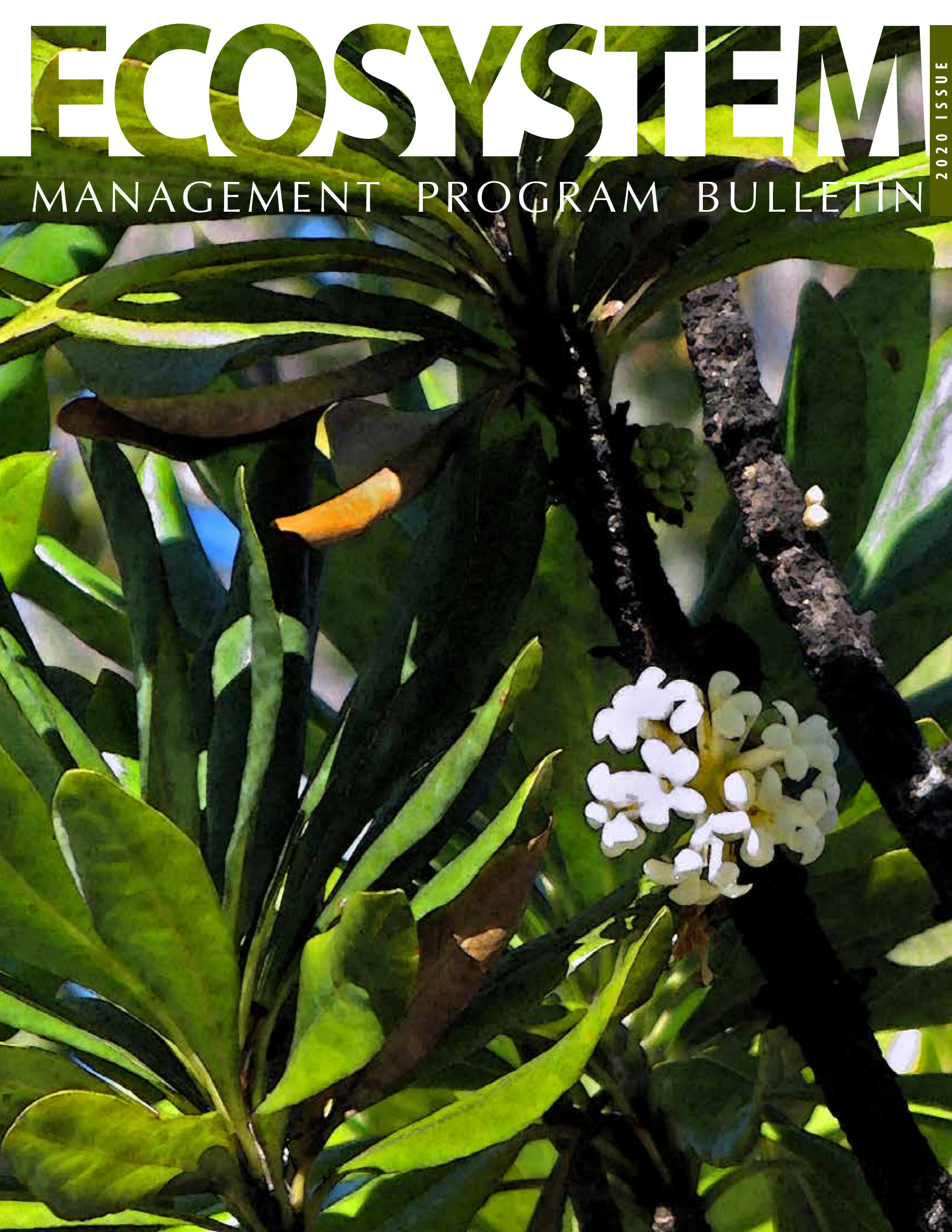
ECOSYSTEM

MANAGEMENT PROGRAM BULLETIN

2020 ISSUE



ON THE COVER AND BACKGROUND **A mature *Pittosporum terminalioides*, a native hō'awa tree that has been classified as a Species at Risk (SAR) by the Department of Defense.**

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 resource programs on O'ahu and Hawai'i Island manage more than 120 threatened and endangered species. Likewise, the Army's cultural resource 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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"Managing for species at risk, such as the hō'awa, helps to preserve the biodiversity of native Hawaiian flora while supporting military training."

JAHKOTTA BURRELL LEWIS

Jahkotta Lewis has studied archaeological and ecological environments of Hawaiian lava tubes for 17 years with the National Park Service and the University of Hawai'i. Outside of her work in cave environments, Jahkotta has interests in Hawaiian spatial divination, gendered spaces, and indigenous science.

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"Climate change is insidious. It impacts the past, present, and future all at once. We must strive to understand the extent of its impacts before it's too late for archaeological and cultural resources."

JAMES WHITNEY

James Whitney has worked as an archaeologist in cultural heritage preservation for over 20 years, both in the field and in museums from Alaska to Hawai'i.

James is a curation specialist with the University of Hawai'i, Pacific International Center for High Technology Research, working for the U.S. Army Cultural Resources Program at PTA.

"Artifacts are physical connections to our ancestors and carry unique insight into their lives and culture."

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Jackie Walden began working as an archaeologist in Hawai'i in 2006, with a focus on historic preservation and research. Jackie holds a graduate certificate in Historic Preservation and a Master's in Library Information Science from the University of Hawai'i at Mānoa.

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"History Matters. I feel so lucky to live in Hawai'i and to work in a field where I support the management of historic resources for future generations."

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SPECIES AT RISK:

A STORY OF THE NATIVE HŌ'AWA

BY TIANA LACKEY

A fully ripe hō'awa fruit, split open to reveal bright orange flesh and shiny black seeds, is a tempting display for fruit-eating birds.
PRECEDING SPREAD **Tufts of leaves top each branch of a mature hō'awa tree at Pōhakuloa Training Area on Hawai'i Island.**

ABOVE **Immature fruit of the hō'awa tree (*P. terminalioides*) are the size of a walnut and grow right along the main branches.**

At Pōhakuloa Training Area (PTA), one of the rare species the Army is working to protect is the hō'awa tree species, *Pittosporum terminalioides*. This particular hō'awa species occurs in dry, mesic, and subalpine woodlands between 980–6,600 feet, in the southern end of the Hawaiian island chain. While *P. terminalioides* can still be found on Lāna'i and Maui, numbers on Hawai'i Island appear to be extremely low and Army Natural Resources staff at PTA are working hard to determine just how many remain.

The genus *Pittosporum* includes nearly 150 species found in tropical and subtropical regions including Africa, Asia, Australia, New Zealand and several Pacific Islands. Scientists believe that all Hawaiian hō'awa trees may be descendants of a single plant that was first introduced by a bird, in seed form, long before humans set foot on the Hawaiian Islands. Today, botanists recognize a total of 11 uniquely Hawaiian (endemic) hō'awa species; a result of birds spreading hō'awa seeds from the initial "founder" population to additional Hawaiian islands, along with the varying effects of isolation and natural selection over time.[1]

Anyone who comes across a hō'awa fruit can quickly discern how birds became the primary mode of transportation for this tree's progeny. The walnut-sized, pale brown capsules appear wrinkled and resemble small brains. They grow in clusters, sprouting directly from the main trunks or branches, a growth pattern known in the botanical world as "cauliflory," which accommodates larger animals or birds that perch or climb along trees branches. While the hō'awa fruit capsule's dry outer shell is not particularly attractive, when the fruit ripens, it transforms into a billboard advertising a forest feast. When fully mature, the capsule splits open to reveal a startlingly vivid orange and fleshy inner-wall laden with a buffet of reddish-black seeds covered in shiny, sticky resin.

