

ECOSYSTEM

MANAGEMENT PROGRAM BULLETIN





ON THE COVER A view of Pu'u Nohona O Hae on Hawai'i island in the Ke'āmuku region. BACKGROUND A native ko'oko'olau (*Bidens menziesii*) is one of the many native shrubs repopulating the restoration sites of Pu'u Nohona O Hae. 📷 Doug Doty, CEMML Staff

MOVING FORWARD TOGETHER

The Hawaiian Islands are the most geographically isolated group of islands on Earth. They are also home to more than 500 federally listed threatened and endangered species and countless cultural and archaeological resources.

A number of these unique resources can be found on U.S. Army installations and training areas. From plants and birds, to snails, bats and insects, the Army's natural resources programs on O'ahu and Hawai'i Island manage more than 120 threatened and endangered species. Likewise, the Army's cultural resources programs in Hawai'i manage more than 3,000 significant cultural resources, including historic sites, structures, buildings and artifacts.

The Ecosystem Management Program Bulletin is designed to educate the public and the military community about the unique resources on Army-managed lands and the Army's efforts to conserve them. Our hope is to encourage a collective conservation ethic, foster innovation and inspire and expand opportunities for collaboration and partnership with academia, industry and beyond.

The Army's core mission is to train our Soldiers so they are ready when called, and this mission is directly tied to the environmental stewardship of the resources in our care. Protecting the environment means sustaining the mission and securing the future.

U.S. ARMY GARRISON HAWAI'I



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*Published for the U.S. Army Garrison Hawai'i
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“I am constantly inspired by the grandeur and majesty of Pōhakuloa and grateful to work toward conserving these landscapes.”

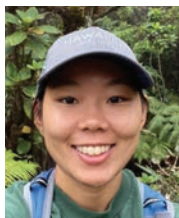


CHRIS LUM

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“Common native plants are the backbone of an abundant Hawaiian ecosystem. Without them, interactions between organisms at every level become disrupted and cease to exist.”



TAYLOR MARUNO

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“Appreciate the small things—the smell of naupaka kuahiwi, the sound of falling rain, the way shells of kähuli shine in the light.”



KAIA KONG

Kaia Kong started her conservation career as an intern with the Army Natural Resources Program on O‘ahu in 2016. She held various positions on natural resources field teams before becoming the Animal Program Coordinator. Being born and raised on O‘ahu, she has a deep passion for conserving and protecting what makes this beautiful island so special.

Kaia is a natural resource program specialist with the U.S. Army Garrison, Hawai‘i, DPW Environmental Division, Natural Resources Program.

“The plants and animals that we are so privileged to work with are more than just natural resources, they are kūpuna. It is our responsibility to safeguard them with unwavering dedication.”

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RESTORING

Native Vegetation for Endangered Plants on Pu'u Nohona O Hae

by LENA SCHNELL



A native cowpea restoration site, where staff from the Army Natural Resources Program have removed invasive grasses. *PRECEDING SPREAD* A survey is being conducted at Pu'u Nohona O Hae. 📷 CEMML Staff



ABOVE O'ahu cow pea (*Vigna o-wahuensis*) BELOW Nehe flower (*Lipochaeta venosa*) 📷 CEMML staff

Pu'u Nohona O Hae on Hawai'i island dominates the landscape traveling south on the Māmalahoa Highway from Waimea town. A rich assemblage of native plants once covered this prominent cinder cone, but after years of impacts from cattle ranching and browsing by goats and sheep, the once lush vegetation has been reduced

to patches of native plants surrounded by invasive grasses. Despite pressures from invasive species, the cinder cone is still home to several endangered plants and the Natural Resources Program at U.S. Army Garrison, Pōhakuloa Training Area is working to restore native habitats to benefit these rare plants.





Current Conditions on the Pu'u

Pu'u Nohona O Hae is in the Ke'āmuku region on the western slope of Mauna Kea and is nestled near the intersection of the Old Saddle Road and the Māmalahoa Highway. In 2006, the Army purchased 23,000 acres of former ranch land, which included Pu'u Nohona O Hae, to expand Pōhakuloa Training Area (PTA). Prior to the purchase, endangered plants were documented on Pu'u Nohona O Hae (Cuddihy 1983) and the State of Hawai'i Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW) fenced the pu'u in 1991 to exclude cattle and feral goats and sheep from the cone. Surveys funded by the Army in 2002 confirmed five endangered plant species on the pu'u—honohono (*Haplostachys haplostachya*), aupaka (*Isodendron hosakae*), nehe (*Lipochaeta*

venosa), po'e (*Portulaca villosa*), and O'ahu cowpea (*Vigna o-wahuensis*). The nehe and O'ahu cowpea are extremely rare and most of their state-wide populations are confined to Pu'u Nohona O Hae.

Today, invasive grasses are the dominant vegetation on Pu'u Nohona O Hae but islands of native shrubland remain and within these islands, endangered species occur. These invasive grasses outcompete the native shrubs and degrade the habitat. Honohono, aupaka, and po'e are no longer present on the pu'u and the numbers of nehe have declined. To slow and reverse the habitat degradation, the Army Natural Resources Program (ANRP) staff initiated habitat restoration projects for nehe and O'ahu cowpea on the pu'u.



