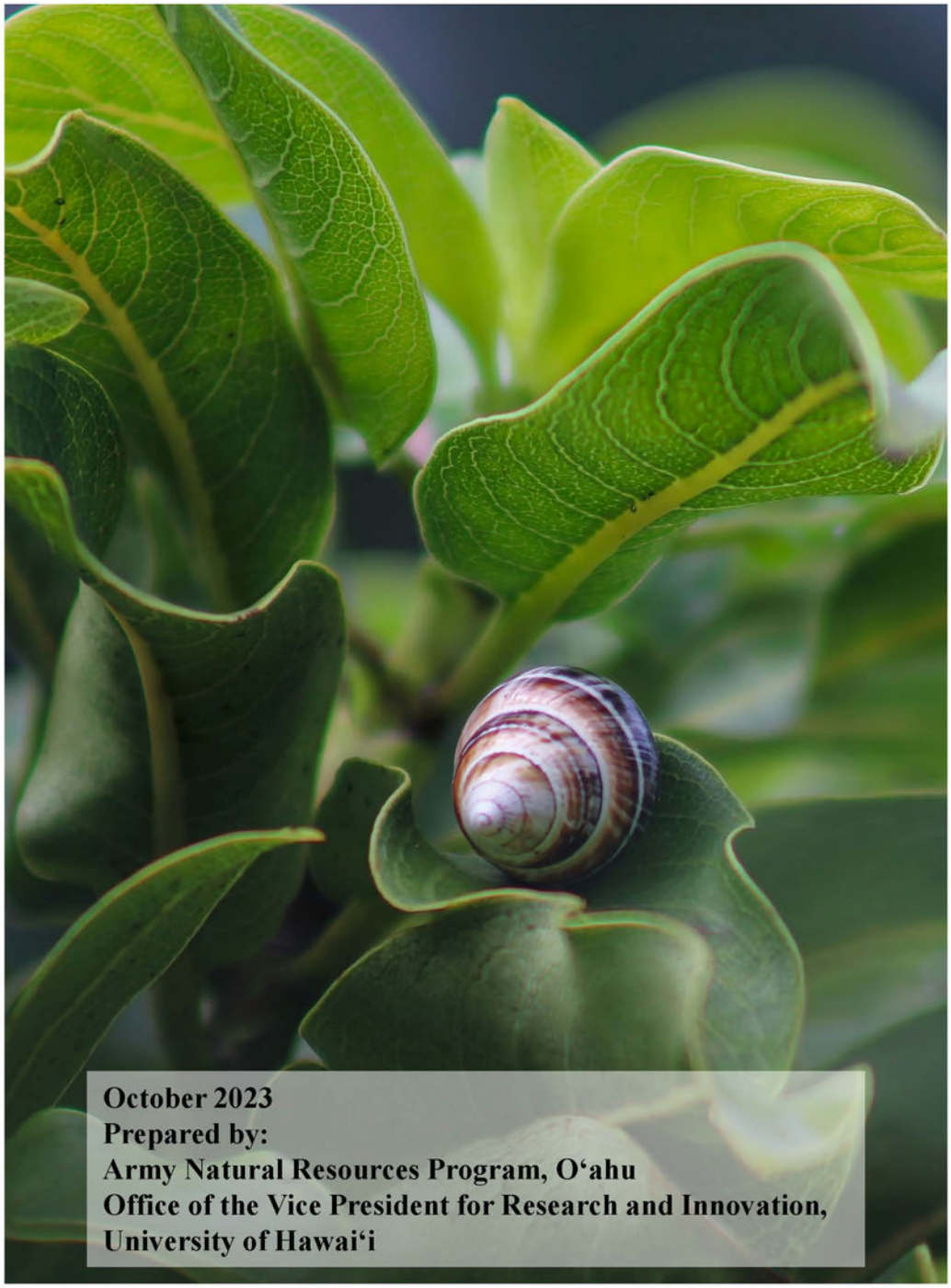
2023 Status Report for the Mākua and O‘ahu Implementation Plans



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*Cover photo: Celebrating the year of the kāhuli, *Achatinella mustelina* on a pilo (*Coprosma longifolia*) inside the Palikea South Snail Enclosure.

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EXECUTIVE SUMMARY

The Army Natural Resources Program on Oʻahu (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, Hawaiʻi (USAG-HI) to the University of Hawaiʻi (UH). Staff levels in Fiscal Year (FY) 2023 were similar to FY 2022. For FY 2023, ANRPO received a total of $5,602,200 to implement Mākua Implementation Plan (MIP) projects and Tier 1 projects from the Oʻahu 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 2022, for FY 2023, 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 Oʻahu 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 19) and OIP (Year 16). The period covered in this report is July 1, 2022 to June 30, 2023.

This is the first year the report includes Hawaiian diacritical marks. In past reports, diacritics were referenced in an appendix but not used throughout the document for ease of formatting and consistency. This year, they are used throughout the report with the exception of tables generated by the ANRPO database, which does not support diacritical marks, and appendices not written by ANRPO staff. Proper spelling of Hawaiian names shows respect and honor for the history of the people and places, acknowledges the indigenous identity of this land, and promotes preservation of ʻŌlelo Hawaiʻi. This year ANRPO formed a committee dedicated to maintaining a dynamic resource to help guide proper spelling of Hawaiian names. In situations where multiple documented spellings of names were discovered, the committee took the initiative to choose a single spelling for the sake of maintaining consistency. To ensure accuracy, the committee sought guidance from qualified language experts when no documented sources contained diacritical marks for a particular name. It is important to note that ANRPO recognizes the possibility of errors in our choices and humbly acknowledges them.

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 includes tables summarizing 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-1 for a tutorial on how to use this database).

ANRPO is reporting on the 19th year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the 16th 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 Mākua Biological Opinion (BO) in 2007 and amended BO in 2008, both issued by the USFWS, require that the Army provide threat control for all Oʻahu ʻElepaio (*Chasiempis ibidis*) pairs in the Mākua 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 Maʻo hau hele (*Hibiscus brackenridgei* subsp. *mokuleianus*). The OIP outlines stabilization measures for 23 additional plant taxa, 75 pairs of Oʻahu ʻElepaio, and six extant Koʻolau *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 11 taxa

present in the Schofield Barracks West Range Action Area and in the Kahuku 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 (ACOE), Engineering Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) to complete an updated Programmatic Biological Assessment (PBA) for the Army to enter into formal consultation for all Oʻahu training ranges (including Mākua Military Reservation). Following the USFWS draft review, a final draft PBA is currently under review by Army installation staff to produce a final draft for Army Headquarters' approval. This final draft will be transmitted to USFWS to initiate formal consultation. 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. It also analyzes impacts to species recently discovered on Army land, such as federally listed seabirds. Mākua Military Reservation is included in this PBA, while in previous consultations it was separate. This approach allows the Army to present a combined analysis of impacts to Oʻahu's endangered species. Management requirements will be determined through the consultation process and outlined in the BO to be issued upon completion of this process.

The Army also contracted ERDC with FY 23 funds to revise the Oʻahu Integrated Natural Resources Management Plan (INRMP). The plan requires a major overhaul and realignment with the new PBA. In the interim, in response to the USFWS proposal to designate critical habitat for the Green Sea Turtle (GST), the U.S. Army Environmental Command and USAG-HI prepared an addendum to the INRMP to address GST. The addendum was signed by the Garrison Commander and will be incorporated in the INRMP revision underway. GST management actions are summarized in the rare vertebrate chapter 6.

PANDEMIC EFFECTS ON PROGRAM

Impacts on work due to various COVID-19 response and management guidelines were minimal compared to last year and peak pandemic. Regular work continued in accordance with State, Department of Defense, and CDC guidance, with emphasis on staff safety.

INFRASTRUCTURE

A new shadehouse was erected in the baseyard interpretive garden to accommodate more *Pritchardia kaalae* living collections. In addition, ANRPO received National Public Lands Day funding to expand the catchment capacity at Kahua seed orchard on Schofield Barracks.

PROGRAM STAFFING AND STRUCTURE

Over the course of this reporting period, ANRPO has maintained staffing levels projected for its cooperative agreement with the Army. The ANRPO organizational chart is included in Appendix ES-2. ANRPO experienced turnover at all levels of the program, with openings at the coordinator level and subsequent promotions from within the program leading to additional moves elsewhere. This, in addition to normal attrition of technicians, led to some periods of low field team staffing. Inflation rates have also remained high in recent years and entry level staff struggle financially. Raises were given in January 2023 but additional increases will be required to ensure staff earn a living wage. While some positions are currently vacant, current staffing levels are sufficient to implement the tasks from the Cooperative Agreement and positions are being backfilled as rapidly as possible.

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 continued with Hawai‘i Reserves, Inc. (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 three-year right of entry agreement for Gill Ewa Lands expired in May 2019 and also needs to be renewed. The Army must utilize the ACOE Real Estate Division to enter into and renew real estate agreements. The ACOE office has experienced high staff turnover in the last several years, which has complicated agreement renewal efforts. 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 Hawai‘i, Department of Land and Natural Resources (DLNR) for the use of DLNR lands to meet MIP and OIP goals. Currently, the Army holds six State of Hawaii permits for ANRPO work on O‘ahu, including a combined Natural Area Reserves (NARs), Rare Plants, and Native Invertebrate Research Permit for rare taxa of interest on NARs and Forest Reserves, a second combined permit for *Schiedea hookeri* collection and propagation at Pu‘u Hāpapa, a Forest Reserve Access and Special Use Permit, a Conservation District Use Permit, a State Parks Special Use Permit, and a Protected Wildlife Permit. During this report year, additional short term permits were applied for and granted. These include two DLNR combined permits for the Ka‘ena NAR, one for rodent and ungulate threat control, and the other for aerial UAV monitoring of *Euphorbia celastroides* var. *kaenana,* and two State Parks Special Use Permits for the same Ka‘ena projects, which straddled the NAR and State Parks boundary. When the DLNR combined permit was renewed in June 2023 (expires June 2026) and the State Parks permit was renewed in January 2023 (expires December 2023), these short term projects were incorporated into the renewals. In 2021, the Army and the State finalized a lease for ANRPO’s use of the DLNR Nike site mid-elevation greenhouse and associated facilities in 2021. The lease can be extended through 30 Sept 2026 and has been extended for fiscal year 2024 via the ACOE Realty Branch.

In early 2023, ANRPO began the process of amending and renewing its recovery permit with the USFWS, including requesting permission to conduct environmental DNA sample collection from rare plants. USFWS issued the renewal permit in August 2023 (expires August 2028).

ANRPO continues to work collaboratively with the UH Natural Resources and Ecosystem Management (NREM) program, primarily via the UH Ecosystem Extension Professor. This work includes facilitating research with UH professors and affiliates via discussion and coordination of ANRPO research needs, collaborating on and providing data or plant material for research projects, assisting with undergraduate and graduate student projects, and funding for graduate assistantships. It also includes supporting development of targeted workshops and working groups for small vertebrates and vegetation management, as well as more general development of training, education, and development needs for natural resources staff across the State.

ANRPO continued participation in the Hawai‘i Conservation Alliance (HCA) steering committee this year. ANRPO Program Managers and the UH Extension Professor continue to be active in committee meetings and assist with HCA initiatives. ANRPO continues to provide and receive support from partner agencies including the O‘ahu Invasive Species Committee (OISC), O‘ahu Plant Extinction Prevention Program (OPEPP), State DLNR Native Ecosystems Protection and Management Program (NEPM), Hawai‘i Invertebrate Program, Snail Extinction Prevention Program (SEPP), and the Ko‘olau and Wai‘anae Mountains Watershed Partnerships. The Army is also an official member of the Ko‘olau

Mountains Watershed Partnership, the Waiʻanae Mountains Watershed Partnership, the Coordinating Group on Alien Pest Species, and the Hawaiʻi Rare Plant Restoration Group. Highlights of Army natural resource partnership work over this report year included the following: cooperation in wildfire response; aerial surveys for highly invasive species and pathogens; rare snail enclosure construction and maintenance; identification, treatment, and disposal of coconut rhinoceros beetle (CRB) (*Oryctes rhinoceros*) infestations; research on CRB habitat and feeding preferences; and numerous habitat improvements for endangered plants and animals.

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.

The outreach program continued offering monthly volunteer trips. Volunteers included individual community members from across Oʻahu and community organizations, such as schools and non-profit organizations. Volunteers contributed 2,979 hours in the field and 529 hours at the ANRPO baseyard. Outreach staff led 63 volunteer trips and facilitated 14 additional opportunities for volunteers to assist natural resource staff with conservation field projects. In addition, the program hosted six interns during this reporting period. Many former interns return to work for ANRPO after college graduation. See Chapter 2 – Environmental Outreach for more details.

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; 5) control of invasive slugs around susceptible rare plant sites; 6) surveys and of invasive ant taxa around sensitive habitats and rare taxa; and 7) surveys, research, and collaboration on other invertebrate forest pests, including but not limited to CRB, Rapid ʻŌhiʻa Death, and other pathogens. Summaries of these program areas are included below.

UNGULATE PROGRAM

During this report period, ANRPO repaired 1,144.40 meters of fencing, with most of this work occurring at the Kaluaʻā MU on State land. Effort was focused on the installation of 1,010 meters of mesh along the lower portions of the existing fence in response to a rising trend in ungulate ingress. In addition to quarterly fence checks, in particular areas staff responded to increased pressure by deploying baited box traps to remove pigs and game cameras to monitor pig activity and identify possible ingress locations (see Chapter 1 – Ungulate Control Program). During this reporting period, unexploded ordnance (UXO) was removed from MMR, allowing staff to resume ungulate control in the lower sections of the valley. Trials of a new type of pig trap, the Pig Brig, show promising results, which may improve pig control in some areas. This year, ungulate control was conducted to mitigate pig pressure outside and remove ungulates

within MUs. The majority of ungulates controlled this year were from the unfenced portions of Mākua Military Reservation. Monitoring intervals are suitable for detecting any ungulates that breach fence boundaries, and response is efficient. In addition, ungulate removal continued within Līhu‘e, the largest MU. For more details about ANRPO ungulate control, see Chapter 1 – Ungulate Control Program.

VEGETATION MANAGEMENT PROGRAM

In this reporting period, ANRPO spent 8,665 hours controlling weeds across 400 hectares (ha). The number of hours and area treated decreased compared to last year. This reduction in effort is due to staff shortages at the Technician level within the program as well as a shift away from intensive devil weed control. Incipient weed eradication and suppression efforts accounted for 331 ha (82% of total area controlled). Staff spent 1,699 (20% of total effort) hours on Incipient Control Area (ICA) management and conducted 488 visits to 255 ICAs. Fourteen ICAs were declared eradicated over the reporting period, for a total of 84 eradications over the last 17 years. No new ICAs were identified this year. General habitat weed control efforts covered 68.5 ha (17% of total area controlled). ANRPO conducted control in Weed Control Areas (WCAs) for a total of 6,966 hours (80% of total effort) over 776 visits at 181 WCAs. WCA effort and area treated decreased this year.

ANRPO conducted 149 road, landing zone, campsite and weed transect surveys to detect and prevent the spread of any newly introduced invasive species. ANRPO submitted 6 non-native plant samples to Bishop Museum. 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 (Manuwai, ‘Ōpae‘ula Lower, Pahole, and Kalua‘ā and Wai‘eli). All are included in this year’s report (see Appendices 3-1 to 3-4).

VEGETATION RESTORATION

Complementary to weed control efforts, additive active restoration work continued during this reporting period. The total number of outplants was about the same as last year, and the area over which outplanting was conducted was also about the same as last year. Again, there was an emphasis on outplanting rather than using seed sows, divisions and transplants. In 17 MUs, across 3.38 ha 13,202 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 Kahanahāiki and Kalua‘ā and Wai‘eli 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 and Appendix 3-07 Restoration Projects for more information on habitat restoration efforts.

RODENT CONTROL PROGRAM

ANRPO conducts rodent control in MUs by maintaining trapping grids year-round. 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 O‘ahu ‘Elepaio. During this reporting period, ANRPO maintained 39 year-round rodent control areas consisting of 1,707 A24 traps, which is an increase from last year. Additionally, ANRPO continues to monitor rodent activity using tracking tunnels and game cameras to surveil managed taxa. Over this reporting period, ANRPO continued to address CO_2 leakage challenges on A24 traps. To reduce impacts from non-functioning A24 traps, staff returned to servicing traps every

four months rather than every six months. Additionally, ANRPO prioritized replacement of aging traps, especially in high priority MUs. By increasing the frequency of maintenance and replacing older traps with new units, the failure rate was lower program-wide. Rodent control efforts continue to increase into new and larger territories to better protect listed taxa. Based on positive results of initial field tests, this year ANRPO expanded use and field trials of AT-220 traps. 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 PROGRAM

During this reporting period, the Alien Invertebrate and Forest Pest Control Program focused on rosy wolf snail (*Euglandina rosea*), slugs, ants, CRB, ROD, and myrtle rust. ANRPO conducts slug control at 52 rare plant population reference sites for 14 species susceptible to slug predation. The total area over which slugs are being controlled using molluscicide is 5.18 ha, which is about the same area as last year.

ANRPO continues to cooperate with other agencies in control and detection efforts for island-wide forest pest threats, including ROD, CRB and LFA on Oʻahu. ANRPO staff support early detection efforts for ROD by assisting partners with restricted airspace access for twice a year helicopter surveys. During this report year, ROD was detected outside of ANRPO's MU in Mākaha Valley. Staff continue look for potential damage incidentally during other field work. ANRPO joined the Hawaiʻi Myrtle Rust Monitoring network this year. Samples of ʻōhiʻa and other plants in the myrtle family have been collected and sent for identification.

During this report year, CRB range continued to expand across Oʻahu and to other Hawaiian islands. In August 2022, a CRB was found in a trap at the summit of Mount Kaʻala. In April 2023, CRB damage was identified on a reintroduced loulu (*Pritchardia kaalae*) in the ʻŌhikilolo MU. CRB traps are useful for detecting the presence of CRB rather than control of CRB, and CRB are widespread throughout Oʻahu and are consistently present during regular trap checks. ANRPO continues to participate in a working group, which is now focused on researching aspects of CRB survival and fecundity, potential for CRB to shift to non-palm food sources and threaten other native taxa, and genetic storage of *P. kaalae*.

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. The yellow crazy ant population at Kahanahāiki expanded to two acres around the snail enclosure, with an estimated 2,000 nests in this area. The impacts of these ants on *Achatinella mustelina* remain unclear. Methods for control in a forest setting are still limited; however, partner collaboration is ongoing to stay abreast of current research. See Chapter 9 – Alien Invertebrate Management for details.

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 Kapuna Upper and Palikea MUs and analyzed data for ʻŌhikilolo MU (monitoring conducted last report year). Results for all but Palikea can be found in Appendices 3-8 and 3-9. Palikea results will be presented next year;

- Monitored and analyzed native woody vegetation cover post-fire at ʻŌhikilolo Lower MU (results in Appendix 3-11);

- Monitored IPA-treated *Morella faya* status and associated soil stability at Palikea (results in Appendix 3-10);

- Collaborated with the Vegetation Management Program to conduct and analyze a trial testing the efficacy of organic herbicides for the control of *Chromolaena odorata* (results in Appendix 3-6);

- Conducted and analyzed data from snail enclosure vegetation monitoring for the Kahanahāiki, Three Points, and Palikea North enclosures (results in Appendices 5-1, 5-2, and 5-3); and,

- Continued developing drone utilization protocols to capture photos documenting rare plants and change over time.

FIRE MANAGEMENT

This year, two fires occurred on Army training lands in the Waiʻanae Mountains on Oʻahu. One fire burned 132.6 acres at the base of Koʻiahi Ridge August 2022, see Appendix ES-3 for the full fire report. The other fire burned 1.82 acres above the fire break road at Puʻu Pane in March 2023. This area has burned many times in the past. No Oʻahu ʻElepaio critical habitat or territories were affected by this fire. Because there were no impacts to sensitive natural resources, niether a fire survey nor report were completed. Last year, there was a fire near the Kaluakauila MU that was not included in the 2022 report. From ʻŌhikilolo, ANRPO observed smoke in the Kuaokalā Forest Reserve adjacent to Kaluakauila and staff notified fire response personnel. Rapid notification allowed the fire to be promptly extinguished. There were no impacts to listed species.

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, 38 of 99 MIP PUs (38%) and 10 of 31 (32%) 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 1,974 individuals of 20 species of MIP and OIP taxa at 35 Manage for Stability reintroduction sites. In the last year, ANRPO made 185 observations at *in situ* sites and 291 at outplanting sites of Implementation Plan (IP) taxa. One new five-year plan was prepared covering *Phyllostegia kaalaensis*. This is included as Appendix 4-4. In addition, the five-year plans for *Hibiscus brackenridgei* subsp. *mokuleianus* and *Delissea waianaeensis* were updated and are included as Appendices 4-5 and 4-6 respectively.

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 reintroduction updates, 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: 38 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 2022	# 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	0	8	0%	100%	No	
		Makaha	5	5	0	0	6	75	59%	100%	No	
		Makua	4	4	0	0	4	15	33%	100%	No	
		Alectryon macrococcus var. macrococcus Total:	11	11	0	0	12	151				0 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	317	261	56	1	226	20	84%	100%	Yes	
		Kahanahaiki and Pahole	446	304	142	0	425	276	100%	100%	Yes	
		Makaha and Waianae Kai	100	52	48	0	74	12	57%	88%	Yes	
		Cenchrus agrimonioides var. agrimonioides Total:	863	617	246	1	725	308				3 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	65	15	50	0	45	0	75%	100%	No	
		North branch of South Ekahanui	130	53	77	0	98	5	100%	100%	No	
		Pahole to West Makaleha	111	71	40	0	125	46	76%	96%	No	
		Palikea (South Palawai)	696	661	35	2	685	63	77%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	1002	800	202	2	953	114				1 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	59	41	18	0	87	66	91%	98%	No	
		Makaha and Waianae Kai	21	19	2	0	21	4	67%	100%	No	
		Pahole	227	56	171	10	234	114	100%	100%	No	
		Cyanea longiflora Total:	307	116	191	10	342	184				0 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	93	17	76	0	153	152	100%	100%	No	
		Kaluaa	64	0	64	0	85	0	N/A	0%	No	
		Makaha	39	34	5	0	71	0	N/A	100%	No	
		Palikea	205	19	186	0	296	0	N/A	100%	No	
		Cyanea superba subsp. superba Total:	401	70	331	0	605	152				0 of 4

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 38 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 2022	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	94	29	65	12	74	97	72%	100%	No	
		Kawaiiki (Koolaus)	21	2	19	1	21	50	0%	0%	No	
		Opaeula (Koolaus)	112	48	64	0	108	26	27%	98%	No	
		Pahole to West Makaleha	2610	820	1790	659	2422	300	100%	100%	Yes	
		Cyrtandra dentata Total:	2837	899	1938	672	2625	473				1 of 4
Delissea waianaeensis	100											
		Ekahanui	125	68	57	0	125	58	100%	100%	No	
		Kahanahaiki to Keawapilau	180	135	45	0	143	34	83%	100%	Yes	
		Kaluaa	305	201	104	10	292	44	100%	100%	Yes	
		Manuwai	115	29	86	0	40	0	N/A	100%	No	
		Delissea waianaeensis Total:	725	433	292	10	600	136				2 of 4
Dubautia herbstobatae	50											
		Makaha	80	3	77	0	215	0	69%	100%	No	
		Ohikilolo Makai	48	48	0	0	48	700	22%	100%	No	
		Ohikilolo Mauka	139	125	14	0	139	1300	62%	100%	Yes	
		Dubautia herbstobatae Total:	267	176	91	0	402	2000				1 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	1	1	0	0	1	26	81%	0%	No	
		Kaena	886	843	43	0	1154	300	100%	0%	Yes	
		Makua	66	66	0	0	66	40	100%	100%	Yes	
		Puaakanoa	137	132	5	0	133	157	62%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1090	1042	48	0	1354	523				3 of 4
Euphorbia herbstii	25											
		Kaluaa	49	14	35	0	44	0	N/A	100%	No	
		Kapuna to Pahole	121	83	38	0	100	170	48%	100%	Yes	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Euphorbia herbstii Total:	170	97	73	0	144	170				1 of 3
Flueggea neowawraea	50											
		Kahanahaiki to Kapuna	73	10	63	0	59	32	43%	100%	No	
		Makaha	23	12	11	0	23	4	64%	83%	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:	98	23	75	0	84	39				0 of 4

Table 1 (continued)**.**

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 38 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 2022	# 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	55	0	96%	100%	No	
		Gouania vitifolia Total:	55	5	50	0	55	0				0 of 1
Hesperomannia oahuensis	75											
		Haleauau	15	0	15	0	20	0	100%	100%	No	
		Makaha	30	16	14	9	40	13	20%	100%	No	
		Pahole NAR	0	0	0	0	1	8	N/A	100%	No	
		Pualii	18	17	1	5	32	0	N/A	100%	No	
		Hesperomannia oahuensis Total:	63	33	30	14	93	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	56	46	10	7	99	4	95%	0%	No	
		Keaau	138	57	81	11	132	0	97%	100%	Yes	
		Makua	59	30	29	0	59	7	80%	100%	No	
		Manuwai	138	38	100	0	138	0	N/A	100%	No	
		Hibiscus brackenridgei subsp. mokuleianus Total:	391	171	220	18	428	11				1 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	70	40	30	0	98	60	84%	95%	No	
		Central Makaleha and West Branch of East Makaleha	4	3	1	0	9	47	94%	100%	No	
		Kahanahaiki to Pahole	102	70	32	0	74	161	100%	100%	Yes	
		Makaha to Ohikilolo	207	83	124	0	209	0	N/A	100%	Yes	
		Kadua degeneri subsp. degeneri Total:	383	196	187	0	390	268				2 of 4
Kadua parvula	50											
		Ekahanui	110	97	13	23	145	0	N/A	100%	Yes	
		Halona	148	26	122	0	158	64	100%	65%	No	
		Ohikilolo	90	71	19	0	97	66	100%	100%	Yes	
		Kadua parvula Total:	348	194	154	23	400	130				2 of 3
Neraudia angulata	100											
		Kaluakauila	59	47	12	47	38	0	N/A	100%	No	
		Makua	124	44	80	0	124	29	40%	100%	No	
		Manuwai	86	18	68	0	86	12	100%	100%	No	
		Waianae Kai Mauka	13	11	2	0	13	46	35%	100%	No	
		Neraudia angulata Total:	282	120	162	47	261	87				0 of 4

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 38 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 2022	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Nototrichium humile	25											
		Kaluakauila	39	30	9	0	107	200	84%	100%	Yes	
		Makua (south side)	53	50	3	0	53	138	2%	100%	Yes	
		Manuwai	102	101	1	0	102	0	N/A	100%	Yes	
		Waianae Kai	188	53	135	0	188	200	32%	92%	Yes	
		Nototrichium humile Total:	382	234	148	0	450	538				4 of 4
Phyllostegia kaalaensis	50											
		Keawapilau to Kapuna	0	0	0	0	0	0	100%	100%	No	
		Makaha	0	0	0	0	0	0	N/A	100%	No	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Pahole	0	0	0	0	0	10	100%	100%	No	
		Phyllostegia kaalaensis Total:	0	0	0	0	0	10				0 of 4
Plantago princeps var. princeps	50											
		Ekahanui	3	0	3	0	8	33	88%	100%	No	
		Konahuanui	41	36	5	3	41	0	0%	0%	No	
		North Mohiakea	138	63	75	0	138	30	62%	100%	Yes	
		Ohikilolo	0	0	0	0	0	14	81%	100%	No	
		Plantago princeps var. princeps Total:	182	99	83	3	187	77				1 of 4
Pritchardia kaalae	25											
		Makaleha to Manuwai	125	122	3	0	125	141	2%	46%	Yes	
		Ohikilolo	1103	178	925	483	1102	473	14%	100%	Yes	
		Ohikilolo East and West Makaleha	267	45	222	13	267	75	N/A	100%	Yes	
		Pritchardia kaalae Total:	1495	345	1150	496	1494	689				3 of 3
Sanicula mariversa	100											
		Kamaileunu	213	31	182	1	213	26	100%	100%	No	
		Keaau	16	14	2	0	16	141	68%	100%	No	
		Ohikilolo	129	12	117	0	127	162	34%	100%	No	
		Sanicula mariversa Total:	358	57	301	1	356	329				0 of 3
Schiedea kaalae	50											
		Kaluaa and Waieli	127	120	7	0	134	55	100%	100%	Yes	
		Kaluanui	110	46	64	0	110	0	N/A	0%	No	
		Pahole	76	48	28	0	111	3	100%	100%	No	
		South Ekahanui	183	151	32	60	183	85	95%	100%	Yes	
		Schiedea kaalae Total:	496	365	131	60	538	143				2 of 4

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 38 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 2022	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	217	168	49	5	200	65	82%	100%	Yes	
		Kapuna-Keawapilau Ridge	44	24	20	0	79	4	100%	100%	No	
		Makaha	140	140	0	0	174	0	N/A	100%	Yes	
		Schiedea nuttallii Total:	401	332	69	5	453	69				2 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	754	186	568	26	526	90	100%	100%	Yes	
		Keawapilau to West Makaleha	98	19	79	52	88	36	100%	100%	No	
		Makaha	221	135	86	0	325	0	N/A	100%	Yes	
		Schiedea obovata Total:	1073	340	733	78	939	126				2 of 3
Tetramolopium filiforme	50											
		Kalena	62	35	27	0	62	0	18%	100%	No	
		Ohikilolo	3549	2808	741	20	3290	2500	14%	100%	Yes	
		Puhawai	0	0	0	0	0	12	80%	0%	No	
		Waianae Kai	21	21	0	0	21	22	0%	100%	No	
		Tetramolopium filiforme Total:	3632	2864	768	20	3373	2534				1 of 4
Viola chamissoniana subsp. chamissoniana	50											
		Halona	51	51	0	0	54	3	26%	75%	Yes	
		Makaha	124	25	99	3	124	50	44%	28%	No	
		Ohikilolo	232	182	50	0	232	0	16%	100%	Yes	
		Puu Kumakalii	77	73	4	0	77	20	24%	0%	Yes	
		Viola chamissoniana subsp. chamissoniana Total:	484	331	153	3	487	73				3 of 4
Wollastonia tenuifolia	50											
		Kamaileunu and Waianae Kai	1061	815	246	274	1061	880	2%	21%	Yes	
		Mt. Kaala NAR	155	131	24	0	155	250	4%	100%	Yes	
		Ohikilolo	581	570	11	0	581	2009	6%	100%	Yes	
		Wollastonia tenuifolia Total:	1797	1516	281	274	1797	3139				3 of 3

Table 2: OIP Plants Executive Summary.

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 10 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 2022	# 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	96	72	24	6	104	44	86%	100%	Yes	
		Kaawa to Puulu	195	35	160	0	199	124	9%	63%	No	
		Kahanahaiki	96	71	25	0	103	0	100%	100%	Yes	
		Makaha Makai	247	81	166	0	147	100	76%	72%	Yes	
		Abutilon sandwicense Total:	634	259	375	6	553	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%	0%	Yes	
		Makaleha to Mohiakea	303	210	93	0	303	118	22%	100%	Yes	
		Cyanea acuminata Total:	877	359	518	52	877	190				2 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	64	40	24	0	64	76	3%	53%	No	
		Opaeula to Helemano	29	22	7	0	29	13	0%	55%	No	
		Poamoho	39	20	19	0	39	12	5%	50%	No	
		Cyanea koolauensis Total:	132	82	50	0	132	101				0 of 3
Eugenia koolauensis	50											
		Kaunala	32	6	26	2	27	141	88%	83%	No	
		Oio	4	3	1	1	4	74	77%	67%	No	
		Pahipahialua	3	2	1	21	3	291	87%	100%	No	
		Eugenia koolauensis Total:	39	11	28	24	34	506				0 of 3
Gardenia mannii	50											
		Haleauau	175	58	117	0	121	2	44%	100%	Yes	
		Helemano and Poamoho	23	23	0	0	23	18	48%	48%	No	
		Lower Peahinaia	38	9	29	0	29	46	42%	44%	No	
		Gardenia mannii Total:	236	90	146	0	173	66				1 of 3
Geniostoma cyrtandrae	50											
		East Makaleha to North Mohiakea	207	195	12	0	216	100	16%	93%	Yes	
		Koloa	6	3	3	0	3	0	N/A	100%	No	
		Geniostoma cyrtandrae Total:	213	198	15	0	219	100				1 of 2

Table 2 (continued).

Oahu Implementation Plan - Executive Summary - Plants **# of Stable IP Population Units: 10 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 2022	# 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%	5%	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	15	11	4	0	16	18	48%	100%	No	
		Koloa	18	15	3	1	18	0	60%	87%	No	
		Puu Palikea	97	7	90	0	46	0	N/A	100%	No	
		Phyllostegia hirsuta Total:	130	33	97	1	80	18				0 of 3
Phyllostegia mollis	100											
		Ekahanui	6	2	4	0	6	35	100%	100%	No	
		Kaluaa	6	6	0	4	25	49	100%	100%	No	
		Pualii	0	0	0	0	0	0	100%	100%	No	
		Phyllostegia mollis Total:	12	8	4	4	31	84				0 of 3
Schiedea trinervis	50											
		Kalena to East Makaleha	1169	402	767	377	1163	376	100%	99%	Yes	
		Schiedea trinervis Total:	1169	402	767	377	1163	376				1 of 1
Stenogyne kanehoana	100											
		Haleauau	13	2	11	0	16	1	100%	100%	No	
		Kaluaa	13	5	8	0	14	79	100%	100%	No	
		Makaha	0	0	0	0	0	0	N/A	100%	No	
		Stenogyne kanehoana Total:	26	7	19	0	30	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, predator-resistant snail enclosures; and 5) translocating snails into snail enclosures. ANRPO collaborates and coordinates regularly with the State of Hawai‘i’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 seven managed populations within the six ESUs. Two of the seven managed field populations have over 300 snails; this is two fewer 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 Pu‘u Hāpapa 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	Kahanahāiki	245[1]	60 (Kahanahāiki) 125 (Pahole)	Kahanahāiki/Pahole
B1	‘Ōhikilolo	324	97[2]	Three Points (Makaleha West)
B2	East Makaleha	229[2]		
C	Lower Ka‘ala NAR & Schofield Barracks West Range	295	33	Ka‘ala
D	Central Kalua‘ā to Schofield Barracks South Range to Mākaha	634	569	Hāpapa (Kalua‘ā and Wai‘eli)
E	‘Ekahanui	105	83	Palikea North (Palikea)
F	Pu‘u Palikea	246	79	Palikea South (Palikea)

[1] Count includes TCM from Pahole and total translocations from old Kahanahāiki enclosure
[2] The majority of snails in the Three Points enclosure came from B2

During this reporting period, ANRPO continued to maintain the Kahanahāiki, Makaleha West, Ka‘ala, Pu‘u Hāpapa, Palikea North, and Palikea South snail enclosures. Following a breach by a rat, all snails from the old Kahanahāiki snail enclosure were translocated to the new snail enclosure last year. After two searches with negative results, the old snail enclosure at Kahanahāiki was deconstructed. Since a population of yellow crazy ants (YCA) (*Anoplolepis gracilipes*) was detected in the new enclosure, their distribution has expanded in this location to approximately 2 acres surrounding the enclosure. After early treatment failed to eradicate this population of YCA, application of MaxForce has shown positive results. ANRPO is still working to determine the predation threat to tree snails and is continuing to explore other methods of control. The temporary snail enclosure at Three Points was decommissioned in October 2022 and also deconstructed and no longer contains snails. Translocations continued into the Ka‘ala enclosure this year, and staff observed small snails during monitoring surveys, indicating this population is thriving. Despite several predator incursions (rodents and Jackson’s chameleons) this year, the snail population in the Pu‘u Hāpapa enclosure continues to increase. Aggressive rodent control and chameleon sweeps continue, and the enclosure will be rebuilt in the upcoming year. The Palikea North enclosure is being maintained for habitat and predator control, and the temporary enclosure within was deconstructed this year. Translocation continued into the Palikea South enclosure, which will also be rebuilt in the upcoming year.

Some wild snail populations occur in steep areas and are typically monitored on rappel and foot. However, this year these sites were monitored only on foot where possible. Due to this monitoring strategy, counts are lower when compared to rappel years.

ANRPO and partners continue to monitor population trends for *A. mustelina* within the Kahanahāiki, Makaleha West, Kaʻala, Puʻu Hāpapa, Palikea North, and Palikea South snail enclosures using timed-count monitoring. Also, the State (including SEPP) is actively restoring and managing threats at the Pahole snail enclosure. For more details on rare snail management, see Chapter 5 – *Achatinella mustelina* Management.

RARE VERTEBRATE MANAGEMENT

Currently, ANRPO manages three species of rare vertebrates: the Oʻahu ʻElepaio (*Chasiempis ibidis*); the ʻŌpeʻapeʻa, or Hawaiian hoary bat (*Lasiurus cinereus semotus*); and Honu or Hawaiian green sea turtle (*Chelonia mydas*). In addition, seasonal wetlands are monitored for native wetland birds. Management consists of active predator control for the Oʻahu ʻElepaio, surveying for ʻŌpeʻapeʻa at Army installations across Oʻahu, and working with partners to monitor and manage threats to nesting Honu on Army beaches.

This year ANRPO controlled rats to protect 123 pairs of Oʻahu ʻElepaio at five management sites, exceeding the required 75 pairs for species management in the Oʻahu BO. Rodent control is implemented as landscape-scale grids, which benefits Oʻahu ʻElepaio as their population continues to grow and expand. At managed sites, predator control is conducted using A24 automatic traps.

This year Oʻahu ʻElepaio survey efforts again focused on abundance surveys in and around managed areas in the Waiʻanae Mountains, and surveys are expected to be completed by the end of 2023. Results so far, compared to the 2004-2010 surveys, show a 168% increase in Oʻahu ʻElepaio abundance in the Waiʻanae Mountains. For more information, see the Chapter 6 - Rare Vertebrate Management and Chapter 8 – Rodent Management.

There was one fire this year in March 2023 that burned 1.82 acres above the fire break road at Puʻu Pane. No Oʻahu ʻElepaio critical habitat or territories were affected by this fire.

Endangered waterbird surveys are typically conducted annually and after flooding events. During this reporting period, no significant flooding occurred at Dillingham Army Airfield. Therefore, no surveys were conducted and no observations were reported to or made my ANRPO staff.

In previous years, the Hawaiian hoary bat was detected via listening stations flying over all Army installations on Oʻahu. 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 March 2023 the USAG-HI Tree Cutting Moratorium policy was re-signed, renewing the 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 20 bat surveys over a total of 11 hours (not including travel time). A total of 71 trees were screened for bats during the summer of 2023. This is more total surveys and time spent than last year, but fewer trees were surveyed, and again no bats were detected.

A Hawaiian green sea turtle nest was identified in July 2023 at the beach at Dillingham Military Reservation. It was determined no eggs were laid and the nest was a false crawl. 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) collaborated with the Division of Forestry and Wildlife (DOFAW) and the Oʻahu Plant Extinction Prevention Program (OPEPP) to outplant *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; and 5) facilitated surveys by SERDP grant researchers from the University of California at Berkeley. Surveys for *Hylaeus* were not conducted this report year. All activities are summarized in Chapter 7 – Rare Insect Management.

ANRPO facilitated entomological surveys by SERDP researchers. The primary purpose of this research is to develop an effective biosecurity monitoring system for invasive terrestrial arthropods using DNA "meta-barcoding" of bulk samples. Survey sites included Puʻu Hāpapa, Kaluaʻā, Schofield Barracks East Range, Līhuʻe and Kahuku Training Area. The use of eDNA in these surveys should provide interesting results that may have broad applications useful for conservation. See research project description in Research Projects section below.

RESEARCH PROJECTS

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

- Austin, Khyl. *et al*. Surveys for invasive and native Lepidoptera on Oʻahu Army lands. UH.
- Gabrielson, Sara M. E. *et al*. 2023. DNA metabacoding reveals diet composition of invasive rats and mice in Hawaiian forests. Biol Invasions.
- Gabrielson, Sara M. E. et al. 2023. Measuring the macroecological and local effects on plant-animal interaction using artificial fruits. (not published yet)
- Gillespie, Rosemary. *et al*. This team 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. This project will be ongoing for the next five years.
- Greene, Kauanoe. *et al*. 2023. Intraspecific variation in functional traits and drought tolderance of *Dodonaea viscosa* to inform restoration under climate change. UH Mānoa.
- Madson, Austin. *et al*. 2022. A Near Four-decade Time Series Shows the Hawaiian Islands Have Been Browning Since the 1980s. Environmental Management, (2023), 71:965-980.
- Price, Dr. Melissa. ANRPO staff worked with undergraduates in Dr. Melissa Price's Environmental Problem-Solving class (NREM), who conducted a structured decision-making exercise around management plans for *Hibiscus brackenridgei* subsp. m*okuleianus* at MMR.

- Sperry, Jinelle Dr. *et al*. Demonstration of Environmental DNA as a Management Tool for Endangered and at-risk Pollinator Species on Military Lands. U.S. Army ERDC-CERL.

- Wagenman, Isaiaha and Dr. Yinphan Tsang. ANRPO staff provided data to graduate student Wagenman for a study looking at potential connections between natural resource management activity and watershed health as characterized by stream flow and sedimentation.

- Young, Sophie. Sugar transport in the context of C4 photosynthesis in tree-form Hawaiian *Euphorbia*. Lancaster University.

- Two 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.

    - Case, Samuel B. *et al*. 2023. Effects of fruit novelty on feeding preference in four globally invasive frugivorous birds. Journal of Animal Ecology.

    - Case, Samuel B. and C. E Tarwater. 2023. Exploitation competition between seed predators and dispersers introduced to Hawaiian forests. Ecology.

- ANRPO-annually funds graduate assistantships (GAs). Three GAs were awarded in 2021.

    - 1) Sunyoung Park (Dr. Anna Sugiyama and Dr. Curt Daehler) studied *Dubautia herbstobatae* breeding biology.

    - 2) Nikki Preston (Dr. Melissa Price) studied O‘ahu ‘Elepaio nest predation.

    - 3) Yoko Uyehara and Kathrine Fryer (Dr. Qi Chen) mapped invasive weeds using high-resolution aerial images and AI models.

Funding for the last two projects was continued for a second year, and concluded in the summer of 2023. While funding was not continued for the first project, staff continue to provide in-kind assistance and access to study plants. New GAs were awarded this year and will be starting work in the 2023-2024 school year.

    - 1) Annie Hall (Dr. Nicole Hynson) will be studying the effects of local mycorrhizal communities on Hawaiian *Gardenia*.

    - 2) Kevin Faccenda (Dr. Curtis Daehler) will be conducting biogeographical modeling of incipient invasive plants.

    - 3) Tressa Hoppe (Dr. Tamara Ticktin) will be studying the ecological benefits of native ferns, in particular seedling recruitment. The first two projects will begin in the Fall 2023 semester, and the third, which is an on-going project, will be funded starting Spring 2024.

TABLE OF CONTENTS

**Starred appendices are printed at the end of Chapter 9. All appendices are included in electronic format on a CD enclosed with this document.*

CHAPTER 1: UNGULATE MANAGEMENT

Threat control for ungulates is summarized for each Management Unit (MU) or non-MU land division within this chapter from the 2022-2023 report year. Begining with Section 1.1 - Project Highlights, notable developments are presented such as large fence replacement projects, fence construction, ungulate control data and new tool developments. Next, in Section 1.2 - OIP/MIP Management Unit Fence Status a snapshot of the fences maintainted by the Army Natural Resrouce Program on O'ahu (ANRPO) highlights the number of Managed for Stability (MFS) taxa represented within those units, the status of each fence and the current threats. Finally, in Section 1.3 - Future Projects, highlights the upcoming fence repairs, and ungulate removal plans.

1.1 PROJECT HIGHLIGHTS

1.1.1 Summary of Repair & Construction Efforts

In the 2022-2023 report year, a total of 193 fence checks were completed over 2,011 person hours, and 1,144 meters of fence were repaired. A summary of repairs can be found in Table 1 with reasons for repair listed in the far-right column; a majority of that effort was focused on the installation of 1,010 meters of mesh in response to a rising trend in ungulate ingress. It is anticipated that additional MUs will require a reinforcement of mesh installations as the current fence design allows smaller ungulates to fit through the portions of the fence closest to the ground. Thus, reinforcement will continue to contribute to a large component for repair. In addition, as ANRPO's infrastructure ages through time, weathering and the spread of corrosion will play an equally significant yet increasing role in planning and repair, and will be addressed throughout the Ungulate Management section.

Table 1: Ungulate fence repair and construction summary for report year 2023.

Fence Code	Fence Name	IP Management Unit	Fence Length (m)	Distance Repaired (m)	Reason for repair/construction
EKA-A	ʻĒkahanui MU Perimeter	ʻĒkahanui	4360	3	Tree fall. A tree was removed from the fence. No other damage to the fence.
KAH-A	Kahanahāiki MU Subunit I Perimeter	Kahanahāiki	3050	7	Flooding and erosion. A buildup of dirt and debris along the fence was removed.
KAL-A	Kaluaʻā/Waiʻeli Section A (Perimeter)	Kaluaʻā	4780	1027	Small piglets were observed entering the unit through the lower sections of panel in 2020. This repair is a continuation of efforts to reduce the fence square spacing by installing a smaller mesh. In addition, several trees were removed, and a cross-over was installed.
KAL-C	Kaluaʻā/Waiʻeli Section between I and II/III	Kaluaʻā	36	5	Tree fall. Several trees were removed from the fence and no other damage was observed.

Table 1 (continued).

Fence Code	Fence Name	IP Management Unit	Fence Length (m)	Distance Repaired (m)	Reason for repair/construction
KAP-A	Kapuna/Keawapilau Perimeter	Kapuna/Keawapilau	5150	3.50	Vandalism. A small section of fence was patched after it was peeled back. Tree fall - various trees were removed, and the fence was patched. No other significant damage was observed.
KTA-A	ʻŌʻio	ʻŌʻio	430	5	Tree fall. Several trees were removed, and a small portion of the fence was patched due to digging pressure.
KTA-B	Pahipahiʻālua	Pahipahiʻālua	370	3	Vandalism. Several patches were made due to deliberate cuts in the fence and unrelated erosion.
KTA-C	Kaunala	Kaunala	600	17	Tree fall and digging. High winds and significant digging from ungulates were the primary mode of damage to this fence.
KTA-D	Kaleleiki	Kaleleiki	355	2	Tree fall. A tree was removed from the fence. No other damage to the fence observed.
LEH-C	Three Points	Makaleha West	640	22	Digging and erosion. A crossover was built, and sections of skirting were anchored due to digging and erosion from ungulates.
LIH-A	Kamaohanui	Līhuʻe	1360	1	Repaired a small section due to a blowout in the fence.
LIH-C	Firebreak Road	Līhuʻe	3980	2	Tree fall. Removed various trees from the fence.
LIH-D	Kalena-Kaʻala Ridge	Līhuʻe	4960	1	Tree fall. A small section was repaired due to another tree falling on the fence. Alarming increase in ungulate presence observed outside of the fence from the Kaʻala Strategic to Kalena in the Waiʻanae Kai Forest Reserve. State employees were informed of the damage.
MAK-C	Mākaha Subunit I	Mākaha	2520	8	Erosion and tree fall. A section of fence was repaired due to tree fall and subsequent erosion.
MAK-D	Mākaha Subunit II	Mākaha	2750	4	Tree fall and erosion. Removed several trees that caused various impacts to the fence. Significant erosion on the main trail to Kaʻala continues to be a challenge to fence maintenance and water bars that divert the water off the trail could serve as a solution.

Table 1 (continued).

Fence Code	Fence Name	IP Management Unit	Fence Length (m)	Distance Repaired (m)	Reason for repair/construction
MAK-E	Kamāʻili (Mauka and Makai)	Kamāʻili	1160	13	Tree fall. Various trees were removed from the fence. Erosion and blowouts continue to pose a significant hazard to these fences, the future projects section will discuss new methods of baffle construction and fence reinforcement
MMR-A	Kaluakauila	Kaluakauila	3150	5	Tree falls and erosion. Various trees were removed, and small sections of the fence were patched due to erosion. Ungulate sign was observed outside the fence and near a common native outplanting. Since then, no further sign has been detected thus far.
MMR-B	ʻŌhikilolo Section A and B	ʻŌhikilolo	7190	6	Erosion. Skirting was pinned down. Significant pressure from goats and extensive weathering continues to degrade the fence along the crest line.
MMR-K	MMR Perimeter (Makaleha West)	MMR no MU	983	4	Digging. A section of skirting was pinned down due to a continuation of ungulate pressure into Mākua Valley.
PUA-A	North Pualiʻi	Pualiʻi North	1730	6	Erosion and tree fall. A section of skirting was pinned down due to continued erosion and a tree was removed from the fence line.
				Total 1144	

The history of fence construction in the program begins in 1996, with the first fence built in Kahanahāiki, and between 2006 - 2012, the majority of the fences were constructed. From 2013 – 2021 the construction phase came to an end with the *Megalagrion xanthomeles* fence on Dillingham Military Reservation. During the initial fence installation repair was not required, however as time progressed, extenisve repairs became necessary. This is supported by data in Figure 1 illustrating that the rate of repair is in a general rising trend. However, it is important to note that ANRPO began methodically tracking repair in 2010 after the creation of the data base. Records of data prior to 2010 are incomplete and do not provide an acurate description of repair. Therefore, examing the years between 2010 - 2023 provides the most accurate rate of repair. Figure 1 also illustrates that this year's repaired distance of 1144 meters is slightly lower when compared to a moving average (defined as the average value of the last three years) of 1,764 meters/year. Looking back to 2020 and 2022 reveals two peaks that represent increased rates of repair including reinforcement projects due to ungulate ingress in Mākaha and Kaluaʻā, located in the Waiʻanae Mountain range, and large-scale repairs due to rust for ʻŌpaeʻula, and Koloa, located in the Koʻolau Mountain Range. As rust spreads and ungulate pressure increase across the program's infrastructure, ANRPO will need new ways to anticipate, plan and respond to the compounding degradation, which will be discussed in Section 1.3.

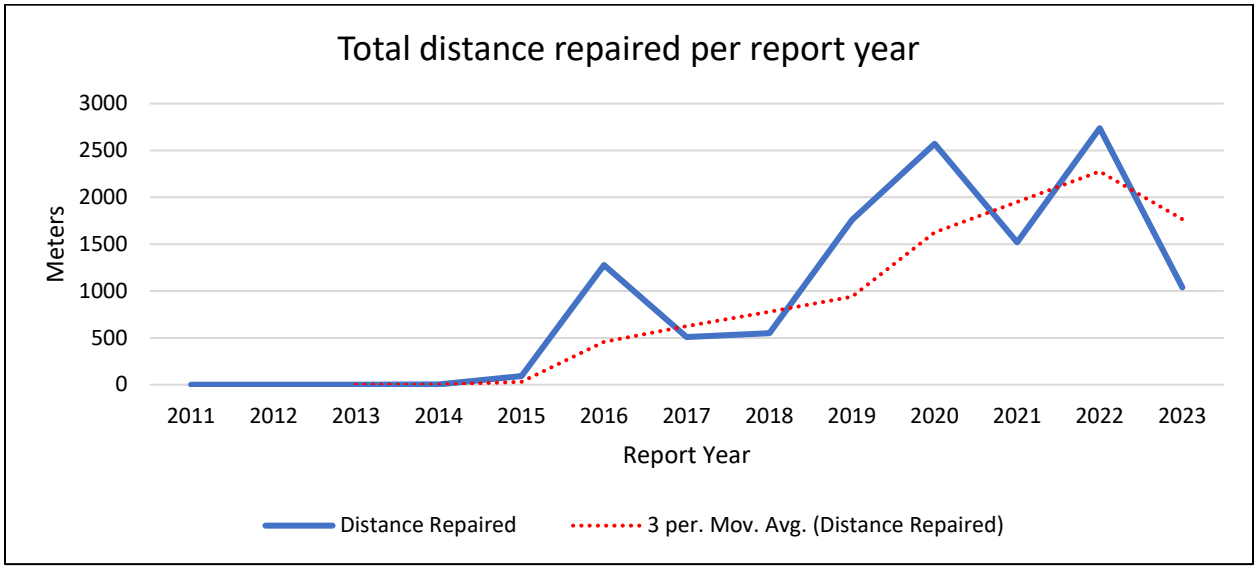

Figure 1: A graph of fence repair from 2010 to 2023. The blue line indicates distance repaired per year and the red dotted trend line indicates the average rate of repair using a moving average defined as the average value of the last three years.

1.1.2 Summary of Fencing Efforts

- **Kalua‘ā/Wai‘eli:** In an ongoing effort to reduce ungulate ingress into the unit, staff have installed mesh over the fence with 300 meters remaining to be covered. Initial efforts to reinforce the fence began in January of 2020 on the north side of the unit, meanwhile an observation by the State of Hawai‘i Department of Land and Natural Resources (DLNR) noted several piglets entering and exiting the unit at the top of the south line in November 2021. The north side was finally completed in April 2022, and staff began work on the south side in November 2022 with an installation of an additional 1,010 meters of mesh represented by the red line in Figure 2. To date staff have attached roughly 1,984 meters of mesh around Kalua‘ā.

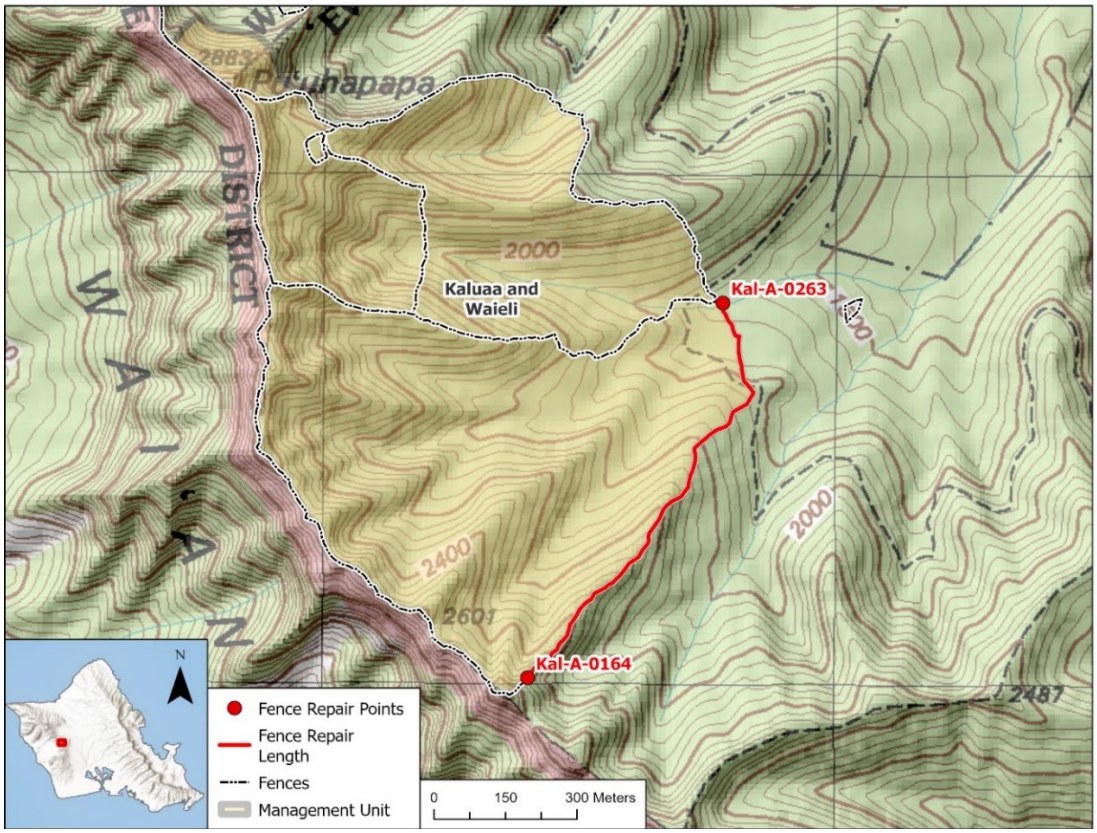

Figure 2: A map representing the location of fence reinforcement for Kalua‘ā between 2022 and 2023. The red line indicates the section reinforced with mesh and the red points indicate specific fence tags.

- **Makaleha West:** Roughly 22 meters of fence and skirting were repaired by pinning down anchors and installing several t-posts. The primary factor creating the need for repair was erosion due to significant digging from ungulates outside the fence. Staff also installed a cross-over between an internal fence and the snail enclosure to reduce wear to the fence during traverses and to assist program volunteers.

- **ʻŌhikilolo:** There are large areas denuded of vegetation due to weathering, mass movement of sediment, and erosion caused by overgrazing from goats, which continues to place pressure on the infrastructure across the unit. Notable areas of erosion affect a wide area spanning in elevation from Red Dirt Puʻu and the Forest Patch to lower elevations as viewed in Figure 3. Staff pinned down roughly six meters of skirting and dropped panels shown in Figure 4 to address gaps under the fence in Q2 of 2023. Projects to address this issue will be discussed in Section 1.3.

Figure 3: A section of erosion adjacent to the fence in ʻŌhikilolo. This view is looking back towards the cabin facing east.

Figure 4: Staff repairing a section of the fence in ʻŌhikilolo due to ongoing erosion.

1.1.3 Summary of Ungulate Removal Efforts

Through the report year, staff removed a total of 28 ungulates across four MUs. Observations recorded a general increase in erosion due to ungulate activity on several fences, most notably Kaʻala and ʻŌhikilolo. Most of the captures originate in Mākua Military Reservation (MMR), as this unit still has a remaining pig population and the amount of time required to declare MMR ungulate free is currently undefined. Efforts to estimate the remaining number of pigs within MMR will be discussed in Section 1.3.

- **Kaʻala:** Staff from ANRPO and DLNR observed an increase in ungulate activity in three locations: within the Natural Area Reserve (NAR), adjacent to the Kaʻala Snail Enclosure, and directly outside the fence in the Waiʻanae Kai Forest Reserve. At this point in time, explanations for the recent surge in pigs and a point of entry are unknown though field observations indicate reduced resources within the valleys below and a possible increase in hunting pressure all driving pigs up in elevation. In addition to scheduled quarterly fence checks, staff are responding to the increased pressure by implementing baited box traps within the unit to remove pigs and game cameras to monitor further sign and identify possible ingress locations.

- **Kahanahāiki:** Historically, control eforts were initially installed below the Kahanahāiki fenceline in MMR to keep ungulate pressure off of the fence, and to reduce the population in MMR. In 2018, ANRPO lost two Conservation Control Technicians that intitaed control when

needed and inspected these areas for ungulate sign. In 2021, a new technician was hired and it was planned to survey these areas again when access to MMR became available. In the 2022 report year, staff began to survey older areas of control in the hanging valleys below Kahanahāiki. The first check in Q4 of 2022 re-established a trail, found scat, and in response staff initialed control. In Q2 of 2023 a resurvey of the area recorded three new captures resulting in the removal of a mature boar, and two adolescent sows in Flueggea Gulch.

- **Kaluakauila**: Staff responded to old sign observed in Q3 of 2022 by initiating control in Punapōhaku, a gulch within the MMR MU adjacent to the Kaluakauila fenceline. A follow-up survey revealed no obvious signs of trails or scat present around the unit or near rare taxa. In Q4 of 2022, staff observed pig scat within the Kaluakauila MU near a common restoration area. In Q1 of 2023, staff did not observe further ungulate sign, however, a thorough scan of the area is necessary to locate the area of ingress and deem the fence ungulate free.

- **Makaleha West (Three Points**): A large boar of 24 months was caught in a box trap adjacent to the fence. This trap was set up to reduce the pressure to the outside of the fence and to halt erosion due to extensive digging. In response, staff made repairs to the skirting and anchoring system to close possible entry points along the fence.

- **Mākua Military Reservation (MMR)**: During the reporting year staff removed a total of 22 pigs from an area ranging from Weed Control Area (WCA) ‘Ōhikilolo-15 to ‘Ōhikilolo-18 in the valley and from WCA MMRnoMU-18 to Kahanahāiki above. Beginning with the valley below, control started in Q3 of 2022 following up with two more efforts in Q4. However, two additional unexploded ordinances (UXO) were discovered, and entry was halted until disposal could occur. Meanwhile, the survey for old control points dating back to 2017 continued in the hanging valleys and ridges that serve as the boarder for MMR in Q4 of 2022. Staff started in the southern section of the ridges adjacent to Makaleha West and moved north to Kahanahāiki, which resulted in the removal of four pigs - two adults, and two adolescents. In February 2023, the recently identified UXO were disposed of, and staff followed up on previous control efforts in the lower sections of the valley resulting in an additional 18 captures in Q2 of 2023. Discussion regarding further ungulate removal plans in MMR will be covered in Section 1.3.

- **‘Ōhikilolo MU**: Overgrazing by goats outside the ‘Ōhikilolo fence on the remaining vegetation holding the soil together has created vast areas across the ridge that are heavily denuded of vegetation. Control is restricted to within the unit as the area outside of the fence serves as the boundary to a public hunting area or is on private land in Kea‘au. Occasionally goats breach the fence and cross into the unit prompting staff to initiate control or elevate sections of fence. In Q3 of 2022, staff responded with traps to observations of two juvenile goats or “kids” within the unit adjacent to ‘Tetramolopium Peak’. One goat was controlled after the initial survey, and two additional surveys in Q1 of 2023 revealed no additional sign. It has been assumed that the juvenile goat found a way out of the unit or is no longer alive due to its age and specific need for nutrition in the form of milk from a doe.

1.1.4 New Tool Development

- **Pig Brig:** ANRPO began trialing in Q1 of 2023 trialing the Pig Brig by Pig Brig Trap Systems in controlled settings. It is a light weight, transportable, circular, self-resetting live trap made of rope woven into a net like system. It can be set up with T-posts, or in a forest setting in can be attached directly to trees (no T-posts). Pigs in the surrounding area are habituated to the trap location by baiting the site with fermented corn at the same time of day, once a week for three weeks with the

net fixed above (Figure 5). After the pigs have been conditioned to the site, they establish a regular feeding pattern in the trap roughly around the same time of day. The trap is monitored via celluar game camera that sends updates on pig interaction with the trap and presence in the area. With constant monitoring, staff can alter bating methods to adjust for weary pigs.

Figure 5: Conditioning period of the Pig Brig. Fermented corn is set out at regular intervals for three weeks. This setup uses T-posts as an anchoring system.

After the conditioning period the net is dropped, and the trap is tensioned appropriately for capture. Typically, the pigs will arrive at the site around the established feeding time and will root underneath the net for bait (Figure 6). As juvenile pigs enter the system, mature pigs follow, and an entire sounder may be removed from the landscape overnight (Figure 7). The design of the trap allows for continuous reset as the net falls back into position after each capture. Subsequent resets can be planned for boars that are difficult to capture.

Figure 6: Capture period of the Pig Brig. The net is lowered and ungulates familiar with the net enter the trap.

Figure 7: An entire sounder has been captured in one go using the Pig Brig System.

After trialing the Pig Brig in an open setting, ANRPO Staff set up the system in a forested area that represents a typical MU where mobility and speed or safety may be desired due to UXO presence. In this set-up T-posts might not always be available nor safe to utilize (Figure 8). After two attempts, Staff improved their set-up and break down time, however this test produced no captures as the area was likely compromised due to high human activity adjacent to the trap in addition to possible hunting dog presence. As a result, the capture strategy was adjusted to include alternate locations during the test period. With practice and proficiency with the forest set-up, ANRPO Staff will be poised to respond quickly to incursions within all 28 MUs that allow weekly access and cellular game camera monitoring.

Figure 8: An example of the Pig Brig deployed with the forest set-up when an area has UXO concerns, or speed and mobility are desired. In this set-up, the Pig Brig is tied to supporting trees and no T-posts or metal anchors are utilized.