As it happens, hō'awa was one of the main food sources for the 'alalā or Hawaiian crow (*Corvus tropicus*). According to Joseph Rock, a renowned botanist who studied native plants in Hawai'i from 1907 to 1920, approximately 80% of the 'alalā's diet was composed of hō'awa. Back then, hō'awa trees and 'alalā were a common sight. They both evolved together, complementing their ecological niches. However, 'alalā are now considered extinct in the wild and populations of hō'awa in the birds' former range have become very scarce likely due, in part, to the decline of its primary seed disperser, the 'alalā. The last time an 'alalā

[1]W.L. Wagner, D.R. Herbst, and D.H. Lorence. 2005-. Flora of the Hawaiian Islands website, accessed January 5, 2021, http//botany.si.edu/pacificislandbiodiversity/hawaiianflora/index.htm

was recorded at PTA was in 1986 during a forest bird survey in Training Area 22. The hō'awa and 'alalā are a classic example of the interdependent relationship that exists between native plants and animals in the Hawaiian ecosystem.

In addition to a decline in key seed dispersers, the hō'awa biology is another factor that makes conservation of rare species such as *P. terminalioides* particularly challenging. Hō'awa are dioecious, meaning male and female flowers are found on separate plants. If the number of *P. terminalioides* trees are already low, and production of the walnut-sized fruits are dependent on pollinators visiting both male and female trees, then protection of this rare hō'awa becomes especially important to sustain a healthy number of male and female plants that will produce successive generations.

The endemic hō'awa is both naturally and culturally significant in Hawai'i. Like the 'alalā, early Hawaiians were attracted to the eye-catching fruit, and over time developed numerous hō'awa tree applications. Medicinally, the outer layers of the fruit were pounded and applied to sores on the skin[2] and the fleshy orange lining of the fruit capsule was an important ingredient in a botanical mixture used to treat a swollen neck.[3] In addition, the light-colored wood of the hō'awa tree was sometimes used to make canoe gunwales, or mo'o, the narrow strips of wood placed along the upper edge of the hull, to protect the canoe from wear and tear.[4]

WHAT IS A SPECIES AT RISK?

While some species of native hō'awa are still common enough to be used in landscaping on some Hawaiian islands, the *P. terminalioides* on Hawai'i Island is considered a species at risk (SAR). The Department of Defense classifies a plant as a SAR if the plant is not federally listed as threatened or endangered under the Endangered Species Act (ESA), but is designated as a candidate for federal listing or is regarded as critically imperiled or imperiled throughout its range.

The Army recognizes the importance of managing for SARs at PTA. By proactively monitoring and managing for SARs and their habitat, the Army can help preclude the need for federal listing under the ESA, protect significant biological diversity and reduce recovery costs, while maintaining military training capacity. ESA compliance is one of the primary management drivers at PTA, and continued training is contingent upon meeting ESA requirements. There are currently 26 federally listed threatened and endangered species at the installation (20 plants and 6 animals). Many other PTA species are not listed, but are rare or declining and identifying SARs is a first step in developing species management plans to help stabilize populations.

IDENTIFYING SPECIES AT RISK AT PTA

Traditionally, the Army has focused efforts and analysis on federally listed species. Rare species that have been classified as SARs at PTA benefit from threat management that the Army conducts at a landscape level, to protect federally listed species in the same area. In 2019, PTA natural resources staff took a systematic approach to gathering information that could help identify additional species that meet SAR criteria and cross-referenced literature reviews, installation data, state and federal agency information, and data from NatureServe, a national online species database (natureserve.org). A wide array of information was compiled on each species including: ESA, State, and International Union for Conservation of Nature status; number of occurrences and estimated population size on PTA; field survey dates; percentage of statewide distribution on PTA; and a summary of PTA management conducted for each species. A total of 26 plant SARs have been observed at PTA since 2015 and up to 24 animal SARs have been observed at the installation since the 1990s.

PRELIMINARY MONITORING EFFORTS

In 2020, the PTA Natural Resources Program initiated SARs monitoring for a subset of species over a portion of the species' range at the installation. Historical data was used to guide the monitoring effort for SARs because the species selected for monitoring are generally long-lived and were not specific targets during previous surveys for federally listed plants. With preliminary information gathered, staff plan to develop more comprehensive approaches to monitor SARs across all known distributions at PTA to determine the status and trajectories of populations.

[2]Marie C. Neal, *In Gardens of Hawaii* (Honolulu: Bishop Museum Press, 1965), 382-383.
[3]M.N. Chun, *Native Hawaiian Medicine* (Honolulu: First People's Productions, 2003), 91-92.
[4]Beatrice H. Krauss, *Plants in Hawaiian Culture* (Honolulu: University of Hawai'i Press, 1993), 324.

ABOVE **Clusters of fragrant, one-inch blossoms adorn a hō'awa tree (*P. terminalioides*), a native species that is imperiled throughout its remaining habitat on Hawai'i island.**

ABOVE **Paul Martin, a field biologist with the Center for Environmental Management of Military Lands, measures the trunk diameter of a rare hō'awa tree (*P. terminalioides*) at Pōhakuloa Training Area as part of an ongoing monitoring program that supports Army management of natural resources.**

The status of *P. terminalioides* is included in these monitoring efforts. Historical surveys have documented 114 locations of this species at PTA and natural resources staff have incidentally re-located 13 trees while conducting surveys for other species of federally listed plants. A more targeted follow-up of previously documented hō'awa locations, as well as other SARs, is in the works to get a better idea of current species distributions and trends.

BENEFITS OF LANDSCAPE-LEVEL MANAGEMENT EFFORTS

Primary threats to ecosystem health, and therefore to federally listed species, SARs, and their habitats, come from direct impacts, as well as changes to the landscape as a result of wildland fire, feral ungulates, and invasive species. To manage these threats, the Army implements landscape-level efforts such as fuel breaks and fencing at PTA.

Fuel breaks mitigate the threat by wildland fires and military training-related fires to federally listed species, SARs, and native habitat. There are 14 fuel breaks totaling approximately 38 miles at PTA. The fuel breaks are in strategic locations and configurations to protect the majority of known SARs locations at PTA.

Many SARs, especially the *P. terminalioides*, are severely impacted by ungulate browse. Ungulate exclusion fence units protect native ecosystems at a landscape scale. The purpose of the fence units is to exclude ungulates (primarily goats, sheep and pigs) from habitat that supports this rare hō'awa and other threatened species. The Army completed the fencing project at PTA in 2013 at a cost of over $10 million. Fifteen fence units enclose nearly 37,300 acres of native habitat, including all or most of the known distributions of SAR species at PTA. All fence units are currently considered ungulate-free. By managing these threats, SARs with low numbers may begin to recover and increase in number at the installation.

ADDED VALUE: CULTURE, CONSERVATION, AND TRAINING CAPACITY

Managing for SARs provides cultural and conservation benefits while supporting the Army mission. With continued landscape-level management, some rare species may once again support the practices of the native Hawaiian community. Preserving these species and their habitats may allow for continued traditional cultural and medicinal utilization of numerous species of hō'awa, including the *P. terminalioides*. Protecting rare species also helps preserve the valuable biodiversity of these rare ecosystems. Hō'awa plays an integral role in the native dryland and mesic forest and embodies the symbiotic relationship between the island's flora and fauna. With the recent reintroduction efforts of the 'alalā into the wild on Hawai'i Island, the interdependent relationship between the bird and its favorite food source, hō'awa, may once again prove to be mutually beneficial.

