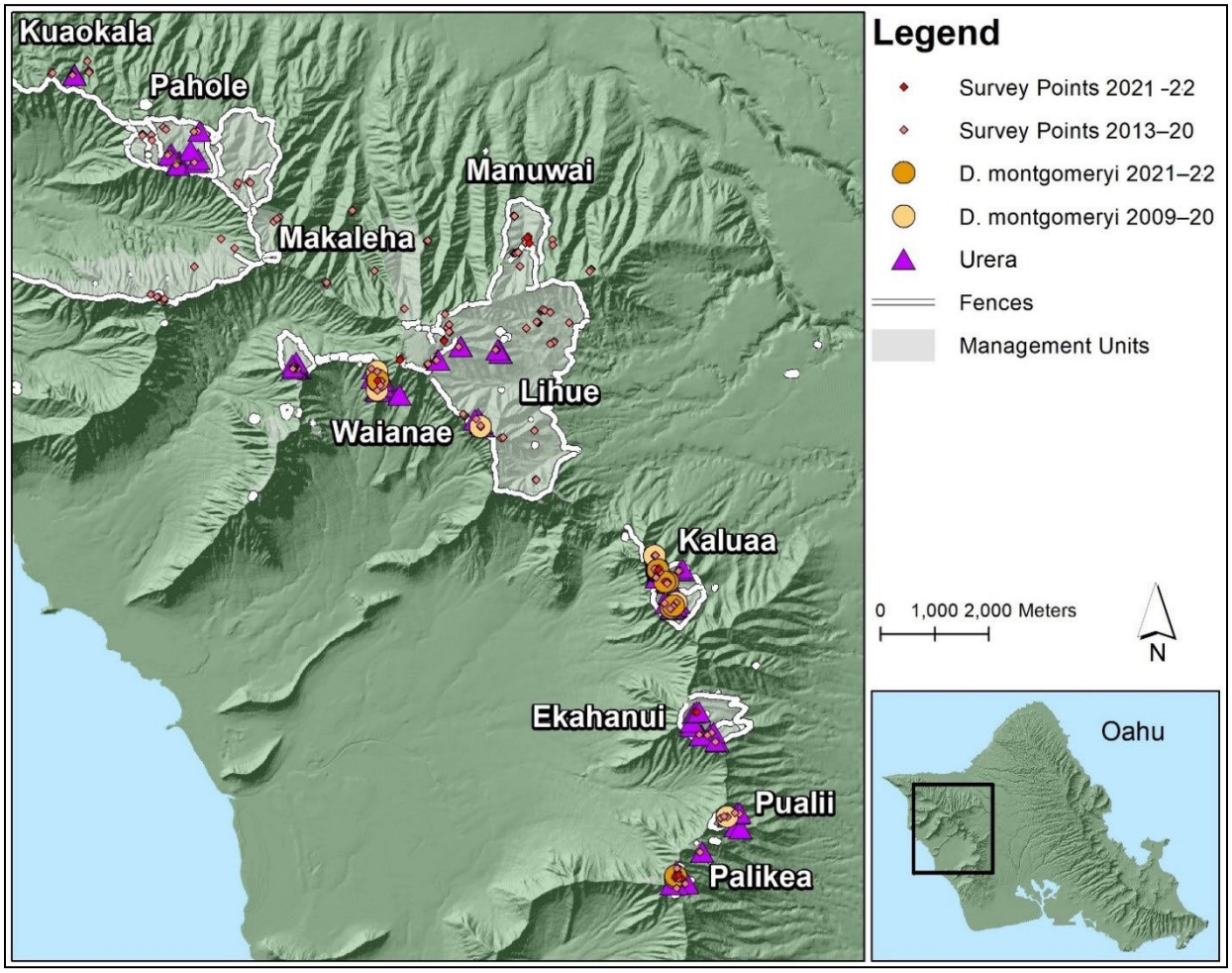

Figure 1: Distribution of *Drosophila montgomeryi* observations in the 2021–22 reporting year and earlier records from 2009–22, with known mature *Urera* spp. sites and all survey points in the Waianae range.

higher priorities elsewhere, there has been no monitoring since 2017, and no other actions were taken. Other known populations (Kaala and Opaeula Lower 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 in areas suggested by other staff as having host plants, at historic collecting localities, and in new sites where surveys have been minimal.

In cooperation with SERDP researchers Dr. Rosemary Gillespie and Dr. George Roderick, initial trials were conducted to determine the efficacy of new techniques in the detection of low-density *Drosophila* species using eDNA (Environmental DNA) analysis. If successful, these methods may allow for better and more efficient detection of rare *Drosophila* species.

7.1.3 *DROSOPHILA MONTGOMERYI*

Drosophila montgomeryi is a small yellow-brown species that breeds in rotting bark of *Urera kaalae* and *Urera glabra* (opuhe). While *U. glabra* occurs widely across the Waianae range (Table 1), 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 were outplanted. The Division of Forestry and Wildlife (DOFAW) botanist has planted several hundred additional *U. kaalae* as part of a

recent initiative, but plants are still young and do not yet provide breeding habitat. *Drosophila montgomeryi* is recently known from ten sites in five population units (PUs), effectively covering nearly its entire historic range in the Waianae Mountains (Figure 1). Kaluaa (all three sites collectively), Ekahanui, and Palikea were designated as Managed for Stability (MFS) PUs.

7.1.3.1 Population Status

Site	Days	Max No. 21-22	Max No. 20-21
Kaluaa - Central	11	18	9
Kaluaa - North	11	0	5
Puu Hapapa	12	5	3
Palikea	11	0	8
Waianae	1	9	16
Ekahanui	1	0	0

Table 1: Survey effort for *D. montgomeryi* across all potential sites in the 2021–22 and 2020-2021 reporting periods, in survey days. "Max No." is the highest number of flies observed in a single day.

Kaluaa and Waieli MU (MFS)

Three sites in this MU – Puu Hapapa, North Kaluaa, and Central Kaluaa gulch 1 – have been monitored monthly since June 2013 (though not every site was visited each month) over a total of 247 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 the El Nino of 2015–17, there was no such winter pulse in *D. montgomeryi*. Numbers largely recovered in 2017–18 and 2018–19, but with less consistency across the season. In both 2019–20 and 2020–21, observations remained unusually high through most of the summer despite the relatively dry season, but without an obvious spike during winter. 2021 recorded one of the highest winter rainfalls of the past 20 years but it was concentrated during a short period in February; consequently the soil at many sites never became saturated and remained quite dry through the rest of the reporting year. In 2021-2022 observations of *D. montgomeryi* fell at both Puu Hapapa and North Kaluaa, with no observations in North Kaluaa and no winter spike at Hapapa. Central Kaluaa saw a large number of *D. montgomeryi* with 18 individuals observed in May 2022. The population trends observed since monitoring began seem to be linked to wetter weather periods. As weather patterns change, the patterns of *D. montgomeryi* abundance seem to change as well.

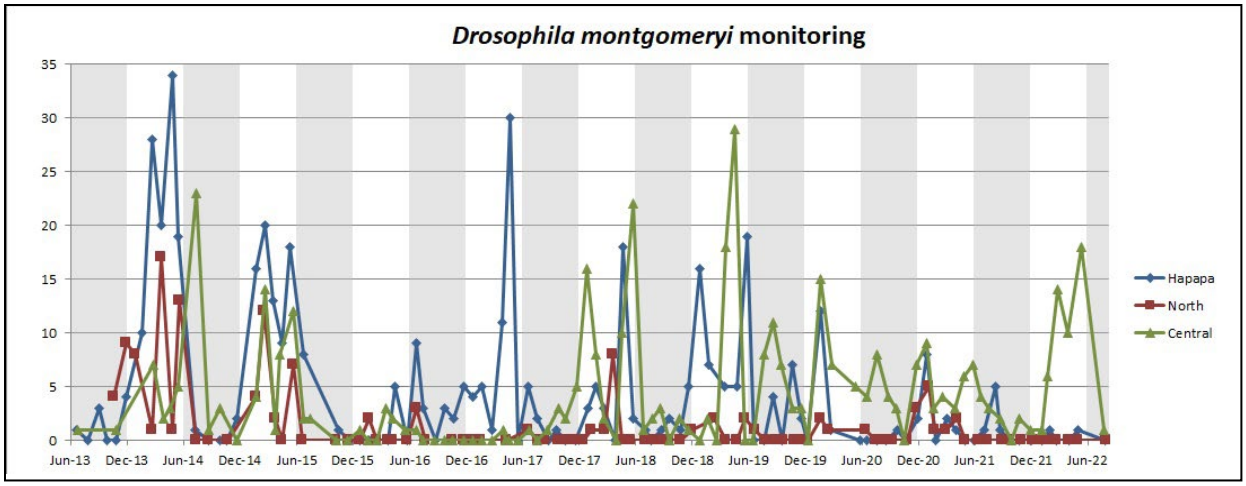

Figure 2: *Drosophila montgomeryi* numbers during monthly monitoring at three sites in Kaluaa PU (Puu Hapapa, North Kaluaa, and Central Kaluaa). Y axis is the maximum number observed across the entire site on the survey day (see Survey Methods, section 7.1.2). Gray shading indicates the summer low season.

Palikea (MFS)

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. After a year of occasional sightings it disappeared, possibly due in part to drying of the site from canopy clearing. Since that time, *U. glabra* has increased naturally as weed control reduced alien cover, and outplanting has significantly boosted the *Urera* population. Outplanted *U. glabra* here have done exceptionally well – after six years, many of them are large sprawling trees 8–10 feet tall. Continuous treefalls of *Schinus terebinthefolius* and other larger trees have damaged some *Urera* and slowed growth, but also provide breeding habitat for *D. montgomeryi*. *Urera kaalae* were also planted here by the Oahu DOFAW Botanist, and are thriving. Still, ten of the 13 records here have been of single individuals, indicating that the *D. montgomeryi* population remains low. In the 2021-2022 reporting period despite the heavy rain events in December through February, no *D. montgomeryi* were seen in Palikea.

Pualii (No Management) and Ekahanui (MFS)

Pualii was visited for the first time in 2014, and quarterly monitoring began in 2015. At the time of the first visit, the last wild *U. kaalae* tree in North Pualii Gulch recently fell and the decaying trunk was supporting a large number of *D. montgomeryi*. Unfortunately, the fly has not been seen since the second visit there in 2014, and the population appears to be extirpated. Only one of the original *U. kaalae* outplants remains, and while several natural offspring of these plants have grown up, other outplants of both *U. kaalae* and *U. glabra* elsewhere in the gulch have not survived or failed to thrive. Ekahanui in contrast has hundreds of *Urera* reintroductions that are doing well, slug control, and a large rodent control grid. Therefore, ANRPO designated Ekahanui as the third MFS site instead of Pualii, and focus efforts on habitat restoration there in anticipation of a future *Drosophila* reintroduction. Ekahanui formerly had the largest population of *D. montgomeryi* during early surveys in the 1970s. There are some small patches of *U. glabra* where it could still persist, though it has not been detected to date. However, surveys were not repeated at many sites, and tiny populations may not be easily detected. eDNA surveys, if shown to be practicable, may be an option to determine if any extant populations exist in Ekahanui.

Waianae Kai (No Management)

The largest known population of *D. montgomeryi* occurs in the northeastern sub gulches 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 rule out 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. The site was visited two times in the 2021–22 period, with flies present both times and highest in January with nine individuals. The population seems to be trending lower in the past couple years, but the small sample size of only two monitoring days in this timeframe could be playing a role in this.

7.1.3.2 Management Actions

Following discussion of the Implementation Team in February 2021, several new steps were agreed upon for management of *D. montgomeryi*: ant control, and slug control. These are reviewed below, in addition to previous work on outplanting *Urera*.

Ant Control

An ANRPO-supported study by Krushelnycky et al. (2017, Biological Conservation 215:254–257) showed substantial impacts of the semi-cryptic thief ant *Solenopsis papuana* on abundance of picture-wing *Drosophila*. After a follow-up study showed minimal nontarget impacts on native insects, staff began ant control at *D. montgomeryi* sites in North and Central Kaluaa with applications of Amdro Home Perimeter bait in March 2021. The treatment areas at the two sites are 600 m^2 and 760 m^2 respectively. A survey of both sites in June found ants still almost completely suppressed within the target area, despite very high numbers in the adjacent untreated parts of the gulches. These sites will be periodically resurveyed and re-treated at intervals of 3–6 months alongside regular fly monitoring for evaluation of effectiveness. Palikea has very low abundance of *S. papuana*, so it will not be treated unless conditions change. Since no *D. montgomeryi* are currently known from Ekahanaui, no ant control is currently conducted. If *D. montgomeryi* are found in Ekahanui, ant control will be reevaluated.

Slug Control

Slugs are known to be destructive herbivores on *Urera* seedlings, and *Urera* exhibit almost no natural recruitment due in large part to slug predation. To evaluate the effectiveness of slug control in enhancing recruitment, we plan to begin slug control by application of FerroxxAQ when *U. glabra* begins to fruit in the fall. For the coming year this will probably be limited to North Kaluaa since several trees there fruit prolifically. Nighttime surveys for *Achatinella* snails were conducted in North, and Central Kaluaa recently with none found, Puu Hapapa is known to have snails outside the predator-free enclosure so there are no plans to bait there.

Outplanting

Two-hundred and four total *U. glabra* were planted in Ekahanui (98), Kaluaa (49), and Puu Hapapa (57 *U. glabra*, 113 *U. kaalae*) in 2021–22 as part of restoration efforts. Most of these are in currently known *D. montgomeryi* habitat, and should mean an improvement in habitat for the flies when the trees mature. At Hapapa specifically, the *Urera* along with other common natives should improve the habitat following the opening and drying that has taken place over the past years. In addition to ANRPO's outplanting program, the Oahu Plant Extinction Prevention Program (OPEPP) has planted 2500 *U. kaalae* in the last three years with 1500 planted this reporting period. In 2021-2022 OPEPP planted groups of five hundred plants in Ekahanui, Pahole, and Makaha. ANRPO plans to establish ex-situ plantings of *U. glabra* at the ANRPO baseyard and possibly the Kahua site. The plants grown at these sites will provide breeding material for experimental augmentation of *D. montgomeryi* breeding sites, material for the rearing program, as well as seed production for future outplantings. The efficacy of augmenting wild sites with breeding material will be determined using current monitoring techniques.

Drosophila Rearing Program

This year ANRPO began coordination with DOFAW to establish a *Drosophila* rearing program with the goal of augmenting existing populations of *D. substenoptera* and *D. montgomeryi*. ANRPO is collaborating with Kelli Konicek (DOFAW) at UH Manoa, who is rearing several rare *Drosophila* including *D. montgomeryi*. Given the results she has seen thus far, it seems practicable to artificially rear and release rare *Drosophila* to augment our wild populations. This is most likely to occur through a collaboration with DOFAW staff to rear *Drosophila* for ANRPO in the near term.

7.1.4 *DROSOPHILA SUBSTENOPTERA*

7.1.4.1 Population Status

Based on collection records, *D. substenoptera* requires moderately tall, non-boggy wet forest with its host plants, *Cheirodendron* spp. (olapa) and *Polyscias* (=*Tetraplasandra*) *oahuensis* (ohe mauka), a habitat which is relatively uncommon since these trees tend to occur most abundantly in boggy, short-stature forest near summit crestlines. Compared to other islands, *Cheirodendron* is rather uncommon on Oahu relative to available habitat, and a large proportion occurs on steep slopes or in the bottom of drainages that are weedy and difficult to access.

Currently, there are three PUs for *D. substenoptera* – Palikea, Kaala-Kalena, and Opaeula Lower (Figure 3), and all are considered MFS. PU trends are only graphed for Palikea; the other two PUs are only occasionally monitored and *D. substenoptera* is highly sporadic at them, typically occurring as single individuals observed only once during a day. This rarity has undoubtedly hampered our ability to detect it at new sites. Management currently consists of general habitat maintenance and improvement, since it does not appear to be host-limited and other factors in its rarity remain unknown. *Cheirodendron* has been extensively outplanted at Palikea for general habitat restoration which should help *D. substenoptera*.

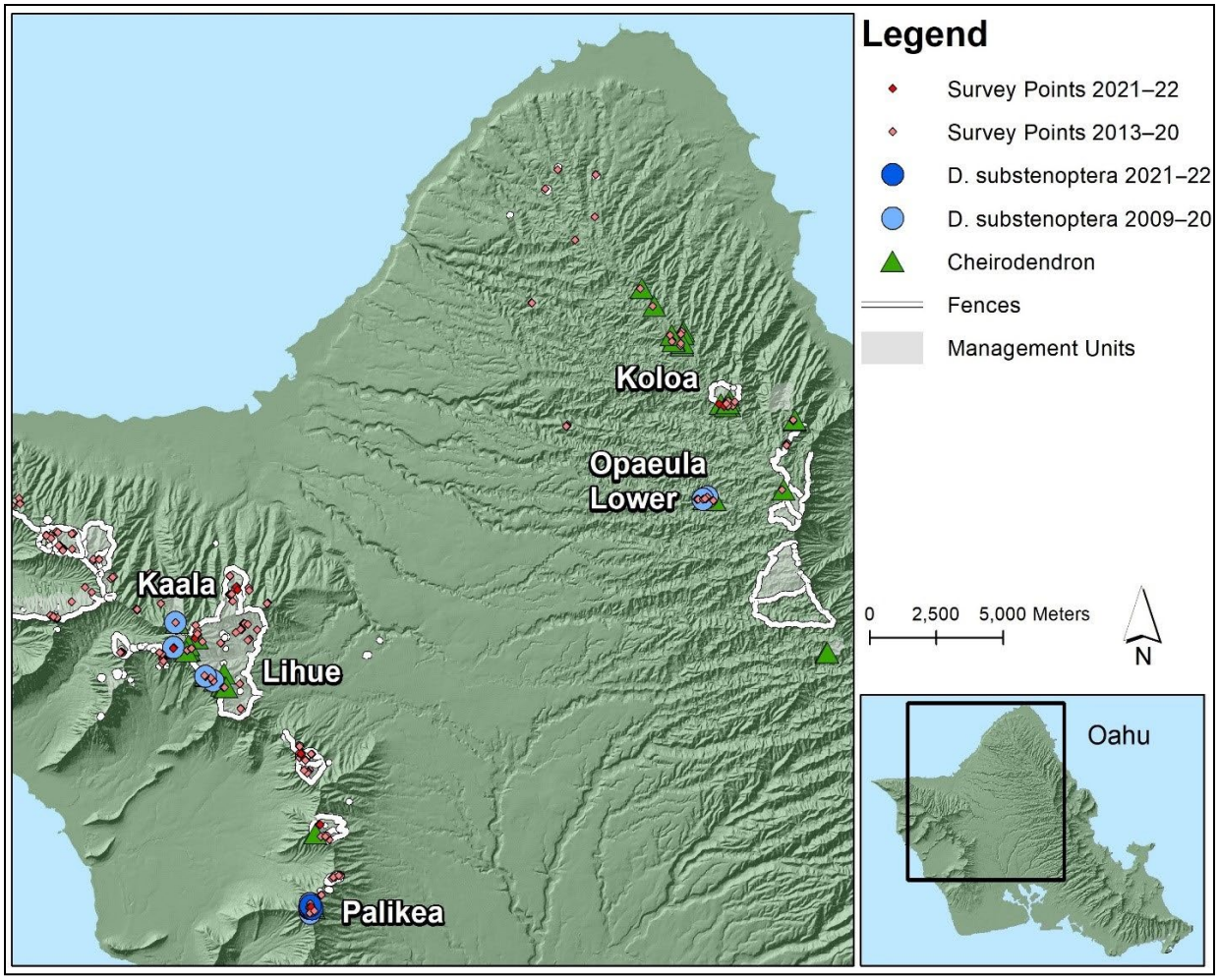

Figure 3: Distribution of *Drosophila substenoptera* observations in the 2020–21 reporting year and earlier records from 2009–20, with selected *Cheirodendron* spp. sites and all survey points.

Waianae Range (Palikea and Kaala-Kalena PUs)

Monthly monitoring in the northern portion of Palikea MU has been ongoing since May 2013 (102 survey days' total, 11 in the current reporting period; Table 2). Aside from a large flush in late May 2013, numbers of *D. substenoptera* (Figure 4) and another endangered species, *D. hemipeza*, have been consistently low to modest, but they were almost always present through the summer of 2018. Between the summer of 2018 and July 2021 there was a decrease in observed individuals below normally observed levels. A striking spike of the two common species at the site, *D. crucigera* and *D. punalua*, in May and June 2020 and continued moderately high numbers since then did not result in a corresponding increase in either *D. substenoptera* or *D. hemipeza* during this time (Figure 5). There may be a correlation between large observations of common species and rare species of Drosophila. This may be down to similar needs such as moisture and abundance of breeding materials after wind events. Where population spikes do not see similar trends in the same time period it may be indicative of other unknown factors limiting the breeding potential of rare species.

Recently, there has been a spike in both *Drosophila substenoptera* and *Drosophila hemipeza*, the former reaching 2017 levels of observed individuals. This reporting period also saw an increase in *D. hemipeza* observed as well as the largest count of *D. hemipeza* since monitoring began in 2013.

Site	Days	Max No.
Palikea	11	11
Kaala	1	0

Table 2: Survey effort for *D. substenoptera* and number of flies found across all potential sites in the 2021-2022 reporting period, in survey days. "Max No." is the highest number of flies observed in a single day.