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 (MFS) Population Units 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 Mākua Implementation Plan (MIP) and Table 3 has information for those units that protect species outlined in the O‘ahu 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												
Kahanahāiki	Kahanahāiki I	Yes	Yes	64/64	1996	14	1	2			Complete and ungulate free.	None
	Kahanahāiki II	Yes	Yes	30/30	2013						Complete and ungulate free.	None
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002	6		1			Complete and ungulate free.	None
ʻŌpaeʻula Lower	ʻŌpaeʻula Lower	Yes	Yes	26/26	2011	2		2	1		Complete and ungulate free.	None
ʻŌhikilolo	ʻŌhikilolo	Yes	No	3885/574	2002	13	1	1			The Northern Mākua 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, 32 goats have been able to breach the fence. One goat was removed in the past reporting year. Sections of the fence were replaced in 2014 and 2016.	Goat Errosion Corrosion
ʻŌhikilolo Lower	ʻŌhikilolo Lower	Yes	No	70/70	2000	3					This strategic fence is complete.	Pig
Puʻu Kūmakaliʻi	Puʻu Kūmakaliʻi	No	-	-	-	3					No fencing needed but is partially included within the Līhuʻe fence. Any potential goat issues will be dealt with as they arise.	None
STATE OF HAWAIʻI DEPARTMENT OF LAND AND NATURAL RESOURCES (DLNR)												
ʻĒkahanui	ʻĒkahanui I	Yes	Yes	44/44	2001	4	1	2		1	Completed by the Nature Conservancy of Hawaiʻi (TNCH). Staff and partner organizations 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.	Pig
	ʻĒkahanui II	Yes	Yes	165/159	2009						Complete and ungulate free.	Goat
Haili to Keālia	Haili to Keālia	No	-	-	-	1					As per DLNR Division of Forestry and Wildlife staff 'no fence needed'. Pigs are considered low risk in this MU	None
Kaʻena	Kaʻena	Partial	-	-	-	1					There is a predator proof fence installed by the State but it only protects a portion of the *Euphorbia celastroides* var. *kaenana* plants. Pigs are considered a low risk in this MU. However, sign was observed in August 2022 that conicided with the opening of the dog and knife hunting period for the Kuaokala Game Management Area	Rat Pig

Table 2 (continued).

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete	# MFS PUs					Notes	Current Threats
						MIP		OIP				
						P	I	P	I	V		
Kalua'ā/Wai'eli	Kalua'ā/Wai'eli I	Yes	Yes	110/99	1999	7	1	3	1		Completed by TNCH and ungulate free.	None
Kalua'ā/Wai'eli	Kalua'ā/Wai'eli II	Yes	Yes	25/17	2006						Completed by TNCH.	None
	Kalua'ā/Wai'eli III	Yes	Yes	43/11	2010						Complete and ungulate free.	None
Kea'au	Kea'au II	Yes	Yes	8/33	2014	1					Complete and ungulate free. DLNR requested to reduce the size of original proposed MU fence.	None
	Kea'au III	Yes	Yes	4/33	2015						Fence was built by the O'ahu Plant Extinction Prevention Program (OPEPP) with assistance from the Wai'anae Mountain Watershed Partnership and ANRPO staff.	None
Kea'au/Mākaha	Kea'au/Mākaha	Yes	Yes	1/3	2010	1					Complete and ungulate free.	None
Manuwai	Manuwai I	Yes	Yes	166/166	2011	8	1				Complete and ungulate free.	None
Nāpepeiao'ōlelo	Nāpepeiao'ōlelo	Yes	Yes	1/1	2009						Complete and ungulate free.	None
Pahole	Pahole	Yes	Yes	224/224	1998	6	1				Complete and ungulate free.	None
Palikea	Palikea I	Yes	Yes	25/21	2008	2	1		2		Complete and ungulate free	None
Kapuna Upper	Kapuna I/II	Yes	Yes	32/182	2007	4	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						Complete and ungulate free	None
Wai'anae 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 Kamā'ili unit due to the continuous rock fall damage and threat to personnel. Fence not being maintained.	Pig/Goat

Table 2 (continued).

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete	# MFS PUs					Notes	Current Threats
						MIP		OIP				
						P	I	P	I	V		
Makaleha West	Makaleha West	Yes	Yes	11/11	2001	5					All PU fences are complete and pig free. The Three Points fence was expanded in 2018.	None
BOARD OF WATER SUPPLY												
Kamaile'unu	Kamaile'unu	Yes	Yes	5/2	2008	1			1		Both of the *Sanicula mariversa* PU fences at Kamaile'unu and Kawiwi are completed and ungulate free.	None
Mākaha	Mākaha I	Yes	No	85/96	2007	8	1				Complete and ungulate free	None
	Mākaha 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												
Ka'ala-Army	Ka'ala	Yes	Yes	183/183	2008			4	1		Strategic fences complete. Pigs were caught in 2010, and three pigs were caught in 2014. New fence extension completed in August 2018. Two pigs were recently caught in the Ka'ala Nar in 2023.	Pig
Kaunala	Kaunala	Yes	Yes	5/5	2006			1			Complete and ungulate free.	None
Līhu'e	Līhu'e	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 the unit.	Pig
'Ō'io	'Ō'io	Yes	Yes	3/3	2006			1			Complete and ungulate free.	None
'Ōpae'ula / Helemano	'Ōpae'ula / Helemano	Yes	Yes	271/271	2001/ 2007			1			Complete and ungulate free.	Rust
'Ōpae'ula Lower	'Opae'ula Lower	Yes	Yes	16/16	2011	1		1	1		Complete and ungulate free.	Rust

Table 3 (continued).

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		
Pahipahi'ālua	Pahipahi'ālua	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 taxon *Hesperomannia swezeyi* occurs within this MU. DLNR is proposing to build a larger unit encompassing this proposed fence. Army also put in for funding as INRMP fence.	Pig
Tripler Megalagrion xanthomelas Fence	Tripler Army Medical Center (TAMC)	Yes	Yes	.23/.23	2021						Complete and ungulate free.	None
Dillingham *MegXan* Fence	Dillingham Military Reservation (DMR)	Yes	Yes	.03/.03	2021						Complete and ungulate free.	None
STATE OF HAWAI'I DEPARTMENT OF LAND AND NATURAL RESOURCES												
Huliwai	Huliwai	Yes	Yes	.3/1	2014			1			Complete and ungulate free.	None
'Ēkahanui	'Ēkahanui 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 Līhu'e 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
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 Puali'i	North Puali'i	Yes	Yes	25/25	2006	1		1	1		Completed by TNCH. Ungulate free.	None
BOARD OF WATER SUPPLY												
Kamā'ili	Kamā'ili	Yes	Yes	9/7	2014	1		1			Complete and ungulate free.	None
HAWAI'I RESERVES INC.												
Koloa	Koloa	Yes	Yes	176/160	2012			4			Complete and ungulate free.	Rust

Table 3 (continued).

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		
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 Koʻolau 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 Hālawa	North Hālawa	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												
Kīpapa	Kīpapa	Yes	Yes	120/4	2015						U.S. Fish and Wildlife Service constructed a 120-acre unit.	None

1.3 FUTURE PROJECTS

There are 87 fences totaling 94,759 meters, and to date, 11,435.40 meters or 12% of the total distance were repaired since they were constructed. At the inception of ANRPO, the estimated lifespan of these fences was projected to be 20 years. Considering that the average age of ANRPO's fence infrastructure is 15 years old, and 22 individual fences are over 20 years old, highlights that they have likely exceeded their life expectancy. With several fences showing their age, it is necessary to develop tools to demonstrate the remaining lifespan and the amount of time needed to replace the infrastructure at the current level of repair.

To approximate what the repair rate at the end of the decade may look like, a simple forecast was generated with Excel Forecast. Figure 9 expands on Figure 1, and projects repair/year out to 2030. This forecast encompasses the last 12 years of data and is back-tested to 2019 with a mean absolute scaled error of 0.64 suggesting a reasonable projection. It illustrates a rising trend in repair with an estimated rate of 1500-3700 meters/year with an average of 2600 meters/year. If staff conduct repairs at an average of the 2030 forecasted rate, it will take roughly 32 years to replace the remaining fences, however, this number is only based on previously repaired distance and does not consider the stochastic nature of catastrophic events. Furthermore, this number is likely an underestimation and will likely be higher by 2030 as the rate of erosion and fence degradation due to corrosion/rust still needs to be factored into this assessment.

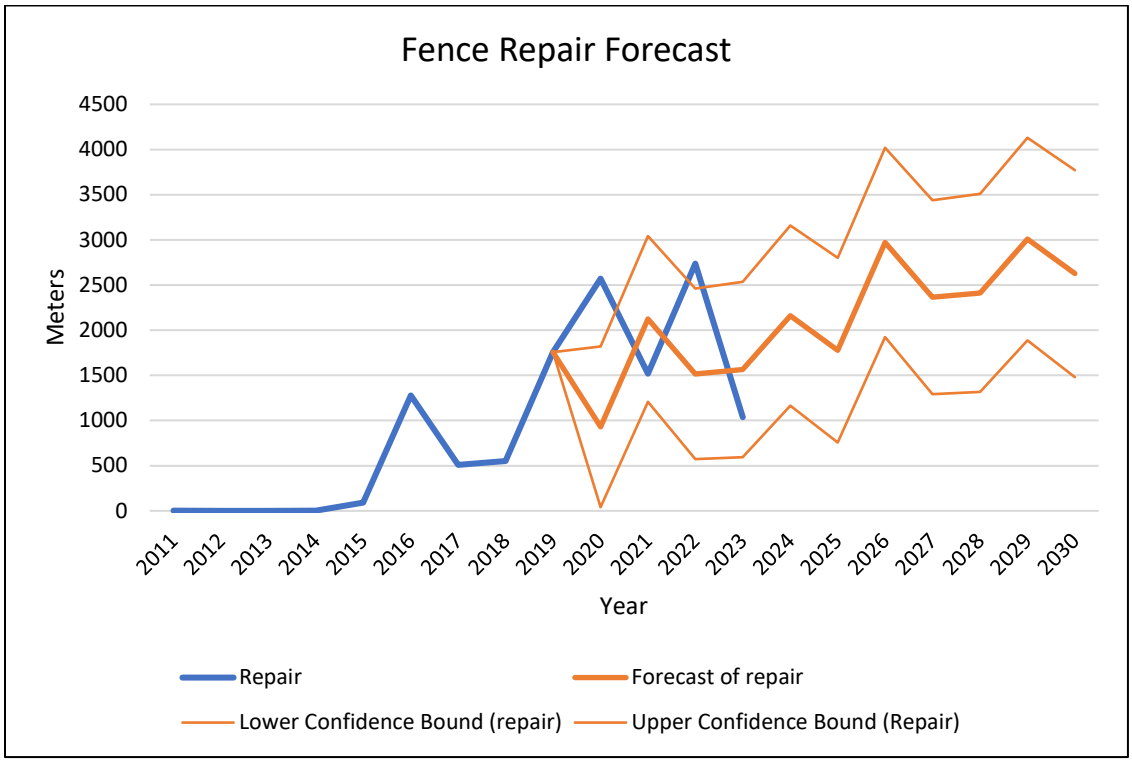

Figure 9: A graph forecasting future rates of repair.

Many of the stochastic factors impacting ANRPO's fence infrastructure are linked with the change in the local and global climate. These factors can be divided into physical, chemical and biological processes

and further subdivided into small or large scale i.e. infrastructure-wide impacts. These processes have adverse impacts on ANRPO's fences, and will likely increase as climate change continues to exacerbate severe weather conditions. As the climate continues to warm, the atmosphere holds more moisture, which creates conditions for storm activity to intensify, thereby leading to increased huricane wind intensity and rainfall (Tarolli *et al.* 2023). Thus, increasing the rate of physical, singular events that impact fences such as tree fall, flooding, and landslides. This coincides with the fact that large wind and rain events across the state create the impetus for the majority of the program's repair efforts as noted in Table 1.

Fire represents a physical, large-scale imapct to ANRPO's fence infrastructure as heat significantly impacts galvanic coatings. As a state-wide drought persists, conditions favor the spread non-native grasses, left over from converted pastureland, into lower elevation native forests in Hawai‘i (Hawbaker *et al.* 2017). These non-native grasses contribute to the fuel loads that exacerbates several of the brush fires in the state dating back to 1950 (Ellsworth *et al*. 2014). Through the program's history, fire has impacted several fences with notable cases in Mākua Valley. A training incident in 2010 lead to a fire that reached the Kaluakauila fence (Figure 10) and weakened the galvanic coating that protected the fence from rust development, and to this day there are sections of the fence that are displaying elevated rates of corrsion. Moreover, the threat from fire is not limited to MMR and will continue to pose a threat to all ANRPO's fences due to a growing trend in a statewide reduction in rainfall (Trauernicht 2019, Madison *et al*. 2022).

Figure 10: The aftermath of the 2010 fire that started in MMR and crested the ridgeline in to the Kaluakauila MU.

The change in climate is also creating a large-scale, chemical impact to ANRPO's fence infrastructure. It has been demonstrated in controlled experiments that an increase in temperature from 19°C to 20°C doubles the rate corrosion in carbon steel (Kirby 1979). The rate of corrosion on the fences will likely increase in relation to rising global temperatures (Stewart *et al*. 2019, Zhang *et al*. 2022) and sea spray activity (Staniec *et al*. 2021). The program's fences in the Ko‘olau Mountains that face the prevailing

Trade Winds are the most susceptible to rust (Figure 11), as sea surface areosols and soluble chlorides are transported via orographic lifting and deposited along the fence line. Furthermore, these fences are constantly inundated with moisture, which significantly increases the rate of drying and enhances the rate of corrosion (Goodwin 2010).

Figure 11: Rust development on a fence in the Koʻolau mountains.

Ungulates represent a small scale, biological imapct to the program' s fences, and as drought conditions continue to persist and average temperatures increase through time, a reduction in the carrying capactiy of lower elevation habitat for ungulates results (Malpeli 2022). Thus, climate change may serve as the significant driver of ungulates moving higher in elevation while they search for food, water and shelter. This hypothesis is supported by the recent obsevations of ungulate pressure and digging up at Kaʻala and Līhuʻe (Figure 12). As ungulates move higher in elevation they often reach physical human-made barriers in the form of a fence, and will attempt to dig under the fence in search of resources. This pressure is causing erosion and is increasinig along several fence lines (ANRPO 2022).

Figure 12: Digging from pigs along the Kalena-Kaʻala ridge.

To anticipate these fluctuations across two mountain ranges and 28 units, staff will collect data such as damage location, ungulate presence, and impacts of rust via ArcGIS Field Maps beginning in Q4 of 2023. To help visualize past and present damage, georeferenced database layers in ArcGIS Pro will house the additional data. Thus, emerging trends and patterns in damage and the rate of rust development will be identified across MUs and a strategic response will be developed to monitor and replace damaged fence as the program's infrastructure continues to age through time.

In summary, with a combination of georeferencing tools to track changes through time, and evolving models to create forecasts that integrate catastrophic events, erosion, corrosion rates, and ungulate presence, ANRPO will be prepared to anticipate major repairs to the fences and budget changes. As the primary mode of defense, fences are critical to the protection of rare taxa.

1.3.1 2023 – 2024 Future Fence Projects

- **Puali‘i:** A section of fence that crosses the gulch bottom in the Puali‘i 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 design a system to allow debris and boulders to pass beneath the fence without compromising it during extreme rain events in addition to serving 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 serves as an essential barrier to pigs 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 Koʻolau Mountains north of the ʻŌpaeʻula / Helemano MU, this 340-meter fence is constantly exposed to the harsh weather that is commonly associated with this region. Portions of the fence and skirting remain, however specific sections exposed to high winds laden with sea salt suffer from significant corrosion calling into question the effectiveness of protection around rare taxa. Beginning in Q3 of 2023, ANRPO staff plan to replace the compromised sections of fence with new cattle panels and reinstall the existing skirting.

- **Kaluakauila:** In Q4 of 2023, Staff plan to anchor a 76-meter section of skirting along the ridgeline between MMR and Kaluakauila. Currently, there is soil eroding out from under the fence and skirting causing a gap to form under the fence. In addition, a larger project for the unit involves replacing roughly 1000m of fence compromised by the fire in 2010 which resulted in acccelerated corrosion. Also, smaller strategic sections in the lower portion of the valley were affected by landslides and will be addressed in 2024.

- **Kamāʻili:** While the initial baffle system helped to stop small rocks from impacting the fence, the design was a simple wall placed perpendicular to the trajectory of the falling debris which failed to stop damage from larger landslides. In the next phase of development, Staff will install an improved system in a series of delta shaped baffles arranged at 60-degree angles above, below and adjacent to each other in a "Plinko – The Price is Right" style to alter the path, and velocity of falling boulders.

- **ʻŌhikilolo:** Staff from the Horticulture and Blue Team are trialing different methods to reduce erosion along the fence. Several types of weed-mats will be tested for durability and subsequently inoculated with common native species endemic to the area and allowed to establish roots within the greenhouse. These mats will be flown up to specific regions along the fence and pinned down on the inside of the fence to create a natural erosion prevention control system.

- **Koloa:** Portions of the fence exposed to high winds will be monitored for oxidation to establish rates of decay to estimate the lifespan of the fence.

- **ʻŌpaeʻula/Helemano:** Portions of the fence require significant repair due to extreme corrosion, however variable weather patterns in the Koʻolau Mountains often create difficult windows of opportunity for work. A ladder crossing is planed for the north side of Helemano Stream and will be installed to assist staff in their traverse down into the gulch. This MU will also be included in the oxidation monitoring. Efforts to repair/replace fences in specific areas will begin in Q2-Q3 of 2024.

1.3.2 2023 - 2024 Future Ungulate Management Plans

- **Mākua Military Reservation (MMR)** The Mākua Valley section of Ohikilolo MU is a 15-hectare unit containing an abundance of UXO making ungulate control in certain areas difficult to achieve. To increase the level of safety while still achieving the goals of an ungulate free unit, an assessment of the population density will need to be defined to determine if control efforts are having an effect. To achieve this, two methods of surveys will be employed. First, imagery produced through a grid of motion activated game cameras (500 m x 500 m) (Figure 13) (D. Riesch, pers comm.) will help to assess the fine scale details such as number, age, sex, habit and movement under the forest canopy (Figure 14), however, given the threat of UXO in MMR, it will not be practical to install cameras in some of the areas displayed below. Additionaly, all the game cameras must be accessed manually as cellphone recption is limited within the valley.

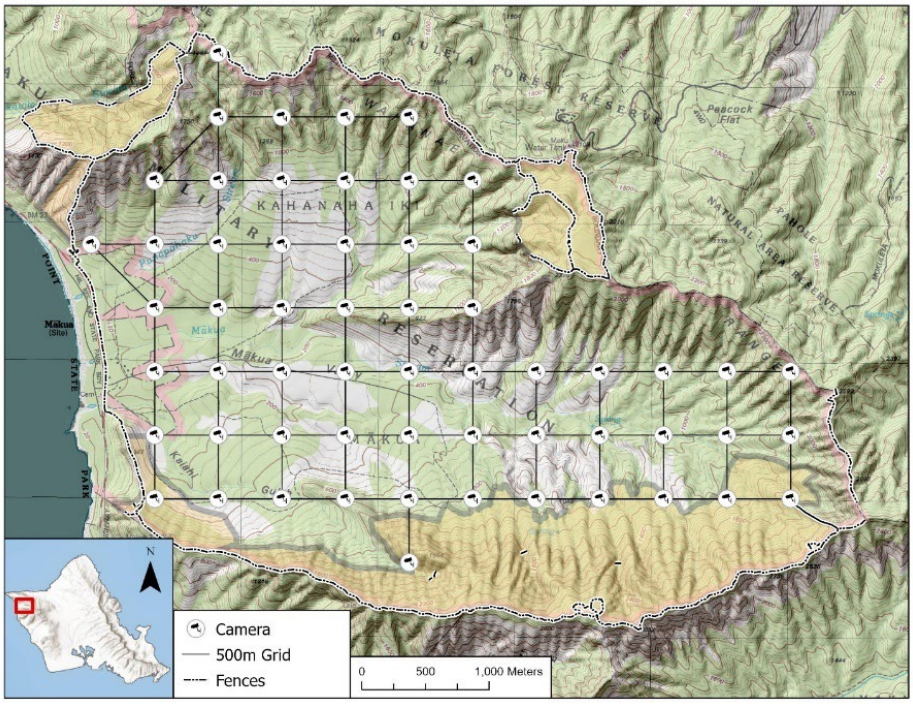

Figure 13: A hypothetical 500m x 500m grid of game cameras in Mākua Valley.

Figure 14: A sounder of pigs in MMR from a game camera installed in the previous report year.

The second method to detect ungulates will be an aerial thermal survey that builds on a previous study. In Janurary 2022, ANRPO contracted KIA Hawai‘i to conduct a forward looking infrared (FLIR) aerial surveys for Mākua valley and Lihue (ANRPO 2022). ANRPO will employ an Unmaned Aerial Vehicle (UAV) (Autel EVO2 640 Dual) that will conduct a thermal survey across several ungulate control areas (UCA) (Figure 15). These photos will be stitched together to

produce a single photomosaic revealing the thermal signatures of pigs across MMR. In addition, to avoid the high cost of tagging and tracking with radio collars, the thermal imagery will serve as an inexpensive and repeatable method of quality control for the game cameras images to verify numbers and reduce the over counting of individuals that may have similar physical features. Unfortunately, the pathway to perform UAV surveys on Army Land with restricted airsapce such as MMR is undefined. However, when the UAV is employed in areas where access is not limited, the thermal mosaic will likely aid in the quick location of ungulates during initial phases of a fence breach.

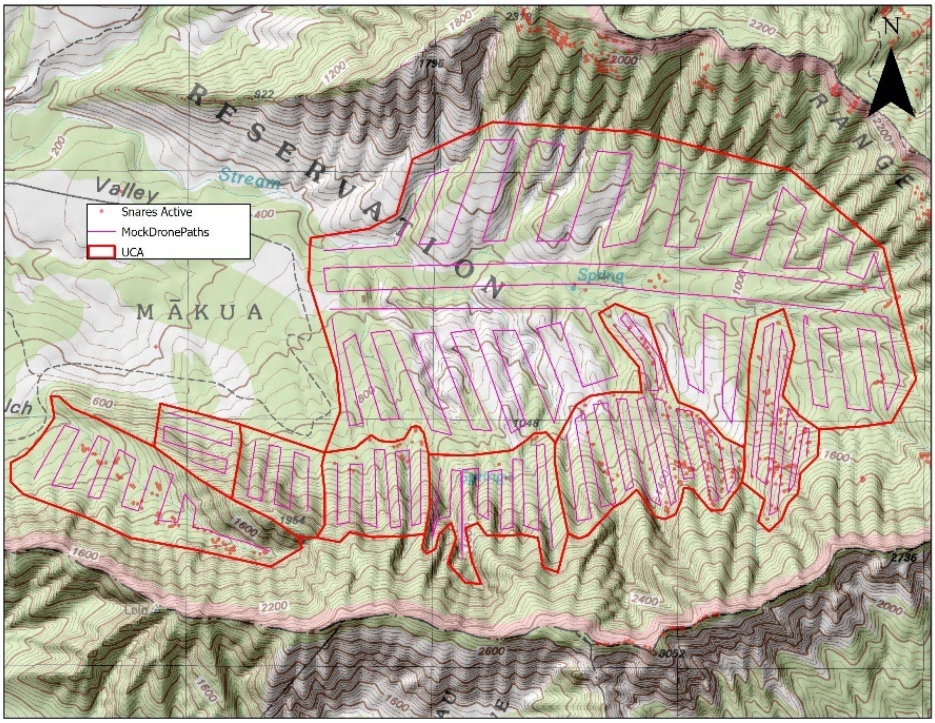

Figure 15: Hypothetical flight patterns of a UAV in Mākua Valley over various UCAs.

Ungulate control methods for MMR will include the following: passive control, pneumatic air guns (PAG), live trapping such as the Pig Brig and an installation of a large corral trap much like a hīnaʻi or basket fish trap around two of the dip ponds in the valley. This approach will be spread over three areas including on the road in Lower Mākua, the back of the valley adjacent to rare taxa, and in the upper reaches of the valley. Progress will be reported in next year's report.

- **Līhuʻe MU:** Complete ungulate removal in the Līhuʻe Management Unit has been an ongoing project since completion of the fence in 2012, and to date, a total of 548 pigs have been removed from this MU. FLIR surveys conducted in January 2022 located three pigs inside of the unit. However, after examining the data and considering the different variables involved in conducting the survey such as the canopy density, fluted valleys, flight path, and operator function, ANRPO predicts that there may be more than three pigs inside of Līhuʻe, and that they likely reproduced. Additonaly, the danger of 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.

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Chapter 2: Environmental Outreach

The Army Natural Resources Program on O‘ahu’s (ANRPO) environmental outreach program 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 Hawai‘i’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.
- 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 742 active volunteers with 120 of these joining as new volunteers this report year.

Figure 1: Patagonia staff controlling an invasive thicket of *Clidemia hirta* in Kahanahāiki.

With the decline in COVID positivity rates and the additional help from the teams staffing a designated technician to assist with volunteer trips, ANRPO resumed offering monthly volunteer trips this report year. Most of our volunteer service trips included individual community members from across O'ahu who signed up in advance for listed volunteer trips on our volunteer website. Sign-ups occur every two months. In addition, numerous organized community groups volunteered with ANRPO and accomplished mutually beneficial goals, experienced important connections to places and educational opportunities, and provided important assistance with natural resource management actions. Community groups participated in 39% of the volunteer trips this report year and included a wide range of individuals, including staff from Waimea Valley, participants in multiple school programs, and Patagonia staff (Figure 1). The list below includes different communities (school, conservation, army) that volunteered with ANRPO this report year:

- Ho'āla School Camp Kōkua Summer Program, 3rd – 8th grade school group
- Ho'āla School, K-8th grade school group
- Protect & Preserve Hawai'i, conservation community
- Wai'anae High School, Marine Biology Program, 9th -12th grade school group
- PALS & PLACES Hawai'i : *Pua Kaiāulu,* 11th – 12th grade school group
- University of Hawai'i- Dr. Bielmann's geography class, higher education
- Leeward Community College Botany Class, higher education
- Mililani High School Hui Mālama Club, 9th -12th grade school group
- Wai'anae Intermediate, 7th – 8th grade school group
- Waimea Valley Staff, conservation community
- Papahana 'O Kaiona, K-12th grade school group
- Patagonia staff , conservation community
- Ka'ala Farms staff, conservation community
- USDA AgDiscovery group, K-12th grade school group
- Diamond Head State Parks staff, conservation community
- Schofield Engineer Brigade, Army community

The table below (Table 1) compares volunteer participation for report year 2023 with that of previous years, distinguishing between volunteer efforts spent in the field and around the baseyard (which includes GIS support, rare plant nurseries, the seed conservation lab, the native seed orchard, and the interpretive garden).

Table 1: ANRPO volunteer participation from 2010 to 2023.

Reporting Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Worksite**	Total Volunteer Hours at Baseyard ***
2023	**2,979**	**658.5**	**528.5**
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

Table 1 (continued).

Reporting Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Worksite**	Total Volunteer Hours at Baseyard ***
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 and native seed orchard*
⁺Shorter reporting year, spanning nine (9) months

Outreach staff led a total of 63 volunteer trips and facilitated 14 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 Ka‘ala, Kahanahāiki, Makaleha West, Mākaha, Palikea and Kalua‘ā and Wai‘eli Management Units during the 2023 report year (Figure 2). Of the 63 volunteer field actions listed in Table 2, roughly 92% supported weed control goals (38% incipient and 54% general ecosystem). The remaining 8% of volunteer field actions aided-outplanting, fence monitoring, and rare plant monitoring. Aside from field actions, we had four regular volunteer who assisted with actions at the ANRPO baseyard, including projects in the seed conservation lab, weed control/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 Waiʻanae range, including: Kaʻala (top left, bottom left, bottom right) & Palikea (top right).

The following table (Table 2) summarizes volunteer field work by management unit (MU) and project.

Table 2: Volunteer field actions for reporting year 2023.

Management Unit	Type of Project	Number of Field Actions
Kaʻala	Incipient weed control	21
	Ecosystem weed control in WCAs	8
Kahanahāiki	Ecosystem weed control in WCAs	9
	Outplanting	1
Makaleha West	Ecosystem weed control in WCAs	9
	Outplanting	1
Kaluaʻā and Waiʻeli	Ecosystem weed control in WCAs	3
Palikea	Incipient weed control	3
	Ecosystem weed control in WCAs	2
Mākaha	Ecosystem weed control in WCAs	2
	Outplanting	1

Table 2 (continued).

Management Unit	Type of Project	Number of Field Actions
Kaluakauila	Fence monitoring	1
	Rare Plant monitoring	1
Pahole	Ecosystem weed control in WCA's	1
West Base Nursery	Greenhouse Support	1

2.2 INTERNSHIPS AND MENTOR PROGRAMS

Outreach staff recruited and hired 6 young adults for internship positions with ANRPO during this report year.

- *ANRPO Summer Internship*

  During this report year, ANRPO had two intern cohorts. From our 2022 intern cohort, we had two summer interns join the program, one as a full-time Natural Resource Management Technician and the second as a student assistant working on ANRPO taxa at the propagation lab at Lyon Arboretum.

  For our 2023 intern cohort, the Native Plant Restoration Biologist and the Invasive Plant Biologist, scored 30 applications, interviewed 14 applicants, and awarded six individuals with paid summer internships with ANRPO, with direction from the Operations Manager and Outreach & Volunteer Specialist. Interns were placed with each field team, the animal program, the vegetation restoration program, and the greenhouse and the rare plant program. Outreach staff and field crews planned and implemented a four-day orientation session for the summer interns, consisting of new hire training modules and educational field activities at various MUs as shown in Figure 3. The 2023 summer internship lasted for 12 weeks.

Figure 3: Six of the ANRPO summer interns joined the Green Team at Palikea 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.

- *Hawai'i Conservation Conference Mentorship Program*
  Five staff members from ANRPO attending the 2023 Hawai'i Conservation Conference were paired with up-and-coming youth conservationists to inspire and assist them with professional development opportunities and discuss career paths they could possibly take in the future. Later, one of the mentees was hired as student assistant.

2.3 EDUCATIONAL MATERIALS

Educational materials were developed and presented on natural resource issues specific to Mākua and O'ahu 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:

Educational Signs

- Two signs, created in the previous report year by the Outreach Staff and AmeriCorps member, were hung at Army Beach Mokulē'ia by staff to inform the public about turtle nesting in the area.

Presentations

- Range Safety Officer/Officers in Charge (RSO/OIC) Natural Resources Brief
  Updated presentation to include pre-recorded video of ANRPO staff presenting relevant information (Table 3).

- Mākua Military Area Natural Resources Brief for soldiers and marines
  Updated presentation to include pre-recorded video of ANRPO staff presenting relevant information (Table 3).

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 14 general community outreach events with students and staff from elementary schools and high schools, university classes, and conservation organizations. Due to COVID restrictions still in place at the time, one of these outreach events was a virtual presentation. An interest in establishing native gardens on campus also initiated outreach opportunities with administration and resource staff from Schofield elementary schools.

Military community outreach increased this report year. Last year, outreach staff updated the Mākua Military Reservation (MMR) brief to include a pre-recorded natural resources section and implemented it this report year to help ensure consistency in our message and improved engagement through delivery of versed professionals in conservation. This update also provided greater flexibility for units to schedule MMR briefs while still providing an effective tool for communicating natural resources concerns. This report year included numerous briefs to troops by ANRPO staff, while Range Staff continued to deliver the RSO/OIC Natural Resources Brief (developed and updated by Outreach staff). The MMR Briefings are monthly and serve around 10 people, while the RSO/OIC Briefs are twice per month with around 20 folks each. The Outreach Specialist checks in annually for updates on these briefs. In addition, an exhibit booth at the annual Schofield Earth Day & Fun Fest provided ANRPO with an opportunity to share natural resource information with the military community. These outreach activities are summarized in Table 3 and Figure 4 below.

- Total number of people served during outreach events: 1580

Table 3: Outreach events for Report Year 2023.

Event	Format	Attendance	Audience
Protect & Preserve Community Volunteer Day	Presentation & community service	35	Community group/general public
Native Hawaiian Advisory Council, Mākua and Baseyard Seed lab Visit and Briefing	Tour of Seed Lab & Site Visit	20	
Kāhuli Festival- Bishop Museum (2022)	Exhibit & activities	100	
Ecosystem Conservation and Restoration Class (Institute of Integrative Biology, Zurich, Switzerland)	Presentation	25	higher education
Army Beach Clean-up with Hoʻāla Camp Kōkua	Community service	11	K-12 schools
Protecting Hawaiian Ecosystems- Maʻemaʻe Elementary	Presentation	90	
Purple Maiʻa - Kaʻala Farms Curriculum filming	Community Service	4	
Hoʻākea: Mauka to Makai (Nānākuli H.S. and Intermediate)	Exhibit & Activities	150	

Table 3 (continued).

Event	Format	Attendance	Audience
Kākoʻo Connections (Kupu)	Tour of Seed Lab and Nursery	11	K-12 schools
Kupu Teachers Externship	Community Service	6	
Hawaiʻi Conservation Conference Exhibit Booth (July 2022)	Virtual exhibit	46	Natural Resources and Conservation Professionals
Hawaiʻi Conservation Conference Exhibit Booth (June 2023)	Exhibit	500	
Rare Plant Conservation and Ecosystem Restoration on Oʻahu: U.S. Army Natural Resources Program with Hawaiʻi Botanical Society	Virtual presentation	20	
Hawaiian Diacritical Presentation-ANRPO staff meeting	presentation	55	
Bryophyte Workshop in Partnership with Bishop Museum	Laboratory & Field workshop	45	
Schofield Barracks Earth Day and Fun Fest	exhibit	300	Military troops & military community
Solomon Elementary School Garden Party Event	Exhibit & Activities	150	
Seed lab seed processing/drying protocols and greenhouse training for PTA staff	Presentation	1	
Tour of Natural Resource Nursery and Seed lab with The Fort Shafter Hui (military spouses club)	Tour	11	
Total Number in Attendance	**1580**		

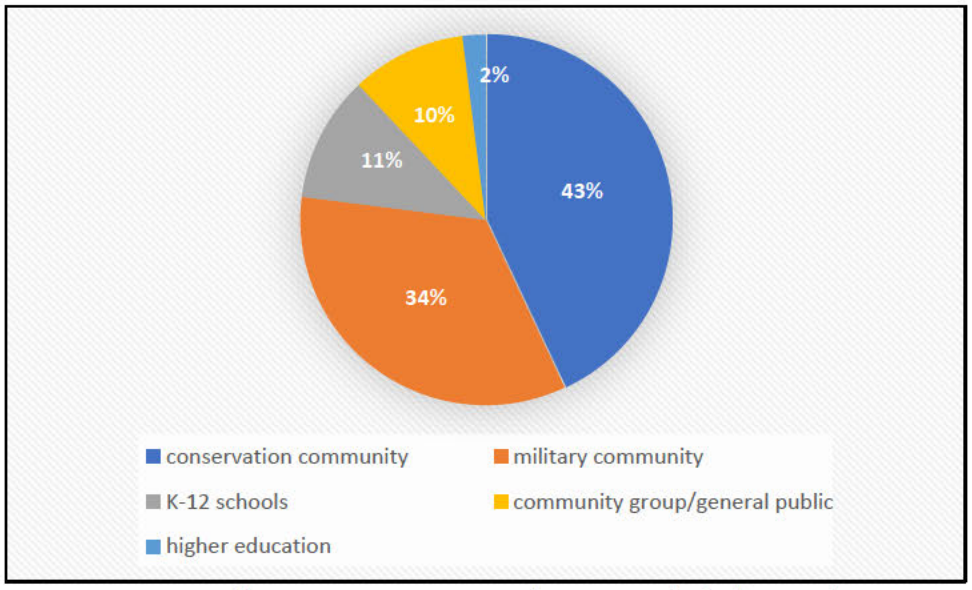

Figure 4: Target audience at 2022-2023 outreach events, not including RSO/OIC briefings, MMR briefings, or ECO officer trainings.

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 summarizes contributions to conferences and workshops in the 2023 report year (Table 4).

Table 4: Contributions to Conferences and Workshops in 2023 report year.

STAFF CONTRIBUTIONS TO CONFERENCES & WORKSHOPS (July 1, 2022 – June 30, 2023)				
Presentation Title	**Format**	**Venue**	**Date**	**Author***
How Do We Better Maintain and Grow Local Professionals	Conference forum	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	**Joby Rohrer, Clay Trauernicht,** Tara Meggett, Sharon Ziegler-Chong, Noelani Puniwai, Marigold Zoll, Lorena "Tap" Wada, Elia Herman
Conservation Connections: Explore Your Possible Pathways	Conference forum	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	Tara Meggett, **Clay Trauernicht, Joby Rohrer,** Paahana Kincaid
Army Natural Resources Program Rodent Control Program: Trap Operations	Virtual Presentation	2022 Hawai'i Predator Control Forum	2022-11-03	**Troy Levinson**
Using Native Vegetation Restoration to Offset Invasive Species Expansion on O'ahu	Oral presentation	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	**Christopher Lum, Michelle Akamine**
"Meeting our Restoration Needs for Native Seed: Hawai'i's Endemic Plant Supply Chain"	Oral Presentation	2023 National Native Seed Conference (Washington D.C.)	2023-03-28	**Tim Chambers**
"The Need for Seed: Assessing Native Seed Production Requirements and Bottlenecks for Hawai'i	Conference Forum	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	**Clay Trauernicht, Tim Chambers,** Matt Keir
Women in Field Work	Networking Conference Forum	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	**Kaia Kong, Chelsea Tamayo**
Polish Your Resume	Networking Conference Forum	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	**Jane Beachy, Chris Lum**
Persistence of Ma'o Hau Hele Populations Considering Fire and Climate Change	Conference Forum	Hawai'i Conservation Conference	2023-06-27 to 2023-06-29	**Mānowai Morgan Kobashigawa,** Sabrina Carll, Bailey Chan, **Jane Beachy,** Melissa Price, Lauren Katayama
Wildlife Managers Panel Discussion	Networking Conference Forum	2023 Hawai'i Climate Adaption Science Summit	2023-01-09	**Kapua Kawelo**
The value and importance of Army Natural Resource Program on O'ahu collaborations with Bishop Museum to inform and guide conservation efforts	Oral Presentation	Bishop Museum Conservation Partnership Symposium	2023-06-16	**Jane Beachy**

**ANRPO authors in bold font*

2.6 PUBLIC RELATIONS AND PUBLICATIONS

ANRPO staff were featured in multiple peer reviewed online journals and publications this report year (Figure 5). In addition, the USAG-HI Facebook page featured 11 posts highlighting ANRPO staff and the natural resource work that was accomplished this report year (Figure 6). Staff coordinated published media with the USAG-HI Public Affairs Office. The table below (Table 5) provides a summary of media and publications relating to ANRPO management in report year 2023.

Figure 5: Outreach staff produced the Ecosystem Management Program Bulletin 2023, featuring an article on 25 Years of Army Rare Plant Conservation on O'ahu written by ANRPO staff members.

Table 5: Media coverage and publications in 2023.

Title	Format	Publication	Date	Author
Twenty-Five Years of Rare Plant Management on O'ahu	Electronic magazine	Ecosystem Management Program Bulletin	2022-2023 issue	**Tim Chambers, Kapua Kawelo**
Endangered O'ahu Loulu Under Threat from Coconut Rhinoceros Beetles	Electronic magazine	Ecosystem Management Program Bulletin	2022-2023 issue	**Jessica Adinolfi**
Effects of Fruit Novelty on Feeding Preferences in Four Globally Invasive Frugivorous Birds	Electronic Journal	Journal of Animal Ecology	Manuscript Submitted	Samuel Case, **Kapua Kawelo,** et al.
Removal of Non-Native Trees Fosters but Alone is Insufficient for Forest Regeneration in Hawai'i	Academic Article Repository	Science Direct: Forest Ecology and Management	2022-08-01	Lauren Nerfa, Zoe Hastings, Amy Tsuneyoshi, **Kapua Kawelo, Jane Beachy,** Tamara Ticktin
Federal funding to protect native birds; Army seed lab's conservation efforts A closer look at the only Army seed bank in the country Inside the Army's seed bank on O'ahu's North Shore	Public Radio Station/Podcast	Hawai'i Public Radio: The Conversation	2023-06-28	**Tim Chambers, Makanani Akiona, Kapua Kawelo**

ANRPO authors in bold font

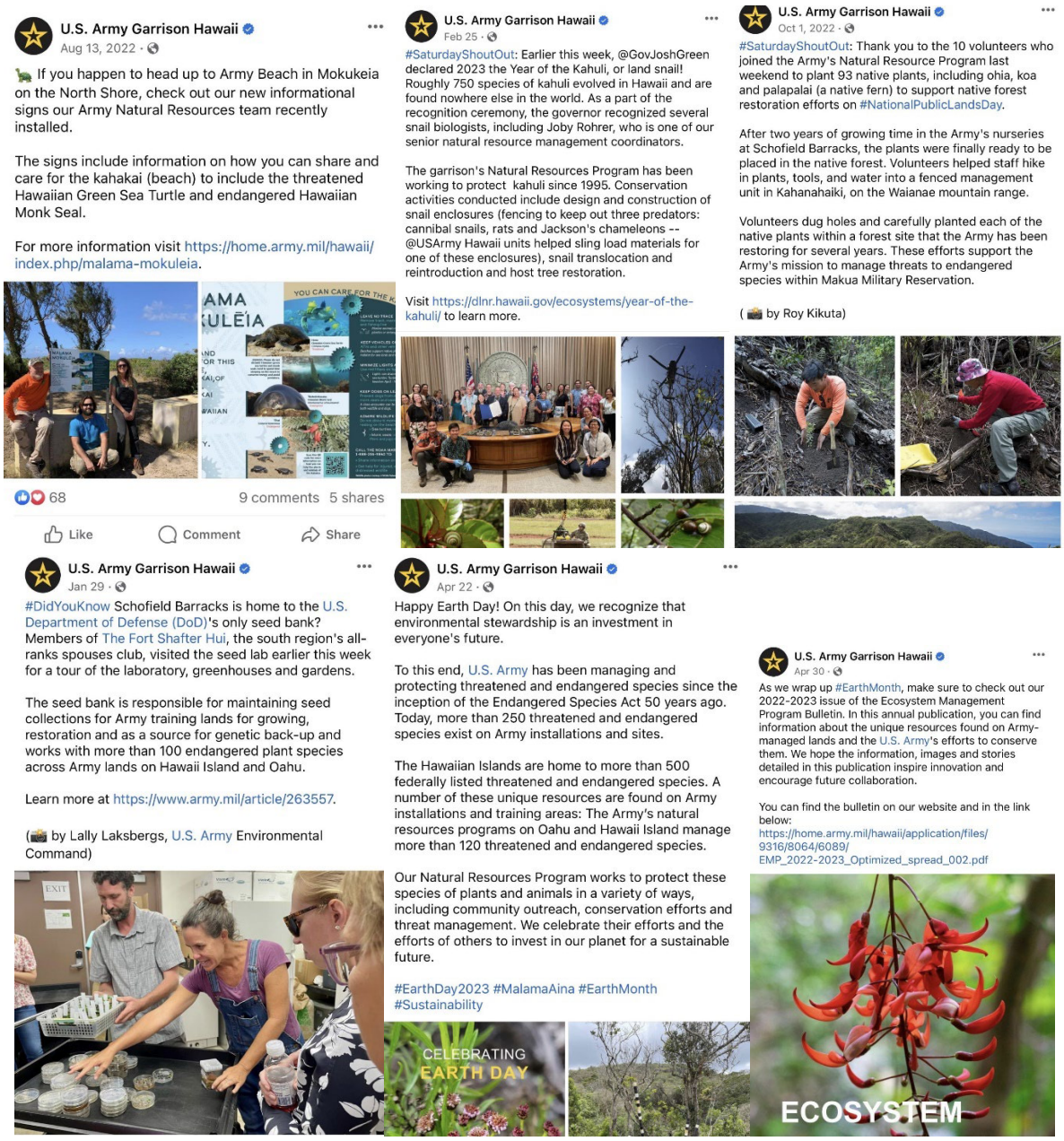

Figure 6: USAG-HI Facebook posts featuring ANRPO and staff.

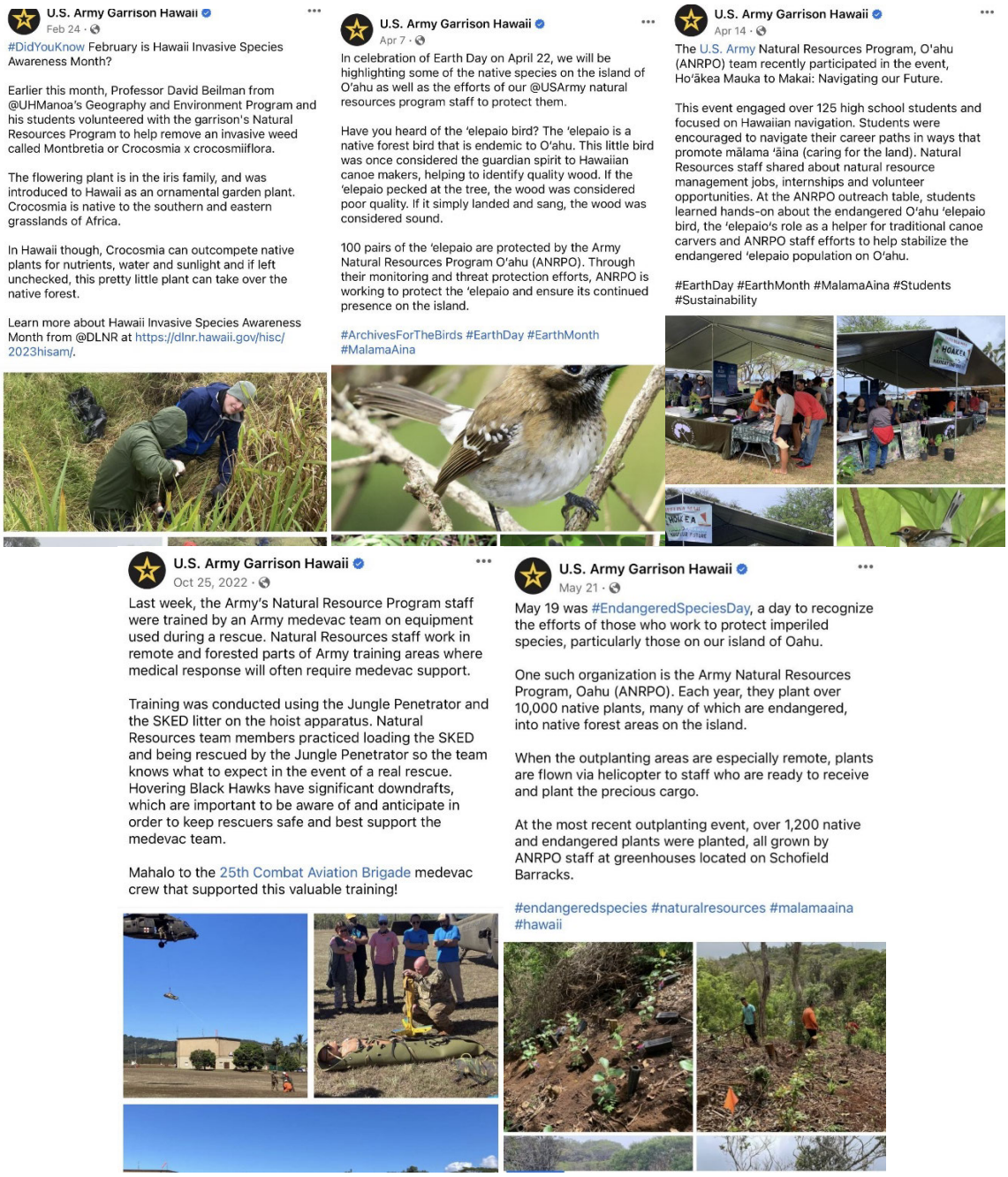

Figure 6 (continued).

2.7 VOLUNTEER RECOGNITION

Each year, outreach staff nominate eligible volunteers for the President's Volunteer Service Award. Nominations for this reporting year included volunteer service from 01 July 2022 - 30 June 2023. A total of three individuals volunteered over 100 hours with ANRPO within this report year. They are listed below in Table 6. Each of them will be honored with certificates signed by the President of the United States and commemorative pins.

Table 6: 2022 President's Volunteer Service Awardees.

Award Level	Name	Hours of Service in 2022-2023
Silver	Elaine Mahoney	334
Bronze	David Danzeiser	197
Bronze	Roy Kikuta	112

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 $7,050 from the 2022 National Public Lands Day (NPLD) Department of Defense Legacy Grant to support volunteer plant reintroduction efforts in Kahanahāiki and building a native plant shade house. Outreach staff hosted a public volunteer trip to help reintroduce native plants into the wild such as ʻŌhiʻa (*Metrosideros polymorpha)* and Koa (*Acacia koa*) (Figure 7). The help of volunteers was also employed to build a shade house and benches for plants at ANRPO's baseyard to support the restoration program via plant production, and provide flexible space for genetic storage, experimentation, and production.

Figure 7: ANRPO volunteers preparing to hike in native plants for the National Public Land's Day 2022 outplanting trip in Kahanahāiki.

The funds were used to purchase materials for a hoop structure for additional greenhouse space, as well as backpack sprayers to water plants, work gloves, and different tools and equipment used by the program to complete the project (such as pruners, handsaws, pin flags, and shovels) (Figure 8).

Figure 8: ANRPO volunteers standing in completed hoop structure for additional green house space.

CHAPTER 3: VEGETATION MANAGEMENT

Highlights of vegetation management work and notable projects from the 2022-2023 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 Mākua and Oʻahu 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 Oʻahu (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 ʻŌpaeʻula Lower, Pahole, Kaluaʻā and Waiʻeli and Manuwai ERMUPs were revised, and are included as Appendices 3-1 to 3-4.

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 8,665 hours controlling weeds across approximately 399.7 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 this year and 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 are overjoyed to keep the area clear of weedy asters in Kalua‘ā.

Table 1: Summary Statistics for Weed Control.

Report Year	Effort (hours)	Area (ha)	Hours/ha
2022-2023	**8,665**	**399.7**	**21.7**
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, effort hours dropped 31% and area weeded dropped 14% compared to last year. However, hours/ha, or weed intensity, is comparable to other years. This year weed control continued to focus on high intensity projects such as expanding restoration sites. In addition, overall effort hours may have declined due to personnel shortages and refocusing efforts away from intensive ICA sweeps in KTA. With personnel shortages on field teams, staff likely prioritized work on time-sensitive actions (fence

checks, slug control, rat control, plant introductions and collections, etc.), rather than weed control, which could have contributed to this decline. Table 1 shows a great comparison of effort each year, but there are no further analyses to determine the exact reason for the decline in this year's effort.

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 Kahuku Training Area (KTA), Schofield Barracks East Range (SBE), Mākua Military Reservation (MMR), Schofield Barracks South Range (SBS), and Schofield Barracks West Range (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 Hawai'i Pacific Weed Risk Assessment (HPWRA) website to gauge the risk a species poses and species distribution data from the Bishop Museum, incidental observation by staff, 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, 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 a 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 are difficult to detect at younger stages 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, its highly invasive biology, uncontrolled spread by the public (motocross) 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 'Ōhikilolo Lower, 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 Mākua 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 Ka‘ala 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 Ka‘ala. These taxa are highly invasive, but none of these boardwalk ICAs are 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 61 taxa in 451 ICAs. Of the total 399.7 ha controlled, ICA efforts covered 331.2 ha. This year, staff spent 1,699 hours on ICA management, conducted 488 visits to 30 taxa in 255 ICAs and achieved eradication at 14 ICAs. This is a lower effort spent and area covered for incipient weeds than the 2022 reporting period (Table 2), which could be attributed to lessening intensive ICA sweeps in KTA. ICA work accounted for 82% of the total area weeded and 20% 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
2022-2023	**218**	**488**	**1,699**	**331.2**	**5.1**
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 121 out of 218 ICAs checked. In addition, staff were able to confidently declare eradications at 14 ICAs this year (Table 3), for a total of 83 eradications in ANRPO’s history. For a species to be declared eradicated, ten years must pass (or three years for grass species) without finding any mature plants, and the site must be checked consistently and entirely. There were no new ICAs recorded in this report year. An explanation for the lack of new ICAs is that ANRPO sanitation

protocols have been diligently followed, decreasing the probability of tracking incipient species into new areas. Although ANRPO has stringent sanitation protocols in place, there are plans to re-evaluate protocols to further improve decontamination and invasive plant material spread.

Table 3: ICAs Eradicated in 2023.

Taxon	MU	ICA Code	Comments
Chromolaena odorata	Waimea No MU	WaimeaNoMU-ChrOdo-01	There was only one immature plant found within this ICA in 2011 and it has been checked regularly (a total of 22 times) with no new plants reported for the past 12 years.
Dicliptera chinensis	Pahole	Pahole-DicChi-01	This ICA had three immature plants found in 2011 and then again in 2013. It has been checked annually since then with no target plants reported for the past 10 years.
Ehrharta stipoides	Mākaha No MU	MākahaNoMU-EhrSti-02	Only two mature plants reported in 2007 with no new plants recorded over the next 16 years.
	Kahanahāiki	MMR-EhrSti-11	This ICA was established in February of 2019 and has been checked quarterly for the past four years (a total of 21 times). No plants have been reported for the past three years.
		MMR-EhrSti-12	This ICA was established in May of 2019 and has been checked regularly for the past four years (a total of 17 times). No plants have been reported since the first sighting and treatment.
Leptospermum scoparium	Helemano	KLOA-LepSco-05	No plants seen for 13 years.
Melochia umbellata	KTA No MU	KTA-MelUmb-03	No plants seen for over 10 years. Only two plants were ever found in this ICA, and none since 2011.
		KTA-MelUmb-04	No plants seen for 10 years. Mature plants found in 2006 and again in 2013. Checked regularly and no plants have been seen since.
		KTA-MelUmb-07	No plants seen for 12 years.
Morella faya	Wai‘eli No MU	Wai‘eliNoMU-MorFay-01	One mature plant found in 2012. No plants have been seen since.

Table 3 (continued).

Taxon	MU	ICA Code	Comments
Pterolepis glomerata	Kapuna Upper	KapunaUpper-PteGlo-01	The Division of Forestry and Wildlife's (DOFAW) Native Ecosystems Protection and Management (NEPM) Program has been helping to control this ICA in Kapuna. Plants found in 2010 and 2011 and then none reported for the past 12 years.
Rubus argutus	ʻŌhikilolo	MMR-RubArg-06	Only three immature plants reported since June 2016. None reported since then.
Setaria palmifolia	Kapuna Upper	KapunaUpper-SetPal-01	NEPM Program has been helping to control this ICA in Kapuna. Only one immature plant reported in 2009 with no new plants recorded since then.
	ʻŌpaeʻula	KLOA-SetPal-04	One immature found most recently in 2013. No new plants observed since.

Last year ANRPO re-evaluated *Chromolaena odorata* management in KTA. Previously, the goal for this incipient species was eradication, however, starting in Quarter 1 2023 ANRPO 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 this 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 ongoing. Changes to total effort and area change are reflected in the latter quarters of the 2023 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 Hawaiʻi" by Samantha Shizuru suggests that *C. odorata* has a strong flowering and seeding season from late fall to spring. Thus, ANRPO has modified sweeps and control to occur 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.

ANRPO continues to re-evaluate all ICAs according to updated distribution, numbers, etc. *Angiopteris evecta* is a problematic tree fern, which is widely distributed throughout the Koʻolau and Waiʻanae 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, control is effective as the species takes at least 3 years to mature. In the 2022 report year, *A. evecta* was designated as a target taxon where control takes place in known hotspots along the gulches every 2-3 years and all ICAs were discontinued. Kaluaʻā and Waiʻeli and Pahole ICAs have followed with this change in this report year (See appendix for ERMUP).

3.2.1 2023 ICA Effort by Select Target Taxa

Four taxa accounted for 74% (244.3 ha) of all treated area: *C. odorata*, *S. condensatum*, *S. palustre* and *C.* x *crocosmiiflora*. These four accounted for 60% (1,014 hrs) of all treatment efforts. The taxa highlighted in this section all reported ≥ 10% of Total ICA Effort. The 2021-2022 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: ʻAimuʻu No MU, Kaiwikoʻele to ʻElehāhā No MU, Kahana No MU, Kahanahāiki, Kahuku Lāʻie No MU, Kamāʻili, Kaluaʻā No MU, Kawaiiki No MU, KTA No MU, Mākaha I, Mākaha No MU, Makaleha Central No MU, Makaleha East No MU, Manuwai, Oʻahu North Central No MU, Pahole, SBE No MU, SBW No MU and Waimea No MU.

2022-2023 Highlights:

- Total 2023 Control: 432 hrs; 198.5 ha; 102 visits; accounted for 25% of time spent on ICA work, and 60% of all ICA area controlled. Most of the effort was spent in SBW working on ICA sweeps, power spraying and aerial spraying.
- 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 Kahanahāiki, Kaluaʻā No MU, and Mākaha I.
- Total 55 ICAs, 48 of which were visited this year.
- The shift in strategy from eradication to containment in KTA commenced in March 2023. The new strategy involves keeping roads, buildings, gravel piles and known military training/bivouac areas free of *C. odorata* to prevent further spread.
  - Staff checked 26 out of 32 ICAs; and 9 ICAs reported no plants observed.
  - A total of 140 effort hours over 50 visits were reported.
  - ANRPO continued to contract OISC to conduct work, however drastically cut their responsibilities due to the new strategy; see OISC's progress reports in Appendix 3-5. OISC will focus work in the Alpha 1 training area which also allows public motocross access on the weekends.
- Second largest infested area, SBW No MU.
  - Staff checked 7 out of 7 ICAs; and 3 ICAs still reported no plants observed.
  - A total of 247 effort hours over 16 visits were reported.
  - SBWNoMU-ChrOdo-01 and SBWNoMU-ChrOdo-04 continue to be the largest infested ICAs and account for most time spent by staff. Both ICAs were sprayed aerially, and from the ground.
- The HelemanoNoMU-Chrodo-01 ICA continues to produce mature plants. While doing opportunistic checks beyond the main infestation, more plants are found in vegetation surrounding the open field. The ICA is checked twice per year and will be checked in conjunction with other actions.
- Drum Road ICAs: No plants were found at KLOA-Chrodo-01. The newest ICA on Drum Road, KLOA-ChrOdo-02, has not been checked after its discovery and will be checked only during road surveys or opportunistically.
- Kaluaʻā ICAs: Numbers have been declining at KaluaʻāChrodo-01. No new matures have been found since 2018, however, immatures have been controlled there during this report year. Since the initial finding of KaluaʻāNoMU-ChrOdo-02 last year, only immatures have been found since.

- The Kaluaʻā NoMU-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.
- No new plants were observed this year at MMR-ChrOdo-01 in Kahanahāiki.
- Kaʻala Road ICAs: No plants have been observed in the CMakalehaNoMU-01 ICA since 2018. Since an immature plant was found initially, the ICA has been discontinued. Numbers have been declining at CMakalehaNoMU-02 ICA since a mature was found in 2019. At EMakalehaNoMU-ChrOdo-03, numbers continue to decline.
- No additional plants have been found in the Kamāʻili ICAs (Kamāʻili-ChrOdo-01 and Kamāʻili-ChrOdo-02) since 2018 and 2019, respectively.
- No plants have been observed at the SBE ICA (SBE-ChrOdo-01) since 2015.
- No plants have been seen at the Manuwai ICA (Manuwai-ChrOdo-01) since 2017. However, plans to sweep the 200 m buffer around the Manuwai population are set for late 2023. Although an initial buffer sweep resulted in no plants, a second buffer sweep will be conducted because much of the terrain was too steep to negotiate and the status of these cliffs remains unknown. A second buffer sweep five years after the initial discovery will help to determine if there are plants remaining in the area, especially if there were any missed on the cliffs. If no plants are discovered, buffer sweeps will end.
- Staff continue to work with OISC, the Hawaiʻi Department of Agriculture, the U.S. Forest Service, DOFAW, and Biosecurity Queensland to pursue testing of the biocontrol agent, *Cecidochares connexa*. The final stages of host-specificity testing are under way and staff will send a few more batches of *C. odorata* plants to coincide with rearing the agent. 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.
- ANRPO is in the middle of conducting a ten-year seed longevity trial on *C. odorata*. The trial will test viability in year-long intervals on buried *C. odorata* seed packets. Tests have shown that viability greatly drops after 5-6 years of being buried. Yearly viability testing will be complete in 2025. These results will aid in making critical decisions on future ICA management.
- ANRPO conducted a trial on the efficacy of organic herbicides on *C. odorata* at different life stages. Results from this trial are in Appendix 3-6. Herbicide trials aid in determining different options for chemical control.

Figure 2: Staff manually removing a large *C. odorata* plant in SBW No MU.

Taxon: *Schizachyrium condensatum*

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

2022-2023 Highlights:

- Total 2023 Control: 193 hrs; 40.3 ha; 31 visits; accounted for 11% of time spent on ICA work and 12% of all ICA area controlled. This is like the amount of effort in the last report year.
  - Staff checked 10 out of 10 ICAs; and four ICAs reported no plants found.
  - 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.
  - The smaller ICAs are outliers located along the Pineapple Junction Road and have low numbers of plants; four of these ICAs reported $\leq$ 4 plants.
- 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.
- No plants have been observed since 2018 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. This ICA has not been checked regularly due to military training, however, after no observations for more than 5 years and because it is a grass species, the ICA will be eradicated in the next report year.
- There have been steady, albeit low numbers of matures found at the Manuwai-SchCon-01 ICA. Better identification, especially for cryptic immature plants, may help in eliminating matures in this ICA and eventually could lead to eradication.

Taxon: *Sphagnum palustre*

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

2022-2023 Highlights:

- Total 2023 Control: 191 hrs; 3.6 ha; 26 visits; accounted for 11% of time spent on ICA work, and 1% of all ICA areas controlled. The majority of total control accounted for buffer surveys that are scheduled every 2-3 years to re-delineate the ICA boundaries.
- 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.
- Total 9 ICAs at Kaʻala MU, all of which were visited this year. No new ICAs were established.
- Three out of 9 ICAs reported no plants. Plant numbers are counted per discrete clump since the growing habit is clustered and it is difficult to discern individuals. In addition, plants are vegetative.
- Staff did not report large patches across all ICAs. Most of the plants remains close to the boardwalk, where the initial infestation began, with small, isolated *S. palustre* further off the trails.
- Kaʻala-SphPal-03 is relatively large and the vegetation can be dense, making it extremely difficult to detect every single *S. palustre* sprig. Staff continue to find patches sporadicly throughout.
- 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.

Taxon: *Crocosmia* x *crocosmiiflora*

List of MUs with active ICAs: Kaʻala Army, Kaʻala NAR, Makaleha East No MU, Nānākuli No MU, Palikea, and Waimānalo to Kaʻaikukui.

2022-2023 Highlights:

- Total 2023 Control: 198 hrs; 1.9 ha; 33 visits; accounted for 10% of time spent on ICA work, and 0.6% of all ICA area controlled. Control is very tedious as most of the work is achieved through handpulling. Effort hours are one of the highest, however, the area controlled is low.
- Total 15 ICAs, all were visited during this report year. No new ICAs were established.
- Two out of 15 ICAs reported no plants including Kaʻala-CroCro-07 and PalikeaNoMU-CroCro-03. Other ICAs outside Kaʻala MUs report numbers in the hundreds.
- Kaʻala NAR and Kaʻala Army ICAs: A large majority of time spent on *C.* x *crocosmiiflora* control is accounted for at Kaʻala-CroCro-05 (86 hrs). This ICA is located on the emergency helipad just outside the gate and is mostly controlled by the volunteer program. Other ICAs report hundreds of individuals controlled, though it is difficult to discern numbers as they grow vegetatively from underground corms.
- Palikea, Palikea No MU, Nānākuli No MU and Waimānalo to Kaʻaikukui ICAs: These ICAs occur inside the MU, outside the MU and along the main trail from Palehua Road. Palikea-CroCro-03, just inside the MU fence reported the highest amount of time (9 hours), while time spent outside the fence was the greatest at Palikea-NoMU-Crocro-01 (12 hours) along the trail. At PalikeaNoMU-CroCro-01 a total of 412 immatures were controlled solely by the volunteer program.
- The majority of *C.* x *crocosmiiflora* ICAs are managed by the Green Team, 8 out of 15, while the rest are controlled by the volunteer program, including: Kaʻala-CroCro-01, Kaʻala-CroCro-05, Kaʻala-CroCro-06, Palikea-CroCro-01, PalikeaNoMU-CroCro-01, PalikeaNoMU-CroCro-02, and PalikeaNoMU-CroCro-03. The total effort from the volunteer program ICAs exceeds the work from all other ICAs combined with 153 hours, 0.89 ha, and 15 visits.
- The tenacity of *C.* x *crocosmiiflora* is astonishing. Its biology, dispersal mechanism and affinity to wet habitats makes it extremely difficult to manage. ANRPO currently does not have a totally

effective method of control, but manual control is the common practice. Other cocktails and trials have been conducted to try to find an effective concoction, however, do not kill the underground corms that retain a lot of energy. Staff will continue to search for new methods to control *C*. x *crocosmiiflora*.