ABOVE Invasive grasses at the Nehe restoration site at Pu'u Nohona O Hae  CEMML Staff

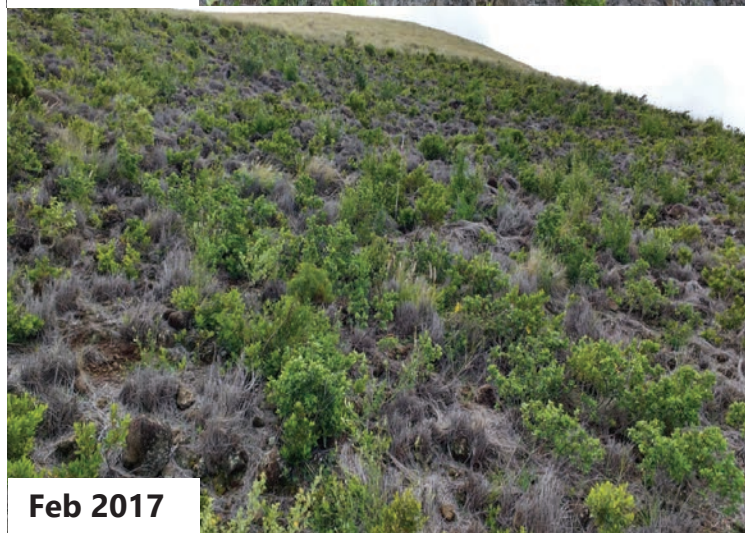
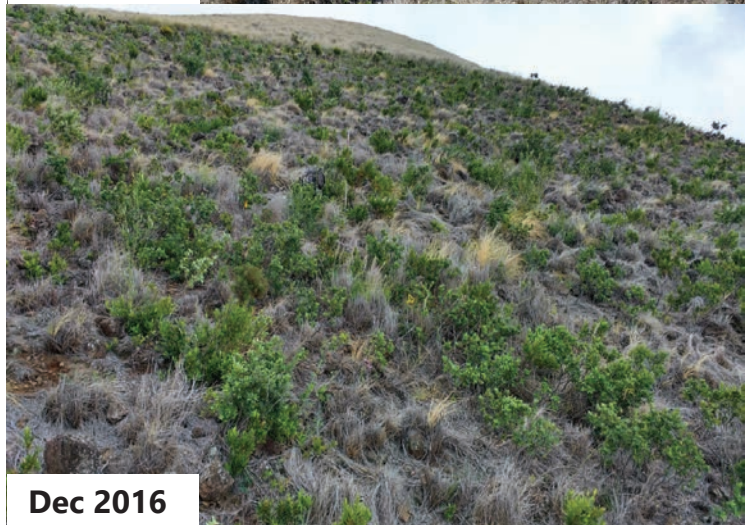
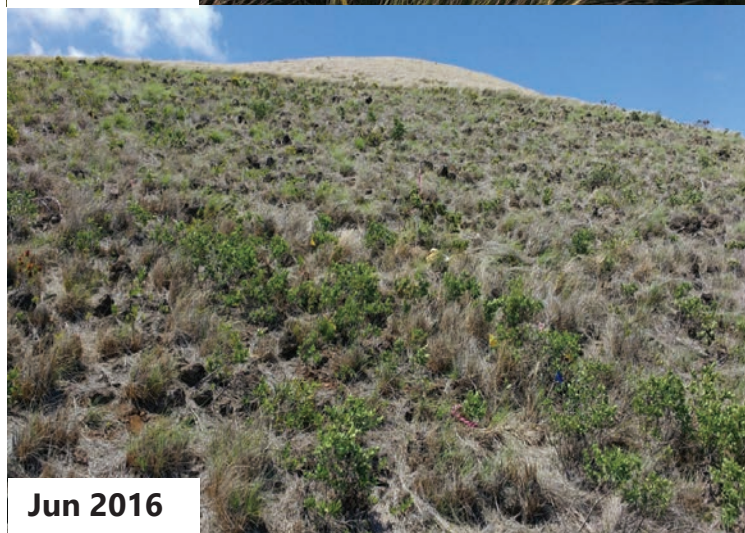
Setting Restoration Goals - Historical Accounts of Pu'u Nohona O Hae

Before starting restoration, ANRP staff used historical accounts and records of vegetation from the region to guide which species and how many of each to plant. Early written accounts from western naturalists provide a general description of the vegetation communities prior to large-scale cattle ranching in the Ke'āmuku region. On an excursion to collect plants in 1793, Archibald Menzies, the naturalist on the H.M.S. Discovery under Captain George Vancouver, described the vegetation around Waimea, Hawai'i as sparse herbs and grasses wilted by the intense sun. In the 1888 Flora of the Hawaiian Islands, William Hillebrand described the vegetation of the high central plain between Mauna Kea, Mauna Loa, and Huallai as stunted and scrubby.

Around 1910, Joseph Rock, a University of Hawai'i botanist, described the Ke'āmuku region and noted the diverse native vegetation on Pu'u Nohona O Hae despite wide-spread ranching and pasture grasses in surrounding areas. Rock listed common native species such as 'a'ali'i (*Dodonaea viscosa*), māmane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), and ko'oko'olau (*Bidens* species), which are still present in low numbers on the pu'u today. Rock also noted rare species that are no longer found on the pu'u today such as honohono and a'e (*Zanthoxylum hawaiiense*), an endangered tree.

Habitat Restoration for Nehe (*Lipochaeta venosa*)

In 2002, there were about 1,250 nehe plants on the pu'u and by 2016 the number declined to 79 individuals. Higher densities of grass corresponded to areas where the nehe plants were gone. In response, ANRP staff designed a restoration project to remove invasive grasses with the aim of restoring native species that were once present and increasing native shrub density to keep the invasive grasses at bay. Over several months in 2016, we removed invasive grasses in 4.4 acres by hand, with brush cutters, and applied herbicide selectively. Pictures from quarterly monitoring in 2016 show steady passive recovery of the native shrub community. Within 5 months, there was a noticeable difference in shrub size and leaf color indicating improved health. Once the grass was controlled, the native shrubs germinated from the latent seed bank and proliferated; no outplanting was needed to increase the shrub density. Today, the native shrubs help keep the invasive grasses in check and fewer hours and resources are needed to manage the site. Nehe is recovering more slowly. Weather, specifically water availability, likely influences population numbers with more plants present in wetter years. We still are learning basic life-history information for this species. To improve our knowledge, we started a new monitoring project in 2023 to track tagged plants so we have a more accurate population count and a better understanding of population dynamics.