Figure 4: *Drosophila substenoptera* (right) next to non-native *Drosophila* at Palikea MU.

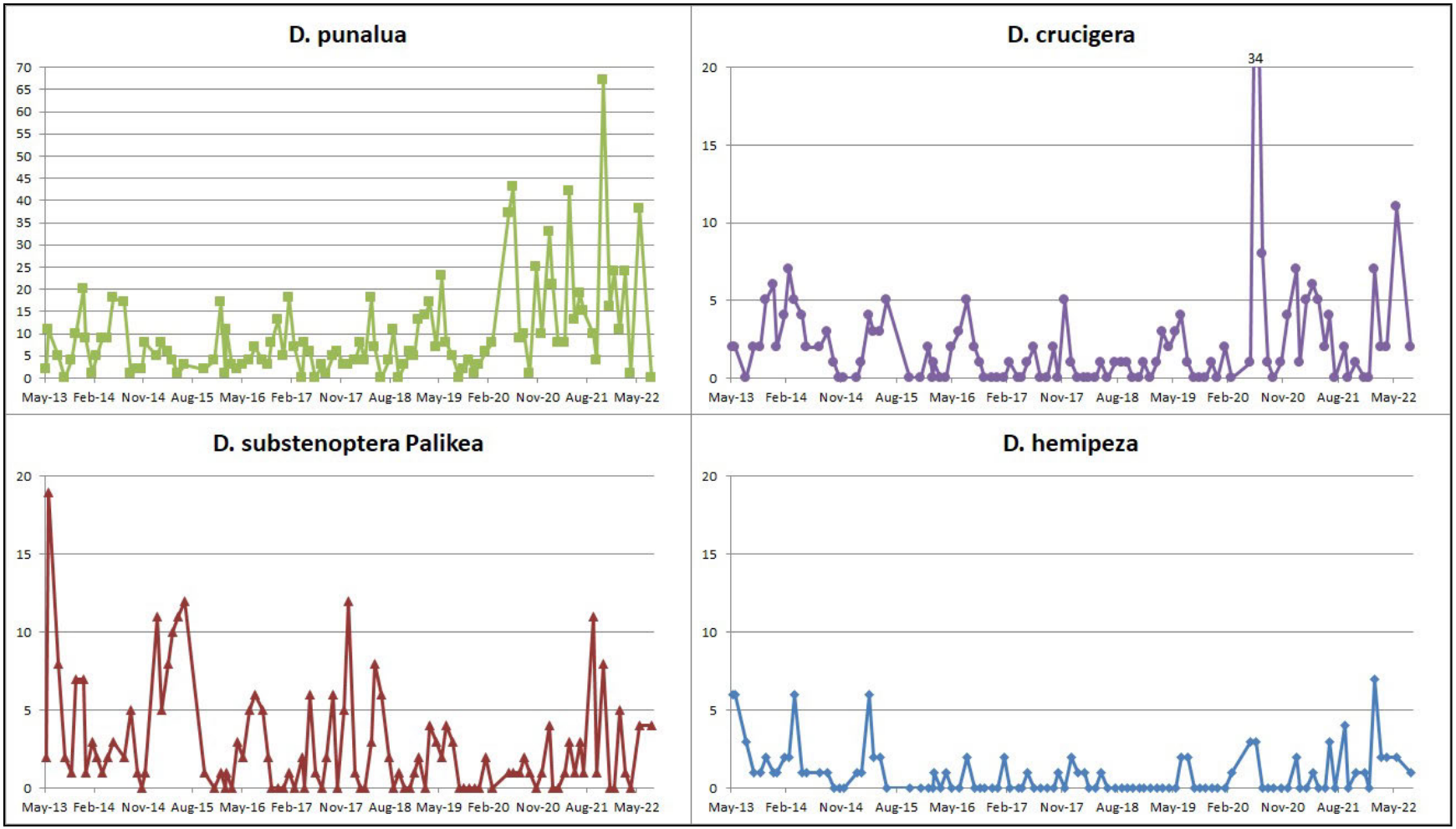

Figure 5: Monthly monitoring results for two common (above) and two endangered (below) picture-wing *Drosophila* species at Palikea, from May 2013 to June 2022.

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 Koolau mountains than in the Waianae range. However, collection effort has been limited due to the difficulty in accessing areas of intact habitat for this species. ANRPO survey trips in the Koolaus are now relatively few due to higher priorities elsewhere, and concentrated in only a few sites. In 2021–2022, there was no *Drosophila* monitoring conducted in the Koolau mountains. Finding additional Koolau populations is a high priority for this species; Helemano, Poamoho, Kaluanui, and Kaukonahua have not been surveyed yet. Opaeula Lower and Koloa will continue to be checked given the extremely high quality of habitat there and low observation rate at sites where *D. substenoptera* is known to be present.

7.1.5 *DROSOPHILA OBATAI*

Drosophila obatai was rediscovered in Manuwai Gulch MU in 2011, 40 years after the previous record in 1971. Historically it was known from East Makaleha, several gulches in lower Kaala NAR, and the southeastern Koolau range around Wailupe Valley. It breeds in rotting stems of *Dracaena* (=*Chrysodracon*) spp. (halapepe), which suffers from very low reproduction rates but remains widespread in the northern Waianae range thanks to its longevity. *D. obatai* is currently known from seven sites in four potential PUs (Makaleha, Manuwai, Palikea Gulch, and Pulee), although three of these are within 1,200 m of each other and could potentially form one contiguous population (Figure 6). While the populations were almost certainly contiguous until recently, native forest in general and *Dracaena* in particular is now much more fragmented and moving between patches of host trees is more difficult for the flies.

There have been few surveys for *D. obatai* since 2017 due to difficulty accessing SBW (Pulee) and Manuwai, limited survey time available, and focus on monitoring *D. montgomeryi* (Table 3). Access to both areas has recently been restored and the former is a high priority to survey. Three sites were surveyed this year for *D. obatai*, with none observed.

Manuwai is the only site with *D. obatai* reliably present in the past and the only currently known site for several other extremely rare species, but may be threatened by expansion of yellow crazy ants (*Anoplolepis gracilipes*). The lowest site has already been extirpated by ants, and the site on the west side of the valley has been heavily altered by treefalls and subsequent invasion of alien vegetation, becoming hotter and drier.

Table 3: Survey effort for *D. obatai* across all potential sites in 2021–22 reporting period, in survey days.

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

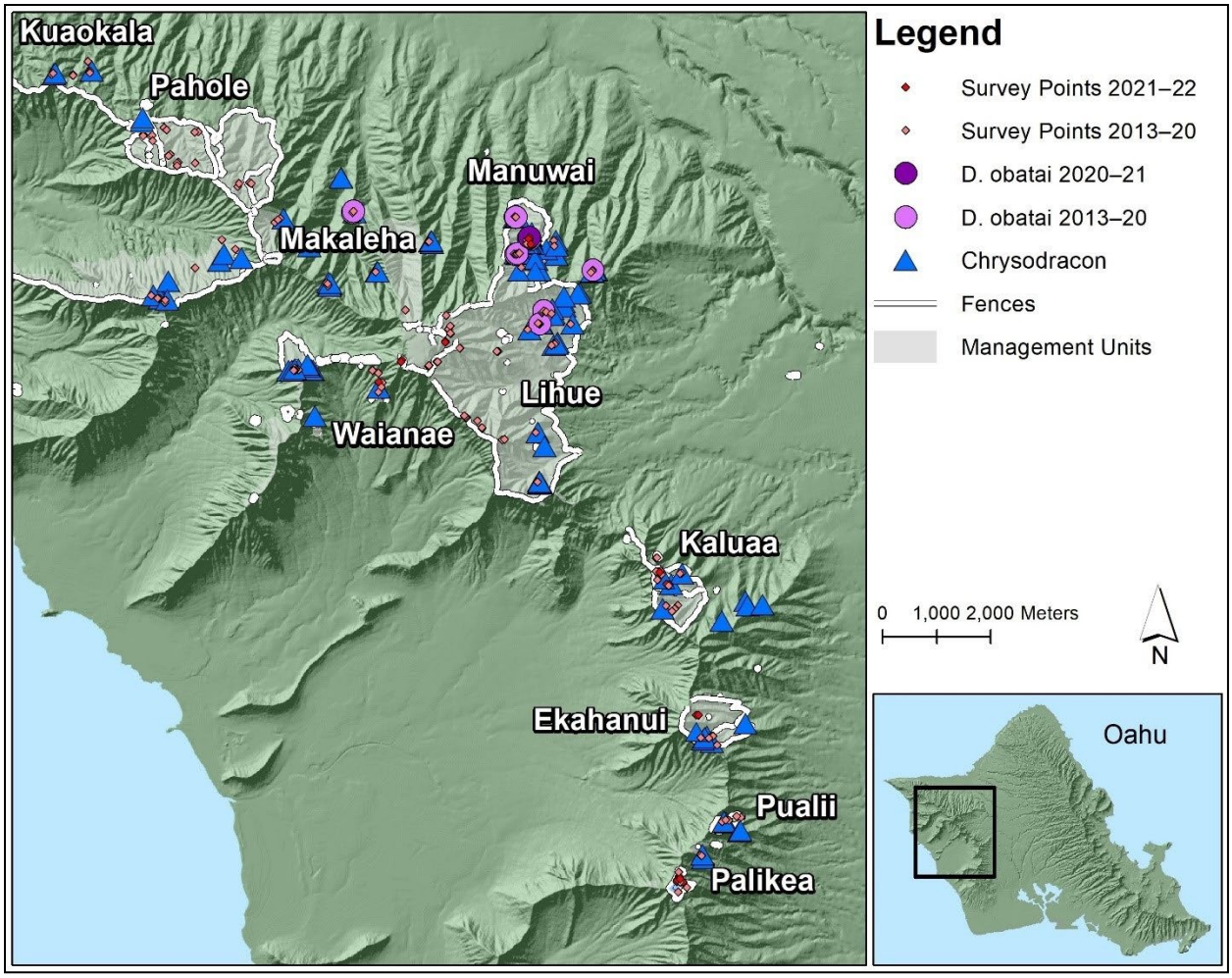

Figure 6: Distribution of *Drosophila obatai* observations in the 2021–22 reporting year and earlier records from 2009–20, with selected *Chrysodracon* spp. sites and all survey points.

Management is limited at present, as *D. obatai* is not yet formally included in the Army's Integrated Natural Resources Management Plan (INRMP). It will be included in the upcoming Biological Assessment (BA). One of its host plants, *Dracaena forbesii*, is a listed endangered species and will also be included in the BA, so it will receive management for its own sake as well as related to *D. obatai*. The other host, *Dracaena halapepe*, is not listed but also suffers from very low recruitment and mature trees are in decline. These species grow very slowly and may take decades to reach maturity, but staff are beginning to work on propagation methods suited for them. Propagation techniques have been promising and germination rates for both *Dracaena halapepe* and *Dracaena forbesii* have been fairly high in tests. Initial outplantings in Ohikilolo and Kahanahaiki of *D. forbesii* have been successful so far with over 75% of outplanted individuals surviving after two years. There are plans to extend the area of *D. forbesii* outplantings in Ohikilolo into the most intact forest site, closer to possible *D. obatai* sites. In late 2017 and early 2018, A24 rat traps were installed at two sites in Pulee and one in Manuwai in hopes of increasing *Dracaena* recruitment. Due to access issues, they have not always been serviced regularly but have been kept up for the *Dracaena* fruiting season.

7.1.6 OTHER RARE *DROSOPHILA*

During the course of surveys, five additional rare but non-listed *Drosophila* were found in management units (Table 4). Many of the rare species that were found in 2014 (*D. kinoole*, *D. paucicilia*, *D. reynoldsiae*, *D. sobrina*, *D. spaniothrix*, and *D.* n. sp. nr. *truncipenna*) have not been seen since then.

Table 4: Non-target rare *Drosophila* observed during surveys, July 2021–June 2022. "Max No." is the highest number of flies observed in a single day.

Species	MUs	Total Observed	Max. No.
D. divaricata	Kaluaa and Waieli	8	2
D. hemipeza	Palikea	20	7
D. nigribasis	Kaala	2	2
D. oahuensis	Kaala, Koloa	1	1
D. turbata	Kaluaa	1	1

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. Although present only in a very small, restricted range at Kaluaa, it appears to be more like a common species, maintaining consistent abundance and frequency numbers there. This year there has been noticeable drop off in observations with only 8 being seen, compared to 54 the previous year.

Drosophila hemipeza (Figure 7) is the only listed endangered species on Oahu that is known to be extant but does not occur on Army lands or OIP/MIP action areas, although it historically occurred at Kahuku Training Area and West Makaleha Gulch adjacent to Makua. It has been consistently found at Palikea MU for several years but always in low numbers; in 2014–2015 occasional individuals showed up at Puu Hapapa as well. This year elevated numbers were observed at Palikea as well as the most observed at one time.

Drosophila nigribasis (Figure 7) breeds in *Cheirodendron*; it is related to *D. substenoptera* but appears to favor wetter habitats. In ANRPO surveys, it has been restricted to Koloa and the vicinity of Kaala summit. One individual was found from two surveys. This individual was found in a new patch in the Kaala bog.

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. There was only one survey at its preferred habitat this year with one individual being found at a new patch on Kaala bog.

Drosophila turbata breeds in sap fluxes of *Acacia koa* and is very similar to another species, *D. gradata*. It is generally rare, but fairly regularly found at Ohikilolo. However, the one sighting this year was in Kaluaa, an unusual site for this species.

Drosophila nigribasis in Kaala bog with conspicuous sexual dimorphism. ♂- left, ♀- right

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

Figure 7: Some unmanaged rare *Drosophila* species found during surveys.

7.2 *MEGALAGRION XANTHOMELAS* REINTRODUCTION

7.2.1 Background

Megalagrion xanthomelas is an endemic damselfly, formerly widespread and common in the lowlands of all islands but now extremely rare. The aquatic naiads are highly vulnerable to predation by alien mosquitofish and topminnows, which are nearly ubiquitous in Hawaiian water bodies. After the last collection from springs around Pearl Harbor in 1977, it was thought to be extirpated from Oahu. In 1995, it was rediscovered on the grounds of Tripler Army Medical Center (TAMC). The population is now maintained as an artificial "stream" from a hose that is always kept on. The population was monitored monthly by ANRPO staff from October 2013 through April 2020; previously it was monitored weekly or biweekly from 2012-2013, and sporadically prior to that, by Bishop Museum personnel under contract. During this time the population has stayed relatively stable, though the number of individuals observed fluctuates widely between visits. In June and July 2019, the population at TAMC experienced a large population spike of observed adults, followed by a sharp decline. A more drastic decline occurred between October and December 2021. From December 2021 through June 2022 numbers of observed adults at TAMC have remained low. Most of the adults observed during this period were captive reared, and as releases of adults ceased and this cohort senesced, observations of adult *Megalagrion* again declined. Recent counts of adults at TAMC are somewhat steady, but low, with no more than 20 being observed in a day.

Establishing additional populations has long been a priority for management of the species, in part due to anticipation of a drastic decline in the small TAMC population. Translocations were attempted at Dillingham Military Reservation (DMR) (1999), Makiki Stream (2003), Kalaeloa (2010), Waimea Botanical Garden (2012), Lyon Arboretum (2019), and Waianae Kai Forest Reserve (2019), but all failed for various reasons. In 2016, the state Division of Forestry and Wildlife (DOFAW) established an insectary facility that allows rearing of large numbers of damselfly naiads, enabling a less disruptive and more effective method of establishing new populations than capturing adults from Tripler and releasing them at a new site.

7.2.2 Release and Monitoring

DOFAW continues to rear and release *M. xanthomelas*, with assistance from ANRPO; DOFAW also continues to monitor both populations at DMR and TAMC. Monitoring was conducted weekly and consisted of counting lab-reared and wild damselflies along both stream corridors. All lab-reared adults were marked with a number on the wing, allowing for both identification of individuals and cohorts and recognition of wild, unmarked individuals. The numbers of reproductive adults observed tended to correlate with those released four weeks earlier, indicating a pre-reproductive vagile period (Figure 8). Mating and oviposition were observed during the initial release, and wild-emerged damselflies were observed approximately three to four months later.

At DMR, DOFAW began releases of adult *M. xanthomelas* in June 2020. Releases continued through June 2021 when releases stopped so that DOFAW could monitor the population of wild adults now in the stream. Other management actions during this time included the construction of rocky pools to maintain a constant water level in parts of the stream and planting native vegetation for oviposition. In December 2021 a heavy rain event caused severe damage to the stream at DMR, destroying the artificial pools and washing a large amount of sediment, plant material, and presumably *M. xanthomelas* eggs and naiads downstream. After this event the number of observed adults declined to almost zero until the ponds were rebuilt and releases resumed in April 2022. Numbers of observed adults then began to rise again. During this reporting period DOFAW conducted weekly releases between April 7, 2022 and June 2, 2022. A total

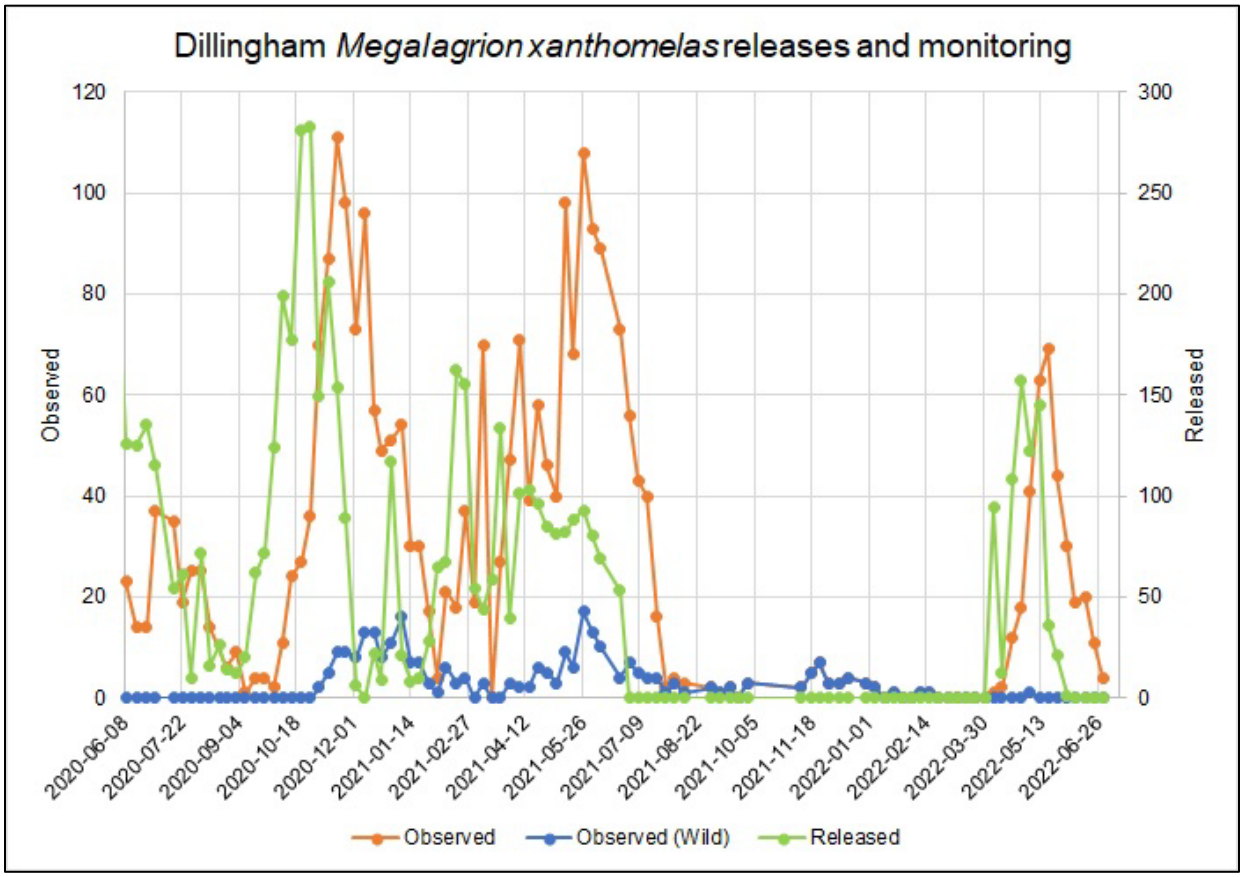

Figure 8: Graph of *Megalagrion xanthomelas* releases and observations at Dillingham Military Reservation from June 2020 through the end of 2021–22. Note that releases are on a different y axis.

of 696 adults were released over this period. Once the release of the 2022 cohort is complete releases will stop. DOFAW will then monitor the wild population at DMR to evaluate the success of this site

At TAMC, 4885 damselflies were released between July 2021 and the end of June 2022 to augment the wild population. Releases were then paused in May 2022 apart from small numbers of adults from an experimental trial, in order to focus on the DMR site and to see if the wild population would recover naturally. Since that time, the number of wild-born damselflies observed has been steady but low.

However, nearly all of the wild damselflies seen at TAMC were observed at the drainage ditch around the cooling plant (Figure 9) rather than the stream. Previously there were very few found there and most were at the stream (lab-reared damselflies were mostly found at the stream, where they were released). This concrete ditch was thought to be a low-quality, transient site, but apparently it did not dry out over the past two years and has continued supporting a damselfly population. We have not found any chemical or physical problems with the stream that is excluding or killing them there.