- ICAs will be monitored once or twice per year. Volunteer ICAs may be visited more to accommodate work for groups visiting Kaʻala. If needed, staff will collaborate with the Division of Forestry and Wildlife to help in controlling plants on their land.

Table 4 highlights ICA species controlled at each MU. Each management unit is unique in the kinds of incipient species that grow there. This table gives a description of the status of each species at these MUs.

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).

Table 4: 2023 ICAs Controlled by IP Management Unit.

MU	Total # of ICAs checked	ICA Species	Comments
ʻĒkahanui	3 of 4	*A. mearnsii* and *E. stipoides*	ʻĒkahanui-EhrSti-01 was eradicated as the last plant observed there was in 2019. ʻĒkahanui-EhrSti-03, located by the '*Cenchrus* bump out', is a newer ICA. New plants continue to spring up, most likely introduced by staff. Sanitation is an important practice that will be evaluated further. The *A. mearnsii* ICA has not been checked since 2019 and is a low priority. Staff will map and control any new plants seen in the course of other work.
Kaʻala Army	22 of 22	*A. evecta*, *Anthoxanthum odoratum*, *C.* x *crocosmiiflora*, *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.* x *crocosmiiflora* ICAs. The *A. evecta* ICA has been discontinued after this report year. *C.* x *crocosmiiflora* 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. *D. esculentum* continues to creep further outside the ICA. Control is easy with a foliar spray of Ranger Pro, but detection through the tall grass is difficult.
Kaʻala NAR	13 of 13	*C.* x *crocosmiiflora*, *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. *D. esculentum* is difficult to treat in the waterway, as herbicides are ineffective and manual control is implemented instead. It is also unknown how far downstream propagules may have traveled and what the population is like beyond the ICA boundary. Control will focus on known ICA boundaries along the roadside and staff will defer to NEPM for the interior/state-owned portion of the NAR.
Kahanahāiki	16 of 19	*Acacia mearnsii*, *A. evecta*, *C. glauca*, C. *odorata*, *E. stipoides*, *Macfadyena unguis-cati*, *P. glomerata*, *S. palmifolia*, *S. cooperi*	There is a steady decline in all *E. stipoides* ICAs. No plants have been observed at the *C. odorata* ICA since its discovery. No *M. unguis-cati* has been seen since the establishment of the ICA. ANRPO will designate *A. mearnsii* and *A. evecta* as target taxa instead of ICAs as there is a persistent seedbank as well as too many other sources 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. There were no *S. cooperi* found in the entire ICA during this report year.

Table 4 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Kaiwiko'ele to 'Elehāhā No MU	2 of 2	*C. odorata* and *R. tomentosa*	The *C. odorata* ICA was originally confined to one spot along Drum Road. A survey upstream revealed more mature plants, however, the population extent was never delineated. This ICA is on private land and is not ANRPO responsibility, so the ICA was reduced back to its original location just off the road to prevent spread by Army. Information about this infestation was shared with the landowner. The *R. tomentosa* ICA has shown a decrease in plants since 2017.
Kalua'ā and Wai'eli	9 of 10	*A. evecta*, *Blechnopsis orientalis*, *Casuarina equisetifolia*, *Dovyalis hebecarpa*, *E. stipoides*, *Solanum capsicoides*	The *A. evecta*, *C. rosea*, and *D. hebecarpa* 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. Like *A. evecta*, *B. orientalis* will be discontinued because of the unfeasibility of managing fern species. One *E. stipoides* ICA that was eradicated has been re-established as new plants were found. It is unknown whether this is a new introduction or the result of a premature eradication.
Kalua'ā No MU	3 of 4	*Clusia rosea*, *Morella faya*, and *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 newer ICA. *A. cordifolia* 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. Staff have been effectively controlling the vegetative corms manually.
Kamā'ili	2 of 2	*C. odorata*	Both *C. odorata* ICAs have been visited 2 times in this report year and had no plants observed. Only a total of 3 immature plants for both ICAs have been found. Staff will continue to check these ICAs on an annual schedule but may consider eradiation in 2025 for both ICAs.

Table 4 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Kapuna Upper	8 of 14	*D. intortum*, *E. stipoides*, *E. mollis*, *Neonotonia wightii*, *P. glomerata*, *S. palmifolia*	ANRPO collaborates with NEPM on ICA control. The *E. mollis* is a new ICA. *E. mollis* is a common trail weed in the Koʻolaus, but not well-established in the Waiʻanaes. The *S. palmifolia* ICA was discontinued as there have been no plants found for 2 years. *N. wightii* has been discontinued as it is unfeasible to control and prevalent in other areas outside the MU. The *D. intortum* ICA around the hunter's shelter was not checked this year. This ICA will be discontinued as it has not seen consistent control and the species is prevalent outside the MU.
Kawaihāpai No MU	1 of 1	*Rubus argutus*	Staff continue to observe no *R. argutus* on the Kuaokalā Road since 2013. This ICA can be eradicated at the end of 2023.
Kawaiiki No MU	1 of 2	*C. odorata*, *L. scoparium*	These ICAs occur on Drum Road from Helemano Military Reservation to Kahuku Training Area. Staff control *L. scoparium* during annual LZ surveys. This ICA is located on Army LZ Black and few plants have been found. A newer *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 with 20% Garlon 4 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 with glyphosate/pre-emergent/imazypyr cocktail as it gave the longest suppression as compared to the other methods. Constant *C. acutangulus* numbers also suggests that this species has a persistent seed bank. A five-year seed-viability testing showed only a small decrease from initial testing (no treatment, 100% viability) to 88% by the fifth year.
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. No plants were found this year. ANRPO plans to re-map boundaries of where *H. coronarium* have been found to better inform control efforts.

Table 4 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
KTA No MU	34 of 40	*Acacia mangium*, *C. setaceus*, *C. odorata*, *Melochia umbellata*, *Senecio madagascarensis*	Staff spend most effort on *C. odorata* control (see discussion above). The *A. mangium* ICAs continue to have low numbers. The *M. umbellata* ICAs are large and are densely vegetated, making it extremely difficult to spot plants. Staff will need to re-evaluate control strategies to determine the most effective method. There is some success in control, with three ICAs (KTA-MelUmb-03, -04 and -07) eradicated this year. 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 fruiting *C. odorata*. Only 1 mature plant in 2017 was found at the *S. madagascarensis* ICA and none were seen since.
Līhu‘e	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. Staff were unable to check the *S. capsicoides* ICA this year due to range scheduling and unavailability of EOD escorts.
Mākaha I	2 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 will be eradicated. Staff continue to report low numbers of *P. glomerata* in this ICA.
Mākaha 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 consistent amount, which is probably due to the inability to suppress the seed bank with a pre-emergent, as the ICAs fall within Board of Water Supply land. *Setaria palmifolia* has not been observed since 2017, so checks can be less frequent.
Mākaha 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*. The *E. stipoides* ICA was eradicated. ANRPO continues to collaborate with Wai‘anae Mountains Watershed Partneship (WMWP) on *L. scoparium*. Few plants have been found in walkable areas. Other techniques are required to control the remaining *L. scoparium,* but this is a lower priority ICA to complete.

Table 4 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Makaleha Central No MU	5 of 5	*A. glomeratus* var. *pumila*, *C. odorata*, *P. glomerata*	Only 1 mature plant has ever been found at the *A. glomeratus* var. *pumila* ICA. The *C. odorata* ICAs have low numbers and are steadily declining. *P. glomerata* ICAs have sporadic upticks in numbers but are on a steady decline.
Makaleha East No MU	3 of 4	*C. odorata*, *C. crocosmiiflora*, *P. glomerata*	Staff continue to report low numbers of *C. odorata*. The culvert 59 *C.* x *crocosmiiflora* continues to have a steady number of plants. Only a 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 it is on track for eradication next year. Both *P. glomerata* ICAs reported low numbers. No plants have been found at the *E. mollis* ICA this year.
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. Four mature and 43 immature *S. condensatum* were controlled this year. This seems to be an increase from past years. As staff become better in identifying this cryptic species, numbers will decrease.
Nānākuli No MU	1 of 1	*C.* x *crocosmiiflora*	This ICA is located on the Palikea trail and is managed by the Volunteer Program. Reports state that there was one unreachable clump spotted below the trail. Staff will go back with proper equipment to ensure this plant is removed.
O‘ahu North Central No MU	1 of 1	*C. odorata*	Staff continue to check the ICA just off the Poamoho access road quarterly and report a 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.

Table 4 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
ʻŌhikilolo	6 of 8	*Cirsium vulgare*, *E. stipoides*, *P. glomerata*, *R. argutus*, *Sideroxylon persimile*	Staff continue to report zero *Cirsium vulgare* plants; this ICA is on scheduled for eradication by 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 ʻŌhikilolo, the "Ctenitis PriKaa" site and Camp LZ have recorded zero plants for over 4 years. Two *R. argutus* ICAs were eradicated this year (MMR-RubArg-06, -07). The *R. argutus* Red dirt Puʻu will be 'Discontinued' as it is extremely steep and too dangerous for staff to continue to check. The *S. persimile* ICA is in Lower Mākua and will be 'Discontinued' as only 1 mature plant was ever found.
ʻŌhikilolo Lower	2 of 2	*C. setaceus*, *Tithonia diversifolia*	There is a consistent number of *C. setaceus* plants found on the ridge (MMR-CenSet-02), but aerial sprays have been effective in managing this population. No plants at the *T. diversifolia* ICA have been observed since it was established in 2021.
ʻŌpaeʻula Lower	4 of 4	*Rhyncospora caduca*, *S. palmifolia*	The fenceline and weatherport *R. caduca* ICAs have a consistent number of recruits from the seedbank. An influx of plants from other infestations in the Koolaus adds to the complexity of controlling of *R. caduca* at ʻŌpaeʻula Lower. 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	9 of 17	*A. evecta*, *Axonopus compressus*, *C. odorata*, *Dicliptera chinensis*, *E. mollis*, *P. glomerata*, *R. tomentosa*, *Tecoma capensis*	Again, *A. evecta* will be discontinued as an ICA species but staff will continue to target them whenever found. Most *A. evecta* ICAs were not visited this year as checks occur every other year. There were low numbers recorded at all ICAs. There have been no more plants reported at the *C. odorata* ICA. Few plants have been found in the *A. compressus* ICA. *D. chinensis* and *R. tomentosa* ICAs have been declared eradicated during this report year. Only a few plants have been reported for both *E. mollis* ICAs over the past couple of years. Last *T. capensis* reported by staff was 2018, so current control will continue.
Pahole No MU	1 of 1	*Cryptostegia madagascariensis*	*C. madagascariensis* has a high WRA assessment score of 13 and others in the genus are reported to be highly invasive. This plant is found on both sides of Pahole Road in the privately-owned ranchlands. Staff do not have owner permission to access the plants, instead, they check the ICA once per year to ensure that it remains localized and off the main road.

Table 4 (continued).

MU	Total # of ICAs checked	ICA Species	Comments
Palikea	11 of 12	*Arthrostemma ciliatum*, *C.* x *crocosmiiflora*, *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.* x *crocosmiiflora* ICAs report high constant numbers. This taxon is difficult as staff are limited to manual control and there is no approved effective treatment method available. ANRPO will investigate new control methods. The *D. chinensis* ICA reports low numbers. No *P. glomerata* has been seen at the fenceline and North Palikea Snail Enclosure for over three years. The Cabin DZ *P. glomerata* had only 1 mature plant in 2021. Three of the four *S. palmifolia* ICAs reported no plants. Palikea-SetPal-01 was eradicated in this report year.
SBE No MU	18 of 19	*A. glomeratus* var. *pumila*, *C. odorata*, *Heterotheca grandiflora*, *R. tomentosa*, *S. condensatum*, *Smilax bona-nox*, *Vitex trifolia*	Most 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 (see *S. condesatum* discussion above). 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*, *E. poepiggiana, 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 others are smaller ICAs that have not reported many plants in the last few years. A buffer survey was never completed for SBWNoMU-ChrOdo-06 because it goes in the impact area. No *S. condensatum* plants have been reported since 2019 and this ICA will be evaluated for eradication in the next report year.
Wai‘eli No MU	1 of 1	*M. faya*	The last observation of *M. faya* plants was in 2012 when it was established. None were found this year and the ICA was reported as eradicated.
Waimānalo to Ka‘aikukui No MU	3 of 3	*C.* x *crocosmiiflora*, *S. palmifolia*	All *C.* x *crocosmiiflora* 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 and can be eradicated in the next report year.
Total: 215 of 255 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 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 level of 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 ʻŌhikilolo 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 the 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 5: Summary Statistics for WCAs.

Report Year	Visits	Effort (hours)	Area (ha)	Hours/ha
2022-2023	**776**	**6,966**	**68.5**	**101.7**
2021-2022	1,001	9,741	75.7	128.6
2020-2021	1,028	8,650	115.2	75.1
2019-2020	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

This year, WCA efforts covered 68.5 ha. Staff spent 6,966 hours over 776 visits at 181 WCAs. WCA work accounted for 17% of the total area controlled and 80% 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 5 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 visits, effort, weeded area and hours/ha decreased from last year. This year weed control continued to focus on high intensity projects such as expanding restoration sites. It is unknown why numbers are low, as lower efforts were recorded in all MUs compared to last year. There are no further analyses to determine the exact reason for the decline in this year's effort or where hours were allocated.

All MUs which received ≥ 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 ʻĒkahanui, Kaʻala Army, Kahanahāiki, Kaluaʻā and Waiʻeli, Kapuna Upper, Līhuʻe, Mākaha I, ʻŌhikilolo, Pahole, and Palikea. Two MUs on the list are in severely degraded habitat and host one or two IP taxa; these include Keaʻau Hibiscus and ʻŌhikilolo Lower; both are dominated by alien grasses. Maintaining low fuel levels around the rare taxa at these MUs is a high priority and requires consistent, large inputs of time in a relatively small area around the plants.

Figure 3: Staff weed around restoration area in Kapuna Upper MU.

Table 6: 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?
Kahanahāiki	24 of 34	1,048	109	4.56	No	Yes	Yes
Ka‘ala Army*	4 of 43	684	51	11.81	Yes	Yes	Yes
Kalua‘ā & Wai‘eli	16 of 19	667	61	2.1	No	Yes	Yes
Palikea	8 of 8	641	73	3.22	No	Yes	Yes
Makaleha West	3 of 8	564	59	2.51	Yes	Yes	Yes
Mākaha I	12 of 21	506	42	2.01	Yes	Yes	Yes
‘Ōhikilolo Upper*	9 of 62	435	35	15.03	Yes	No	Yes
Pahole	16 of 41	339	53	4.89	Yes	Yes	Yes
Kea‘au Hibiscus	3 of 3	252	25	1.24	Yes	No	Yes
Kapuna Upper	12 of 23	246	33	1.58	No	No	Yes
‘Ōhikilolo Lower	3 of 4	234	25	3.04	Yes	No	Yes
‘Ōpae‘ula Lower	3 of 3	229	19	1.1	Yes	No	Yes
Līhu‘e	6 of 26	191	16	3.66	No	No	No

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: Ka‘ala Army, ‘Ōhikilolo Upper, Pahole, and Līhu‘e. 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 ‘Ōhikilolo are accessible only via rope (noted * in Table 6). The following situations may have contributed to the numbers seen in Table 6, which shows the total number of MFS populations that received weed control. They are explained in greater detail below.

- 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. This is true for *Hedychium gardnerianum* sweeps at Ka‘ala Army where multiple teams covered a large area (11.81 hectares).
- Volunteer work trips remained similar to the 2022 report year. These efforts contribute to many of the largest number of hours and visits are in the Ka‘ala Army, Palikea, and Makaleha West MUs.
- Restoration projects typically require large amounts of effort, particularly during initial weed clearing. As restoration sites mature, weed effort gradually declines. This year, a couple new sites were established including “Liana lane” in Kalua‘ā and Wai‘eli and a small site in Makaleha West.

- 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 fences were cleared this year.

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 7. 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 2021-2022 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 7: MU WCA Weed Control Summary, Report Year 2022-2023.

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
DMR No MU	N/A	4.06	**0.03**	**1**	**1**	0.06	2	24	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*. Last year much of the clearing was done to increase light levels, however this year additional clearing was not needed as much.
ʻĒkahanui	87.50	179.51	**1.08**	**19**	**90**	1.54	41	376	Efforts in this large, highly degraded MU were centered on rare taxa locations, restoration sites, and grass/fuel control.
Haili to Keālia I	7.91	1.13	**0.25**	**11**	**98**	0.29	13	94	Staff target woody weeds and grasses around the *Hibiscus brackenridgei* subsp. *mokuleianus in situ* and reintroduced plants.
Haili to Keālia No MU	343.18	31.42	**0**	**0**	**0**	0.03 (267 m^2)	1	2	Staff control weeds along the access trail to Haili to Keālia MU as needed.
Honolulu East No MU	N/A	2.43	**0.39**	**4**	**29**	2.43	3	12	Greenhouse staff conduct regular maintenance throughout the year around rare plant living collections at Koko Crater Botanical Garden. The increase in effort hours could be the result of intense and meticulous weeding around rare plant taxa sites.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Huliwai	0.1	0.20	**0.06 (711 m^2)**	**2**	**10**	0.13	4	21	This MU is centered on an *Abutilon sandwicense* population located in a small, fenced enclosure. Weed control is usually coupled with rare plant monitoring Effort hours decreased considerably this year as the plant population was visited less.
Huliwai No MU	N/A	9.53	**0.12**	**2**	**7**	0.08	3	19	Staff conduct grass control around a *Cenchrus agrimonioides* var. *agrimonioides* site and along the ridge access trail to the site. Effort hours decreased considerably this year as the plant population was visited less.
Ka'ala Army	49.02	125.59	**11.81**	**51**	**684**	8.4	43	448	*Hedychium gardnerianum* and *P. cattleianum* are primary weed targets at Ka'ala. Staff conduct weed control around rare plant reintroduction sites, along fencelines and throughout the bog flats. The increase in effort hours from last year could be attributed to the greater number of times the teams have performed these meticulous sweeps.
Ka'ala NAR	20.03	24.65	**0.20**	**6**	**21**	0.52	11	24	Staff maintain grasses at the shelter/campsite and along the boardwalk trail. Staff also focus efforts on the Ka'ala snail enclosure and rare IP taxa sites.
Ka'ena	10.06	3.28	**0.08 (634 m^2)**	**1**	**5**	0.21	2	11	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. The decline in effort from last year could be due to less need for weeding in the extremely dry weather.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Ka'ena East of Alau	14.51	1.20	**0**	**0**	**0**	0.19	2	11	Staff focus on reducing grassy fuels around the small *E. celastroides* var. *kaenana* site, including the access trail. Staff have not returned to this area since 2021, due to the failing *E. celastroides* var. *kaenana* population. This site may be dropped as a Manage For Stability (MFS) population and weed control will cease.
Kahanahāiki	37.70	82.77	**4.56**	**109**	**1,048**	11.91	159	1,535	Staff continue to control weeds at rare plant sites, rare snail enclosures, restoration sites, and along trails and fencelines. There were no new large-scale restoration projects this year, which showed in the decrease in effort hours and area weeded compared to last year.
Kaleleiki	0.12	0.80	**0**	**0**	**0**	0.02 (244 m²)	1	1	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. No weed control was needed this year.
Kalua'ā and Wai'eli	80.97	164.10	**2.10**	**61**	**667**	2.63	67	632	Staff perform weed control at several rare plant populations, insect sites, restoration sites and the Hāpapa Snail Enclosure.
Kalua'ā No MU	N/A	14.88	**0.13**	**3**	**5**	1.21	3	6	Staff spray the invasive grass *S. palmifolia* and other trailside weeds along the access trail.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaluakauila	42.73	61.27	**1.04**	**19**	**130**	1.49	17	143	Staff weed around rare plant outplantings including *Neraudia angulata*. Grass control is also a main focus as fire is a major threat.
Kaluanui No MU	N/A	209.57	**0**	**0**	**0**	0.04 (486 m²)	2	26	Staff weed the around the *Schiedea kaalae* outplants. This action is usually combined with rare planting outplanting or monitoring, but monitoring was not done this year.
Kamā'ili	2.57	3.92	**0.55**	**9**	**72**	0.87	13	103	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 decrease in effort hours could be due to staff shortages and prioritizing other actions.
Kamā'ili No MU	N/A	4.51	**0.01 (100 m²)**	**1**	**1**	0.03 (388 m²)	3	25	Staff maintain the LZ, DZ, campsite, and trail to facilitate access to the Kamā'ili fences. Staff continue to control the *M. hibiscifolia* stand adjacent to the LZ.
Kapuna Upper	172.35	507.69	**1.58**	**33**	**246**	1.49	32	285	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.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kea'au Hibiscus	N/A	7.35	**1.24**	**25**	**252**	1.02	26	291	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. Staff continued to make a 10 m wide fuel break along the western portion of the population after starting this work in 2022.
Kea'au No MU	N/A	0.73	**0.09 (1,011 m^2)**	**2**	**2**	0	0	0	Regular maintenance is conducted along the access trail to the MU and LZ as needed. Both grasses and woody weeds are targeted.
Koloa	71.54	72.95	**3.58**	**10**	**60**	1.61	10	183	Located at the summit of the Ko'olau Mountains, weather poses a major challenge to conducting effective weed control. Staff focus weeding efforts around reintroduction zones and sweeping for target taxa, *A. evecta*, throughout the MU.
KTA No MU	N/A	3.53	**0**	**0**	**0**	0.79	3	7.50	Last year, staff sprayed out any leftover herbicide from controlling a nearby *C. odorata* hotspot with a power sprayer along the Bravo Road. There was no need for weed control along the roads this year, as other entities are contracted to mow, spray and maintain the roads.
Kuaokalā No MU	N/A	0.83	**0.01**	**1**	**1**	0	0	0	Staff control grass along the road as needed. Grass control has been a low priority, as the 2022 and 2023 years show little to no effort.
Līhu'e	711.92	1439.46	**3.66**	**16**	**191**	3.11	22	288	Much effort is around four rare taxa sites, particularly the 'Olopua' and 'Hame' fences and maintaining trails. Staff hours may have been lower this year due to range access issues.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Mākaha I	34.20	71.20	**2.01**	**42**	**506**	4.98	68	601	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. Area weeded, # visits and effort hours decreased this year as one of the restoration sites has done exceptionally well and does not require large efforts anymore.
Mākaha II	26.69	14.73	**0.52**	**13**	**117**	1.37	28	246	Staff prioritize weed control in rare plant sites and along fencelines. This year, the total area weeded, #visits, and effort was cut in half due to maintaining already established restoration areas instead of creating new ones.
Makaleha Central No MU	N/A	0.19	**0.001 (14.61 m^2)**	**1**	**1**	0.10	1	1.50	Staff concentrate weed control around the remaining *in situ Kadua degeneri* var. *degeneri* population when monitored.
Makaleha East West Branch	1.14	1.23	**.00008 (0.91 m^2)**	**1**	**2**	0.01 (65.60 m^2)	1	1.50	Staff concentrate weed control around the remaining *in situ K. degeneri* var. *degeneri* population when monitored.
Makaleha West	38.05	8.89	**2.51**	**59**	**564**	1.87	73	999	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. Compared to last year there was an increase in area weeded as the restoration site was cleared and weed efforts throughout the newly cleared area allowed for more coverage.
Makaleha West No MU	N/A	0.36	**0.02 (214 m^2)**	**2**	**11**	0.06	3	7	Staff maintain the trail to the MU by clearing weeds and spraying invasive grasses as needed.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Manuwai	122.49	254.74	**1.35**	**31**	**133**	1.23	25	201	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.
Manuwai No MU	N/A	4.17	**0.04 (503 m^2)**	**1**	**1**	0	0	0	Staff control grasses along the western access trail and fenceline as needed.
MMR No MU	N/A	24.13	**0**	**0**	**0**	0.12	4	5	Weed control is mainly conducted along the 'Re-Veg' road and MMR and Kahanahāiki fencelines as needed. This year, no weed control was needed.
Moanalua No MU	N/A	88.95	**0.04 (503 m^2)**	**5**	**35**	0	0	0	Staff focus on controlling *L. leucocephala* and grasses along the Tripler fenceline of the *M. xanthomelas* enclosure as needed.
Nānākuli No MU	N/A	6.01	**0.27**	**1**	**4**	0	0	0	This leeward facing bowl stretches between the Palikea and Palikea IV MUs. Staff cleared the trail and LZ at Halona to support rappelling operations along the ridge.
'Ōhikilolo	232.79	155.29	**15.03**	**35**	**435**	3.83	58	862	Access to the Lower Mākua portion of the MU has been inconsistent due to UXO issues. Most work reported here occurred in the 'Ōhikilolo 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 area weeded due to grass sprays.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
ʻŌhikilolo Lower	28.75	4.62	**3.04**	**25**	**234**	3.34	19	233	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.
ʻŌpaeʻula Lower	10.15	14.02	**1.1**	**19**	**229**	0.88	24	414	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 a decrease in total effort hours due to less scheduled camp trips.
Pahole	88.02	193.65	**4.89**	**53**	**339**	4.56	64	479	Staff prioritize effort at rare plant sites. In the back of gulch 2 and the 'Bill Garnett' site, ANRPO and the State have been increasing weed control efforts to improve overall native habitat. Trail and fence maintenance are also regularly completed.
Pahole No MU	N/A	24.28	**6.39**	**7**	**26**	7.26	6	21	Staff control weeds along the Pahole road, around the Nike greenhouse and LZ, along the beginning of the Kahanahāiki-Pahole access trail, on the access trail to the main Pahole gulch, and around the *C. agrimonioides* var. *agrimonioides* site near the Pahole-Kahanahāiki crossover.
Pālāwai No MU	N/A	5.97	**.002 (23 m^2)**	**1**	**1**	0.01 (142 m^2)	2	1	This area immediately abuts the Palikea MU. Small-scale efforts at this site include grass sprays near the fenceline.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Palikea	9.95	22.14	**3.22**	**73**	**641**	4.30	109	991	Staff continue to focus on maintaining restoration sites, rare taxa sites, in/around the snail enclosures, grass control, and rodent control trail/fence maintenance. No new restoration sites were cleared this year which could attribute to low effort.
Pua'akanoa	10.70	2.21	**0.12**	**4**	**31**	0.48	9	28	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.
Puali'i North	7.99	10.98	**0.79**	**8**	**47**	0.56	10	66	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	4.22	**0**	**0**	**0**	0.08	3	5	Staff control weeds around East Base to reduce the potential for staff and volunteers to act as vectors. Although weeding is regularly done (at least 2 times/year), the data was not recorded for this year.
SBW No MU	N/A	2.62	**1.32**	**18**	**37**	0.98	8	13	This region includes both West Base and the Kahua Living Collection site. 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.
Wai'anae Kai	3.66	1.14	**0**	**0**	**0**	0.002 (16 m^2)	1	1	Last year, the majority of effort at this MU was spent clearing weeds around wild *Nototrichium humile* in two small fences. No weeding was conducted this year, due to time limitations.

Table 7 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2023 Report Year			2022 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Waimānalo to Ka'aikukui	N/A	0.27	**0.28**	**1**	**2**	0.47	2	2	This area includes the trail from the parking area to Palikea MU. Staff spray the trail to prevent weeds, particularly *E. stipioides*, from spreading. Staff also weed a *Kadua parvula* outplanting that is along the trail, outside the MU fence.
Waimea No MU	N/A	1	**0.14**	**3**	**4**	0	0	0	Staff weed among outplantings of *E. koolauensis* and *N. humile* at Waimea Valley. Weeding is paired with monitoring. Although efforts probably occurred in 2022, they were not recorded.
TOTAL	N/A	5336.52	**68.45**	**776**	**6,966**	75.7	1,001	9,741	Total area, # visits and effort decreased for report year 2023 in many MUs. This reflects a reduction in team staffing and less priority placed on weed actions this year.

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 Hawai‘i, 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 Mākaha Valley.
- Coordinating Group on Alien Pest Species (CGAPS). The Federal Biologist participates in the CGAPs working groups on all alien pests.
- Delta Environmental Technical. Staff are required to have Explosive Ordnance Disposal (EOD) escorts when working in impact areas on Army training areas. Staff use Delta’s services at least once per month when the impact areas are closed on SBW.
- 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 is coordinating logistics and helping to guide priorities with the researchers involved in this study.
- DOD Office of Local Defense Community and Cooperation (OLDCC). Staff drafted a letter of support for the development of a new biocontrol facility on O‘ahu and sent to OLDCC.
- Federal Aviation Administration (FAA), Ka‘ala facility. Staff informally share information on invasive plants found within the FAA facility on the summit of Ka‘ala, and along the Ka‘ala access road, with FAA and road maintenance personnel.
- Hawai‘i Agricultural Research Center (HARC). This year, staff continued to assist HARC with their project to develop fungus-resistant *Acacia koa* stock for the Wai‘anae Mountains, which may be used by staff for restoration projects. Staff also helped in developing a plan for a seed orchard on HARC property. In addition to *A. koa* seed, ANRPO helped to maximize planting space for other native species to use in restoration efforts and will contribute plants and growing space to the project.
- Hawai‘i Conservation Alliance: As members of the HCA ANRPO are working towards industry scale solutions to invasive species control soluations. Recent efforts on the Effective Conservations Programs subcommittee to develop website accessible BMPs (Best Management Practices).
- Hawai‘i Department of Agriculture (HDOA). This year, staff continued working with HDOA on the development of a biocontrol for *C. odorata*.
- Hawai‘i Vertebrate Introductions and Novel Ecosystems (VINE) Project. ANRPO continues to support research projects led by the VINE team. This year, staff provided a study location at Kahanahāiki MU for a world-wide, island-focused research project titled “Measuring the macroecological and local effects on plant-animal interaction using artificial fruits.” Local leads Dr. Don Drake and Sara Gabrielson facilitated field work on O‘ahu, which was completed in winter 2022.

In total, approximately 24 authors collected data at 75 plots on 30 islands. Results will provide greater understanding of interactions between native and invasive birds and plants.

- 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 Botanical Garden and Wahiawa Botanical Garden. This work includes vegetation maintenance.
- Koʻolau Mountains Watershed Partnership (KMWP). The U.S. Army Garrison, Hawaiʻi is an active member of the partnership and attends meetings that guide management on Army lands. Cooperative work with ANRPO staff did not occur in 2023.
- Oʻahu 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, collaborating on overall management strategy, and pursuing a biocontrol.
- University of Hawaiʻi (UH). University of Hawaiʻi; Department of Natural Resources and Environmental Management (NREM), School of Life Sciences (SLS), and Department of Geography and Environment (GEO). ANRPO staff continued to collaborate with a variety of UH professors and students this year. In addition, OVPRI continues to fund graduate assistantships (GAs) conducting research relevant to ANRPO goals.
    - ANRPO staff provided data to graduate student Isaiah Wagenman (NREM, advisor Dr.Yinphan Tsang) for a study looking at potential connections between natural resource management activity and watershed health as characterized by stream flow and sedimentation.
    - ANRPO staff worked with undergraduates in Dr. Melissa Price's Environmental Problem-Solving class (NREM). These students conducted a structured decision-making exercise around management plans for *Hibiscus brackenridgei* subsp. *mokuleianus*, which took in to account the high labor of vegetation management in degraded habitats.
    - ANRPO supported the work of graduate student Kauanoe Greene (SLS, advisor Dr. Kasey Barton), who is studying *Dodonaea viscosa* variability to determine if it reflects phenotypic plasticity or genetic differentiation among populations. *Dodonaea* is an important component of Waiʻanae forests, with three distinct varieties.
    - Graduate student Yoko Uyehara (GEO, advisor Dr. Qi Chen) was awarded a Graduate Assistantship (GA) in the fall of 2021 for a project to develop automated identification of target plants (*Pritchardia* spp. and *Angiopteris evecta*) from imagery, using a large ANRPO image dataset (collected via a helicopter-mounted system by a contractor in 2021). This project was extended for a second year (fall 2022) of GA funding; with the addition of more target plants (*Schefflera actinophylla* and *Toona ciliata*). The GAship was transferred to graduate student Katherine Fryer partway through the year. Final reports for this project are pending.
    - Graduate student Kevin Faccenda (SLS, advisor Dr. Curt Daehler) was awarded a GA for the fall 2023 semester. He will be conducting biogeographical modeling of more than 20 incipient invasive plants.
- State of Hawaiʻi: 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 Kaʻala 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 is in constant communication to share program information and updates in areas where management overlaps with state-owned lands. ANRPO informs the State of any new invasive species occurrences.

- 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.
  - *Chromolaena odorata* plants sent from ANRPO were potted and maintained at the Volcano facility for rearing gall flies.
  - The USDA established a successful colony of gall flies.
  - Staff sent two batches of native plants for host-specificity testing.
  - ANRPO hired a Biocontrol Research Technician to assist with gall fly rearing and testing at the USDA Volcano quarantine center. This was a year-long term position, which ended in 2022. This position is currently vacant. It may be filled in future, to assist with remaining testing, dependent on USDA needs.
  - Plans to finish host-specificity testing is set to finish in 2024.
- Waiʻanae Mountains Watershed Partnership (WMWP). The U.S. Army Garrison, Hawaiʻi is a member of the partnership.
- Waimea Valley. ANRPO manages two rare taxa living collection sites.

3.5 VEGETATION MONITORING

During this reporting period, vegetation monitoring analyses were completed for Kapuna Upper and ʻŌhikilolo MUs; Palikea *M. faya* IPA treatments, and ʻŌhikilolo Lower post-fire. Results of these monitoring efforts are included in Appendices 3-8 through 3-11 and will be used to modify weed control and restoration plans. In the coming year, staff plan to complete inaugural MU vegetation monitoring at both the Makaleha West and Kaluakauila MUs.

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 partnered with Range Division to deliver and record the Natural Resources brief for soldiers. This ensures consistent and effective delivery of the required materials. ANRPO attend these briefs once per year to quality check that everything is running smoothly.

- ANRPO staff created a one-hour video presentation for the Environmental Compliance Officer (ECO) training which occurs six times per report year. This class is for enlisted personnel and contractors that work on Army training lands.
- Prior to any training at Mākua Military Reservation (MMR), units receive a joint brief from range control, DPW Cultural Resources, and DPW Natural Resources. The Natural Resources portion of the brief emphasizes prevention of invasive species spread and wildfires. This in-person brief has now also been replaced by the pre-recorded video of the briefing, which provides more scheduling flexibility for the trainer and consistent and effective delivery of natural resource training material. This year, the total number of briefings only includes half of the reporting year due to staff turnover at range control. A total of 21 briefs were given to 270 people from July through December 2022. Similar numbers could be expected for the remainder of the report year (January to June 2023).
- 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. The Army DPW Natural Resources Manager attends these meetings.

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

- ITAM and ANRPO collaborate on many occasions including yearly aerial sprays on range. Data is exchanged between both parties and consistent communication occurs, especially before and during these sprays.
- Range Division ensures the safety of ANRPO staff on all Army training areas. Every month ground and airmobile requests are granted by Range Division so staff have access to Army lands to fulfill the goals of the MIP/OIP.

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 Oʻahu. 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 all were operational this year. The availability of each washrack this year was, CVWF 273 days, SBE Wash rack 262 Days, and the KTA Wash Rack 264 days.
- Analysis of RFMSS (the range scheduling program) data on wash rack use shows the total number of days that wash rack facilities were utilized during this reporting period was 398, as compared to 430 days last year. The reason for this decrease is unknown, however, some annual variation is expected as the number of training events (and thus need) varies from year to year. 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 251 days, SBE Wash rack 34 Days, and KTA Wash Rack 113 days.

Wash Rack Sediment Disposal

- Each wash rack has sediment bays where the vast majority of dirt and debris accumulates. When the collection of dirt becomes excessive, it is deposited at a secure location and monitored for invasive species germination. The most recent disposal site was at Area X on SBW (last sediment disposal was

in 2021). However, with logistical difficulties, the possibility of contamination with trash/unwanted material and not finding any significant invasive weeds, a decision was made to discontinue disposing wash rack sediment on Range. ANRPO will no longer be surveying the sediment dumps. Staff believe the environmental conditions of the sediment bays (shaded from the sun and consistently flooded with water) are enough to destroy any seeds that may wash into those bays allowing for safe disposal of sediment in the future. (Vidal *et al.* 2014).

PTA

- Staff continue to coordinate with Center for Environmental Management of Military Lands (CEMML) staff at Pōhakuloa Training Area (PTA) on Hawai‘i Island to share notable weed finds in range areas. As soldiers often train at both PTA and O‘ahu ranges, there is a risk of weeds spreading between the islands. The new discovery of *C. odorata* on Hawai‘i Island in 2022 is concerning. Although plants were not found near PTA, staff will share useful information on notable invasive species, like *C. odorata*, to allow PTA crews to be equipped with control techniques and 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 Hawai‘i 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. The Army has not used this DZ for training this year.

MMR

- A 2022 fire in MMR burned into a known *C. setaceus* population; these invasive plants thrive after burns and may lead to increased fire risk in this area in the future. ANRPO conducted aerial surveys but did not find any notable new populations.

- The presence of trespassers has increased on range. Hunters access the range via storm drainage gates and have been seen walking on the firebreak road around the training area. As range control staff leave around 2 pm each day and are not present on weekends, trespassers can access the training area freely. There is increased potential for spread of invasive weeds.

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 O'ahu 'Elepaio habitat. There are four ICAs on the road that passes 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 sign-posted 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. ANRPO staff monitor installed signs and maintain them as needed.

SBS

- No new high priority incipient invasive weed sites were found on SBS this year.

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 8 for a summary of all surveys conducted this year. One inaugural survey was completed in this report year, LZ-MAK-092 Lower Makai-Mākaha. This LZ eases access to the rat grid trails and aids staff in movement through the MU.

Table 8: 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.	25 surveys on 25 roads
LZ Survey	Actively used Army LZs are surveyed once per year. ANRPO LZs are surveyed only if used within a given quarter.	89 surveys on 42 LZs
Transect Survey	Surveys are conducted annually along high use access trails to MUs, selected MU fencelines, and high-traffic trails inside MUs.	15 surveys on 15 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.	20 surveys at 10 sites

Figure 4: At the start of road surveys staff gather to identify a few weeds to get a starting list for the rest of the survey.

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 9. 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" (Table 9).

All surveys on Army installation cantonment areas were recorded in this report year, including: RS-Helemano-01 (Helemano Army Reservation), RS-Shafter-01 (Fort Shafter Rd Survey), RS-Tripler-01 (Tripler Army Medical Center), and RS-Wheeler-01 (Wheeler Rd Survey) (Figure 5). While there were many new species first observed in these surveys, none of them were deemed significant pests. There were a number of ornamental and edible plants, especially in the housing areas, as people have affinities towards those species. Schofield Barracks has never been surveyed as extensively as the other Army installations; only the roads in the training areas are surveyed each year. In the future a new survey could be added to include all parts of Schofield Barracks cantonment areas. These surveys will be carried out every 2-3 years.

ANRPO contracted the Bishop Museum to identify unknown species. This year, a total of 6 alien taxa submissions were sent to Bishop Museum for identification or to document new locales for select taxa. In the past few years Bishop Museum submissions for identification have decreased. With new applications using identification technologies such as Artificial Intelligence (AI) or crowdsourcing it has become easier to narrow down the identity of an unknown plant. Moving forward, using a combination of both

botanical identification applications combined with consistent submissions for identification will be beneficial for ANRPO.

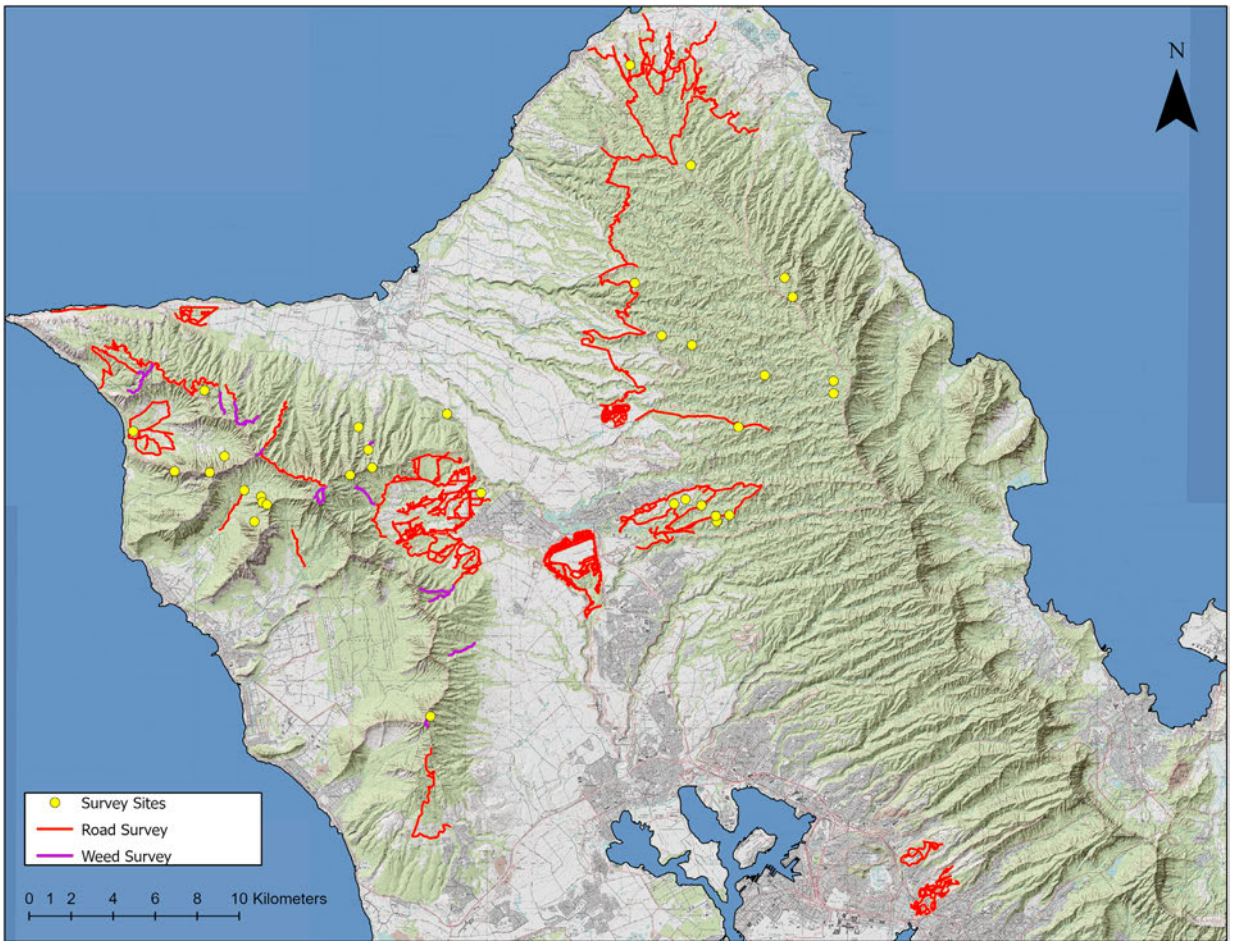

Figure 5: Map of surveys conducted in 2023.

Table 9: Summary of Noteworthy Alien Taxa Found on Surveys from 2023 report year.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Multiple Surveys/ Incidental	**RS-SBS-02** South Range Roads (Southern portion) **Manuwai NoMU**	*Chromolaena odorata*	*C. odorata* continues to spread as it is seen more frequently outside the main infestation at KTA, especially in degraded and open habitats such as roadways. Besides in KTA, the plant was first discovered in the Schofield Barracks North Ranges in 2013 and appears periodically on road surveys there, however only recently has it been found in the neighboring South Ranges. Since 2021 there have been two new *C. odorata* ICAs created in the South Ranges. In addition, a population of about 50 matures was found off the road to Manuwai MU on private property. This was not designated an ICA as it is not under Army jurisdiction. The landowner was notified and sent information about the population. Fires or large disturbances could exacerbate the spread as Kaukonahua Gulch (between Schofield Barracks and Manuwai) has burned several times in the past.
Road	**RS-KA'ALA-01** Ka'ala Road	*Rhyncospora caduca*	One plant was found while surveying the upper reaches of Ka'ala Road. *R. caduca* is a highly invasive plant found in wetter environments and is mostly absent in the Wai'anae Mountains. Its WRA score is 11 and is highly invasive. Staff will keep an eye on it and an ICA designation might be warranted.
Road	**RS-Mākaha-01** Mākaha Road	*Setaria verticillata*	This species has appeared on road surveys throughout the years and was first observed on Ka'ena Point Road Survey in 2008. It has appeared more recently on Schofield Barracks (OS-SBW-03) at the Area X Sand/Gravel Stockpile but has not been recorded since. This year it was recorded on Mākaha Road. The invasiveness of other members within the genus are concerning as staff already check nine *S. palmifolia* ICAs. However, *S. verticillata* is common in coastal and dry lowland sites, especially in areas of disturbance. Staff will continue to keep on the lookout on road surveys, but it is not a priority for control at this time.
Weed Transect	**WT-Kalua'ā-03** Hāpapa Access Trail	*Cinnamomum burmanii*	*C. burmanii* is a highly invasive weed as it tolerates shade and is dispersed by birds. It has a WRA score of 12, which is a high risk. *C. burmanii* was first noted nearby on the SBS South Range Road survey in 2004. It is also found on SBW North firebreak Road. The recent find on the Kalua'ā weed transect demonstrates that the species is moving higher up in elevation and into the MU. Staff will track locations incidentally during the course of regular fieldwork.
LZ Survey/Incidental	**LZ-KLOA-038** LZ Red	*Blechnopsis orientalis*	*B. orientalis* started appearing on several different road surveys (KTA, SBE and Ka'ala) and incidental observations (Kalua'ā and Wai'eli) in 2021. In 2022 it was identified in 'Ōpae'ula Lower MU. This year it was found on Red LZ in the Ko'olaus. The speed and geographical extent of the spread is alarming, and ferns are difficult to create an effective management program for. Staff will continue to document spread as a target taxon and control during the course of regular fieldwork.

Table 9 (continued).

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
LZ Survey	**LZ-MMR-008** Mākua Campsite	*Themeda villosa*	*T. villosa* is mostly found on Koʻolau surveys and has rarely appeared on Waiʻanae surveys. In the Waiʻanae mountains, *T. villosa* has been identified on LZ Luna Skeet in Mākua and on the SBW North firebreak road. This year it was recorded on the Mākua Campsite LZ, a few hundred meters away from Luna Skeet. *T. villosa* has a high WRA of 14 and poses a high fire risk. Staff will control around the campsite and LZs to limit spread to other areas.
LZ Survey	**LZ-WAIKAIFR-104** Waiʻanae Kai Cigar	*Parthenium hysterophorus*	*P. hysterophorus* is known as Santa-Maria and famine weed and is a noxious weed in many parts of the world. It also has medicinal benefits which make it marketable to the health care sector (Patel 2011). *P. hysterophorus* was reported on multiple road surveys (Tripler 2021 and Wheeler 2017) and was highlighted as a "Noteworthy Alien Taxon" in prior annual reports. This weed is naturalized in the lowlands of the northern leeward Waiʻanaes and was the first time reported on the Waiʻanae Kai Cigar LZ survey. Since the LZ is accessed by multiple organizations, it would be easy to spread to higher elevations. Staff will maintain the weeds on the LZ as needed and will target the weed if seen.
Incidental	**Kahanahāiki -16**	*Angiopteris evecta*	*A. evecta* is not that prevalent in Kahanahāiki, however it is found in several subgulches of neighboring Pahole and Kapuna. There are infrequent and inconsistent observations from Kahanahāiki including a few immatures in 2009 and one mature in 2016 found at Camp Joe. ANRPO has recently discontinued several *A. evecta* ICAs and instead will be targeted on sweeps or regular threat control weeding because of the difficult nature of eradicating fern species.
Incidental	**Kahanahāiki**	*Gamochaeta pensylvanica*, *G. argyrinea*	Plants were found incidentally during other work at a newly cleared restoration site and along the trail in Kahanahāiki. *Gamochaeta* is prevalent in disturbed areas and it can be difficult to identify. A few specimens were sent to Bishop Museum for identification and two species were identified, *G. pensylvanica* and *G. argyrinea*, both of which are naturalized on Oahu. One specimen was determined a hybrid, demonstrating the difficulty in identifying *Gamochaeta*. Staff will not do any control, as the plants are herbaceous and non-habitat altering.
Incidental	**Palikea**	*Nephrolepis cordifolia*	*Nephrolepis cordifolia* is commonly known as the sword fern and is a highly utilized ornamental. The species has many different varieties. Recent suspicion of more than one type/variety present at Palikea caused staff to look further into the matter with confirmation from Bishop of the non-native variety. There are populations of the non-native variety that exist naturally in the MU (probably due to escape from cultivation), and with the difficulty of controlling spore-borne species, no control will be done.

3.8 RESTORATION ACTIONS UPDATE

3.8.1. Management Unit (MU) Summaries

Restoration actions continued in high priority 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 plant 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 vegetation to expand and native seed bank to repopulate the area. Frequent weed control is often required immediately after non-native canopy removal; weed control efforts decline 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 specific rare plant populations, 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 while SDT actions can be done opportunistically and as needed. The 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). The outplanting area and SDT area are recorded separately, and these areas may overlap. A summary of restoration actions for each MU in 2023 is presented in Table 10. Locations of each MU can be identified using the map in Figure 8.

Reporting of common outplants started in 2016 and has since grown to fit the needs of active restoration (Figure 9). This year, ANRPO outplanted a total of 13,202 common native plants. This number roughly is in line with last year's total of 13,131 and is ANRPO's highest production amount to date. However, it is also the upper limit of what the greenhouses can produce as space is limited. Expectations for the number of outplants are set much lower for next year, as circumstances surrounding other rare taxa have changed, requiring additional greenhouse space. This is covered in greater detail in section 3.8.2.

Over the years, as restoration strategies have changed, the types of vegetation chosen for outplanting have too. In early years, the majority of outplantings consisted of tree and shrub species. This was largely a reflection of needs at the time. Previously, most restoration projects left large non-native canopy trees intact, thus herbaceous groundcovers were not a priority. As restoration projects incorporated larger canopy removal, the need for more fast-growing herbaceous plants arose. These herbaceous plants, which largely function as "groundcovers", as labeled in previous annual reports, have become a major component of current restoration strategies. When planted in high density, they reduce available area for weeds to germinate, shield the ground from direct sun, retain soil moisture, reduce erosion, and create more favorable conditions for other outplants to establish down the line. Figure 10 shows the distribution of trees, shrubs, and herbaceous species for each year from 2016 through 2022.

Figure 6: Outplanted *Dianella sandwicensis* holding in the slope at Palikea ʻIeʻie site.

This year, restoration efforts marginally increased in area for both SDTs and outplants (Figure 11). Outplanting restoration area totaled 33,751 m², compared to last year's total of 33,400 m². SDT restoration area increased from 6,250 m² last year to 7,457 m² this year. These totals by year do not account for any overlap in area between years, thus some of the area may be additive. Building upon last year's efforts to learn about which species work well in seed sows, we started more trials to track success of various species more carefully. Although there is no data to report yet, species currently being tested in trials include *Rumex albescens*, *Alyxia stellata*, *Planchonella sandwicensis*, *Bidens torta*, *Dianella sandwicensis*, *Coprosma longifolia*, and *Hibiscus arnottianus*. By identifying which species perform well in seed sows, this will inform other aspects of restoration including seed production, with the goal being to produce large quantities of seeds that can be dispersed onto the landscape and successfully establish on their own. As we incorporate more SDTs in restoration techniques, especially in larger projects, SDT area totals may fluctuate dramatically from 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 12-25 and Tables 11-18). All other MUs with restoration efforts this year, are summarized in Table 19 and do 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. For a summary of restoration projects to date and their current restoration phase, see Appendix 3-7.

Table 10: Summary of 2023 Restoration Actions by MU.

MU	Total # Outplants	Total Outplant Area (m^2)	SDT Total Area (m^2)
ʻĒkahanui	460	438	-
Haili to Keālia	469	2,038	690
Kahanahāiki	1,910	5,328	2,477
Kaluaʻā and Waiʻeli	2,282	3,493	664
Kaluakauila	520	1,445	-
Kamāʻili	220	773	-
Kapuna Upper	695	881	-
Keaʻau Hibiscus	242	495	-
Līhuʻe	-	-	356
Mākaha I	1,081	1,717	291
Mākaha II	397	1,235	-
Makaleha West	1,435	6,565	440
ʻŌhikilolo	1,428	2,378	-
ʻŌhikilolo Lower	8	223	1,480
ʻŌpaeʻula Lower	186	1,437	-
Pahole	269	1,196	454
Palikea	1,600	4,110	398
Total:	13,202	33,751	7,250

Figure 7: Happy planters welcoming rain immediately after outplanting in Mākaha.

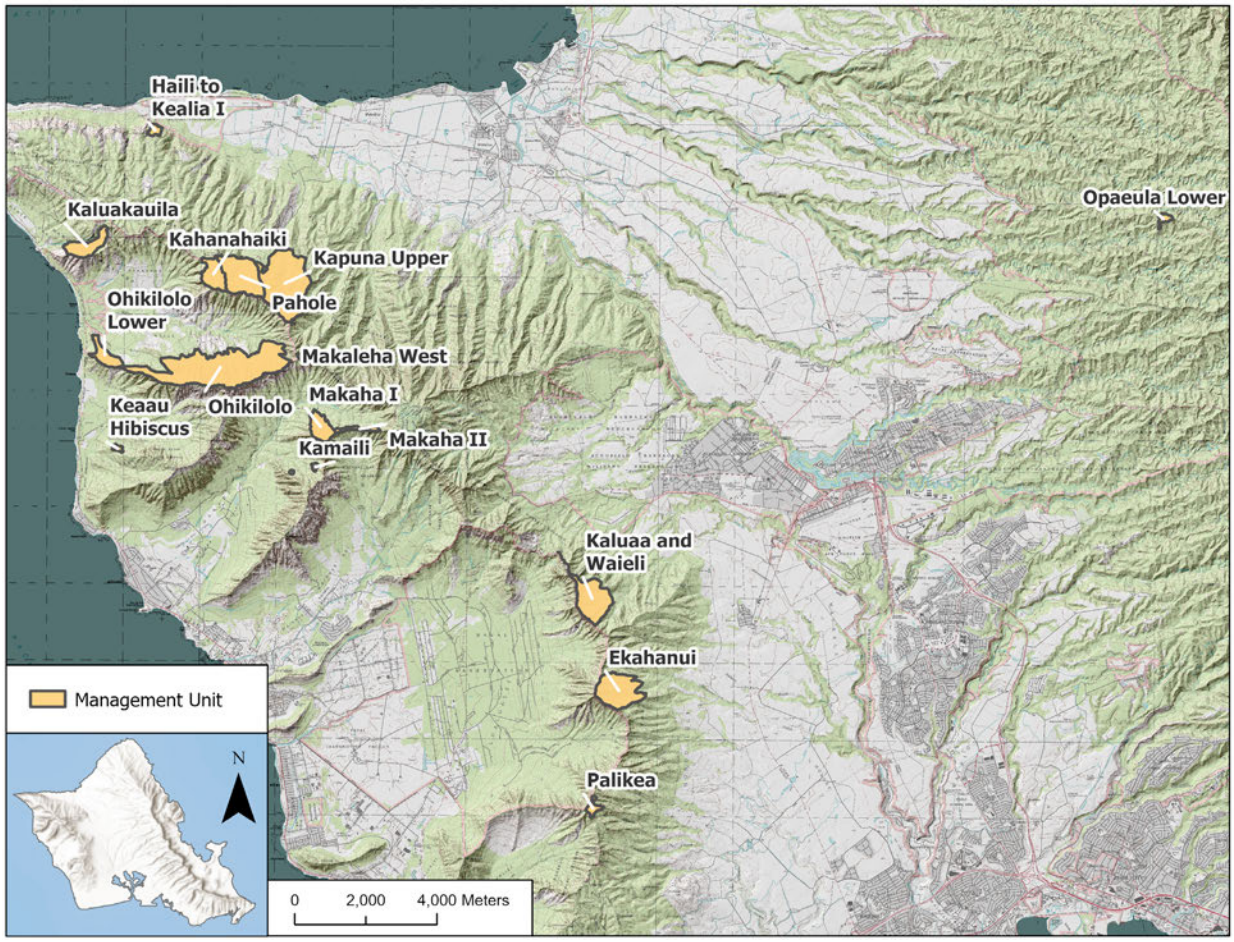

Figure 8: Map of ANRPO MUs.

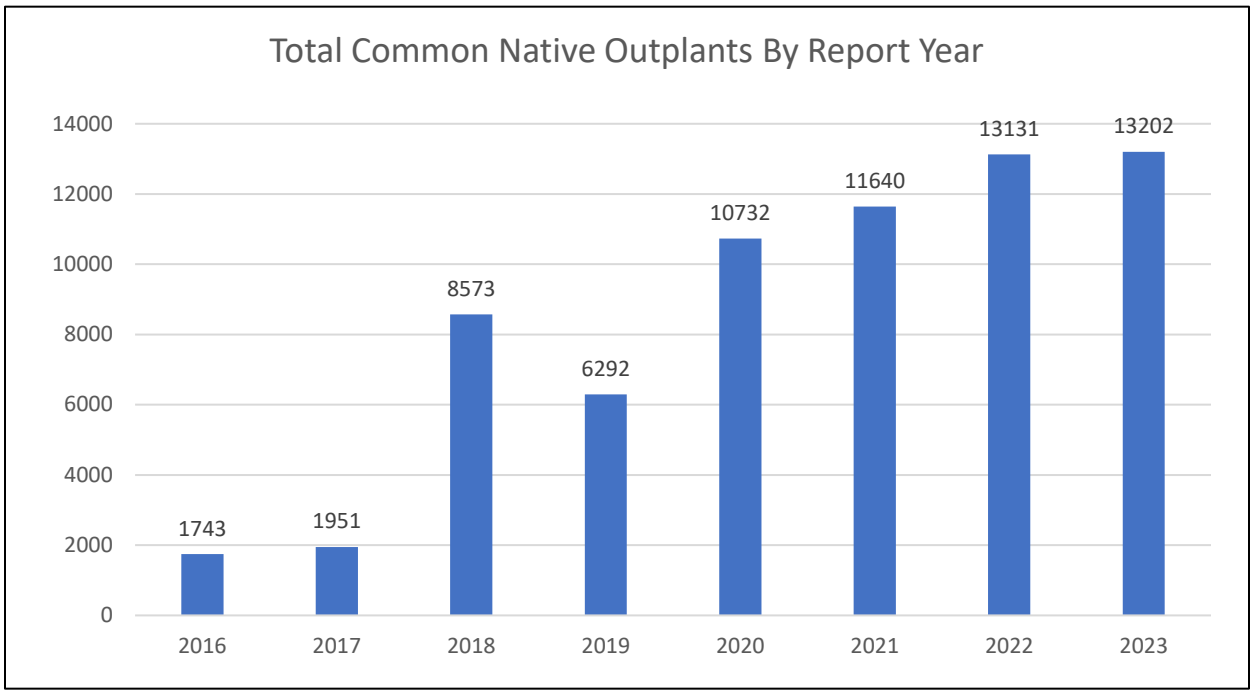

Figure 9: Total number of outplants each report year since 2016.

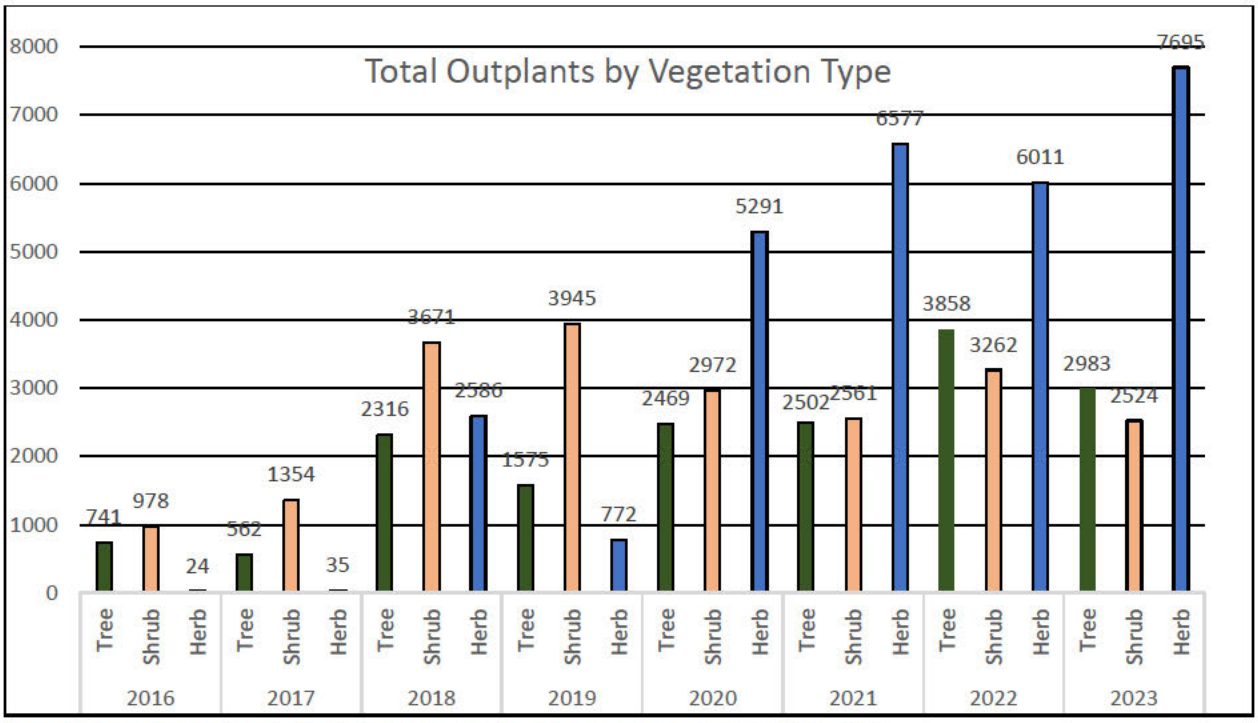

Figure 10: Total number of outplants by growth habit each report year since 2016.