Additionally, managing for a SAR before a drop in the population size necessitates endangered status listing at the federal level, helps ensure no net loss of training capacity at the installation. While efforts to date have focused on plant SARs, similar efforts are underway for animal SARs at PTA. The Army plans to continue its efforts to proactively manage for all SARs at the installation as part of its integrated natural resources management program.

Monitoring Cave Climates at Pōhakuloa

BY JAMES WHITNEY AND JAHKOTTA BURRELL LEWIS

The Interior Plateau of Hawai'i Island, A.D. 1665…

The bird hunter looked up at Mauna a Wākea (Mauna Kea) from where he stood on the expanse of an ancient pāhoehoe lava flow. The weathered pāhoehoe was warm beneath his ti leaf sandal clad feet, and the lā (sun) beamed down on him and his family as they walked. They were silent, their eyes focused upslope, searching for the ahu (stone cairn) that marked the ana (lava tube cave) that would be their shelter this hunting season. They were here for 'ua'u (Hawaiian petrel). The bird hunter's wife would help prepare the bird for transport while his son would help capture the sea bird from burrows in small pits and crevices in the lava flow.

The bird hunter saw the ahu that marked their destination and headed toward it. As he walked, he reminded his son that when the lā bid them farewell, the landscape would be filled with the sound of young 'ua'u calling into the night; a sound that reverberated in this realm of the gods and could be mistaken for keiki (children) crying.

The ana breathed out gently as the bird hunter approached. He stopped a moment, and his family did the same. This ana was a sacred place, a place that protected them, as it had done for his father and his father before him. He could see the gourds were where he had left them, in the twilight zone of the entrance, on stacked piles of cobbles and stone slabs. They would be full by now with life-giving wai (water) provided by the ana. Three large scatters of charcoal and ash from the fires of the previous hunting season decorated the floor of the cave, while a stone shrine with offerings of bird stone and ti leaf stood prominently within the entrance. The bird hunter began to chant…

ABOVE AND PREVIOUS PAGE **A lava tube cave at Pōhakaloa Training Area with rich archaeological material indicative of bird hunting, including a stone table, fire pit and ash along with stone tools and cooking implements hidden within the rocks.** RIGHT **Gourds hidden in a cave entrance were used by Native Hawaiians that accessed the interior plateau to carry feathers, collect water and store material.**

The Interior Plateau of Hawai'i Island today...

Lava tube caves like the one described in the fictional account on the previous page are important archaeological sites at Pōhakuloa Training Area (PTA). Located within the interior plateau of Hawai'i Island between Mauna Kea, Hualālai, and Mauna Loa volcanoes at 6,190 foot elevation, the PTA landscape includes sparsely vegetated expanses of lava flows. Networks of caves dot the area and were used in the past as temporary shelters by travelers, warriors, priests, and bird hunters alike. These subterranean environments are repositories for rich assemblages of pre-Contact and historic era artifacts.

> *The preservation of artifacts in PTA caves, particularly fragile items such as ti leaf sandals and braided cordage, is exceptional and likely due to the cool, arid climate.*

The preservation of artifacts in PTA caves, particularly fragile items such as ti leaf sandals and braided cordage, is exceptional and likely due to the cool, arid climate. Understanding cave climates can provide data needed to make management decisions that will best preserve the archaeological record in the face of climate change while providing insight into how these environments reflect past human activity. Cave climate data can also contribute to our understanding of ancient Hawaiian practices of bird hunting.

The PTA Cultural Resources Section began a cave monitoring program three years ago as a result of the Infantry Platoon Battle Course (IPBC) Programmatic Agreement (PA). This recently constructed battle course allows infantry platoons to train on foot or in vehicles for deployment. Under the IPBC PA, the Army monitors archaeological cave sites determined eligible for the National Register of Historic Places for potential impacts from military training. Cave climate monitoring has now been added into the Army's overall site monitoring program.

The PTA Site Monitoring Program

The PTA Cultural Resources Section manages more than 1,200 archaeological sites, of which 259 are cave sites. Four of these cave sites are monitored quarterly under the IPBC PA by using photographic documentation and detailed maps that plot artifact locations at each site. Motion sensor cameras are used to protect the sites and ensure unauthorized personnel are not entering these locations.

One of the four caves monitored is site 50-10-31-29023A, in the kilometer long ABC Lava Tube System. The site contains rich archaeological deposits and radiocarbon dating indicates the site was used as early as A.D. 1665. Climate data collected from this site is part of a comprehensive approach to cultural resources management that connects archaeological sites with curated collections in the PTA repository.

Large breakdown slabs and bedrock outcrops form rough stone stairs into the pāhoehoe sink entrance of site 29023A. The cave interior contains many stone structures, including

TOP **A cave used for temporary habitation is monitored and protected by the Cultural Resources Program at Pōhakuloa Training Area (PTA).**
LEFT **Deep within a lava tube system beneath PTA.**

platforms, fire pits, and enclosures. Bird cooking stones, bird feathers and bones, braided cordage, gourds, hammerstones, stone tool flakes, kukui (*Aleurites moluccanus*) nut shell, 'opihi (*Cellana* sp.) shell, and adze cut wood fragments suggest the cave was used as a camp site by bird hunters.

The Cave Climate

A climate data logger was placed in the cave next to a stone enclosure and a large concentration of artifacts to record temperature and relative humidity. This data logger is the same technology used to monitor the PTA curation facility environment to provide optimal conditions for artifact preservation. Monitoring cave environments in the same way allows for a risk assessment of artifact deterioration. Inexpensive and rugged, the data logger is perfect for monitoring caves. Data is downloaded from the cave entrance via Bluetooth technology allowing the site to remain undisturbed during monitoring.

Climate data indicates cave and surface temperatures follow the same seasonal fluctuations. However, temperatures in the cave are much more stable, staying cooler during the day and warmer during the night. Annual mean cave temperature was 55 °F with a high of 64 °F and a low of 44 °F, while mean surface temperature was 59 °F and fluctuated daily with a high of 82 °F and a low of 32 °F. The cave remains a temperate refuge from the extreme heat of the day and freezing temperatures at night.