Habitat Restoration for O'ahu cowpea (*Vigna o-wahuensis*)

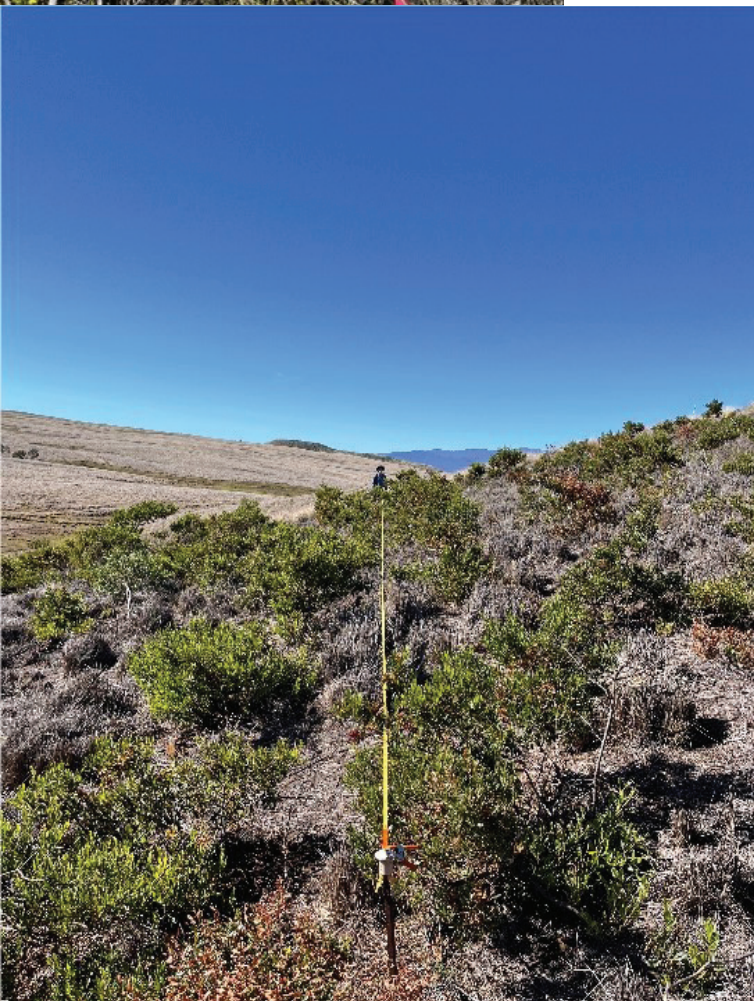
Because the native plants on Pu'u Nohona O Hae responded so rapidly and favorably to invasive grass removal, in 2022 we implemented a second restoration project for the wild population of endangered O'ahu cowpea on the opposite side of the cinder cone. Where the O'ahu cowpea grows invasive grasses are so thick that walking is difficult, and the grasses smother the remaining native shrubs. The O'ahu cowpea struggles in the grass and entangles itself as it climbs to reach the sunlight. The invasive grasses are superior competitors for moisture in this arid landscape and are likely impacting the O'ahu cowpea population. From year to year and season to season, the number of O'ahu cowpea plants ranges widely with as few as 10 plants to hundreds of plants being present.



Nov 2022

We established restoration goals to reduce invasive grass cover, to increase the number of native species present at the site, and to increase native shrub density. Through these actions we aim to maintain at least 75 reproducing O'ahu cowpea plants. We plan to restore 7 acres within the O'ahu cowpea population on the pu'u but are currently only managing 2.5 acres. We monitor the vegetation and the individual O'ahu cowpea plants and use the data to learn how the system responds to management and to ensure the O'ahu cowpea plants thrive.

One year after removing most of the invasive grass, native shrubs are rebounding and looking green and healthy. Invasive grass cover is below the 20% cover target but is still plentiful at the site and requires management quarterly. Following favorable winter weather in 2022, many native shrubs seedlings established in areas with less grass. We also planted native shrubs such as, 'ūlei (*Osteomeles anthyllidifolia*), 'ākia (*Wikstroemia pulcherrima*), 'akoko (*Euphorbia multiformis*), a few wiliwili (*Erythrina sandwicensis*) and 'iliahi (*Santalum paniculatum*) trees. We plan to plant many more individuals of native species in 2024 to speed up the recovery process.



Nov 2023

The O'ahu cowpea response to restoration efforts is more complicated. Many seedlings germinated during the wet winter weather in 2022 but then died back during dry summer weather. We believe this is part of the natural life cycle of this species, but we need to learn more. Again, as the rain returned in winter 2023, seedlings emerged in large numbers. We plan a new approach to tag and monitor individual plants through the year to learn about the natural progression from seedling to adult. We hope to see more O'ahu cowpea plants survive through the dry summer months now that competition with the invasive grasses for moisture is reduced. Through our management efforts, we aim to restore a vegetation community with native species that historically occurred on Pu'u Nohona O Hae and that will support the O'ahu cowpea throughout the year and into the future.

PRECEDING PAGE The 2016 annual monitoring of this Nehe restoration site show steady passive recovery of the native shrub community from invasive grasses. LEFT Invasive grass removal one year a part at the O'ahu cowpea monitoring plots highlight a bit more success with healthy native shrubs. 📷 CEMML Staff, David Cole

"The country is extremely dry, and when very windy the dirt is carried for miles so thickly that everything appears to be hazy in a dense mist or fog."

– Joseph Rock (1913, p. 54)





Future Restoration

These restoration projects are highly visible from the Māmalahoa highway and have piqued public interest and comment. Currently, USAG-PTA does not have a public volunteer program. We plan to explore opportunities to involve the public with restoration activities at Pu'u Nohona O Hae. By leveraging public assistance, we can expand managed areas and increase suitable habitat for threatened and endangered plant species. In fact, in 2024 we plan to outplant 46 aupaka to the nehe restoration to reintroduce this species to the pu'u. As we continue to manage and expand these highly visible restoration sites, we will continue to educate, and hopefully involve, the public with the Army's natural resources programs.