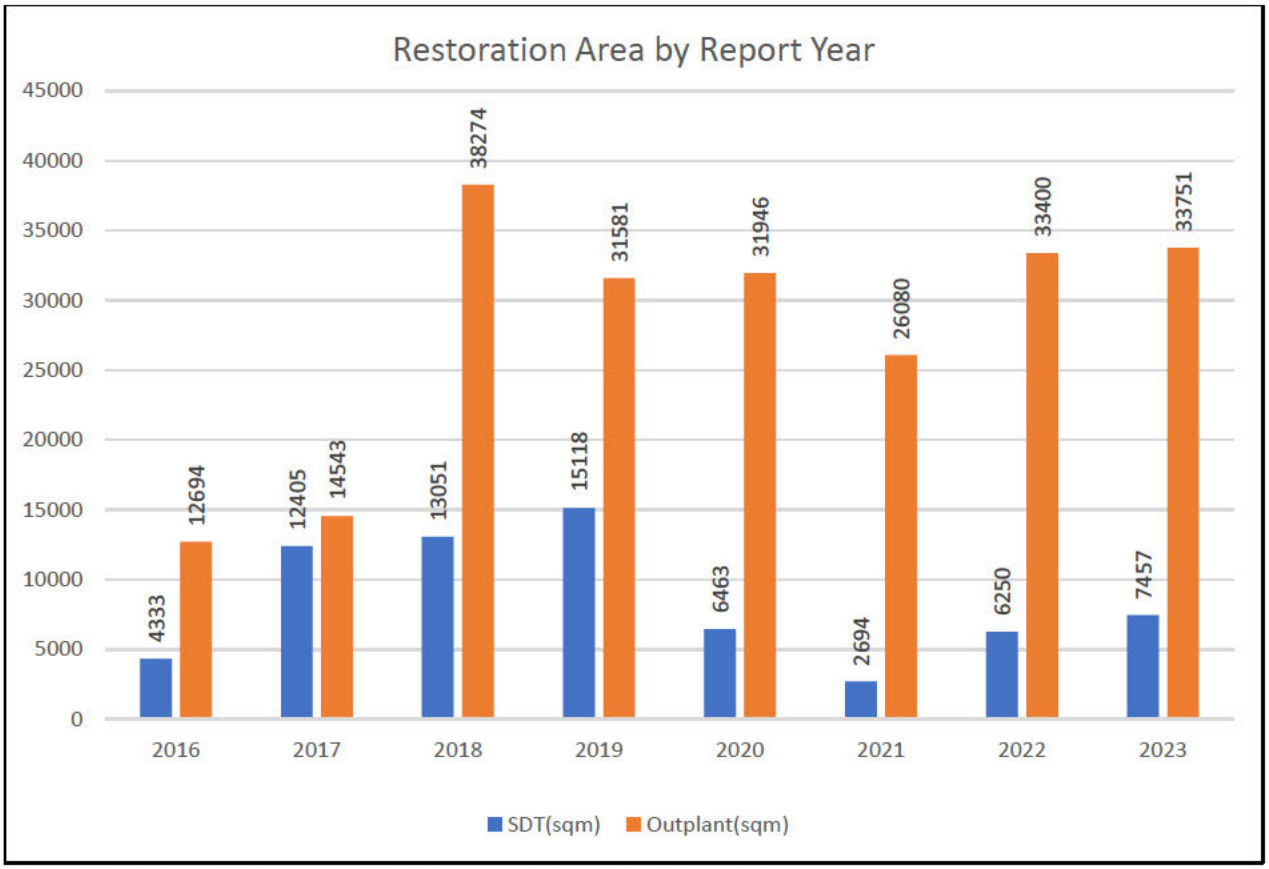

Figure 11: Total outplant area and SDT area each report year since 2016.

Over the years, ANRPO's methods for restoration have changed. Since 2020, there has been a dramatic decrease in SDT area accounted for. This is largely due to the approach in management style as there was a personel shift. Current practices emphasize much denser outplantings and SDTs. Since 2020, numbers of outplants have gone up while outplanting area has gone down and the same can be said of SDTs. In addition, "restoration area" is a loose term as almost no restoration has reached a completed phase. Prior to 2020, divisions and transplants were done regularly by taking plant materials from other restoration areas or nearby sites. These division and transplant efforts accounted for a good chunk of SDT area recorded but failed to acknowledge the reduction of plant materials at another site. While divisions can be an effective tool on occasion, keeping plant materials and restoration sites intact are a likely better solution for long-term success as soil disturbance can promote weed growth and removing plant material reduces native plant coverage in that area.

For seed sows, it is important to acknowledge that not much is known yet about their efficacy or appropriate seeding density. Many seed sows are done opportunistically without expectations for performance. Recently, staff have been logging these trials more accurately to draw meaningful conclusions. However, the number of seeds needed for effective direct sow restoration exceeds ANRPO's collection capacity by several orders of magnitude. To address this, staff have taken on numerous seed orchard projects to amplify the amount of seed available. While this is a promising step forward, seed production is still years away, and it is not a problem ANRPO can tackle by itself. Solving this will require entire industries focused on native seed collection, production, processing, storing, and application.

Kahanah

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Sensitive Information
Available Upon Request

Figure 12: Map of 2023 Restoration Actions in Kahanahāiki MU.

Figure 13: Staff outplanting western section of Tacky-10.

Table 11: Summary of 2023 Restoration Actions in Kahanahāiki MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	1,910	5,328	AcaKoa, AntPla, BidTor, CarMey, CarWah, CeoBru, ChaObo, ChaTom, CopFol, CypHyp, DiaSan, DodVis, EraGra, HibArn, KadAff, MetPol, MetTre, MicStr, MyrLes, PlaSan, PolOah, PsyMar, SapOah, ScaGaua
This year MU restoration outplanting occurred in 5 WCAs throughout Kahanahāiki. In WCA-03, "Schobo Baggins" received 350 plants; about 60% were herbaceous species and the rest trees and shrubs. Although staff thought they would be done planting prior to this season, teams found spaces in need of additional outplants when they cleared away some weedy asters (Asteraceae). In WCA-07, "Hene'iwa" received 101 *Microlepia strigosa* outplants to fill in around the *Schiedea obovata* MMR-I population. In WCA-09, "Nalu's," staff outplanted 140 plants in the area just east of the Kahanahāiki Snail Enclosure. The majority was *M. strigosa*, with a small amount of *Charpentiera* spp., *H. arnottianus*, and *Myrsine lessertiana*. In WCA-10, "Tacky-10," staff outplanted 842 plants as efforts expanded westward to the other side of the gulch. This site will continue to expand west with plans for VegRest and Green teams to start a larger restoration project in the flats that will connect to the current boundary of Tacky-10. Lastly in WCA-16, "Schweppe's Extension," staff outplanted 477 plants, filling in gaps left after removing dead *Pipterus albidus* and consolidating some slash piles.			
MU restoration-SDT	24,550 seeds, 15 divisions	2,477	AlySte(200 seeds), BidTor(2800 seeds), CeoBru(75 seeds), CopFol(53 seeds), DiaSan(1,095 seeds), DioSan(40 seeds), DodVis(25 seeds), GahBee(15 divisions), HibArn(250 seeds), LepTam(2,300 seeds), PipAlb(17,712 seeds)
This year, teams continued to use SDTs in restoration areas across Kahanahāiki. WCA-03 received two efforts: one *A. stellata* seed sow and one *Gahnia beecheyi* division effort. WCA-10 received seedsows of *A. stellata*, *Coprosma foliosa*, *Diospyros sandwicensis*, *Leptecophylla tameiameiae*, *P. albidus*, *B. torta*, and *Dianella sandwicensis*. WCA-15, "Plane Crash," was also seedsowed with *Diospyros sandwicensis* and *L. tameiameiae*. WCA-16 is home to a cohort of trials testing the efficacy of seedsows for some of these species including *Ceodes brunoniana*, *Dodonaea viscosa*, *Dianella sandwicensis*, *B. torta*, and *H. arnottianus*.			

Figure 14: Photopoints of Nalu's Restoration Area comparing March 2020 (top) to April 2023 (bottom).

Kalua‘ā and Wai‘eli

Image Redacted Sensitive Information Available Upon Request

Figure 15: Map of 2023 Restoration Actions in Kalua‘ā and Wai‘eli MU.

Table 12: Summary of 2023 Restoration Actions in Kalua‘ā and Wai‘eli MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - Outplanting	2,065	3,493	AcaKoa, BidTor, CarWah, CeoBru, CeoUmb, ClePer, CopFol, DiaSan, DodVis, DraHal, EraGra, GenKaa, KadAcu, KadAff, KadCor, MetPol, MicSpe, MicStr, PipAlb, PlaSan, PsyHat, PsyMar, RumAlb, ScaGaua, SidFal, SmiMel, SopChr, TouOah, WalInd
MU Restoration occurred in three WCAs this year. In WCA-02, staff outplanted 217 plants around the Hāpapa Snail Enclosure. In WCA-06, 275 outplants were used to continue to improve habitat around the *Cyanea grimesiana* subsp. *obatae* KAL-D population. In WCA-08, a new restoration area “Liana Lane” was started. In total it took 1,381 outplants to cover the area with good planting density. The site will continued to be weeded, but no plans of additional outplants are scheduled next season as we switch to OA-02 seedzone. In the same WCA, 409 plants were used to continue the buffer of the *Delissea waianaensis* KAL-C population.			

Table 12 (continued).

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - SDT	189 seeds	664	CeoBru(164), PitCon(25)
Seedsows occurred in WCA-08 in part of the newly opened "Liana Lane" restoration area. A small number of *C. brunoniana* and *Pittosporum confertiflorum* seeds were scattered across the site in attempts to fill it in at different strata, although there is plenty of *Acacia koa* recruitment as well.			
Drosophila stabilization-Outplanting	217	646	ClePer, GenKaa, KadAff, MetPol, MicSpe, PsyMar, RumAlb, TouOah
One effort was recorded under restoration for *Drosophila* stabilization in WCA-02 at Hāpapa around the weatherport and snail enclosure. A variety of species were planted, but only a small handful of *Touchardia oahuensis* (*Drosophila* host species, formerly *Urera glabra*) were among them. In the coming years, more *T. oahuensis* will be utilized to increase the amount of host material for the *Drosophila* species.			

Figure 16: Outplanting on the upper slope of Liana Lane.

Kapuna Upper

Image Redacted Sensitive Information Available Upon Request

Figure 17: Map of 2023 Restoration Actions in Kapuna Upper MU.

Table 13: Summary of 2023 Restoration Actions in Kapuna Upper MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - Outplanting	695	881	AcaKoa, AntPla, CarWah, CeoBru, ChaTom, CibCha, CopFol, DiaSan, EraGra, HibArn, MetPol, MicStr
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. Teams continued to remove *Psidium cattleianum*, *G. robusta*, and *S. terebinthifoius*, replacing them mostly with herbaceous plants and a smaller number of trees and shrubs. In the coming years, we plan on expanding east of the current location using the same strategy.			

Mākaha I

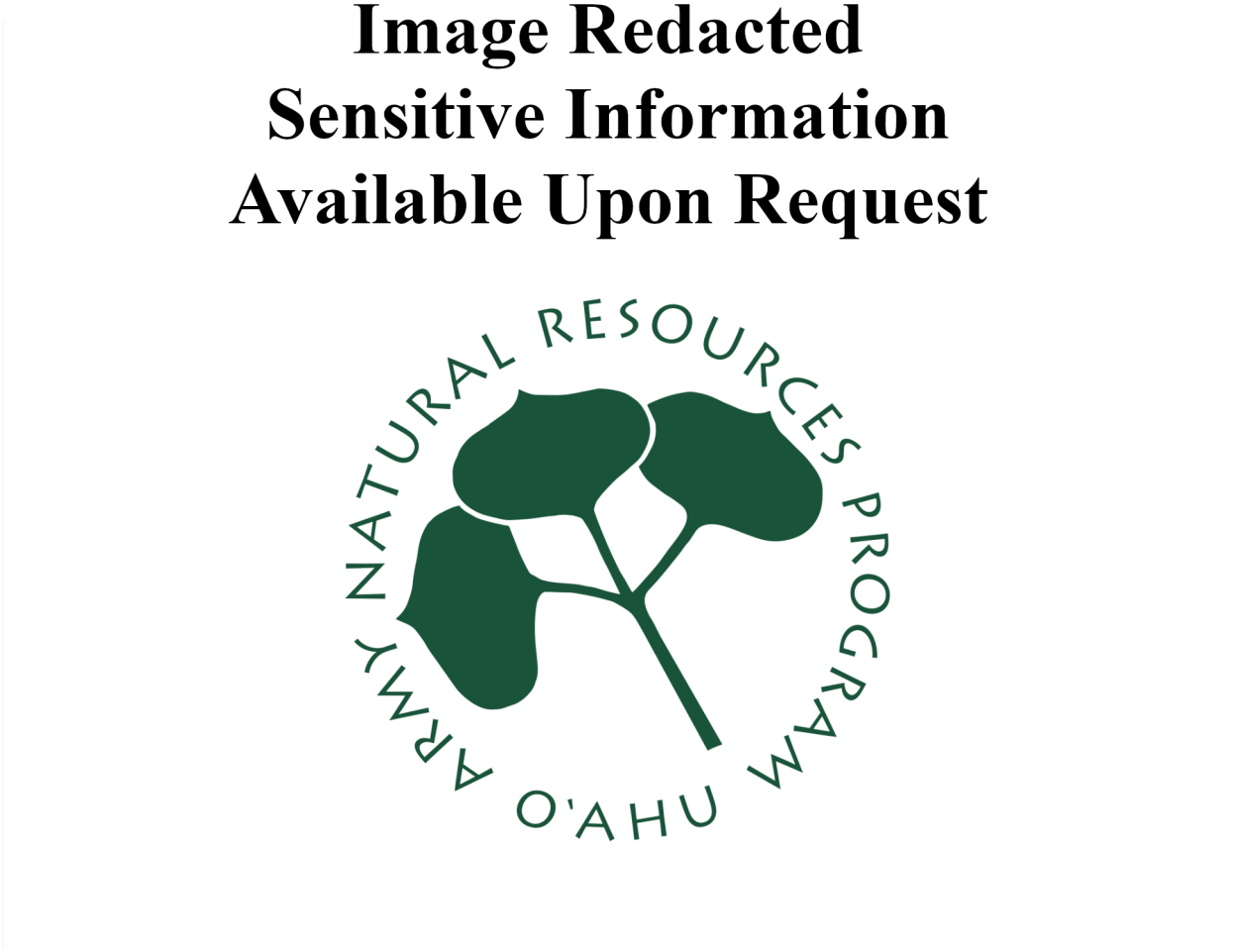

Figure 18: Map of 2023 Restoration Actions in Mākaha I & II MUs.

Table 14: Summary of 2023 Restoration Actions in Mākaha I MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	1,081	1,717	AntPla, CarWah, CibCha, CopFol, CopLon, DiaSan, DodVis, EraGra, KadAff, MetPol, MetTre, MicStr, PlaSan, SadCya, SapOah, SyzSan, WikOah
Outplanting restoration efforts occurred in two WCAs this year. In WCA-02, staff expanded on an older restoration site "Radagast." This now extends the restoration site all the way to the eastern edge of the ridge, further reducing weed incursion from that side. In total, 891 outplants were used to fill the area, 471 of which were herbaceous. In WCA-05 staff planted 190 plants around the *Schiedea nutallii* MAK-A population, continuing the buffer that they started last year.			
MU restoration – SDT	325	291	DiaSan, ScaGaua
In WCA-02 "Radagast Extension," staff seed sowed *Dianella sandwicensis* and *Scaevola guadichaudiana* to hopefully speed up the restoration process in the area. Both species have been observed recruiting in adjacent restoration areas, so there is a strong likelihood this method is effective for this area.			

Figure 19: Outplanting at Radagast Extension in Mākaha I.

Mākaha II

Table 15: Summary of 2023 Restoration Actions in Mākaha II MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	397	1,235	AntPla, CarWah, CibCha, CopFol, CopLon, DiaSan, DodVis, EraGra, KadAff, MetPol, MetTre, MicStr, SadCya, SyzSan, WikOah
In WCA-10, 191 plants were planted along the top of the fence above the *S. nutallii* MAK-A population, again building on the buffer started in report year 2020. In WCA-14, 206 plants were planted around the *Cenchrus agrimonioides* var. *agrimonioides* MAK-B and the *Schiedea obovata* MAK-E populations. These outplantings added to already established buffers around these rare plant populations.			

Makaleha West

Image Redacted Sensitive Information Available Upon Request

Figure 20: Map of 2023 Restoration Actions in Makaleha West MU.

Table 16: Summary of 2023 Restoration Actions in Makaleha West MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	1,326	6,565	AntPla, CarWah, CeoBru, ChaTom, CibCha, ClePer, CopFol, CopLon, DipSan, DodVis, IleAno, KadAff, MetPol, MetTre, MicSpe, MicStr, MyrLes, PitGla, PolOah, SadCya, ScaMol, SyzSan
Restoration efforts occurred in three WCAs this year. In WCA-02, 574 plants were used in MU restoration efforts in the "Okazu bowls." The area has filled in significantly and we may wait for this round of outplanting to grow more before deciding if more outplants are necessary. In WCA-04, "'I'i nui" was outplanted with 603 plants as staff continued to fill gaps in the restoration area. This year, plants skewed more towards tree species and more sensitive herbs and shrubs, but still included a smaller amount of *M. strigosa* and *Carex wahuensis*. Staff also planted 149 common native understory species in WCA-03 to buffer the immediate area around the new *Schiedea obovata* LEH-D reintroduction. Of the 149 outplants, 128 were ferns from four different species: *M. strigosa*, *Microlepia speluncae*, *Cibotium chamissoi*, and *Diplazium sandwichianum*.			

Table 16 (continued).

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration – SDT	185,291 seeds	440	CopLon(250 seeds) CypPol(183,308 seeds), IleAno(1,573 seeds), ScaGaua(160 seeds)
All SDT efforts this year happened in WCA-04. Since last year's seed sow trial of *Cyperus polystachyos* was a success, this year staff sowed seed from those parent plants across "'I'i nui." In other SDT efforts, staff sowed seeds of *Coprosma longifolia*, *Ilex anomala*, and *S. gaudichaudiana* taken from nearby areas into WCA-04.			
Snail Stabilization – Outplanting	109	2023	AntPla, CarWah, ClePer, CopFol, CopLon, DodVis, KadAff, PolOah, SadCya, SyzSan
In WCA-02, the Makaleha West Snail Enclosure received 109 plants to continue filling spaces and create continuity in vegetation from the northeastern corner of the enclosure where snails were originally released to the rest of the enclosure.			

Figure 21: 'I'i nui restoration area in 2023 with herbaceous groundcovers of *C. polystachyos*, *C. wahuensis*, and *Dianella sandwicensis*.

ʻŌhikilolo

Image Redacted Sensitive Information Available Upon Request

Figure 22: Map of 2023 Restoration Actions in ʻŌhikilolo MU.

Table 17: Summary of 2023 Restoration Actions in ʻŌhikilolo MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration-Outplanting	1,428	2,378	AcaKoa, AlySte, AntPla, CarWah, CibCha, CopFol, DiaSan, DioHil, DodVis, EraGra, FreArb, HibArn, IleAno, KadAff, KadCor, MetPol, MetTre, MicStr, MyrLes, OstAnt, PolOah, PsyHat, PsyMar, SadCya, SopChr, SyzSan, WikOah
Restoration continued in WCA-13 of ʻŌhikilolo as staff planted throughout "LanCam Gulch." As this section of the WCA fills out, staff intend to move restoration efforts over to the gulch east of this, where a patch *Pteralyxia macrocarpa* exists and could use buffering.			

Palikea

Figure 23: Map of 2023 Restoration Actions in Palikea MU.

Table 18: Summary of 2023 Restoration Actions in Palikea MU.

Restoration Action	# of plants	Area (m²)	Taxa
MU restoration - Outplanting	1,302	2,919	AcaKoa, AlySte, AntPla, CarWah, CheTri, CopLon, CypPol, DiaSan, DodVis, EraGra, FreArb, KadAff, MetPol, MicSpe, MicStr, MyrLes, PerSan, PolOah, PsyHat, PsyMar, RumAlb
This year, MU restoration in the form of outplantings occurred in five WCAs. In WCA-01, "The Meadows" site received 378 plants, mostly herbaceous groundcovers. In WCA-03, "Slope of Hope" received 311 outplants as staff continued to fill gaps in the existing restoration area. In WCA-06, "Fern Gully" Hawai'i Youth Conservation Corps (HYCC) helped to outplant 448 *M. speluncae* just below the trail. This outplanting looks great and has filled in nicely so far. In WCA-08, 229 plants were put into "'Ie'ie site." Most of these were tree species that were planted under the māmaki canopy, which was selectively thinned to allow small light gaps. These trees will eventually replace this māmaki, as we expect most of the māmaki to senesce over the next three years. In WCA-09 "Koa site," 98 herbaceous plants like *R. albescens*, *Eragrostis grandis*, and *C. polystachyos* were planted to stabilize the looser sections. The soil here is dry and powdery and has historically been difficult to revegetate.			

Table 18 (continued).

Restoration Action	# of plants	Area (m²)	Taxa
Snail Stabilization - Outplanting	369	1191	AntPla, FreArb, MetPol, MyrLes, PolOah, PsyMar
In WCA-11 "North Palikea Snail Jail," staff added tree species and other host plants for *Achatinella* species, including *Freycinetia arborea*. The snail enclosure is progressing nicely and is now very full of plants. We will monitor progress and only add plants if necessary.			
MU restoration – SDT	43,027 seeds	398	CheTri(217 seeds), CopLon(121 seeds), KadAff(189seeds), ScaGaua(2070 seeds), CleObl(40,000 seeds), PipAlb(350 seeds)
This year, SDT efforts in Palikea occurred in two WCAs. In WCA-05, inside the TNC fence, staff sowed seeds of *Cheirodendron trigynum*, *Coprosma longifolia*, *Kadua affinis*, and *S. gaudichaudiana*. Additionally, in WCA-06, "Fern Gully," staff sowed seeds of *Clermontia oblongifolia*, *C. longifolia*, *P. albidus* and *S. gaudichaudiana*.			

Figure 24: Staff and HYCC planting *Microlepia speluncae* at Fern Gully.

Other 2023 Restoration Efforts

Figure 25: Technician Cameron Young ecstatically watering outplants at HailitoKealia-04.

Table 19: 2023 Restoration Efforts in other MUs (no maps).

MU	Restoration Action	# of plants	Area(m²)	Taxa
ʻĒkahanui	MU restoration - Outplanting	460	438	AcaKoa, CarWah, DiaSan, DodVis, DraHal, EraGra, KadCor, MetPol, PsyMar
In WCA-13 of ʻĒkahanui, "Bumpout fence" received 460 outplants to continue to improve habitat surrounding the *C. agrimonioides* var. *agrimonioides* population. Staff will let this site rest next year and revisit this project in the future.				
Haili to Keālia	MU restoration - Outplanting	469	2038	CheOah, DodVis, EraVar, ErySan, SapOah, SidFal
One outplanting effort in WCA-04 was aimed at creating better habitat surrounding the *Hibiscus brackenridgei* ssp. *mokuleianus* LIA-C population. Efforts nearest the *H. brackenridgei* ssp. *mokuleianus* focused on shrubs and herbaceous species to avoid creating too much shade, while common native trees were planted further away on the perimeter to shade out invasive grasses.				
Haili to Keālia	MU restoration - SDT	64,176 seeds	690	CheOah(60,313 seeds), EraVar(3,863 seeds)
In the same area of WCA-04, seeds were sown for *Chenopodium oahuense* and *Eragrostis variablis*. Although the number of seeds seem high, germination and survival are expected to be low. These seeds sows were done opportunistically in concert with natural seeding times, rather than seasonal rains.				

Table 19 (continued).

MU	Restoration Action	# of plants	Area(m²)	Taxa
Kaluakauila	MU restoration – Outplanting	520	1445	CarWah, CheOah, DodVis, EraGra, ErySan, MicStr, OstAnt, PolSan, SapOah, SidFal, WalInd
In Kaulakauila, two areas within WCA-02 received outplants. Around the *Neraudia angulata* MMR-F population, 403 outplants were used to add to the buffer zone. Upslope near the catchment, 117 plants were used to buffer the *H. brackenridgei* ssp. *mokuleianus* MMR-H population.				
Kamā‘ili	MU restoration - Outplanting	220	773	CarWah, DodVis, EraGra, PluZey
In WCA-02 of Kamā‘ili, staff outplanted 220 common natives. The vast majority were herbaceous plants for the understory designed to improve habitat surrounding a population of *N. angulata*.				
Kea‘au Hibiscus	MU restoration - Outplanting	242	495	DodVis, ErySan, SanEll
In WCA-01, a total of 242 plants were split between the wild *H. brackenridgei ssp. mokuleianus* KEA-A population and the *Gouania vitifolia* reintroduction area. We will suspend restoration in the coming years, but plans are to eventually continue merging these two restoration spots into one. Staff plan to strategically use the natural rock formations in the area as fuel breaks in case of another fire.				
Līhu‘e	MU restoration – SDT	1,008 seeds	356	PerSan
In WCA-07, one effort using *Perrottetia sandwicensis* fruit estimated to be 1,008 seeds were sown and watered in. This was an opportunistic collection from Ka‘ala and was done as an experiment.				
‘Ōhikilolo Lower	MU restoration – Outplanting	8	223	ThePop
In WCA-03, staff planted eight *Thespesia populnea* or milo trees as an experimental planting after a fire burned through the area in June 2022. Since invasive grasses are a consistent problem here, staff tried planting drought tolerant shade producing trees around the perimeter of the *H. brackenridgei* ssp. *mokuleianus* populations to reduce the density of grass. Trees will be monitored regularly to see if suitable for such purposes.				
‘Ōhikilolo Lower	MU restoration – SDT	?	1,480	DodVis
One effort of a *D. viscosa* seed sow was recorded in WCA-01 immediately after weeding the area. Unfortunately, no accurate number of seeds was logged, but it was estimated as a half-gallon size Ziploc bag of mature fruit.				
‘Ōpae‘ula Lower	MU restoration - Outplanting	186	1437	CheTri, CleKak, CopFol, IleAno, MetPol, PitGla, ScaGaua, ScaMol, WikOah
In WCA-03, common natives continue to be used to improve habitat around the *Cyrtandra dentata* OPA-F population and the *Gardenia mannii* OPA-A population. The goals are to one day connect these two areas with a band of common natives, providing ample space for additional reintroductions, or hopefully, recruits. In WCA-04, a small number of plants were used to improve habitat around the *A. koa* planting near the cabin. In total, 141 plants went to WCA-03, and 45 plants went to WCA-04.				
‘Ōpae‘ula Lower	MU restoration-SDT	5 transplants, 15 divisions	207	CibCha(5 transplants), MacMar(15 divisions)
In addition to outplants, staff saw an opportunity to do some divisions and transplants of common natives in the *C. dentata* OPA-F area. Five *C. chamissoi* were transplanted and 15 divisions of *Machaerina mariscoides* were made from three founder plants.				

Table 19 (continued).

MU	Restoration Action	# of plants	Area(m²)	Taxa
Pahole	MU restoration - Outplanting	269	1196	AntPla, CarWah, CeoBru, ChaTom, CibCha, MetPol, MetTre
In WCA-01, 84 common natives were outplanted within the *D. waianaensis* PAH-C population to improve habitat. In WCA-03, 185 common natives were outplanted around the *Flueggea neowawraea* and *Euphorbia herbstii* populations also to improve habitat.				
Pahole	MU restoration - SDT	937 seeds	454	AlySte(130 seeds), CanGal(50 seeds), DioSan(25 seeds), LepTam(700 seeds), PlaSan(32 seeds)
In WCA-02, staff saw an opportunity during a rare plant reintroduction to sow seeds of *A.stellata*, *L. tameiameiae*, and *Diospyros sandwicensis*. In WCA-03, staff sowed seeds of *Canavalia galeata* and *Planchonella sandwicensis*.				

3.8.2 Future Restoration Efforts

As ANRPO's restoration program evolves, so too must the practices in the approach to restoration. Over time, restoration efforts have grown from small restorations in a small number of management units, to many different sized efforts across almost all management units. While it is widely acknowledged that many of these areas are in desperate need of restoration and could benefit greatly from this work, it has stretched ANRPO's greenhouse capacity to the absolute limits. The current limit of around 13,000 common natives will be reduced in the coming year due to reduced greenhouse space. As coconut rhinoceros beetles have started to move into *Pritchardia kaalae* habitat, it has become apparent that those plants need to be moved into living collection to better preserve genetics. However, this means the limited space for producing common natives will now contract to about half its current size. Expect roughly 6,000 common natives per year for the foreseeable future.

This change in greenhouse production ability prompts the difficult decision on how restoration projects should be prioritized to best meet objectives outlined in management unit plans. With this in mind, small projects that mainly buffer existing rare plant sites without changing canopy composition move lower in priority, while large projects that can significantly alter canopy composition become the highest priority. In addition, for the next two years, ANRPO will be focusing on a single seed zone, OA-02, Wet Wai'anae North. This seed zone was chosen because it hosts a range of MUs with the highest potential for large restoration projects. Areas like Mākaha, Kahanahāiki, West Makaleha, and Kapuna Upper all fall within this seed zone, and all have existing large restoration projects in place with ample room to expand.

After two years of working to restore the OA-02 seed zone, staff will let those areas rest, moving efforts back to other seed zones like OA-01 (Dry Leeward Wai'anae North), OA-03 (Dry Windward Wai'anae North), OA-05 (Wet Ko'olau North), and OA-08 (Wet Wai'anae South) for two years. Because projects in these areas tend to be smaller, hopes are that ANRPO can accommodate outplants for most of these projects simultaneously. It is anticipated that projects in OA-08 will take the bulk of what can be produced both years, while other seed zones may have their restoration needs fulfilled in one year.

To supplement projects with additional plant propagules while greenhouse capacity is limited, staff will be using SDTs far more. Seed sows will become an important input for new restoration areas, utilizing herbaceous species as groundcover. Trials for seed sow efficacy on a variety of species are already in place and will hopefully yield results that can inform restoration at scale. By understanding germination and survival rates from seed sows, staff can better calculate how many seeds are needed for a given area, saving valuable resources for other projects.

As restoration efforts are concentrated, site selection becomes even more important. In order to do so effectively, staff have devised a rubric to help the evaluation process. Figure 26 show the scoring sheet which considers qualities like terrain, existing native plant structure, difficulty of invasive removal, soil quality, aspect, proximity to existing projects, size of project, and team enthusiasm. By giving each project a numerical score, it should help prioritize areas that can be restored most efficiently and provide the most benefit to the overall management unit.

Restoration Rubric	Max Score	Score
Slope/Terrain		
(5=Flat, 4= slight slope room for chipper, 3= moderate slope room for chipper, 2= steep slope in spots no chipper, 1= steep throughout)	5	
Native Recruitment Potential		
(5= multi big mother trees present, 4= single big mother tree, 3= natives present not large, 2= manini natives, 1=no natives present)	5	
Invasive Removal Difficulty		
(5= normal ground fell/no chance of damage to natives, 3= need webbing/moderate chance, 1= special training or equiptment/high probability of damage)	5	
Soil type		
(5= nice humic soils, 3= clay soils not rocky, 1= just rocks/very hydrophobic)	5	
Aspect		
(3=north facing, 2=anything but south, 1=south)	3	
Proximity		
(5=Adjacent to existing projects, 3=within stone's throw, 1= super isolated)	5	
Size of footprint total projection		
(5=2,000 sqm, 3= 1000 sqm, 1= 500 sqm)	5	
Stoke factor		
(3=super stoked, 2=alright, alright, alright, 1=ehhhh)	3	
Total	36	

Figure 26: Restoration Rubric used to evaluate potential sites.

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 Oʻahu 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 ʻŌhiʻa Death (ROD), however, they can also be applied to other common native plant species. The Oʻahu seed zones were delineated by overlaying Oʻahu moisture zones, biogeographic regions, Hawaiʻi 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.

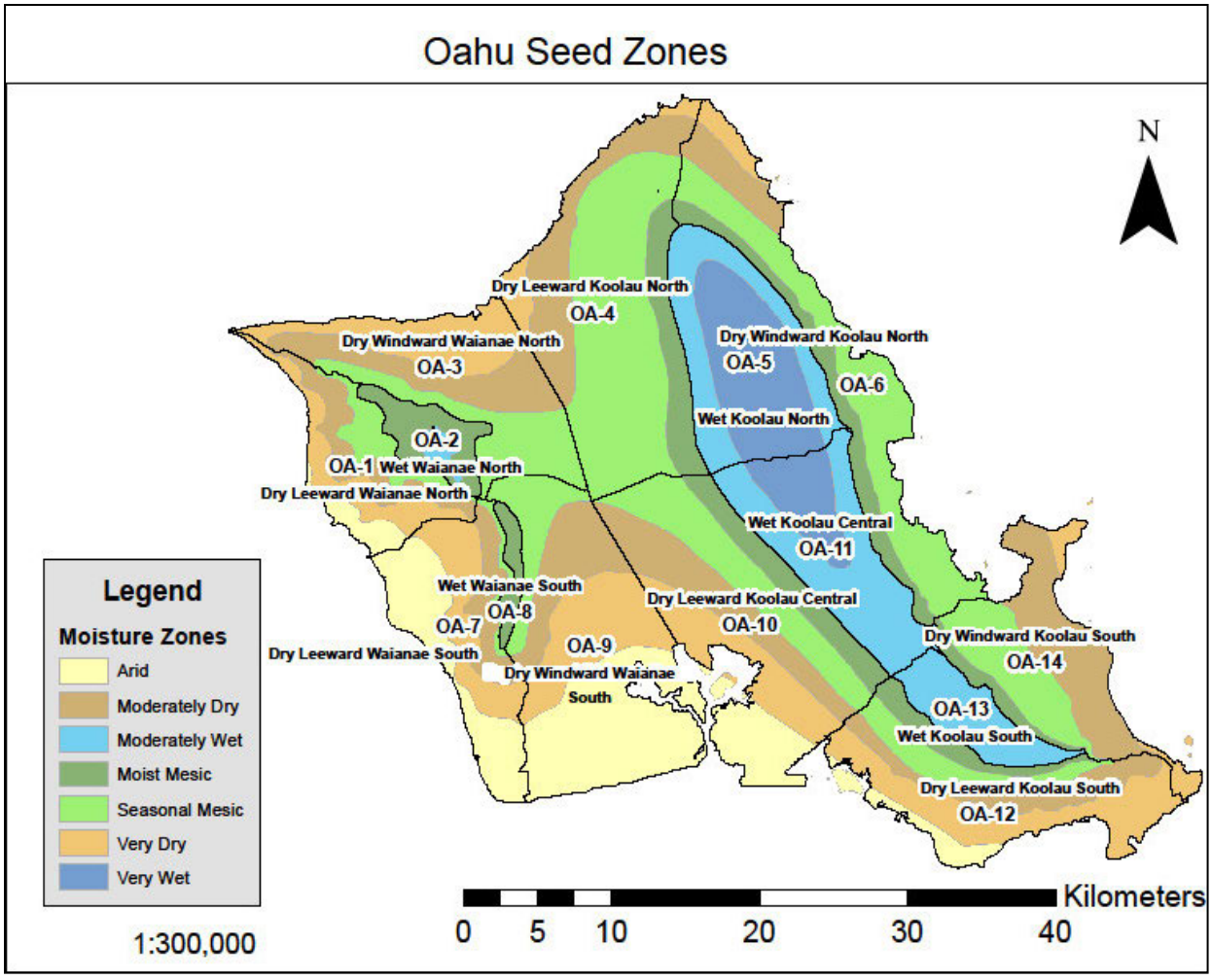

Figure 27: Map of Oʻahu Seed Zones (Laukahi Hawaiʻi Plant Conservation Network 2021).

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 the 2023 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 with more than ten founders represented within each accession. Collections with less than ten founders are counted along maternal lines so that each maternal line is an individual accession. The total seed accessions currently in storage column removes accessions with zero seeds or less and is current to the end of the report year. This number may conflict with the # of seed accessions collected in 2023 as those accessions may have been used within the year.

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 2023	Seed Zones Represented
Abutilon incanum	AbuInc	Malvaceae	Yes	S	24,748	19	3	OA-1
Acacia koa	AcaKoa	Fabaceae	Yes	S	51,762	62	2	OA-1,2,5,8
Alyxia stellata	AlySte	Apocynaceae	Yes[e]	S	693	12	1	OA-2,8
Antidesma platyphyllum	AntPla	Phyllanthaceae	Yes[e]	S,V	3,478	17	2	OA-2
Asplenium kaulfussii[a]	AspKau	Aspleniaceae	Yes[d]	S	NA	2	1	OA-2
Bidens cervicata	BidCer	Asteraceae	Yes	S	1,808	17	2	OA-1
Bidens torta	BidTor	Asteraceae	Yes	S,V	680,548	45	3	OA-1,2,8
Bobea elatior	BobEla	Rubiaceae	Yes	S,V	0	0	1	----------
Canavalia galeata	CanGal	Fabaceae	Yes	S	287	7	3	OA-1,2
Carex meyenii[a]	CarMey	Cyperaceae	Yes	S	23,813	9	2	OA-2
Carex wahuensis	CarWah	Cyperaceae	Yes	S	335,381	26	7	OA-1,2,8
Ceodes brunoniana	CeoBru	Nyctaginaceae	No	S,V	740	2	0	OA-8
Ceodes umbellifera	CeoUmb	Nyctaginaceae	No	S,V	0	0	1	----------
Charpentiera obovata	ChaObo	Amaranthaceae	Yes	S	9,582	11	2	OA-2
Charpentiera tomentosa	ChaTom	Amaranthaceae	Yes	S	24,622	18	8	OA-2
Cheirodendron trigynum	CheTri	Araliaceae	Yes	S	38,939	22	2	OA-5,8
Chenopodium oahuense	CheOah	Chenopodiaceae	Yes	S	8,371,589	21	0	OA-1,3,8
Cibotium chamissoi[a]	CibCha	Dicksoniaceae	Yes[d]	S	NA	11	3	OA-2,5
Cibotium menziesii	CibMey	Dicksoniaceae	Yes[d]	S	NA	4	1	OA-5
Clermontia kakeana	CleKak	Campanulaceae	Yes	S	72,795	12	0	OA-2,8,5
Clermontia persicifolia	ClePer	Campanulaceae	Yes	S	14,788	6	0	OA-2,5,8
Clermontia oblongifolia	CleObl	Campanulaceae	Yes	S	22,259	2	2	OA-2
Coprosma foliosa[a]	CopFol	Rubiaceae	Yes	S	3,126	9	4	OA-2
Coprosma longifolia	CopLon	Rubiaceae	Yes	S	80,895	66	2	OA-2,8
Cyperus hillebrandii var. *hillbrandii*[a]	CypHil	Cyperaceae	Unknown	No	0	0	0	----------
Cyperus polystachyos[a]	CypPol	Cyperaceae	Yes	Yes	315,175	5	0	OA-2,8
Deparia prolifera[a]	DepPro	Athyriaceae	Unknown[b]	V	NA	0	0	----------
Dianella sandwicensis	DiaSan	Xanthorrhoeaceae	Yes	S,V	112,574	25	10	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 2023	Seed Zones Represented
Diplazium sandwichianum [a]	DipSan	Athyriaceae	Unknown[b]	S	NA	1	0	OA-8
Dodonaea viscosa	DodVis	Sapindaceae	Yes	S	492,977	123	17	OA-1,2,3,8
Doodia kunthiana[a]	DooKun	Blechnaceae	Yes[d]	S	NA	9	2	OA-2,8
Eragrostis atropioides	EraAtr	Poaceae	Yes	S	474	1	0	----------
Eragrostis grandis	EraGra	Poaceae	Yes	S	177,163	27	5	OA-2,8
Eragrostis variabilis	EraVar	Poaceae	Yes	S	17,881	3	0	OA-3
Erythrina sandwicensis	ErySan	Fabaceae	Yes	S	7,461	34	3	OA-1,3
Freycinetia arborea [a]	FreArb	Pandanaceae	Yes	S	987,319	19	1	OA-2,8
Gahnia beecheyi [a]	GahBee	Cyperaceae	Yes	No[c]	17,301	7	0	OA-2,8
Geniostoma kaalae	GenKaa	Loganiaceae	Yes	S	4,841	5	2	OA-8
Gossypium tomentosa	GosTom	Malvaceae	Yes	S	235	5	0	OA-03
Gynochthodes trimera	GynTri	Rubiaceae	Yes	S	73	2	0	OA-8
Hibiscus arnottianus subsp. *arnottianus*	HibArn	Malvanceae	Yes	S,V	5,038	8	3	OA-2
Ilex anomala	IleAno	Aquifoliaceae	Yes	S	91,669	32	4	OA-2,5,8
Kadua acuminata	KadAcu	Rubiaceae	Yes	S	12,766	2	0	----------
Kadua affinis	KadAff	Rubiaceae	Yes	S	114,737	54	1	OA-2,8
Kadua cordata	KadCor	Rubiaceae	Unknown	No	11,131	1	0	OA-8
Luzula hawaiiensis	LuzHaw	Juncaceae	Yes	S,V	920	3	0	OA-2,8
Machaerina angustifolia [a]	MacAng	Cyperaceae	Yes	No	0	0	0	----------
Machaerina mariscoides	MacMar	Cyperaceae	Unknown	No	0	0	0	----------
Melicope oahuensis [a]	MelOah	Rutaceae	Unknown	No	82	4	0	OA-5
Metrosideros macropus	MetMac	Myrtaceae	Yes	S	31,190	3	0	OA-2
Metrosideros polymorpha	MetPol	Myrtaceae	Yes	S	7,798,086	365	14	OA-1,2,5,8
Metrosideros tremuloides	MetTre	Myrtaceae	Yes	S	2,680,439	91	1	OA-2
Microlepia speluncae [a]	MicSpe	Dennstaedtiaceae	Yes[d]	S,V	NA	5	1	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 2023	Seed Zones Represented
Microlepia strigosa var. *strigosa*	MicStr	Dennstaedtiaceae	Yes[d]	V,S	NA	19	6	OA-1,2,8
Myoporum sandwicense	MyoSan	Scrophulariaceae	Yes	S,V	15,332	160	0	OA-1,3
Myrsine lessertiana	MyrLes	Primulaceae	Yes	S	2,112	11	8	OA-2,8
Nephrolepis cordifolia	NepCor	Nephrolepidaceae	Unknown	S,V	NA	0	0	----------
Nephrolepis exaltata subsp. *hawaiiensis*[a]	NepExa	Nephrolepidaceae	Unknown	No	NA	0	0	----------
Notelaea sandwicensis	NoteSan	Oleaceae	Unknown	S,V	720	10	9	OA-2
Osteomeles anthyllidifolia	OstAnt	Rosaceae	Yes	S	3,561	6	0	OA-1,2
Panicum nephelophilum	PanNep	Poaceae	Unknown	S	1,761	4	2	OA-2,8
Perrottetia sandwicensis	PerSan	Dipentodontaceae	Yes	S,V	6,079	11	6	OA-8
Pipturus albidus	PipAlb	Urticaceae	Yes	S,V	315,749	10	1	OA-2,8
Pittosporum conferiflorum	PipCon	Pittosporaceae	Yes	S	1,287	11	0	OA-8
Pittosporum glabrum	PitGla	Pittosporaceae	Yes	S	5,930	33	10	OA-2,5,8
Planchonella sandwicensis	PlaSan	Sapotaceae	No	S	0	0	0	----------
Plumbago zeylanica	PluZey	Plumbaginaceae	Unknown	V	0	0	0	----------
Polyscias oahuensis	PolOah	Araliaceae	Yes	S	1,887	11	3	OA-2,8
Polyscias sandwicensis[a]	PolSan	Araliaceae	Yes	S	4,044	7	5	OA-1
Psychotria hathewayii	PsyHat	Rubiaceae	Yes	S	1,474	17	1	OA-2,8
Psychotria mariniana	PsyMar	Rubiaceae	Yes	S	935	11	4	OA-2,5,8
Psydrax odorata[a]	PsyOdo	Rubiaceae	Yes	S	691	3	0	OA-1,2
Pteris excelsa[a]	PteExc	Pteridaceae	Yes[d]	S	NA	1	0	OA-8
Rockia sandwicensis	RocSan	Nyctaginaceae	No	S,V	0	0	0	----------
Rumex albescens	RumAlb	Polygonaceae	Yes	S	61,026	15	5	OA-8
Sadleria cyatheoides	SadCya	Blechnaceae	Yes[d]	S	NA	9	3	OA-2,5,8
Santalum spp.[a]	SanSpp	Santalaceae	Yes	S	2,805	20	6	OA-1,2,8

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 2023	Seed Zones Represented
Sapindus oahuensis	SapOah	Sapindaceae	Unknown	S	3,943	13	2	OA-1,2,8
Scaevola gaudichaudii [a]	ScaGaud	Goodeniaceae	Yes	S	0	0	0	----------
Scaevola gaudichaudiana	ScaGaua	Goodeniaceae	Yes	S,V	3,187	19	10	OA-2,5,8
Scaevola mollis	ScaMol	Goodeniaceae	Yes	S,V	507	8	1	OA-5,8
Scaevola taccada	ScaTac	Goodeniaceae	Yes	S,V	0	0	0	----------
Sida fallax [a]	SidFal	Malvaceae	Yes	S,V	30,803	26	4	OA-1,2,3,8
Sophora chrysophylla	SopChr	Fabaceae	Yes	S	4,930	21	3	OA-2,8
Syzygium sandwicense	SyzSan	Myrtaceae	Unknown	S	0	0	1	----------
Touchardia oahuensis	TouOah	Urticaceae	Yes	S,V	10,316	10	0	OA-8
Waltheria indica	WalInd	Malvaceae	Yes	S	21,804	7	3	OA-1,3
Wikstroemia oahuensis	WikOah	Thymelaeaceae	Yes	S	3,160	15	3	OA-5,8
Viola chamissoniana subsp. *tracheliifolia*	VioChaTra	Violaceae	Yes	S, V	584	3	4	OA-2,8
Xylosma hawaiiense	XylHaw	Salicaceae	Unknown	S	0	0	3	----------

[a] Native species target 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 Oʻahu (ANRPO) outplanted a total of 1,974 rare plants representing 20 Mākua Implementation Plan (MIP) and Oʻahu Implementation Plan (OIP) taxa at 35 Manage for Stability (MFS) reintroduction sites. In the last year, ANRPO made 185 observations at *in situ* sites and 291 at 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, the rare plant management plan for *Phyllostegia kaalaensis* and updated management plans for *Delissea waianaeensis* and *Hibiscus brackenridgei* subsp. *mokuleianus* are presented. Some of this year's highlights include:

- This winter, nine *Hesperomannia oahuensis* seedlings were observed at MAK-B in the Mākaha PU and five seedlings at PUA-A in the Puali'i Population Unit (PU). Recent observations indicate that the majority of seedlings are healthy and actively growing.
- In response to the 2022 fire in Mākua that directly impacted both wild and reintroduced *Hibiscus brackenridgei* subsp. *mokuleianus* plants at MMR-A and MMR-F respectively, ANRPO reinitiated ouplanting efforts in the Kaluakauila Management Unit (MU). MMR-C, originally established in 2002, was augmented with additional outplants and a new reintroduction, MMR-H, was established near the upper catchment restoration site. These reintroductions currently do not count towards ANRPO's stabilization goals, and we recommend designating Kaluakauila as a Manage Reintroduction for Stability (backup site) PU.
- Using excess plant materials produced by DOFAW, ANRPO established a new outplanting of *Abutilon sandwicense* in Kamā'ili (MAK-F). This is an augmentation of wild plants in the Mākaha Makai Population Unit (PU).
- The Pacific Island Climate Adaptation Science Center (PI-CASC) proposal, "Assessing the success and vulnerability of Hawaiian rare plant introductions to inform future stabilization effort", submitted by Dr. Tamara Ticktin, Dr. Clay Trauernicht, Dr. Lucas Fortini, and Tim Chambers was accepted, with an August 2023 start date. This two-year research project will leverage datasets spanning two decades of ANRPO and PEPP census data for more than 300 populations for 38 rare plant taxa to synthesize the effects of management interventions and climate variability on reintroduced rare plant populations. Using multiple modeling approaches, this project will identify: direct and indirect drivers of reintroduction success; long-term persistence of 10 focal species under climate change scenarios; and species traits that predict reintroduction success or failure.
- The first Coconut Rhinoceros Beetle (CRB) damage to *Pritchardia kaalae* in its wild habitat was observed on ʻŌhikilolo in April 2023. The individual plant impacted was MMR-H-172, a reintroduced plant. The last observations indicate that this plant is immature and healthy, with only one frond showing signs of CRB damage.
- Natural Resources staff have long questioned whether *Gardenia mannii* seedlings start off as epiphytes or hemi-epiphytes. At ʻŌpaeʻula Lower, survivorship of *G. mannii* outplants tends to be rather low, where plants are often planted into gray, anaerobic soils due to the large container size of airlayered plants. In response to these observations, in March 2023, 14 HEL-E-1 seedlings in 2" pots were outplanted in nurse logs and other similar sites, rich in organic matter. All 14 seedlings are surviving and actively growing.

- ANRPO's Rare Plant Coordinator, seed laboratory and horticulture staff offered a two-week training for Pōhakuloa Training Area Natural Resource Program's Plant Genetic Conservation Specialist. This training included seed processing and drying protocols of rare and endangered taxa, as well as rare plant greenhouse protocols and maintenance. Unfortunately, this individual did take another job. We look forward to continuing to build our collaborations with PTA in the future.
- Seed collections from the Pōhakuloa Training Area Natural Resources Office were received and processed by ANRPO staff in the Conservation Seed Laboratory. Nine accessions, representing 102 maternal founders of *Exocarpos menzeisii, Isodendrion hosakae, Neraudia ovata, Solanum incanum, Vigna o-wahuensis,* and *Wollastonia venosa* were processed and tested for germination. Seedlings were maintained in incubators until PTA staff were able to return them to PTA.
- One individual of *Sicyos macrophyllus* representing a lone founder from the Keamuku Maneuver Area at Pōhakuloa Training Area is persisting in the West Base interpretive garden. Seeds have been collected and returned to the Pōhakuloa Training Area Natural Resources Office.
- Collection efforts of *Pritchardia kaalae* have begun in earnest in the face of Coconut Rhinoceros Beetle invasions. Collections are being germinated in the seed lab with the intention of building a living collection within the ANRPO nursery. ANRPO and DOFAW/PEPP are collaborating with the San Diego Zoo to establish out-of-state living collections of *Pritchardia kaalae, P. bakeri, P. kahukuensis,* and *P. lowreyana*. We are currently working to ensure all necessary permits are in place and could begin shipping bare root seedlings to the San Diego Zoo as early as October 2023.
- Seed lab staff received wild collections of *Pteralyxia macrocarpa* and were successful in germinating seeds that represent two Mākaha founders. Seedlings are maintained by horticulture and seed lab staff and will be planted back into restoration areas.
- The ANRPO Seed Conservation Laboratory received 459 incoming collections. 224 accessions were of endangered taxa, 72 accessions of species at risk, ten accessions of species of conservation concern, 152 accessions were of common native taxa, and one accession was an incipient weed. Seed lab staff received 1,153,250 seeds that represent 124 taxa.
- Seven *Flueggea neowawraea* Hawai'i Island founders are maintained by ANRPO Horticulture staff. Successful crosses with O'ahu founders have been made and 32 seedlings resulting from initial germination tests are currently being maintained in the greenhouse. The Hawai'i Island founders will be maintained into the future to continue an inter-island breeding program for *Flueggea*. Seedlings will be planted this coming outplanting season at the MMR-I reintroduction in the Kahanahāiki to Kapuna Population Unit (PU).
- *Flueggea neowawraea* planted at Koko Crater Botanic Gardens have survived for more than a year but are facing challenges due to Rose beetles. Cages to exclude the beetles have been installed to slow the effects of the beetles. Other treatments will be implemented as needed to maintain the *Flueggea*.
- *Eugenia koolauensis* have recruited at Koko Crater Botanic Gardens. Seedlings receive residual fungicide treatments and are getting larger after each visit. Seedlings will be maintained until a decision on what to do with them can be made.
- A *Gardenia mannii* female (HEL-E-1), planted at ANRPO's West Base, has flowered many times and pollination efforts using stored pollen took place over the last 2 months of the reporting year. This represents one of the largest witnessed flowering events by *Gardenia mannii* and will hopefully yield viable fruit.

- The Pahole nursery experienced a high wind event during the spring of this year where the pressure of the wind pressed down on the plastic covering, causing a portion of the greenhouse to collapse. Parts to repair the greenhouse are on order and the greenhouse will be converted back into a shadehouse, rather than covered in plastic, to avoid damage in future high wind events. The shade cloth will allow wind to pass through the structure thus minimizing damage.
- A *Waltheria indica* seed production plot has been established in the bioretention plot at West Base. Seed from this plot will be collected and stored for use in future restoration efforts or will be used as stock seed to establish larger seed production areas.
- Founders of *Cenchrus agrimonioides* var. *agrimonioides, Dubautia herbstobatae, Eugenia koolauensis, Flueggea neowawraea, Gardenia mannii, Neraudia angulata, Nototrichium humile* and *Wollastonia tenuifolia* have been added to the West Base Interpretive Garden. The plantings are an attempt to utilize all of the space available to ANRPO to manage living collections and a way to solve the problem of pot binding in the nursery.
- Nursery fan installation has reduced temperatures in the Greenhouse significantly. Although 2019 and 2020 were two of the hottest years on record for Oʻahu, data from the HOBO data logger indicates that the greenhouse experienced fewer days with temperatures above 90ºF in the past two years. During the months of August 2019 and 2020, the greenhouse recorded 30 days with temperatures over 90ºF. That number was reduced to 12 days in 2022 and 13 days in 2023.

4.2 POPULATION UNIT STATUS SUMMARY

In the last year, there have been changes in the numbers of mature plants at 60 of the 131 MFS PUs managed by ANRPO. Forty-three MFS PUs showed a decline in mature plants, while 17 showed an increase, and 71 PUs showed no change. This represents a decrease of 25 MFS PUs that showed an increase in mature plants as compared to last year. Tables 1 and 2 show the PUs where a change was observed in the last reporting period. Taxa are listed by six digit abbreviations in the tables with the first three letters of both the genus and species. 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.

Several new reintroductions were established in this reporting year. *Cyrtandra dentata* was reintroduced in the ʻŌpaeʻula, Kahanahāiki, and Pahole to West Makaleha PUs. Two reintroductions were established in the Pahole to West Makaleha PU. Population structure at this PU is very stable with over 800 mature plants and over 2,400 plants in the immature and seedling age classes. The purpose of these outplants was to use excess greenhouse plant stock resulting from germination tests conducted in the seed lab and to gain experience reintroducing this taxon. *C. dentata* LEH-C is in the Makaleha West MU and was planted with stock originally collected from this MU. KAP-D located in the Kapuna Upper MU was planted with KAP-A and B stock. Reintroductions of *C. dentata* at the ʻŌpaeʻula and Kahanahāiki PUs were established to build population structure as both PUs currently do not meet stabilization goals for mature plants. Outplanting at these two sites will continue over the next two outplanting seasons. *Flueggea*

neowawraea PAH-E was established in gulch three in the Pahole MU. This is an experimental reintroduction and plants are being treated with CoreTect® in an attempt to protect outplants from the impacts of the black twig borer. The active ingredient in this product is Imidacloprid and it is labeled for use in forest applications. Prior to applying this product in the field, ANRPO discussed this action with expert entomologists and they agreed to the application of this product on a small scale, which will likely have little to no impact on native insects. *Delissea waianaeensis* ANU-B was established in the Manuwai PU in the eastern portion of the MU. This reintroduction is intended to replace ANU-A, where survivorship of outplants has been in steady decline and no recruitment has been observed since establishment in 2013. Utilizing preliminary climate range maps (Fortini, 2021) to select climate appropriate reintroduction sites for *Phyllostegia hirsuta,* the PAK-C reintroduction was established just above the Palikea North Snail Enclosure. This is the first of several new reintroductions that are planned for this taxon over the next several years. Currently only two of the three MFS PUs for *Schiedea obovata* meet stabilization goals for the mature age class. The Keawapilau to West Makaleha PU only supports 19 mature plants and the new LEH-D reintroduction was established to replace the failed reintroduction at LEH-C. *Schiedea obovata* LEH-D is located adjacent to the wild occurrence, LEH-A, where the last remaining founder was observed dead in spring 2023. Once outplanting is complete, this site will include plant stock representing wild founders from the Kahanahāiki to Pahole and Keawapilau to West Makaleha PUs.

Efforts to monitor cliff dwelling species continued this year. Further monitoring at *Tetramolopium filiforme* MMR-H in the ʻŌhikilolo PU revealed a 49% increase in mature plants at this site, despite direct impacts from the 2022 Mākua fire, compared to the last complete census conducted in 2004. This represents a 17% increase in mature plants in the ʻŌhikilolo PU overall. In fall 2022 ANRPO and DOFAW/PEPP organized a cooperative trip to monitor *Viola chamissoniana* subsp. c*hamissoniana, Kadua parvula,* and *Plantago princeps* var. *princeps* on rappel at Hālona. The number of mature plants at *V. chamissoniana* subsp. c*hamissoniana* HAL-A increased from eight mature plants observed in 2018 to 13. Cuttings from five *V. chamissoniana* subsp. c*hamissoniana* HAL-A were collected, of which three were successfully propagated and are maintained in living collection. Otherwise, the number of mature plants at all other sites showed a decline since the last census, with zero plants observed at *P. princeps* var. p*rinceps* HAL-A and *V. chamissoniana* subsp. c*hamissoniana* HAL-B. Mature plants at *K. parvula* HAL-A and B decreased from eight plants observed in 2018 to two at HAL-A and 13 to seven plants at HAL-B. Censuses were initiated at multiple PUs of *Sanicula mariversa* and *Wollastonia tenuifolia* but were not completed. These monitoring efforts will continue into the next reporting year.

Notable increases in plant numbers were observed in this reporting year for *Neraudia angulata* at the Kaluakauila PU, *Cenchrus agrimonioides* var. *agrimonioides* at Central ʻĒkahanui, *Kadua degeneri* subsp. *degeneri* at Kahanahāiki to Pahole, *Cyrtandra dentata* at Pahole to West Makaleha, and *T. filiforme* at ʻŌhikilolo. In addition to receiving additional outplants this past season, 47 new seedlings were observed at *N. angulata* MMR-F in Kaluakauila. In this reporting year a significant number of immature plants transitioned to the mature age class at *C. agrimonioides* var. *agrimonioides* reintroductions EKA-B and D and the number of mature plants at EKA-A (*in situ*) increased by 30%. Mature plants increased by 7% and 62% at EKA-B and D respectively. Both of these sites maintained both F1 generation mature and immature age classes with 74% of the mature plants at EKA-B representing the F1 generation and 28% at EKA-D. Thorough monitoring of *K. degeneri* subsp. *degeneri* at the Kāhanahaiki to Pahole PU showed a 29% increase in total plant numbers, whereas total plant numbers of *C. dentata* at Pahole to West Makaleha and *T. filiforme* at ʻŌhikilolo increased by 25% and 7% respectively.

The last three summers have been marked by drought conditions and as a result declines in population numbers were observed for multiple taxa, across multiple PUs. Declines observed at the *Schiedea nuttallii* Kapuna-Keawapilau Ridge and Mākaha PUs and *S. obovata* Kahanahāiki to Pahole and Mākaha PUs, are likely associated with drought conditions. Drought stress has recently been observed on plants at all sites. *S. obovata* in the Kahanahāiki to Pahole PU experienced a 39% decline in mature plants, but the immature age class increased by 61%. Some of this increase can be attributed to the addition of 61 outplants to the MMR-I reintroduction site this reporting year; however, recent monitoring shows both the MMR-G and I reintroductions support over 260 immature recruits and 48% of the mature plants at MMR-G are recruits. *S. nuttallii* plant numbers in the Kapuna-Keawapilau Ridge and Mākaha PUs declined by 54% and 20% respectively. PIL-B (reintro), the only site with plants remaining in the Kapuna-Keawapilau Ridge PU, experienced a 65% decline in the mature age class, however, of the remaining 24 mature plants, 17 are mature recruits and all immature plants on site recruited naturally. In contrast, all mature plants surviving at MAK-A are outplants and there are no surviving recruits.

However, in the case of *Euphorbia celastroides* var. *kaenana,* damage inflicted on plants by rats, mice, and pigs observed in the summer of 2022 is directly responsible for the decline in population numbers observed at the Ka‘ena PU. At this PU mature plants decreased by 4% and immature plants by 84%, with a total population decline of 24%. Damage caused by invasive mammals was widespread across the KAE-B population reference site, however, with the installation of rodent control via an A24 and Victor trap grid, no significant damage from mice, rats, or pigs was observed in recent monitoring efforts. DOFAW, who monitors and addresses periodic pig ingress from the neighboring Kuaokalā Game Management Area, was notified about the pig damage observed in the summer of 2022. Discussed in the 2022 Year End Report, the June 2022 fire at Mākua directly impacted the *H. brackenridgei* subsp. m*okuleianus* Mākua PU. Post fire monitoring revealed a population decline of 34% and a 45% decrease in mature plants. Censuses initiated in February 2023, but not completed, at both MMR-A (*in situ*) and MMR-F (reintro) showed a continued decline in mature plants since June 21, 2022, however, both immature and seedling age classes increased significantly. Mature plants declined by 80%, whereas immature plants increased by 36%. MMR-A currently supports two mature and 42 immature plants and MMR-F, four mature, two immature, and an estimated 129 seedlings. The total population of *H. brackenridgei* subsp. *mokuleianus* at Haili to Kawaiū declined by 53 plants (11 mature, 32 immature plants, and 9 seedlings), as a direct result of the endemic vine, *Sicyos pachycarpus*, smothering outplants and recruits. Moving forward, staff will remove immature *S. pachycarpus* plants from around *H. brackenridgei* subsp. *mokuleianus* and prune mature vines that are observed climbing *Hibiscus.* The last plant of *Hesperomannia oahuensis* in the Pahole NAR PU at PIL-A (reintro) was observed dead this reporting year. Survivorship of outplants has been in steady decline at this site since establishment in 2010. Efforts will be made in the coming year to select an alternative reintroduction site in this PU.

Currently, 48 of the 131 MFS PUs meet stabilization requirements for mature plants, a decrease of 2 PUs compared to last reporting year (ANRPO 2022a). In the coming year ANRPO will continue to prioritize monitoring of cliff dwelling species with particular focus on *Wollastonia tenuifolia* and *Sanicula mariversa.* Monitoring priority will also be given to PUs that have not been surveyed in the last five years or longer. Additionally, we will collaborate with DOFAW to monitor *Alectryon macrococcus* var. *macrococcus* No Management PUs to sample propagules for O‘ahu’s last remaining wild individuals to add to ANRPO’s living collection for this taxon. We were unable to accomplish these actions in this reporting year due to scheduling conflicts and cancellations due to weather. Outplanting efforts are planned for *C. grimesiana* subsp*. obatae*, *C. longiflora*, *Cyanea superba* subsp*. superba*, *C. dentata*, *D. waianaeensis, Dubautia herbstobatae, Euphorbia herbstii*, *Hesperomannia oahuensis*, *K. degeneri* subsp*. degeneri*, *Geniostoma cyrtandrae*, *Neraudia angulata*, *P. princeps* var. p*rinceps, Phyllostegia hirsuta, 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. Horticulture staff are maintaining over 80 *H. oahuensis* plants in the greenhouse and Natural Resources field staff are excited to augment reintroductions in Puali‘i, Mākaha, and Hale‘au‘au this coming outplanting season. Propagation efforts continue 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 continuing to work with the Amend and Hynson Laboratories at the University of Hawai‘i at Mānoa 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 with a decrease in matures, sorted by greatest to least % Change Mat. Bold PUs have only wild plants. ΔMAT= the difference in mature plants between 2022 and 2023. %Change MAT= percent change observed in mature plants. ΔPop= the difference in total plant numbers between 2022 and 2023. %Change Pop= percent change observed in total plant numbers. Population Unit Name= PU. An asterisk (*) after the PU indicates it meets stabilization goals for mature plants.

Plan	TaxonCode	PopulationUnitName	Δ Mat	% Change Mat	Δ Pop	% Change Pop.
MIP	HesOah	Pahole NAR	-1	-100.00	-1	-100.00
MIP	PlaPriPri	**‘Ēkahanui**	-1	-100.00	-5	-62.50
MIP	DubHer	Mākaha	-18	-85.71	-135	-62.79
OIP	PhyMol	Kalua‘ā	-14	-70.00	-15	-60.00
MIP	SchNut	Kapuna-Keawapilau Ridge	-43	-64.18	-50	-53.19
MIP	KadDegDeg	**Central Makaleha and West Branch of East Makaleha**	-3	-50.00	-5	-55.56
MIP	SchObo	Keawapilau to West Makaleha	-19	-50.00	42	38.89
MIP	CyaSupSup	Mākaha	-24	-41.38	-32	-45.07
MIP	NerAng	Mākaha	-12	-41.38	7	12.96
MIP	SchObo	Kahanahāiki to Pahole*	-117	-38.61	246	46.07
MIP	CyaLong	Pahole	-29	-34.12	-7	-2.87
MIP	SchObo	Mākaha*	-68	-33.50	-106	-32.42
MIP	NotHum	**Kaluakauila***	-13	-30.23	-68	-63.55
MIP	SchKaa	Pahole	-19	-28.36	-35	-31.53
MIP	CyaLong	Kapuna to West Makaleha	-15	-26.79	-28	-32.18
MIP	CenAgrAgr	Mākaha and Wai‘anae Kai*	-19	-26.76	20	25.00
MIP	HesOah	Puali‘i	-6	-26.09	-9	-28.13
MIP	CyaGriOba	Kalua‘ā	-5	-25.00	20	44.44
MIP	KadPar	‘Ēkahanui*	-26	-21.14	-15	-10.14

Table 1 (continued).