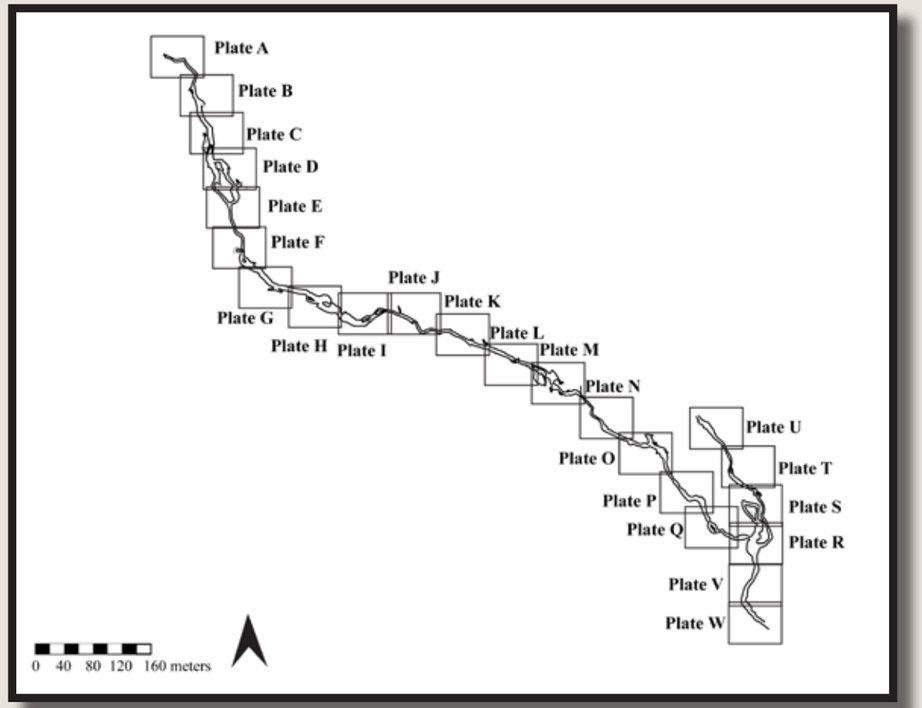
Relative humidity (RH) in the cave and at the surface also follow the same seasonal fluctuations with higher RH in the spring and fall. Two seasonal rainy periods in the spring and the fall correspond with the increases in RH. Annual mean RH in the cave was 93% with a high of 100% and a low of 23%. Annual mean RH at the surface was 77% and fluctuated daily with a high of 100% and a low of 1%. Mean RH inside the cave was higher but remains much more stable despite the large daily fluctuations on the surface.

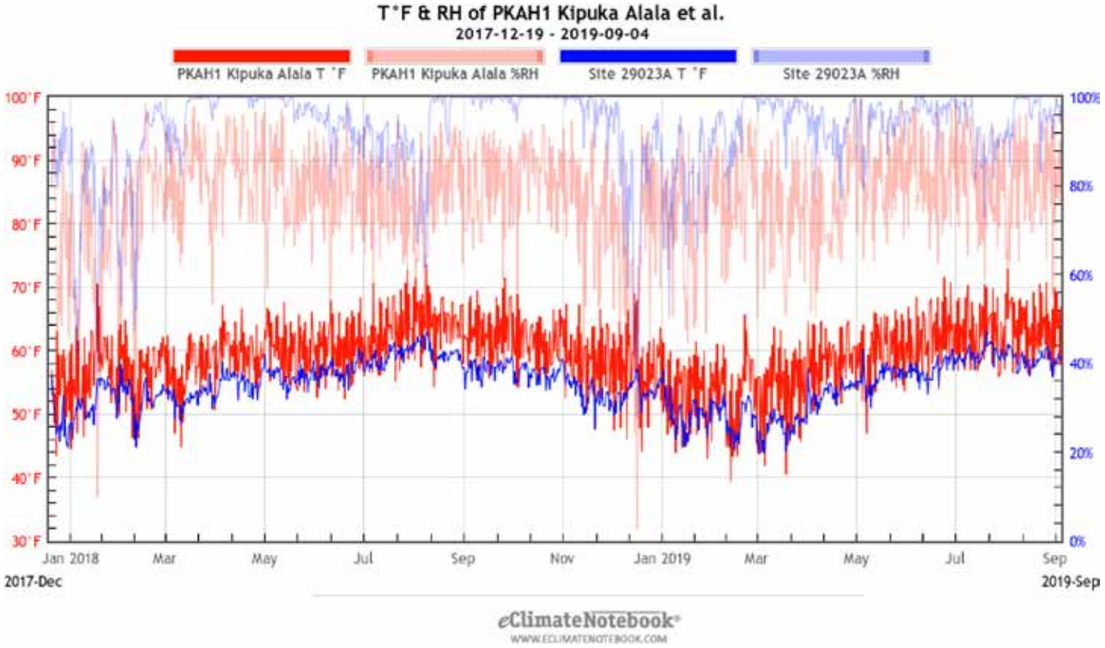
Data collected with the HOBO MX2301A data logger corresponds with seasonal observations made during site monitoring efforts. In December, while some water drips were noted, the cave walls and floor were mostly dry and entrance vegetation had died back. The following April, active water drips had increased and the walls were wet and slick with cave slime and algae. Entrance vegetation had grown back, the cave floor was saturated, and erosion was noted with fluvial rills and sediment down-cutting.

TOP LEFT **Bird cooking stones, such as this one located within a stone platform, were heated and inserted into the body of a butchered bird.** TOP RIGHT **A map of the ABC Lava Tube System that has been documented by staff of the Cultural Resources Program at Pōhakuloa Training Area (PTA).** BOTTOM LEFT **An 'opihi (*Cellana* sp.) shell on a natural boulder breakdown in the entrance of a cave site at PTA.** BOTTOM RIGHT **A data logger is placed next to a stone enclosure on the cave floor to collect information on cave climate.**

A 1.2 KILOMETER LAVA TUBE SYSTEM CONTAINS ARCHAEOLOGICAL DEPOSITS DATING BACK TO A.D. 1665

The ABC lava tube system is one of the most archaeologically significant systems at Pōhakuloa Training area, with sites eligible to the National Register of Historic Places.





ABOVE **Climate data from cave site 29023A (blue line) at Pōhakuloa Training Area was compared to climate data from a nearby remote weather station (red line), indicating air temperatures above ground and below follow the same seasonal fluctuations, but that daily temperatures within the cave are far more stable, providing a temperature refuge.**

What it All Means: Artifact Preservation, Understanding the Past, and Changing Climates

The climate data collected at Site 29023A shows predictable and definable environmental extremes associated with seasonality. In most environments, this would indicate a high risk of decay for artifacts. However, recent research in museum conservation demonstrates rapid changes in temperature can be most detrimental to artifacts as they respond to temperature changes within hours whereas moisture equilibrium from changes in RH takes days or weeks. The stable, cool temperatures recorded in the cave may account for the excellent preservation of organic artifacts.

Climate trends indicate that wet conditions in the cave also correlate with the 'ua'u (*Pterodroma sandwichensis*), fledgling season, which traditionally occurs during October. This would have been convenient for the bird hunter, as water collection in the cave was optimal during the fledgling season, with seasonal rains and condensation dripping into gourds. While a wet cave may seem uncomfortable for habitation, diverse microclimates likely created drier and more inviting areas. Native Hawaiians modified their environment to meet their needs and used caves according to their microclimates. Fire pits and charcoal scatters made the cave environment more comfortable and also modified the climate.

Coastal archaeological sites are often thought of as the most impacted by rising sea levels but archaeological sites in caves far from the coast can also be affected by changes in climate. Climate data from Site 29023A shows a stable, cool cave environment that corresponds with exterior temperatures and relative humidity. When exterior temperatures rise, interior cave air and soil temperatures rise, increasing microbial degradation of artifacts. Increased severity of hurricanes caused by climate change will increase moisture levels within the cave and will accelerate artifact decay. Cave climate data has the potential to predict artifact degradation rates while providing useful baseline data for predictive cave climate modeling. While the full implications of cave climate monitoring have yet to be explored, its application in cultural resources management of archaeological cave sites is far-reaching.