LEFT ANRP staff hand clearing invasive grasses at the Nehe restoration site. ABOVE Nehe flowers 📷 CEMML Staff, Lena Schnell

Restoring

Native Forests

by Christopher Lum

For millennia, Hawai'i's forests stood untouched, sculpted by time and teeming with a diversity of plant and animal life. But in a blink of geological time, humans arrived and brought with them animals this land had never seen. Pigs brought by Polynesian voyagers and later goats and cattle by European traders, razed the native vegetation, leaving behind landscapes ripe for competition from invasive weeds.

Plants from around the globe can thrive in tropical climates like Hawai'i's, including some of the worst weeds like strawberry guava (*Psidium cattleianum*). Brought to Hawai'i from South America in the early 19th century for its edible fruit, strawberry guava quickly escaped cultivation and found suitable habitat along the denuded mountain slopes left by feral ungulates. Today, conservationists across the state grapple with the spread of invasive weeds like strawberry guava encroaching on the last of Hawai'i's intact native forests.

flowering plants, ferns, and mosses thrive. This forest structure, with its many niches, is a significant reason why the Hawaiian Islands are home to over 1,200 native plant species.

In invaded Hawaiian forests, non-native trees threaten biodiversity. The smooth, slick bark of strawberry guava doesn't provide suitable habitat for native mosses and ferns, allowing rainwater to run straight down the trunk. On the forest floor, leaf litter from strawberry guava is allelopathic, chemically disabling the germination of other species' seeds. The remaining native plants are slowly choked out by limited light, further promoting the propagation of strawberry guava seedlings and continuing the invasive species expansion, ultimately leading to monotypic stands if left uncontrolled. This is just one example, but similar strategies are used by other weed species as well.

Two Forests - Two Functions

To an untrained eye, the lush greenery of Hawai'i is stunningly beautiful. However, conservationists will point out that vast expanses of our forests are completely invaded by non-native species. Once you see it, it becomes hard to ignore; a slow undignified death for many of our native species.

In intact native Hawaiian forests, layers of canopy are occupied by a wide variety of native vegetation, supporting a high amount of biodiversity and maximizing rainfall absorption at every level. Large trees like 'ōhi'a lehua (*Metrosideros polymorpha*) form the upper canopy, hosting ferns and mosses along their trunks. Below them, large tree ferns like hāpu'u (*Cibotium chamissoi*) build a subcanopy layer, and even further down, various


Watching the Weeds

The Army Natural Resources Program, O'ahu's (ANRPO) vegetation monitoring program started in 2008 to track changes in forest composition over time and inform management decisions. Transects, covering miles of mountain ranges, are divided into plots and observed in regular three to ten year intervals. Every species within each plot, both canopy and understory, is recorded with a percentage cover. All this data gives ANRPO a detailed inventory at the time of each observation and insight into changes over long periods of time.

Unfortunately, despite best weeding efforts,





ABOVE The vegetation restoration team works to clear a stand of invasive strawberry guava from Kahanahāiki with the help of a wood chipper.  ANRPO Staff: Christopher Lum

natural resource managers have witnessed invasive species steadily expanding for years, and monitoring data confirms that. According to Monitoring Program Biologist, Michelle Akamine, in seven out of eight management units monitored, non-native canopy is increasing at an average rate of 16% per decade. Much of this change is driven by just three weedy tree species: strawberry guava, christmas berry (*Schinus terebinthifolia*), and Australian red cedar (*Toona ciliata*).

Restoration- Starts with a Chainsaw

ANRPO has been saving some of Hawai'i's most endangered species since 1995. While great strides have been made in securing and propagating these rare plants, finding suitable habitat for reintroductions has been difficult. Managers recognize that maintaining native ecosystems is crucial to the long-term survival of the most threatened species. This is why another goal for ANRPO is to limit the amount of non-native vegetation to 50% of total cover across management units. To accomplish

this, ANRPO is using aggressive weed control paired with outplanting of common native plants to restore ecosystems. Since starting efforts in 2012, a total of 68,000 common native plants have been planted for the restoration of these ecosystems. But before any plants go into the ground, adequate growing space must be prepared.

Teams start by clearing weedy trees from an area using chainsaws and herbicide, revealing what natives are left. Fallen trees are then bucked up into smaller sections and stacked into neat piles on the edges of these restoration sites. Sometimes, if the terrain allows, wood chippers are flown in by helicopter to make the job a little easier. What was once a dense invaded forest quickly transforms into something unrecognizable in just a few days or weeks.

The difference are stark and eye opening. When standing on the edge of a restoration site, you can see just how much was removed—in most cases, about 90% of the canopy. Just behind you, an identical situation to what was just there—a sea of invasive trees shrouding the forest floor. Sometimes, a blank slate is what's needed.



Plant! Plant! Plant!

Teams then follow up this clearing effort by putting thousands of native plants into the ground. Due to the remote nature of these sites, helicopters are regularly used to drop off boxes that look like large dog houses filled to the brim with plants and tools. Technicians scramble to quickly remove the materials from the box and call in the pilot for a pickup, just to have it filled up again and a second round delivered. Once all materials are on site, augers are fired up to plunge holes into the ground while other people start digging with hand trowels. It's not uncommon for teams to plant upward of 1,000 plants on a two-day trip.

From 2012 through 2016, ANRPO had been planting a small number of common native plants to support ecosystem restoration, averaging 630 per year. However, efforts really ramped up in 2017 when staff planted 6,200 plants. Since 2018, ANRPO has been averaging over 9,800 common native plants per year. All these plants are produced in the ANRPO nursery with propagules collected from the field.

In total, ANRPO's restoration efforts have covered over 39 acres of O'ahu's forest, and we are now starting to see the positive effects of this work show up in monitoring data. While the overwhelming trend for plots outside of restoration sites is increased non-native canopy cover, the opposite is true in plots within restoration sites, mainly due to aggressive clearing efforts and consistent follow-up weeding. Simultaneously, there is an increase in native understory cover in those same plots as outplants continue to grow, taking advantage of new found light.

While restoration projects take thousands of hours of hard work from the planning stages to clearing, outplanting, and frequent weeding, it's reassuring to know that it's not in vain. Restoration can truly have a noticeably positive impact, and these sites will one day provide habitat for even more native species.