Plan	TaxonCode	PopulationUnitName	Δ Mat	% Change Mat	Δ Pop	% Change Pop.
MIP	SchNut	Mākaha*	-34	-19.54	-34	-19.54
MIP	DelWai	Manuwai	-7	-19.44	75	187.50
MIP	HibBraMok	Haili to Kawaiū	-11	-19.30	-52	-45.22
MIP	KadPar	Hālona	-6	-18.75	-10	-6.33
MIP	EupHer	Kalua‘ā	-3	-17.65	5	11.36
MIP	AleMacMac	**Mākaha**	-1	-16.67	-1	-16.67
MIP	CyaGriOba	North branch of South ‘Ēkahanui	-7	-11.67	32	32.65
MIP	KadDegDeg	Makaha to ‘Ōhikilolo*	-10	-10.75	-2	-0.96
OIP	AbuSan	**Ka‘awa to Pū‘ulu**	-4	-10.26	-4	-2.01
MIP	KadPar	‘Ōhikilolo*	-8	-10.13	-7	-7.22
MIP	SchNut	Kahanahāiki to Pahole*	-18	-9.68	22	11.00
OIP	PhyHir	Hale‘au‘au to Mohiākea	-1	-8.33	-1	-6.25
OIP	AbuSan	‘Ēkahanui and Huliwai*	-5	-6.49	-5	-4.67
MIP	CyaSupSup	Kahanahāiki	-1	-5.56	-60	-39.22
MIP	VioChaCha	Hālona*	-3	-5.56	-3	-5.56
OIP	GenCyr	East Makaleha to North Mohiākea*	-11	-5.34	-9	-4.17
MIP	EupCelKae	**Ka‘ena***	-37	-4.20	-268	-23.22
OIP	SchTri	Kalena to East Makaleha*	-16	-3.83	6	0.39
MIP	HibBraMok	Kea‘au*	-2	-3.39	8	5.67
OIP	AbuSan	Kahanahāiki*	-2	-2.74	-8	-7.69
MIP	KadDegDeg	Alaiheihe and Manuwai	-1	-2.44	-32	-31.37
MIP	SchKaa	Kalua‘ā and Wai‘eli*	-3	-2.44	-27	-17.53
MIP	EupCelKae	**Pua‘akanoa***	-1	-0.75	4	3.01
MIP	CyaGriOba	Palikea (South Pālāwai)*	-1	-0.15	11	1.60

Table 2: MFS PUs with an increase in matures, sorted by greatest to least % Change Mat. Bold PUs have only wild plants. ΔMAT= the difference in mature plants between 2022 and 2023. %Change MAT= percent change observed in mature plants. ΔPop= the difference in total plant numbers between 2022 and 2023. %Change Pop= percent change observed in total plant numbers. Population Unit Name= PU. An asterisk (*) after the PU indicates it meets stabilization goals for mature plants.

Plan	TaxonCode	PopulationUnitName	Δ Mat	% Change Mat	Δ Pop	% Change Pop.
MIP	NerAng	Kaluakauila	28	147.36	68	178.94
OIP	SteKan	Hale‘au‘au	1	100.00	-3	-18.75
OIP	GarMan	Hale‘au‘au*	21	56.75	54	44.62
MIP	CenAgrAgr	Central ‘Ēkahanui*	94	56.28	92	40.70
MIP	KadDegDeg	Kahanahāiki to Pahole*	24	52.17	28	37.83
OIP	GenCyr	Koloa	1	50.00	3	100.00
MIP	CyrDen	‘Ōpae‘ula (Ko‘olaus)	14	41.17	-7	-5.88
MIP	CyrDen	Pahole to West Makaleha*	184	28.93	726	29.09
MIP	DelWai	Kahanahāiki to Keawapilau*	26	23.85	37	25.87
MIP	DelWai	Kalua‘ā*	36	21.81	23	7.88
MIP	TetFil	**‘Ōhikilolo***	486	20.93	259	7.82
MIP	EupHer	Kapuna to Pahole*	12	16.90	19	18.63
MIP	HesOah	Mākaha	2	14.28	-1	-2.50
MIP	CyaGriOba	Pahole to West Makaleha	8	12.69	-14	-11.20
MIP	FluNeo	Kahanahāiki to Kapuna	1	11.11	14	23.73
MIP	PriKaa	‘Ōhikilolo*	17	10.55	7	0.44
MIP	CenAgrAgr	Kahanahāiki and Pahole*	29	10.54	21	4.94

The Population Unit Status Summary for each IP taxon is included in 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 2022	Total Immature 2022	Total Seedling 2022	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	275	150	0	**304**	**142**	**0**	70	27	0	234	115	0	2023-05-30	
Kuaokala	Genetic Storage				0	0	0	**0**	**0**	**0**	0	0	0	0	0	0	2022-06-15	
	In Total:	210	66	0	275	150	0	**304**	**142**	**0**	70	27	0	234	115	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 2022	Total Immature 2022	Total Seedling 2022	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	167	59	0	**261**	**56**	**1**	93	34	0	168	22	1	2022-09-08	
Makaha and Waianae Kai	Manage for stability	9	3	0	71	3	6	**52**	**48**	**0**	6	0	0	46	48	0	2023-06-15	
South Huliwai	Genetic Storage	27	0	0	32	5	0	**34**	**29**	**11**	34	29	11	0	0	0	2022-07-20	
	Out Total:	56	3	0	270	67	6	**347**	**133**	**12**	133	63	11	214	70	1		
	Total for Taxon:	266	69	0	545	217	6	**651**	**275**	**12**	203	90	11	448	185	1		

***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 for the 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, as well as data from the Oʻahu Plant Extinction Prevention Program (OPEPP) and Oʻahu NEPM 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*:** This is the 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 are 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. a*grimonioides.*

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	304	Partial 100%	Partial 100%	Partial 79%	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	261	Yes	Partial 99%	Yes	No	No
Makaha and Waianae Kai	Manage for stability	52	Partial 88%	Partial 88%	Partial 100%	Partial 79%	No
South Huliwai	Genetic Storage	34	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 Oʻahu. 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. Iron phosphate is the active ingredient (AI) in Ferroxx AQ at a 5% concentration. 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 Mākua 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 Pūʻulu, Kihakapu, Palikea, Kaimuhole, Alaiheihe, Manuwai, Kaumoku Iki, Kaumoku Nui and Kaʻawa; in the Puʻu Palikea areas that were threatened by the Nānākuli fire in 2016; and areas threatened by the Keaʻau fire in 2018, and the 2022 Mākua and Koʻiahi ridge fires. 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 the 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 weeds are 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, 108 received 'Partial' weed control status. This is a decrease of three MFS PUs from the previous year and is the result of a change in weed control status for *Cyanea acuminata* in the Kaluanui and Maʻakua PU, *Euporbia celastroides* var. *kaenana* in the East of Alau PU, *Schiedea kaalae* in the Kaluanui PU, and *Tetramolopium filiforme* in Waiʻanae Kai. Of the 108 PUs assigned 'Partial' weed control status, 77 received weed control for ≥ 50% of mature plants in the PU. This represents a decline of three PUs from last reporting year (ANRPO 2022). 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 weeds, 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 70% of MFS PUs. This is an increase of five percent from the previous year (ANRPO 2022). Partial and full control was attained at 38 (51%) and 14 (19%) 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 via 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 no change from last reporting year (ANRPO 2022). Partial and full control was attained at 50 (42%) and 69 (58%) MFS PUs respectively. In the event of an ungulate incursion into a fence unit where ungulates were previously cleared, the control designation will remain as "Full" unless the incursion is significant, either involving large numbers of animals or persisting 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. This represents no change from last reporting year a (ANRPO 2022). Although not reflected in the

threat control analysis at the PU level, slug control at PRS increased from 49 to 52 sites since last reporting year. Of the 83 MFS PUs, 31 (37%) received partial and four (5%) full control. Increases in slug control are the result of program efforts, initiated in 2021, to expand slug control to priority PUs. ANRPO expects to further increase slug control at additional PRS following the completion of multiple native snail surveys at new PRS selected for slug control. 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 in the following section (Table 8) on page 120. 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 57 PUs out of 226 that reached their storage goal, representing 1,088 founder plants and 29 taxa (Table 5). There was an increase of 2 PUs meeting storage goals since last reporting year, and an additional 48 founder plants in the category of "goals met" as compared to the previous year (ANRPO 2022). Among PUs where goals are not 100% complete, there has been progress with 1,311 founder plants in 157 PU partially represented. The *Delissea waianaeensis* Keālia PU as well as the *Neraudia angulata* Punapōhaku PU met 100% genetic storage goals with the addition of one new founder each. The *Hibiscus brackenridgei* subsp. *mokuleianus* Waialua PU remained at 100% genetic storage this year and saw 20 additional founders. There was also an increase of 37 founders of the *Euphorbia celastroides var. kaenana* Ka'ena PU, bringing the total number of individuals to 105. This year's increase in founder representation in genetic storage through conventional seed banking is attributed to field collection efforts made by ANRPO program staff.

Table 5: Summary statistics indicating progress during the 2023 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	2022	2023
Number of PUs with 100% Genetic storage	55 (1,076 founders)	57 (1,088 founders)
MIP and MIP/OIP Overlap PUs with 100% Genetic Storage	38	42
OIP PUs with 100% Genetic Storage	17	17
Average PU Genetic Storage Completion	46%	46.9%
PUs with No Founder Representation in Genetic Storage	55	55
PUs with ≥90% Genetic Storage Complete	58	62
PUs with ≥50% Genetic Storage Complete	111	113
Total Founders with 100% Genetic Storage	2,351	2,399

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 far right column for reference.

Species	Founders w/ >3 in Nursery 2022	Founders w/ >3 in Nursery 2023	Change in founders w/ >3 in Nursery	Total Number of Potential Founders (2023)
Alectryon macrococcus var. *macrococcus*	15	13	-2	29
Cenchrus agrimonioides var. *agrimonioides*	50	60	10	361
Dubautia herbstobatae	75	75	0	512
Eugenia koolauensis	113	130	17	141
Flueggea neowawraea	17	22	5	43
Gardenia mannii	30	29	-1	69
Hibiscus brackenridgei subsp. *mokuleianus*	117	88	-29	177
Wollastonia tenuifolia	11	9	-2	1,757
Neraudia angulata	37	40	3	135
Nototrichium humile	118	129	11	550
Schiedea nuttallii	32	18	-14	60
Viola chamissoniana subsp. *chamissoniana*	34	44	10	410

ANRPO maintains living collections in the nursery for the plants listed above in Table 6. Living collection founders meeting the goal of three or more replicates per founder generally increased with some exceptions, *Alectryon macrococcus* var. *macrococcus*, *Gardenia mannii*, *Hibiscus brackenridgei* subsp. *mokuleianus, Wollastonia tenuifolia* and *Schiedea nuttallii*. Horticulture staff is currently propagating founders of these taxa to ensure three plants in the living collection for each wild founder. For *Alectryon macrococcus* var. *macrococcus* and *Wollastonia tenuifolia,* founders have been lost from the living collection this reporting year. *A. macrococcus* var. *macrococcus* MAK-A-12 was lost from the living collection and is no longer alive in situ or at reintroductions. *W. tenuifolia* MMR-D-4 and MMR-E-4 were also lost from the living collection. MMR-E-4 is still alive in the wild and propagule collection has been scheduled, whereas the MMR-D PRS no longer supports plants, therefore genetic storage collection efforts will be focused at MMR-E and MMR-K to amass new founders in the living collection for the ʻŌhikilolo PU.

For *Hibiscus brackenridgei* subsp. *mokuleianus,* the outplanting of extremely pot bound individuals representing the Keaʻau PU into the Kahua seed production plot accounts for 80% (23 founders of 29) of the decline of goals met within the nursery. Our goal is to transition genetic storage for the Keaʻau PU from living collection to seed storage over the next two years through seed collected at Kahua. Horticulture staff have already begun the propagation of these founders to meet genetic storage goals. Other founders within the Mākua PU and Waialua PU account for the other 20% (6 founders of 29); those founders will be propagated to meet goals as materials become available. The decline of founders meeting

goals of *Schiedea nuttallii* was due to a failure of irrigation. The propagation of these founders will begin as materials become available.

Increases in the number of founders meeting goals for *Cenchrus agrimonioides* var. a*grimonioides, Eugenia koolauensis, Flueggea neowawraea, Neraudia angulata* and *Viola chamissoniana* subsp. *chamissoniana* can be directly attributed to propagation efforts of the Horticulture staff.

A large number of *Nototrichium humile* not represented in the living collection were received from PEPP staff, increasing the number of founders in the nursery by 3. Other increases in *Nototrichium* founders meeting goals can be attributed to increased collection efforts by field staff.

Table 7: Micropropagation Summary.

Species	Founders in Microprop 2022	Founders in Microprop 2023	Change in founders in Microprop
Dubautia herbstobatae	28	28	0
Wollastonia tenuifolia	7	6	-1
Schiedea nuttallii	11	20	9
Viola chamissoniana subsp. *chamissoniana*	30	24	-6

Horticulture staff have been steadily increasing representation of founders for the species listed above (Table 7). In the 2022-2023 reporting year, *S. nuttalii* representation increased thanks to propagation efforts in the nursery and the Lyon Arboretum Micropropagation Lab. ANRPO will discontinue *Wollastonia tenuifolia* representation in micropropagation due to the poor performance of the species in-vitro and will focus efforts on the living collection at Schofield Barracks West Base. Horticulture staff will continue to work with Lyon Arboretum Micropropagation lab staff to increase founder representation for the remaining three species listed above until genetic storage goals are complete as founders become available. Six founders of *V. chamissoniana* subsp. *chamissoniana* were lost in micropropagation over the last reporting year. These losses are not unexpected, especially given that this taxon presents challenges when cloning in tissue culture and Micropropagation lab staff are still refining the protocols. The founders lost in micropropagation are still secured in the ANRPO living collection.

In 2021, Horticulture staff proposed performing trials to test new copper products to prevent the incursion of molluscs into the nursery (ANRPO 2021). The implementation of regular applications of Deadline MP and Ferrox AQ have proven to be effective in reducing the number of molluscs detected during plant cleaning efforts during the outplanting season. Horticulture staff have also begun to apply Copper Sulfate to the floors of the greenhouse to combat algal growth with the added benefit of mollusc deterrence. Due to the reduction of mollusc detections, Horticulture staff have opted to forego copper barrier trials and will rely on the chemical application rotation currently in use. An updated phytosanitation plan is included in this year's report (Appendix 4-7).

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: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: Dead and Repres.	Partial Storage Status: # Plants >= 10 in SeedLab	Partial Storage Status: # Plants >= 10 Est Viable in SeedLab	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	Storage Goals: # Plants >= 50 in SeedLab	Storage Goals: # Plants >= 50 Est. Viable in SeedLab	Storage Goals: # Plants >=3 in Microprop	Storage Goals: # Plants >=3 Army Nursery	Storage Goals Met: # Plants that Met Goal	Storage Goals Met: % Completed Genetic Storage Requirement
Action Area: In														
Cenchrus agrimonioides var. agrimonioides														
Kahanahaiki and Pahole	Manage for stability	70	27	68	89	75	0	0	63	39	0	0	48	96%
Kuaokala	Genetic Storage	0	0	1	1	1	0	1	1	1	0	1	1	100%
Action Area: Out														
Cenchrus agrimonioides var. agrimonioides														
Central Ekahanui	Manage for stability	93	34	53	90	66	0	51	57	22	0	32	42	84%
Makaha and Waianae Kai	Manage for stability	6	0	8	12	10	0	9	7	2	0	8	8	57%
South Huliwai	Genetic Storage	34	29	28	47	40	0	36	39	26	0	19	31	62%

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
203	90	158	239	192	0	97	167	90	0	60	130

***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 (clones in test tubes) 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 *P. kaalaensis* and updated plans for *H. brackenridgei* subsp. *mokuleianus* and *D. waianaeensis* are presented in Appendices 4-4, 4-5, and 4-6, 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. Two changes have been made to the Table 9 timeline. *Wollastonia tenuifolia* was moved from 2023 to 2024. This change will allow ANRPO additional time to update demographic information for this taxon to inform the development of the management plan. *Alectryon macrococcus* var. *macrococcus* was moved from 2024 to 2026 to accommodate the change for *W. tenuifolia*.

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		2026	
Cenchrus agrimonoides var. *agrimonoides*	MIP	2020		2030
Cyanea acuminata	OIP		2025	
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		
Neraudia angulata	MIP	2013		2026

Table 9 (continued).

Species	IP	5 Year Management or Genetic Storage Plan Date Completed	Future Expected Completion Date	Expected Update
Nototrichium humile	MIP	2013		2027
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		
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
Wollastonia tenuifolia	MIP		2024	

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 Hawai'i 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. On public documents, locations of rare species and sensitive data will be obscured.

- ***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 Hawai‘i 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, 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 fewer 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*:** This is 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.

LITERATURE CITED

ANRPO. 2021. Appendix 4-7 Updates to ANRPO Phytosanitation Protocols *in* Status Report for the Mākua and Oʻahu Implementation Plans.

ANRPO. 2022a. Appendix 4-1 Taxa Status Summary *in* Status Report for the Mākua and Oʻahu Implementation Plans.

ANRPO. 2022b. Appendix 4-2 Threat Control Summary *in* Status Report for the Mākua and Oʻahu Implementation Plans.

ANRPO. 2022c. Appendix 4-3 Genetic Storage Summary *in* Status Report for the Mākua and Oʻahu Implementation Plans.

CHAPTER 5: *ACHATINELLA MUSTELINA* MANAGEMENT

5.1 BACKGROUND

In this chapter, *Achatinella mustelina* management by the Army Natural Resources Program on O‘ahu (ANRPO) is reported for July 2022-June 2023. *Achatinella mustelina* across the Wai‘anae 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. For the same reason three managed populations were initially designated for ESU-D as well. However, due to the lack of suitable terrain in ESU-D2 for a snail enclosure, a single population in ESU-D1 was selected for the whole ESU in 2020. The Mākua 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 six ESUs, current and historic *A. mustelina* sites, and snail enclosure locations. ESU-F has been expanded to show both snail enclosures located in Palikea.

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, mice, rosy wolf snails (*Euglandina rosea*), 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 snail, and Jackson's chameleon 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 ArcGIS Pro. A 50-meter radius buffer around PRSs was created. If weed control efforts covered the entire buffer for a particular population reference code, it was counted as full management and assigned a 'Yes.' If only part of the buffer was weeded, it was assigned a 'Partial.' 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 across the entire enclosure. Vegetation monitoring at the enclosures provides specific data on native habitat vs. weed density.

Rats are considered a 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 throughout 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. Rodent threat management within and around snail enclosures includes the use of Goodnature A24 automatic resetting traps (A24s), snap traps, and has recently included the addition of NZ AutoTraps AT220 automatic self-resetting traps. Rodenticide (Diphacinone D-50) is also hand-broadcasted outside of all snail enclosures as a preventative measure on a quarterly basis, and inside when rat or mice incursions occur (see Chapter 8). Presence of rats and mice is detected with tracking tunnel cards on at least a quarterly basis. The snail enclosure wall includes a hood 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.

At this time, 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.' 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 work towards achieving MIP goals, working closely with various landowners and partner agencies such as the State of Hawai'i's Department of Land and Natural Resources Snail Extinction Prevention Program (SEPP) to achieve such goals. At two of the seven managed populations in the ESUs (B1, D), the goal of 300 snails is met (Table 1) based on Timed-Count Monitoring (TCM), see below for methods. In five other ESUs (A, B2, C, E, F) the number of counted snails is approaching the goal of 300 and given that the detection rate during TCM is not 100%, the number of snails at each site is 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%. In Table 1, the highest number of snails counted

within the report year is reported for each ESU, as well as the average count for the quarterly timed-counts at the enclosures. This helps to account for the variations in detectability due to the listed factors, particularly inconsistency in observers, which is largely the cause for low counts. The highest number, while still considered an underestimate of the population, gives 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. Table 1 shows the numbers for report year 2023 (July 2022-June 2023) as well as report year 2022 (July 2021-June 2022) for ease of comparison.

Table 1: Recent counts of ESU MFS populations and snail enclosure status based on data from report years 2022 and 2023, or most recent monitoring events.

ESU	Highest # Snails Observed in ESU 2022	Highest # Snails Observed in ESU 2023	Average # Snails Counted in Enclosures based on Quarterly Counts 2022	Average # Snails Counted in Enclosures based on Quarterly Counts 2023	Enclosure Name and Location (MU)
A	356	245[1]	104 (Kahanahāiki) 96 (Pahole)	60 (Kahanahāiki) 125 (Pahole)	Kahanahāiki /Pahole
B1	324	324	110[2]	97[2]	Three Points (Makaleha West)
B2	353	229[2]			
C	268	295	25	33	Ka‘ala
D	562	634	507	569	Hāpapa (Kalua‘ā and Wai‘eli)
E	127	105	102	83	Palikea North (Palikea)
F	228	246	89	79	Palikea South (Palikea)

[1] Count includes TCM from Pahole and total translocations from old Kahanahāiki enclosure
[2] The majority of snails in the Three Points enclosure came from B2

At MFS PRSs, snails are monitored on a regular basis using TCM and 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, which 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. Day and night surveys can't be compared, as detectability is significantly higher at night. For GSP surveys, the ground is searched within a designated plot and all *A. mustelina* shells and shell fragments are collected and counted. This method also ensures comparable data across surveys and is used to assess trends in mortality. Additionally, close examination of ground shells provides the opportunity for observers to note any unusual damage or signs of predation.

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 new Kahanahāiki snail enclosure.

5.2.1 Management History and Population Trends

ESU-A spans parts of Kahanahāiki Gulch and Pahole Natural Area Reserve (Figure 3). Two snail enclosure sites (Kahanahāiki 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 Kahanahāiki and Pahole enclosures combined have at least 245 snails (the actual population size is likely higher due to detection rate being less than 100%). Almost all of the NM PRS snails have been moved into one of the two snail enclosures. The old snail enclosure at Kahanahāiki has been deconstructed and all snails have been moved to the new enclosure. ANRPO manages the snail enclosure at Kahanahāiki (MMR-P), and the 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 Kahanahāiki enclosure to ensure that they have not breached the enclosure walls. Four rat tracking tunnels and four A24s have been installed inside the enclosure. The A24s have been maintained at six-month intervals in the past, but will checked and re-baited at four-month intervals going forward. Tracking tunnels are set out quarterly during the TCM operations. The enclosure lies within the larger Kahanahāiki A24 grid, which also includes the recent addition of AT220 traps. Jackson's chameleons are not common in this area, but staff always search for them during TCM and other field work.

Table 2: ESU-A population structure and threat control summary for MFS PRSs. The count reported, which only includes snails sighted during TCM and not snails translocated, 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	76	2022-12-05	41	14	21	0	Yes	Yes	Yes	Yes	Yes
New Kahanahaiki Snail Enclosure												
PAH-B	Manage for stability	169	2023-06-01	87	73	9	0	Yes	Yes	Yes	Yes	Yes
Pahole Exclosure												
	ESU Total:	245		128	87	30	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-A Old Kahanahāiki Enclosure NM-PRS: After a rat breach was detected inside the old enclosure, ANRPO began translocating snails to the new enclosure. Five translocation events took place and a total of 238 snails have been removed from the old enclosure (Table 3). All *Psidium cattleianum* trees inside the enclosure were cut down and thoroughly searched for snails. The enclosure was searched in December 2022 and March 2023, but no additional snails were found. In June 2023, the old enclosure was deconstructed. See the Kahanahāiki Translocation Plan for complete protocol and monitoring plans (ANRPO 2022).

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 Kahanahāiki Enclosure PRS: The newly constructed enclosure at Kahanahāiki is the focus of ANRPO's management within ESU-A. A total of 238 snails were collected from the old enclosure over five visits and all snails were introduced within a designated area in the new enclosure (ANRPO 2022). 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 the new enclosure after snails were introduced. Figure 4 shows the population trend in the new enclosure since re-introduction. A downward trend in TCM in the first few months was likely due to movement of the snails into higher (less visible) canopy and into the surrounding trees, as GSP counts were low. This was followed by several months of stable numbers. Snails have also been found outside the enclosure or on the wall.

An invasion of *Anoplolepis gracilipes* (yellow crazy ants) was first detected near the old Kahanahāiki enclosure in 2017. After assessing the extent of the infestation and consulting with experts on the best means of controlling the infestation, treatment was initiated but quickly abandoned as ANRPO staff realized that eradication was not feasible. With the construction of the new enclosure, attention was brought back to the population and ANRPO staff began to re-evaluate available tools (for more on this, see Chapter 9). There was a marked increase in GSP numbers and a slight downward trend in TCM during the first two quarters of 2023. We are unable to definitively attribute the increase in GSP numbers to any one factor, but suspect that it was largely a result of *A. gracilipes* predation. ANRPO will continue to diligently track these trends with increased (monthly) GSP monitoring, and work towards eradication of *A. gracilipes* at the site. Though the area experienced drier conditions following clearing of non-native trees during construction of the enclosure, native vegetation cover has been increasing substantially over time with the growth of outplantings as well as natural recruitment. See Appendix 5-1 for the Kahanahāiki snail enclosure vegetation monitoring results.

Table 4: TCM and GSP data for the reporting period.

Kahanahāiki Snail Enclosure								
	Night TCM				**Ground Shells**			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
2022-08-29	15	9	52	76	2	0	2	4
2022-12-05	21	14	41	76	0	0	9	9
2023-03-20	12	6	41	59	13	0	8	21
2023-05-17	5	12	34	51	19	19	11	49
2023-06-19					24	23	22	69
Average				**65**	**Total ground shells**			**152**

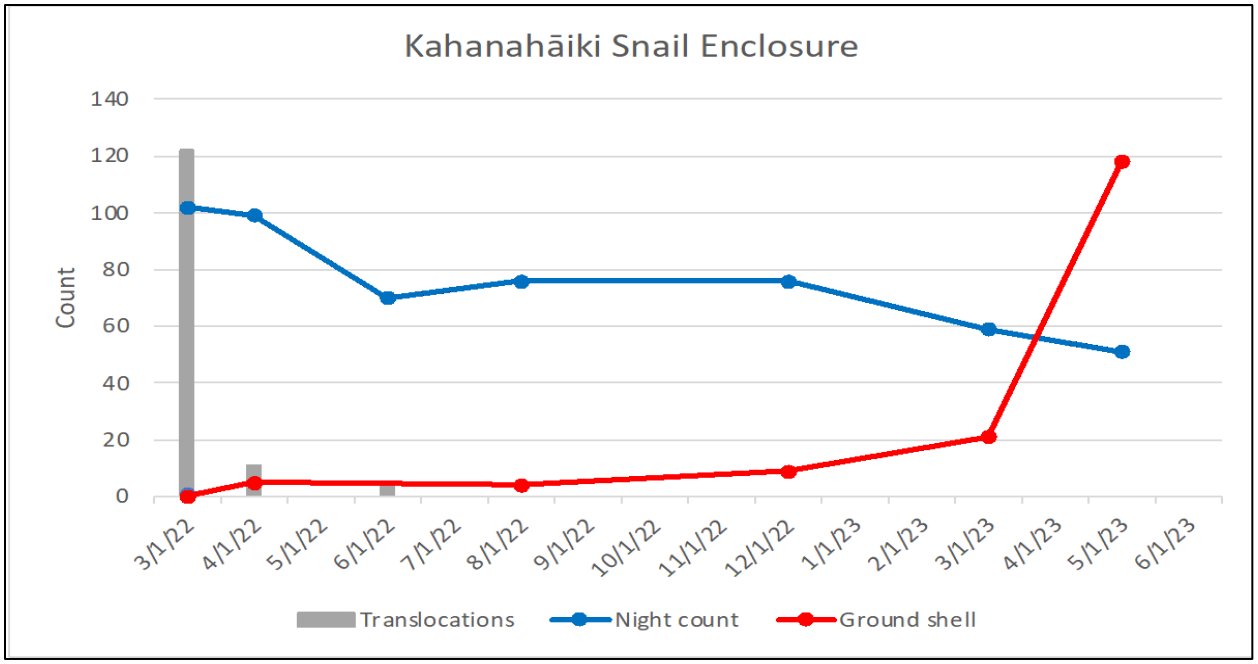

Figure 4: Quarterly timed-count monitoring (TCM) and quarterly ground shell counts for *A. mustelina* in the new Kahanahāiki snail enclosure from March 2022-June 2023, with numbers of snails translocated into the enclosure over time.

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. Counts are done for a duration of 3 person-hours, and are always conducted in the daytime. Data is collected by SEPP and shared with ANRPO.

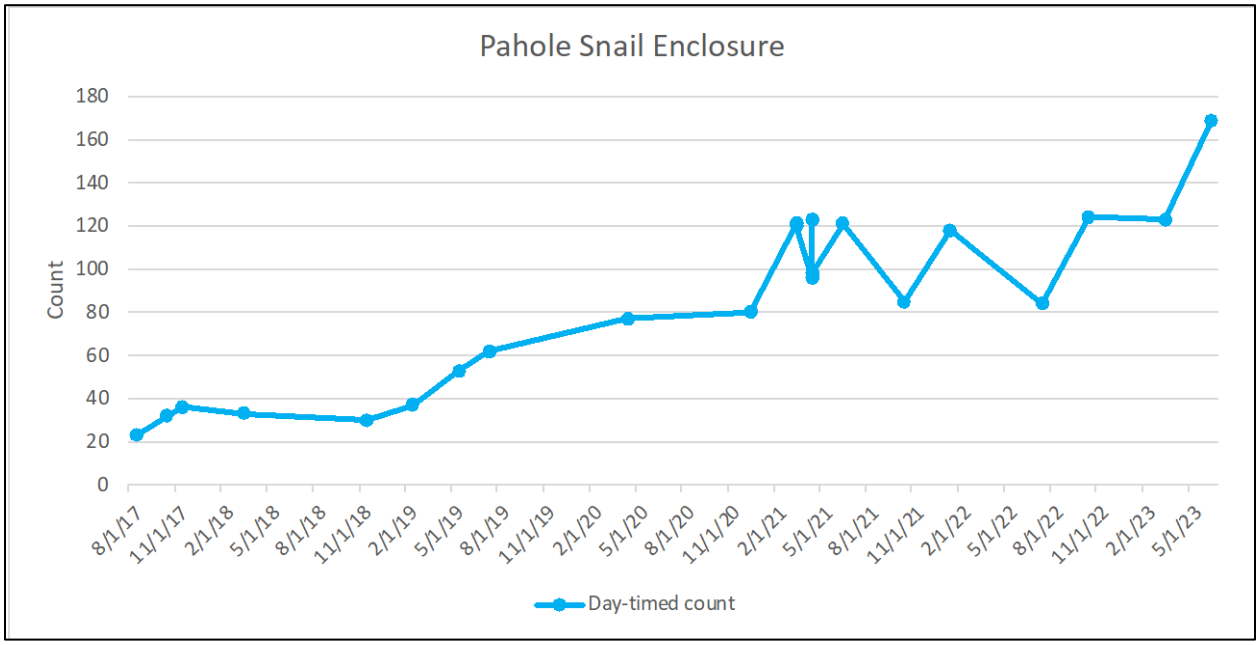

Figure 5: Day timed-count monitoring (TCM) conducted by SEPP for *A. mustelina* in the Pahole snail enclosure since 2017.

5.2.2 Future Management

ANRPO will continue to implement the monitoring plan outlined in Table 5, including night TCM for MMR-P. Threat control will continue inside and around the existing enclosures, including tracking tunnels, AT220s, D-50, and A24s for rats, quarterly searches for rosy wolf snails, and localized ant control. Weed control and habitat improvements will continue cautiously to ensure there are no impacts on the snails at the enclosure.

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

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-P New Kahanahāiki enclosure	TCM	Quarterly	All	Conduct night TCM within designated area inside enclosure 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 Mākua rim and ESU-B2 along the north-facing rim of the Mokulē‘ia Forest Reserve. The subdivision of ESU-B has a genetic basis (see Mākua Implementation Plan 2001). Management of ESU-B1 is focused at ‘Ōhikilolo, though a small proportion B1 snails have been incorporated into the Three Points snail enclosure in Makaleha West. ESU-B2 includes the gulches spanning Makaleha West, Central, and East. Management of ESU-B2 is focused at the Three Points snail enclosure in Makaleha West.

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Figure 7: Map of ESU-B1 and the Three 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 (ʻŌhikilolo Mauka) and MMR-F (ʻŌhikilolo Makai) (Figure 7 and Table 6). The most recent TCM at these PRSs occurred in June 2022, with a combined total of 324 snails. Due to the massive effort and time commitment necessary to complete the counts at these sites, MMR-E and MMR-F will only be surveyed every 2 years.

The main fenced portion of ʻŌhikilolo MU remains unique in that neither rosy wolf snails nor Jackson's chameleons have ever been recorded in the area. This year, however, *Euglandina* shells were found at Ctenitis Ridge, which is another fenced area containing *Pritchardia kaalae* within ESU-B. 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 ʻŌhikilolo Mauka PRS: The population was last monitored in June 2022 and a total of 22 snails were counted, none of which were removed (Figure 8). This count is one year after a subset of snails were collected and translocated to the Three Points snail enclosure. There is a slight decline in the numbers 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 count.

MMR-F ʻŌhikilolo Makai PRS: The population was last 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 Three Points snail enclosure. One snail was translocated into the Makai patch from MMR-Q prior to the TCM.

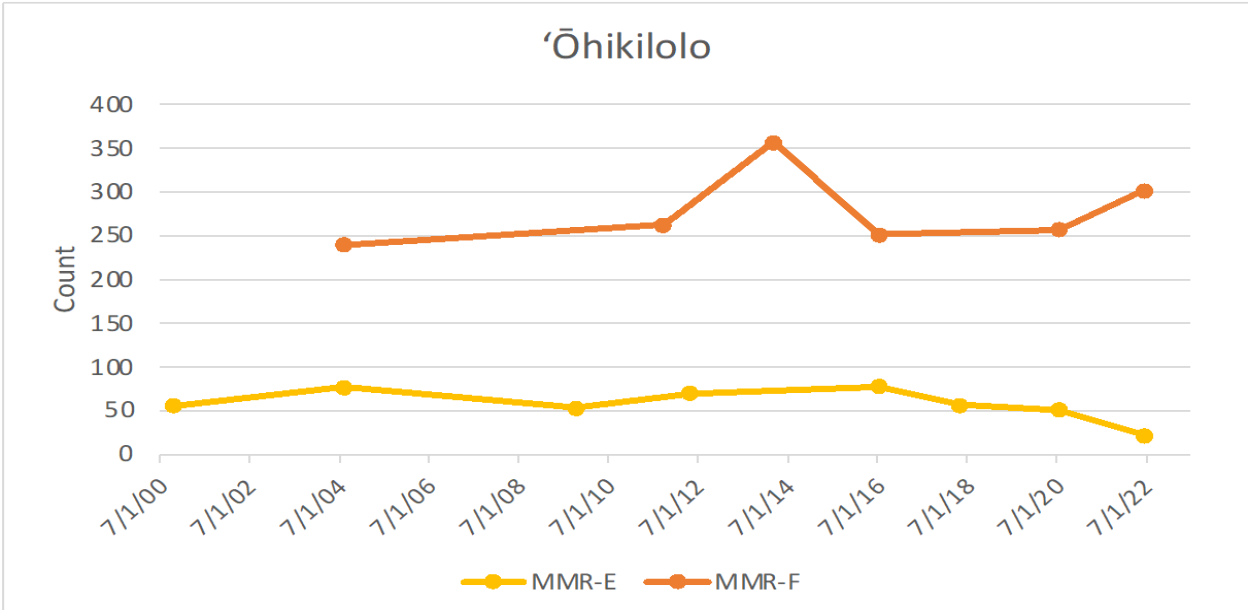

Figure 8: Day timed-count monitoring of MMR-E and MMR-F.

MMR-Q Ko'iahi Big MyrLes spot NM-PRS: On June 1, 2022, a single snail was found by staff during the course of other field work and translocated to MMR-F. In January 2023, staff returned to the site and searched the surrounding area to determine the extent of the population, but no snails were found. There are no monitoring plans for this site, but staff will continue to collect snails opportunistically.

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 impacts to snails.

Table 7: ESU-B1 monitoring plan for PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-E 'Ōhikilolo Mauka	TCM	Every 2 years	2024	8 person-hours day survey with binoculars.
MMR-F 'Ōhikilolo Makai	TCM	Every 2 years	2024	46 person-hours day TCM with binoculars.
	GSP	Every 2 years	2024	Search the ground within the marked plot.

5.3.3 ESU-B2 Management History and Population Trends

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

There are three MFS PRSs within ESU-B2: two located below the Ka‘ala Road, LEH-C (Culvert 69) and LEH-D (Culvert 73); and LEH-N (the Three Points snail enclosure) in Makaleha West (Figure 9 and Table 8). Together these PRSs have 229 observed snails. Snails have been collected and translocated to the Three Points enclosure from LEH-C, LEH-D, the NM-PRSs (See ANRPO 2020 for list of collection sites and numbers), and KAO-B. Currently rats are controlled with a total of 20 A24s at LEH-C along the ridge crest, and at LEH-D. At the Three Points snail enclosure, rodents are monitored with tracking tunnels and there are six A24s inside the enclosure, in the case of an incursion. The snail enclosure is also surrounded by a larger A24 grid. 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 of 119 for LEH-N is the highest count observed between July 2022-June 2023.

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	17*	2022-10-17	10	4	3	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	119	2022-10-24	54	27	38	0	Yes	Yes	Yes	Yes	Yes
Three Points Enclosure												
	ESU Total:	229		143	41	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: In previous years, monitoring of this population involved two to three days of rappel due to the steepness of the area. Rappel efforts were last conducted in August 2020 with 277 snails observed. Monitoring the entirety of this site requires massive effort and time commitment, so in October 2022, TCM of the walkable portion of the site was initiated off-rappel, with 17 snails counted. This resulted in a drastic decline in observed snails due to a 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. The last monitoring of the population occurred in November 2020 and a total of 93 snails were observed. This count was done after the 2019 translocation to Three Points and the 93 snails represent the remaining population. In October 2022, staff attempted to monitor the population, but were not able to locate the area and no snails were found.

LEH-N Three 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 10 snails from KAO-B. In October 2022, the temporary enclosure was discontinued and is no longer being used to contain snails within one area. The TCM area expanded, and survey time increased from two to three person-hours. Although a total of 510 snails have been reintroduced into the enclosure, the

highest number of snails counted for this report year was only 119. On average, 97 snails were counted (Table 9), which is ~19% of the total population that was released into the enclosure. Monitoring data shows fluctuating numbers (Figure 10), but snail movement and 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 (see Appendix 5-2 for vegetation monitoring results for the enclosure). A minimal number of ground shells were found this report year, however, this could be due to pooling and muddy conditions after a large rain event causing shells to be buried under the mud.

Table 9: TCM and GSP data for the reporting period.

Three Points Snail Enclosure								
Night TCM					Ground Shells			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
8/22/2022	37	30	44	111	2	1	0	3
10/24/2022	38	27	54	119				
3/1/2023	19	19	46	84	1	2	5	8
5/24/2023	20	21	32	73	0	0	1	1
Average				**97**	**Total ground shells**			**12**

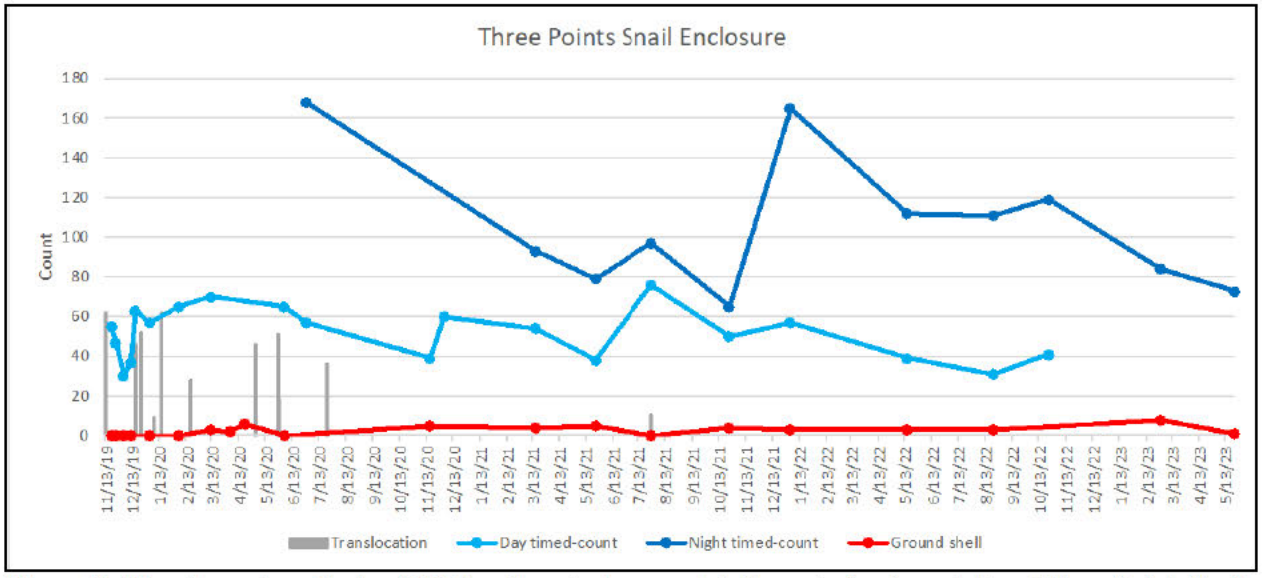

Figure 10: Timed-count monitoring (TCM) and quarterly ground shell counts for *A. mustelina* at Three Points Snail Enclosure (LEH-N) since November 2019, with numbers of snails translocated into the enclosure over time. Night timed-count monitoring was initiated because snails were moving up into the canopy and were difficult to see during the day. In 2022, it was determined that day counts were no longer necessary.

5.3.4 ESU-B2 Future Management

Translocations to the Three Points snail enclosure ended in 2021 with a total of 510 snails reintroduced into the enclosure. Native understory restoration will continue inside the enclosure as needed, with considerations for adding native ground cover to reduce pooling in the enclosure after large rain events.

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

Threat control will continue inside and around the 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	2024	Conduct night TCM for 2 person-hours along the ridge.
LEH-D East Culvert 73	TCM	Every 2 years	2024	Conduct day TCM for 4 person-hours.
LEH-N Three Points	TCM	Quarterly	All	Conduct night TCM area inside enclosure for 3 person-hours.
	GSP	Quarterly	All	Search the ground of release site.

5.4 ESU-C

Figure 11: *Achatinella mustelina* from ESU-C.

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Figure 12: Map of ESU-C with the location of the new Kaʻala 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 12). There are two MFS PRSs within ESU-C: SBW-W (Kamaohanui) and ALA-A (Kaʻala snail enclosure) (Table 11). Several NM PRSs were re-surveyed in 2020 and any snails found were translocated to SBW-W so they could acclimate before moving even higher up to Kaʻala (this occurred prior to the snail enclosure completion). ANRPO conducts rat control at SBW-W with 25 A24s, and at the Kaʻala snail enclosure with four A24s inside and eight A24s outside. Rats and mice are monitored with four tracking tunnels on a quarterly basis within the enclosure.

Rosy wolf snails are present across the ESU, but have never been observed at the snail enclosure. Jackson's chameleons are not often seen across Līhuʻe MU, however, they are present although their distribution is not well known.

Table 11: ESU-C population structure and threat control summary. The 242 snails counted at SBW-W in January 2023 during the translocation event was used as the highest number for the ESU this 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: C	**Schofield Barracks West Range, Alaiheihe and Palikea Gulches**											
ALA-A Kaala Snail Enclosure	Manage for stability	53	2023-06-19	43	7	3	0	Yes	Yes	Yes	Yes	Yes
SBW-W Skeet Pass	Manage for stability	242 *	2023-01-24	135	68	39	0	Partial	No	Yes	No	No
	ESU Total:	295		178	75	42	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 Kamaohanui PRS: In November 2022, staff counted a total of 41 snails during an on-foot timed-count monitoring. This count, however, does not accurately depict the population along Kamaohanui, since in January 2023, staff conducted a search on rappel and collected 242 snails to be introduced into the Ka‘ala snail enclosure (Table 11). The next TCM will be in 2024 and it is expected that less snails will be observed because of this translocation event.

ALA-A Ka‘ala Snail Enclosure: In January 2023, staff searched for snails on the slopes of Kamaohanui on rappel and collected a total of 242 snails (39 S, 68 M, 135 L) for introduction into the Ka‘ala snail enclosure. This is in addition to the 101 snails, also from SBW-W, translocated in November 2021. Timed-count monitoring has been conducted quarterlt since then, and on average 33 snails were counted per visit, which is less than 10% of the total population released into the enclosure. This is not a concern, however, as snails have been seen dispersing from their initial release site and into the surrounding canopy. It is also important to note that the vegetation inside the snail enclosure is very dense, which makes surveying difficult. Small snails have been observed, which is an indication that the population is growing. Table 12 shows the snail observations for this report year. The habitat prior to construction was already considered appropriate snail habitat and outplanting was not required. Snails have also been found outside the enclosure or on the wall.

Table 12: TCM and GSP data for the reporting period.

Ka‘ala Snail Enclosure								
	Night TCM				**Ground Shells**			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
8/8/2022	6	1	17	24	1	0	5	6
10/10/2022	5	0	15	20	1	0	0	1
1/12/2023	2	2	11	15	1	0	2	3
3/9/2023	13	4	36	53	1	0	3	4
6/19/2023	3	7	43	53	0	1	7	8
Average				**33**	**Total ground shells**			**22**

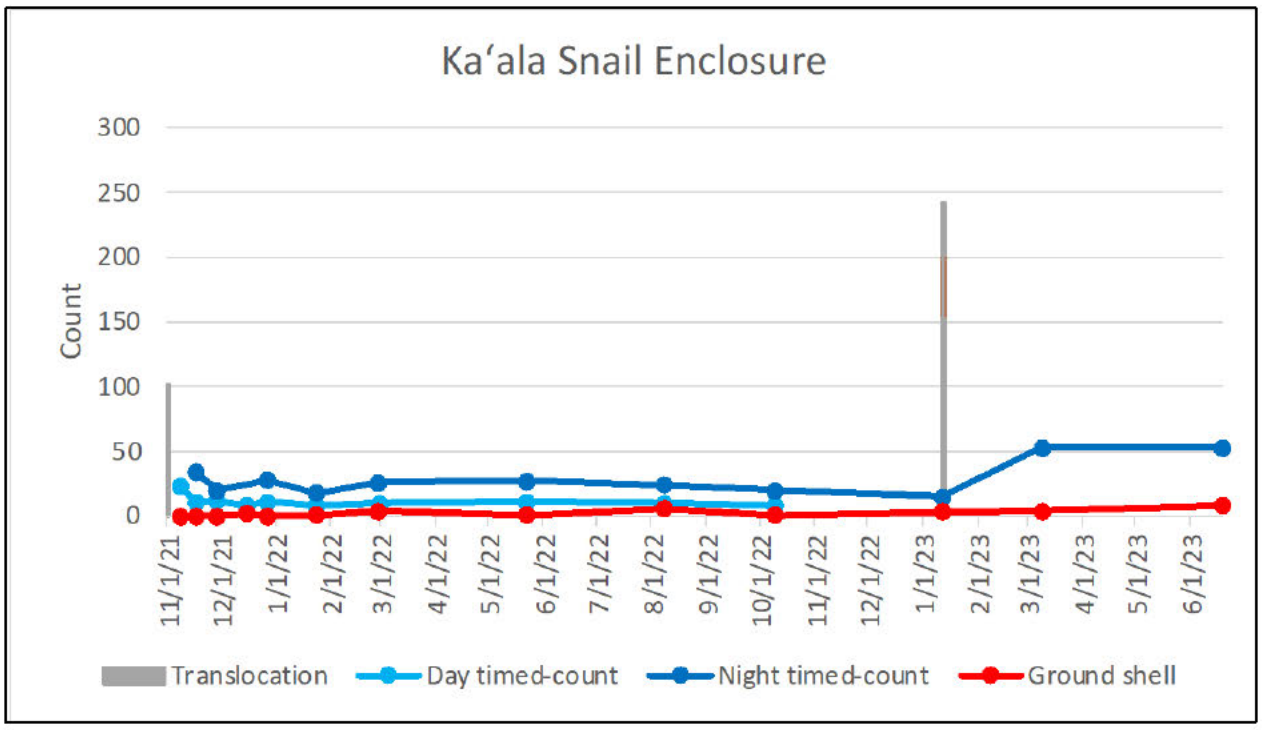

Figure 13: Timed-count monitoring (TCM) and quarterly ground shell counts for *A. mustelina* at Ka‘ala Snail Enclosure (ALA-A) since November 2021, with numbers of snails translocated into the enclosure over time.

5.4.2 ESU-C Future Management

Since a total of 343 snails were translocated into the Ka‘ala enclosure, there will no longer be efforts to collect snails from the slopes of Kamaohanui. Monitoring along Kamaohanui ridge will continue every two years. The existing A24 traps at this site will continue to be maintained on four-month intervals.

Table 13: ESU-C Monitoring Plans.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
SBW-W Kamaohanui PRS	TCM	Every 2 years	2024	Conduct night TCM for 9.25 person-hours.
ALA-A Ka‘ala Snail Enclosure	TCM	Quarterly	All	Conduct night search within release site and surrounding area for 2 person-hours.
ALA-A Ka‘ala 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 Kaluaʻā area including Hāpapa (D1), the Mākaha area (D2), and the Līhuʻe area (D). Initially, ANRPO planned to manage snails at both D1 and D2, the geographic extremes of the ESU. However, due to lack of suitable terrain at D2, in report year 2019-2020, the decision was made to manage the entire ESU at one location, Puʻu Hāpapa in the Kaluaʻā and Waiʻeli MU. The only MFS PRS in ESU D is the Puʻu Hāpapa snail enclosure. Snails from D, D1, and D2 have since been translocated into the enclosure. Some PRSs in D are higher in elevation than the Puʻu Hāpapa enclosure (Figure 15); these will be left *in situ*, as moving them down in elevation in a warming climate is predicted to have a deleterious effect. 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 regions.

5.5.1 ESU-D1 Management History and Population Trends

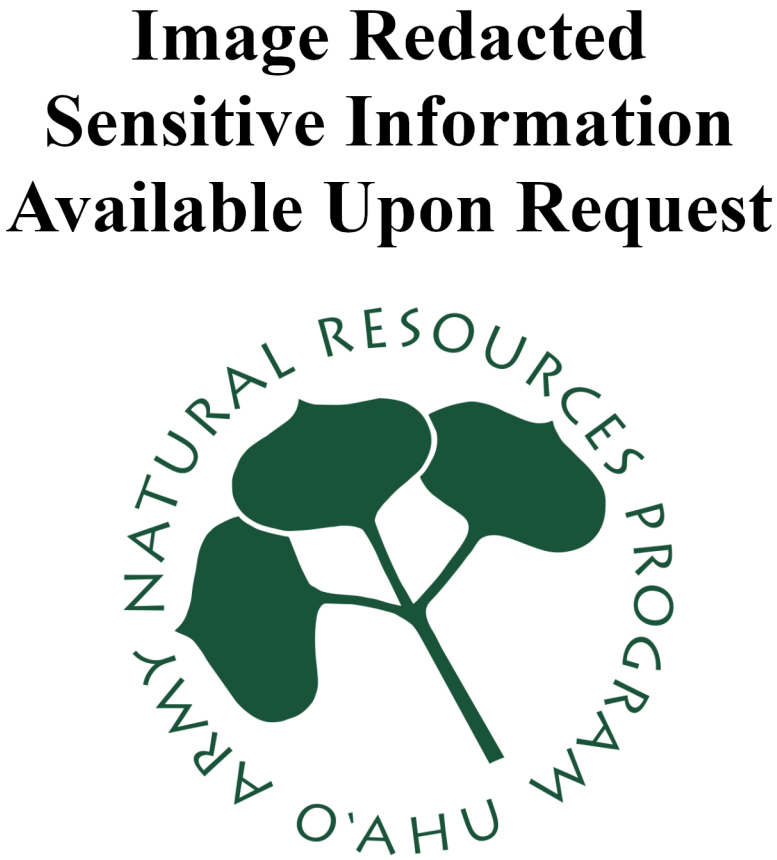

Figure 15: Map of ESU-D.

Image Redacted Sensitive Information Available Upon Request

Figure 16: Map of ESU-D1.

There is one MFS PRS at KAL-G (Puʻu Hāpapa Snail Enclosure) (Figure 16 and Table 14). Habitat restoration efforts in the Puʻu Hāpapa 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 Puʻu Hāpapa Snail Enclosure. Threats are abundant outside of the enclosure, with rosy wolf snails and Jackson's chameleons present across the region.

Table 14: ESU-D1 Population Structure and Threat Control Summary.

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D1	**North Kaluaa, Waieli, Puu Hapapa, and Schofield Barracks South Range**											
KAL-G	Manage for stability	634	2023-06-13	303	170	161	0	Yes	Yes	Yes	Yes	Yes
Puu Hapapa snail enclosure												
	ESU Total:	634		303	170	161	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 Pu‘u Hāpapa Snail Enclosure PRS: During TCM, 634 snails were observed in June 2023, and the average number of snails counted was 569 (Table 15). Since last year, there has been a slight increase in both the highest observed number of snails as well as the average observed number of snails. Unfortunately, the number of ground shells recovered was significantly higher this year (225) than last year (149). Staff will continue to monitor for any indications of high mortality. A total of 17 snails were translocated to Hāpapa snail enclosure over the last year from KAL-A, KAL-D, MAK-A, MAK-C, and MAK-F. The habitat continues to improve and the snails were observed spreading out into new vegetation as outplanted native trees grow larger.

The aging Pu‘u Hāpapa snail enclosure has suffered numerous incursions this year, of rats, mice, and Jackson’s chameleons. Rat and mice tracks have continually been observed in the snail enclosure beginning in September 2022. Ground shells found within the enclosure have been found with what appears to be evidence of rodent predation. Efforts to eradicate the rodents from the inside of the enclosure have included baiting and setting snap traps, installing an AT220, maintaining six A24s, frequent monitoring with four tracking tunnels, and applying D-50 rodenticide to the inside and outside of the enclosure. Application of D-50 began in June 2023. There are also 15 A24s and an additional AT220 surrounding the enclosure. A total of five mice and four rats have been removed from inside the enclosure during this report year. It seems that rodents are entering the snail enclosure through networks of tunnels that have been oberved in and around the structure.

A female Jackson’s chameleon was found during a TCM in December 2022. Staff subsequently swept the enclosure quarterly with tree climbers as well as on-foot searchers, specifically surveying for Jackson’s chameleons. None have been found during these targeted sweeps, however, a dead male chameleon was found in May 2023 during a *E. rosea* sweep in the same area the female was found. It is unclear how the Jackson’s chameleons got into the enclosure.

Table 15: TCM and GSP data for the reporting period.

Hāpapa Snail Enclosure								
Night TCM					Ground Shells			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
9/12/2022	137	95	381	613	30	4	7	41
12/12/2022	96	72	259	427	16	7	11	34
3/15/2023	179	165	256	600	53	31	9	93
6/13/2023	161	170	303	634	26	21	10	57
Average			**569**		**Total ground shells**		**225**	

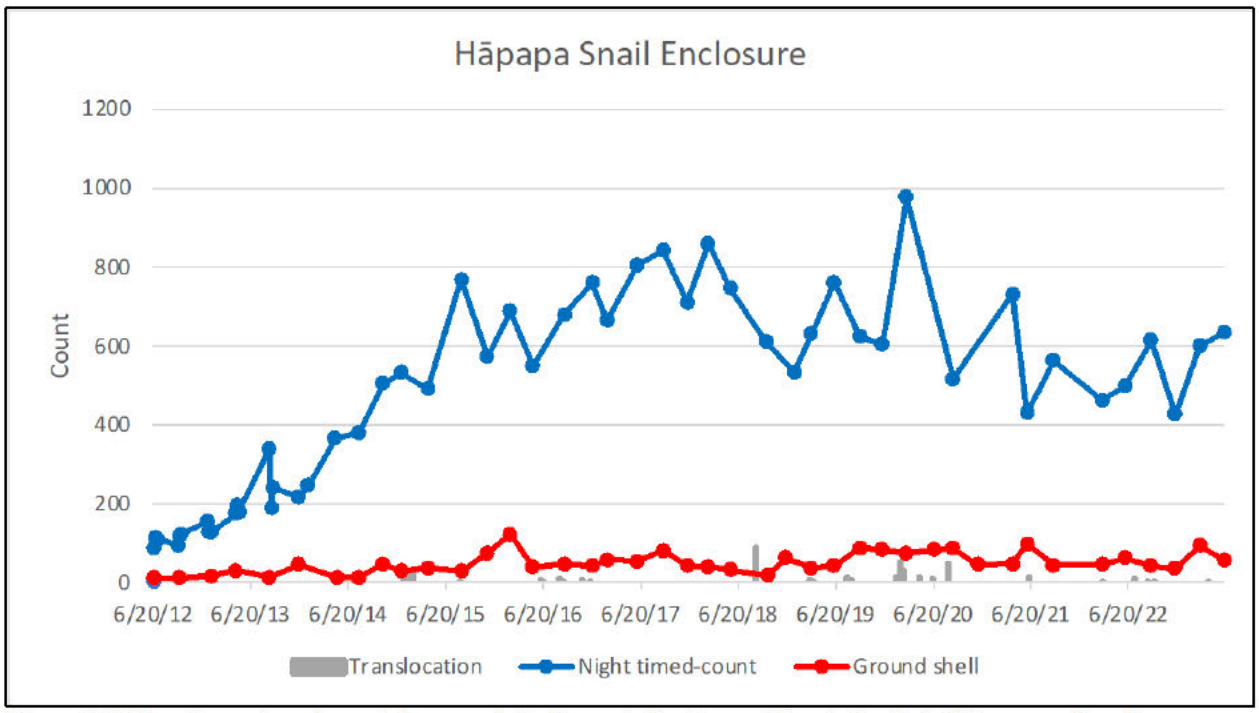

Figure 17: Timed-counts and quarterly ground shell counts for *A. mustelina* in the Pu'u Hāpapa snail enclosure from June 2012 to June 2023, with numbers of snails translocated into the enclosure over time.

No Management PRSs: The 12 NM PRSs 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 Hāpapa enclosure.

5.5.2 ESU-D1 Future Management

ANRPO staff will continue monitoring KAL-G (Pu'u Hāpapa Snail Enclosure) (Table 16). Threat control will continue in and around the existing enclosure, along with searches for rosy wolf snails and Jackson's chameleons. A protocol has been developed to guide response to Jackson's chameleon incursions (See Appendix 5-4). 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 will compromise the integrity of the barriers. ANRPO plans to re-build the structure in the upcoming year.

Table 16: ESU-D1 Monitoring Plan for MFS PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
KAL-G Pu'u Hāpapa 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

Monitoring of snails in ESU-D2 (Mākaha) has shown a steady decline over the years, and there is no suitable area for a snail enclosure. Therefore, translocations of all snails in walkable/accessible areas to the Pu'u Hāpapa snail enclosure began in 2020. ESU-D2 is now considered No Management. In the past year, snails were collected from MAK-A, MAK-C, and MAK-F, and collections are ongoing.

Image Redacted Sensitive Information Available Upon Request

Figure 18: Map of ESU-D2 and the Hāpapa snail enclosure. Due to the lack of flat terrain in Mākaha, snails were translocated to the Hāpapa snail enclosure.

MAK-F Waiʻanae Kai NM-PRS: Staff surveyed portions of this site in September 2022. A total of 12 snails (11 L, 1 S) were found, and one was translocated to Hāpapa snail enclosure. During these monitorings, staff surveyed only on-foot. Further surveys are required to determine the extent of this population and threat levels.

MAK-G Upper Mākaha NM-PRS: Staff last surveyed the area on ropes in December 2021. In August 2022, staff surveyed only on-foot on the ridge and not on slopes. Two large snails were found, but were not collected. 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 are 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 Mākaha opportunistically to collect snails and move them to Puʻu Hāpapa.

Table 17: ESU-D2 Monitoring Plans.

PRS	Monitoring Type	Comments
MAK-F Wai‘anae Kai	Scope	Conduct day survey on ropes to determine the extent of remaining population.
MAK-G Upper Mākaha	Scope	Conduct day survey on ropes to determine the extent of remaining population.

5.6 ESU-E

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

Image Redacted Sensitive Information Available Upon Request

Figure 20: Map of ESU-E. Snails from ESU-E have been 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 ʻĒkahanui and Huliwai (Figure 20). A sharp decline in snail numbers at ʻĒkahanui was observed and plans were made with the Implementation Team (IT) in 2015 to translocate snails to a permanent ESU-E dedicated enclosure at Palikea since ʻĒkahanui did not have a site with flat terrain suitable for constructing an enclosure and attempts to manage the population in ʻĒkahanui had failed (see ANRPO 2019 for ESU-E management history).

All lab reared ESU-E snails have been translocated into the Palikea North snail enclosure. Sites in ʻĒkahanui were searched and all reachable snails were translocated directly to Palikea North snail enclosure. There are still snails being discovered occasionally in ʻĒkahanui and staff will opportunistically move these to Palikea. 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	105	2023-02-01	69	13	23	0	Yes	Partial	Partial	Yes	Yes
ESU-E snails in Palikea North Enclosure												
	ESU Total:	105		69	13	23	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 NM-PRS: This site was previously considered a historic snail population and Ferroxx AQ was utilized for rare plant protection as it is the largest rare plant site, known also as the "2D Site," in ʻĒkahanui. However, during the previous report year, after seeing a snail, staff discontinued the use of Ferroxx AQ, and translocated several snails to the Palikea North enclosure. In May 2022, staff surveyed and found a snail high up in the canopy. In October 2022, staff returned to the site but determined that it was unsafe to climb the tree to retrieve the snail.

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 ʻĒkahanui/Huliwai and snails from the SEPP captive rearing facility. The average number of snails observed during the timed-counts over the past year was 83 (Table 19). Though counts oscillated, the population remains stable (Figure 21), and ground shells numbers were similar to the last report period. Prior to the temporary enclosure being deconstructed in September 2022, snails were already escaping to the surrounding vegetation. Monitoring was increased by one person-hour to include the surrounding vegetation around the old temporary enclosure. Native vegetation continues to expand in the understory and canopy, now covering over 80% of the enclosure. See Appendix 5-3 for the Palikea North snail enclosure vegetation monitoring results.

In early September 2022, the ladder leading into the snail enclosure, unfortunately, was found left down. Tracking tunnels were set out immediately and mice tracks were found. Efforts to eradicate the mice from the inside of the enclosure include maintaining ten A24s, baiting and setting up snap traps, and more frequent monitoring of four tracking tunnels. In addition, D-50 rodenticide was applied outside the enclosure. A total of four monitoring events showed signs of mice tracks, but no mice were caught or removed. Mice tracks have not been observed on the tracking cards since January 2023.

Table 19: TCM and GSP data for the reporting period.

