

State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Forestry and Wildlife

April 24, 2020

Chairperson and Members
Board of Land and Natural Resources
State of Hawaii
Honolulu, Hawaii

Land Board Members:

SUBJECT: AUTHORIZATION OF FUNDING FOR THE NATURE CONSERVANCY FOR \$545,952 DURING FY 21-26 FOR CONTINUED ENROLLMENT IN THE NATURAL AREA PARTNERSHIP PROGRAM AND ACCEPTANCE AND APPROVAL OF THE WAIKAMOI PRESERVE EAST MAUI IRRIGATION ADDITION LONG RANGE MANAGEMENT PLAN, TAX MAP KEY: (2) 2-4:016:004, POR., MAUI

BACKGROUND:

The State's Natural Area Partnership Program was established in 1991 and provides matching funds (\$2 State to \$1 private) for the management of qualified private lands that have been permanently dedicated to conservation (Hawai'i Revised Statutes § 195-6.5).

The attached Long-Range Management Plan (LRMP) for Fiscal Years 2021-2026 provides a detailed description of the natural resources protected in the Preserve and the management activities planned over the next six years. Although Natural Area Partnership agreements are made in perpetuity, funding is authorized on a six-year basis to allow for regular periodic State and public review. The Natural Area Reserve System Commission approved this LRMP during their August 22, 2019 meeting.

CHAPTER 343, HAWAII REVISED STATUTES – ENVIRONMENTAL ASSESSMENT:

The actions proposed in the plan fall under activities categorized in Part 1 of the Environmental Assessment exemption list reviewed and concurred on by the Environmental Council on March 3, 2020. Activities categorized as "Part 1" fall under §11-200.1-16 (a) (1), Hawaii Administrative Rules, which are exempted from the preparation of an EA and the requirements of section 11-200.1-17 because the agency considers the specific activity to be *de minimis*.

RECOMMENDATIONS:

That the Board:

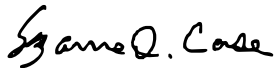
- 1) Approve the Waikamoi Preserve East Maui Irrigation Addition Long-Range Management Plan submitted for Fiscal Years 2021-2026;
- 2) Authorize the matching funding for the management of the Waikamoi Preserve East Maui Irrigation Addition for the full six-year period as outlined in the Long-Range Management Plan for Fiscal Years 2021-2026; and
- 3) Authorize the Chairperson to negotiate and sign a Partnership Agreement with The Nature Conservancy, subject to approval as to form by the Attorney General's office.

Respectfully submitted,



DAVID G. SMITH, Administrator
Division of Forestry and Wildlife

APPROVED FOR SUBMITTAL:



SUZANNE D. CASE, Chairperson
Board of Land and Natural Resources

Attachment

Waikamoi Preserve East Maui Irrigation (EMI) Addition

East Maui, Hawai'i

Long-Range Management Plan
Fiscal Years 2021-2026



to the
Hawai'i Department of Land and Natural Resources

By



The Nature Conservancy, Maui Program
March 2020

EXECUTIVE SUMMARY

The Nature Conservancy is an international private, non-profit organization based in Arlington, Virginia. The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. Since 1980, the Conservancy has protected more than 200,000 acres of natural lands in Hawai'i and works with other public and private landowners to protect the islands' key watersheds. The Conservancy manages a statewide network of 11 preserves totaling 40,000 acres and works in 12 coastal communities to protect the coral reefs and near-shore waters of the main Hawaiian Islands. In 1991, TNC helped to pioneer the watershed partnership model, which now includes more than 2.2 million acres of conservation land statewide.

The State's Natural Area Partnership Program (NAPP) is an innovative program that aids private landowners in the management of their native ecosystems. NAPP provides matching funds (\$2 state to \$1 private) for the management of qualified private lands that have been permanently dedicated to conservation. The Waikamoi Preserve East Maui Irrigation (EMI) Addition was approved for NAPP funding in 2015, and this Waikamoi EMI Addition Long-Range Management Plan (LRMP) follows the most initial plan that covered fiscal years (FY) 2015–2020. The Nature Conservancy of Hawaii (TNCH) is seeking reauthorization of NAPP funding for the next six-year period for the programs described within this *Waikamoi Preserve EMI Addition FY2021–FY2026 Long-Range Management Plan*.