LEFT Helicopter delivering a plant box for outplanting at Keālia. TOP RIGHT An example of a monotypic strawberry guava invaded forest. BOTTOM RIGHT An example of native forest with 'ōhi'a lehua and alani trees laden with mosses and ferns in the canopy and hāpu'u and other native species in the understory. 📷 ANRPO staff, Christopher Lum & Michelle Akamine

Jewels of Hope

**BY KAIA KONG
&
TAYLOR MARUNO**







An aerial view of Pu'u Hāpapa predator-resistant enclosure prior to supplementary native plant reintroductions. 📷 ANRPO Staff PRECEDING SPREAD The view from the snail survey in Mākaha, overlooking Wai'anae Valley and Mākaha Valley. 📷 ANRPO Staff, Taylor Maruno

O'ahu tree snails, often referred to as “jewels of the forest”, are quite literally hidden gems. Maybe unassuming at first glance, their ability to persist and persevere in a changing environment filled with relentless challenges speaks volumes beyond their small size. Maybe one of the most diverse members of this group is the Wai'anae endemic, *Achatinella mustelina*.

With assorted patterns of white, browns and tans, and no bigger than a tater tot, *A. mustelina* make their home in the cracks and crevices of native forests, clinging to plants like 'ōhi'a, olopua, 'ie'ie, hame and hāpu'u. Looking up, they're easy to blink and miss. But if you stop in just the right place and turn your head in just the right direction, you may catch a glimpse of a glossy shell, shining in the light. Though listed under the same species name, *A. mustelina* vary genetically between geographic populations across the Wai'anae mountains. Separated by ridges and valleys, each group is a unique product of evolution. Like most of Hawai'i's native land snails, *Achatinella* are fungivores. They scrape the fungus off of leaves and cycling nutrients in our native forest ecosystems. Also like the hundreds of other land snail species in Hawai'i, they are incredibly threatened and at risk of extinction. In an effort to protect these “jewels of the forest”, the Army Natural Resources Program on O'ahu (ANRPO), in partnership with the State of Hawai'i's Department of Land and Natural Resources (DLNR) Snail Extinction Prevention Program (SEPP), maintains multiple predator-resistant enclosures across O'ahu.

Out of all the predator-resistant enclosures in the Wai'anae mountains, the Pu'u Hāpapa enclosure has a large population of *A. mustelina*—boasting over 600 snails at the latest timed-count monitoring survey, a population size that has been stable at


this number for nearly a decade. In reality, the actual population size is likely much larger, as surveyors only record a portion of the population during timed-counts – what they can visually see from the ground. In addition to *A. mustelina*, Pu'u Hāpapa is also the enclosure with the largest diversity of other native land snails. At least 12 species and 10 genera across five taxonomic families are represented – from the ground-dwelling *Amastra spirizona* to the cinnamon-bun shaped *Philonesia hartmanni* to the tiny *Pronesopupa*, smaller than a grain of rice.

Coined “The Land of 10,000 Snails” by botanist Ken Wood in the 1990s, Pu'u Hāpapa was the first enclosure to be built with all three barriers used in conjunction to minimize predator incursions. All of the enclosures are equipped with multiple barriers, including an angle, a surface of cut copper mesh, and bands of electrical copper wires to keep out invasive snails. The top of the enclosure features a rounded hood, which keeps out rats and mice. The walls and hood of the enclosures are also made of materials that are difficult for rodents and Jackson's chameleons to navigate. Prior to its construction, the landscape was overrun by invasive alien weed species, creating an open understory habitat that was unsuitable for the delicate snails. However, through rigorous restoration efforts, invasive plants were removed – making way for the reintroduction of native plant species. This transformation turned the area into a complex forest patch, fostering long-term resilience and creating an environment conducive to the thriving existence of these remarkable snails. In a landscape where native snail habitat is dwindling, Pu'u Hāpapa stands as a kīpuka of hope and collaboration. It showcases the success achievable when communities work together to protect these precious “jewels of the forest,” offering a glimmer of optimism for the future of the beloved kāhuli.



CLOCKWISE FROM TOP LEFT A *Laminella sanguinea* adult on the underside of a manono leaf; A cluster of *A. mustelina* differing in age class, juvenile, sub-adult, and adult; An *Auriculella* traversing on a hame featuring an adult *A. mustelina* in the background; This little cinnamon-bun shaped snail is a *Philonesia*. CENTER A pair of *A. mustelina* nestled together. 📷 ANRPO staff, Taylor Maruno



The first *Achatinella mustelina* found during the snail survey in Mākaha, on *Miconia crenata*. OPPOSITE PAGE Top Right Closer look of the first *A. mustelina* found during the snail survey in Mākaha, on *Miconia crenata*. Bottom left The *A. mustelina* relocated to its new home from the original snail survey.  ANRPO staff: Taylor Maruno

A SNAILER'S STORY

by Taylor Maruno



I wipe away the drops of sweat clinging to my nose. We haven't moved for an hour, but it's hot in the still, midday air.

"Should we call it?" I hear Glacel ask, ten feet above me on the steep trail. I look up from the binoculars in my hands. Around us, a sparse canopy of 'ōhi'a and fronds of hāpu'u hang down like broken brown and green curtains as 'ie'ie snakes high around the surrounding tree trunks. At our ankles, uluhe pokes out here and there between dense clumps of invasive grass and weeds. We came here to search for snails – to find *Achatinella mustelina*.

That was three hours ago.

I look over at Ryan, who's circled back to the same spot for the second time.

"Yeah, we can just call it,"

I reply. My eyes are googly from staring into the binoculars too long.

Glacel had received an email from a conservation colleague, who incidentally found a snail a couple weeks prior in this exact spot – on the ground...in the middle of the trail. Maybe it was just an empty shell she found, maybe it somehow hitchhiked...or rolled down? I mean,

after all, *Achatinella* had never been recorded here before.