LEFT **Currently listed as an endangered species, this 1890 depiction of the 'ua'u (*Pterodroma sandwichensis*) or Hawaiian petrel, by Frohawk-Wilson & Evans, was created at a time when these and other native seabirds were far more common.** RIGHT **An artistic rendering of a cave entrance at Pōhakuloa Training Area.**

In Plain Sight: Historic Properties at Fort DeRussy

BY JACQUELINE PAMERLEAU-WALDEN

ABOVE **A 1938 photograph of Fort DeRussy on O'ahu provides a glimpse of the Alawai Canal and neighboring Waikīkī community.** TOP LEFT **A modern day view from Kuroda Field at Fort DeRussy, looking towards the Hale Koa Hotel and the neighboring Hilton Hawaiian Resort.** PRECEDING PAGE **Fort De Russy in 1932.**

Although not always obvious, history surrounds us every day. History tells our stories, connects us to the past, and shapes our future.

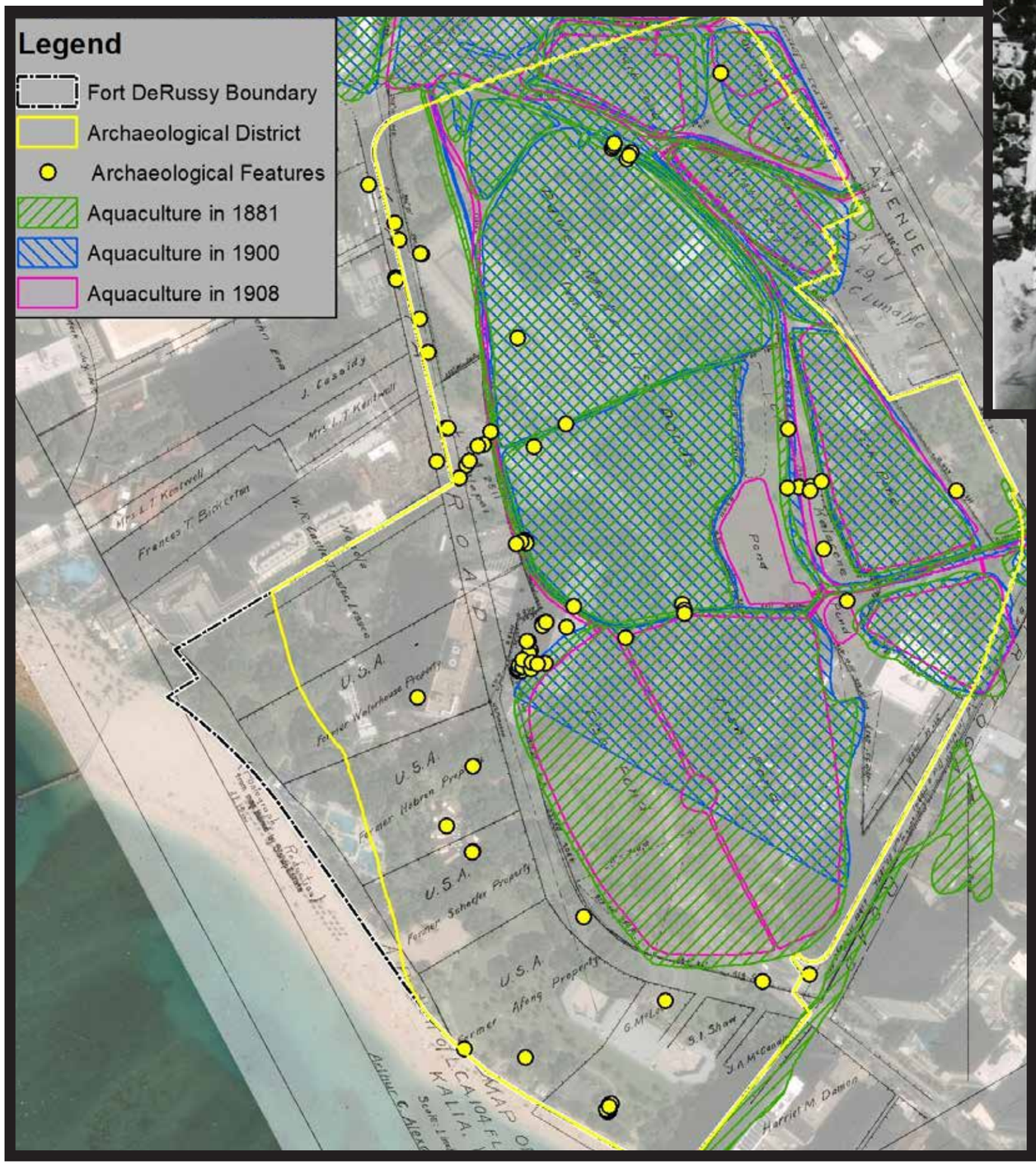
For instance, take Fort DeRussy, an Army Installation situated in the heart of Waikīkī. On the surface Fort DeRussy is home to a resort, a museum, and an oasis of shady green space that stretches from Kalākaua Avenue to the shoreline. In actuality, there is more history present than what the eye can see.

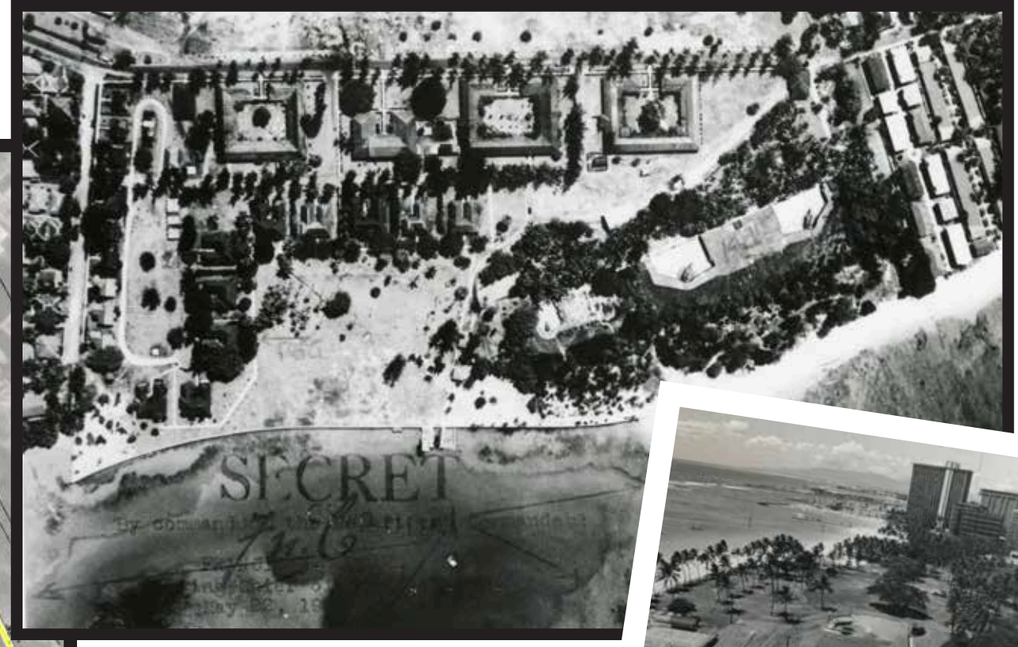
A Holistic Perspective

U.S. Army Garrison Hawai'i (USAG-HI) archaeologist Dave Crowley evaluated the eligibility of the archaeological sites at Fort DeRussy and through his research, identified an entire archaeological district. Records of earlier excavations, tests and construction monitoring provided Crowley with important details that helped him to understand the context, nature and results of previous archeological work performed in the Fort DeRussy area. The research process took many months and through careful analysis of past archaeological studies and reports, historic maps, geographic information system data and land use history records, Crowley began to develop a clear picture of the archaeology at Fort DeRussy.