Palikea North Snail Enclosure								
	Night TCM				Ground Shells			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
9/19/2022	4	10	59	73	1	0	3	4
11/21/2022	10	2	44	56	0	0	12	12
2/1/2023	23	13	69	105	0	1	1	2
5/31/2023	14	20	62	96	5	2	6	13
Average			**83**		**Total ground shells**		**31**	

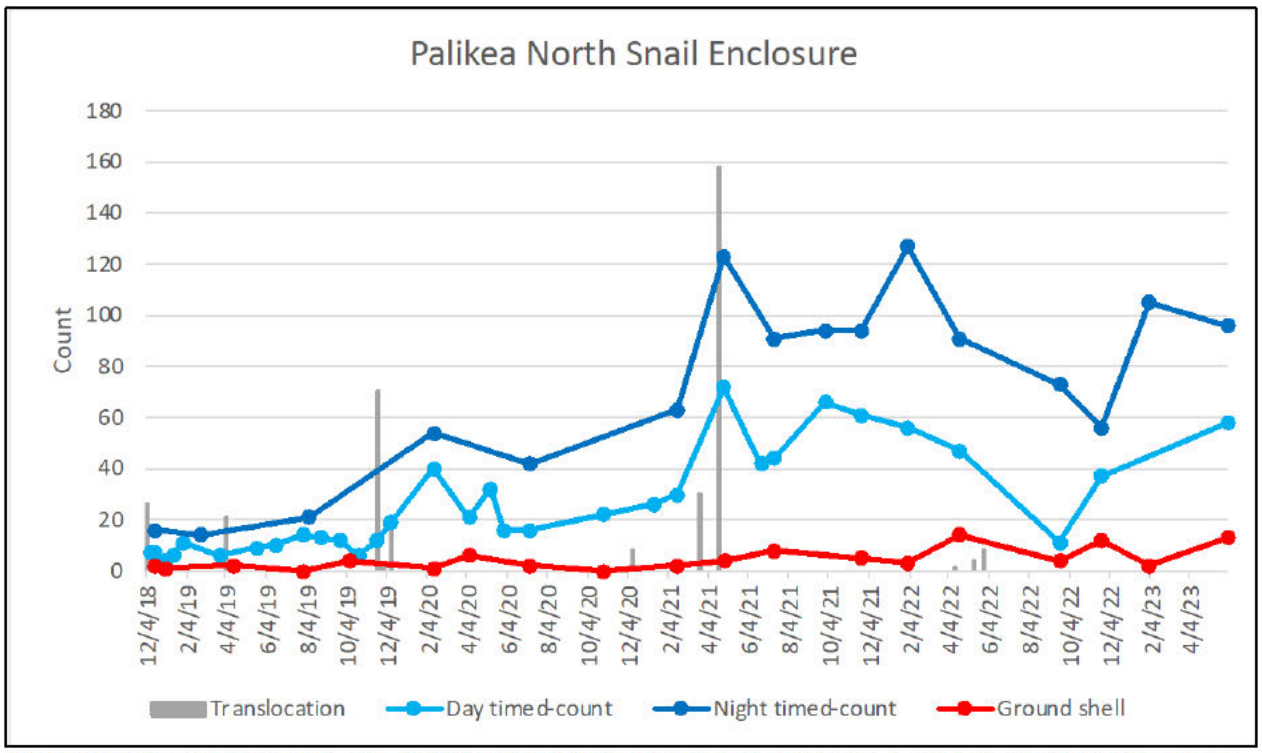

Figure 21: Timed-count monitoring (TCM) and quarterly ground shell counts for *A. mustelina* in the Palikea North snail enclosure, with numbers of snails translocated into the enclosure over time.

5.6.2 ESU-E Future Management Plans

ANRPO will continue to work according to the monitoring plan which includes day and night surveys (Table 20) for PAK-T. Threat control will continue inside and around the existing enclosures, including tracking tunnels, AT220s, D-50, and A24s for rats, and quarterly searches for rosy wolf snails. Weed control and habitat improvements will continue cautiously to ensure there are no impacts on the snails at the enclosure. NM PRSs at ESU-E will be visited again opportunistically to collect any remaining snails.

Table 20: ESU-E Monitoring Plan for MFS PRS.

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
PAK-T Palikea North	TCM	Quarterly	All	Conduct day and night TCM within a designated area for 3 person-hours. This includes the vegetation surrounding the old temporary enclosure.
	GSP	Quarterly	All	Search the entire old temporary enclosure for ground shells.

5.7 ESU-F

Figure 22: *Achatinella mustelina* from ESU-F.

Image Redacted
Sensitive Information
Available Upon Request

Figure 23: 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 Pālāwai. There is one MFS PRS in ESU-F, the Palikea South snail enclosure, (Figure 23) which includes 246 observed snails (Table 21). 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 Pālehua Road.

Table 21: ESU-F Population Structure and Threat Control Summary. The number of snails recorded here is from June 2023 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	246	2023-06-01	172	37	37	0	Yes	Partial	Yes	Yes	Yes
Palikea snail exclosure												
	ESU Total:	246		172	37	37	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.

PAK-P Palikea South Enclosure PRS: TCM is conducted during the day on a quarterly basis for four person-hours (Figure 24) within two designated plots. The highest number of snails observed in the last year was 105 and the average number of snails seen was 79 (Table 22). Once a year, a night TCM is performed for four–person-hours covering the entire enclosure; in June 2023 staff counted 246 *A. mustelina*. The increased vegetation density resulted in some areas becoming harder to survey and many of the snails in those areas were not counted. ANRPO plans to re-build the enclosure in the upcoming report year. The structure (Figure 25) is aging and could potentially allow predators to continue breaching its walls. During the re-build of the enclosure, the integrity of the predator-resistant barriers will be maintained, and rigorous rodent, predatory snail, and weed control and surveys will be conducted. A total of four snails were translocated to Palikea South snail enclosure over the last year from PAK-K and PAK-Q. The habitat continues to improve and the snails were observed spreading out into new vegetation as outplanted native trees grow larger.

There have been several incursions of mice at the Palikea South snail enclosure this year. Mouse tracks have been observed inside the enclosure, and a total of three mice have been removed during this report year. Efforts to eradicate the rodents from the inside of the enclosure have included baiting and setting snap traps, maintaining nine A24s, and more frequent monitoring with four tracking tunnels. The enclosure is also situated within the larger MU A24 grid.

Table 22: TCM and GSP data for the reporting period.

Palikea South Snail Enclosure								
	Day TCM				Ground Shells			
Date	**Small**	**Medium**	**Large**	**Total**	**Small**	**Medium**	**Large**	**Total**
8/1/2022	8	15	45	68	1	1	4	6
9/20/2022	2	2	44	48	2	2	12	16
11/1/2022	27	7	55	89	0	3	7	10
2/1/2023	5	4	73	82	0	0	6	6
5/31/2023	16	9	83	105	0	0	11	11
Average			**79**		**Total ground shells**		**49**	

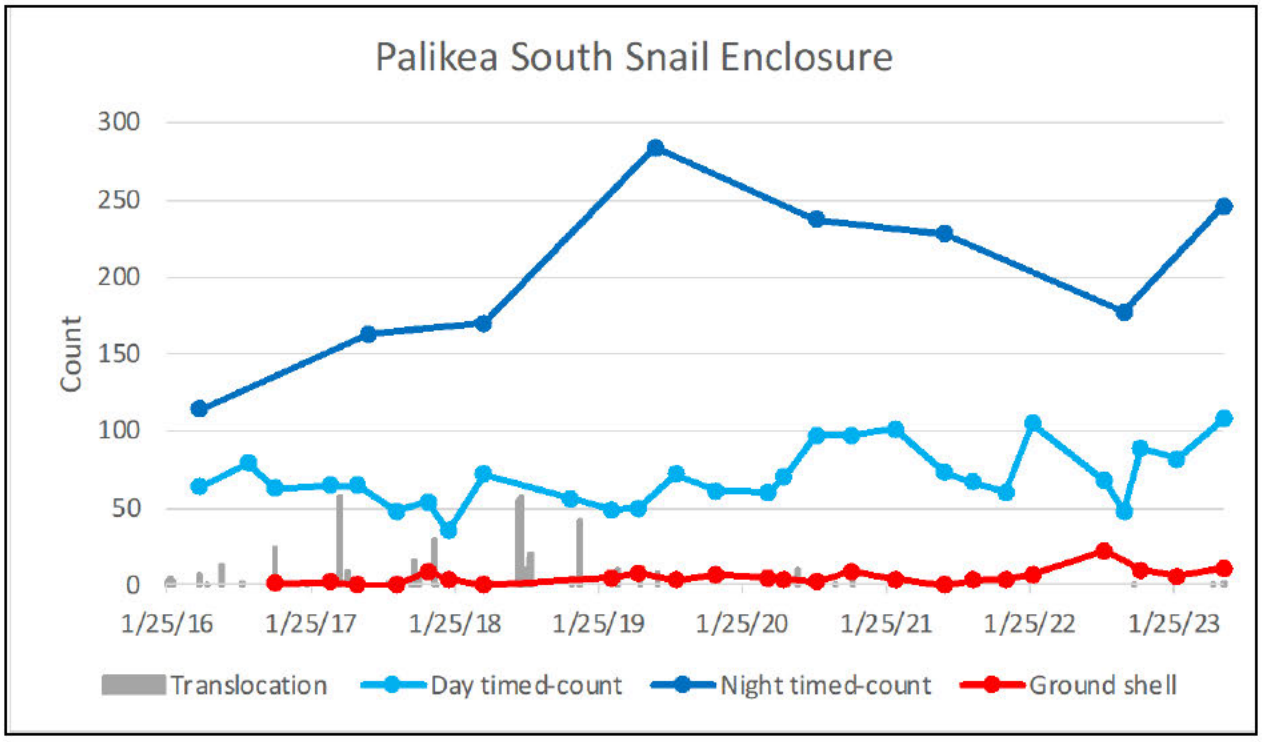

Figure 24: Quarterly and annual timed-counts and quarterly ground shell counts for *A. mustelina* in Palikea South snail enclosure from April 2016 to January 2023, with numbers of snails translocated into the enclosure over time. Note: Snail detection is much greater at night than during the day, and the entire enclosure is searched at night, but only subsampled in plots during the day.

Figure 25: Palikea South snail enclosure.

5.7.2 ESU-F Future Management

ANRPO will continue monitoring and managing snails at this ESU as described in Table 23. Small snail populations may still occasionally be found in the Palikea MU and will be translocated to the enclosure. Threat control will continue in the MU, including quarterly application of D-50, tracking tunnels for rats, and searches for rosy wolf snails and Jackson's chameleons focused in and around the snail enclosures. D-50 will be applied to the inside of the snail enclosure at any point when rodent incursions occur. 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 23: 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	All	Search two marked plots for all ground shells.
	TCM	Annual	All	Conduct night TCM across entire enclosure for 4 person-hours.

LITERATURE CITED

ANRPO. 2017. Chapter 5: *Achatinella* Species Management *in* 2017 Status Report for the Mākua and O‘ahu Implementation Plans.

ANRPO. 2019 Chapter 5: *Achatinella* Species Management *in* 2019 Status Report for the Mākua and O‘ahu Implementation Plans.

ANRPO. 2022. Appendix 5-1 Management Plan for the Translocation of *Achatinella mustelina* ESU-A at the Kahanahāiki Snail Enclosure, February 2022 *in* 2022 Status Report for the Mākua and O‘ahu Implementation Plans.

CHAPTER 6: RARE VERTEBRATE MANAGEMENT

The Army Natural Resources Program on Oʻahu (ANRPO) manages or monitors six vertebrate species, the Hawaiian Monarch Flycatcher (Oʻahu ʻElepaio), Hawaiian Stilt (Aeʻo), Hawaiian Coot (ʻAlae keʻokeʻo), and Hawaiian Gallinule (ʻAlaeʻula), Hawaiian Hoary Bat (ʻŌpeʻapeʻa) and Hawaiian Green Sea Turtle (Honu). Results of ANRPO management efforts for each of these species are presented below.

6.1 OIP OʻAHU ʻELEPAIO MANAGEMENT 2023

6.1.1 Background

In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the Oʻahu ʻElepaio (*Chasiempis ibidis*) endangered species status under the Federal Endangered Species Act and designated critical habitat on Oʻahu for the ʻElepaio 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 Oʻahu ʻElepaio 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, ʻĒkahanui Gulch in the Honouliuli Forest Reserve, Moanalua Valley, Pālehua (Gill Ewa Lands), Mākaha Valley (Board of Water Supply), 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 Waiʻanae Mountains. The new monitoring strategy currently focuses on surveys of Management Units (MUs) and drainages with suitable habitat throughout the Waiʻanae Mountains. The results of these ongoing surveys are compared to surveys conducted from 2004-2010 (VanderWerf *et al*. 2011) and will provide an updated population estimate for the species across the Waiʻanae range. These surveys will also be an indicator of the impact of decades of ANRPO management for Oʻahu ʻElepaio, as managed populations may act as sources for Oʻahu ʻElepaio dispersal elsewhere. In order to visit all areas surveyed from 2004-2010 at least once, 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, staff planned to continue with the monitoring study at ʻĒkahanui and Huliwai where ANRPO had collaborated with UH Mānoa graduate student, Nikki Preston. During the 2022 breeding season, a select group of Oʻahu ʻElepaio pairs were monitored to compare nesting success and nest-site characteristics between areas with rodent control and areas without. Unfortunately, ANRPO decided not to continue with this study and details on why this decision was made are summarized in this chapter.

Other monitoring did take place at SBW in gulches with territories benefiting from A24 trap lines. Monitoring at SBW had not been conducted since 2019 and it was encouraging to document an increase in the population. Staff also have been carefully monitoring the expansion of Oʻahu ʻElepaio at this site and other MUs, as some managed populations have been so successful that new territories are being established outside of protected areas. To facilitate this monitoring, we continue to capture Oʻahu ʻElepaio with mist-nets and mark birds with a standard aluminum band and a unique combination of three colored plastic bands. This is useful because it allows individual birds to be distinguished through binoculars and provides important information about the demography of the population, such as survival and movement of birds within and between years. It also makes it easier to distinguish birds from neighboring territories, yielding a more accurate population estimate. In most cases, Oʻahu ʻElepaio vocal

recordings were used to lure birds into a mist-net. Each bird was weighed, measured, inspected for molt, fat, overall health, and then released unharmed at the site of capture within 20 minutes.

ANRPO will continue to conduct rodent control for a minimum of 75 pairs at six management areas. To ensure territories with rodent control are benefitting O‘ahu ‘Elepaio, each year staff will confirm the presence of a pair in territories within managed areas.

This chapter summarizes the results of the O‘ahu ‘Elepaio surveys in the Wai‘anae Mountains thus far. Also included are the results of monitoring territories at SBW and the expansion of O‘ahu ‘Elepaio populations at specific management areas. 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

All O‘ahu ‘Elepaio populations benefited from another year of Goodnature auto-resetting (A24) trapping lines and grids within the territories to help reduce the threat of predation, primarily by introduced arboreal black rats (*Rattus rattus*). These traps are able to provide year-round protection from rodents and require rebaiting every four months. In SBW, rodent control was conducted with the use of A24 trap lines traversing through 30 territories in Mohiākea and Banana gulches. O‘ahu ‘Elepaio at Mākaha Sub Unit I, ‘Ēkahanui, Palikea, and Pālehua benefit from large-scale A24 trapping grids. In 2023, approximately 57 pairs were managed at ‘Ēkahanui, 12 pairs at Pālehua, nine pairs at Palikea, and six pairs at Mākaha. Difficult terrain and wide-spread territories at Moanalua Valley do not allow for the use of large-scale grids, so nine A24 traps are placed within each individual territory. Nine paired territories were managed via these smaller-scale trapping grids at Moanalua, the only ANRPO managed population in the Ko‘olau Mountains. In total, ANRPO provided rodent control for approximately 123 O‘ahu ‘Elepaio pairs in 2023.

Figure 1: An adult O‘ahu ‘Elepaio hard at work collecting nesting material in Moanalua Valley.

6.1.2.2 Surveys

The Oʻahu ʻElepaio surveys in the Waiʻanae Mountain range are almost complete. Only a handful of areas in the northwest region of the mountain range remain un-surveyed and are scheduled to be completed in late 2023. Last year, surveys were once again conducted between late summer and early winter so that they would not coincide with the breeding season when birds are less likely to be detected as they focus on nest building or feeding offspring. The majority of the surveys completed in the last year occurred in areas not included in the previous 2004-2010 surveys. These include drainages or gulches that make up the Mokulēʻia Forest Reserve. Also surveyed were two gulches in the Pahole Natural Area Reserve, as well as Kahanahāiki gulch. These are areas where ANRPO manages a variety of resources throughout the year, though no Oʻahu ʻElepaio are ever detected. Despite the amount of time staff spend in these gulches a thorough survey of the area for Oʻahu ʻElepaio was conducted. The results of the Waiʻanae Mountain range surveys thus far are displayed in Table 1, which lists the locations or drainages where surveys were completed from 2004-2010 by Eric VanderWerf and Steve Mosher, in comparison with recent surveys completed from 2016-2023 by Philip Taylor. It is important to note that this is still a partial list of locations surveyed in the past; as these locations are resurveyed, they will be added to Table 1. Also displayed in the table are the number of Oʻahu ʻElepaio 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 Oʻahu ʻElepaio in the surveyed drainages 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.

Figure 2: A juvenile Oʻahu ʻElepaio is captured using a mist-net.

Table 1: Comparison of surveys completed before 2010 and the latest surveys completed by ANRPO staff from 2016-present. Locations listed geographically from north to south. A "–" indicates that no survey was conducted.

O‘ahu ‘Elepaio Abundance in the Wai‘anae Mountains						
Location	No. of Pairs	No. of Single Males	Previous Survey	No. of Pairs	No. of Single Males	Latest Survey
Kahanahāiki Gulch	0	0	**2007**	0	0	**2023**
Pahole Gulch	0	0	**2009**	0	0	**2023**
Kapuna Gulch	0	0	**2009**	0	0	**2023**
Ka‘ala NAR	1	1	**2010**	0	0	**2022**
Mākua Valley	2	2	**2010**	3	1	**2022**
Makaleha West	–	–	–	0	0	**2022**
Makaleha Central	–	–	–	0	0	**2022**
Makaleha East	–	–	–	3	1	**2022**
Ka‘awa Gulch	–	–	–	4	1	**2022**
Kaumoku Nui Gulch	–	–	–	4	2	**2023**
Kaumoku Iki Gulch	–	–	–	3	0	**2022**
Manuwai Gulch	–	–	–	15	3	**2020**
Alaiheihe Gulch	–	–	–	8	4	**2022**
Kaimuhole Gulch	–	–	–	1	0	**2022**
Palikea Gulch	–	–	–	2	1	**2022**
Kihakapu Gulch	–	–	–	2	0	**2022**
Pū‘ulu Gulch	–	–	–	2	1	**2022**
Mākaha Valley	5	13	**2009**	13	9	**2021**
Wai‘anae Kai Forest Reserve	0	4	**2009**	0	0	**2022**
Schofield Pūle‘e	1	3	**2010**	16	2	**2020**
Schofield North Hale‘au‘au	12	1	**2010**	28	5	**2019**
Schofield Central Hale‘au‘au	15	11	**2010**	30	3	**2016**
Schofield South Hale‘au‘au	1	1	**2010**	7	0	**2020**
Schofield North Mohiākea	8	2	**2010**	13	0	**2020**
Schofield South Mohiākea	5	2	**2010**	30	1	**2020**
Wai‘eli Gulch	0	0	**2006**	0	0	**2021**
Kalua‘ā Gulch	1	5	**2006**	17	1	**2020**
Maunauna Gulch	0	0	**2006**	2	1	**2021**
Manawai‘elelū Gulch	0	1	**2006**	8	0	**2020**
Huliwai Gulch	0	5	**2006**	20	1	**2020**
‘Ēkahanui North	1	3	**2009**	27	2	**2021**
‘Ēkahanui Central+South	37	8	**2009**	59	2	**2019**
Pu‘u Maialau Gulch	0	0	**2006**	9	2	**2020**
Pōhākea Gulch	0	0	**2006**	4	1	**2020**
Puali‘i Gulch	0	1	**2006**	1	0	**2020**
Nāpepeiao‘ōlelo Gulch	0	0	**2006**	0	0	**2020**
Pālāwai Gulch (Palikea)	0	6	**2006**	13	1	**2020**
Ka‘aikukui Gulch	1	2	**2009**	6	1	**2020**
Manuwaika‘ale Gulch	1	1	**2010**	2	0	**2020**
Nāmo‘opuna Gulch	1	2	**2010**	0	0	**2020**
Kalo‘i Gulch (Pālehua)	15	4	**2010**	16	2	**2020**
Total	**107**	**78**		**368**	**48**	
Total Population	**292**			**784**		

Makaleha to Kaumoku Nui

Image Redacted
Sensitive Information
Available Upon Request

Figure 3: Map of Oʻahu ʻElepaio abundance and distribution at the Mokulēʻia Forest Reserve.

Makaleha, Kaʻawa, and Kaumoku Nui are a group of large drainages in the Mokulēʻia Forest Reserve in the northern Waiʻanae Mountains. Accessing suitable habitat where Oʻahu ʻElepaio prefer to establish territories is a challenge and surveys have not taken place until now. With the exception of Kaumoku Nui, each of these drainages were accessible from Kaʻala Road and required walking down to approximately 800 feet elevation. Two Makaleha drainages were already surveyed last year (2022). A survey of Makaleha West resulted in no Oʻahu ʻElepaio, while in the east fork of the Makaleha East drainage five birds were observed, including two pairs and one single male. This year, surveys resumed in Makaleha. No Oʻahu ʻElepaio were found in Makaleha Central. However, one pair was found in the west fork of Makaleha East. Less attractive habitat and a greater distance from the management unit at SBW likely contributed to the lack of birds in these drainages. Moving further east towards SBW the surveys had much better outcomes with four pairs and a single male found in Kaʻawa gulch. Four pairs and two single males were observed in Kaumoku Nui, a survey that involved an overnight camp trip and access via helicopter.

Kahanahāiki to Kapuna

Image Redacted
Sensitive Information
Available Upon Request

Figure 4: Map of surveyed area in 2023 at Kahanahāiki and Pahole NAR.

During the late 1990s, O‘ahu ‘Elepaio sightings were not uncommon in Kahanahāiki and Pahole NAR. ANRPO staff were even conducting rodent control for two pairs in Kahanahāiki gulch and knew of two additional single males. Not many years later observations started to decline and by 2007 O‘ahu ‘Elepaio had disappeared from these drainages. Despite over two decades of ANRPO staff working in this area managing a variety of other resources, no O‘ahu ‘Elepaio have been observed since. Recent surveys for O‘ahu ‘Elepaio also revealed no detections. This is not all that surprising, since a short distance away, no O‘ahu ‘Elepaio have been seen in Makaleha West either, and only recently have O‘ahu ‘Elepaio started to repopulate Mākua Valley. If the Mākua population continues to increase, aided by the installation of new rodent control grids, it would be expected that birds will disperse from the valley and reestablish territories in the northern Wai‘anae gulches.

6.1.2.3 Monitoring

During the 2022 breeding season, ANRPO partnered with UH Mānoa graduate student Nikki Preston (advisor Dr. Melissa Price) on a project to monitor and identify factors which influence Oʻahu ʻElepaio nesting success. The project compared nesting success and nest-site characteristics between areas with and without rodent control in ʻĒkahanui and Huliwai gulches (Honouliuli Forest Reserve). This was intended to be five-year field study to help identify management actions that are beneficial to the population growth and expansion of the species, which ANRPO intended to use in the planning and implementation of Oʻahu ʻElepaio recovery. A lot of effort went into monitoring at these remote sites on a weekly basis to ensure thorough observation of breeding activity at 37 territories over a period of seven months. Important data was collected and much was learned throughout this detailed study, but it was decided that the monitoring would end after one breeding season. With the UH Mānoa partnership only lasting for one field season and recognizing the amount of time, effort, and staff needed to continue the study, it was clear that ANRPO could not maintain the intensity of field work needed for the full comparative field study.

Figure 5: Colored leg bands allow staff to quickly identify Oʻahu ʻElepaio and track their movements in a MU.

In October and November 2022 ANRPO staff monitored Oʻahu ʻElepaio territories in areas with rodent control at SBW (Līhuʻe) in Mohiākea and Banana gulches . Detailed monitoring and surveys had not been conducted since 2019, when a total of 27 Oʻahu ʻElepaio pairs were found in both gulches. Access is often limited due to Army training, so staff do not monitor on a consistent basis. During monitoring conducted in 2022 staff found another three pairs with territories in the rodent controlled area, bringing the total number of managed pairs in SBW to 30. Staff also monitored the increase in the number of Oʻahu ʻElepaio establishing territories below the firebreak road and outside of rodent control areas. Since 2019 the number

of territories that are entirely outside of or have a portion of their territory east of the MU boundary has increased from two to ten territories. These territories often have significantly less desirable habitat (i.e.,grassy or bare ground with shorter canopy cover) than where Oʻahu ʻElepaio typically establish a territory. This suggests that the population at SBW is increasing and forcing Oʻahu ʻElepaio to establish territories outside of the MU because vacancies within it are no longer available. This is not the only MU where this increase has been observed. This year at ʻĒkahanui three new pair territories have been found ranging from 100 to 350 meters below the rodent trapping grid. Despite the lower quality of habitat and increased levels of threats by predators, all three pairs fledged offspring. Both of these observations at SBW and ʻĒkahanui are extremely encouraging and suggests a dramatic increase in the populations over a short period of time.

6.1.3 OIP Summary Terms and Conditions for Implementation

This section summarizes specific Biological Opinion requirements for Oʻahu ʻElepaio management, and current status of related actions.

Minimize direct impacts of military activities on survival and reproduction of Oʻahu ʻElepaio 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 Oʻahu ʻElepaio territories.*

[One fresh 155mm artillery projectile was identified above the firebreak road in November 2022]

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

[There was one fire in March 2023 that burned 1.82 acres above the fire break road at Puʻu Pane. No Oʻahu ʻElepaio critical habitat or territories were affected by this fire.]

3. *The Army will limit training actions in the forest above the fire break road at SBMR in the Oʻahu ʻElepaio 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 Oʻahu ʻElepaio that are killed is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaiʻi, 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, Hawaiʻi (telephone: 808/541-2681; fax: 808/541- 3062) for instructions on disposition*.

[No specimens were collected by ANRPO staff]

Minimize loss of Oʻahu ʻElepaio 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 Oʻahu ʻElepaio and Oʻahu ʻElepaio habitat at SBMR, SBER, and KLOA.

1. *The Army will report to the Service in writing annually the number of Oʻahu ʻElepaio 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 Oʻahu ʻElepaio 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 Oʻahu ʻElepaio and Oʻahu ʻElepaio 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 Oʻahu ʻElepaio and resulting in the loss suitable Oʻahu ʻElepaio habitat at SBMR. The feasibility of restoring critical habitat areas that have been lost also will be reassessed during this formal review.*

[Completed]

Figure 6: The adult Oʻahu ʻElepaio looks on as its two nestlings do their best to stay atop a deteriorating nest.

6.2 MIP O‘AHU ‘ELEPAIO MANAGEMENT 2023

6.2.1 Background

The initial Biological Opinion (BO) that triggered the development of the Mākua Implementation Plan (MIP) was issued in 1999 (USFWS 1999). At that time, the O‘ahu ‘Elepaio was not listed as an endangered species, but the 1999 BO did include recommendations related to O‘ahu ‘Elepaio. These included conducting complete surveys of the Mākua Action Area (AA) for O‘ahu Elepaio presence, monitoring of all known O‘ahu ‘Elepaio within Mākua Military Reservation (MMR) and installing and maintaining predator control grids around nesting pairs within MMR. In 2000, the USFWS granted the O‘ahu ‘Elepaio endangered species status under the Federal Endangered Species Act and in 2001 designated critical habitat on O‘ahu for the O‘ahu ‘Elepaio. In the *Supplement to the Biological Opinion and Conference Opinion for Proposed Critical Habitat for Routine Military Training at Mākua 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 Mākua AA for plants and O‘ahu ‘Elepaio. This BO outlined additional requirements related to this critical habitat. The most recent BO issued in 2007 required the protection of all O‘ahu ‘Elepaio pairs within the Mākua AA. A term and condition in this 2007 BO was to construct ungulate-proof fencing around Mākua Military Reservation and control rodents using aerially broadcast rodenticide when authorized.

Figure 7: A total of eight O‘ahu ‘Elepaio have been found in the back of Mākua Valley, with three pairs now benefiting from A24 rodent control grids.

Mākua

Image Redacted
Sensitive Information
Available Upon Request

Figure 8: Map of updated (2023) O‘ahu ‘Elepaio abundance and distribution at Mākua Valley.

6.2.2 MIP Management Actions 2023

This past year ANRPO accessed Mākua Valley twice in an effort to monitor the growing O‘ahu ‘Elepaio population and complete an assortment of other management actions. During a two-night camping trip in November 2022 a third A24 trapping grid consisting of nine traps was installed in a paired territory that was discovered after the first two grids were installed during a prior trip the valley. All gulches in the back of the valley were also surveyed for new O‘ahu ‘Elepaio, but no new birds were found. Staff returned for a second camping trip in June 2023 and while surveying the gulches a juvenile male was found. This is the second known single male in Mākua. These two males along with three pairs brings the current population up to eight O‘ahu ‘Elepaio. During this second trip staff also monitored for successful breeding, though no nests or fledglings were found within the paired territories. Now that Mākua Valley is more accessible than in past years due to the removal of hazardous UXO, ANRPO plans to increase monitoring efforts during the O‘ahu ‘Elepaio breeding season. This will be beneficial for monitoring breeding success, tracking changes in the population, and identifying threats within the territories.

6.3 FEDERALLY LISTED WATERBIRD MANAGEMENT 2023

6.3.1 Background and Management Summary

During periods of heavy rainfall, Dillingham Military Reservation (DMR) has the potential for flooding within a grass meadow in the P1 training area. This transformation from open grassy field to ephemeral pond attracts three species of federally listed waterbirds that include the Hawaiian Stilt *(Himantopus mexicanus knudseni)* or Aeʻo, Hawaiian Coot *(Fulica alai*) or ʻAlae keʻokeʻo, and Hawaiian Gallinule *(Gallinula chloropus sandvicensis)* or ʻAlaeʻula. 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 Āliamanu 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. This past year no significant flooding occurred at DMR and there were no incidental observations reported to or made by ANRPO staff from any other location.

Figure 9: An adult Hawaiian Gallinule at DMR in early 2022.

6.4 HAWAIIAN GREEN SEA TURTLE MANAGEMENT 2023

6.4.1 Background and Management Summary

The green sea turtle (*Chelonia mydas*) population in Hawai‘i has been listed as threatened under the Federal Endangered Species Act since 1978. Critical habitat has not yet been designated; however, the USFWS has proposed designating critical habitat units on O‘ahu for increased protection of the species. The Army owns land at both the Dillingham Military Reservation (DMR) and Mākua Military Reservation (MMR), where there are suitable sandy beaches for nesting. Training does not occur along the shoreline or on the beach at either DMR or MMR. Green sea turtle nesting typically occurs between 15 May to 30 September. Reported sightings of green sea turtle nesting along the beaches near DMR and in MMR are very limited. The most recent nesting attempts include one confirmed nest found on Mākua Beach in 2021 and another at Dillingham Beach in 2022, though it turned out to be a ‘false crawl’ (tracks and excavations observed, but no eggs laid). Most recently, a nest was found at Dillingham beach in July 2023. It is still not known whether eggs were laid at this year’s nest or if it is another ‘false crawl’.

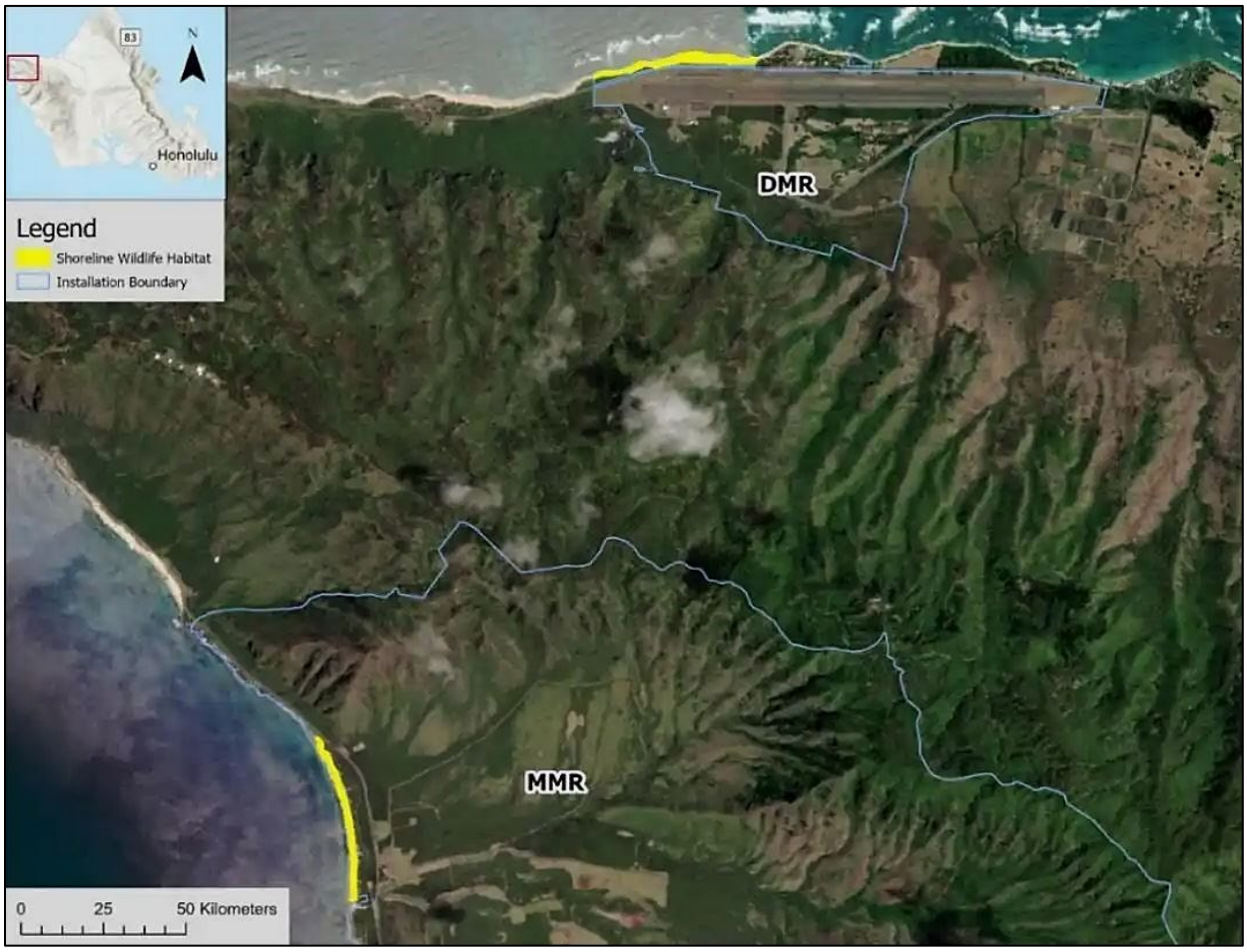

Figure 10: Map of DMR and MMR relative to Shoreline Wildlife Habitat on O‘ahu.

The following natural resources management activities are conducted at DMR and MMR:

- Installation of barricades at DMR to protect coastal habitat from the destructive effects of off-road vehicles.
- Installation of educational signs at DMR that inform beachgoers on ways they can minimize their impacts to native wildlife and plants.
- Lighting surveys to ensure there is no threat of hatchling confusion from bright lights.
- Biannual beach cleanups at DMR to help reduce entanglement and entrapment hazards for nesting adults and emerging hatchlings, and attraction of predators to the area. This year, beach cleanups were conducted by Sustainable Coastlines in May, ANRPO in August, and 808 Cleanups in September.
- Military Police presence to deter and minimize inappropriate use of the coastal area. A DPW conservation law enforcement officer is also being proposed to assist police efforts.
- The Army's collaboration with USFWS and Mālama i nā honu enhances surveys, monitoring, and overall protection of green sea turtle nests. Information gathered assists USFWS and National Oceanic and Atmospheric Administration (NOAA) in assessing species status.

Figure 11: Hawaiian green sea turtle tracks leading to a suspected nest at Dillingham beach.

6.5 ʻŌPEʻAPEʻA MANAGEMENT 2023

6.5.1 Background

ANRPO originally conducted acoustic monitoring for the Hawaiian Hoary bat (*Lasiurus cinereus semotus*) or ʻŌpeʻapeʻa from 2010 to 2013 on all Oʻahu 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 over 301 nights in order to establish bat presence or absence and, if possible, document potential seasonal use of habitats by ʻŌpeʻapeʻa. Acoustic monitoring confirmed the presence of ʻŌpeʻapeʻa on all Oʻahu 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 Oʻahu are much lower than from data collected on Hawaiʻi, Maui and Kauaʻi islands (C. Pinzari pers. comm.).

6.5.2 ʻŌpeʻapeʻa Management Summary

The Army continues to abide by a tree cutting moratorium of any tree over 15 feet tall during the ʻŌpeʻapeʻa 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 2023 pupping season there were 20 requests for bat pup surveys. One was conducted by ANRPO staff and 19 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. ANRPO continued to employ a combination of acoustic monitoring (Echo meter Touch) and thermal imager (Fluke Ti400) surveys to determine if bats were utilizing the trees for roosting and if pups were present. Both the contractor and ANRPO staff recorded whether any other wildlife was observed during the surveys. Table 2 shows the results of the 20 surveys conducted by both ANRPO and the contractor. All totaled, approximately 11 hours were spent conducting these surveys (not including transportation time) in 71 trees. No bats were observed during these surveys.

The ʻŌpeʻapeʻa Acoustic/Thermal Survey summary table below shows the total number of roosting bat surveys throughout the 2023 pupping season. From the left, column 1 shows the date of each survey. Column 2 lists the surveyor, either ANRPO (staff initials) or Tree Solutions and Environmental Consulting Services (TSECS). Column 3 is the type of survey. Column 4 shows the time of the survey. Columns 5 and 6 show whether there were any detections, bat or other wildlife. Column 7 lists the Army installation: Fort Shafter Military Reservation (FSMR), Schofield Barracks Military Reservation (SBMR), and Wheeler Army Airfield (WAAF). Finally, columns 8-20 present the different species of trees that were surveyed.

Table 2: 2023 ʻŌpeʻapeʻa 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	*Arucaria columnaris*	*Cassia fistula*	*Cocos nucifera*	*Enterolobium cyclocarpum*	*Ficus microcarpa*	*Fraxinus uhdei*	*Melaleuca quinquenervia*	*Peltophorum pterocarpum*	*Pithecellobium saman*	*Pterocarpus indicus*	*Roystonea regia*	*Schefflera actinophylla*	*Senna saimea*
14-Jun	TSECS	Thermal	05:45-06:00	No	Yes	SBMR									1				
20-Jun	TSECS	Thermal	05:45-06:00	No	Yes	SBMR									1				
26-Jun	TSECS	Thermal	05:35-06:00	No	Yes	FSMR			6										
29-Jun	TSECS	Thermal	05:40-06:00	No	No	WAAF			2								3		
13-Jul	TSECS	Thermal	05:00-05:20	No	Yes	FSMR												1	
14-Jul	TSECS	Thermal	0540:-06:10	No	Yes	SBMR									4				
19-Jul	TSECS	Thermal	05:40-06:20	No	Yes	FSMR		1					5	4	1	2			
24-Jul	TSECS	Thermal	05:30-06:10	No	Yes	FSMR		1					5	4	1	2			
25-Jul	TSECS	Thermal	06:00-06:30	No	Yes	FSMR									4				
26-Jul	TSECS	Thermal	06:00-07:00	No	Yes	FSMR				3	2								
27-Jul	TSECS	Thermal	06:00-07:00	No	Yes	FSMR				1	1				1				
2-Aug	TSECS	Thermal	06:00-06:30	No	Yes	FSMR									1				
3-Aug	TSECS	Thermal	06:00-06:30	No	Yes	FSMR									1				
8-Aug	TSECS	Thermal	04:45-06:00	No	Yes	SBMR				3	1								
11-Aug	TSECS	Thermal	06:00-06:10	No	No	FSMR												1	
21-Aug	TSECS	Thermal	06:00-06:30	No	Yes	WAAF						2							

Table 2 (continued).

Date	Surveyor	Thermal or Acoustic Survey	Time	Bat Detected (T/A)	Wildlife Detected	Army Installation	Arucaria columnaris	Cassia fistula	Cocos nucifera	Enterolobium cyclocarpum	Ficus microcarpa	Fraxinus uhdei	Melaleuca quinquenervia	Peltophorum pterocarpum	Pithecellobium saman	Pterocarpus indicus	Roystonea regia	Schefflera actinophylla	Senna saimea
24-Aug	TSECS	Thermal	06:00-06:30	No	Yes	FSMR									1				
27-Aug	PT	Both	05:10-05:50	No	Yes	WAAF													3
9-Sep	TSECS	Thermal	06:00-06:30	No	No	SBMR									1				
6-Sep	TSECS	Thermal	06:00-06:30	No	No	WAAF	1												

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CHAPTER 7: RARE INSECT MANAGEMENT

This chapter covers management of the four endangered insects known from Army lands on O‘ahu: the pomace flies *Drosophila montgomeryi*, *D. obatai*, and *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.

7.1 *MEGALAGRION XANTHOMELAS*

7.1.1 Background/ Overview

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 freshwater bodies. After the last collection from springs around Pearl Harbor in 1977, it was thought to be extirpated from O‘ahu. In 1995, it was rediscovered on the grounds of Tripler Army Medical Center (TAMC). The population is now maintained using 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, when Division of Forestry and Wildlife (DOFAW) took over monitoring; 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 stayed relatively stable, though the number of individuals observed fluctuated 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 remained low. Most of the adults observed during that period were captive reared, and as releases of adults ceased and this cohort senesced, observations of adult *Megalagrion* again declined.

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), and Waimea Botanical Garden (2012), but all failed for various reasons. In 2016, the state 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. New translocation efforts using these insectary reared damselflies resumed at Lyon Arboretum (2019), Wai‘anae Kai Forest Reserve (2019), and again at DMR (2020). Among these, DMR is the only site that has had a modicum of success.

During the 2021-2022 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 make the threat level of this Cnidarian unclear. Regardless, all staff working in and around TAMC should practice decontamination of footwear to prevent spread of this, or other potentially detrimental invertebrate species into *Megalagrion* habitat. Thus far no *Hydra* have been detected at DMR stream, despite surveying for them.

In this last reporting period *Megalagrion xanthomelas* at Tripler, observations declined in another apparent population crash. On April 11th 2023 the last *Megalagrion* was seen at Tripler at the cooling plant ditch. Prior to this, observations were never higher than 10 individuals seen at a time since August

2022. This is an extremely alarming development as this was the last remaining wild population of *Megalagrion xanthomelas* on O‘ahu. In addition, apart from the individuals being reared by the DOFAW Insectary, the damselflies reintroduced at DMR are currently the only known *Megalagrion xanthomelas* to be extant on O‘ahu.

7.1.2 Tripler Army Medical Center

7.1.2.1 Release and Monitoring

DOFAW continues to rear and release *M. xanthomelas*, with assistance from ANRPO; DOFAW also continues to monitor the population at 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. Mating and oviposition were observed during the initial release, and wild-emerged damselflies were observed approximately three to four months later.

Nearly all of the wild damselflies seen at TAMC in the previous reporting period were observed at the drainage ditch around the cooling plant 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. This past year saw a water main break above the cooling plant at TAMC. The resulting runoff from this event filled the ditch with soil, rocks, and other debris thus rendering this area inhospitable for *Megalagrion*. No *M. xanthomelas* have been observed at the cooling plant ditch since this event. A contract through DPW is currently being finalized that will have outside contractors remove the debris from the ditch and to clear the ditch if similar events happen in the future.

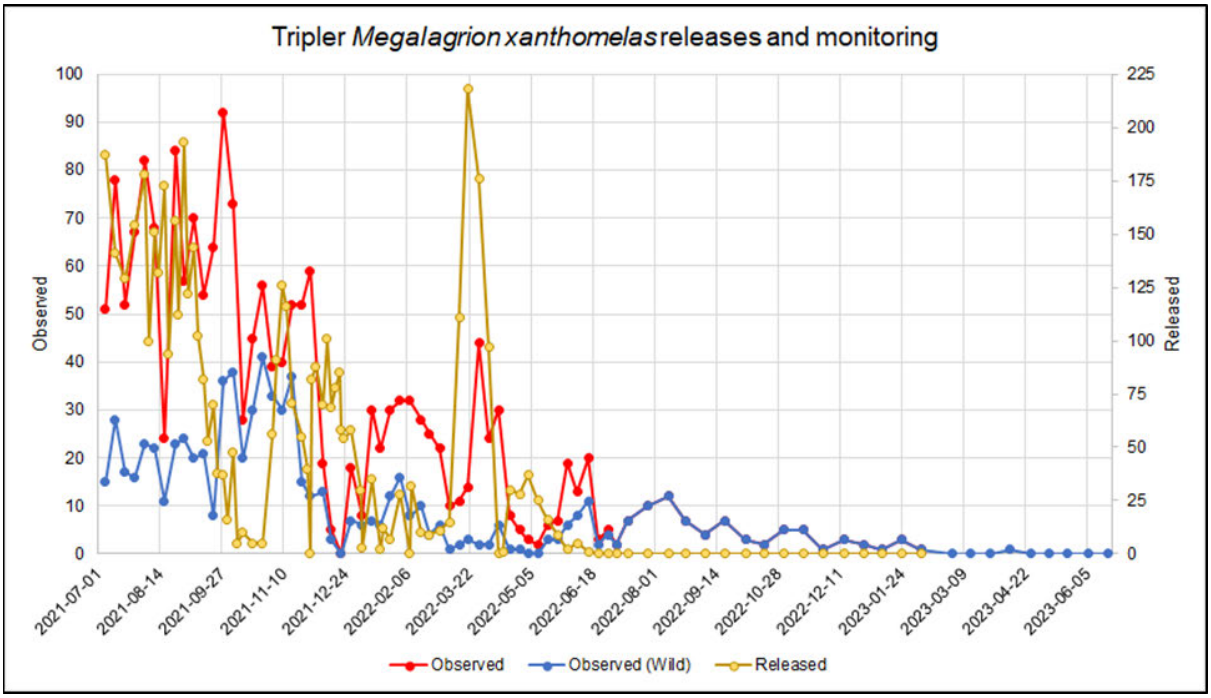

Figure 1: Graph of *Megalagrion xanthomelas* releases and observations at Tripler Army Medical Center from July 2021 through the end of 2022-2023. Note that releases are on a different y axis.

At TAMC, no damselflies were released between July 2022 and the end of June 2023. Previous releases began in March 2021 through June 2022, but then stopped in order to focus on the DMR site and to see if the wild population would recover naturally.

Monitoring at TAMC (Figure 1) during this reporting period saw a sudden absence of *M. xanthomelas* observations beginning in April 2023. Though this sudden absence may be attributed to many factors, it brings into question the future of management of *M. xanthomelas* at this site. The location is urban and adjacent to infrastructure such as the cooling plant for TAMC, and housing. The site should be thought of more as a holdout due to absence of specific threats such as fish, than as ideal habitat for *Megalagrion.* The future of this site should be discussed as the species may benefit more from work elsewhere than indefinite artificial maintenance of the population via reintroduction.

eDNA (Environmental DNA) sampling is currently planned for this fall at TAMC as well as DMR in order to better understand the invertebrate communities at both sites. This sampling will be conducted in coordination with DOFAW, the Strategic Environmental Research and Development Program (SERDP) researchers Rosemary Gillespie, George Roderick, Natalie Graham. Water will be taken from both streams and analyzed to determine the composition of the invertebrate community within both streams. This sampling will allow ANRPO to better understand not only the species of possible predators of *Megalagrion* present, but their abundance as well. This information will allow for a better understanding of all possible predators at the site. The presence of *Megalagrion* eDNA within TAMC stream may also point to an extremely low density yet persisting population of *Megalagrion* there.

In 2022 Pūlama Lānaʻi and NFWF (National Fish and Wildlife Foundation) were awarded funding from the DOD's Readiness and Environmental Protection Integration (REPI) program that included a project to reestablish *Megalagrion xanthomelas* in an artificial setting on the Island of Lānaʻi. Oʻahu stock will be used in the genetic mix that is reintroduced to Lānaʻi. Given the current situation at TAMC, this would help to ensure the genetic security of Oʻahu's *M. xanthomelas.*

7.1.2.2 Management Actions

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. Invasive trees were removed at two different areas, each around 10m circular in area, along the stream in the fall of 2022. Subsequent monitoring saw observations of *M. xanthomelas* at the newly cleared sites, however, the population declined further and made the effects of clearing difficult to assess.

7.1.3 Dillingham Military Reserve

7.1.3.1 Release and Monitoring

DOFAW continues to rear and release *M. xanthomelas*, with assistance from ANRPO; DOFAW also continues to monitor the population at DMR. 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. Mating and oviposition were observed during the initial release, and wild-emerged damselflies were observed approximately three to four months later.

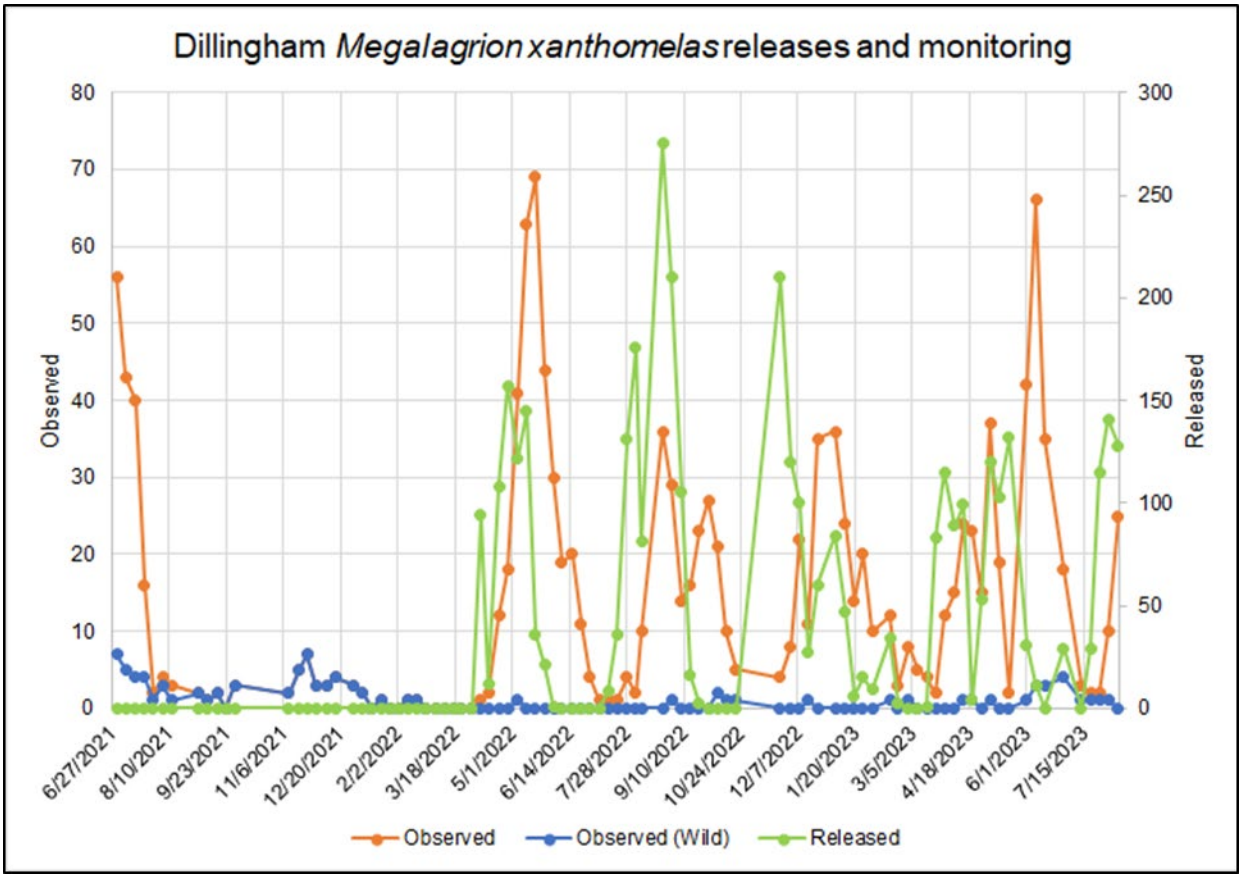

Figure 2: Graph of *Megalagrion xanthomelas* releases and observations at Dillingham Military Reservation from June 2021 through the end of 2022–23. Note that releases are on a different y axis.

At DMR, DOFAW began releases of adult *M. xanthomelas* in June 2020. Releases paused in June 2021 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 July 7, 2022 and June 29, 2023. A total of 2,624 adults

were released over this period. Numbers of observed wild individuals remained low during this period, however, wild born females were observed mating and ovipositing in the area of the ponds.

Based on the numbers of wild individuals seen, the *M. xanthomelas* population at DMR (Figure 2) appears to be persisting, but at very low levels which continues to leave the population susceptible to stochastic events. The crash this year at TAMC has spurred a new discussion on the future of management of *Megalagrion* at the site and whether further releases at the site are warranted. Given the different challenges at TAMC including *Hydra vulgaris*, water issues, and degraded habitat it may be prudent to focus on DMR, or another more favorable site.

7.1.3.2 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 water flow, the pools quickly filled in, and the outplantings 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 outplanted *Bacopa monnieri* has thrived providing stable breeding habitat for *Megalagrion xanthomelas*.

During this reporting period, another two ponds were constructed by ANRPO and DOFAW within the fence. Since then, the new ponds have been colonized by aquatic vegetation and *Megalagrion* have been observed ovipositing in the new habitat. The addition of these ponds should allow a higher carrying capacity and hopefully higher observations of individuals in the future.

Further canopy clearing along the stream is planned for the fall of 2023. A good proportion of *Megalagrion* observations at DMR occur in sunny, open habitat. Much of the stream above the ponds ranges from partial to deep shade with close canopy of non-native trees. The clearing of canopy along the stream will provide more favorable conditions for adult *Megalagrion* and hopefully more oviposition and naiads.

7.2 *DROSOPHILA* MANAGEMENT

7.2.1 BACKGROUND AND HIGHLIGHTS

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 Oʻahu, 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 2023 saw a general increase in most common and rare species with the expected population spikes in spring.

This year saw some positive trends with *Drosophila* observations. Central Kaluaʻā continues to be the site with the most observations of *D. montgomeryi*. Puʻu Hāpapa had the most observations of *D. montgomeryi* since 2019. North Kaluaʻā also saw the first observation of *D. montgomeryi* since 2021. *Drosophila substenoptera* monitoring at Palikea shows low but consistently observed numbers. *Drosophila obatai* was observed in Manuwai for the first time since early 2021.

7.2.2 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 Kaluaʻā 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 ANRPO decided to change monitoring to a quarterly interval. For *D. montgomeryi*, Puali‘i (designated as a management site for *D. montgomeryi*) and Waiʻanae Kai (historically the largest population but unmanaged) were designated to be monitored quarterly. However, due to apparent loss of the population at Puali‘i, decline of the host plant, and higher priorities elsewhere, there has been no monitoring since 2017 and no other actions were taken there. Waiʻanae Kai has seen similar host plants declines as Puali‘i, and has seen a dramatic decrease in *D. montgomeryi* at the site. Other known populations (Kaʻala and ʻŌpaeʻula Lower for *D. substenoptera*, Līhuʻe and Manuwai for *D. obatai*) are visited periodically through the year, typically quarterly or less. New populations of endangered *Drosophila* were opportunistically 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.

7.2.3 *DROSOPHILA MONTGOMERYI*

Drosophila montgomeryi is a small yellow-brown species that breeds in rotting bark of *Urera kaalae* and *Touchardia oahuensis (=Urera glabra)* (Ōpuhe). While *T. oahuensis* occurs widely across the Waiʻanae range, it often occurs as scattered clumps of one or a few individuals, unsuited for survival of *D. montgomeryi* and probably not viable for long-term survival of this dioecious, wind-pollinated tree. *Urera kaalae* is critically endangered and only a handful of wild plants remain, although several hundred were outplanted. The Division of Forestry and Wildlife (DOFAW) and Oʻahu Plant Extinction Prevention Program (OPEPP) have planted ~1500 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 Waiʻanae Mountains. Kaluaʻā (all three sites collectively), ʻĒkahanui, and Palikea were designated as Manage for Stability (MFS) PUs (Table 1).

7.2.3.1 Population Status

Table 1: Survey effort for *D. montgomeryi* across all potential sites in the 2022–23 and 2021-2022 reporting periods, in survey days. "Max No." is the highest number of flies observed in a single day. The three populations of *D. montgomeryi* in Kalua'ā and Wai'eli are comprised of Kalua'ā – Central, Kalua'ā – North, and Pu'u Hāpapa.

Site	Days	Max No. 22-23	Max No. 21-22
Kalua'ā - Central	14	14	18
Kalua'ā - North	13	1	0
Pu'u Hāpapa	15	12	5
Palikea	14	0	0
Wai'anae Kai	6	4	9
'Ēkahanui	1	0	0

Kalua'ā and Wai'eli MU (MFS)

Three sites in this MU –Pu'u Hāpapa, North Kalua'ā, and Central Kalua'ā (Figure 3) – were monitored monthly between June 2013 and August 2022 (though not every site was visited each month) over a total of 289 survey days.

Image Redacted
Sensitive Information
Available Upon Request

Figure 3: Distribution of *Drosophila montgomeryi* observations in the 2022–23 reporting year and earlier records from 2013-2021.

This site has had a quarterly monitoring interval since summer 2022. 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. 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 Niño weather pattern 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 2022-2023 observations of *D. montgomeryi* were fairly positive (Figure 4), possibly due in part to the wet season lasting through May. Central Kalua‘ā continues to be the site with the most observations of *D. montgomeryi,* with 14 observed as this year’s peak. Twelve individuals were observed at Pu‘u Hāpapa, the most since 2019. One fly was observed in North Kalua‘ā, the first observation of *D. montgomeryi* in two years.

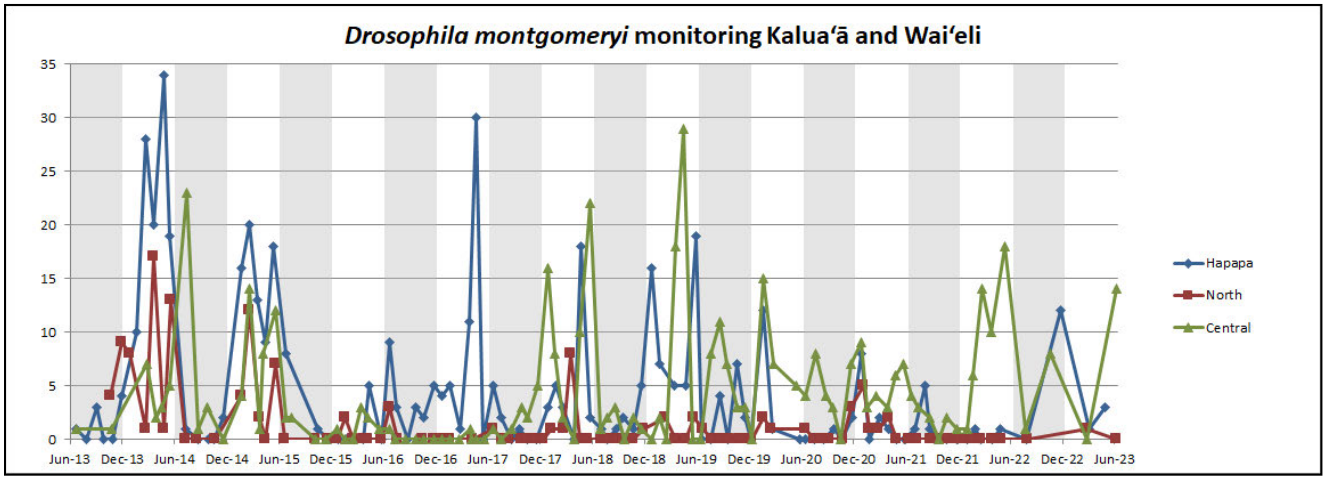

Figure 4: *Drosophila montgomeryi* numbers during monthly (2013-2022), and quarterly (2022-present) monitoring at three sites in Kalua‘ā PU (Pu‘u Hāpapa, North Kalua‘ā, and Central Kalua‘ā). Y axis is the maximum number observed across the entire site on the survey day (see Survey Methods, section 7.1.2). 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, *T. oahuensis* has increased naturally as weed control reduced alien cover, and outplanting has significantly boosted the *Touchardia* and *Urera* populations. Outplanted *T. oahuensis* here have done exceptionally well – after six years, many of them are large sprawling trees 8–10 feet tall. Continuous treefalls of *Schinus terebinthefolia* and other larger trees have damaged some *Urera* and slowed growth, but also provide breeding material for *D. montgomeryi*. *Urera kaalae* were also planted here by DOFAW/OPEPP, and are thriving. Still, ten of the 13 records here have been of single individuals, indicating that the *D. montgomeryi* population remains very low. In the 2022-2023 reporting period no *D. montgomeryi* were seen in Palikea, despite the increases in habitat for *D. montgomeryi*. With the advances in lab rearing *Drosophila*, it may be possible to reintroduce *D. montgomeryi* into the improving habitat in Palikea in the future.

Puali‘i (No Management) and ‘Ēkahanui (MFS)

Puali‘i was surveyed 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 Puali‘i Gulch had recently fallen and the decaying trunk was supporting a large number of *D. montgomeryi*. Unfortunately, the fly has not been seen since the second visit there 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 *T. oahuensis* elsewhere in the gulch have not survived or have failed to thrive. ‘Ēkahanui in contrast has hundreds of *Urera* reintroductions that are doing well in part due to slug control, and a large rodent control grid. Therefore, ANRPO designated ‘Ēkahanui as the third MFS site instead of Puali‘i, and focuses efforts on habitat restoration there in anticipation of a future *Drosophila* reintroduction in October 2023. ‘Ēkahanui formerly had the largest population of *D. montgomeryi* during early surveys in the 1970s. There are some small patches of *T. oahuensis* 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.

Wai‘anae Kai (No Management)

The largest known population of *D. montgomeryi* historically occurred in the northeastern sub gulches of Kūmaipō stream, Wai‘anae Valley. Four sites have been discovered so far, all at the base of Mt. Ka‘ala and consisting of small patches totaling ~0.5 ha in area, 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, subsequent weed invasion, and death of host plants. The site was visited six times in the 2022–2023 period with ten flies being observed. The population seems to be trending drastically lower in the past couple years with no more than ten individual flies seen in a day since early 2021 compared to over 50 individuals seen on a day in 2019.

7.2.3.2 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, which is in addition to existing ungulate and weed control at management sites. These are reviewed below, in addition to previous work on outplanting *Urera* and *Touchardia*.

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 Kalua‘ā 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 2023 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 ‘Ēkahanui, no ant control is currently conducted. If *D. montgomeryi* are found in ‘Ēkahanui, ant control will be reevaluated.

Slug Control

Slugs are known to be destructive herbivores on *Urera* and *Touchardia* 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 Ferroxx®AQ when *T. oahuensis* begins fruiting. For the coming year this will probably be limited to North Kalua‘ā since several trees there fruit prolifically. Nighttime surveys for *Achatinella* snails were conducted in North and Central Kalua‘ā recently with none found. Pu‘u Hāpapa is known to have snails outside the predator-free enclosure so there are no plans to bait there.

Outplanting

Most outplantings of host taxa to date are in currently known *D. montgomeryi* habitat and should mean an improvement in habitat for the flies when the trees mature. At Pu‘u Hāpapa specifically, the *Urera kaalae* and *Touchardia oahuensis* along with other common natives should improve the habitat following the clearing of non-native canopy and drying that has taken place over the past years. In addition to ANRPO’s outplanting program, the DOFAW/PEPP planted 2500 *U. kaalae* in the last three years. In 2021-2023 OPEPP planted groups of hundreds of plants in Kalua‘ā/ Hāpapa ,‘Ēkahanui, Pahole, Palikea and Mākaha. ANRPO plans to establish small plantings of *T. oahuensis* to 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 *Drosophila* monitoring techniques. Thus far, frozen *Cyanea* stems have been placed at a *Drosophila hemipeza* reintroduction site in ‘Ēkahanui. They were brought to Kelli Konicek’s *Drosophila* rearing chamber at the University of Hawai‘i at Mānoa after several weeks, and subsequently had several species of picture-wing flies emerge including the endangered *D. hemipeza*. This is a very positive initial result of this possible management action, though we expect to see similar results with *Drosophila montgomeryi*.

7.2.4 *DROSOPHILA SUBSTENOPTERA*

7.2.4.1 Population Status

Based on collection records, *D. substenoptera* requires moderately tall, non-boggy wet forest with its host plants, *Cheirodendron* spp. (‘Ōlapa) and *Polyscias* (formerly *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 O‘ahu 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.

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Figure 5: Distribution of *Drosophila substenoptera* observations in the 2022–23 reporting year and earlier records from 2013–21. Pentagons represent new sites surveyed in 2022-2023.