Based on the numbers of wild individuals seen, the *M. xanthomelas* populations at both TAMC and DMR appear to be sustaining themselves, but at very low levels which continue to leave both susceptible to stochastic events.

This year Pulama Lanai has submitted a proposal to seek funds through the DOD's Readiness and Environmental Protection Integration (REPI) program to reestablish *Megalagrion xanthomelas* in an

artificial setting. This could further aid the resiliency of *Megalagrion* by providing geographically distinct habitat for the species.

7.2.3 Management Actions

At DMR, the stream was originally prepared for the reintroduction by creating some light gaps, removing weeds, deepening pools, and planting aquatic plants for oviposition sites. Due to the slow and very silty

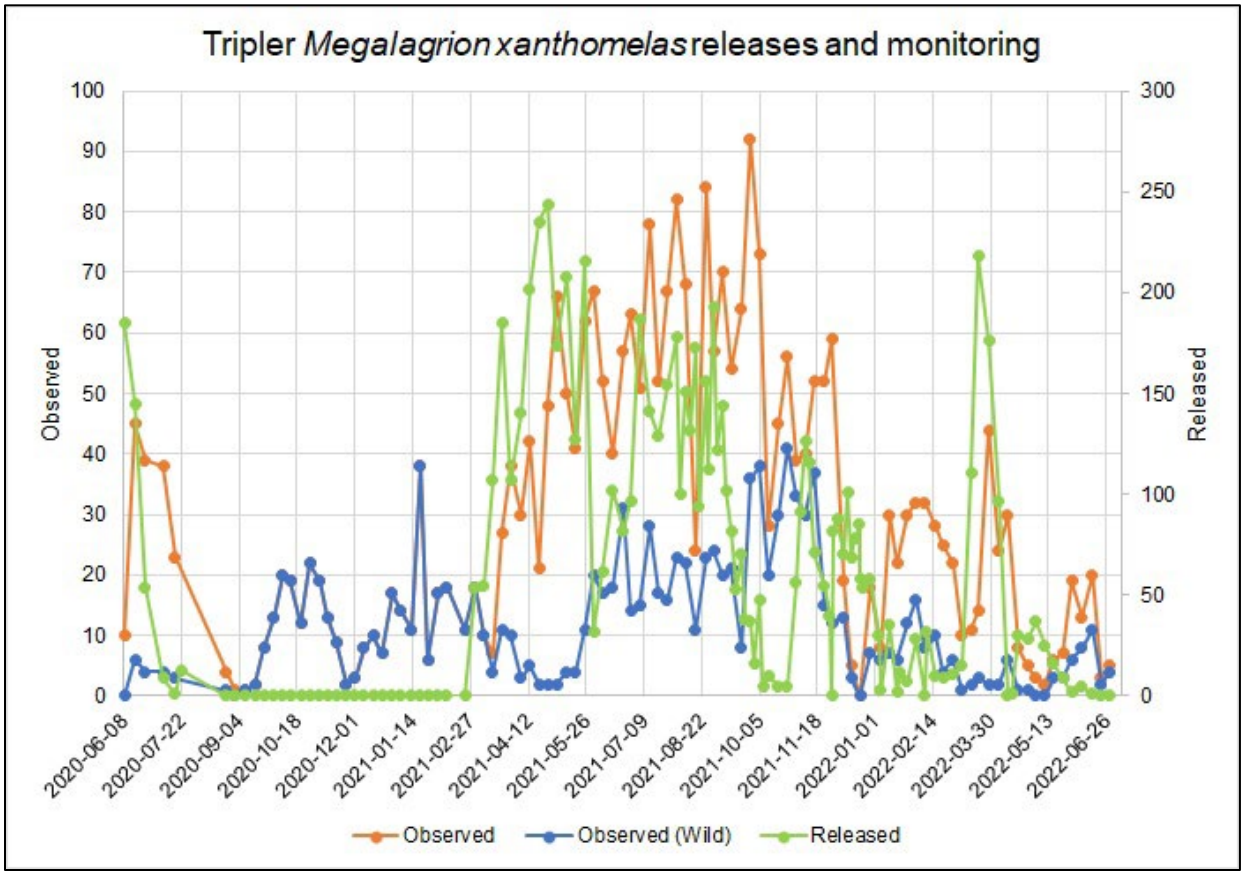

Figure 9: Graph of *Megalagrion xanthomelas* releases and observations at Tripler Army Medical Center from June 2020 through the end of 2021-2022. Note that releases are on a different y axis.

water flow, the pools quickly filled in, and the outplants were mostly destroyed by pigs and peafowl. A small fence surrounding the pools and immediate area was completed in November 2021. This fence has been effective at excluding pigs from the pools and surrounding area. An additional pool was also constructed using pond liner and rocks. As a result of these actions vegetation such as *Bacopa monnieri* has thrived providing stable breeding habitat for *Megalagrion xanthomelas*.

Over the last few decades the stream at TAMC has become much more shaded than in years past. This is supported by photographs from the 1990's that show a much sunnier, open habitat at the stream. ANRPO staff think that this is one of the factors affecting *Megalagrion* success at this site. In May 2022 ANRPO submitted a Section 7 consultation to FWS in order to begin vegetation management at TAMC. This was approved by FWS in June 2022 with the agreement that certain conservation measures are taken during vegetation modification. These measures include the preservation of some shady areas along the stream, that the canopy coverage be quantified before and after any canopy cutting, and that any vegetation along the stream be inspected for any *Megalagrion* eggs before removal. Canopy cover surveys were conducted

at TAMC, and DMR sites in August 2022 to evaluate canopy levels prior to cutting to better monitor how *M. xanthomelas* respond to the increased light levels once the cutting is complete. Tree cutting is currently planned for fall of 2022 to create a sunnier mosaic of stream habitat for *M. xanthomelas*.

During this reporting period *Hydra vulgaris*, a freshwater Cnidarian predator was found in TAMC Stream. DOFAW staff were concerned that the predation by this predator on *Megalagrion* naiads may have been correlated to the decline in *Megalagrion* observed in the stream. Lab trials and further surveys of the stream seem to discredit this species as the cause of this sharp decline. Regardless, all staff working in and around TAMC should practice decontamination of footwear to prevent spread of this, or other potentially detrimental species to *Megalagrion* habitat.

This year, during a heavy rain event, the cooling plant ditch filled with up almost a foot of sediment and plant matter throughout most of its length. This sediment has largely blocked the flow of water and possibly impacted numbers of *Megalagrion xanthomelas* at this site. ANRPO plans to remove this sediment in the ditch and regularly maintain water flow.

7.2.4 Schofield Barracks East Range (SBE) Damselfly Surveys

In order to inform the ongoing Endangered Species Act Section 7 Consultation and address comments from the U.S. Fish and Wildlife Service (USFWS), ANRPO staff planned a two-day survey for federally listed damselflies in the South Kaukonahua Drainage, SBE (Figure 10). Three survey teams divided up to cover 100 % of walkable stream reach from the eastern edge of the Action Area to the Cannon Dam at 1,200 ft elevation. This dam serves as a barrier to introduced fish that are known predators of the aquatic larvae of native Hawaiian damselflies. The map below shows the coverage of the South Kaukonahua stream during these surveys.

Surveys teams were delivered by helicopter to temporary landing zones nearest a team's assigned stream section. ANRPO staff in addition to two staff from the Hawaii Invertebrate Program (State of Hawaii, Division of Forestry and Wildlife) made up the survey teams. Expertise was split up to ensure someone with entomology background or damselfly knowledge was included on each survey team. Each team had a collection net, a camera with macro-function, hand lenses, GPS capability and the damselfly clasper ID chart from *Hawaiian Damselflies: A Field Identification Guide* by Polhemus and Asquith. The specific target taxa for surveys included, *Megalagrion oceanicum*, *Megalagrion leptodemas* and *Megalagrion nigrohamatum nigrolineatum*.

The stream within the survey area (Figure 11) was largely traversable on foot, unaided by ropes. There was only one impassable waterfall encountered along the surveyed sections. *Megalagrion oceanicum* has been found in the Kawailoa Training area along fast-flowing sections or pools of Helemano and Opaeula streams between big waterfalls. This habitat was limited in the SBE survey area and *M. oceanicum* was not observed. Hundreds of *M. nigrohamatum* ssp. *nigrolineatum* were observed along all surveyed habitat but was most abundant along narrow side drainages off the main Kaukonahua stream corridor. One individual of *M. leptodemas* was observed during surveys conducted by the Hawaii Natural Heritage Program in 1997 in the headwaters of South Kaukonahua. This taxon was not observed during this recent survey but headwaters were not part of the survey area. Two additional *Megalagrion* taxa were observed during the surveys, *M. oahuense* and *M. hawaiiense*.

Survey results have been incorporated into the Draft Programmatic Biological Assessment in order to address USFWS damselfly comments received.

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Sensitive Information
Available Upon Request

Figure 10: South Kaukonahua Damselfly survey area.

Figure 11: Various pictures from South Kaukonahua survey.

Habitat in the upper elevation areas surveyed was predominantly native and becoming more invaded with descending elevation. Along the stream corridors of the north and south Kaukonahua forks, *Hibiscus arnottianus* is abundant and it may be host to the threatened *Vestaria coccinea* or I'iwi. Surveys should be conducted during peak *Hibiscus* flowering season. Invasive plants observed along the stream included *Angiopteris evecta*, *Heliocarpus popayanensis* and *Falcataria moluccana*.

7.3 SERDP SURVEYS

In June 2022 ANRPO hosted University of California, Berkeley researchers Rosemary Gillespie, and George Roderick. The two were awarded a grant from SERDP (Strategic Environmental Research and Development Program) in order to conduct entomological surveys on Army lands in order to establish baseline species lists across areas impacted and adjacent to training areas. Their survey sites included Ohikilolo, Puu Hapapa, Kaluaa, and Kahuku Training Area. Surveys included leaf litter collections, collections of flowers for eDNA (Environmental DNA) analysis, beating of vegetation, and collections of spiders at night.

At Ohikilolo, spider surveys were particularly productive as many individuals of *Tetragnathid hawaiiense*, and *Tetragnathid quasimodo* were collected. In addition, we also found several individual *Tetragnathid* spiders that appear to be undescribed species. Dr. Gillespie and Dr. Roderick expressed interest in further surveys at Ohikilolo to collect more individuals of these undescribed species in addition to further general surveys.

During the surveys at Ohikilolo a *Rhyncogonus* weevil (Figure 12) was found on *Freycinetea arborea*. This *Rhyncogonus* species is distinct from the species *R. fordi* which is known to occur at Ohikilolo. This individual is most morphologically similar to *Rhyncogonus freycinetei* which is only known from the northern Koolau Mountains. Given the flightless nature of *Rhyncogonus* and the distance and isolation to the closest known population of *R. freycinetei*, further work identifying this species should be conducted.

Figure 12: Unknown *Rhyncogonus* species collected from Ohikilolo.

CHAPTER 8: SMALL VERTEBRATE PEST MANAGEMENT

The Army Natural Resources Program on Oahu (ANRPO) has managed species that are subject to small vertebrate predation with various strategies since 1997 under the Makua Implementation Plan (MIP) and Oahu Implementation Plan (OIP). This chapter discusses small vertebrate control methods conducted over the past reporting year and highlights recent changes and implementation of adaptive management. There are six main sections: Section 8.1 provides an overview of the current rodent control program and discusses recent changes; Section 8.2 introduces tracking tunnel/game camera results from large-scale grids; Section 8.3 examines the CO_2 leakage issue impacting ANRPO managed A24 traps; Section 8.4 discusses updated rodent control at Pualii Management Unit (MU); Section 8.5 discusses ANRPO's initial field testing of the AT-220 automatic trap system, manufactured by NZ Auto Traps. Section 8.6 describes future plans for small vertebrate control at ANRPO.

8.1 RODENT CONTROL PROGRAM SUMMARY

In previous years, ANRPO managed rats seasonally or year-round, depending on managed taxa protection needs. For example, Oahu Elepaio (*Chasiempis ibidis*) were only protected during the nesting season, while *Achatinella mustelina* were protected from predation year-round. Other grids were deemed 'rapid response' to address seasonal or temporary threats to endangered plant resources. Over the history of the program, methods of rodent control used include: kill-traps (Victor snap traps, Ka Mate traps, and Goodnature A24 traps (A24s)), Diphacinone bait (Ramik and Diphacinone-50 Conservation deployed via bait stations, hand broadcasts, and aerial broadcasts), ContraPest birth control, and predator-proof fences. To determine ANRPO rodent trapping efficacy, independent monitoring systems such as tracking tunnels with ink cards and game cameras have been used concurrently with management methods.

ANRPO has used A24s since 2013 at several MUs and conducted numerous trials of the traps and bait. Bait longevity and attractiveness are key to trapping success. Bait durability and attractiveness decreases over time due to mold, ants, and slugs. Historically it was common to see slugs remove all the bait within weeks of placement. Previous bait systems relied on a "static" lure that would only last from one to four weeks at MUs. This was the limiting factor in the A24 system initially, as the CO_2 cartridge and trap would hold CO_2 longer than the bait would remain attractive to rodents. As developments have been made in trap technology, A24s have become ANRPO's primary method for controlling rodents.

Goodnature now manufactures an Automatic Lure Pump (ALP) baiting system with 'slug repellent' bait. This system provides a supply of attractive, fresh bait for up to six (6) months at a time. This innovation allowed ANRPO to transition all trapping grids from single-kill traps (Victor snap traps and Ka Mate traps), to A24s that are baited with ALPs. In early 2020, ANRPO switched to these slug-repellent ALPs at all control sites. This allowed ANRPO to conduct year-round rodent control with drastically reduced labor inputs, and expand our rodent control efforts to new MUs. Due to this bait transition, ANRPO's typical maintenance check interval was extended to twice a year (one maintenance visit every six (6) months). A maintenance check consists of replacing the old ALP with a new ALP that contains fresh bait and replacing the old CO_2 cartridge that fires the trap with a new CO_2 cartridge.

ANRPO operates 35 rodent control areas that are maintained year-round. These 35 rodent control areas are composed of a program wide total of 1,575 A24 traps (Table 1). ANRPO rodent control areas range from small trapping grids with six traps, to MU scale grids of up to 306 traps. Areas that have less than 40 traps are considered small grids, where trap spacing is site and resource dependent. Rodent control areas that have greater than 50 traps are considered large-scale grids, and typically have a standardized 100 by 50 meter spacing between each trap. Trap spacing is based on best management practices from conservation managers in New Zealand, who have led the way in practical field use of A24s.Spacing is

also dependent on terrain, and in certain cases might be closer or further apart with considerations of staff safety and management unit size taken into account.

In 2019, ANRPO began observing large numbers of A24 traps that developed CO_2 retention issues as they aged. This has been discussed in previous year end reports, and will be examined in this chapter. Upon transitioning to six (6) month maintenance checks (2019-2020), this leaking problem seemed to be exacerbated; the majority of ANRPO's A24 rat control grids have been experiencing unacceptably high rates of traps completely depleted of CO_2. As ANRPO's trap inventory has aged following large installation events in 2017 and 2018, the leakage problem has continued to persist and worsen. This issue will be discussed further in section 8.3 and 8.6.

ANRPO will be transitioning back to four (4) month maintenance check beginning in October 2022, in an effort to maximize the total number of traps that are functioning year-round.

Table 1: Rat control areas in 2021-2022. Specific grids that have "*" listed next to them are new trapping grids that were installed during 2021 and 2022. Grids that have "**" listed are sites where trap grid design was changed during this reporting period.

MU (Area)	Primary Spp. Protected	Description	# A24 Traps
Ekahanui	*Chasiempis ibidis*, *Achatinella mustelina*, *Cyanea grimesiana* subsp. *obatae*, *Schiedea kaalae*, *Delissea waianaeensis*	Large-scale grid	306
Kaala Army	*Geniostoma cyrtandrae*	One small grid	32
Kaala (Snail Exclosure)	*A. mustelina*	Predator-proof fence (in and out)	12
Kaena Point NARS*	*Euphorbia celastroides* var. *kaenana*	One large grid	40
Kahanahaiki (Snail Exclosures)	*A. mustelina*	Two predator-proof fences (in and out)	6
Kahanahaiki	*A. mustelina*, *C. superba* subsp. *superba*, *D. waianaeensis*, *Schiedea nuttallii*, *S. obovata*	Large-scale grid	76
Kaluaa & Waieli (Central Gulch)	*D. waianaeensis*, *C. grimesiana* subsp. *obatae*	One small grid	30
Kaluaa & Waieli (Hapapa bench)	*A. mustelina*	One small grid	15
Kaluaa & Waieli (Hapapa Snail Exclosure)	*A. mustelina*	Predator-proof fence (in)	6
Kaluaa & Waieli (North gulch)	*C. grimesiana* subsp. *obatae*	One small grid	6
Kamaili (Makai Fence)	*Abutilon sandwicense, Neraudia angulata* var. *angulate*	One small grid	12
Kamaohanui (in Lihue)	*A. mustelina*	One small grid	25
Keawapilau (in Kapuna Upper)	*Hesperomannia oahuensis*, *S. nuttallii*, *Cyanea longiflora*	One small grid	17
Lihue (Coffee and Guava)	*Drosophila obatai*	Two small grids	17
Lihue (Mohiakea and Banana)	*C. ibidis*	Two large grids	219
Lihue (Haleauau)	*A. mustelina*	Two small grids	24
Lihue (Mohiakea)	*D. waianaeensis*	One small grid	10

Table 1 (continued).

MU (Area)	Primary Spp. Protected	Description	# A24 Traps
Makaleha East (Culvert 69/73)	*A. mustelina*	Two small grids	20
Makaleha East *	*Pritchardia kaalae*	Three small grids	16
Makaleha West	*C. grimesiana* subsp. *obatae*	One small grid	15
Makaleha West	*A. mustelina*	Predator-proof fence (in and out)	12
Makaha I	*A. mustelina, H. oahuensis, C. superba, C. longiflora, S. obovata*	Large-scale grid	98
Makaha II	*C. grimesiana* subsp. *obatae, C. longiflora, H. oahuensis, S. nuttallii*	Numerous small grids	51
Makua Valley	*C. ibidis*	Multiple small grids	18
Manuwai	*D. waianaeensis*	One small grid	8
Manuwai	*D. obatai*	One small grid	6
Moanalua	*C. ibidis*	Numerous small grids	99
Nike Greenhouse	All greenhouse grown plants	One small grid	6
Ohikilolo	*A. mustelina*, *P. kaalae*	Large-scale grid	73
Opaeula Lower	*Cyrtandra dentata*	Large-scale grid	50
Palehua	*C. ibidis*	Large-scale grid	97
Palikea	*A. mustelina, C. superba, C. grimesiana* subsp. *obatae*	Large-scale grid	108
Palikea North	*A. mustelina*	Predator-proof fence (in and out)	10
Palikea South	*A. mustelina*	Predator-proof fence (in and out)	10
Pualii North**	*H. oahuensis*	One small grid	25
Total:			**1,575**

*New grids installed in 2021-2022
**Grid design was changed or altered at these sites.

8.2 Overview of ANRPO Tracking Tunnel/Game Camera Results

For this report and all future reports, a graph of tracking tunnel results is provided for most large-scale grids (Kahanahaiki, Ekahanui, Palikea, Makaha, and Ohikilolo) (see Figures 1-5). At most sites, there is historical tracking data for as far back as 2009, however, only data collected since the conversion of these grids to 100% A24 traps will be presented. These graphs depict the difference in observed tracking percentages between years and between control and treatment sites (where available).

At grids where tracking tunnels are used as the monitoring metric, ANRPO's goal is to maintain tracking levels at or below 10% throughout the year. This percentage is based on goals developed in New Zealand and used as an indication of the level of rodent activity needed to see a positive response demonstrated by two bird species found in New Zealand (Innes et al., 1999), (Armstrong et al., 2006). It is important to keep in mind that this 10% tracking metric is specific for New Zealand taxa, and is not necessarily correlated with a positive response for protected species in Hawaii. ANRPO is working to refine this tracking metric for the IP taxa.

In 2019, ANRPO conducted a study that attempted to quantify the differential sensitivity of using tracking tunnels or game cameras to detect rodent activity at Kahanahaiki and Kapuna MUs. Results from the study were presented in the 2019 Annual Report and have been used to inform adaptive management

of rodent monitoring. It was determined that game cameras were significantly more sensitive than tracking tunnels in regards to observing rats and cats at these two specific management units, during the observation period. ANRPO is still working with other researchers to determine what an effective tracking "goal" to aim for when using game cameras as the primary monitoring method.

ANRPO transitioned small vertebrate monitoring protocols from tracking cards to game cameras at Makaha MU (December 2020) and Palikea MU (March 2021). This decision was made to minimize labor inputs for small vertebrate monitoring at these two sites. Paired observations with game cameras and tracking cards were not prioritized at these two sites, and only game camera observations have been recorded for this reporting period. This has reduced our labor inputs for small vertebrate monitoring, but has complicated ANRPO's ability to compare the efficacy of our trapping grids at these two locations. Without having the paired observation data of camera and cards for a period of time; it is difficult to know with certainty if the sensitivity variances of each monitoring method that were observed at Kahanahaiki and Kapuna are applicable to other MUs in the Waianae range such as Palikea and Makaha.