This plethora of archaeological resources, when examined holistically, confirmed the existence of a substantially intact, buried archaeological district at Fort DeRussy, comprised of features related to traditional Hawaiian and early historic occupation and subsistence, sealed under a thick cap of imported fill material deposited in the early 20th century.

The recognition that the dozens of archaeological features and sites found throughout the buried landscape are an interrelated, unified entity will enable better description and comprehension





Images Courtesy of the Tropic Lightning Museum

of the archaeological resources that underlie Fort DeRussy, more effective management of the archaeological resources in accordance with the National Historic Preservation Act and Army regulations, and an important acknowledgment of the traditional holistic pattern of Hawaiian land usage.

The evaluation and understanding of the archaeological district will not stop with the determination of eligibility. Documentation of the archaeological district at Fort DeRussy describes an area with a story to tell, beginning with the earliest estimation of Hawaiian habitation in Waikīkī (12th century A.D) to 1909. As history is unveiled, work to increase our understanding of the cultural ties to this landscape will continue through consultations with Native Hawaiian Organizations.

In addition to a buried archaeological landscape, Fort DeRussy is also home to a historic building: Battery Randolph. In the historic military context of Battery Randoloph, Battery Dudley and the coastal defenses of O'ahu, a battery is a fixed fortification for artillery emplacements. Battery Randolph was built as a coastal artillery fortification in 1911. On the surface, the building itself was non-descript, offering few clues to its purpose to the casual observer. The beach-front battery consisted of two 14-inch disappearing rifled guns and along with Battery Dudley (now demolished), served as part of the Army's coastal defense system.

Battery Randolph is listed on the Hawai'i State Register of Historic Places for its unique design and construction, and on the National Register of Historic Places as part of the Artillery District of Honolulu.

FACING PAGE **A multi-layered map created by USAG-HI Cultural Resources Program to highlight the distribution of previously discovered buried archaeological and aquaculture features within the archaeological district at Fort DeRussy.** TOP **Two 14-inch rifled guns are visible on the upper deck of Battery Randolph, in this photograph of a declassifed 1928 plan view.** ABOVE **The demolition of Battery Randolph in the 1970s came to a halt after the demolition company declared they were unable to remove the fortified building.**

ABOVE **The United States Army Museum of Hawai'i, built within the foundation of Battery Randolph at Fort DeRussy on O'ahu.**

Community Engagement

Years later, after Battery Randolph had served its purpose, the Army adaptively transformed the building into the U.S. Army Museum of Hawai'i, established in 1976. The museum honors and shares the extraordinary history of the Army in the Pacific centered on Hawai'i's contributions to our nation's defense and its rich Army heritage. The exhibits offer visitors a window to the past through displays that feature collections from traditional Hawaiian warfare up to present day Army engagements in the Pacific.

"As stewards of the U.S. Army Hawai'i's storied history in the pacific, our museum and its dedicated staff take great pride in representing the U.S. Army Center of Military History as one of their flagship museums," said museum director Nevin Field, adding that the museum has the privilege of sharing this story with an average of 95,000 visitors annually from around the world.

The Army Cultural Resources Program recognizes that the history of place is important. "One of the purposes of our program is keeping people connected to the history and culture expressed through places," said Richard Davis, USAG-HI Cultural Resources Program manager.

The cultural resources team consults with more than 100 Native Hawaiian Organizations and interested parties and engages with a variety of project proponents. According to Davis, the team's work is about more than establishing compliance with regulations; relationship building is an important aspect of the program. It is this spirit of community building that will help to further our collective understanding and appreciation for the history of places like Fort DeRussy and guide effective management of historic and cultural resources across USAG-HI installations.

The U.S. Army Museum of Hawai'i is free and open to the public, 10 a.m.-5 p.m., Tuesday through Saturday. Groups entering the Museum are currently limited to 5 persons per group. The museum is located at 2131 Kalia Rd., Fort DeRussy, in Waikīkī. For more information visit **https://hiarmymuseumsoc.org/**

The Cultural Resources Program within the Environmental Division at the Directorate of Public Works ensures that the cultural and historic resources under the stewardship of the U.S. Army Garrison Hawai'i (USAG-HI) are managed as required by federal law.

The Cultural Resources Program manages over 6,400 archaeological sites and historic buildings on O'ahu and Hawai'i Island. There are many paths used by the Cultural Resources Program to manage and maintain the cultural and historical resources located within Army Installations.

The Cultural Resources Program handles inventory and monitoring, project reviews and compliance, consultation, mitigation implementation, curation, and information and records management, all in support of the USAG-HI's mission.

THE LEADING EDGE

OF THE INVASIVE PLANT BATTLE:

INCIPIENT WEED CONTROL

Natural resource management technicians with the Army Natural Resources Program on O'ahu, conduct a weed sweep in the East Range training area on Schofield, as part of an effort to locate and control recent invasive weed introductions on O'ahu.

Schcon!

Need reinforcements?

Yeah. It's a hot spot!

Any matures?

Just one, but we've got a carpet.

Copy. Headed your way!

Unfortunately, this cryptic conversation above is repeated several more times between Army natural resources field technicians as they scan roadways and open grasslands of the Schofield Barracks, East Range training area on O'ahu. "Schcon," is short for *Schizachyrium condensatum*, a species of invasive grass that is native to tropical America. Once every three months, a team of field technicians walk painstakingly slowly through this training area in a phalanx formation—a line of people, six to ten feet apart—to search for this invader. This weed sweep search formation has nothing to do with COVID-19 physical distancing requirements; it enables team members to accurately identify all weed targets without passing them by.

With very little tree canopy cover, the average daily temperatures at East Range hovers near 90 degrees, adding to the already challenging task of spotting the target grass species within a sea of other introduced grasses and weedy shrubs. If the offending grass is found, "Schcon!" is called out and the weed sweep comes to halt. A "hot spot"

is an area where a cluster of mature (seed bearing) plants are found. All flowers and fruits are carefully snipped off and bagged, to prevent the wind-dispersed seeds from escaping, and all remaining parts of the mature plant are removed from the ground. Before the march of the weed sweep can continue, technicians come together to clear the "carpet" of purplish-blue stemmed Schcon seedlings. GPS points are also taken at the hot spot, to mark yet another location that will have to be revisited in three more months.

While Schcon, otherwise known as bush beard grass, is not known to be widespread on O'ahu, it is an invasive weed that is widespread on the island of Hawai'i. It gained notoriety for its ability to establish on previously barren lava fields, its extreme flammability, and its ability to carry destructive wildfire through native forest areas in Hawai'i Volcanoes National Park. This reputation makes Schcon management in the East Range training area on O'ahu extremely important to the Army. As a target, Schcon is difficult to tell apart from many of the other grasses established in East Range. The only noticeable trait that you can spot from afar is the seed head that looks like an upside down broom.

The Army's Natural Resources Program Manager, Kapua Kawelo, joins a team of natural resources field technicians periodically to assist in the effort. She reflects on her experience with a roll of the eyes.

"After looking for Schcon all day long," Kawelo shares, "I have a raging headache, my eyes are tired and I really can appreciate the team's persistence on this target. It takes incredible concentration to discern Schcon from other grasses and finding the seedlings is exceedingly difficult."