We gather on a flat ledge and hoist our bags back on our backs. While we file ourselves in a line, I hear a soft sigh of defeat. Today was Ryan's first time snailing (searching for snails). He'd never seen a native snail in real life before. When we arrived, his eyes lit up as we showed him pictures on our phones. He'd looked like a little kid ready for an Easter egg hunt.

"I'm gonna find one," he proudly proclaimed. A giddy smile stretched across his face as he bounced down the trail. "It's okay if you don't. You know...they're pretty rare," I chuckled, trying not to get his hopes too high. I wanted to explain that most days we hardly ever find anything at all, but he was so excited that I kept my mouth shut.

And here we were, three hours later and ready to call it. What a sad first snailing experience. I felt bad. I trailed behind them as we began the hike back out. No one said a word. Without a breeze, even the trees were silent. Glacel pulled herself up over a deep step. I mean...I



ABOVE From left to right: Ryan Saito (ANRPO student hire), Taylor Maruno (ANRPO Rare Snail Conservation Biologist), and Glacel Lopez (ANRPO Natural Resource Field Team Leader) on the day of their snail survey in Mākaha. RIGHT A view overlooking into Wai'anae and Mākaha Valleys. FAR RIGHT Taylor Maruno and Glacel Lopez relieved to find some snails. 📷 ANRPO staff, Ryan Saito



guess they could've been here at one poi-

“WAIT!! IS THAT ONE!?”

Ryan stopped dead in his tracks and pointed boldly off the side of the trail.

Glacel turned back and gasped, “Oh my gosh, wait!” I tiptoed to try to get a glimpse, but I couldn't see anything. “Wow, no way! Great find, Ryan!”

“What, where?” I asked frantically. He pointed again. He wasn't pointing up at any trees though, he was pointing down at a patch of weeds bordering the trail. Sure enough, amongst the mess of cratered, bristly-haired leaves was a kāhuli – a lone *A. mustelina*, nestled peacefully on *Miconia crenata*.

Maybe the common name alone is telling, but *Miconia crenata* (previously *Clidemia hirta*), also known as Koster's curse, is an incredibly invasive weed – widespread and undoubtedly threatening Hawai'i's native forests. In conservation, it can be infuriatingly easy to get bogged down by the magnitude of destruction

our local ecosystems and native species face – snails included. One might hear this and feel discouraged at the fact that invasive weeds are encroaching into native habitat or that kāhuli are being driven to live on them – worried for the future that our snails may face.

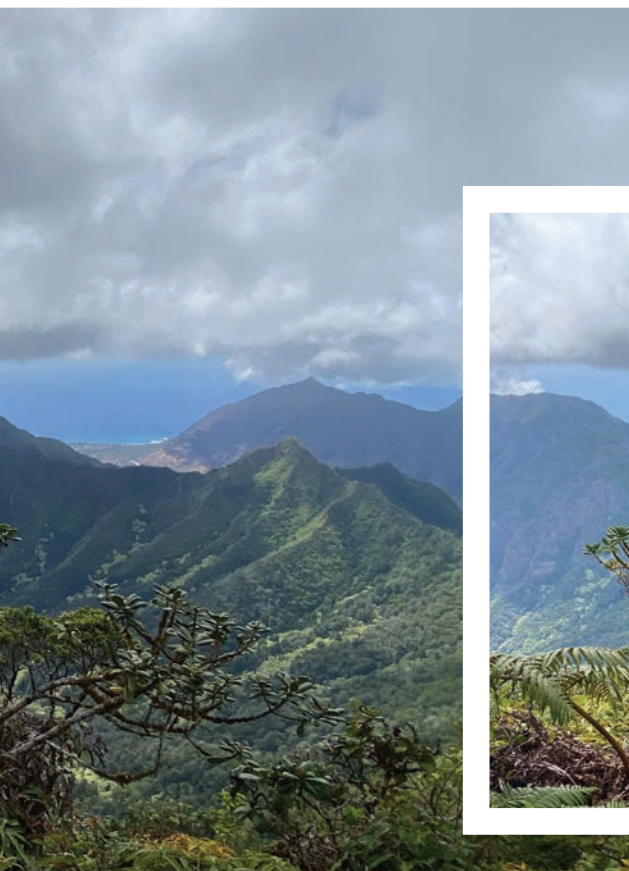
That day, however, as we squeezed through brush to move the lone *A. mustelina* to a small 'ākia tree hidden a little ways off the trail, hoping to provide it with at least some protection, we found it wasn't actually alone.

“Wait...is that another one?”

Glacel stared in disbelief at indeed, another *A. mustelina*, clinging tightly to the underside of the soft 'ākia leaf.

They say good things come in threes and, in this story, they would be right. Not even five minutes later, as we're continuing our hike back out, Glacel casually gestured towards the canopy of a short 'ōhi'a right off the trail,

“Oh look, there's another one.”





Against a deep backdrop of green, its caramel brown shell glinted fearlessly—a jewel of the forest in the light.

This is not a story of defeat—this is a story of perseverance and resilience. Kāhuli are alive. Despite every threat, every alteration, every barrage that’s been thrown their way – they have found a way to persist. In the face of change, they’ve adapted. In all honesty, it has not and will not be an easy road ahead for our native land snails. Old and new threats continue to challenge their existence. But, just as that shimmering shell depicted that day, this is also a story of hope – the glimmering proof that they’ve survived this long. The reminder that their fight is not over.

Hundreds of thousands of years ago – whether by the waves, the wind, or with the help of birds – snails somehow traversed the Pacific Ocean and made Hawai‘i home. That we are still able to see their descendants today is extraordinary. Though the “Year of the Kāhuli” has come to an end, whether you’re new to snails or a seasoned “snailer”, this is a reminder to keep celebrating kāhuli – appreciate their history, acknowledge their presence, and continue to fight for their future.

◀ Can you spot the snail?