Results from game cameras should not be exclusively used to compare success with tracking tunnel-monitored sites. Although ANRPO has gathered extensive data from game camera tracking, at this point in time there is very minimal research that points to what is a suitable tracking goal when rodent activity is monitored with game camera methodology. It is important to develop innovative ways to reduce labor inputs in rodent monitoring. However, data continuity is a critical aspect of ANRPO's rodent control program. It is critical to continue to conduct rodent activity monitoring with tracking cards while also developing best practices with game camera monitoring. The rodent activity time series that ANRPO has collected over the years have been based only on utilization of tracking cards within tracking tunnels. Therefore it is crucial that we continue to use this methodology, until the protocols and goals for using game cameras are more clearly defined.

ANRPO has decided to transition back to solely using tracking cards in tunnels as our monitoring method at Palikea and Makaha MUs for the foreseeable future. For the July 2022-June 2023 reporting period, all major monitoring grids will be reported utilizing the tracking card methodology. This will allow ANRPO to have a better historical context about how well rodent control efforts are currently working at MUs across Oahu.

Developments in the fields of artificial intelligence, computer learning, and game camera design have made dramatic leaps in the past decade. ANRPO has amassed extensive video and photo archives of game camera footage from monitoring sites across Oahu, especially at Palikea, Kahanahaiki, Kapuna, and Makaha MUs. ANRPO will work on continuing to develop practical uses of game cameras for small vertebrate monitoring. At this point in time, ANRPO needs to focus on working through the backlong of imagery that has been archived over the past years. ANRPO will seek to engage with researchers at UH-Manoa, and international partners to develop more efficient ways to categorize imagery data. In the next few years, we are hopeful that by working to develop imagery analysis tools, our program will be in a better positon to meaningfully use game cameras to monitor rodent and small vertebrate activity in the future.

During this reporting period ANRPO continued to gather evidence demonstrating the impact that non-target species interference that may limit the effectiveness of traditional tracking cards/tunnels. At management units Ekahanui and Ohikilolo (Figures 2, 5), ANRPO staff observed increasing tracking rates of feral cat (*Felis catus*) and small Indian mongoose (*Herpestes auropunctatus*). Tracking cards are baited with a drop of peanut butter which attracts rodents into the tunnel, encouraging them to move across the inked pad and leave observable tracks which are used to construct a rodent activity index. Opportunistic *F. catus* and *H. auropunctatus* have been cuing into our tracking system, and will often "rob" the tunnel of peanut butter (Figures 6, 7, 8, 9), as soon as 15 minutes after being baited (staff observations from Ohikilolo, game camera footage at Ekahanui, Makaha). This skews tracking card data

as the bait is frequently robbed before evening sets in, and is less attractive to rats and mice who are primarily nocturnal. ANRPO will continue to track the extent of this issue, and seek to develop tunnels that exclude these non-target species. It is important to note and report this interference, and the role it could play in impacting the rodent tracking percentages that ANRPO reports annually.

One option that could reduce *F. catus* impact on tracking tunnels is changing the length of the tunnel. Often the cats will reach in with one paw, and snatch the peanut butter off of the card. It is possible to elongate the tunnel, and attach wire over the ends. This would discourage a cat from sticking its paw inside the tunnel, and also would attempt to put the card at a distance where even if a paw can be inserted, the cat won't be able to remove the peanut butter off the card. ANRPO will explore these methods in 2022 and beyond.

Another option is to implement *F. catus* or *H. auropunctatus* specific trapping lines in close proximity to tracking tunnels or on an MU scale, attempting to reduce non-target pressure in the vicinity. This would add to program wide labor inputs related to rodent activity monitoring, but would allow us to report rodent tracking with higher confidence.

8.2.1 KAHANAHAIKI TRACKING TUNNEL RESULTS

Many rat control methods have been used at Kahanahaiki over the years with varying results. This site had a grid of A24 traps that was removed in May 2017, primarily due to mechanical issues. In October 2018, a grid of 76 new A24 traps was installed. In February 2021, ANRPO discontinued use of the game cameras at Kahanahaiki and Kapuna and reverted back to the use of tracking tunnels, which are checked on a quarterly interval. Results from tracking tunnels show that the reference site had higher rat activity during the reporting period as compared to Kahanahaiki (Figure 1).

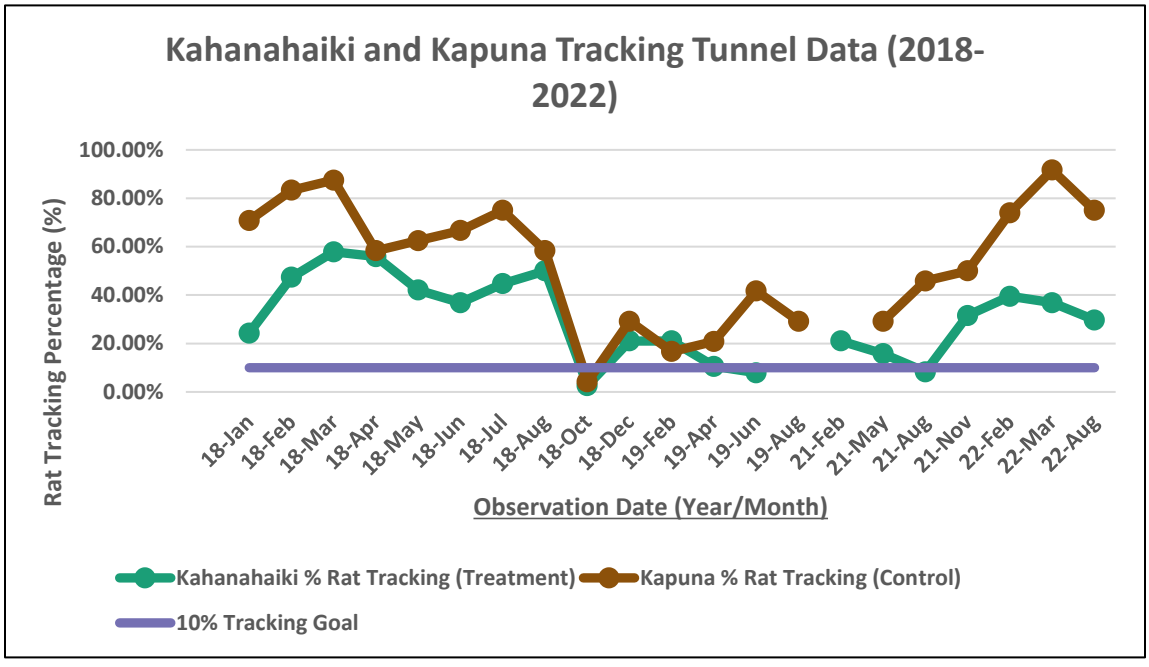

Figure 1: Percent rat activity at Kahanahaiki (treatment site, 39 tunnels) and Kapuna (control site, 24 tunnels) from January 2018-August 2022.

Rat activity at Kahanahaiki was higher than our target goal of 10%. ANRPO anticipates this is due to the size and shape of the MU, and issues with CO_2 retention impacting deployed A24 traps. The A24 grid at Kahanahaiki had higher than expected numbers of traps that were depleted of CO_2 during 2020 and 2021

(38.7 % and 49.43% respectively). This reduction in trap efficacy could have contributed to the spike in rat tracking (>30%) from November 2021- August 2022.

8.2.2 EKAHANUI TRACKING TUNNEL RESULTS

Ekahanui rodent monitoring relies on a total of 59 tracking tunnels within the management unit (Figure 2). From February 2011 to September 2017, the Ekahanui grid consisted of ~600 Victors with a few A24s installed around *A. mustelina* areas. Rat activity had a relatively stable trend with a high of 30% in June 2015, while most monitoring showed rates around the 10% goal (see 2018 Status Report). This grid was very labor intensive, with a two-week re-baiting interval such that control was only conducted during the Oahu Elepaio breeding season (December to June). In 2017, due to advancements in the performance of the A24s, the victor snap trap grid was removed and 306 A24s were installed at standard 100 meter by 50 meter spacing.

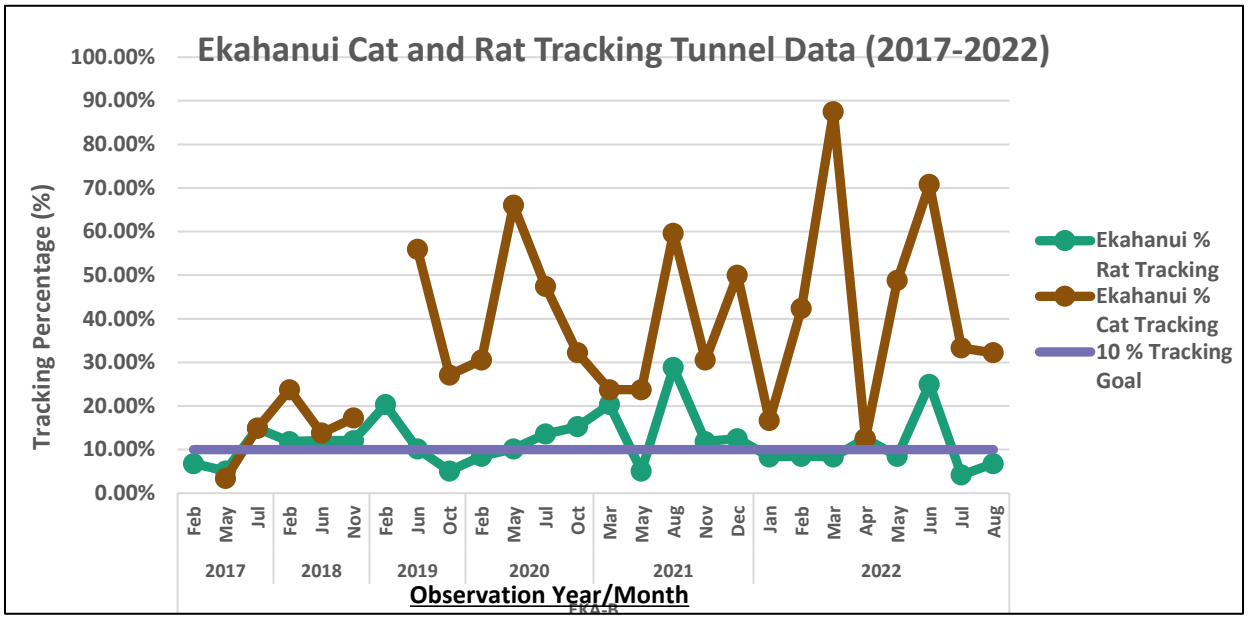

Figure 2: Percent rat activity at Ekahanui (59 tunnels) from February 2017- August 2022.

Since A24 installation, rat tracking at this site has generally stayed around 10%, with the exception of February 2019, July 2020- March 2021, August 2021, and June 2022 (Figure 2). It is important to note that the tracking tunnels at this site are primarily set within gulches. ANRPO will continue to monitor tracking tunnels at their current location for the sake of data continuity, and staff safety.

Ekahanui MU is located west of Kunia Loa Ridge Farmlands. This agricultural area was previously utilized by Monsanto (now Bayer Corp.). There are numerous feral cat (*F. catus*) colonies that have sustained populations in the area, and seem to be growing in size due to the patchwork of landownership and use and lack of oversight. Since 2017, ANRPO has documented a general increase in *F. catus* tracking at Ekahanui. During this reporting period, ANRPO observed cat tracking rates in up to 80% of tracking tunnels at this site. It is evident that feline interference is impacting ANRPO's ability to accurately report rat tracking data, and steps need to be taken to reduce the impact from cats. Increasing cat control effort in the surrounding area and altering tracking tunnels to exclude non-target animals are all options on the table to get this issue under control in ANRPO MUs, specifically at Ekahanui. This issue seems to be continually impacting ANRPO operations. It is important to note that the majority of the tracking observations where *F. catus* rates dramatically fell were periods when weather was wet and rainy during the 24 hour observation period.

8.2.3 PALIKEA TRACKING TUNNEL/GAME CAMERA RESULTS

The Palikea grid previously consisted of approximately 200 KaMate traps (August 2010 to October 2017). Rat tracking had a relatively stable trend with a high of 53% in June of 2011. In October 2017 all KaMate traps were removed and 108 A24s were installed. During the first two years following installation, rodent activity was monitored with tracking cards in tunnels, as had been done for the previous years (Figure 3).

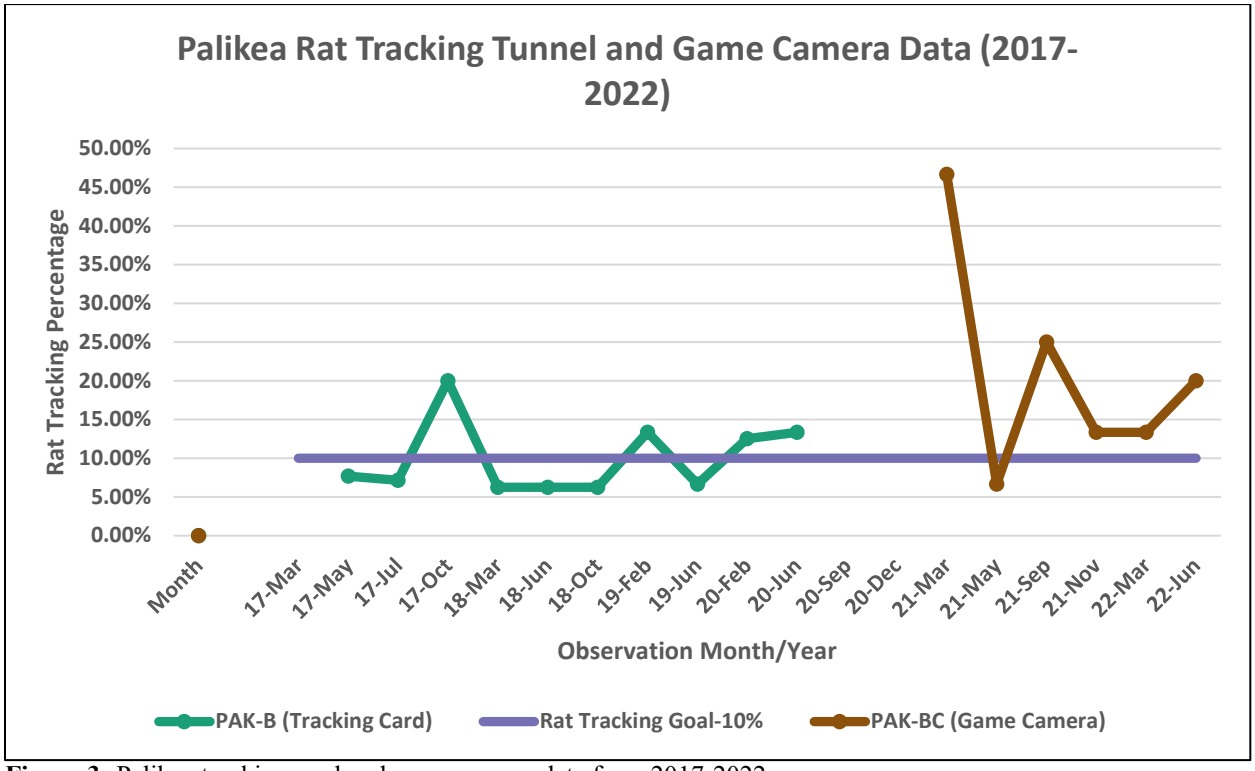

Figure 3: Palikea tracking card and game camera data from 2017-2022.

In the two years after A24 grid installation, there were four observations where rat tracking was greater than 10%: October 2017 (20%), February 2019 (13.33%), February 2020 (12.5%), and June 2020 (13.33%). This is slightly higher than ANRPO's 10% tracking goal, but is a significant reduction in the activity prior to A24 installation. In March 2021 ANRPO transitioned this site from tracking cards set in tunnels, to game camera utilization. Since this change occurred, ANRPO observed variable rat tracking, with activity spikes up to 47% (March 2021), and down as low as 7% (May 2021) (Figure 3). ANRPO will revert back to solely using tracking cards set in tunnels as the monitoring methodology for the 2022-2023 reporting period.

8.2.4 MAKAHA TRACKING TUNNEL/GAME CAMERA RESULTS

In May 2018, the Makaha subunit 1 MU grid was modified due to concerns that the grid was too small and did not adequately protect all resources within the MU. The entire MU is now gridded with 98 A24s at standard 100 by 50 meter spacing. Upon installation of the larger A24 grid, ANRPO observed continually falling rodent activity as measured via tracking cards within tunnels. From October 2018-December 2019 tracking levels were maintained at, or below 10%. There was a large spike in rat activity in January 2020, with tracking cards indicating activity at 43.75% of tunnels (Figure 4). In December 2020 ANRPO switched the monitoring method from tunnels to cameras at Makaha MU. Since

transitioning to game cameras as the only monitoring method at Makaha, rat tracking has maintained levels higher than 10%. There have been observation dates with rat activity approaching 60% as observed via game cameras (March 2021). As mentioned previously, it is difficult to compare game camera results to our traditional tracking card dataset, as paired observations have only been conducted at Kahanahaiki/Kapuna. As at Palikea, ANRPO will revert back to using the tracking card/tunnel methodology to monitor rodent activity for the 2022-2023 reporting period.

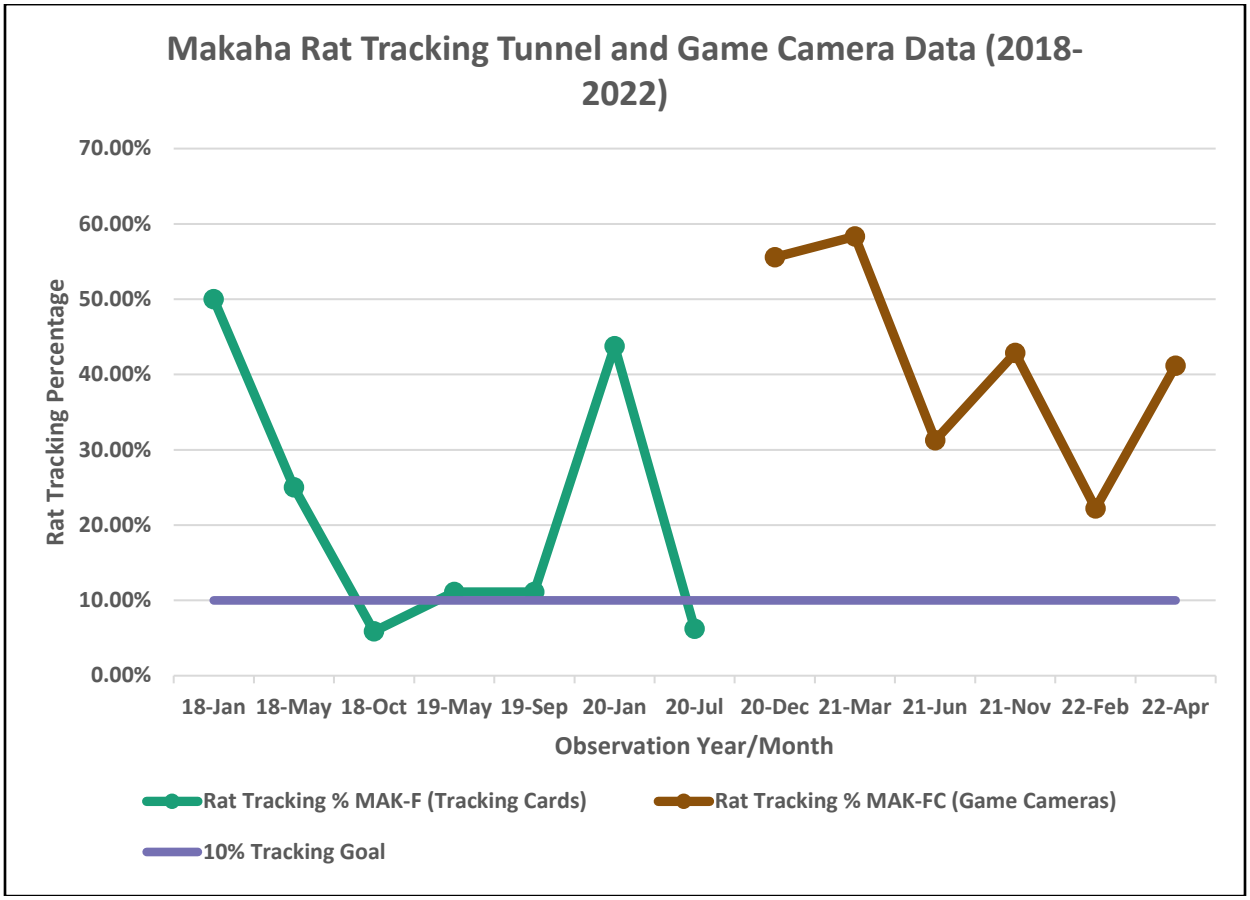

Figure 4: Percent of rat activity at Makaha (18 Tunnels and Cameras) from January 2018-April 2022.

8.2.5 OHIKILOLO TRACKING TUNNEL RESULTS

In 2021, the Ohikilolo A24 grid was expanded to a total of 73 traps; to protect a population of *Achatinella mustelina*, twelve traps were added to the west side of the MU. The tracking trends for *Rattus* spp, and *H. auropunctatus* over the past four (4) years are displayed below (Figure 5). This data points to successful rat control since January 2021, with the exception of one observation window with > 10% rat tracking (July 2021).