Incipient invasive species control is a critical component of the Army Natural Resources

ABOVE **Army natural resource management technicians on the Green Team carefully inspect a known "hot spot" for *Schizachyrium condensatum* (Schcon), a highly invasive grass species.** LEFT **Green Team Field Supervisor Chelsea Tamayo and technician Wesley Piena carefully bag the seed head of a mature Schcon to prevent seeds from spreading on Army training land.**

Program. In the conservation world, *incipient* refers to an invasive plant species that is not yet established or widespread and generally still at population levels where complete eradication may be achieved. In the case of Schcon, the Army's goal is to eradicate it from training areas on O'ahu.

A THREE-POINT PREVENTION SYSTEM

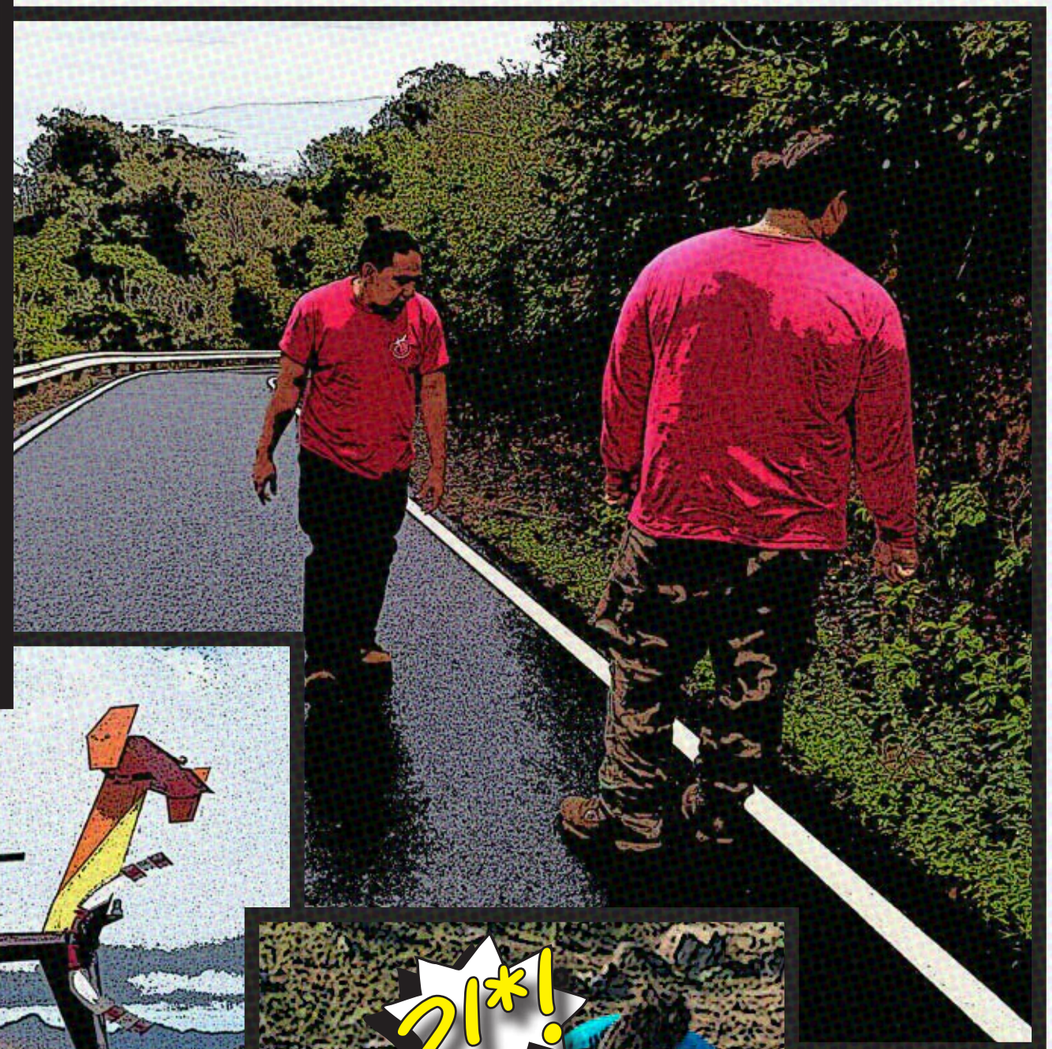
A key component for successful management of incipient and non-incipient invasive plant species is preventing further spread of these weedy species. Invasive weeds can move around on army training equipment and personal soldier field gear. The Army's invasive species prevention system involves education, early detection and rapid-response.

Soldiers are briefed about the importance of cleaning field gear before and after training. They are also educated on the U.S. Army Hawai'i's mandatory wash rack use policy that requires vehicles to be cleaned when moving between training areas. The Army maintains and operates three vehicle and equipment wash rack facilities on O'ahu and one at Pōhakuloa Training Area.

For early detection, the Army's Natural Resources program conducts annual roadside and helicopter landing zone surveys in order to identify invasive plants of concern early on. Rapid response and control of these identified invasive species is critical in keeping them from becoming widespread across the area and preventing weed species establishment.

As career conservationists, our own potential harm must also be considered

CLOCKWISE FROM RIGHT **An end-of-day gear cleaning session detects a seed from *Ehrharta stipoides*, an invasive grass, that hitchhiked on the velcro of a field tabi; natural resource management technicians Petelo Maosi (left) and Wesley Piena conduct a weed survey along Ka'ala Road; Field team leader Kupono Matsuoka and Maosi identify and document weed species in lower 'Ōhikilolo; the pilot arrives at 'Ōhikilolo landing zone to transport Army natural recources field staff back to civilization.**



and minimized. The work we conduct puts us into the most pristine and remote parts of O'ahu. This is both an honor and a privilege. The Army natural resources field staff take biosecurity seriously. Precautions to prevent the spread of aggressive incipient and invasive weeds include daily boot washing to remove seeds and decontamination with alcohol spray to prevent the spread of rapid 'ōhi'a death (caused by two species of *Ceratocystis* fungal pathogens) and other plant pathogens. Natural resources staff also dedicate special gear for incipient control projects where contamination is likely and maintain awareness about the presence or absence of weeds in Army management units.

BUILDING MORALE

Despite the challenges of locating and controlling incipient invasive weeds, Army natural resources field technicians manage to make it fun. On one particularly grueling day of searching for Schcon hotspots in Schofield East Range, one field technician adapted the words from the 1979 Donna Summer hit, *Hotstuff* and began to sing, "Lookin' for some *hotspots*, baby, this evenin'." When the other team members joined in, a weed sweep theme song was born.

On this particular day, we visit numerous incipient control areas for Schcon and it is soon apparent that many Schcon hotspots have earned a nickname linked to the original finders: *Schtelo's* for natural resource management technician Petelo Maosi; *Schcunda's* for a field team leader with *tunda* as his radio call sign; or Schkong's after field supervisor Kaia Kong. Learning these identities, and a little about the finders themselves, made me feel as though I had been welcomed into some kind of secret weed warrior society.