ABOVE LEFT **Glacel Lopez** with a keiki *Achatinella mustelina* she spotted on a snail survey. 📷 ANRPO staff, **Taylor Maruno** ABOVE RIGHT **Zoomed in photo of keiki *A. mustelina* from previous photo.** NEXT PAGE CLOCKWISE **Two adult *A. mustelina* on a kōlea at Hāpapa; An adult *A. mustelina* spotted during an evening timed-count at Hāpapa; State of Hawai‘i Department of Land and Natural Resources website highlights the Year of the Kāhuli.** 📷 Department of Land and Natural Resources (n.d.). 2023: **YEAR OF THE KĀHULI.** [Hawaii.gov](https://dlnr.hawaii.gov/ecosystems/year-of-the-kahuli/). Retrieved May 21, 2024, from <https://dlnr.hawaii.gov/ecosystems/year-of-the-kahuli/>

“Kāhuli are alive. Despite every threat, every alteration, every barrage that’s been thrown their way – they have found a way to persist.”



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2023: YEAR OF THE KĀHULI



2023 was officially the **Year of the Kāhuli**, proclaimed by Governor Josh Green on February 23, 2023. There were once roughly 750 species of kāhuli, or Hawaiian land snails, across our islands and found nowhere else in the world. Our kāhuli are both ecologically important (as cleaners of fungus and bacteria from our native plants) and culturally important, as they are featured in Native Hawaiian mele, hula, oli, and lei. In the Year of the Kāhuli, we both celebrate these snails and recognize their plight: of those roughly 750 species, 60% have now been lost forever. Our remaining kāhuli face serious threats including invasive species predation, habitat loss, and climate change, and 100 or more species may go extinct in the next 10 years without additional action.

Governor Green proclaimed the Year of the Kāhuli to raise awareness of these imperiled jewels of Hawaiian forests. To learn more and get involved, check out the activities below and stay tuned for kāhuli events all year long. You can also learn about different snail species and the work of the Snail Extinction Prevention Program and Bishop Museum Malacology Program through the links at the bottom of this page.



The Department of Defense (DoD) plays a key role at the intersection of national security and conservation, which is where DoD's Readiness and Environmental Protection Integration (REPI) Program functions as a vital tool. The REPI Program fosters multi-agency initiatives and collaboration through cost-sharing partnerships to bolster local and regional conservation of natural resources and open space, while simultaneously preserving compatible land uses near military installations and ranges.

What has the REPI Program brought to Hawai'i?

Since 2005, the REPI Program has partnered with several key stakeholders in Hawai'i, all of which are focused on conserving natural resources, supporting indigenous forests and agricultural lands, increasing climate resilience, and strengthening military readiness. As the Pacific region grows in strategic importance, the REPI Program has continued to increase efforts to preserve and protect cultural, natural, and land resources that benefit Hawai'i residents and the DoD mission.

Through FY 2023, the Department has invested over \$91 million in Hawai'i, and DoD partners have contributed nearly \$116 million. In FY 2023 alone, the REPI Program invested an additional \$31 million for partnership projects in Hawai'i. REPI partnerships drive sustained efforts to support the longevity of working lands, protect natural areas and native species, promote freshwater supplies, and preserve cultural resources for the community while ensuring the viability of DOD mission capabilities. Current partners with REPI projects in Hawai'i include: AES Hawai'i; American Bird Conservancy; Bishop Museum; City and County of Honolulu; Department of Hawaiian Homelands; Department of Land and Natural Resources; Hawai'i Agribusiness Development Corporation; Hawai'i Conservation Alliance; Hawai'i County; Hawai'i Land Trust; Kāko'o 'Ōiwi; Kaua'i County; Kekaha Agriculture Association; Kua'āina Ulu 'Auamo (KUA); MA'O

Organic Farms; Maui County; National Fish & Wildlife Foundation; North Shore Community Land Trust; Office of Hawaiian Affairs; Trust for Public Land; Parker Ranch; USDA Natural Resources Conservation Service; and U.S. Fish and Wildlife Service.

How does REPI enhance collaboration in Hawai'i?

Project prioritization is an evolving process shaped by local, regional, state, and DOD stakeholders coordinating across the state in resource conservation. In October 2022, the REPI Program hosted a series of meetings focused on sustainable resource management practices in Hawai'i. The forum incorporated local, regional, state, and Federal perspectives into the conversation. Given the collaborative setting, DOD officials were able to learn more about Hawai'i-based issues and local perspectives and to discuss avenues for continued teamwork to develop meaningful solutions. Flowing from that powerful collaboration of stakeholders whose primary mission is natural, cultural, and agricultural resource conservation, preservation, and long-term protection, REPI has seen two more successful and impactful REPI project cycles, resulting in new partners and a diverse project portfolio. Additionally, and as a result of enhanced engagement in REPI outreach, many Hawai'i stakeholders began to engage more formally in support of a new landscape-scale partnership in the state. In May 2024, the Hawai'i Sentinel Landscape Partnership was formally designated.

What is the Hawai'i Sentinel Landscape?

The Hawai'i Sentinel Landscape spans over two million acres and includes priority conservation, agricultural, and military mission lands on the islands of Kaua'i, O'ahu, and Hawai'i. The Sentinel Landscape Partnership (<https://sentinellandscapes.org>) is designed to address rapid urban



ABOVE Early stages of a kukui, 'a'ali'i, and alahe'e wind break with volunteers from a local organization, Ka Lau O Ka Lāhui at Kūkaniloko.

and residential development that threatens essential agricultural lands, native forests, and critical habitats, while also obstructing low-elevation flight and drone training, radar, and communication antennas. Similarly, climate threats, extreme weather anomalies, and sea level rise impacts military readiness, community resilience, and cultural resources.

Through the Hawai'i Sentinel Landscape, more than 20 Federal, state, local, and non-governmental partners are focused on safeguarding and maintaining open lands that support agriculture, conservation, and recreation while promoting land use that is compatible with military missions. Formal designation within the Sentinel Landscape Partnership provides landowners and land managers with effective management tools and protection measures to support threatened and endangered species populations; build resilience to extreme weather, wildfire, sea level rise, and climate impacts; and foster the sustained well-being of Hawai'i's conservation areas, working lands, and local communities. To learn more about the Hawai'i Sentinel Landscape, visit <https://sentinellandscapes.org/landscapes/hawai-i/>.