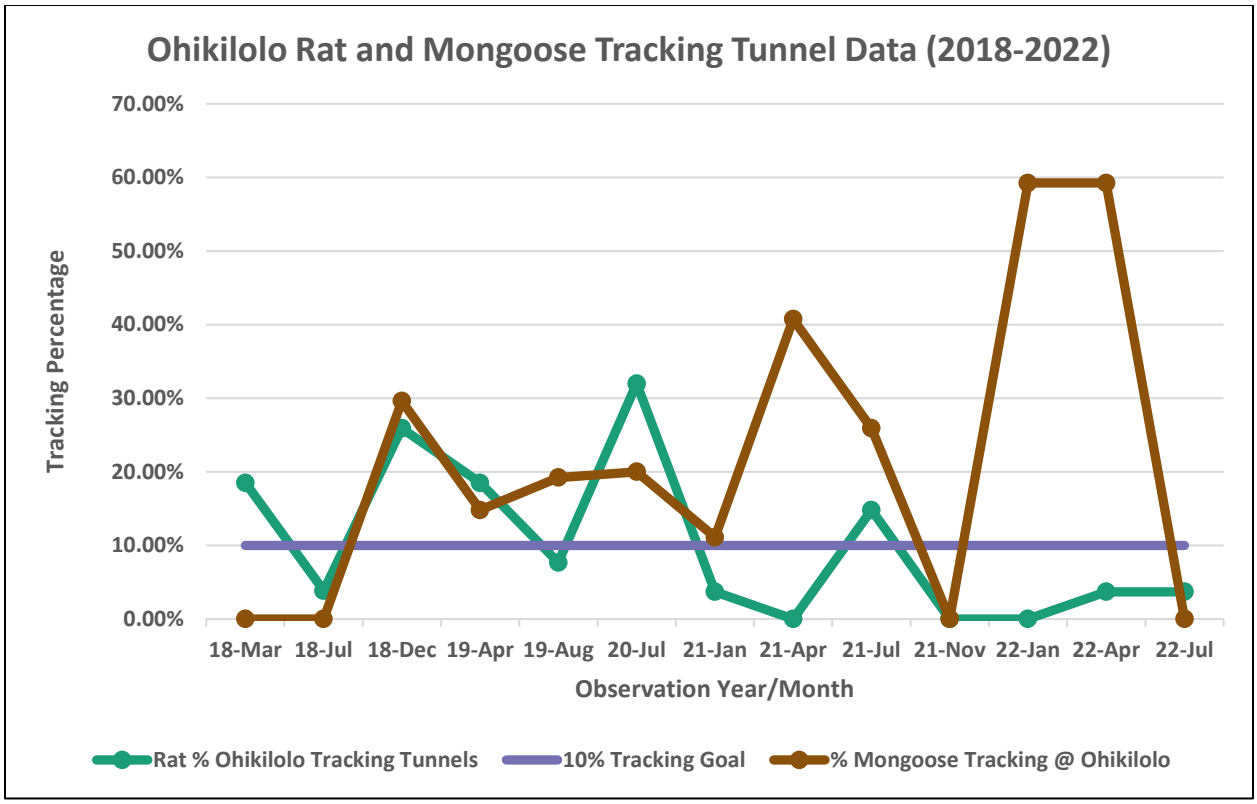

Figure 5: Percent of rat activity at Ohikilolo (27 tunnels) from March 2018- July 2022.

Tracking card data also shows an increasing impact of *H. auropunctatus* on ANRPO rodent monitoring at Ohikilolo over the past four years. During this reporting period (July 2021-June 2022), there have been three observation events with *H. auropunctatus* tracking greater than 20%, and two observations with tracking up to 60%. Staff observations over the past year noted that *H. auropunctatus* at this site were following staff as they set tracking cards out and would remove the peanut butter within minutes of the cards being set. It is important to keep this in mind when observations note 0% rat tracking and high *H. auropunctatus* tracking.

ANRPO installed four NZ Auto Traps AT-220 self-resetting small animal traps within the MU at the end of April 2022 (see section 8.5). This trap is effective at killing *H. auropunctatus*, *Rattus* sp., and *M. musculus*. ANRPO verified that two *H. auropunctatus* were killed within the first 24 hours of trap installation. In the only tracking period since these traps were installed, *H. auropunctatus* tracking was reduced to 0% (July 2022, Figure 5). ANRPO will continue to monitor the effectiveness of this tool at reducing non-target impact to tracking tunnels over the next year. By reducing the interference from *H. auropunctatus*, ANRPO hopes to better understand the true activity indexes of *Rattus* spp. at Ohikilolo and other monitoring sites on the Waianae volcano.
This grid illustrates the challenges with using tracking tunnels as a monitoring system for small sites (three-hectare area). At this site traps are spaced close together and many of the tunnels are on the edge of the "grid".

Figure 6: Small Indian mongoose (*H. auropunctatus*) robbing peanut butter from ANRPO tracking tunnel located in Makaha I management unit. This observation occurred less than an hour after the tunnel was baited with peanut butter.

Figure 7: A feral cat (*F. catus*) robbing a tracking tunnel of peanut butter at Palikea management unit.

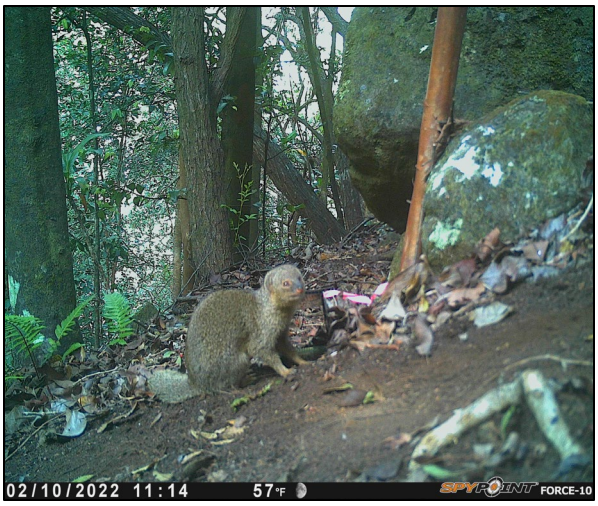

Figure 8: Small Indian mongoose (*H. auropunctatus*) visiting tracking tunnel, likely looking for an easy, tasty, nutritious snack of Skippy.

Figure 9: Feral cat (*F. catus*) visiting ANRPO tracking tunnel at Palikea.

8.3 CO_2 Retention Issue- Goodnature A24 Traps

ANRPO has utilized many different tools and technologies for rodent control over the history of the program. Beginning in 2014, ANRPO began to explore the implementation of Goodnature A24 self-resetting traps (Figure 10) in MUs across the Waianae range (Franklin, 2013). These traps have been a valuable tool for conservation managers at ANRPO and across the state of Hawaii. They allow managers to greatly reduce labor inputs, and are claimed to retain CO_2 for up to six (6) months, which allows for year round rodent control to be conducted at remote plant and bird populations with only two visits per year. In 2017-2018, ANRPO transitioned our rodent control to solely using A24 traps, and installed trapping grids in many of our large MUs.

Figure 10: Cross section of a Goodnature A24 trap. This perspective shows the internal components and CO_2 reservoirs. *Photo taken by Troy Levinson.*

ANRPO has demonstrated that A24 traps are effective at reducing rat activity levels as measured via tracking cards and tunnels, when the majority of the traps are functioning properly. When ANRPO began utilizing A24s in early 2015-2016, traps underwent maintenance checks once a month. These "maintenance" checks would consist of replacing the 16g CO_2 cartridge which fires the trap, and replacing the bait. This was due to the lack of a long lasting bait, and after one month the formulation would degrade to the point of being unattractive to rats and mice. In 2018 (following large grid installations), ANRPO maintained A24 grids on four month intervals, as bait development continued to improve. In 2020, with the development of Goodnature's "slug-repellent" ALP, ANRPO transitioned maintenance checks from a four month to a six month interval. Upon going to this longer time interval between trap checks, ANRPO began to find increasing number of traps completely depleted of CO_2 when staff would return to conduct the next maintenance checks (Figure 11).

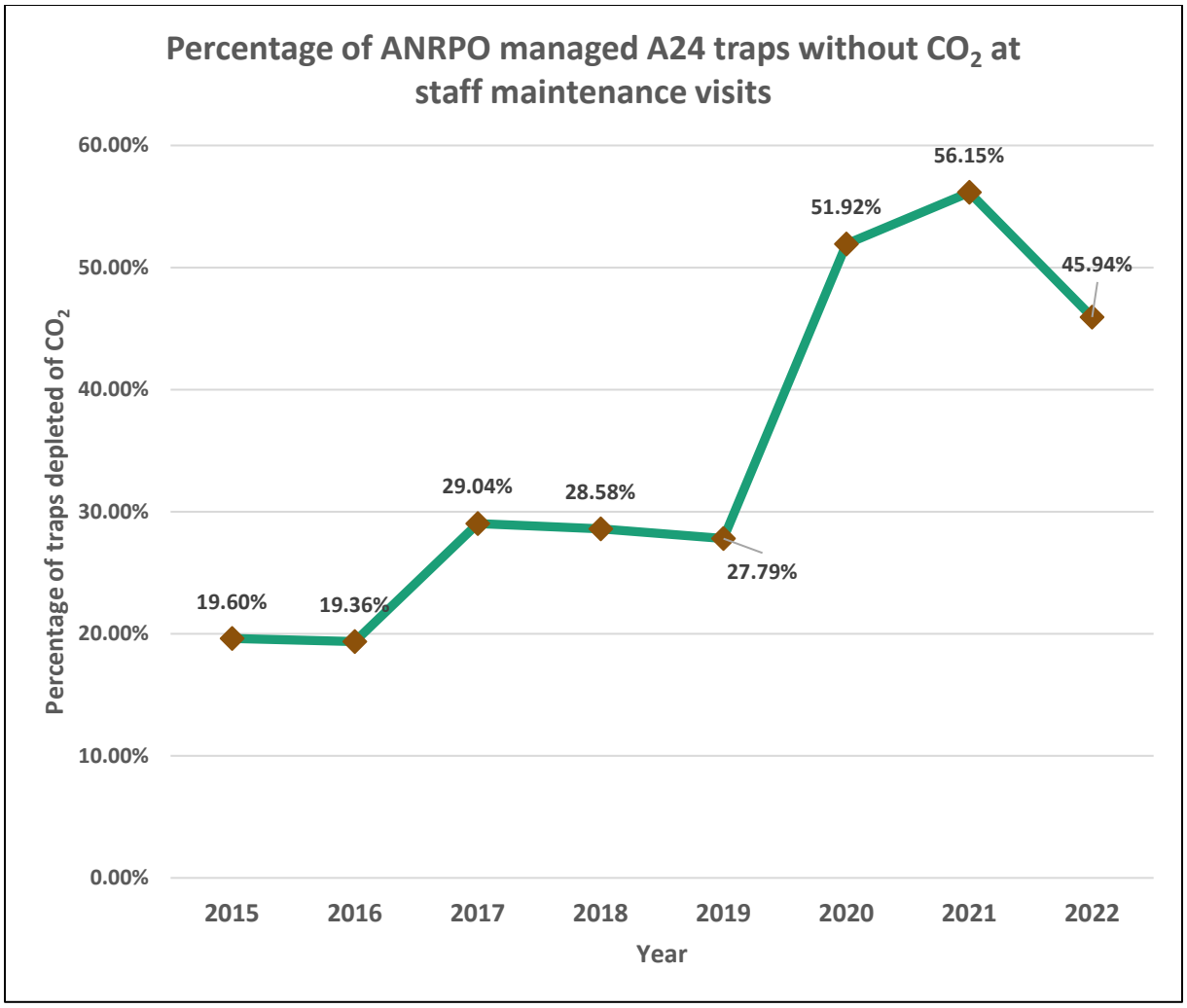

Figure 11: The percentage of all ANRPO managed Goodnature A24 traps that were completely depleted of CO_2 when staff performed maintenance checks at varying intervals. From 2015-2017, the majority of the traps were checked on a 1-3 month interval, with the majority occurring within one month from the previous check. Beginning in late 2017-2019, the majority of the trap maintenance checks occurred on 3-4 month intervals. Beginning in 2020 through 2022, ANRPO conducted maintenance on A24 traps on 6 month intervals

The majority of ANRPO's deployed A24 traps were manufactured in 2017/2018. Over the past year and a half ANRPO has made an effort to replace our aging, failing traps. ANRPO hasn't done extensive testing of the lifespan of A24 traps in Hawaii's varying ecosystems, but there seems to be a spike in trap issues two years after initial deployment, which falls in line with Goodnature's warranty policy. This data will be help inform how frequent ANRPO and other managers should expect to have to replace their entire A24 inventory. The cost-benefit of these traps changes dramatically if they are able to function as designed for 3 years vs 5 years vs 10 years. Previous data published by Goodnature points to varying operational field lives of differing "series" of traps, with many traps developing leakage issues around 600 days post deployment (Gillies, Gorman, Crossan, Conn, Haines, & Long, 2014). These are important considerations to think about as managers continue to assess the long-term viability of this trapping system in Hawaii.

ANRPO has encountered CO_2 retention issues with A24s for the entirety of the time that we have been utilizing this tool, albeit to differing degrees (Figure 12, 13, 14, 15). It is important to note that ANRPO

will likely not be able to get to a point where less than 20% of managed A24s are drained of CO_2, as there seems to be an inherent number of traps that develop slow leaks fresh out of the box (Franklin, 2013). The lowest annual average percentage of traps out of CO_2 was observed in 2016, with 19.36% (Figure 6). During this time period, traps were checked on 1-2 month intervals. As soon as ANRPO increased trap check interval to 3-4 months (2017-2018), an increase in the number of traps out of CO_2 was observed. This percentage increased dramatically when ANRPO changed from 3-4 month checks, to 6 month checks.

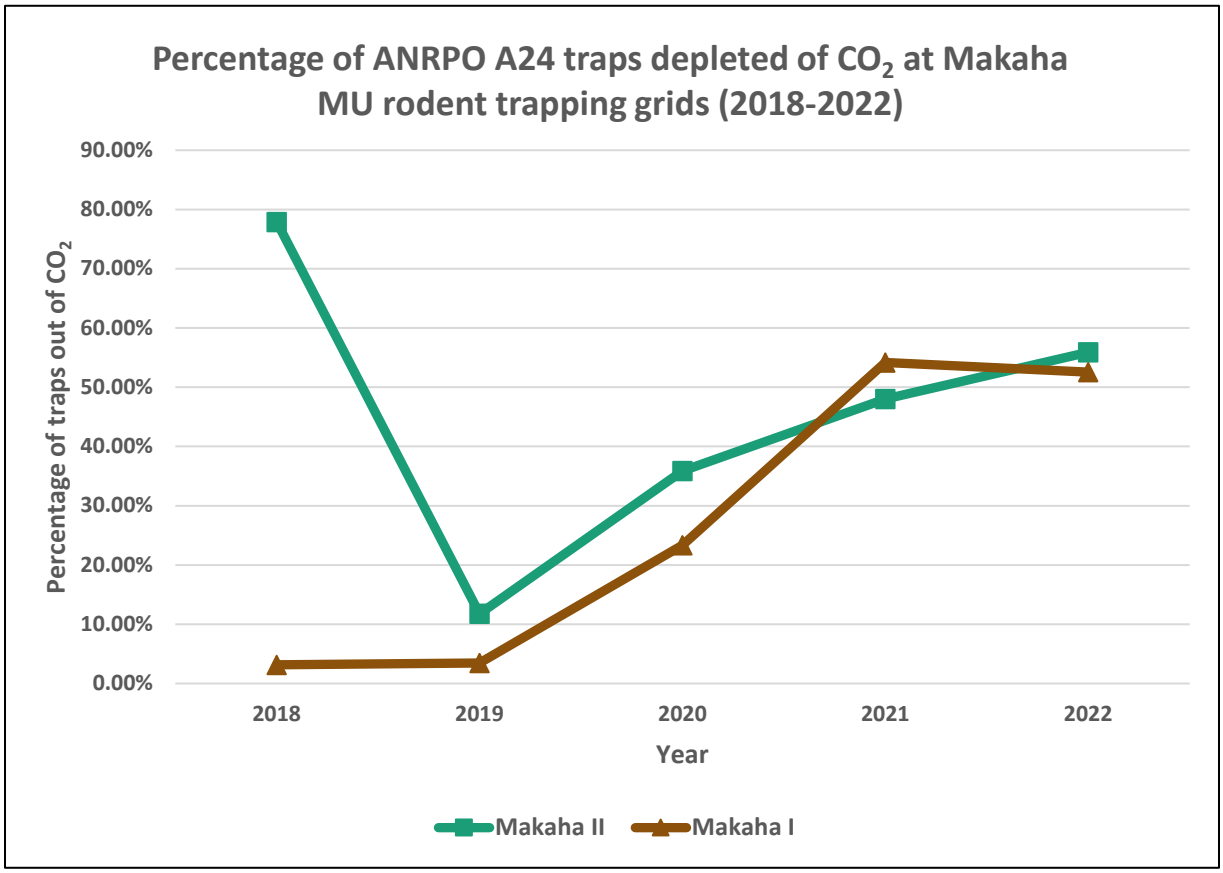

Figure 12: The average percentage of traps in ANRPO's two trapping grids in Makaha Valley that were depleted of CO_2 on staff maintenance checks from 2018-2022. Makaha I consists of 98 A24 traps. Makaha II consists of 51 A24 traps.

In 2020, the percentage of ANRPO managed traps completely out of CO_2 increased from 27.79% to 51.92%. In 2021, 56.15% of ANRPO's A24 traps were depleted of CO_2 during checks. These observed rates are unacceptable for ANRPO's current rodent trapping regime, and could be contributing to the increase in rat tracking that has been observed at Kahanahaiki (Figure 1) over the past year. Due to changes in ANRPO's monitoring procedure at many MUs (Makaha, Palikea) during this same time frame, and an increase in interference from non-target animals (Ohikilolo, Ekahanui), it is difficult to be certain how the increase in observed A24s depleted of CO_2 has and is impacting rodent activity levels in many of the management units across the Waianae range. ANRPO will be going back to using tracking cards in conjunction with game cameras wherever possible, to negate the uncertainty that tracking levels produced by game cameras has led to at many management units.

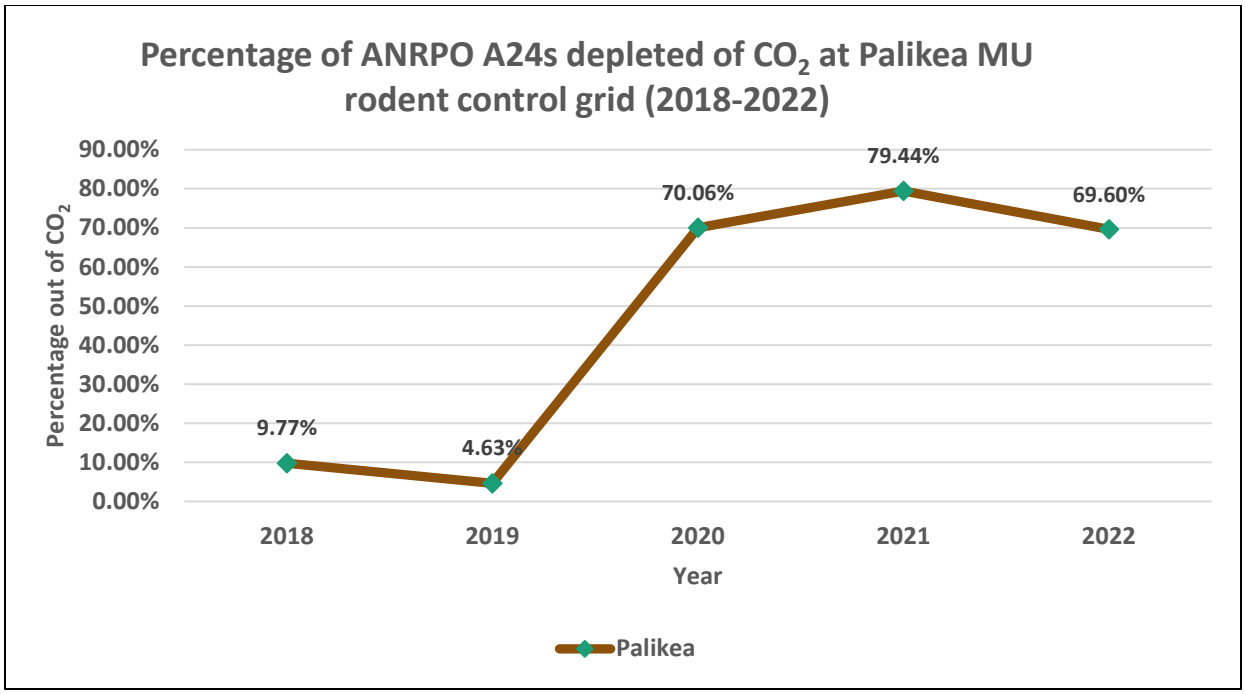

Figure 13: Average percentage of traps in ANRPO's Palikea MU A24 rodent trapping grid that were depleted of CO_2. This figure displays all data from 2018-2022. This grid has experienced some of the highest rates of traps out of CO_2 within the entire ANRPO trapping system. This grid provides protection to multiple managed plant population units, and Elepaio.