Currently, there are three PUs for *D. substenoptera* – Palikea, Kaʻala-Kalena, and ʻŌpaeʻula Lower (Figure 5), and all are considered MFS. PU trends are only graphed for Palikea; the other two PUs are only occasionally monitored and *D. substenoptera* (Figure 6) are 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*.

Table 2: Survey effort for *D. substenoptera* and number of flies found across all potential sites in the 2022-2023 reporting period, in survey days. "Max No." is the highest number of flies observed in a single day.

Site	Days	Max No.
Palikea	5	4
Kaʻala	5	0
Kaluanui	1	0
ʻŌpaeʻula Lower	2	0

Waiʻanae Range (Palikea and Kaʻala-Kalena PUs)

Monthly monitoring in the northern portion of Palikea MU was conducted between May 2013 (105 survey days total, 5 in the current reporting period; (Table 2). Quarterly monitoring is now being conducted at this site. Aside from a large flush in late May 2013, numbers of *D. substenoptera* (Figure 6) 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*, occurred in May and June 2020 and continued moderately high numbers since then were not echoed in a corresponding increase in either *D. substenoptera* (Figure 7) or *D. hemipeza* during this time. 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. In the 2022-2023 period all four species saw a similar decreases in observations at the same time, giving further credence to this hypothesis.

Figure 6: *Drosophila substenoptera* (right) next to non-native *Drosophila* at Palikea MU.

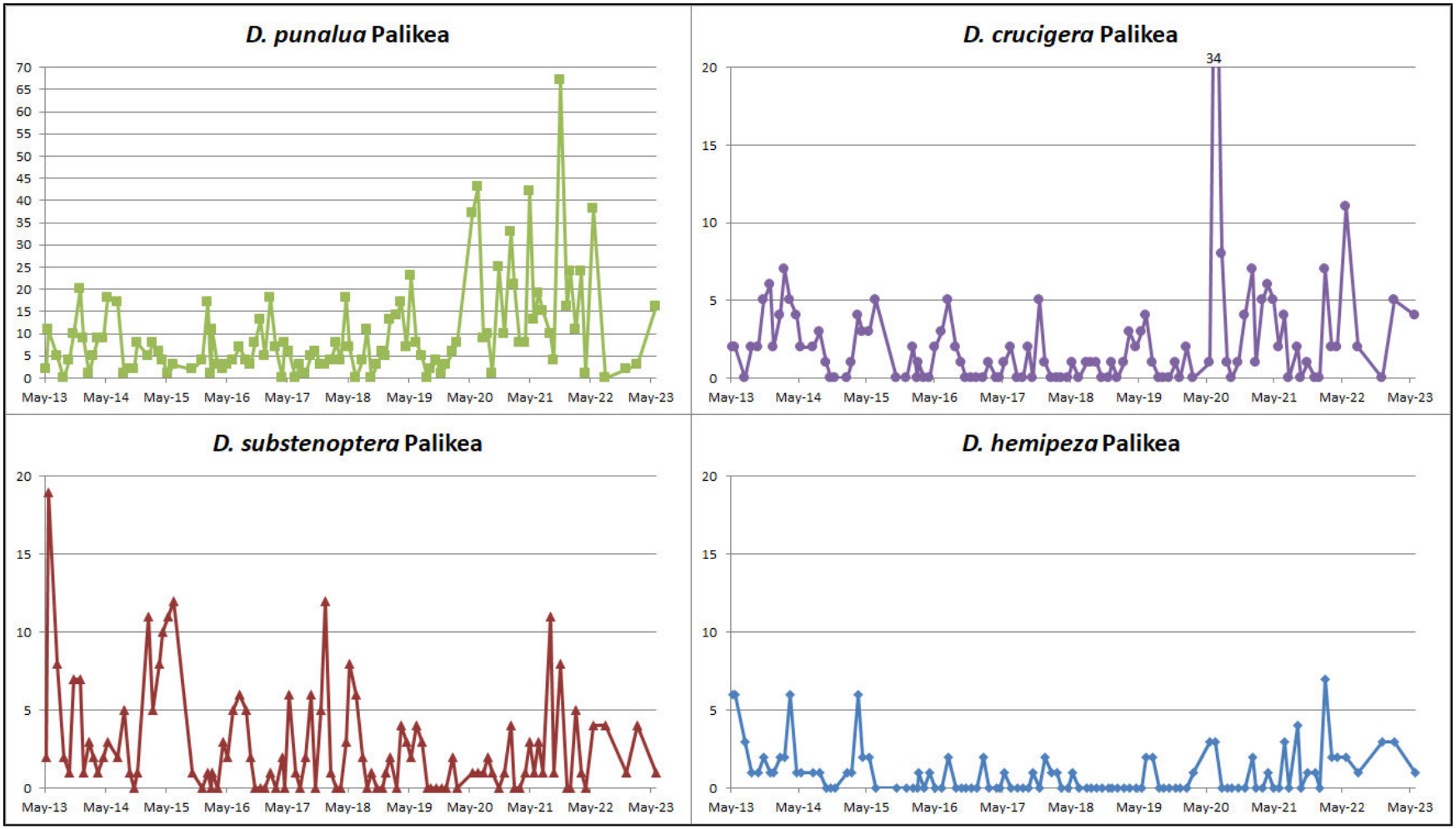

Figure 7: Monitoring results for two common (above) and two endangered (below) picture-wing *Drosophila* species at Palikea, from May 2013 through June 2023. *Note D. punalua* are on a different scale.

In the past year, there have been less *D. substenoptera* observed in Palikea with a maximum number of four flies seen in a day. No flies have been observed on Kaʻala in this period, though surveys are ongoing to identify new potential *D. substenoptera* sites around Kaʻala and in the Koʻolau Mountains (Figure 8).

Koʻolau Range

In December 2013, a single *D. substenoptera* was observed at ʻŌpaeʻula Lower MU, the first record of the species in the Koʻolau range since 1972. In early 2015, it was sighted again in the same area. Historically, *D. substenoptera* was more widespread and abundant in the Koʻolau mountains than in the Waiʻanae range. However, surveying effort has been limited due to the difficulty in accessing areas of intact habitat for this species. ANRPO survey trips in the Koʻolau mountains are 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 Koʻolau mountains. Finding additional Koʻolau populations is a high priority for this species; Helemano, Poamoho, and Kaukonahua have not been surveyed yet. ʻŌpaeʻula Lower and Koloa will continue to be checked given the extremely high quality of habitat there and low observation rate at sites elsewhere that *D. substenoptera* is known to be present. In the 2022-2023 reporting period only one monitoring day occurred at Koloa, with no *D. substenoptera* observed.

7.2.5 *DROSOPHILA OBATAI*

7.2.5.1 Population Status

Drosophila obatai was rediscovered in Manuwai MU in 2011, 40 years after the previous record in 1971. Historically it was known from East Makaleha, several gulches in Lower Kaʻala NAR, and the southeastern Koʻolau range around Wailupe Valley. It breeds in rotting stems of *Dracaena* (formerly *Chrysodracon*) spp. (halapepe), which suffers from very low reproduction rates but remains widespread in the northern Waiʻanae range thanks to its longevity. *D. obatai* is currently known from seven sites in four potential PUs (Makaleha, Manuwai, Palikea Gulch, and Pūleʻe), although three of these are within 1,200 m of each other and could potentially form one contiguous population. While the populations were almost certainly contiguous until recently, native forest in general and *Dracaena* distribution 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 Līhuʻe/Pūleʻe, and Manuwai, limited survey time available, and focus on monitoring *D. montgomeryi* (Table 3). This site had the only observation of *D. obatai* (Table 3) in this reporting period. East Manuwai is also the only site with *D. obatai* reliably present in the past several years and the only currently known site for several other extremely rare species including *D. pilimana*, but may be threatened by expansion of yellow crazy ants (*Anoplolepis gracilipes*). Flies at the lowest site have 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. Manuwai East will be one of the first sites that eDNA *Drosophila* detection will be tested due to the very low density of rare flies at the site.

7.2.5.2 Management Actions

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 likely be included in the upcoming Biological Assessment (BA). One of its host plants, *Dracaena forbesii*, is a listed endangered species and will likely 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. In late 2017 and early 2018, A24 rat traps were installed at two sites in Pūleʻe 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. *D. obatai* have not been observed in Pūleʻe in several years, and the habitat continues to degrade there. In this last year there has been an outplanting of *Delissea waianaeensis* in the Manuwai East site as well as installation of 25 new A24s. The weeding actions and threat control that come with the outplanted *Delissea* will also benefit the *Dracaena* and *D. obatai* at this site and will hopefully lead to higher observed numbers in the future. Surveys at ʻŌhikilolo continue, though *D. obatai* have never been observed there, despite the many large *Dracaena forbesii* present there.

Table 3: Survey effort for *D. obatai* across all potential sites in 2022–23 reporting period, in survey days.

Site	Days	Max No.
Manuwai	2	1
Līhuʻe – Pūleʻe	3	0
ʻŌhikilolo	2	0

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Available Upon Request

Figure 8: Distribution of *Drosophila obatai* observations in the 2022–23 reporting year and earlier records from 2013–21 including all survey points. Pentagons represent positive observations of *D. obatai*.

7.2.6 Other Rare *Drosophila*

During the course of previous years 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 summarizes non-listed rare Drosophila observed this report year.

Table 4: Non-target rare *Drosophila* observed during surveys, July 2022–June 2023. "Max No." is the highest number of flies observed in a single day.

Species	MU	Total Observed	Max. No.
D. divaricata	Kalua‘ā and Wai‘eli	1	1
D. hemipeza	Palikea	8	3
D. nigribasis	Ka‘ala	4	3
D. pilimana	Manuwai	1	1
D. turbata	ʻŌhikilolo	6	6

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 Kalua‘ā, historically it appeared to be more like a common species, maintaining consistent abundance and frequency of numbers there. This year, however, there has been a further drop-off in observations with only one being seen, compared to eight the previous year, and 54 seen the year before that.

Drosophila hemipeza is the only listed endangered species on O‘ahu that is known to be extant but does not occur on Army lands or in OIP/MIP action areas, although it historically occurred at Kahuku Training Area and Makaleha West adjacent to Mākua. It has been consistently found at Palikea MU for several years but always in low numbers; in 2014–2015 occasional individuals showed up at Pu‘u Hāpapa as well. This year they were consistently observed at Palikea, however their observed numbers have decreased since last year's spike.

Drosophila nigribasis (Figure 9) 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 Ka‘ala summit. Four individuals were found from two surveys this year at new sites on Ka‘ala. These were seen during searches for new *D. substenoptera* sites, and it is expected that more will be observed in subsequent surveys.

Drosophila pilimana (Figure 9) has an unknown host plant, and possibly breeds in the leaf axils of plants such as *Freycinetia arborea*; it is similar to *D. obatai* in appearance. It was seen once in the reporting period in East Manuwai. This species used to be one of the most frequently observed *Drosophila* species. In the past it had a dramatic decline, possibly due to the incursion of ants into its habitat.

Drosophila turbata breeds in sap fluxes of *Acacia koa* and is very similar to another species, *D. gradata*. It is generally rare but is found fairly regularly at ʻŌhikilolo. Six individuals were observed at ʻŌhikilolo this year during two surveys conducted there.

Drosophila nigribasis in Ka'ala bog with conspicuous sexual dimorphism. ♂- left, ♀- right

Drosophila pilimana, very similar to *Drosophila obatai* and occasionally found in *D. obatai* habitat.

Figure 9: Some unmanaged rare *Drosophila* species found during surveys.

7.3 *DROSOPHILA* REARING PROGRAM

This year ANRPO continued coordination with DOFAW/ UH Mānoa master's student Kelli Konicek in a *Drosophila* rearing program with the eventual goal of augmenting existing populations of endangered picture-wing flies including *D. montgomeryi*.

Beginning in March of 2023 Konicek, with field support from ANRPO, began releasing reared *Drosophila hemipeza* at the 2D site in ʻĒkahanui (Figure 10). Four flies were collected from Palikea and bred in the INSTAR (Insectary for Scientific Training and Advances in Research) lab at UH Mānoa. Since that time over 7,500 *D. hemipeza* have been reared and released in ʻĒkahanui. This site was chosen due to the high number and density of host plants (*Campanulaceae*, *Urera*, *Touchardia*), and the absence of *D. hemipeza* at the site since the 1970s. Flies were color marked (Figure 11) to indicate cohort and release date and released each week. The flies were also monitored each week before that day's release to determine presence and survivorship of flies from previous weeks. Flies that were released up to 2 months prior have been observed while conducting this monitoring, indicating that flies were able to survive at the site long enough to be able to breed.

Breeding material in the form of rotting *Cyanea* stems were collected from the site after *D. hemipeza* releases began. The stems that were brought back to the rearing lab subsequently had *D. hemipeza* emerge, indicating that released flies were breeding and ovipositing at the site.

Given the success seen with the reintroduction of this species, staff are hopeful for the upcoming release of *D. montgomeryi* to the same site in ʻĒkahanui beginning in the fall of 2023. This future release will follow the same release and monitoring protocol as the *D. hemipeza* releases.

Figure 10: Vials of *D. hemipeza* being released at 2D site in ʻĒkahanui.

Figure 11: Baited monitoring sponge with *D. hemipeza* just after release. All flies released were marked with colors indicating cohort and release date.

7.4 DROSOPHILA YEAST TRIALS

In conjunction with the Drosophila rearing project, the Rare Insect Biologist and Kelli Konicek (DOFAW) at UH Mānoa have undertaken a project to assess the attractiveness of wild yeasts associated with *Drosophila* host plants. Since the 1970s the primary method of attracting Hawaiian picture-wing flies has been through sponges baited with fermented mushroom juice and a banana mash containing baker's yeast (*Saccharomyces cerevisiae*).

In the decades since these baits were developed, many studies have been conducted focusing on the mutualistic relationships between *Drosophila* and various yeast species. Some of the benefits highlighted in such trials include increased survivorship, faster physical development, higher fecundity in adults, and higher rates of attraction to certain species of yeast.

This trial focuses on the hypothesis that highly host specific (one or two species of host plants) *Drosophila* species such as *Drosophila montgomeryi,* and *Drosophila substenoptera*, are also highly specific in their relationship to the yeast species found within their host plants. If these species of *Drosophila* are more attracted to the chemical signals of the yeasts found in rotting material of their host plants, we may use these yeast species (Figure 12) instead of baker's yeast to attract more flies during monitoring and help us acquire a more accurate population estimate of these *Drosophila* species.

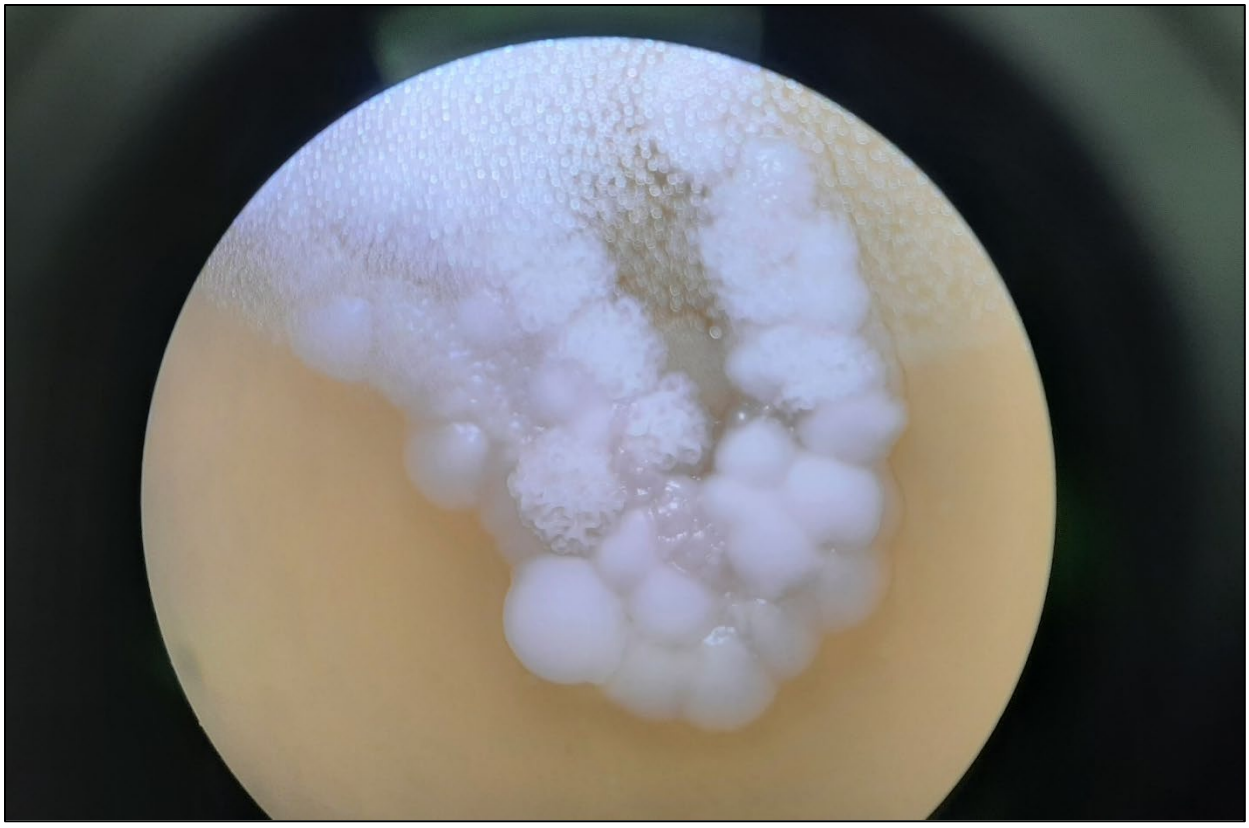

Figure 12: A close-up of yeast colonies of multiple species under magnification. These yeast species were collected from a swab of a newly rotting *Cyanea superba* subsp. *superba* stem at the 2D *Drosophila* release site in ʻĒkahanui.

The trial is currently just beginning, however ANRPO has already begun collection of material from host plants including *Touchardia oahuensis*, *Cyanea grimesiana* subsp. *obatae*, and *Cyanea superba* subsp. *superba* whenever fresh material is found. We will use *Touchardia oahuensis* as the host plant for this project as it is utilized by the three test species of *Drosophila* in this trial. Stems of *T. oahuensis* will be sterilized using an autoclave and placed at wild *Drosophila* sites in physical contact with a wild plant of the same species. This is intended to better capture the yeasts present at the *Drosophila* sites rather than where the stems were collected. After time has passed and we determine that the breeding material has reached a state of colonization by yeast and is attractive to *Drosophila* (Figure 13), we will remove it from the field for further processing. A slurry will then be blended using pulp and bark from this material with sterilized water. Through collaboration with the Amend and Hynson labs at the University of Hawaiʻi at Mānoa, genetic analysis of the resulting slurry will also be conducted at this stage to determine the composition of yeast species present.

At this stage we will be ready to compare attractiveness between baker's yeast and collected wild yeasts found in blended *Touchardia* stem, across three different species of flies: *D. montgomeryi*, *D. hemipeza*, and *D. crucigera*. We will place ~50 individuals of a species into a mesh cage. The cage will contain five different dishes each containing a one-inch cube of sponge soaked with a different solution: a control sponge with PBS (Phosphate-buffered saline), which is not attractive to flies, a slurry of blended wild breeding material, heat killed wild slurry, a live baker's yeast solution, and a heat killed baker's yeast solution. Heat killed solutions are being tested to determine if flies are attracted to the yeasts themselves or merely the products. Similar to monitoring *Drosophila* in the field, the dishes will be observed every half hour to record a count of flies present on each sponge/dish.

Figure 13: Newly rotting *Ceodes umbellifera* stem in ʻĒkahanui with multiple species of wild Drosophila and released *D. hemipeza* interacting. This is typical behavior of *Drosophila* in association with newly rotting host plant material.

If significant differences are found in the attractiveness of the *T. oahuensis* slurry compared to baker's yeast, we will then conduct further testing to determine if one, or several species of yeasts contained within the slurry are responsible for the higher rate of attraction. Isolation and culturing of the yeast of interest would then allow us to propagate the yeast and use it in our baits, similar to how baker's yeast is currently used.

7.5 SERDP Surveys 2023

In January and July 2023 ANRPO hosted SERDP (Strategic Environmental Research and Development Program) researchers Rosemary Gillespie, George Roderick, and Natalie Graham. The researchers were awarded a grant from SERDP to conduct eDNA surveys for invasive insects on Army lands. Their survey sites include Puʻu Hāpapa, Kaluaʻā, Schofield Barracks East Range, Līhuʻe and Kahuku Training Area. Surveys included leaf litter collections, collections of leaves for eDNA (Environmental DNA) analysis, beating of vegetation, and malaise trapping.

Results of these surveys are still forthcoming, but the use of eDNA technology could greatly improve the detection of many native arthropod species. If adapted to our current *Drosophila* monitoring techniques

we may be able to detect very low-density flies, filling in knowledge gaps and allowing us to better manage *Drosophila*, *Megalagrion*, and other rare insects.

In January of 2023 the ANRPO Rare Insect Biologist will conduct a trial eDNA survey for picture wing *Drosophila*. The sampling that will be used is based on current monitoring techniques using baited sponges but will be conducted over several days. This is intended to detect the presence of very low-density populations of *Drosophila* in their habitat, which will prompt further monitoring of an area. This has the potential to greatly decrease the time and labor constraints of surveying for rare flies, and detect extremely low-density flies, which may be missed using current monitoring methods.

eDNA sampling of the stream water is also planned to help monitor *Megalagrion xanthomelas* at TAMC and DMR sites in fall of 2023. This sampling will help determine the presence of *Megalagrion* naiads within each stream as well as inventorying the invertebrate community including organisms that may be predating immature *Megalagrion*. A more complete understanding of the invertebrate communities at these sites will allow us to make better informed decisions when it comes to management of *Megalagrion xanthomelas*.

CHAPTER 8: SMALL VERTEBRATE PEST MANAGEMENT

The Army Natural Resources Program on O‘ahu (ANRPO) has managed species that are subject to small vertebrate predation with various strategies since 1997 under the Mākua Implementation Plan (MIP) and O‘ahu 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 eight 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 collected during the reporting period by ANRPO; **Section 8.3** examines the CO_2 leakage issue impacting ANRPO managed A24 traps; **Section 8.4** highlights the new trapping grids that have been installed or modified by ANRPO during the reporting period; **Section 8.5** discusses ANRPO’s initial field testing of the AT220 automatic trap system, manufactured by NZ Auto Traps; **Section 8.6** discusses updates to small vertebrate control (rodents and chameleons) at ANRPO managed snail enclosures, and the additional rodenticide protection that will be utilized in the future**; Section 8.7** examines new evidence of the impact that introduced Indian peafowl (*Pavo cristatus*) are having on a reintroduction population of *Neraudia angulata* var. *angulata* at Kamā‘ili management unit; **Section 8.8** describes future plans for small vertebrate control at ANRPO.

8.1 RODENT CONTROL PROGRAM SUMMARY

In previous years, ANRPO managed rats in different management units (MU) seasonally or year-round, depending on managed taxa protection needs. O‘ahu ‘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, AT220 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 a few weeks of placement. Previous bait systems relied on a “static” lure that would only last from one to four weeks in the field. This was a limiting factor in the A24 system initially, as the CO_2 cartridge and trap retained CO_2 longer than the bait would remain attractive to rodents. As developments have been made in trap and lure technology, A24s have become ANRPO’s primary method for controlling rodents.

Goodnature 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 has 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 improvement, ANRPO’s typical maintenance check interval was extended to twice a year (one maintenance visit every six (6) months) in 2020. 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. Due to data collected over the past two years that showed an increasing number of traps depleted of CO_2, ANRPO transitioned trap maintenance checks to every four months (three times a year) during the 2022-2023

reporting period. This change was made in an effort to maximize the total number of traps that are functioning properly during any given moment in time.

ANRPO operated 39 year-round rodent control areas during this reporting period. These 39 rodent control areas are composed of a program wide total of 1,707 A24 traps (Table 1). ANRPO rodent control areas range from small trapping grids with two traps, to MU scale grids of up to 306 traps. During this reporting period, ANRPO installed or replaced a total of ~650 A24 traps. This has been the largest trap replacement operation since the program wide installation of A24 traps in 2017/2018. This replacement protocol highlights the reality that trapping infrastructure must be replaced over time in order to continue to operate rodent control at ANRPO's current extent.

Due to the variability of many of the sites where ANRPO conducts rodent control, trap spacing varies from site to site. At isolated plant populations, ANRPO attempts to space traps 15-25 meters apart from one another. This creates a high density of traps in a small area (typically less than a few acres) and seeks to increase the probability of any rodents in the area interacting with a trap during a given period of time. Ultimately, terrain dictates precisely how far apart each individual trap is from one another.

Due to the difficult terrain that many of the grids are installed on, trap spacing varies at ANRPO's larger grids as well. At sites like ʻĒkahanui and Mākaha I, traps are installed on trails that have been cut along the elevational contours of the management units. At these two sites, traps are spaced out on 100m X 50m grid intervals. This is based on best management practices that have been developed over the past decades from conservation managers in New Zealand, who have led the way in the practical field applications of A24s (New Zealand Department of Conservation [NZ DOC] 2021). At a minimum ANRPO strives to have at least two A24 traps per hectare, and in many cases the density of traps is much higher than that. This minimum number of traps per hectare is based on typical home range sizes for *Rattus* spp. in Hawaiʻi (Shiels 2010).

In 2019, ANRPO began observing large numbers of A24 traps that developed CO_2 depletion issues as they aged. This has been discussed in previous year end reports (ANRPO 2022) and will be examined in this chapter. Upon transitioning to six (6) month maintenance checks (2019-2022), this leaking/depletion problem seemed to be exacerbated; the majority of ANRPO's A24 rat control grids experienced unacceptably high rates of traps completely depleted of CO_2. As ANRPO's trap inventory aged following large installation events in 2017 and 2018, the leakage problem continued to persist and worsen. This issue will be discussed further in section 8.3.

As mentioned previously, ANRPO transitioned to a four (4) month maintenance schedule beginning in October 2022, in an effort to maximize the total number of traps that are functioning year-round. An update to how this transition has impacted trap performance will be discussed in section 8.3.

ANRPO utilizes tracking tunnel methodology to track rodent activities over time and has used this tool since 2010 at certain sites such as Kahanahāiki. This methodology was developed in New Zealand by researchers in the 1970s in an effort to quantify activity levels of introduced small mammals (King & Edgar, 1977). ANRPO adopted this methodology and modified it somewhat to fit the smaller areas in which rodents are monitored in Hawaiʻi (Gillies and Williams 2013). Typically in New Zealand tracking tunnels aren't used in areas smaller than 300 hectares (Gillies and Williams 2013). The majority of management units that ANRPO works in are 10-100 hectares in size, so the total number of tracking tunnels set out on the landscape are lower than typically used in New Zealand, but the suggested spacing between each tunnel remains the same. Tracking tunnel activity levels will be reported for 2022-2023 in Section 8.2.

Section 8.4 discusses and provides visual aids relating to the new trapping grids that were installed during the reporting period.

During this reporting period ANRPO continued field testing of the AT220 small mammal trap that is manufactured by NZAutoTraps, a company that is based in New Zealand. The initial results from field testing will be discussed in section 8.5.

Achatinella mustelina is a species of endangered tree snail that is managed by ANRPO. One of the primary methods that ANRPO uses to protect this species is through the construction of predator resistant enclosures that keep the snails protected from predation by invasive species such as the rosy wolf snail (*Euglandina rosea*), Jackson's chameleons (*Trioceros jacksonii xantholophus*), *Rattus* spp., and house mice (*Mus musculus*). While the physical barrier provided by the enclosures deters most incursions, there have been instances of *Rattus* spp. and *M. musculus* burrowing under the barrier and being detected within the confines of the enclosures. New developments and control techniques that will be utilized in the future will be discussed in section 8.6.

Table 1: Rat control areas maintained by ANRPO during the 2022-2023 reporting period. New grids installed this report year are marked with a "*". Grids which underwent a design change this report year are noted with "**".

MU (Area)/Site Code	Primary Spp. Protected	Description	# A24 Traps (# of AT220s)
Ka'ala (Snail Enclosure) **(ALA-A)**	*Achatinella mustelina*	Predator-proof fence (internal and external)	12
Ka'ala Army **(ALA-S)**	*Geniostoma cyrtandrae*	Endangered plant population protection grid	33
Manuwai (West) **(ANU-A)**	*Delissea waianaeensis*	Endangered plant population protection grid	8
Manuwai (East) **(ANU-B)**	*Drosophila obatai*	Endangered plant population protection grid	6
Manuwai West** **(ANU-C)**	*D. obatai, D. waianaensis*	Endangered plant population and invertebrate protection grid	25
'Ēkahanui MU **(EKA-D)**	*Chasiempis ibidis*, *A. mustelina*, *Cyanea grimesiana* subsp. *obatae*, *Schiedea kaalae*, *D. waianaensis*	Management unit grid	306 (4)
Ka'ena Point NARS* **(KAE-A)**	*Euphorbia celastroides* var. *kaenana*	Endangered plant population protection grid	40
Kahanahāiki MU **(KAH-C)**	*A. mustelina*, *C. superba* subsp. *superba*, *D. waianaeensis*, *Schiedea nuttallii*, *Schidea obovata*	Management unit grid	76 (13)
Kahanahāiki Old Snail Enclosure **(KAH-G)**	*A. mustelina*	Predator-proof fence (internal)	2
Kahanahāiki (New Snail Enclosure) **(KAH-I)**	*A. mustelina*	Predator-proof fence (internal and external)	4
Kalua'ā & Wai'eli (Hāpapa bench) **(KAL-A)**	*A. mustelina*	Predator-proof fence (external)	15 (2)
Kalua'ā & Wai'eli ** (North gulch) **(KAL-D)**	*C. grimesiana* subsp. *obatae, D. waianaeensis, U. kaalae, Euphorbia herbstii*	Endangered plant population protection grid	31 (2)
Kalua'ā & Wai'eli (Central Gulch) **(KAL-E)**	*D. waianaeensis*, *C. grimesiana* subsp. *obatae*, *S. kaalae*, *Phyllostegia mollis*, *Chasiempis ibidis*	Endangered plant population protection grid, 'Elepaio territory protection	30

Table 1 (continued).

MU (Area)/Site Code	Primary Spp. Protected	Description	# A24 Traps (# of AT220s)
Kalua'ā & Wai'eli (Hāpapa Snail Enclosure) **(KAL-F)**	*A. mustelina*	Predator-proof fence (internal)	6 (1)
Koloa MU* **(KOL-A)**	*Euphorbia rockii, Phylostegia hirsuta, Geniostoma cyrtandrae*	Endangered plant population protection grid	12
Makaleha West MU** **(LEH-A)**	*C. grimesiana* subsp. *obatae, D. waianaeensis, S. obovata, C. longiflora, P. kaalae, C. dentata*	Endangered plant population protection grid	59
Makaleha East (Culvert 69/73) **(LEH-I)**	*A. mustelina*	*In situ* endangered invertebrate protection	20
Makaleha West (Snail Enclosure) **(LEH-C)**	*A. mustelina*	Predator-proof fence (internal)	6
Makaleha East ** **(LEH-E)**	*P. kaalae*	Endangered plant population protection grid	28
Pālehua **(LOI-D)**	*C. ibidis*	'Elepaio territory protection	97
Moanalua 'Elepaio Territories **(LUA-D)**	*C. ibidis*	'Elepaio territory protection	99
Mākaha II** **(MAK-B)**	*C. grimesiana* subsp. *obatae, C. longiflora, H. oahuensis, S. nuttallii, S. obovata*	Endangered plant population protection grid	56
Mākaha I** **(MAK-K)**	*C. ibidis, A. mustelina, H. oahuensis, C. superba, C. longiflora, S. obovata*	Management unit grid	98
Kamā'ili (Makai Fence) **(MAK-L)**	*Abutilon sandwicense, Neraudia angulata* var. *angulata*	Endangered plant population protection grid	12
'Ōhikilolo MU **(MMR-B)**	*A. mustelina, P. kaalae*	Management unit grid	73 (4)
Mākua Valley 'Elepaio Territories** **(MMR-D)**	*C. ibidis*	'Elepaio territory protection	27
Ko'iahi* **(MMR-H)**	*N. angulata* var. *angulata*	Endangered plant population protection grid	24 (1)
Nike Greenhouse **(NIK-A)**	All greenhouse grown plants	Greenhouse rodent protection	6
Opaeula Lower **(OPA-B)**	*C. dentata*	Endangered plant population protection grid	50
Palikea MU** **(PAK-F)**	*A. mustelina, C. superba, C. grimesiana* subsp. *obatae, C. ibidis*	Management unit grid	108 (3)
Palikea South Snail Enclosure **(PAK-G)**	*A. mustelina*	Predator-proof fence (internal)	10
Palikea North Snail Enclosure **(PAK-I)**	*A. mustelina*	Predator-proof fence (internal)	10
Keawapilau (in Kapuna Upper) **(PIL-A)**	*H. oahuensis, S. nuttallii, C. longiflora*	Endangered plant population protection grid	12

Table 1 (continued).

MU (Area)/Site Code	Primary Spp. Protected	Description	# A24 Traps (# of AT220s)
Puali‘i North **(PUA-A)**	*H. oahuensis*	Endangered plant population protection grid	25
Līhu‘e (Mohiākea) **(SBW-AA)**	*D. waianaeensis*	Endangered plant population protection grid	10
Kamaohanui (in Līhu‘e) **(SBW-I)**	*A. mustelina*	*In situ* endangered invertebrate protection	25
Līhu‘e (Hale‘au‘au) **(SBW-KL)**	*A. mustelina*	*In situ* endangered invertebrate protection	24
Līhu‘e (Coffee and Guava) **(SBW-M)**	*D. obatai*	*In situ* endangered invertebrate protection	17
Līhu‘e (Mohiākea and Banana)** **(SBW-P)**	*C. ibidis*	‘Elepaio territory protection	219

8.2. Overview of ANRPO Tracking Tunnel/Game Camera Monitoring Program

For this report and all future reports, tracking tunnel results are provided for most large-scale grids (Kahanahāiki, ‘Ēkahanui, Palikea, Mākaha, and ‘Ōhikilolo). 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. 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 rodent 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 Hawai‘i.

Tracking cards are baited with peanut butter which attracts rodents into the tunnel, encouraging them to move across the inked card within and leave observable tracks which are used to construct a rodent activity index. As highlighted in ANRPO’s 2022 year-end report (ANRPO 2022), diurnally active non-target species such as feral cats (*Felis catus*) and small Indian mongoose (*Herpestes auropunctatus*) potentially skew field data due to their ability to “rob” the tunnel of peanut butter, likely deterring rodents from entering the tracking tunnel during the night time (Figures 1-4) .

The impact of these taxa on rodent monitoring varies from site to site. At ʻĒkahanui, F. *catus* tracking rates have been observed frequently in over 50% of tracking tunnels at the unit (59 total tracking tunnels). ANRPO will continue to seek to exclude *F. catus* and *H. auropunctatus* via tunnel design and lethal trapping.

Figure 1: Small Indian mongoose (*H. auropunctatus*) robbing peanut butter from ANRPO tracking tunnel located in Mākaha I management unit. This observation occurred less than an hour after the tunnel was baited with peanut butter.

Figure 2: A feral cat (*F. catus*) robbing a tracking tunnel of peanut butter.

Figure 3: Small Indian mongoose (*H. auropunctatus*) visiting tracking tunnel.

Figure 4: A Feral cat (*F. catus*) visiting ANRPO tracking tunnel.

In May 2023, ANRPO installed modified tracking tunnels at ʻĒkahanui to minimize the influence of *F. catus* that are extremely active in the area and have had a noticeable impact on tracking tunnel data. These tunnels were lengthened, and chicken wire was fastened on each end to limit the entry to *Rattus* spp. and *M. musculus*. The results from this initial testing window will be discussed further in section 8.2.2.

ANRPO has used game cameras with mixed results previously (ANRPO 2021), (ANRPO 2022). ANRPO identified that while game cameras were effective at detecting rodent activity, the data produced was difficult to compare to the previous tracking tunnel methodology. Beginning in 2022, ANRPO began to shift away from using game cameras to directly compare rodent activity with tracking tunnels. Instead, game cameras were utilized as a surveillance tool to directly monitor managed taxa. This shift allows ANRPO to maintain the continuity of the tracking tunnel dataset, while also increasing the ability to directly monitor the impact of rodents to managed taxa, even when tracking tunnel data would suggest that rodent activity was minimal in control areas.

By using game cameras as a surveillance tool to monitor endangered taxa, ANRPO was able to identify severe impacts being caused to a population of *Euphorbia celastroides* var. *celastroides* at Ka‘ena Point, O‘ahu this report year. Previously it was thought that rodents were not a threat to this taxon. Upon the discovery of girdling and gnawing of branches and stems on multiple individuals on site, ANRPO installed an extensive rodent control grid that utilizes A24s and Victor snap traps (Section 8.4).

As ANRPO seeks to improve rodent monitoring and endangered taxa surveillance, game camera use will be expanded to more rare plant sites. This will allow ANRPO to monitor rodent activity on different scales, across a control grid, and directly monitor the impacts on various managed taxa. Staff believe that this strategy will also allow our program to respond quickly and efficiently to predation events that were likely missed in the past. ANRPO has been exploring different methodologies to efficiently analyze the thousands of camera images that are produced at *in situ* monitoring sites. Programs such as Wildlife Insights (www.wildlifeinsights.org) and MegaDetector, which utilize computer learning to remove images from datasets that contain ‘blank’ images are beginning to be utilized by ANRPO, and will be vital in expediting the usefulness of utilizing game cameras on a larger scale.

8.2.1 Kahanahāiki Tracking Tunnel Results

Various rat control methods have been used at Kahanahāiki over the years with mixed 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. Tracking tunnels at Kahanahāiki (year-round rodent control site) and Kapuna (reference site, no rodent control conducted) are checked quarterly. Results from tracking tunnels show that the reference site had higher rat activity during the reporting period as compared to Kahanahāiki (Figure 5).

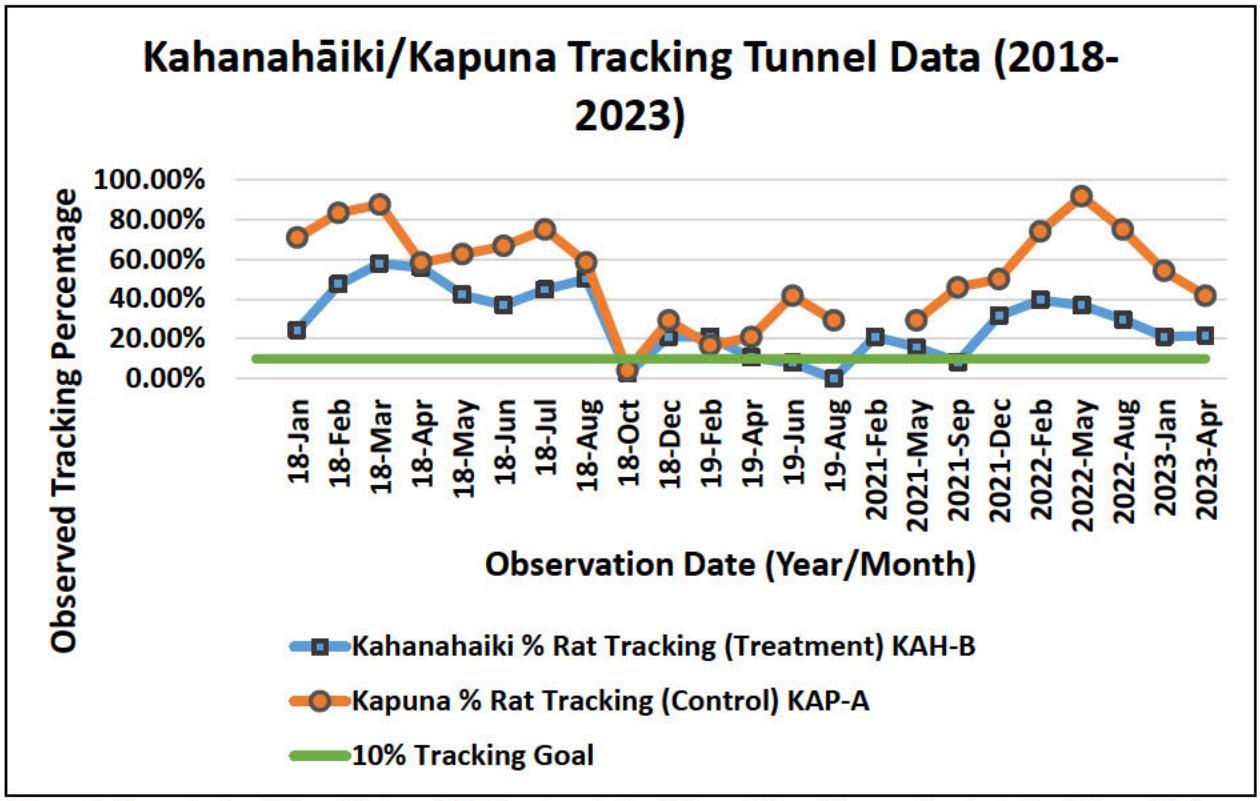

Figure 5: Percent rat activity at Kahanahāiki (treatment site, 39 tunnels) and Kapuna (control site, 24 tunnels) from January 2018-April 2023.

Rat activity at Kahanahāiki was higher than our target goal of 10% during the reporting period. ANRPO thinks this is due to the size and shape of the MU, and issues with CO_2 retention impacting deployed A24 traps.

In April 2023, 13 AT220 traps were installed along the preexisting rodent control trapping lines. These were installed to reduce rodent activity at Kahanahāiki, and also to provide an easily accessible site to expand ANRPO's field testing efforts of this new trap. No tracking tunnel observations have been collected since the installation of the AT220s, but ANRPO will continue to report annual tracking rates in future reports.

8.2.2 ʻĒkahanui Tracking Tunnel Results

ʻĒkahanui rodent monitoring relies on a total of 59 tracking tunnels within the management unit (Figure 6). From February 2011 to September 2017, the ʻĒkahanui grid consisted of ~600 Victors with a few A24s installed around known *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 Oʻahu ʻElepaio 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.

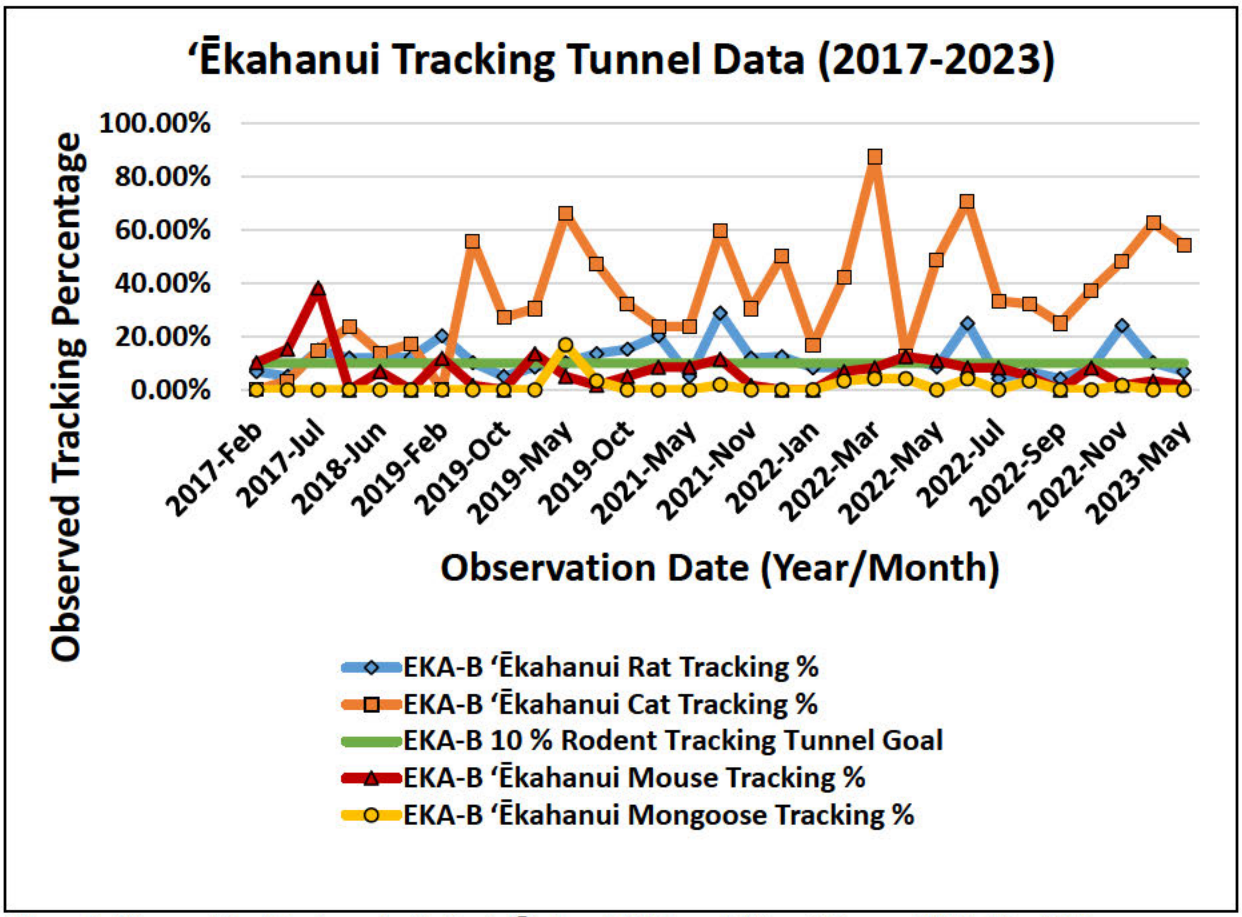

Figure 6: Observed tracking tunnel activity at ʻĒkahanui (59 tunnels) from February 2017- May 2023.

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, June 2022, and November 2022 (Figure 6). 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.

ʻĒkahanui 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 ʻĒkahanui. During this reporting period, ANRPO observed cat tracking rates in up to 60% 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. In May 2023, ANRPO placed modified tracking tunnels in ʻĒkahanui to attempt to reduce cat interference. Modified tunnels were created by fastening two tunnels together, with chicken wire secured on each end (Figure 7). The chicken wire had small rodent sized holes cut into them, to continue to allow easy access while discouraging cats from gaining entry.

ANRPO will continue to assess the efficacy of these modified tunnels over the coming year. If they are deemed effective ANRPO will likely install these at more locations across ʻĒkahanui, and in other management units.

Figure 7: An example of a modified tracking tunnel installed at ʻĒkahanui management unit in May 2023, designed to deter cat interference.

8.2.3 Palikea Tracking Tunnel Results

The Palikea grid previously consisted of approximately 200 Ka Mate traps (August 2010 to October 2017). In October 2017 all Ka Mate traps were removed and 108 A24s were installed. During the first two years following installation, rodent activity was monitored with 15 tracking cards in tunnels, as had been done for the previous years (Figure 8).

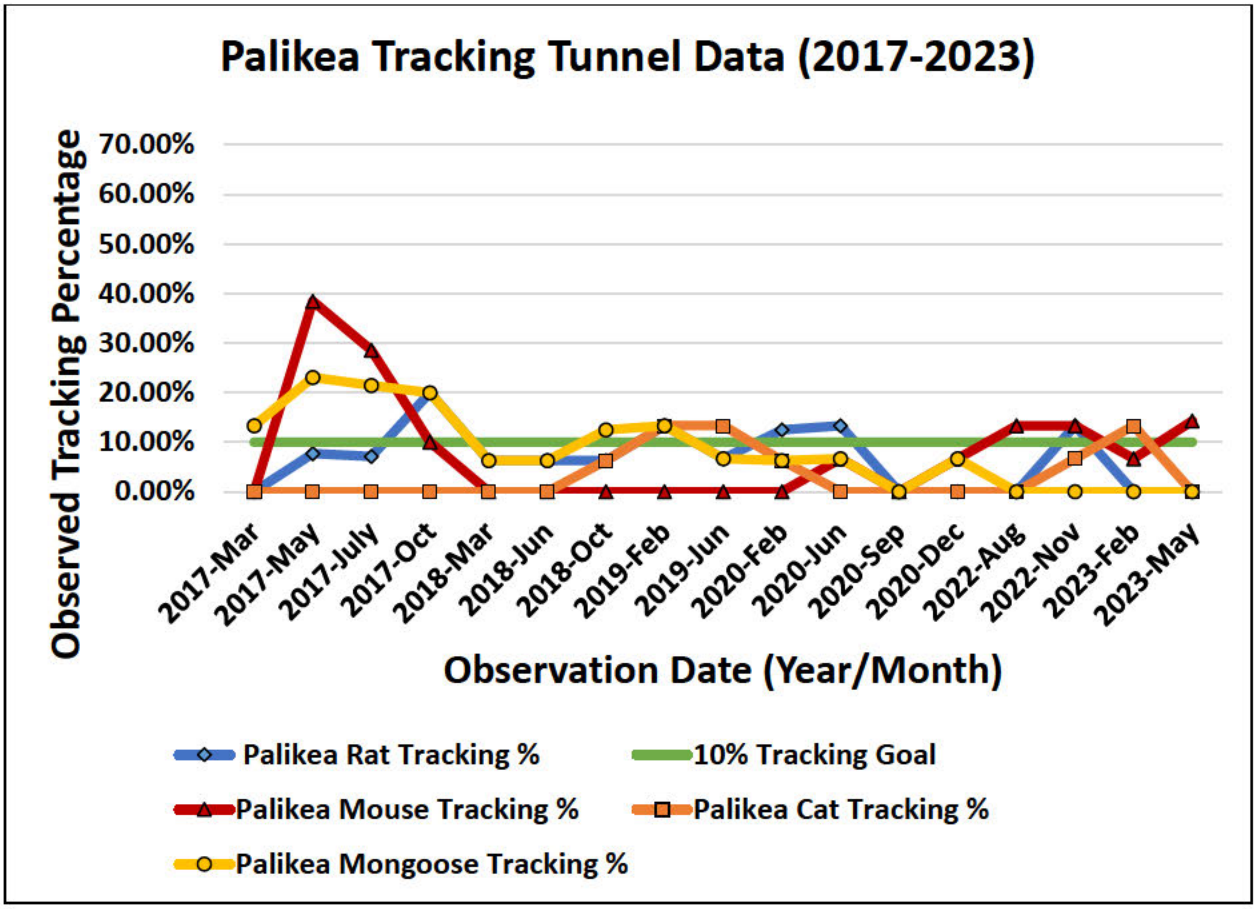

Figure 8: Palikea tracking card (15 tunnels) data from 2017-2023.

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%), June 2020 (13.33%), and November 2022 (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. Beginning in August 2022, ANRPO shifted back to using only tracking tunnel methodology at Palikea. Q1 and Q2 2023 observations both documented 0% rat tracking, a welcome sign.

8.2.4 Mākaha Tracking Tunnel Results

In May 2018, the Mākaha I 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 9).

In December 2020 ANRPO switched the monitoring method from tunnels to cameras at Mākaha MU. Upon transitioning to game cameras as the only monitoring method at Mākaha, rat tracking maintained levels higher than 10% (ANRPO 2022). 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

Kahanahāiki/Kapuna. As at Palikea, ANRPO reverted back to using the tracking card/tunnel methodology to monitor rodent activity for the 2022-2023 reporting period.

There was a large spike in *M. musculus* tracking levels in March 2023 (Figure 9), which could be related to an island wide irruption in mouse populations following a relatively wet winter season. Tracking tunnel monitoring was conducted again in July 2023, where *M. musculus* tracking levels fell back to 0%.

In the future, game cameras will be used to directly monitor managed taxa for rodent predation at this site. Tracking tunnels will continue to be used in an effort to maintain an integrated monitoring approach.

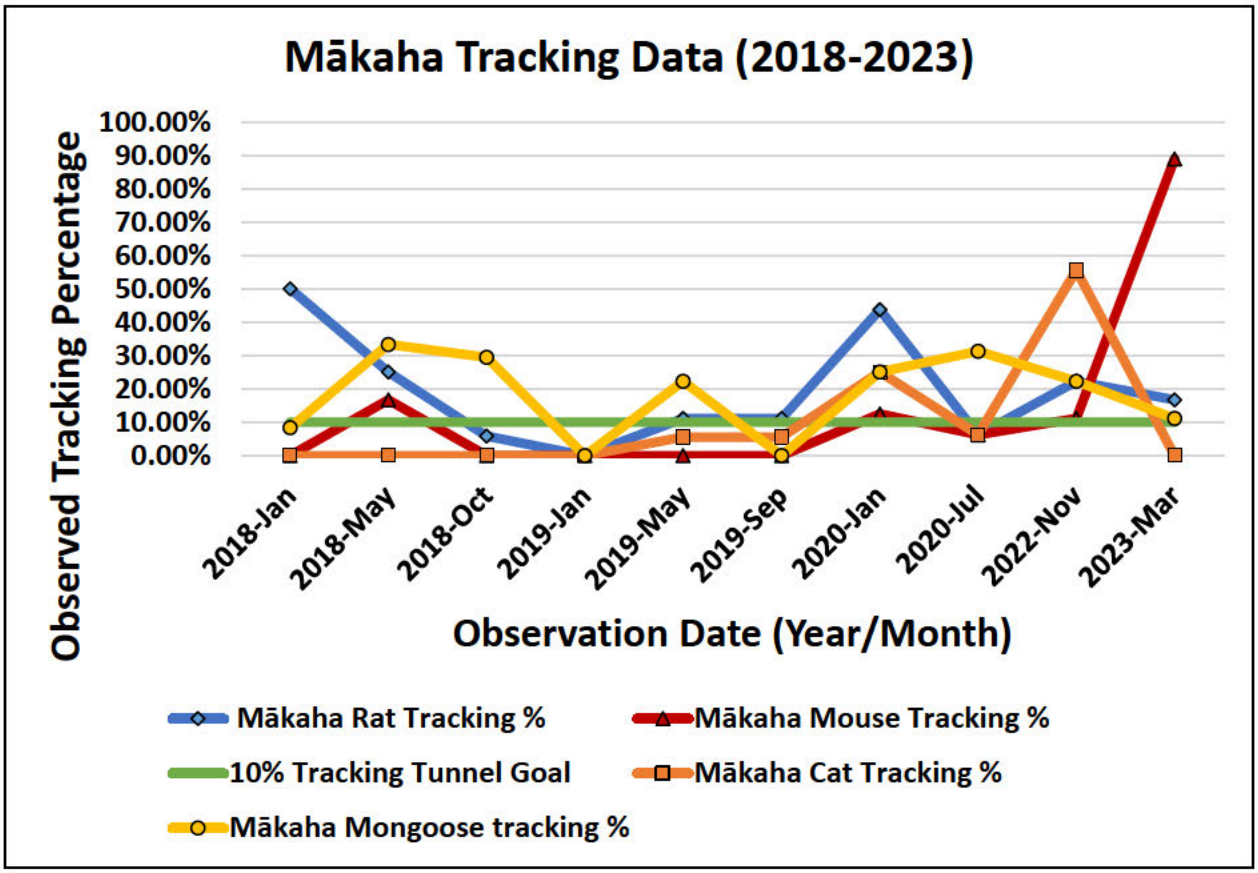

Figure 9: Observed tracking percentages from Mākaha subunit I MU (18 Tunnels) from January 2018-March 2023.

8.2.5 ʻŌhikilolo Tracking Tunnel Results

In 2021, the ʻŌhikilolo 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, *M. musculus*, and *H. auropunctatus* over the past five (5) years are displayed below (Figure 10). This data points to successful rat control since January 2021, with the exception of one observation window with > 10% rat tracking (July 2021).

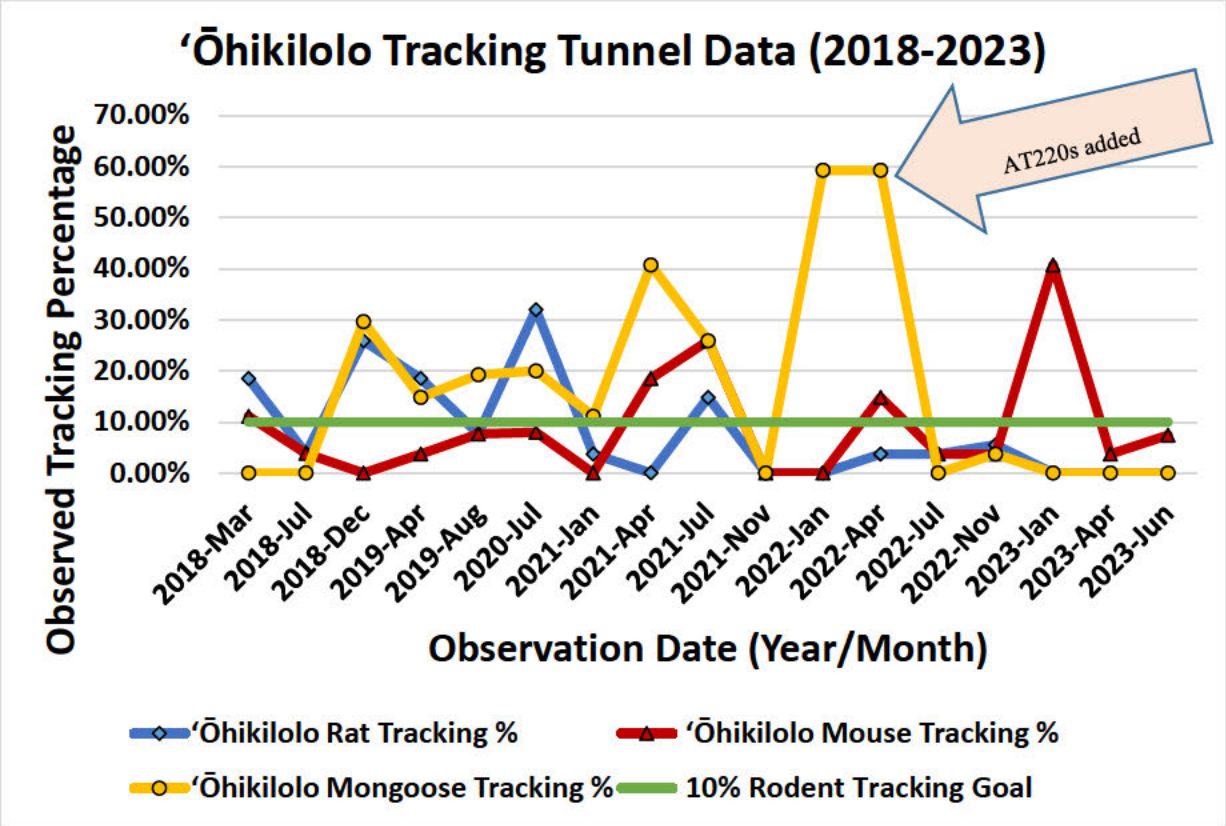

Figure 10: Percent of *Rattus* spp., *M. musculus*, and *H. auropunctatus* activity at ʻŌhikilolo (27 tunnels) from March 2018- June 2023. Four AT220 traps were installed in April 2022 (see arrow), and seem effective at reducing *H. auropunctatus* tracking levels. *F. catus* data wasnʻt included in this figure, as they have never been detected via tracking tunnel methodology at ʻŌhikilolo (they have been detected from the area with game cameras).

Tracking card data also shows an increasing impact of *H. auropunctatus* on ANRPO rodent monitoring at ʻŌhikilolo from 2018-2022. During the July 2021-June 2022 reporting period, there had been three observation events with *H. auropunctatus* tracking greater than 20%, and two observations with tracking up to 60%. Staff observations during the 2021-2022 period 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.

ANRPO installed four NZ Auto Traps AT220 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. Since the installation in April 2022, ANRPO has noted a marked decrease in the tracking percentage of *H. auropunctatus* at ʻŌhikilolo (Figure 10). Staff have noted mongoose and *Rattus* spp. carcasses underneath of these traps during observation periods. The results at this site have been encouraging, and lead to the decision to expand field testing of the AT220 to other ANRPO managed sites.

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 2013, ANRPO began to explore the implementation of Goodnature A24 self-

resetting traps (Figure 11) in MUs across the Wai‘anae range (Franklin 2013). These traps have been a valuable tool for conservation managers at ANRPO and across the state of Hawai‘i. They allow managers to greatly reduce labor inputs and are claimed by the manufacturer Goodnature 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 hypothetically two visits per year. In 2017-2018, ANRPO transitioned to solely using A24 traps, and installed trapping grids in many of our large MUs.

Figure 11: Cross section of a Goodnature A24 trap. This perspective shows the internal components and CO_2 reservoirs.

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 numbers of traps completely depleted of CO_2 (hereafter called ‘CO_2 depleted traps’) when staff would return to conduct the next maintenance checks (Figure 12).

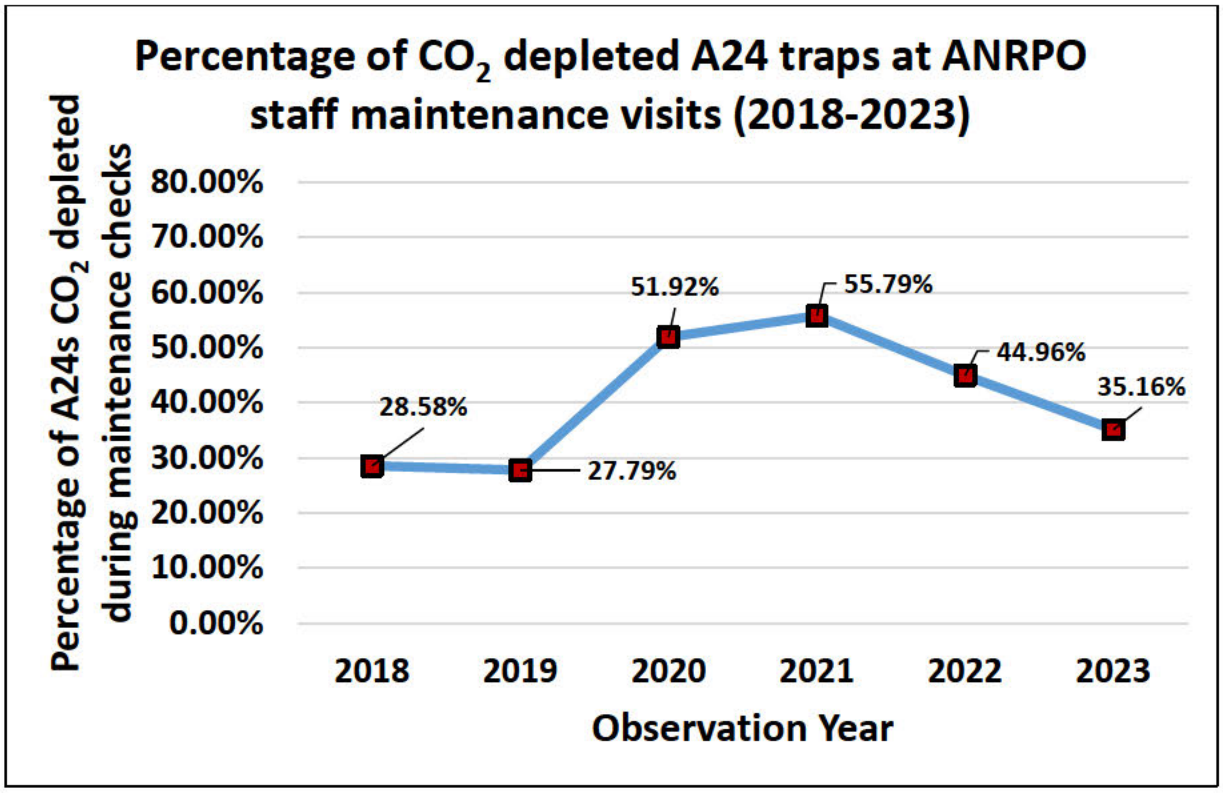

Figure 12: The percentage of all ANRPO managed Goodnature A24 traps that were CO_2 depleted when staff performed maintenance checks at varying intervals. Beginning in late 2017-2019, the majority of the trap maintenance checks occurred on 3–4-month intervals. Beginning in 2020 through 2022, ANRPO conducted maintenance on A24 traps on 6-month intervals. From 2022-2023, traps were once again rebaited and new CO_2 cartridges were installed on four month intervals.

ANRPO has encountered CO_2 depletion issues with A24s for the entirety of the time that the program has been utilizing this tool, albeit to differing degrees at different MUs (Figure 13, 14, 15, 16). 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 CO_2 depleted, 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% (see previous year reports). 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 that were CO_2 depleted was observed. This percentage increased dramatically when ANRPO changed from 3–4-month checks, to 6-month checks.