What is the link between the Hawai'i Sentinel Landscape and future REPI projects?

Hawai'i-based REPI initiatives include an enhanced focus on watershed conservation, the improvement of climate and coastal resilience, and the conservation of culturally significant locations. Along with local and regional partners and the Military Services, the REPI Program is continuing to support partner initiatives through the REPI Challenge, as well as ongoing REPI conservation easement projects that were started as early as 2005, putting land parcels into conservation easements and returning them to local land trusts. As a steering committee member on the Hawai'i Sentinel Landscape, the REPI Program is able to listen to partner agencies firsthand and can facilitate bringing priority projects discussed in sentinel landscape meetings to fruition; in the form of funded REPI projects. Additionally, as a competitive program, REPI projects that support sentinel landscape priorities will receive enhanced scoring during the final project review and funding determination. Ultimately, formal Sentinel Landscape designation, combined with a robust REPI Program in Hawai'i, significantly boosts enhanced climate resilience, resource conservation, and species management across the state.

Readiness and Environmental Protection Integration

REPI

How has the REPI Program and the Hawai'i Sentinel Landscape continued to support local installations and their neighboring communities?

The REPI Program investments supporting cultural and natural resource management, conservation easements, and climate resilience in Hawai'i have increased over time, exceeding \$20 million annually since FY 2022 to address watershed health, mitigate climate risks, protect endangered species, and preserve agriculture and culturally significant parcels in Hawai'i. In FY 2024, the REPI Program continued to support relationship building between Hawai'i installations and their neighboring partners who are expert natural and cultural resources stewards of their respective landscapes, including the State of Hawai'i Office of Hawaiian Affairs (OHA) and the Department of Land and Natural Resources, Maui County, Bishop Museum, Hawai'i Land Trust, and Parker Ranch. As it relates to these community collaboration efforts, the REPI Program contributed \$2.2 million combined with \$5 million in partner contributions toward a new partnership between the U.S. Army Garrison Hawai'i (USAG-HI), OHA, and Wahiawā community partners to fund landscape-scale restoration of the Kūkaniloko Birthing Stones, one of the most culturally sacred sites in Hawai'i. The USAG-HI and OHA collaborated on their shared kuleana—or responsibility—to protect and restore this culturally significant site from decades of degradation and proposed development threats. This restoration includes reforesting native trees, remediating soil to provide a foundation for local food production, planting a native seed orchard to address the statewide native seed shortage, managing invasive species, and implementing on-site educational programming to directly engage the military and the community.

The shared benefits of this effort include the creation of a sustainable buffer against development through reforestation, community food and water security, climate resilience through native species recovery, and the perpetuation of traditional ecological knowledge and other cultural traditions. The Hawai'i Sentinel Landscape will continue identifying shared priorities and developing landscape-scale projects that leverage the REPI Program and other funding sources to achieve actionable solutions toward natural and cultural resource preservation and enhanced installation and community resilience.





PREVIOUS PAGE Multiple partners visit Kūkaniloko and collaborate on future projects to support the restoration efforts and the preservation of its culture this 'āina holds. CLOCKWISE La'akea Rabes, Lori Walker, Kāhealani Hrbacek, and Ioane Jahn working with Schofield Barracks soldiers for cultural education and windbreak maintenance at Kūkaniloko; Ioane Jahn providing instructions at Koa planting event at Kūkaniloko; Kāhealani Hrbacek and La'akea Jahn planting koa at one of the Kūkaniloko restoration sites.

Root into your community

HO‘OA‘A

*U.S. Army Garrison Hawai‘i
Natural Resources Program
staff lead monthly volunteer
service trips to protect rare and
endangered plants and animals
on Army-managed lands. Each
educational trip incorporates
hiking and a hands-on*

*opportunity to care for Hawai‘i’s
natural resources through invasive*

BECOME A VOLUNTEER

JOIN THE VOLUNTEER LISTSERV

Contact OUTREACH@OANRP.COM to be added to the volunteer database.

ORGANIZE A TRIP

Contact OUTREACH@OANRP.COM to organize a service opportunity for your class, hālau or group.



ABOUT U.S. ARMY GARRISON HAWAI‘I

U.S. Army Garrison Hawai‘i is responsible for the day-to-day operations of Army installations and training areas in Hawai‘i. U.S. Army Garrison Hawai‘i team provides facility management and quality Soldier and military family services for more than 95,000 Soldiers, retirees, civilians and families across 22 military installations and training areas on O‘ahu and Hawai‘i Island. These installations include O‘ahu-based Schofield Barracks, Wheeler Army Airfield, Fort Shafter, Tripler Army Medical Center, and the Island of Hawai‘i-based Pōhakuloa Training Area.



The Directorate of Public Works Environmental Division Office at U.S. Army Garrison Hawai‘i is comprised of two branches: the Compliance Branch and the Conservation Branch, which are dedicated to providing guidance, support and liaison services to those who live, work and train on the installation, while also protecting the environment. The Conservation Branch includes the Army's Natural and Cultural Resources Programs, which protect endangered species and cultural resources, respectively, on O‘ahu and Hawai‘i Island. To learn more about the Army's environmental stewardship mission, visit <https://home.army.mil/hawaii/index.php/garrison/dpw/>



ABOUT THE OFFICE OF THE VICE PRESIDENT FOR RESEARCH AND INNOVATION (OVPRI)

The Office of the Vice President for Research and Innovation (OVPRI) provides leadership, coordination and support of research and innovation efforts throughout the 10-campus University of Hawai‘i System, including oversight of extramural funding, compliance, export controls, technology transfer and commercialization, and the Applied Research Laboratory at UH – one of only 13 U.S. Department of Defense University Affiliated Research Centers (UARC). Through a cooperative agreement, OVPRI supports U.S. Army Garrison Hawai‘i Natural Resources Program on O‘ahu. For more about OVPRI, please visit: www.hawaii.edu/research/