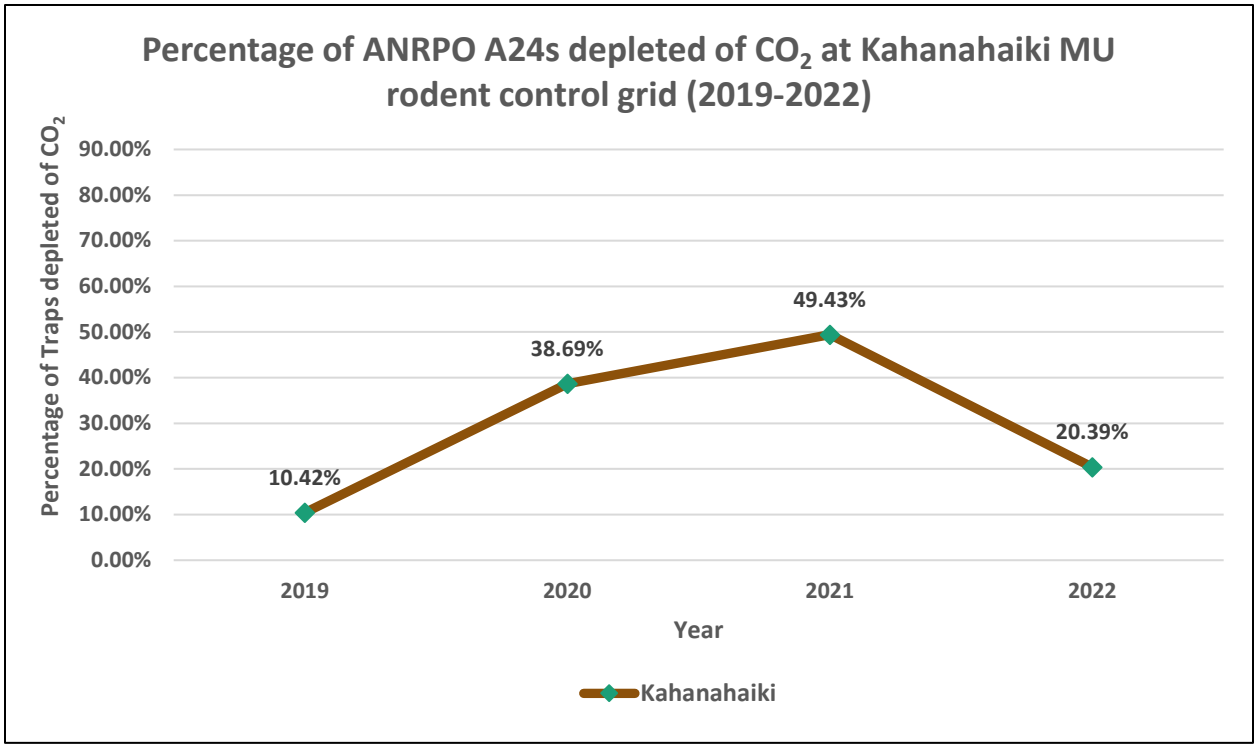

Figure 14: Average percentage of A24 traps in ANRPO's Kahanahaiki A24 grid that were depleted of CO_2. This figure displays all data from 2019-2022, when the current trap configuration was updated to its current extent.

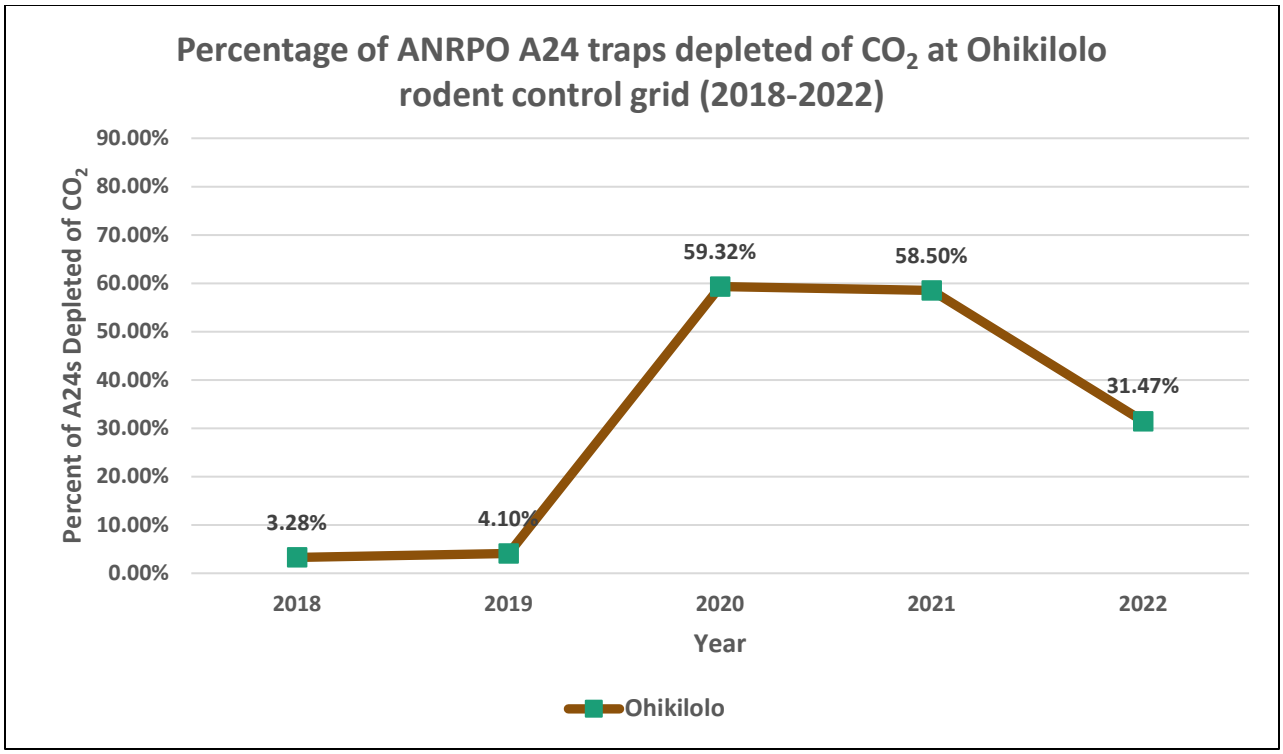

Figure 15: Displays the percentage of A24 traps at Ohikilolo that were completely depleted of CO_2 upon ANRPO staff maintenance checks from 2018-2022. There is a clear increase in the number of traps running out of CO_2 two years after grid installation, which falls in line with what ANRPO sees at many other sites, and reflects previous reports from managers in New Zealand (Gillies et al., 2014).

Due to the high rates of traps fully depleted of CO_2; ANRPO will transition A24 maintenance checks back to four (4) month intervals beginning in October 2022. This regime will be followed for at least one year. If improvements are observed, ANRPO will plan on sticking with this maintenance regime moving forward. ANRPO will deem this interval check as a success if the overall percentage of traps depleted of CO_2 falls below 30% (as was commonly observed from 2017-2019). If the percentage of traps depleted of CO_2 remains at the same level at four month checks as ANRPO has observed during six month checks, steps will be taken to implement alternative rodent control when needed on a site dependent basis. Alternative means of control include the use of Victor snap traps, and utilizing Diphacinone-50 which is approved for conservation use in the state of Hawaii.

It is important to note that while ANRPO measures rodent control success based on tracking percentages gathered from tracking tunnels, the percentage of traps that are functioning and maintaining CO_2 year round is also a critical component of measuring success. Even with *Rattus* sp. tracking percentages hovering around 10% as measured by tracking tunnels, ANRPO staff has documented rodent damage on common native plants and endangered managed taxa, including *Pritchardia kaalae* at Ohikilolo MU (Figure 16). From 2020-2022, ANRPO has documented high rates of A24 traps at Ohikilolo that were completely depleted of CO_2 (Figure 15). This evidence points to the need to shorten ANRPO's A24 maintenance interval in an effort to maximize the total number of traps that are functioning year round. Even with low tracking percentages, all it takes is a few remaining rats to severely damage critically endangered taxa. ANRPO's ultimate goal is to reduce rat impact on ANRPO managed taxa to the absolute lowest possible level. Maximizing the number of traps that are fully functioning in the field is critical to the achieving this goal, even if/when ANRPO is measuring relatively low rat activity via tracking tunnels.

Figure 16: Various stages of rodent damage on *Pritchardia kaalae* at Ohikilolo management unit. These photos were taken on June 1, 2022. Since January 2021 rat activity in tracking tunnels at this MU has been at or below 10%, with one exception in July 2021 with a single observation at 14% (Figure 5). *Photos taken by Troy Levinson.*

8.4 Pualii rodent Control Improvements

Pualii MU is located in the southern Waianae range, south of Pohakea pass. This unit contains a 'manage for stability' (MFS) population of *Hesperomannia oahuensis* (HesOah.PUA-A). ANRPO has conducted rodent control in some capacity (Victor snap traps, Goodnature A24s) since 2015. The majority of this control consisted of "rapid response" trapping, which was focused around the taxon during the flowering season. In 2018, 12 A24 traps were installed at Pualii, and were clustered around the *H. oahuensis*. During the spring of 2021, ANRPO staff identified multiple caches of *H. oahuensis* flowers in the area, likely stashed by *Rattus* sp. A "rapid response" trap grid was installed in May 2021, which consisted of 24 Victor snap traps.

ANRPO's goal for this reporting period was to reduce flower predation and caching at this specific site for the 2022 flowering season. The A24 grid was revamped, and the total number of traps was increased to 25 (Figure 17). These 25 A24s were set up in a grid format, with traps roughly 10-15m apart from one another. This increased the area covered by rat traps to 2+ acres. During previous years the effort was focused directly around individual *H. oahuensis*. No snap traps were used for rodent control at this location in 2022.

ANRPO also conducted four hand broadcast treatments of Diphacinone-50 Conservation (D-50) during 2022. A single D-50 treatment consists of two separate applications, 7-10 days apart. D-50 was applied around *H. oahuensis* individuals, and in a two acre A24 buffer that surrounds the population. Each "treatment" consisted of hand broadcasting 30 lbs of D-50 pellets, or two, 15 lbs applications 7-10 days apart from one another. These treatments occurred in April, June, August, and October 2022.

Figure 17: Updated rodent control at HesOah.PUA-A which was installed in April of 2022. Updated control includes an increased number of A24 traps. ANRPO applies Diphacinone-50 pellets only within the hand broadcast area.

These efforts were a success. No *H. oahuensis* flower caches were observed during 2022. ANRPO was able to collect 400+ viable seeds from this population (HesOah.PUA-A) during the 2022 flowering season. This is an increase from 2021, when limited number of seeds were able to be collected following caching events. ANRPO will plan to continue this control regime in 2023, and the only change will be

adjusting the timing of D-50 treatments to earlier in the year, in an effort to maximize the level of control during critical points of *H. oahuensis'* phenological cycle

8.5 Field Testing The AT-220 from NZ AUTO TRAPS

Over the past decade, there has been tremendous advances in the field of rodent and invasive small vertebrate control. One of these is a new tool from New Zealand, the AT-220 trap (Figure 18), which was developed and is manufactured by NZ Auto Traps.

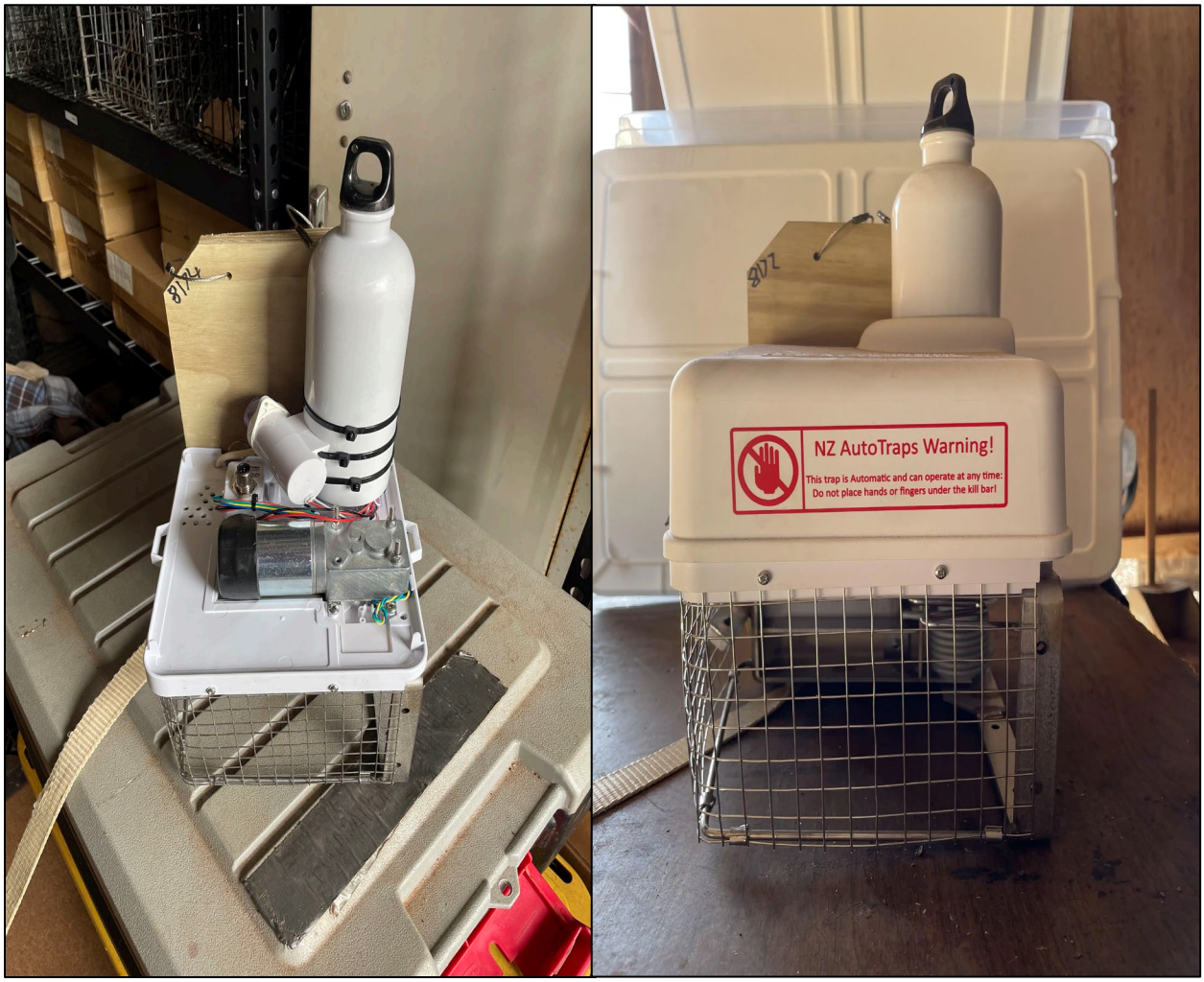

Figure 18: The AT-220 trap manufactured by NZ Auto Traps. The image on the left shows the internal components of the trap (battery hook up, electronic controller, bait bottle, bait pump. The image on the right shows the trap with the component cover which sits on top of all the electrical components and provides protection from weather and external damage. *Photos by Troy Levinson*

This trap operates using a rechargeable battery pack. The battery runs all operations in the trapping system. The battery operates a small pump which pumps bait out of the reservoir (a modified steel water bottle), fires the "kill" bar, and automatically resets the bar post-kill by rotating the gear mechanism which sits inside the trap housing. The carcasses of the target animals fall out of the bottom of the trap once the kill bar resets. This trap is able to collect extensive electronic data on numbers of triggers, time deployed, mechanical issues, location, and size of animal killed. This information can be accessed by

managers using the NZ Auto Traps app, which is available for download. Electronic data collection and processes are run by an internal controller which is built into the trap, and powered by the same rechargeable battery. NZ Auto Traps claims that when equipped with a fully charged battery, the trap will operate for six (6) months at a time, or fire 100 times. The internal controller can also be reprogrammed by the user, a feature that became evident and useful to ANRPO two months into field testing. The firing system is operated by two trigger (photo) eyes, and when an obstruction blocks the two eyes from communicating with one another, the kill bar fires.

The AT-220 was developed in New Zealand to target the common brushtail possum (*Trichosurus vulpecula*) and *Rattus* sp., both of which are invasive species in the country. NZ Auto Traps claims that the AT-220 is also effective in dispatching *F. catus*, and *M. musculus*. ANRPO has been seeking alternative "automatic" traps that could be used in conjunction with current trapping regimes which rely heavily on A24s. The AT-220 is intriguing to ANRPO, as it could further reduce rodent damage to ANRPO managed taxa, while also reducing impact to taxa and rodent monitoring methods from small mammals like *H. auropunctatus* and *F. catus*.

ANRPO received an order of 12 AT-220 in February of 2022. Due to the limited use of these traps in Hawaii, ANRPO decided to do some initial field testing to work out any issues that this system might present on Oahu.

This trap is built with a focus on the conservation issues that are most prevalent in New Zealand. While there are similar issues faced by conservationists in Hawaii, the AT-220 has a few built-in features that need to be modified to be effectively used on Oahu, and in Hawaii generally.

New Zealand is home to many native bird species which are active on or near the ground during the day time. To minimize the impact that the AT-220 could have on these taxa there is a "daytime deactivation" feature that is factory set. This feature disables the trap from sunrise-sunset. This is appropriate in New Zealand, as *T. vulpecula* and *Rattus* sp. are primarily nocturnal. However, here on Oahu, ANRPO seeks trapping systems that work consistently during the day and night, since we encounter diurnal pests. On Oahu, the only birds which spend extensive time on the ground during the daytime are non-native Galliformes.

One exciting application of this trapping system relevant to ANRPO's work is utilizing the AT-220 to remove *H. auropunctatus* which are diurnal, and *F. catus* which are active during both day and night time hours here on Oahu (ANRPO game camera data, staff observations). As mentioned in section 8.2 (tracking tunnel results), ANRPO has seen increasing impacts from non-target small vertebrates on rodent tracking protocols, and the AT-220 could be a new tool that helps to negate this impact. ANRPO deployed four (4) AT-220 traps into Ekahanui MU (Figure 19) for initial testing in March of 2022. Traps were baited with commercial grade fish oil, poured into the liquid bait reservoir (modified steel water bottle). These traps were set along existing tracking tunnel lines in 'Airplane' and 'Cyanea' gulches. Efforts were made to visit each trap and check on operability every two weeks. For the first month and a half, ANRPO left the traps as installed and did not do any reprogramming. Each trap was paired with a Spypoint Force 10 game camera, which were installed to capture any trap interactions with target species in situ.

During the first 1.5 months of deployment at Ekahanui, ANRPO observed all four traps functioning and striking *Rattus* sp. and *Mus musculus* at night. However during the same period staff observed multiple *H. auropunctatus* and *F. catus* individuals sticking their heads into the trap during the daytime, breaking the photo eye connection, but not triggering the traps. This led ANRPO to believe that the "daytime deactivation" feature must be operating on deployed traps.

Figure 19: AT-220 trap setup in 'Cyanea' gulch, Ekahanui, Oahu. The ramp set up is recommended by NZ Auto Traps to assist in clearing carcasses from trap after lethal strikes. *Photo taken by Troy Levinson*.

Figure 20: The AT-220 has demonstrated repeated effectiveness in humanely dispatching small Indian mongoose (*H. auropunctatus*). Here is a trap located within Ekahanui management unit. *Photo taken by Troy Levinson*.

Following these initial observations at Ekahanui, ANRPO contacted NZ Auto Traps to identify a workaround to deactivate the daytime feature. The manufacturer sent ANRPO the information about how to reprogram each trap to disable the daytime deactivation feature. To change this setting, the user must connect to each trap via Bluetooth, and then change a few short lines of code in the NZ Auto Traps app. By using the app, the user is able to have the freedom to change the settings of the trap to best meet the needs of each individual site. This feature is very user friendly and allows the trap to be modified based upon each individual manager's goals. ANRPO removed the daytime deactivation feature from all deployed traps in Ekahanui by the end of April 2022.

From May-June 2022, ANRPO was able to document multiple instances of humane, effective, kills to *H. auropunctatus* of varying sizes at Ekahanui (Figure 20). The AT-220 was able to effectively kill all age classes of *H. auropunctatus*. ANRPO has observed the trap effectively killing small groups of *H. auropunctatus* one after another, even after an individual *H. auropunctatus* observed other individuals dead in the trap. All traps at this site were baited with fish oil which is dispersed daily by the automatic bait pump. ANRPO opportunistically baits the AT-220 with dog jerky whenever staff passes by, but it seems that the fish oil maintains attractiveness for at least three (3) months with no fresh bait added. ANRPO will continue to assess bait attractiveness and alternative formulations in 2022 and 2023. Finding an economical liquid bait/baits that can maintain attractiveness after months in the field will be key in the long-term use of this trapping system.

Figure 21: One of the first documented *H. auropunctatus* kills at Ohikilolo management unit.

Four (4) additional AT-220 traps were deployed at Ohikilolo management unit in the middle of April, to assess the effectiveness of this trap at removing *H. auropunctatus* that were impacting ANRPO rodent

tracking tunnel data (Figure 5). These traps were deployed prior to reprogramming the daytime deactivation feature, as ANRPO hadn't developed a work around to this problem yet. Due to the remote nature of this site, traps were unable to be reprogrammed until the end of May 2022.