Of course, the real initiation came when it was time to join an actual Schcon weed sweep. The team was patient, and took time to point out key Schcon characteristics to help with the search, including: the upside-down broom shaped seed head (obvious on the full grown Schcon grasses); the clumping growth pattern at the base of the grass (somewhat helpful);

RIGHT **Plant identification skills are put to the test as Green Team staff wade through non-native grasses to locate and dig out one grass in particular: the incipient *Schizachyrium condensatum* (Schcon).** BELOW **Natural resource managment technician, Hannah Wilson (right), and field team intern, Kina Poulos, clip and bag a Schcon seed head.** BELOW RGHT **Field Supervisor, Chelsea Tamayo and technician Hannah Wilson confirm the number of bagged Schcon seed heads following a weed sweep, as technician Wesley Piena checks in on the radio.**

A volunteer digs out the incipient weed *Juncus effusus* from the native bog ecosystem at the summmit of Ka'ala.

The Army Natural Resources Program staff and volunteers spend hundreds of hours each year controlling incipient weeds at Ka'ala, the highest point on O'ahu and one of the most intact native forests on the island. One of these incipients is a species of moss, *Sphagnum palustre* which can be difficult to detect among hundreds of native mosses on the forest floor.

TEST YOUR WEED FINDING SKILLS!
The first *S. palustre* moss "sprout" (technically a gametophyte) has been circled. How many more can you find? *Turn the page to see how you did...*

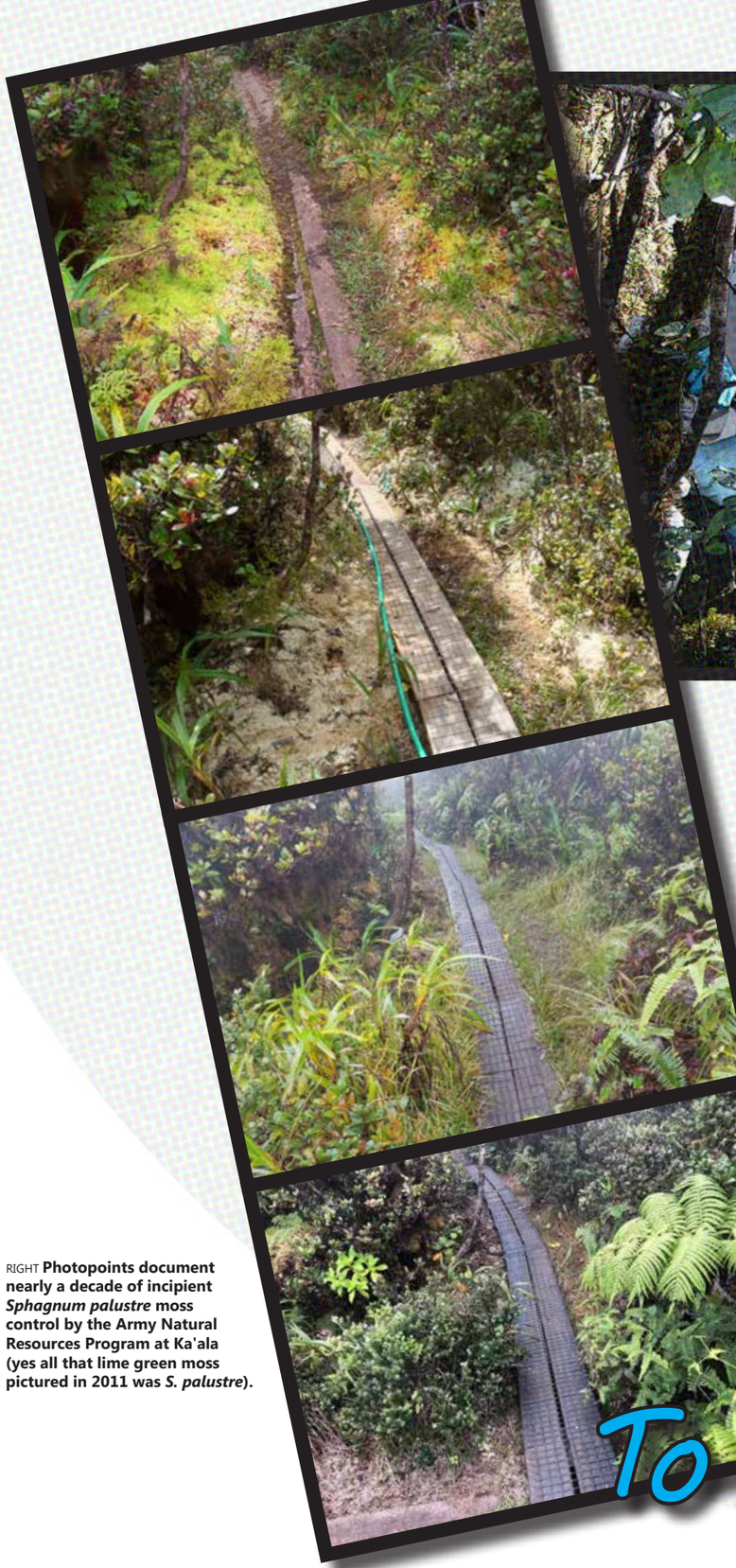
and the lack of very fine hairs along the stems (nearly impossible for me to discern without my reading glasses). They even helped me "search" for Schcon after they located one themselves.

As I stood within a few meters of the offending grass, field technicians guided me with a game of "getting warmer/getting colder" until I zeroed in on the target. While I was not able to locate an entirely new Schcon hotspot and earn the associated naming rights, after several hours of wading through similar looking grasses in search of Schcon, I accepted the sweat-dripping-eye-straining-itchy-skin discomforts, refined my search image, and managed to successfully locate several target species within previously named hotspots.
"Schcon!"

INCIPIENT CONTROL AREAS

Schizachyrium condensatum, or Schcon, is just one of 70 different incipient plant taxa that the Army currently manages on O'ahu. These weeds fall within approximately 250 incipient control areas (ICAs) that have been identified on Army training lands and on offsite management units (lands managed by partner organizations) on both the Wai'anae and Ko'olau mountain ranges.

The ultimate measure of success, when it comes to controlling incipient weeds, is complete eradication. In the last 15 years, staff and volunteers with the Army Natural Resources Program have eradicated a total of 45 ICAs; a success worthy of celebration, or at least a song.



Did you find them all? There are at least SIX incipient *Sphagnum palustre* gametophytes in this otherwise native carpet of moss.

Mahalo to all the volunteers who have been helping the Army Natural Resources Program control this highly invasive moss (and many other incipient weeds) over the past ten years! Your work has made a significant impact on the recovery of the unique wet forest and bog ecosystems at Ka'ala.

RIGHT **Photopoints document nearly a decade of incipient *Sphagnum palustre* moss control by the Army Natural Resources Program at Ka'ala (yes all that lime green moss pictured in 2011 was *S. palustre*).**

ABOVE LEFT AND ABOVE RIGHT **Volunteers Roy Kikuta and David Danzeiser spray *Sphagnum palustre* with a non-toxic mixture of diluted clove oil and citric acid to prevent the spread of this invasive moss along the Ka'ala boardwalk.**

To be continued...

Root into your community

HO'OA'A

The U.S. Army Garrison Hawai'i natural resources program staff leads 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 weed control in native habitat and occasional planting activities.

BECOME A VOLUNTEER

JOIN THE VOLUNTEER LISTSERV

Contact OUTREACH@OANRP.COM or 656-7741 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 THE U.S. ARMY GARRISON HAWAI'I

The U.S. Army Garrison Hawai'i is responsible for the day-to-day operations of Army installations and training areas in Hawai'i. The 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 the 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 resource 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 the U.S. Army Garrison Hawai'i Natural Resources Program on O'ahu. For more about OVPRI, please visit: WWW.HAWAII.EDU/RESEARCH/