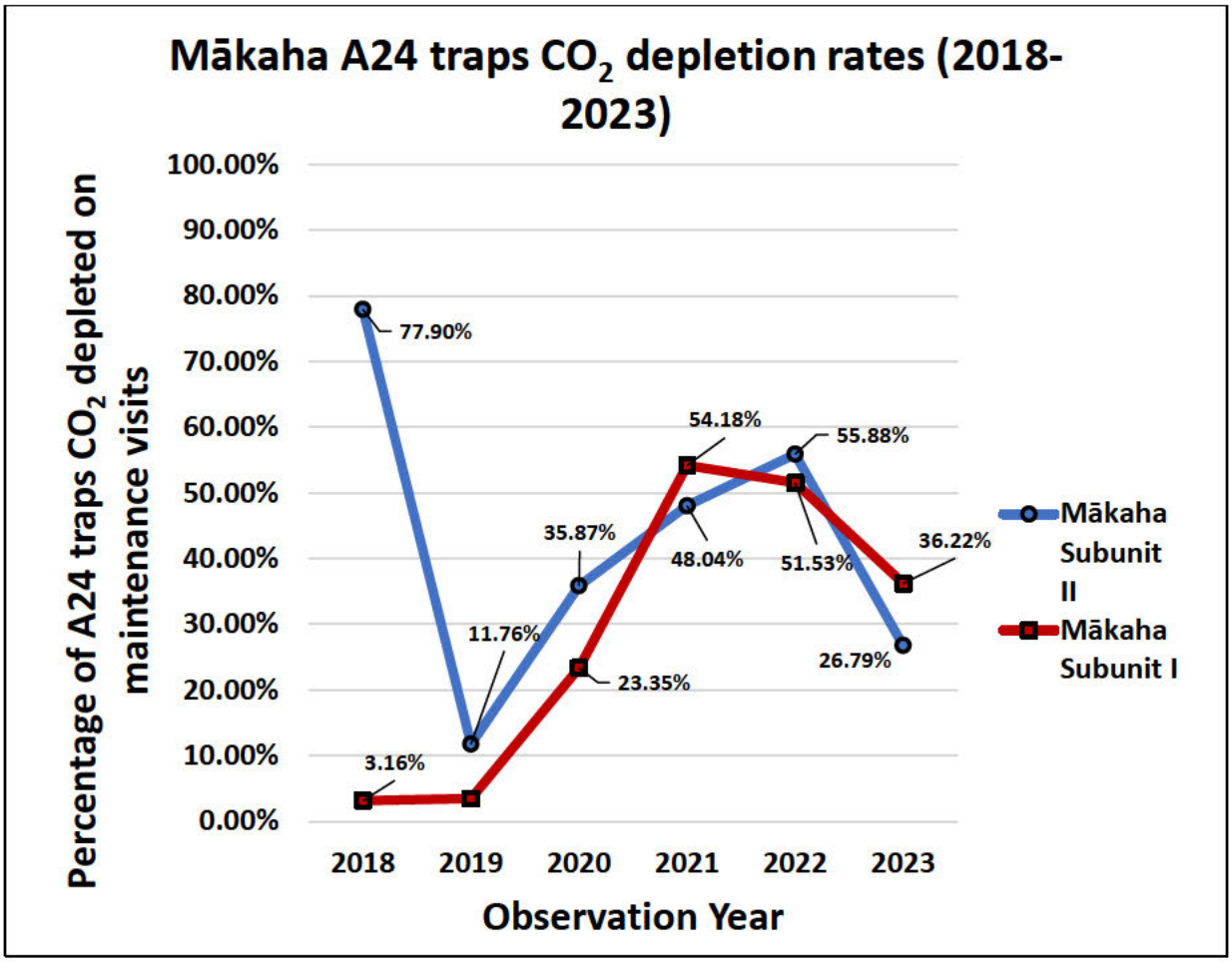

Figure 13: The average percentage of traps in ANRPO's two trapping grids in Mākaha Valley that were depleted of CO_2 on staff maintenance checks from 2018-2023. Mākaha I consists of 98 A24 traps. Mākaha II consists of 51 A24 traps.

In 2020, the percentage of ANRPO managed traps that were CO_2 depleted increased from 27.79% to 51.92%. In 2021, 55.79% of ANRPO's A24 traps were depleted of CO_2 during checks. These observed rates were unacceptable for ANRPO's current rodent trapping regime. Beginning in 2022, ANRPO began shifting back to maintaining A24s three times a year (one visit every four months). Upon each maintenance check, a new bait and new CO_2 cartridge is installed. This shift in maintainence schedule, as well as replacing older traps with new units has played an important role in lowering the CO_2 depletion rate of A24 traps across ANRPO's rodent control program. ANRPO has made great progress in getting this problem under control, lowering the program wide depletion rate from a high of 55.79% of traps depleted in 2021 down to 35.16% of traps in 2023 (Figure 13).

One way to account for the increased number of traps that are CO_2 depleted during a given time period, is to replace older aging traps with new units. It was a priority during this reporting period to replace many of our aging traps, especially in high priority management units. From July 1, 2022- June 30, 2023 ANRPO replaced or installed a total of ~650 A24 traps. This replacement schedule was prioritized based on taxa protected by each grid, and emphasized replacing grids where the failure rate of older traps was >50%.

This prioritization system meant that a few of ANRPO's larger grids were a priority to receive new traps. ANRPO replaced: 102 traps at Palikea MU, 115 traps at Mohiākea/Banana gulch 'Elepaio territories, 110

traps at Mākaha I/II MUs, 59 traps at Makaleha West MU, and many other smaller grids that are highlighted in section 8.4.

As mentioned previously (ANRPO 2022), tracking tunnel indices are an important method to measure ANRPO's ability to control rodents. However, due to the difficulty of correlating rodent control metrics directly to resource response in Hawai'i, it is also critical to maximize the total number of traps that are functioning at any given time. ANRPO will continue to maintain A24 traps three times a year, in an effort to maximize the functionality of all traps 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.

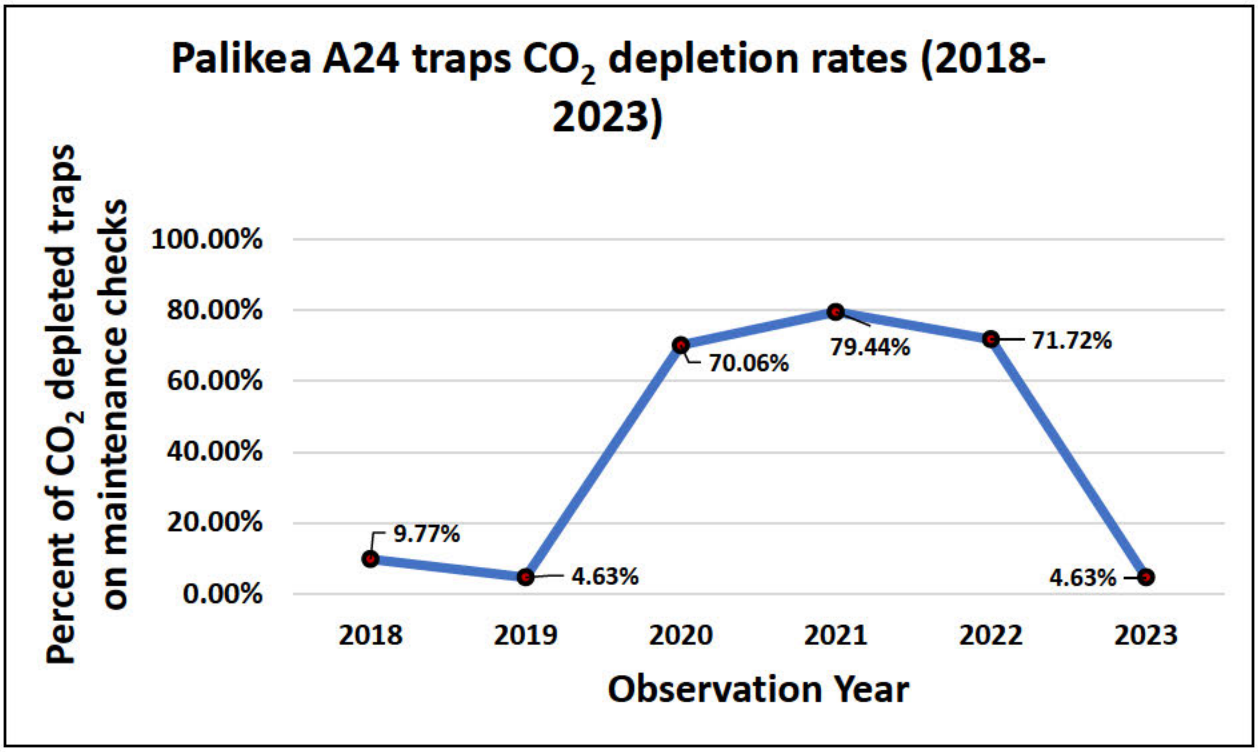

Figure 14: Average percentage of traps in ANRPO's Palikea MU A24 rodent trapping grid that were depleted of CO_2. This figure displays all data from 2018-2023. This grid had experienced some of the highest rates of traps out of CO_2 within the entire ANRPO trapping system. This grid provides protection to multiple managed plant population units, and 'Elepaio. 102 of the 108 traps at this site were replaced in December 2022, which is responsible for the sharp drop in total number of traps reported as CO_2 depleted.

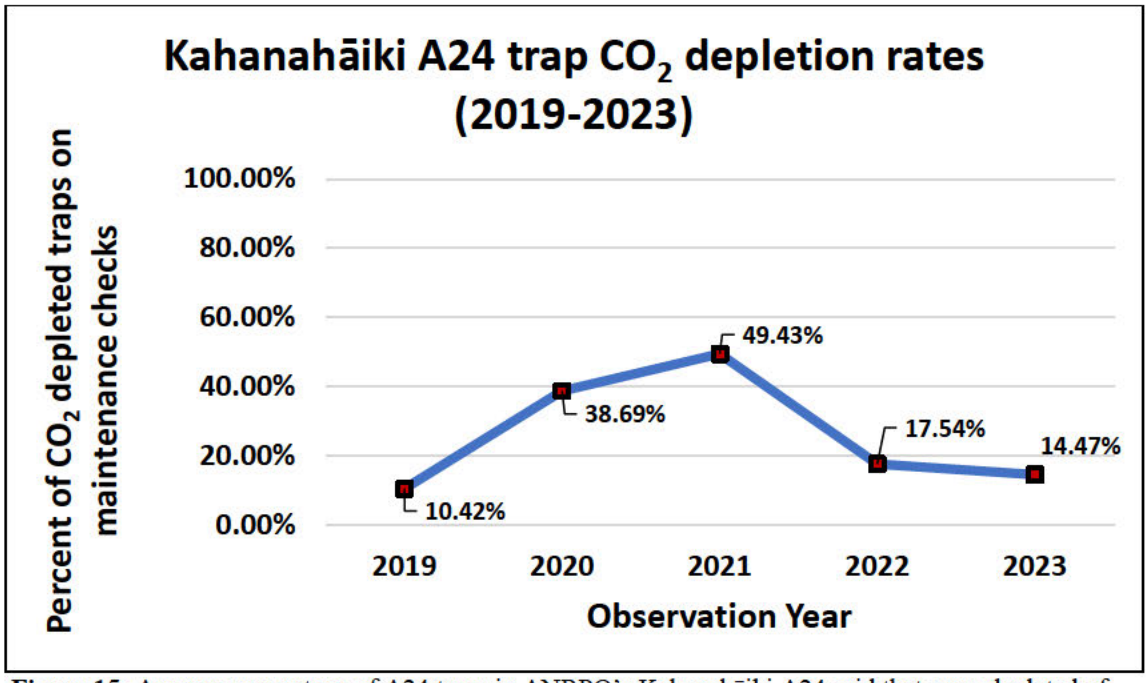

Figure 15: Average percentage of A24 traps in ANRPO's Kahanahāiki A24 grid that were depleted of CO_2. This figure displays all data from 2019-2023, when the current trap configuration was updated to its current extent.

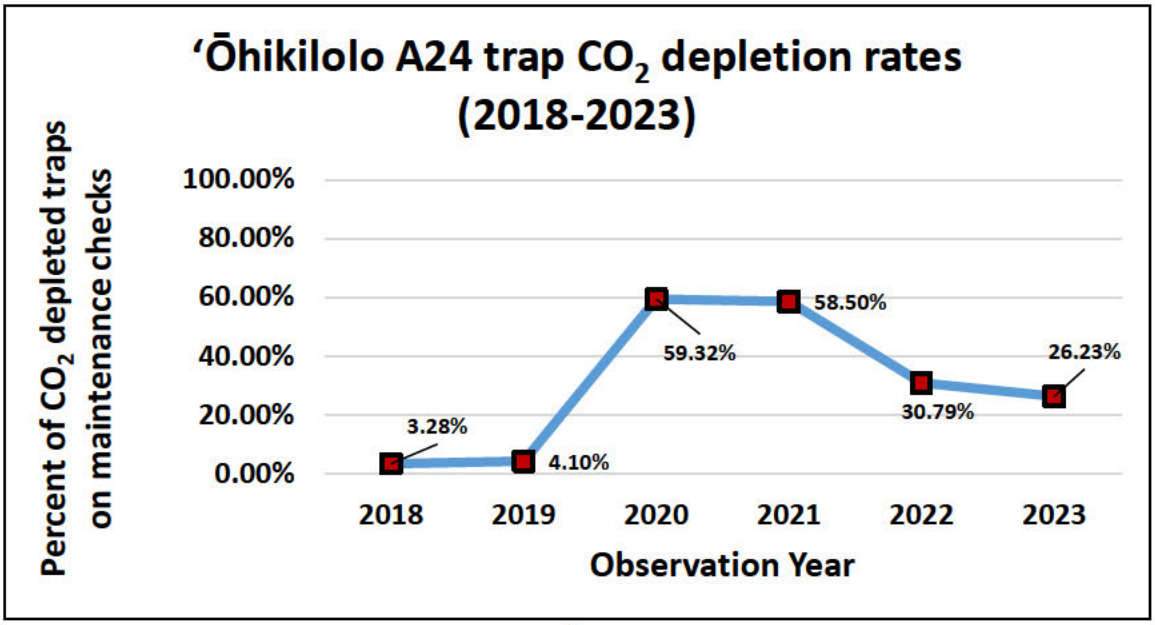

Figure 16: Displays the percentage of A24 traps at 'Ōhikilolo that were completely depleted of CO_2 upon ANRPO staff maintenance checks from 2018-2023. There is a clear increase in the number of traps running out of CO_2 two years after grid installation, which falls in line with what ANRPO sees at many other sites, and reflects previous reports from managers in New Zealand (Gillies *et al.* 2014). After shifting back to a four month maintenance interval, the number of failing traps seems to decrease substantially.

8.4 New ANRPO Rodent Control Grids (Installed during 2023 Report Year)

ANRPO seeks to constantly improve rodent control at all sites where rodents could potentially threaten managed taxa. During the 2023 report year, multiple sites received improved and updated rodent control resources.

8.4.1 Ka‘ena Point

During the summer of 2022, ANRPO noted damage on numerous individuals of *E. celastroides* var. *kaenana* located outside of the State's predator-proof enclosure at Ka‘ena Point (Figures 17, 18). To determine the cause of the damage, game cameras were installed on a few individual plants at this location in August of 2022. Images from game cameras showed that *Rattus* spp. were visiting the plants nightly (Figure 19) and were likely the cause of the visible girdling that was occurring on the branches of numerous individual plants.

Figure 17: Rodent gnawing damage on an *E. celastroides* var. *kaenana* individual at Ka‘ena Point.

Figure 18: Scars from rodent gnawing on *E. celastroides* var. *kaenana* individual at Ka‘ena Point.

Figure 19: Game camera imagery captured from Ka‘ena Point, of *Rattus* spp. visiting and causing damage to a population of *E. celastroides* var. *kaenana*

In response to this threat, ANRPO staff installed a rodent control grid composed of 40 A24 traps, and 32 Victor snap traps in a grid surrounding the population of *E. celastroides* var. *kaenana* to reduce the damage (Figure 20).

Image Redacted
Sensitive Information
Available Upon Request

Figure 20: Displays the full extent of ANRPO's trapping operations at Ka'ena Point. All traps were installed in August 2022.

8.4.2 'Ōhikilolo Ridge-Ko'iahi

ANRPO staff noticed severe damage to a population of *N. angulata* var. *angulata* out planted in 2022. In many cases, plants were gnawed all the way down to their root stock. To respond to this rodent damage, ANRPO installed a rodent control grid consisting of 24 A24 traps, and one AT220 (Figure 21). Since the installation of this control grid, ANRPO staff have not noted any damage on individual plants. Monitoring will continue, but this site will be maintained as a year-round rodent control site as long as there are remaining managed taxa persisting.

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Available Upon Request

Figure 21: Displays the newly installed rodent control grid at the ʻŌhikilolo Ridge/ Koʻiahi population of *N. angulata* var. *angulata*. This control grid was installed in January 2023.

8.4.3 Mākua ʻElepaio

ANRPO has continued to expand rodent control to protect isolated pairs of Oʻahu ʻElepaio that are found in Mākua valley (Figure 22). Currently there are three pairs that are receiving active rodent control in the valley (MMR16, MMR02, MMR10). Each isolated grid consists of nine (9) A24 traps that surround the core of each territory. As more pairs are located in Mākua, ANRPO will continue to expand rodent control to protect new paired territories.

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Sensitive Information
Available Upon Request

Figure 22: Displays the isolated control grids that are protecting ‘Elepaio territories located in Mākua valley. As more pairs are located throughout the valley, more trapping grids will be installed. The two territories without traps are single male birds and are currently not a priority for protection.

8.4.4 Koloa

ANRPO staff have frequently encountered rodent damage to seed collection bags on individuals of *G. cyrtandrae* and *P. hirsuta* at Koloa management unit. In an effort to minimize this continual threat, a small control grid of 12 A24 traps were installed in May 2023 (Figure 23). This grid will be maintained depending on seed collection needs onsite, and could be expanded if needed.

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Available Upon Request

Figure 23: Displays the small rodent control grid that was installed at Koloa management unit in May 2023. These traps are installed in an effort to reduce predation to seed collection bags.

8.4.5 Kalua'ā North Gulch

This site had a very small, limited control grid of six A24 traps from 2018-2022 that protected *C. grimesiana* subsp. *obatae*, *D. waianaeensis*, *E. herbstii, S. kaalae, U. kaalae, F. neowawraea*. Due to continual outplanting of many of the aforementioned taxa that has and will continue to occur at this site, the control grid was expanded to 31 A24 traps, and two AT220s (Figure 24). Installation occurred in March 2023. This expansion of control will provide large areas that supplemental out planting of managed taxa can occur within in the future.

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Available Upon Request

Figure 24: Displays the updated rodent control grid in the north gulch of Kalua‘ā and Wai‘eli MU. This grid was expanded in Q1 2023, and greatly expands rodent control at this site. Previous control efforts were limited to six A24 traps.

8.4.6 Manuwai

Previously, this area of Manuwai had two small independent rodent control grids. One grid (eight A24 traps) that protected a population of *D. waianaeensis,* and another small grid (six A24 traps) that protected a *Drosophila* monitoring site. Due to mortality at the original *D. waianaeensis* site, a new outplanting of the same taxa was planted within the current *Drosophila* site. Due to this overlap of managed taxa, ANRPO reconstructed the rodent control grid to support rodent control to benefit both taxa which are now located at the same site (Figure 25). There are also ‘Elepaio that nest in the area, and ANRPO is hopeful that this control grid will provide overlapping protection for all of these managed resources. In May 2023, a new rodent control grid was installed around the new planting of DelWai.ANU-B and the *Drosophila* zone. This control grid is composed of 25 A24 traps, and will be maintained year-round.

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Available Upon Request

Figure 25: Displays the updated rodent control grid at the Manuwai *Drosophila/D. waianaeenesis* site. This grid was completed in May 2023.

8.4.7 Makaleha West

Makaleha West management unit is home to multiple ANRPO managed plant taxa that are threatened by rodents (*C. grimesiana* subsp. *obatae*, *P. kaalae, C. longiflora, D. waianaeensis*), as well as a snail enclosure that protects *Achatinella mustelina* from ESU B. Due to the high number of managed taxa and the continual expansion of outplanting at this management unit, ANRPO expanded and improved the rodent control . The new grid is composed of 59 A24 traps that primarily cover all of the outplanting, endangered taxa areas (Figure 26), as well as improving the trap spacing around the perimeter of the enclosure. There are also likely nesting sea birds in the area that benefit from the expanison of rodent control.

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Figure 26: Displays the updated rodent control grid at Makaleha West management unit. Previously rodent control was clustered around the snail enclosure and one small outplanting area. Expanded control improves the density of traps, and expands the protection buffer around managed taxa.

8.4.8 Makaleha East Pritchardia Protection

The knife ridges characteristic of the Makaleha East region are home to many critically endangered *P. kaalae*. In an effort to bolster fruit collection from these populations, ANRPO has continued to improve rodent control in areas that are accessible to staff. Beginning in January 2022, ANRPO installed a total of 16 A24 traps around three clusters of *P. kaalae* (Figure 27). In March 2023 ANRPO expanded control with the addition of 12 extra traps, bringing the total on-site to 28 A24 traps. These traps will be maintained until an appropriate number of fruits are collected from new founders that compose these palm stands.

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Figure 27: Displays isolated patches of *P. kaalae* that are now receiving rodent control in the Makaleha East management unit.

8.5 Field Testing the AT220 from NZ Auto Traps

Over the past decade, there have been tremendous advances in the field of rodent and invasive small vertebrate control. One of these is a new tool from New Zealand, the AT220 trap (Figure 28), which was developed and is manufactured by NZ Auto Traps (ANRPO 2022).

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 data on numbers of triggers, time deployed, mechanical issues, location, and size of animal killed. This information can be accessed by staff 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 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.

Figure 28: The AT220 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.

As mentioned in previous years (ANRPO 2022), ANRPO has been seeking alternative "automatic" traps that could be used in conjunction with current trapping regimes which rely heavily on A24s. The AT220 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*.

Four (4) AT220 traps were deployed at ʻŌhikilolo management unit in the middle of April 2022 (Figure 29), to assess the effectiveness of this trap at removing *H. auropunctatus* that were impacting ANRPO rodent tracking tunnel data (Figure 5). ANRPO confirmed two *H. auropunctatus* kills within 24 hours (Figure 30, 31). July 2022 was the first observation period where 0% *H. auropunctatus* tracking was observed via tracking cards since November 2021. Prior to the 0% tracking in November 2021, *H. auropunctatus* tracking percentages maintained levels above 10% since December 2018.

Image Redacted Sensitive Information Available Upon Request

Figure 29: Displays the rodent control grid at ʻŌhikilolo, with the four AT220 traps installed. This map shows the complex terrain that limits the extent that successful rodent control can be conducted at this management unit.

Following the AT220 trap installation in April 2022, ANRPO maintained very low levels of *H. auropunctatus* throughout the reporting period. Aside from two instances of *H. auropunctatus* being detected in two individual tunnels in November 2022, tracking has been reduced to 0%. This has been very encouraging, and these traps will remain in place throughout the 2023-2024 reporting period.

Figure 30: The AT220 has demonstrated repeated effectiveness in humanely dispatching small Indian mongoose (*H. auropunctatus*).

Figure 31: One of the first documented *H. auropunctatus* kills at ʻŌhikilolo management unit.

While ANRPO has confirmed the AT220's effectiveness in removing *H. auropunctatus*, *Rattus* spp., and *M. musculus*, it seems that the AT220 in its current configuration is not the best tool to deal with *F. catus* of varying size and age classes.

At ʻĒkahanui, ANRPO confirmed that two (2) *F. catus* individuals were caught during our testing phase. The fish oil used as bait seemed to be attractive, and would consistently draw different cats to each trap. The two individuals that were caught at ʻĒkahanui were large, 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 AT220 at ʻŌhikilolo MU on August 6, 2022. This cat seemed to be smaller in size than the individuals from ʻĒkahanui, and the AT220 dealt a lethal head strike. Size of each individual animal is likely a critical factor in how well the AT220 can handle each cat.

ANRPO sent photo documentation of these interactions to the manufacturers at NZ Auto Traps. Other users in Hawaiʻi (Haleakalā National Park) have demonstrated similar variability in the lethal impact that the AT220 has on cats. Based on the photos ANRPO sent, NZ AutoTraps will be modifying the AT220 and are adding an additional "choke bar" (Figure 32) 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 AT220 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.

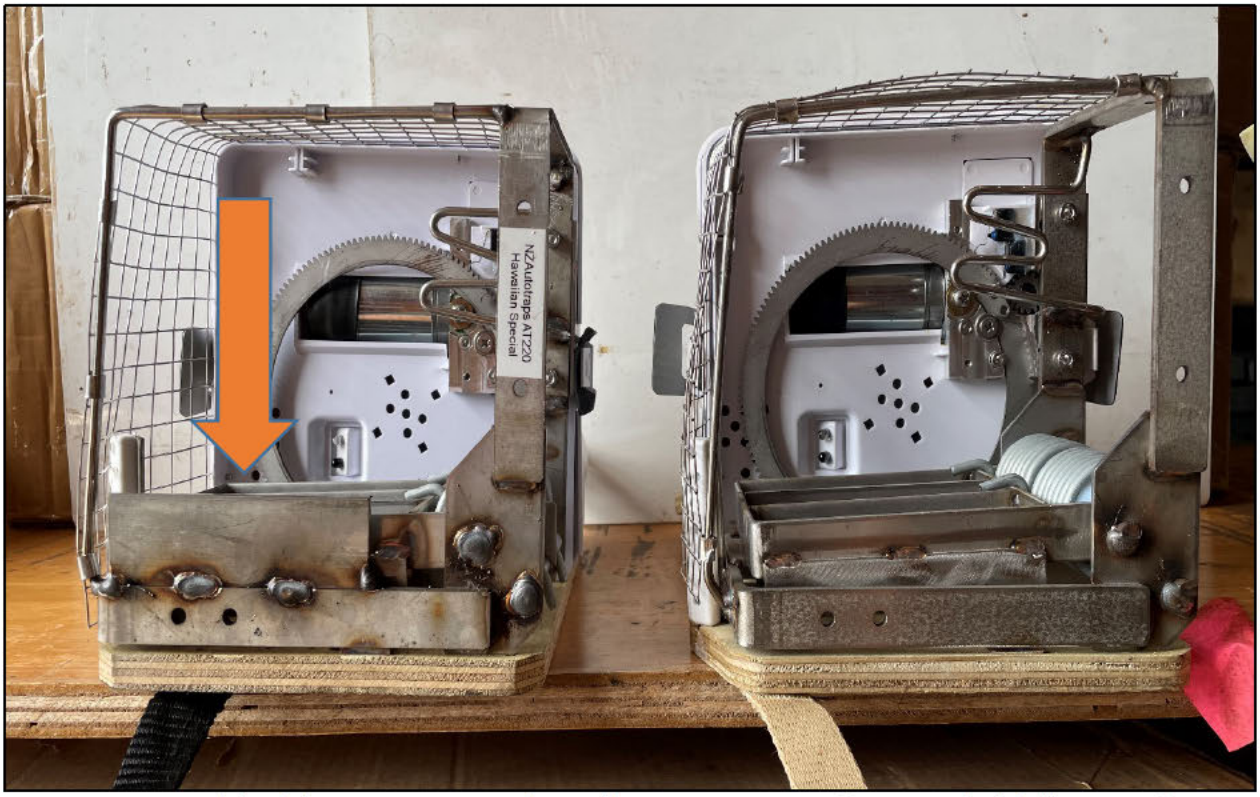

Figure 32: Two models of the AT220 trap manufactured by NZ Auto Traps. The trap on the left (known as the 'Hawaiian special') is modified with an extended choke (see orange arrow) bar with the intent of making the trap more effective at humanely dispatching *F. catus*. *Photo taken by Troy Levinson*

ANRPO is one of the few conservation programs using the AT220 in Hawai'i. 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 over time, especially under the varying field conditions that the ecosystems of O'ahu provide. 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.

8.6 Snail Enclosure Small Vertebrate Control - New Developments

Achatinella mustelina have been managed by ANRPO since the program's founding. Due to the numerous threats to this taxa, the primary means of protection has been the translocation of individuals into predator-proof snail enclosures. These enclosures have been designed and constructed to keep predatory species such as *Euglandina* spp., *Rattus* spp., *M. musculus*, and *T. jacksonii xantholophus* away from the *A. mustelina* populations, while allowing the Kāhuli to still remain in their native habitat.

ANRPO manages six snail enclosures for the protection of *Achatinella mustelina* and their unique ecologically significant units. Due to the physical barrier that each enclosure provides, threats to *A. mustelina* are able to be managed more efficiently at each location. Although these structures overall do a great job at providing protection from predators, rodent incursions do occur with some regularity. Due to stochastic threat incursions, it is important that ANRPO and partners are adaptable and able to respond to threats as they arise.

8.6.1 Rodenticide applications at snail enclosures

Snail enclosures have small trapping grids around their outside perimeter to reduce rodent pressure on the exterior, a few A24 traps on the inside (to deal with any rodents who may be able to get inside), and four tracking tunnels that are used to monitor any potential incursions. ANRPO also maintains snap traps within each of the enclosures in case a rapid response to rodent incursion is needed. Since 2020 ANRPO has also conducted hand broadcasts of Diphacinone-50 Conservation rodenticide on a quarterly basis, to cover a 10m buffer around the perimeter of all enclosures.

This system has worked well over the years for managing *Rattus* spp. Whenever ANRPO has found incursions (via tracking tunnels) staff responded with rapid response snap trapping, and typically rats are found under the A24s in a relatively short time period.

Previously, rodent control within these enclosures was limited to the use of traps, as there was speculation that rodenticides could have detrimental impacts on *A. mustelina* if they ingested the toxicant. The potential for adverse impacts on native snails was examined by the Snail Extinction Prevention Program (SEPP) in 2023, and revealed that the anti-coagulant rodenticide Diphacinone-50 Conservation had no impacts on native snails or non-native snail/slug species (Stiefel et al., 2023) During the reporting period, ANRPO requested an informal consultation from the US Fish and Wildlife Service (USFWS) to allow for applications of Diphacinone-50 Conservation (EPA Reg. No. 56228-35) within ANRPO managed snail enclosures to quickly respond to rodent incursions. On May 22, 2023, USFWS granted ANRPO's request to utilize this tool.

ANRPO will utilize Diphacinone-50 Conservation to control rodent populations if/when rodents are detected inside snail enclosures via tracking tunnels. Treatments will consist of two hand broadcast applications that take place 5-7 days apart and will be broadcast evenly throughout the enclosure area. Treatments will continue until there are two consecutive nights of tracking cards that contain zero rodent prints. During this same period, there will also be treatments occurring in the 10m perimeter buffer around the enclosure. Once there are no rodents detected on the inside, the buffer treatment will revert to normal quarterly applications.

8.6.2 Managing Jackson's chameleons (*Trioceros jacksonii xantholophus*) at snail enclosures

Jackson's chameleons (*Trioceros jacksonii xantholophus*) escaped from captivity in Kāneʻohe, Oʻahu in 1972 (Mckeown 1991). Since that time individuals have been found across the island, even at high elevations in the Waiʻanae range. Due to their behavior as generalist predators, chameleons can cause catastrophic damage to populations of native invertebrates, including populations of *A. mustelina*. During the 2023 report year, two *T. jacksonii xantholophus* individuals were found within the Hāpapa snail enclosure. A live female was collected and a dead male was found at a later date (Figure 33).

Figure 33: Displays the female *T. jacksonii xantholophus* that was collected from within the Hāpapa snail enclosure during a 2022 timed-count monitoring.

Due to the high risk that this species poses to endemic snail populations, ANRPO takes the threat of *T. jacksonii xantholophus* incursions into snail enclosures very seriously. ANRPO instituted a Jackson's chameleon removal protocol whenever an individual is detected within any snail enclosures (Appendix 5-4).

Currently, ANRPO is working with the State of Hawai'i Division of Forestry and Wildlife's Snail Extinction Prevention Program (SEPP) to improve detection protocols for *T. jacksonii xantholophus*. In the next year we are cooperativly working with Rogue Dogs, a company from Washington, to again investigate the possibility of using dogs to detect the presense of *T. jacksonii xantholophus* in enclosures. Due to their cryptic nature, detection can be very difficult. It will be critical to continue to improve protocols for future monitoring.

8.7 Peafowl (*Pavo cristatus*) Damage to ANRPO managed taxa

ANRPO manages and outplants *Neraudia angulata* var. *angulata* in an effort to stablize the taxa in management units across the Wai‘anae range. In early 2022, ANRPO staff noticed damage to a recently outplanted population of *N. angulata* var. *angulata* at the Kamā‘ili management unit. Due to the varied damage on individual plants (girdling of branches, vegetation ripped from plants, trampling), it was important for ANRPO to obtain confirmation of which organisms were causing the damage. Staff installed multiple game cameras on site in the spring of 2022. Upon reveiw of the camera footage it was clear that Peafowl (*Pavo cristatus*) were abudnant in the area, and were the primary animal causing damage to the *N. angulata* var. *angulata* (Figure 34).

Figure 34: (Left to right) Displays various documented instances of *P. cristatus* damaging *Neraudia angulata* var. *angulata* at Kamā‘ili MU.

Due to this population of plants falling on Board of Water Supply (BWS) land, ANRPO shared photos of the damage and the suspected culprits with the conservation managers of BWS. There are relatively limited options for control actions at this site, due to the nature of the land use and the target species. ANRPO proposed the limited use of pneumatic air guns (PAGS) to selectively remove the *P. cristatus* individuals who are causing the bulk of the damage. BWS opposes the use of firearms, or guns of any kind due to the potential public relations issue that their use might generate.

Another control option could utilize body grip traps (Conibear 110/220) to remove the *P. cristatus* in the area. ANRPO will continue to work with the BWS to seek viable control options at this mangement unit, as it is likely that this threat will need to be managed moving forward.

8.8 ANRPO FUTURE SMALL VERTEBRATE PLANS

ANRPO will continue to develop best practices for utilizing Goodnature A24 traps in Hawai‘i. 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 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* spp., and *M. musculus*.

Game cameras provide the ability to conduct rigorous resource response monitoring. ANRPO will 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 AT220 trap system into management units in the Wai‘anae range. ANRPO will seek to install AT220s in conjunction with preexisting control grids to bolster overall effectiveness.

ANRPO will seek to improve small vertebrate threat monitoring and control at snail enclosures across the Wai‘anae range, especially focusing on improving *T. jacksonii xantholophus* detection and control techniques.

Previous research from Case *et al*. (2022) highlight the role of non-native galliforms as seed predators. Due to their somewhat ubiquitous spread across the Wai‘anae range, these birds are increasingly a management concern for native plant species and their long-term recruitment potential. Any seed that makes it to the ground due to successful rodent control, might ultimatley be eaten and destroyed by Kalij Pheasants (*Lophura leucomelanos*) or Erckel‘s Francolins (*Pternistis erckelii*). ANRPO will begin to develop more sustainable control options to manage these threats in MUs across the Wai‘anae range. Shooting the birds is one option, but ultimately developing some sort of trapping regime might be the most sustainable way forward. ANRPO will seek to work with partners to improve the control tools for this group of species that are impacting common native species as well as managed taxa.

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CHAPTER 9: ALIEN INVERTEBRATE AND FOREST PEST MANAGEMENT

Under the Mākua Implementation Plan (MIP) and Oʻahu Implementation Plan (OIP), the Army Natural Resources Program on Oʻahu (ANRPO) is responsible for safeguarding several threatened 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 of decline for many native species. Often, invasive invertebrates will disruptively integrate into the food web applying new predation pressures on native species. *Euglandina rosea,* the rosy wolfsnail (RWS), also known as the cannibal snail, is a generalist predator of terrestrial gastropods. RWS is among the most voracious predators of *Achatinella mustelina* (Hadfield and Mountain, 1980), an endangered tree snail (referred to as 'tree snail' for the remainder of this chapter) that falls under ANRPO protection mandates as it is endemic to the Waiʻanae mountains.

Except for exclusion, there are limited options for RWS removal and control; see Chapter 5 for more information about *A. mustelina* management. ANRPO currently maintains six predator resistant snail enclosures into which tree snails have been translocated to allow for the establishment of stable populations. The enclosure design includes three RWS barriers; one electric and two physical (an angle and mesh wire), which together are assumed to provide adequate protection from RWS incursion into the enclosure (Rohrer *et al*. 2016). These barriers were designed using the best available knowledge of RWS and information obtained from a series of trials conducted by biologists from UH - Mānoa and ANRPO. ANRPO has a RWS survey protocol that is performed quarterly at every snail enclosure (see Appendix 5-5).

9.2 SLUGS (STYLOMMATOPHORA)

9.2.1 Summary of Impacts to MIP/OIP Rare Plants

Slugs are major predators of seedlings; however, their impacts can be difficult to quantify as they are nocturnal and tend to feed on emerging seedlings so tiny that the plants often are destroyed before they can be noticed and accounted for. Host plants at any life stage are 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, but slugs have shown a preference for seedlings. Exclusion experiments revealed slugs have an outsized impact on plant survivorship, which in time, can impact the structure and function of the entire ecosystem (Lauren and Whitlow 2012; Rathke 1985).

Seedling recruitment (or lack thereof) has been shown to be influenced by a vast number of interconnected factors. Natural resource managers working with endangered plants are challenged by these many factors and are forced to attempt to balance and control as many of them as possible to best ensure survival of plant populations. Ecosystems are dizzyingly complex and most often endangered species recovery (and decline) is caused by interconnected factors.

Rare Plant Recovery Plans published by the US Fish and Wildlife (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). In a six-month study, *Cyanea superba* subsp. *superba* and *Schiedea obovata* survival in the presence of slugs was halved when compared to plants that were protected by molluscicides (Joe and Daehler 2008). In food preference studies, Joe 2006 showed that slugs prefer the endangered *Urera kaalae* to any other plant species tested (26 in total), even organic lettuce, to which they are known

to be a significant pest. *Urera* is the primary host for *Drosophila montgomeryi*, an endangered picture wing fly (see Chapter 7: Rare Insect Management). Thus, slug herbivory on endangered plants can impact the long-term survival of endangered invertebrates as well.

9.2.2 Slug Control Program Development 2006-2018

Very few pesticides are approved for forest use, making pest management in natural areas extremely difficult. Land managers who wish to use a product often must work with pesticide manufacturers and government regulators in a long and arduous process to extend the use of a pesticide to include wild lands (forests, natural areas, grasslands, etc.). The crux of the situation is that there is little incentive for the pesticide manufacturer to pay for additional research and the registration fees associated with including wild lands on the pesticide label when the end users are a relatively small handful of conservationists.

Prior to 2010, ANRPO attempted to protect plants from slugs using physical barriers in combination with beer traps. Experiments showed these attempts were futile as neither treatment reduced slug abundance nor improved survival of rare plant taxa. ANRPO significantly invested in research and development of new slug control techniques. Fortunately, the product Sluggo, by Neudorff, was approved via a Special Local Needs label for forest use that same year. 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 Kahanahāiki 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* spp. and *Cyanea* spp. and was, on average, greater for *Cyrtandra* spp. but not significant due to low germination across all groups (Kawelo *et al*. 2012).

In October 2020, after a decade of use, the supplemental label permitting Sluggo to be used in forests expired and was not renewed. The expiration of Sluggo's forest use permit had little effect on ANRPO's slug management because in 2016 ANRPO began using Ferroxx AQ, another iron-based product made by Neudorff which is labeled for use in forests. The Ferroxx AQ label does not include restrictions on application at sites containing native snails, however, to minimize non-target impacts to rare tree snails (along with other endemic snails), staff continue to follow the native snail survey protocols which were developed for Sluggo's use before treating a new area (ANRPO 2022). Following a 2017 study which showed Ferroxx AQ to be more effective than Sluggo under field conditions staff began using Ferroxx AQ throughout all but one of ANRPO's MUs (ANRPO 2017). Mākaha was the exception, where Sluggo was used until Oct. 2020 because of restrictions on the use of new pesticides from the Board of Water Supply (ANRPO 2017). Mākaha is now treated with Ferroxx AQ under a permit that ANRPO annually applies for with the Board of Water Supply.

9.2.3 Current Status: 2022-2023

ANRPO does not have the resources to continuously control slugs at every site containing plants threatened by slugs. Most of the sites with active slug control were prioritized in 2015 according to the following factors; 1. Anecdotal and unpublished evidence of slugs feeding on the plant (no experiments on Hawaiian taxa had been published at the time, but a M.S. completed through the program and field observations confirmed slug damage); 2. The plant population represents the only extant population of that taxon within the MU (generally this will be for rare plants); and 3. Slugs are locally abundant while native snails have been absent from the area for multiple years. This resulted in slug control being prioritized for 11 rare plant taxa.

Slug control areas (SLCAs) are mapped around rare plant populations using ArcGis and are checked

annually during rare plant monitoring actions. The data is used to calculate the Ferroxx AQ application rate which can change over time as plant populations expand (recruitment, additional outplantings) or contract (death). A single SLCA may be comprised of multiple distinct treatment sites (shapes drawn within Arc to symbolize the treatment area) if the plant population is discontinuous. There also may be multiple population reference sites within a single SLCA. Currently, there are 34 SLCAs protecting 51 rare plant population reference sites within ANRPO MUs being treated with Ferroxx AQ (refer to Chapter 4 for more information on rare plant population reference sites). The total area covered by Ferroxx AQ treatments during this reporting year is 51,825 m^2. All but one area are treated on a rolling six week basis. The exception, ʻŌpaeʻula Lower, is treated once per quarter due to difficulties with access. ANRPO plans to continue to expand SLCA areas as rare plant outplantings conitnue and established populations grow. Native snail surveys will be conducted before treatment begins in a new area.

Table 1: Plant species (and populations) treated and slug control treatment area (all SLCAs combined) by MU in 2022-2023.

MU	Plant species treated (Population Reference Code [PRC] in parentheses)	Treatment Area (m^2)	Numbers of SLCAS in MU
ʻĒkahanui	*Cyanea grimesiana* subsp. *obatae* (EKA-C), *Delissea waianaeensis* (EKA-D), *Schiedea kaalae* (EKA-D)	2,615	1
Kaʻala	*Geniostoma cyrtandrae* (ALA-S), *Phyllostegia hirsuta* (ALA-A)	1,445	1
Kahanahāiki	*Cyanea superba* subsp *superba* (MMR-E), *D. waianaeensis* (MMR-A), *Schiedea obovata* (MMR-G, MMR-I)	3,770	3
Kaluaʻā and Waiʻeli	*D. waianaeensis* (KAL-C, KAL-D), *S. kaalae* (KAL-B, KAL-C), *C. grimesiana* subsp. *obatae* (KAL-B, KAL-E), *C. superba* subsp. *superba* (KAL-B), *Phyllostegia mollis* (KAL-C)	14,522	5
Kapuna Upper	*Cyanea longiflora* (PIL-B, PIL-C, PIL-F), *S. kaalae* (KAP-A), *Schiedea nuttallii* (PIL-B), *Euphorbia herbstii* (KAP-C, KAP-E)	2,266	5
Mākaha	*C. grimesiana* subsp. *obatae* (MAK-B), *C. longiflora* (MAK-B, WAI-A), *Hesperomannia oahuensis* (MAK-B) *Kadua degeneri* subsp. *degeneri* (MAK-A), *S. obovata* (MAK-E)	4,019	3
Makaleha West	*C. grimesiana* subsp. *obatae* (LEH-B), *C. longiflora* (LEH-B), *S. obovata* (LEH-B, LEH-D)	2,915	4
Manuwai	*D. waianaeensis* (ANU-A)	1,430	1
ʻŌpaeʻula Lower	*Cyrtandra dentata* (OPA-F)	1,050	1
Pahole	*C. longiflora* (PAH-A, PAH-I, PAH-J), *D. waianaeensis* (PAH-C), *E. herbstii* (PAH-G, PAH-R, PAH-S), *Schiedea kaalae* (PAH-C), *S. nuttallii* (PAH-A, PAH-D, PAH-E)	10,110	7
Palikea	*C. grimesiana* subsp *obatae* (PAK-A, PAK-B, PAK-C), *C. superba* subsp *superba* (PAK-C), *P. hirsuta* (PAK-A)	7,715	3

9.3 Invasive Ants (Formicidae)

Hawaiʻi lacks native ants. Of the over 60 species now present, all were likely transported introductions by humans. Twelve are considered to be invasive and six are members of the infamous IUCN's World's Worst Invasive Species list. With the help of their ability to use a wide variety of resources, ant species have successfully colonized large swathes of disturbed, and on occasion predominantly native, areas (Krushelnycky *et al.* 2005). They can directly prey upon rare native insects, as is the case with *Solenopsis papuana*, which was found to reduce picture wing fly (*Drosophila,* see Chapter 7) survival by 58% (Krushelnycky *et al.* 2017), and *Pheidole megacephala* (Big-headed ants), which threatens native endangered bees (Sarnat *et al.* 2015; Magnacca 2020). Ants also affect plants by reducing pollinators

(Sahli *et al.* 2013) and by farming plant pests such as scales and aphids which can lead to secondary outbreaks of sooty mold.

ANRPO aims for early detection of problem species, delineation of infestations when found, and localized eradication if possible. In many cases, eradication is not possible and ANRPO's focus is long term management of the invasive species to best protect threatened native taxa. In order to accomplish these goals, staff have carried out annual standardized ant surveys since 2004 across areas with a high risk of ant introduction or are particularly susceptible to ant impacts: trailheads, outplanting sites, *Drosophila* sites, campgrounds, fence lines, snail enclosures, helipads, and roads (Figure 1). Ants in these areas have been sampled using either baited vials or cards left out for one hour. The method depends on who is sampling and the purpose of the sampling. The vials are easy-to-use and can provide a good snapshot of species present while the cards are more labor intensive but allow for a more targeted sample when looking for specific species. While sampling is scheduled during the summer months when ants are more active, variability of field conditions and limited site accessibility necessitates sampling opportunistically year-round. Sampling has not been consistent in the past few years due to staffing issues. Sampling resumed in the summer of 2023 and ANRPO will be able to give a detailed breakdown of detected species by MU in next year's report.

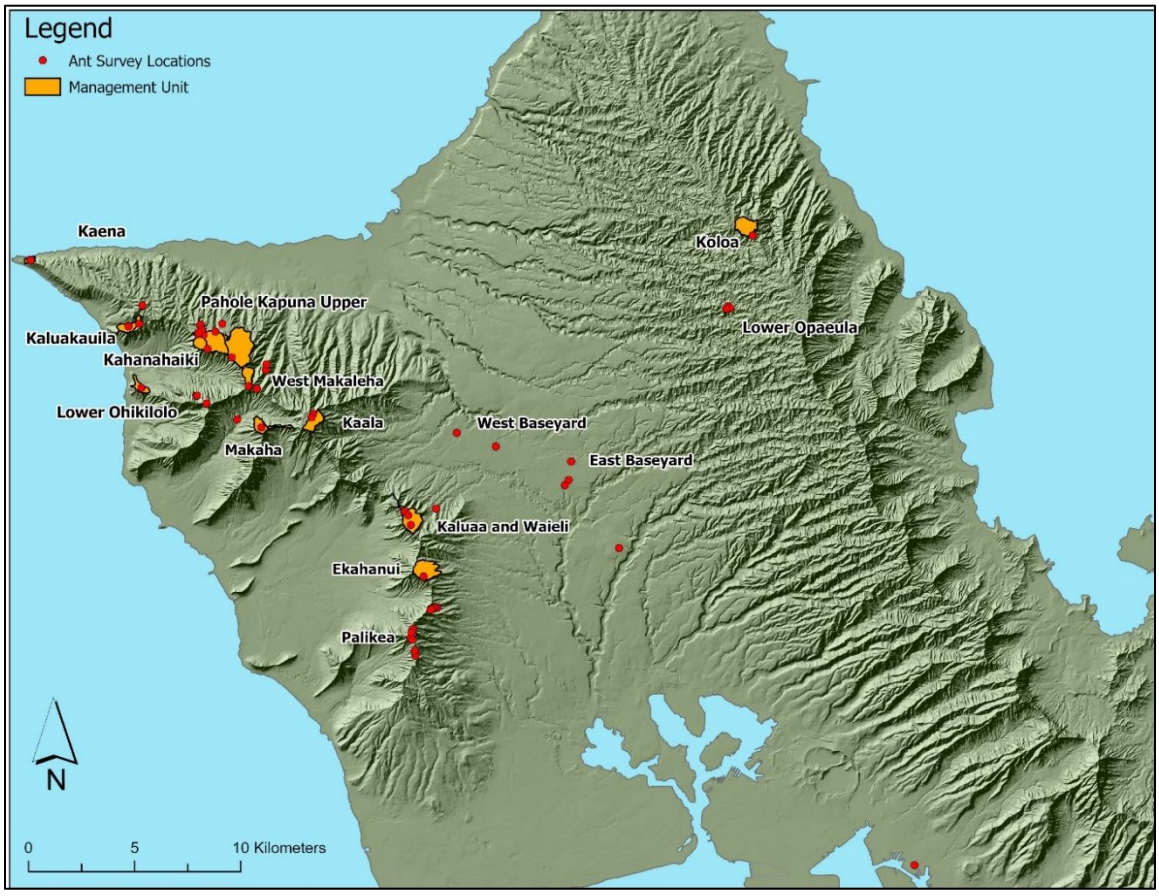

Figure 1: Map showing locations of annual ant surveys for the purpose of detecting new ant incursions.

The methodology that has previously been used for ant sampling is outlined in the 2010 ANRPO year-end report. Starting in the summer of 2023, ANRPO will slightly alter sampling methods to more specifically target two species of significant concern: little fire ants (*Wasmannia auropunctata;* LFA*)* and yellow crazy ants (*Anoplolepis gracilipes;* YCA). Per recommendations from the Hawai'i Ant Lab, LFA

sampling solely uses peanut butter as a bait. YCA are known to be a sugar-loving species, but ant colonies are known to change their dietary preferences based on the needs of the colony. Bait testing with a YCA population in Kahanahāiki has shown that YCA tend to avoid baits with peanut butter (see Figure 2). Therefore, the new sampling protocol involves using 50 mL vials made to target LFA, using peanut butter, and to target YCA, using syrup and spam. The vials will also attract other ant species and will allow for a reliable sampling of the location's ant community. This sampling method is modified from what researchers at USFWS recommend; their recommendation is all 3 baits in one 50 mL vial.

While the sampling methods list above are far from perfect (for complexities surrounding ant sampling see King and Porter 2005), they will provide an adqeuate snapshot of ant species diversity in ANRPO's MUs. If species of concern are found, the Alien and Invertebrate Forest Pest Biologist will revisit the area and sample using a mix of methods (pitfall traps, leaf litter, bait cards, etc.) to get a better understanding of what the infestation looks like and if treatment is an option.

Figure 2: Ant bait testing for yellow crazy ants at the Kahanahāiki snail enclosure. The card on the left has peanut butter (bottom left of the card), spam (top left), and syrup (top right and bottom right). Notice the lack of interest in the peanut butter. The card on the right only has syrup.

Treatment of an ant infestation is heavily dependent on the following factors:

1. Availability of treatment options
2. Size of the infestation
3. Location of the infestation relative to MIP/OIP taxa
4. The species is not widespread in adjacent areas
5. The species is known to harm native species
6. The site is an area of high traffic; the likelihood of the infestation spreading from this location is high

YCA were first detected at the Kahanahāiki snail enclosure in 2017. Early treatment failed to eradicate the population and the population has since expanded its boundaries to two acres around the enclosure. To estimate density within the infestation, ANRPO searched for nests within a 50 m^2 area. The survey led to the conclusion that there is a nest every 4 m^2, equating to 2,000 nests in the broader area. There is a concern that YCA can affect the reproduction and survival of native tree snails, though there is no data that confirms this. This concern largely comes from the well documented ability of YCA to devastate invertebrate and vertebrate communities throughout their invasive range (Lee and Yang 2022). YCA are known to spray formic acid from their abdomens, a behavior that can be offensive or defensive. Currently, the only treatment option for YCA in the forest is MaxForce Complete Granular Insect Bait (Bayer SC). The use of Maxforce has been effective, with foraging YCA populations dropping 85% after

treatment. Maxforce Complete easily degrades in the rain and will be essentially useless during the wet season so alternative treatment options are needed. Relying on a single insecticide (and active ingredient) is also a recipe for disaster with insect control as it is known to lead to inseciticide resistance and bait avoidance. Promising research from UH Manōa has examined the use of hydrogels saturated with dinotefuran or boric acid for YCA control and ANRPO is talking to researchers from USFWS and UH Manōa about pursuing hydrogel trials in the forest.

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.

9.4 COCONUT RHINOCEROS BEETLE (*ORYCTES RHINOCEROS*)

9.4.1 Background and History

Coconut rhinoceros beetle (CRB) was first detected on Oʻahu 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 Hala, agave, sugarcane, banana, and pineapple (USDA-APHIS 2019). Adult beetles burrow into the crown of palm trees, feeding on meristematic tissue. CRB pose a threat to local agriculture and tourism, as well as to Hawaiʻi's native loulu (*Pritchardia* spp.) fan palms. CRB primarily breed in decomposing plant material (mulch, compost, etc.), preferring palm material, and are easily spread via movement of mulch. Adults can also disperse by flying, although experts suggest they are relatively poor fliers.

Since 2014, ANRPO has been a member of the CRB Working Group led by Coconut Rhinoceros Beetle Response Hawaiʻi (CRBRH), in collaboration with the Hawaiʻi Department of Agriculture (HDOA). Starting in February 2014, ANRPO assisted island-wide survey efforts by monitoring and maintaining 18 panel traps (pictured below in Figure 3) on Schofield Barracks, Wheeler Army Airfield, ANRPO's East Base in Wahiawā, 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 Oʻahu area during this time. Internal reports shared with cooperators by the CRBRH show steady CRB spread on Oʻahu since its arrival, with large range expansions occurring over the last three years. CRB is now spread throughout lower elevations on Oʻahu.

In August 2022, a CRB was found in a trap at the Kaʻala summit, marking the highest elevation find on Oʻahu. In April 2023, CRB damage was identified on a reintroduced loulu in the ʻŌhikilolo MU. This was the first time CRB damage was documented on loulu in the upper elevations of the Waiʻanae Mountains. CRB were also found on Kauaʻi in the summer of 2023, the first time CRB have been found on another Hawaiian island.

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 3). 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 most of the traps quarterly while the remainder, due to difficulties with access, are checked opportunistically.

Figure 3: 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.

As concern about CRB establishing on the other Hawaiian islands spreads, natural resource managers have been taking steps towards reducing the likelihood of CRB's spread and setting up early detection systems. The main tool for early detection is the panel trap, some of which have been sent to Army natural resource managers on Hawai'i island for deployment at Pōhakuloa Training Area (PTA) and Hilo International Airport.

9.4.2 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*. Highlights from this year include:

- The group continued supporting research from the Melzer lab (UH) examining habitat limitations and host preferences of CRB.
    - ANRPO staff collected temperature data from 'Ōhikilolo, an area densely populated with loulu, and shared it with Dr. Melzer so his lab could explore CRB survival and fecundity within the location's temperature range. This trial is coming to an end and results are expected in the fall of 2023.
    - CRB can shift to non-palm food sources, and the Working Group is eager to learn what other Hawaiian taxa may be at risk. With input from the group on which taxa to focus on, the Melzer lab has been running feeding trials with adult CRB. The feeding trials will be completed by the end of the year and the next phase of the study, focused on evaluating the breeding abilities of CRB fed alternative hosts, will begin shortly after. The second phase of the trials will use data collected from the feeding trials to see how well CRB survive and reproduce on different food sources. Thus far, the trials have demonstrated that CRB will feed on *Touchardia oahuensis, Sadleria* spp., *Angiopteris evicta,* and *Cibotium* spp.
    - Identifying safe propagule storage for *Pritchardia* is a priority. ANRPO staff is working on this with a Working Group subcommittee. Focus points include supporting research into germplasm cryostorage with Lyon Arboretum and the USDA-ARS-National

Laborartory for Genetic Resource Preservation, and identification of potential living collection sites on O‘ahu, across the state, and on the mainland U.S. San Diego Zoo has agreed to establish a living collection at their facilities but the details of the partnership have yet to be established. ANRPO has constructed a nursery structure to house a living collection on Schofield Barracks. Refer to Chapter 4 for more information.

9.4.3 Survey Results and Field Activity Highlights

Currently, ANRPO staff and DPW collaborators monitor 67 panel traps on state and DOD lands (Figure 4). The majority of the traps are deployed in the Wai‘anae Mountains as this is where the most sensitive loulu habitat is. One trap is deployed in the Kahuku Training Area (KTA), near populations of *P. bakeri* and *P. kahukuensis*. Unfortunately, just during the year, staff documented clear spread of CRB into natural areas (Figure 5).

Details of these surveys are described by region, below.

Image Redacted
Sensitive Information
Available Upon Request

Figure 4: CRB trap locations.

Figure 5: CRB damage from ʻŌhikilolo. The image on the left, a bore hole at the base of a palm frond, is one of the main characteristics of CRB damage. The image on the right, and specifically the frond just above the ANRPO team member, shows another symptom of CRB damage, a fan palm frond cut short with scalloped edges.

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 until July 2021. Currently, staff monitor 38 traps across Schofield and Wheeler. Beetles have been found in 36 of the 38 traps. Beetles have been found boring into royal and fan palms on Schofield as well as their preferred coconut palms. DPW staff continue to coordinate with the contracting office and landscapers to prevent movement of mulch and plant materials on and off Base, guided by the US Army Garrison's new green waste policy (US Army 2023). The removal of a breeding site (CRB larvae were found in a mulch pile) from Green Thumb Nursery on Schofield Barracks was coordinated during the report year and completed in August 2023.

Mākua Valley

In December 2020, CRBRH detected a CRB in a trap on Farrington Highway along the Mākua 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 Mākua 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 Mākua about the threat of CRB to native resources.

In November 2021, 20 coconut palms planted around Range Control were removed and disposed of 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 detected in all eight traps near the Mākua coastline.

ʻŌhikilolo MU

This large MU is home to the largest population of *P. kaalae* on the island. Two traps were installed in the Mākua valley portion of the MU in March 2022; and three were installed close to *P. kaalae* populations on the ʻŌhikilolo Ridge portion of the MU in April 2022. Out of caution and with input from CRB researchers, to minimize the likelihood of attracting CRB to these sensitive areas, these traps were not equipped with phermone lures; the traps were equipped solely with UV/LED lights as attractants. Thus far, only one of the traps in the back of Mākua valley has caught CRB. In April 2023, CRB damage was identified on a reintroduced *P. kaalae* in the MU. A second damaged palm was found in June 2023. The finds led to the decision to equip the traps with pheromone lures. A breeding site survey was conducted across the main *P. kaalae* areas and there were no signs of an established CRB population within the area surveyed.

Pahole Road

There are currently three traps along the Pahole road. The lowest trap, adjacent to Dillingham Ranch, a coconut plantation, was installed in 2014. CRB were first detected at this trap in December 2021. Two additional traps were installed further up the road in November 2021. CRB have been found in all three traps along Pahole road and the majority of the coconut palms at Dillingham Ranch now have CRB damage.

Kaʻala Road

Three traps were installed along the Kaʻala road in October 2021; at the forestry gate, Culvert 24, and the Kaʻala 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 along the road. In June 2022, CRB was detected at the Culvert 24 and Kaʻala campsite traps. Located at 4,000’ elevation, the positive finds at the Kaʻala campsite demonstrate that CRB can reach the highest points on Oʻahu, although experts think it is unlikely they can breed in the cooler and wetter environmental conditions found at the Kaʻala summit. As of July 2022, CRB have been detected in all four traps along the road.

Kaluaʻā/SBS Access Road

Two traps were installed along the Kaluaʻā/SBS access road in July 2021. CRB were detected at both in September 2021 and have been consistently found in the traps since.

ʻĒkahanui Access Trail

Three traps were installed along the ʻĒkahanui 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 ʻĒkahanui 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 ʻĒkahanui fence in March 2022, leaving four

active traps at ʻĒkahanui. CRB were detected at one of the new traps in June 2022, but the highest trap had no detections this report year.

Pualiʻi/Honouliuli Access Road

ANRPO staff check the State's trap at the along the Pualiʻi/Honouliuli access road opportunistically when in the area. High numbers of beetles are rountinely found here, most likely due to the trap's close proximity to Kunia Loa Ridge Farmlands, a known CRB hotspot.

Kahuku Training Area (KTA)

One trap was installed on Drum Road across from Range Control, at around 600' elevation, in March 2022. The trap was last checked in August 2022. CRB have yet to be collected from this trap but are commonly found in CRBRH managed traps along the coastline in this part of the island.

9.4.3 Next Steps

With increasing numbers across the island and a lack of viable control options, CRB eradication has become unrealisitic. While researchers continue to explore options for biocontrol, the current recommended treatment is pesticide trunk injections (AI: imidacloprid). Unfortunately, trials have shown that fan palms have adverse reactions to trunk injections, leading to rots around injection sites. The CRBRH recently stated that they plan to shift their programʻs focus to containment rather than delimitation and control. Ironically, the news about CRB from Kauaʻi came weeks after the team declared that containment was their new focus. 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.

9.5 RAPID ʻŌHIʻA DEATH (*CERATOCYSTIS* SPP.)

Rapid ʻŌhiʻa Death (ROD) was detected on Hawaiʻi Island in 2014. It is a fungal disease which targets Hawaiʻi's most abundant native tree, ʻōhiʻa (*Metrosideros polymorpha)*, and is caused by two pathogens: *Ceratocystis lukuohia* ("destroyer of ʻōhiʻa," or wilt disease) and *C. huliohia* ("change the natural state of ʻōhiʻa," or canker disease). Though both are fatal, *C. lukuohia* is significantly more virulent and causes death much more quickly (Barnes *et. al* 2018). Most new outbreaks are caused by *C. lukuohia*; it accounts for roughly 90% of ROD detections on Hawaiʻi Island (Hauff 2020). Both strains are found on Hawaiʻi Island and Kauaʻi, while only *C. huliohia* is present on Oʻahu and Maui. After *C. huliohia* was confirmed on Oʻahu in July 2019, ANRPO adopted decontamination guidelines recommended by the State to minimize the likelihood of inadvertent spread of the disease (Hauff 2020). *C. huliohia* was detected in the Waiʻanae Mountains for the first time in October 2022 in Mākaha valley, outside of ANRPO's MU (see Figure 6). This remains the only positive ROD detection in the Waiʻanae Mountains.

ANRPO is a member of the ROD Working Group. ROD continues to be an early detection target across Oʻahu for ANRPO and its partners. This year, ANRPO continued to support these efforts by assisting with access to restricted airspace for helicopter surveys by Oʻahu Invasive Species Committee (OISC) staff. In addition, staff continue to note locations of damaged and potentially symptomatic ʻōhiʻa during other field work. Thus far, all of the samples submitted by ANRPO have come back as negative for ROD.

Image Redacted Sensitive Information Available Upon Request

Figure 6: ROD positive detection in Mākaha valley. The only positive detection in the Wai‘anae Mountains to date.

9.6 Myrtle Rust Monitoring

ANRPO joined the Hawai‘i Myrtle Rust Monitoring network in 2023. The project, led by researchers from the U.S. Forest Service (USFS), has connected scientists, land managers, plant lovers, and community members from across the island chain in efforts to detect and identify new introductions of the myrtle rust fungus (*Austropuccinia psidii)*. ANRPO field teams have been collecting rust samples from Myrtaceae plants in the field and in our greenhouses and sending them to the USDA-ARS-Hilo facility for identification. Myrtle rust is a non-native fungus that attacks plants in the Myrtaceae family, to which ‘ōhi‘a belongs, causing infected plants to lose their leaves and die. Currently, only a single strain, the “pandemic” biotype has been identified in Hawai‘i. Research has demonstrated that there are three different strains in Brazil that could have devastating impacts on ‘ōhi‘a trees. Infection by the three highly virulent strains led to an average of a 69% reduction in height growth and a 27% increase in seedling mortality of ‘ōhi‘a six months post-infection (da Silva *et al*. 2014).

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