Once the traps were reprogrammed at Ohikilolo, ANRPO confirmed two *H. auropunctatus* kills within 24 hours (Figure 21). July 2022 was the first observation period where 0% *H. auropunctatus* tracking was observed via tracking cards since November 2021. It is important to keep in mind that the November 2021 24 hour tracking period was characterized by high rainfall, which likely discouraged any *H. auropunctatus* activity. Prior to the 0% tracking in November 2021, *H. auropunctatus* tracking percentages maintained levels above 10% since December 2018. ANRPO will continue to maintain the AT-220 traps at Ohikilolo for the remainder of 2022 and 2023.

While ANRPO has confirmed the AT-220's effectiveness in removing *H. auropunctatus*, *Rattus* sp., and *M. musculus*, it seems that the AT-220 in its current configuration is not the best tool to deal with *F. catus* of varying size and age classes.

At Ekahanui, ANRPO confirmed that two (2) *F. catus* individuals were caught during our testing phase. The fish oil seemed to be attractive, and would consistently draw different cats to each trap. The two individuals who were caught at Ekahanui were large, mature adult cats. Upon sticking their head in the trap, the kill bar fired, striking each cat in the shoulder/neck region. It seems that each of these cats entered the trap in a way that allowed their shoulders to absorb the greatest impact from the kill bar. This pinned the cat in the back of the trap, but didn't provide a lethal head/neck strike. Ultimately, the trap released both of these cats, and they were able to walk off with seemingly minor injuries. Both of these cats have been viewed on game camera footage from the area in the months following their trap encounters, and seemed to be in good health. However they kept their distance from the traps when passing by.

One cat was caught, and killed quickly and effectively by an AT-220 at Ohikilolo MU on August 6, 2022. This cat seemed to be smaller in size than the individuals from Ekahanui, and the AT-220 dealt a lethal head strike. Size of each individual animal is likely a critical factor in how well the AT-220 can handle each cat.

ANRPO sent photo documentation of these interactions to the manufacturers at NZ Auto Traps. Other users in Hawaii (Haleakala National Park) have demonstrated similar variability in the lethal impact that the AT-220 has on cats. Based on the photos ANRPO sent, NZ Auto traps will be modifying the AT-220, and are adding an additional "choke bar" (Figure 22) in the rear of the trap. This should allow the trap to kill via impact for smaller animals (*Rattus* sp, *M. musculus*, *H. auropunctatus*), and via asphyxiation for *F. catus*.

The results we have seen from initial field testing of the AT-220 are encouraging. It is exciting that there are new technologies coming down the "automatic" trap pipeline, and that there are more options and tools for conservation managers coming to market.

While there are many encouraging aspects of this trap, there are also a few downsides. Each individual trap unit is fairly heavy, and field staff struggle to carry more than 3 to 4 units per person at a time. Weight can be prohibitive when installing large trapping grids in remote field sites. Due to some of the advanced features that are built into this trap, there is a longer period of training that must occur for field staff to install and maintain each trap correctly.

Figure 22: Two models of the AT-220 trap manufactured by NZ Auto Traps. The trap on the left (known as the 'Hawaiian special') is modified with an extended choke bar with the intent of making the trap more effective at humanely dispatching *F. catus*. The model on the left is the trap that ANRPO deployed during this reporting period. *Photo taken by Troy Levinson*

ANRPO is one of the few conservation programs using the AT-220 in Hawaii. It will be vital to track the field life of this trapping system over the next few years, so ANRPO can assess the cost-benefit of using these traps as they age. As mentioned in section 8.3, traps tend to degrade overtime, especially under the varying field conditions that the ecosystems of Oahu provides. ANRPO plans to implement these traps slowly over the next few years, so the small vertebrate control program does not become overextended if large scale mechanical failures become apparent.

ANRPO ordered 24 more AT-220s during the summer of 2022, and will begin adding them into our trapping grids on a site by site basis over 2022 and 2023.

The AT-220 will be an effective tool for wildlife conservation in Hawaii. It is the first self-resetting trap that has demonstrated effectiveness, and been directly marketed to managers in Hawaii as a tool for managing small Indian mongoose (*H. auropunctatus*) and *Rattus* sp. concurrently. ANRPO looks forward to expanding the use of these traps for management of *Rattus sp., M. musculus, H. auropunctatus*. ANRPO will report on the effectiveness of the newly modified traps and how well they humanely dispatch *F. catus* in 2023.

8.6 ANRPO Future Small Vertebrate Plans

ANRPO will continue to develop best practices for utilizing Goodnature A24 traps in Hawaii. In an effort to reduce the number of traps that are fully depleted of CO_2, ANRPO will service A24 traps on a four (4) month interval, as opposed to the six (6) month interval that has been standard for the past two years.

ANRPO will reevaluate the effectiveness of this change over the next one-two years, and if improvements are evident this will become the standard operating procedure.

ANRPO will continue to seek ways to improve rodent monitoring methodology. The past five years have shown the importance of developing monitoring methods that exclude non-rodent species (*H. auropunctatus*, *F. catus*) which have interfered with many of ANRPO's tracking card/tunnel systems. ANRPO is working to develop an improved tunnel design that restricts entry to only *Rattus* sp., and *M. musculus*.

ANRPO plans to conduct another aerial broadcast of D-50 at the Lihue MU in November/December 2023 depending on range access and weather forecasts. This broadcast will build on previous rodenticide applications at Lihue. ANRPO will proceed with a single treatment of D-50 at the maximum single application rate of 22.5 kg/ha (20 lbs per acre).

Game cameras provide the ability to conduct rigorous resource response monitoring. ANRPO will seek to expand efforts to utilize game cameras to conduct valuable resource response monitoring in conjunction with continuing to monitor rodent activity via tracking cards and tunnels. Having multiple tools to monitor rodent activity and impact will allow ANRPO and other managers to have a better understanding of the role rodents are playing in many of the MUs that ANRPO works within.

ANRPO will continue to implement the AT-220 trap system into management units in the Waianae range. ANRPO will seek to conduct a field study that examines the differential effectiveness of the AT-220 and A24 trap systems in reducing rodent tracking in the Waianae range, focusing on three MUs: Kaluaa, Huliwai, and Ekahanui. Depending on staffing levels, this study should get underway in 2023 or 2024.

8.7 Literature Cited

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CHAPTER 9: ALIEN INVERTEBRATE AND FOREST PEST MANAGEMENT

Under the Makua Implementation Plan (MIP) and Oahu Implementation Plan (OIP), the Army Natural Resource Program on Oahu (ANRPO) is responsible for safeguarding several imperiled plants and animals. This chapter discusses work completed this year to detect, delineate, eradicate, contain or control alien invertebrates and forest pests which threaten species requiring protection under program mandates.

9.1 ROSY WOLFSNAIL (*EUGLANDINA ROSEA*)

Invasive invertebrates are one of the primary causes for decline for many native species. The rosy wolfsnail (*Euglandina rosea*) or RWS is a case in point. A generalist predator of other terrestrial gastropods, RWS is among the most important predators of *Achatinella mustelina* (Hadfield and Mountain, 1980), an endangered tree snail (referred to as 'tree snail' for the remainder of this chapter) endemic to the Waianae mountains and the only snail species that falls under ANRPO protection mandates.

There are limited options for RWS removal and control, except exclusion; see Chapter 5 for more information about *A. mustelia* management. ANRPO designed, constructed and maintain seven predator resistant snail enclosures into which snails have been translocated to establish viable populations. The enclosure design is detailed in a Technical Report and includes three barriers, one electric and two physical (an angle and mesh wire), which together are assumed to provide strong protection and prevent RWS from crossing into an enclosure. These barriers were designed using the best available, albeit limited knowledge of RWS. The barriers were tested in a series of trials with varying levels of rigor. Last year, staff started more rigorous trials of the barriers but they were not completed due to staffing issues; these will be resumed in the coming year and used to update snail enclosure designs. Staff have a survey protocol in place for removing RWS from snail enclosures, see Appendix 5-2.

ANRPO also supports the Snail Extinction Prevention Program (SEPP) continued efforts to explore the efficacy of working dogs efficacy at detection of RWS. SEPP is working toward contracting another trial with working dogs in early 2023. Additional control and detection techniques are needed for RWS. Staff will continue to investigate and support research into promising options.

9.2 NAIO THRIPS (*KLAMBOTHRIPS MYOPORI*)

Unfortunately, Naio thrips (*Klambothrips myopori*) were found in natural areas where *Myoporum sandwicensis*, one of its hosts, is present. ANRPO detected thrips at Kaluakauila and Keaau MUs during this report period. This pest is now considered established on Oahu, thus eradication efforts have ceased. ANRPO are not pursuing any control strategies, but rather are tracking impacts and collecting *M. sandwicensis* seed for genetic storage.

9.3 SLUGS (*STYLOMMATOPHORA*)

9.3.1 Summary of Impacts to MIP/OIP Rare Plants

Slugs are important predators of seedlings, however, their behavior is subtle and almost never directly observed as they are nocturnal and emerging seedlings so tiny that the plants are destroyed before they are noticed. Plants at any life stage can be vulnerable to slug attack, particularly those with non-woody stems or a prostrate growth form which allow slugs easy access to edible shoots and leaves. Exclusion experiments revealed slugs have an outsized impact on plant survivorship, which in time, changes the structure of the entire ecosystem (Lauren and Whitlow 2012; Rathke 1985)

For managers working with endangered plants, lack of seeding recruitment has been shown to be driven by so many factors it can be overwhelming to identify which are the primary drivers. Doubtless, there are exceptions, but systems are complex and usually endangered species recovery (and the inverse, the cause of their decline) is not due to one factor alone.

Rare Plant Recovery Plans by the USFWS identify slugs as a grave threat to 25 of the 39 endangered plant species under ANRPO protection (USFWS 1998). Certain species are intolerant of herbivory and are preferred and disproportionately attacked by slugs (Shiels *et al.* 2014; Joe and Daehler 2008). Among these are several endangered species managed by ANRPO. In one study, *Cyanea superba* subsp. *superba* and *Schiedea obovata* survival doubled compared to those exposed to slugs over 6 months (Joe and Daehler 2008). In food preference studies Joe (2006) showed slugs prefer *Urera kaalae* to any other plant species tested (26 in total), even organic lettuce. *Urera* is the primary host for *Drosophila montgomeryi*, an endangered picture wing fly (see Chapter 7: Rare Insect Management). Thus, when slugs cause the elimination of one species, it disrupts the ecosystem in ways that may put others in jeopardy.

9.3.2 Slug Control Program Development 2006-2018

Very few pesticides contain language that allow land managers to use the product in forests. Pesticide companies are for-profit industries, they rely on a customer base, which buys the pesticide for use in homes, around buildings, or in agriculture. This is a real problem for land managers who have to pursue permissions from the pesticide manufacturer and government regulators. There is little incentive for the manufacturer to pay for additional research and registration fees when the end users are a comparatively small handful of conservationists.

Prior to 2010 ANRPO attempted to protect plants from slugs using physical barriers in combination with beer traps. Experiments showed none of these reduced slug abundance or improved survival among rare taxa. ANRPO invested in research and development of new slug control techniques, a significant investment of time and resources. Fortunately, the product Sluggo, by Neudorff, was approved for forest use in 2010. Sluggo treatments produced outstanding results when subjected to rigorous comparison against a control. Slug abundances dropped to undetectable levels for up to 2 months while they increased among the control group. In the Kahanahaiki Management Unit (MU), treatment reduced slug abundance four-fold relative to control areas and suppressed slug numbers for 6 months after the last Sluggo application (ANRPO 2007). More importantly, rare plants in the treatment group had significantly greater survival, seedling emergence, and less (though not significantly so) leaf damage (herbivory). Rare plant response to slug control was promising. Seedling emergence and survival improved among *Schiedea* and *Cyanea* and was, on average, greater for *Cyrtandra* but not significant due to low germination across all groups (Kawelo *et al*. 2012).

Following a decade of use, in Oct. 2020, the supplemental label allowing Sluggo to be used in forests, expired and was not renewed. Since 2016, ANRPO has been using an alternate product named Ferroxx AQ, also made by Neudorff, which is labeled for use in forests. It does not include restrictions on application at sites containing native snails or slugs, however staff continue to follow native snail survey restrictions developed for Sluggo, to minimize non-target impact to rare tree snails (see Appendix 5-2). Following research concluded in 2017 which showed Ferroxx AQ to be more effective than Sluggo under field conditions (ANRPO 2017), staff used it exclusively at all of ANRPO's MUs with the exception of Makaha, where Sluggo was used until Oct. 2020. Ferroxx AQ had delayed deployment at Makaha after the Sluggo label expired due to staffing issues.

9.3.3 Current Status: 2021-2022

ANRPO does not have the resources to control slugs continuously at all sites containing plants identified as at risk from slugs. Most of the sites with active slug control were prioritized in 2015 according to the

following factors; 1. anecdotal evidence of slugs feeding on the plant (no experiments on Hawaiian taxa had been published at the time); 2. species represents the only extant population of that taxon within a particular MU; and 3. slugs are abundant locally and no native snails were resident which might be adversely impacted by molluscicide. This resulted in slug control being prioritized at 11 rare plant taxa.

From July 2021 through June 2022, plans to expand slug control to 26 sites of 13 IP taxa began but implementation was delayed due to staffing issues. Native snail surveys need to be completed before treatments can begin. These surveys are done using the Slug Control Area survey protocol (see Appendix 5-4). In the past year, native snail surveys began in Makaha and were completed in Kaluaa and Kahanahaiki. Treatment began in new slug control sites in both Kaluaa and Kahanahaiki. Table 1 summarizes all slug control which occurred this report year; new Population Reference Sites (PRS) receiving slug control are noted in bold. Currently slugs are being partially or fully controlled at 42% of MFS PUs, which is a 12% increase from the previous year. Staff plan to continue native snail surveys and implement slug control at new sites in the next year. In Makaha, after the Sluggo special use label expired, ANRPO applied for and received a one-year permit to use Ferroxx AQ, starting May 2022, from the Board of Water Supply.

Table 1: Plant species treated and slug control treatment area (all sites combined) by MU in 2021-2022. Sites added this year are noted in bold font. Ferroxx AQ is deployed at the label rate on a 6 week rotation year-round with the following exception: Opaeula Lower sites, due to difficulties in accessibility, receive 4 treatments per year.

MU	Plant species treated (Population Reference Code [PRC] in parentheses)	Treatment Area (m^2)
Ekahanui	*Cyanea grimesiana* subsp. *obatae* (EKA-C), *Delissea waianaeensis* (EKA-D), *Schiedea kaalae* (EKA-D)	4,560
Kaala	*Labordia cyrtandrae* (ALA-S), *Phyllostegia hirsuta* (ALA-A)	1,524
Kahanahaiki	*Cyanea superba* subsp *superba* (MMR-E), *D. waianaeensis* (MMR-A), *Schiedea obovata* (MMR-G, **MMR-I**)	1,000
Kaluaa and Waieli	*D. waianaeensis* (KAL-C), *S. kaalae* (**KAL-C**), *C. grimesiana* subsp. *obatae* (**KAL-B**), *C. superba* subsp. *superba* (**KAL-B**),	7,325
Kapuna Upper	*Cyanea longiflora* (PIL-B, PIL-C, PIL-E, PIL-F), *S. kaalae* (KAP-A), *Schiedea nuttallii* (PIL-B)	3,658
Makaha	*C. grimesiana* subsp. *obatae* (MAK-B), *C. longiflora* (**WAI-A**), *Hesperomannia oahuensis* (**MAK-B**) *Kadua degeneri* subsp. *degeneri* (**MAK-A**), *S. nuttallii* (MAK-A), *S. obovata* (MAK-A)	3,323*
Makaleha West	*C. grimesiana* subsp. *obatae* (LEH-B), *C. longiflora* (LEH-B), *S. obovata* (LEH-B)	1,824
Manuwai	*D. waianaeensis* (ANU-A)	1,450
Opaeula Lower	*Cyrtandra dentata* (OPA-F)	1,181
Pahole	*C. grimesiana* subsp *obatae* (PAH-D), *C. longiflora* (PAH-A, PAH-I, PAH-J), *D. waianaeensis* (PAH-C), *Euphorbia herbstii* (PAH-G, PAH-R, PAH-S), *Schiedea kaalae* (PAH-A, PAH-C), *S. nuttallii* (PAH-A, PAH-D, PAH-E)	14,377
Palikea	*C. grimesiana* subsp *obatae* (PAK-A, PAK-B, PAK-C), *C. superba* subsp *superba* (PAK-A, **PAK-C**), *P. hirsuta* (PAK-A)	7,637

*Application of Ferroxx AQ at Makaha started soon after the end of this reporting period

Starting July 2022, staff will actively update all defined Slug Control Areas (SLCAs), so that they include the full extent of the rare plant Population Reference Sites (PRSs) they protect. Some of these SLCAs, or portions of them, cannot be treated due to the presence of native snails from the subfamilies *Amastridae*, *Achatinellinae* and *Endodontidae*. If native snails from other families are found during pre-treatment surveys, ANRPO will work with SEPP and other experts to determine whether or not it is safe to use Ferroxx AQ at the site. One site that has been determined that will not receive treatment is the *Cyrtandra dentata* MMR-A site in Kahanahaiki due to the presence of *Leptachatina spp*.

9.4 INVASIVE ANTS (*FORMICIDAE*)

Hawaii lacks native ants. Of the over 60 species now present, all were likely transported introductions by humans. The result has been widespread colonization of disturbed, and on occasion predominantly native, areas by generalist ants that can utilize a range of resources (Krushelnycky *et al.* 2005). They directly prey upon rare native insects, as is the case with *Solenopsis papuana*, which was found to reduce picture wing fly (*Drosophila*) survival by 58% (Krushelnycky *et al.* 2017), and *Pheidole megacephala*, which threatens native endangered bees (Magnacca 2020). Ants also affect plants by reducing pollinators (Sahli *et al.* 2016) and by farming plant pests such as scales and aphids.

ANRPO aims for early detection of problem species, delineation of infestations of those species, and when possible, eradication. In order to accomplish this, staff have carried out annual standardized surveys since 2004 across areas with a high risk of ant introduction including out planting sites, *Drosophila* sites, campgrounds, fence lines, helipads, and roads (Figure 1). Ants in these areas are sampled using either baited vials or cards left out for one hour. Counts of foraging ants at these locations also are used to measure treatment efficacy. The methodology is outlined in ANRPO (2010).

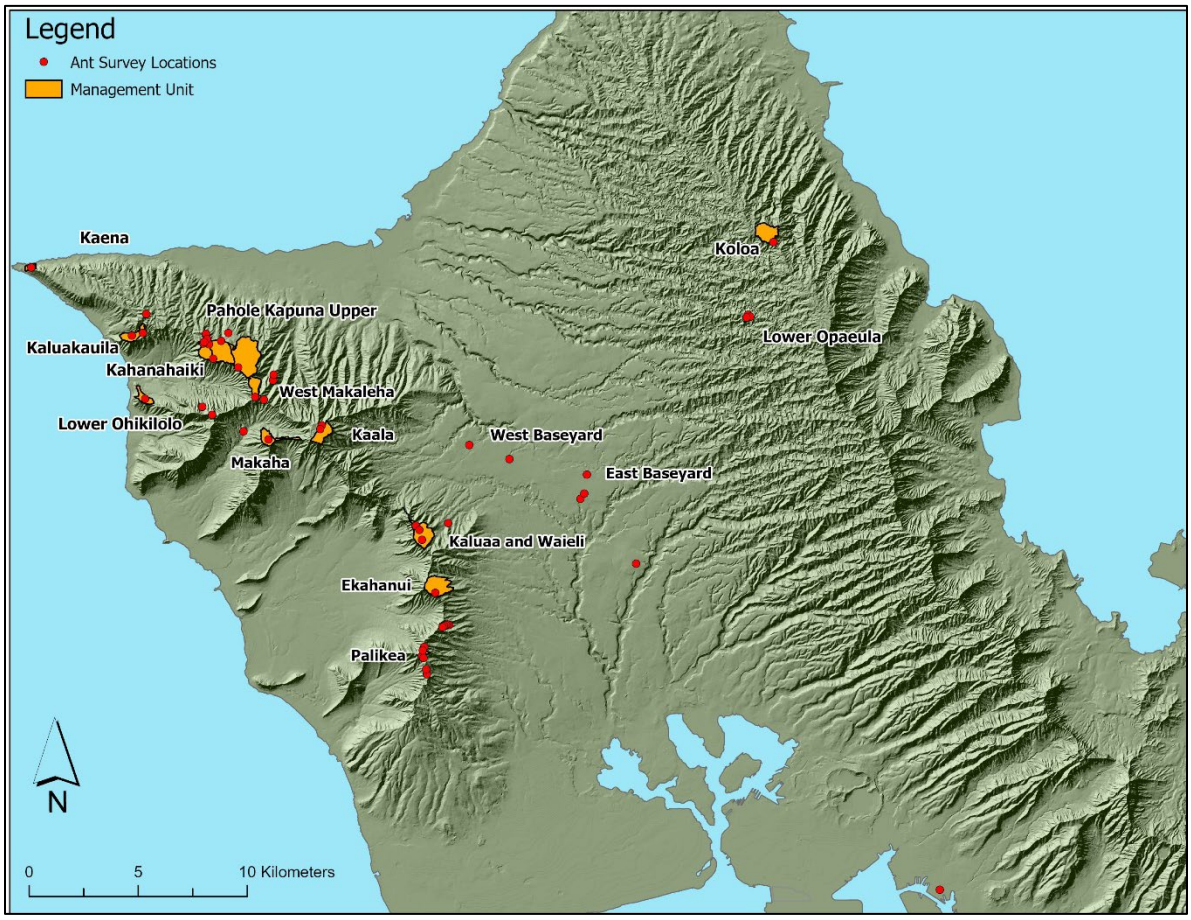

Figure 1: Map showing locations of annual ant surveys for the purpose of detecting new ant incursions.

Staff schedule sampling during the summer months when ants are more active, however, due to field conditions and site accessibility, sampling occurs year round. The samples are frozen, sorted, and then identified.

Ant detections at bait cards can also be used to provide estimates of relative ant density within a sample area, as staff can count the number of individuals of a known species on the card after a one hour period. In contrast, bait vials are used only to detect the presence or absence of ant species in the area. Bait cards or vials can also be used to estimate which ant species are dominant and which are rare at a given site. Since ants do not share resources with other ant species, the first species to find the bait guards it against others. Uncommon species are less likely to find the bait before a more dominant species.

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 predominantly native area.

This report year, surveys were conducted at five MUs, including Kahanahaiki, Pahole, Makaha, Kaluaa, Kaluakauila, and Ohikilolo Lower. Four ant species were detected during these surveys. Only two species are concerning, *Pheidole navigans* and *Anoplolepis gracilipes*.

Pheidole navigans was found in multiple Kahanahaiki samples this year, and was first detected by staff in September 2020. *Pheidole navigans* was first recorded in the State in the Puna District of Hawaii Island in 2001 (misidentified as *Pheidole moerens*, Gruner *et al.* 2003). Little is known about its biology, although it has been expanding its range in the southeastern US and, despite generally forming small colonies, has been considered a pest in some of these areas (Sarnat *et al.* 2015). Though not picked up in the ANRPO sampling at Pahole MU, this species was detected by University of Hawaii Researcher Dr. Paul Krushelnycky in plots at both Kahanahaiki and Pahole in 2019-2020 (Krushelnycky DoD Legacy Project 2021). Staff detected *P. navigans* across more than three acres, ANRPO's threshold for treatment of an ant infestation (ANRPO 2018). Staff are not familiar with any control options for this species that are legal to use in forest areas.

In early 2022, *Anoplolepis gracilipes* was detected at the new snail enclosure in Kahanahaiki. The ants were detected in high densities. There is a concern that *A. gracilipes* can affect the reproduction and survival of native tree snails, though there is no data that confirms this. This concern largely comes from *A. gracilipes'* ability to spray formic acid on perceived threats. Bait card surveys have been conducted to find the extent of the infestation, to assist in deciding if the goal for this taxon should be eradication or localized treatment around the snail enclosure to limit *A. gracilipes* effect on the tree snails. Bait cards were used instead of vials as the ants are more attracted to protein-based bait and to calculate the density of the population based on how many ants are seen on the card after a one hour period. Treatment options for *A. gracilipes* are limited in a forest setting and additional research needs to be done to identify viable and safe control options. Staff observed *A. gracilipes* in the western gulches of Kahanahaiki, stretching into Makua Valley, and on the ridge heading south towards the snail enclosure; staff suspect this is the source of the infestation at the snail enclosure. It is possible *A. gracilipes* spread into this area after vegetation was cleared for snail enclosure construction, making the area more open and attractive. Discussions have begun with partners about possible treatment methods safe to use around the snail enclosure

Staff continued quarterly treatment of ants at ANRPO base yards this year. Staff will continue to implement decontamination procedures and ant sampling at base yards to ensure no inadvertent spread takes place.

9.5 COCONUT RHINOCEROS BEETLE (*ORYCTES RHINOCEROS*)

9.5.1 Background and History

Coconut rhinoceros beetle (*Oryctes rhinoceros*), hereafter called CRB, was first detected on Oahu in December 2013. This large, nocturnal beetle is native to Southeast Asia and invasive across the Western Pacific. Adults primarily attack palms and exhibit preferences for certain taxa, particularly coconut and oil palms, although they can host-shift and have also been documented on agave, sugarcane, banana, and pineapple (USDA-APHIS 2019). Adult beetles dig into trees and feed on the juices of the inner leaves and meristem. CRB pose a threat to local agriculture and tourism, as well as to Hawaii's native *Pritchardia* fan palms. CRB breed in decomposing plant material, and may easily be spread via movement of mulch. Adults can also disperse by flying, although experts suggest they are comparatively poor fliers.

Since 2014 ANRPO has been a member of a CRB Working Group led by Coconut Rhinoceros Beetle Response Hawaii (CRBRH), in collaboration with the Hawaii Department of Agriculture (HDOA). Starting in February 2014, ANRPO assisted island-wide survey efforts by monitoring and maintaining 18 panel traps on Schofield Barracks, Wheeler Army Airfield, ANRPO's East Base in Wahiawa, and the bottom of the Pahole Road next to Dillingham Ranch. In July 2019, HDOA detected CRB at one trap on Wheeler. Following this, ANRPO staff almost doubled the number of traps on Schofield and Wheeler to 32. Unfortunately, CRBRH documented new breeding sites in the central Oahu area during this time. Internal reports shared with cooperators by the CRBRH show steady CRB spread on Oahu since its arrival, with large range expansions occurring over the last three years

Figure 2: Left: Panel trap with pheromone lure (red pouch in center of trap) and light lure (wire with diode). Right: By the end of this report year, staff routinely found large numbers of CRB in panel traps.

ANRPO use panel traps to survey for CRB presence, per CRBRH best practice. While CRB in the traps are removed and killed, panel traps are not considered an effective control and suppression measure. Panel traps consist of large rectangular panels, below which is hung a plastic catch cup (Figure 2). The

trap is usually baited with a pheromone lure as well as light lure. Panel traps are hung from trees, fence posts, etc. CRB drawn to the lures hit the panels and fall into the cups, from which they cannot easily escape. ANRPO staff check the traps quarterly or every six months at some remote field locations, but aim for monthly visits in accessible areas.

9.5.2 CRB – *Pritchardia* Interagency Working Group

Since 2020, ANRPO has participated in the CRB-*Pritchardia* Working Group, led by staff from the State Department of Forestry and Wildlife (DOFAW). This group is specifically focused on the potential impacts of CRB to native *Pritchardia* and natural areas in general. Highlights from this year include:

- Members installed and began monitoring panel traps along remote access roads in natural areas.
    - ANRPO conducted a site visit with Keith Weiser, Deputy Incident Commander of CRBRH, in July 2021 to discuss panel trap installation and monitoring frequency considerations in natural areas. Following this, staff installed traps along the Pahole Road, Kaala Road, Ekahanui access trail, Kaluaa/SBW access road, at KTA, and in the Ohikilolo MU in the back of Makua Valley and around the *P. kaalae* patches on the crest of the Ohikilolo ridge.
    - Partners installed traps along the Makaha access road, Pualii/Honouliuli access road Palehua access road, and Poamoho access road. All partners reported finding CRB in their traps, with the exception of Poamoho.
- The group began supporting research by Dr. Mike Melzer (UH) into refining knowledge of habitat preferences and restrictions of CRB.
    - ANRPO staff provided previously collected temperature data from Ohikilolo to Dr. Melzer, who used it to begin a lab trial examining how well CRB could reproduce under environmental conditions typical of this important *P. kaalae* site. This trial is underway, and results are expected next year.
    - ANRPO took the lead on deploying temperature sensors at other locations. A list of sites was drafted and staff will deploy the sensors, provided by Dr. Melzer, in the coming year. These data will be used for additional lab trials.
    - ANRPO staff conducted a site visit to Ohikilolo with Dr. Melzer and Keith Weiser. This led to valuable discussions of control techniques appropriate to use on *P. kaalae* in natural settings, the challenges posed by the terrain, and the potential risk posed by decomposing slash piles from weeding projects.
    - ANRPO connected Dr. Melzer and Keith Weiser with Dr. Lucas Fortini (USGS), who is modeling climate range maps for CRB for all the main Hawaiian islands. Dr. Fortini expects to publish this in the coming year. This tool will help gauge the risk posed by CRB to various *Pritchardia* species across the State.
- CRB can shift to non-palm food sources, and the working group is concerned about what other Hawaiian taxa may be at risk from CRB feeding damage. Dr. Melzer's lab agreed to run feeding trials. ANRPO staff contributed to a draft list of taxa to test, and will be providing testing material to the lab in the coming year.
- Identifying safe propagule storage for *Pritchardia* is a priority. ANRPO staff is working on this with a working group subcommittee. See Appendix 4-07 for a discussion of *P. kaalae* storage issues and plans. These include supporting research into germplasm cryostorage and identification of potential living collection sites on Oahu, across the State, and on the mainland US.

9.5.3 Survey Results and Field Activity Highlights

This year ANRPO installed panel traps along forestry access roads, trails, and high-value sites to learn more about CRB activity in wild areas, as a complement to the traps in residential and urban areas maintained by CRBRH. Currently, ANRPO staff and DPW collaborators monitor 67 panel traps; see Figure 3. Most of these traps were deployed in the Waianae Mountains, since this is where CRB infestations are most active, and home to the *P. kaalae* populations managed by ANRPO. One trap was deployed in Kahuku Training Area (KTA), as this is in proximity to known populations of *P. bakeri* and *P. kahukuensis*; this habitat is ideal for CRB although no beetles have been detected from the Kahuku region yet. Unfortunately, just during the course of the year, staff documented clear spread of CRB into natural areas, see Figure 4. Details of these surveys are described by region, below.

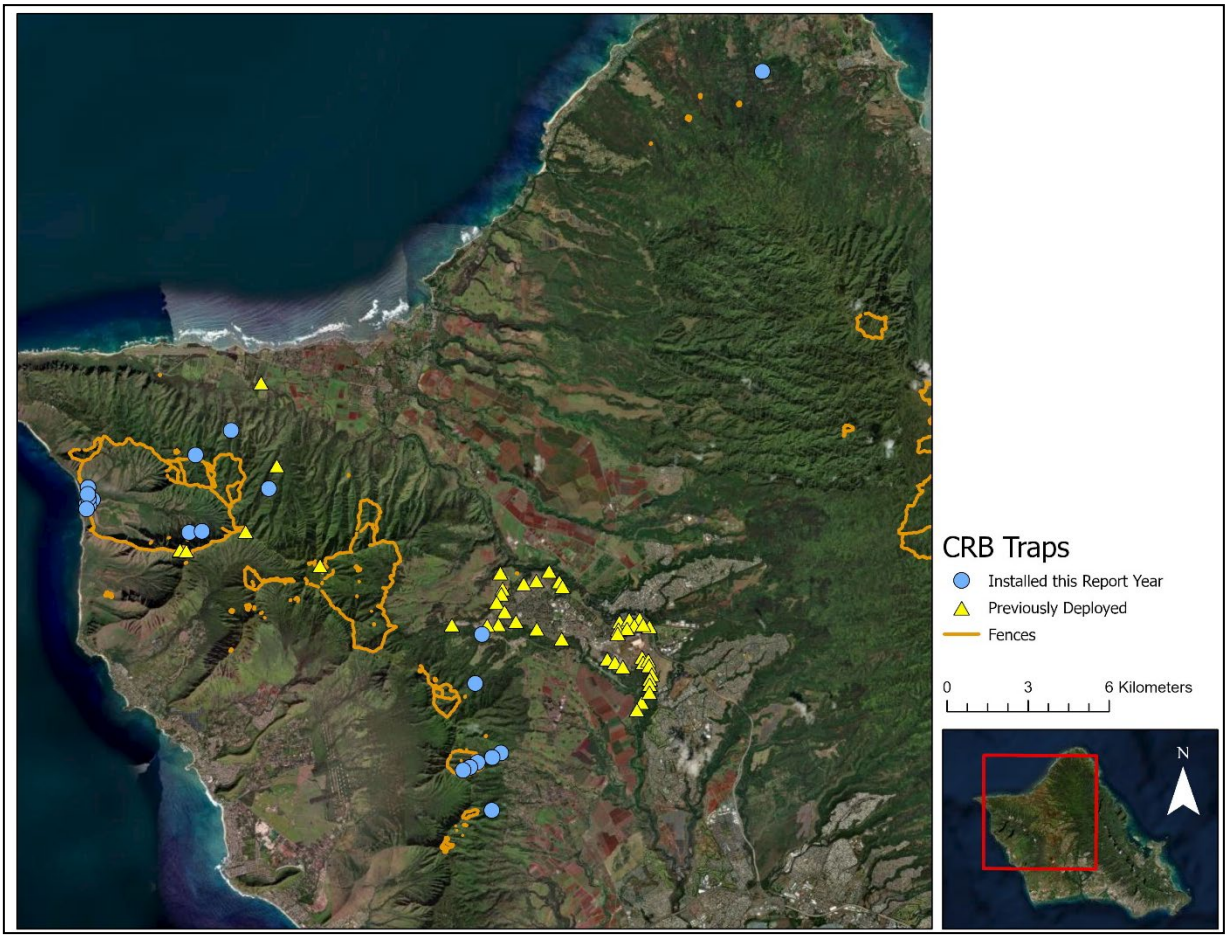

Figure 3: CRB trap locations. Traps noted in yellow were deployed prior to this report year. Traps in blue were installed this year, and include traps in remote locations.

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Available Upon Request

Figure 4: CRB detections in the northern and southern Waianae Mountains. All traps which detected CRB this report year, or anytime in the past, are red. Traps which have never detected CRB are green.

Schofield Barracks and Wheeler Army Airfield

Staff have been monitoring CRB traps on Schofield and Wheeler since 2014. While HDOA staff had one detection of CRB on Wheeler in 2019, ANRPO staff did not detect CRB till July 2021. Currently, staff monitor 38 traps across Schofield and Wheeler. Of these, CRB have been detected at all but 15 as of the end of this report year. Since at least 2020, CRBRH has been aware of breeding populations to the south of Schofield in Mililani and at Kunia Loa Ridge Farmlands; these represent incursion of CRB onto the central Oahu plan, and may be one source of finds in the Schofield-Wheeler region. In addition, staff suspect there may be a breeding site on Base near the Wheeler stables. CRB are consistently found across both facilities, and numbers trapped increased over the course of the year. Staff noted CRB damage on palms on base as well, including on at least one *P. kaalae* at the ANRPO West Base interpretive garden. These trees were later protected with netting provided by CRBRH, which acts as a physical barrier. DPW staff continue to coordinate with the contracting office and landscapers to prevent movement of mulch and plant materials on/off Base.

Makua Valley

In December 2020 CRBRH detected a CRB in a trap on Farrington Highway along the Makua coastline. CRBRH alerted ANRPO staff in April 2021 when additional captures suggested a potential CRB breeding site in the vicinity. ANRPO and CRBRH staff deployed eight traps on range at the mouth of Makua Valley between May and June of 2021.

Around the same time, staff worked with contractors to remove and safely dispose of a large mulch pile of palm fronds and other vegetative material which was stored near Range Control. Though the debris pile was marginal for CRB breeding, as it was dry and not heavily decomposed, it was the most likely potential breeding site in the area. Surveys with both CRBRH staff and their dog team did not detect evidence of breeding. ANRPO also conducted outreach to landscape contractors at Makua about the threat of CRB to native resources.

Figure 5: ANRPO inspecting coconut palms felled by staff at Makua Range Control

In November 2021, around 20 coconut palms planted around Range Control were removed and disposed of in an effort to remove any potentially CRB-attractive materials from the valley (Figure 5). None of the palms showed any sign of CRB damage, although damage may not be evident for up to a year post-attack.

Despite these efforts, as of the end of this report year, CRB have been positively detected at all eight traps. The presence of CRB in Makua is of great concern, as Ohikilolo ridge, on the south rim of the valley, is home to largest population of *P. kaalae* on Oahu.

Ohikilololo MU

This large MU is home to the largest population of *P. kaalae* on the island. Two traps were installed in the Makua valley portion of the MU in March 2022, and three were installed close to *P. kaalae* in the Ohikilolo Ridge portion of the MU in April 2022. To minimize risk of attracting CRB to the *P. kaalae* sites, all five of these traps only have light lures, not pheromone lures, as experts do not know the range of effectiveness of the pheromone. No CRB have been detected in any of these traps to date, although CRB are caught regularly at mouth of Makua at Range Control, and by BWS in Makaha to the south. Staff monitor *P. kaalae* at Ohikilolo regularly for signs of CRB damage; none has been found to date.

Pahole Road

There are currently three traps along the Pahole Road. The lowest trap, adjacent to Dillingham Ranch and a coconut plantation, was installed in 2014. CRB were first detected at this trap in December 2021, and staff also observed damage on the coconuts as well. Two additional traps were installed further up the road in November 2021. While no CRB were detected at the highest trap (approximately 775m below the Nike Greenhouse), CRB were found at the middle trap in February 2022.

Kaala Road

Three traps were installed along the Kaala Road in October 2021 at the forestry gate, Culvert 24, and the Kaala campsite at the summit. CRB was detected at the lowest (forestry gate) trap in April 2022, at which time an additional trap was installed at Culvert 37, for a total of four traps. In June 2022, CRB was detected at the Culvert 24 and Kaala campsite traps. Located at 4,000ft elevation, the positive finds at the Kaala campsite demonstrate that CRB can reach the highest points on Oahu, although experts think it is unlikely they can breed at Kaala. Staff plan to install a data logger at Kaala, so this can be tested by Dr. Melzer's lab in future. As of the end of the report year, no CRB were detected at Culvert 37. These finds are concerning, as *P. kaalae* are sprinkled across the Makaleha slopes north and east of the Kaala Road.

Kaluaa/SBS Access Road

Two traps were installed along the Kaluaa/SBS access road in July 2021. One trap was installed across from a water tank on SBS, and one at the Kaluaa trailhead. CRB were detected at both in September 2021, and increasing numbers have been detected over the course of the report year. The large breeding populations at Kunia Loa Ridge Farmlands, approximately three kilometers to the south, are a likely source of dispersing CRB to Kaluaa and SBS.

Ekahanui Access Trail

Three traps were installed along the Ekahanui access trail September 2021, at the trailhead, midway to the fence, and at the fence. CRB were detected at these traps, respectively, in October 2021, November 2021, and February 2022. This was not surprising, given Ekahanui is located directly behind the known CRB

breeding location at Kunia Loa Ridge Farmlands. The trailhead trap was discontinued, and two additional traps were installed along the trail further in the Ekahanui fence in March 2022, leaving four active traps at Ekahanui. CRB were detected at one of the new traps in June 2022, but the highest trap had no detections this report year.

Pualii/Honouliuli Access Road

Staff check the State's trap at the along the Pualii/Honouliuli access road incidentally when in the area. CRB were detected at every monitoring, and ANRPO staff alone removed 52 beetles from it over the course of this report year. These high numbers are likely due to the traps close proximity to Kunia Loa Ridge Farmlands. In May 2022, staff working at the summit of Pualii found a dead CRB lying on the trail, suggesting CRB moving up in elevation in the area.

KTA

One trap was installed across on Drum Road across from Range Control, at around 600ft elevation, in March 2022. No CRB were detected here to date.

9.5.3 Next Steps

The increasing numbers of CRB found by ANRPO staff, coupled with the island-wide spread reported by the CRBRH indicate that CRB are on Oahu to stay. ANRPO will continue to support efforts to manage and mitigate the impacts from this taxon via participation in both the CRB Working Group and CRB-*Pritchardia* Working Group. Currently, there are no good techniques or tools for controlling CRB infestations in natural areas. Researchers at UH are working to develop biocontrol agents for CRB, and this year, ANRPO wrote a letter of support for Dr. Zhiqiang Cheng (UH) for a DOD grant to further this work. In future, staff efforts will focus on supporting research into CRB habitat preferences, feeding trials, and control techniques development.

9.6 RAPID OHIA DEATH (*CERATOCYSTIS* SPP)

Rapid Ohia Death was detected on Hawaii Island in 2014. It is a disease which targets Hawaii's most abundant native tree, ohia (*Metrosideros polymorpha)*, and is caused by two fungal pathogens: *Ceratocystis lukuohia* ("destroyer of ohia,"or wilt disease) and *C. huliohia* ("change the natural state of ohia," or canker disease). Though both are fatal, *C. lukuohia* is more virulent, causes death more quickly, and is consistently associated with more rapid spread (Barnes *et. al* 2018). Most new outbreaks are *C. lukuohia* and it accounts for roughly 90% of ROD detections on Hawaii Island (CTAHR 2020). Both strains are found on Hawaii Island and Kauai, while only *C. huliohia* is present on Oahu and Maui. After *C. huliohia* was confirmed on Oahu in July 2019, ANRPO adopted decontamination guidelines recommended by the State (CTAHR 2016) as part of best practices to avoid inadvertent spread of the disease in the course of fieldwork.

ANRPO is a member of the ROD Working Group. ROD continues to be an early detection target across Oahu for ANRPO and its partners. This year, ANRPO continued to support these efforts by assisting with access to restricted airspace for helicopter surveys by Oahu Invasive Species Committee (OISC) staff. In addition, staff continue to note locations of damaged and potentially symptomatic ohia in the course of other field work, although no samples were submitted for testing this report year.

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