Although NAPP agreements are made in perpetuity, funding is authorized on a six-year basis to allow for periodic State and public review which requires approval of a six-year management plan by the Board of Land and Natural Resources. Timelines for the management programs described herein are subject to change and may extend past the timeframe of FY21-26 as proposed management actions and their maintenance will be ongoing.

This watershed management plan prevents the degradation of surface water and ground water quality. This plan builds upon and extends the programs implemented under the previous plan and environmental assessments, as well as historic and current management in original Waikamoi Preserve (5,230 acres), which was admitted into the NAPP in 1992. In this plan, we request \$125,000 annually in matched state funds for the six years spanning FY2021–2026. This plan was prepared in compliance with the NAPP agreement between the state, TNCH, and Hawai'i Administrative Rules Chapter 13-210.

The state Department of Land and Natural Resources (DLNR), which administers the NAPP, is kept apprised of our progress in the preserve through written reports and an annual inspection. Semiannual and annual plans and reports are submitted in February and September, respectively. These documents are posted on the DLNR NAPP website.

The first section of this plan is a brief overview of the background, setting, native species, watershed, and water resources protected in the EMI addition adjacent to Waikamoi Preserve (hereafter referred to as the "EMI addition"). The second section discusses management considerations and management programs, with goals, methods, and detailed activities described for each, in addition to accomplishments over the last six years and future plans. A budget summary and table conclude the plan.

Activities covered under this long-range plan will focus on: maintaining zero levels of ungulates across the Preserve; maintaining the three-mile boundary fence built in 2014, other fences, and stream barriers; invasive plant mapping and control; threat and resource monitoring; support for partner surveys and monitoring; improvements and utilization of innovation for management; and infrastructure maintenance (landings zones and trails).

We successfully implemented the resource management projects of the previous six-year long-range plan, as well as many others. See Table 1.

Table 1. Overview of Waikamoi Preserve EMI Addition Accomplishments by Program, FY2015–2019

	Indicator	Measure of Success
Ungulate Control	Total animal catches	<ul style="list-style-type: none"> • 29 pigs
	Total traps checked	<ul style="list-style-type: none"> • All groups checked multiple times annually (1808 individual traps)
	Total hunts conducted	<ul style="list-style-type: none"> • 53 total hunts
	Miles of fence constructed and maintained	<ul style="list-style-type: none"> • 3 miles of fence installed and checked multiple times annually • Honomanū fence extended 20 meters into gulch
	Ungulate monitoring transects installed and monitored	<ul style="list-style-type: none"> • 3 500m ungulate monitoring transects installed and checked semiannually • 11 trails and 1 LZ established to facilitate management
Invasive Plant Control	Acres and total numbers of priority invasive plants treated or removed	<ul style="list-style-type: none"> • 258 <i>Cortaderia jubata</i> plants treated by MISC • 170 acres surveyed for ginger with an estimated 1,464 total m² of ginger treated
Resource Monitoring	Frequency of ungulate sign on ungulate transects	<ul style="list-style-type: none"> • From 66% activity in FY15 to 0% in FY16 to FY19
	Miles surveyed for plant infestations	<ul style="list-style-type: none"> • ~ 200 annually
Rare Species Protection and Research	Number of new rare taxa locations discovered	<ul style="list-style-type: none"> • 416 locations of 35 different species documented & mapped
	Number of species outplanted and recovered	<ul style="list-style-type: none"> • 2 rare species outplanted
	Number of research projects supported in EMI	<ul style="list-style-type: none"> • 3 research projects supported

Benefits as a result of this project:



RESOURCE SUMMARY

Background

In 2013, TNC finalized a conservation easement over 3,721 acres of East Maui Irrigation Co. Ltd. (EMI) lands adjacent to the 5,230-acre Waikamoi Preserve. The land is some of the highest quality and weed-free native forest in the state. In addition, the area has been designated as critical habitat for nine endangered species by the U.S. Fish & Wildlife Service and is primary habitat for the endemic i'iwi (listed as threatened), 'ākohekohe and kiwikiu (both critically endangered Maui endemics). Ungulate and weed management, as well as species recovery in the EMI addition, have long been a management priority for TNC.

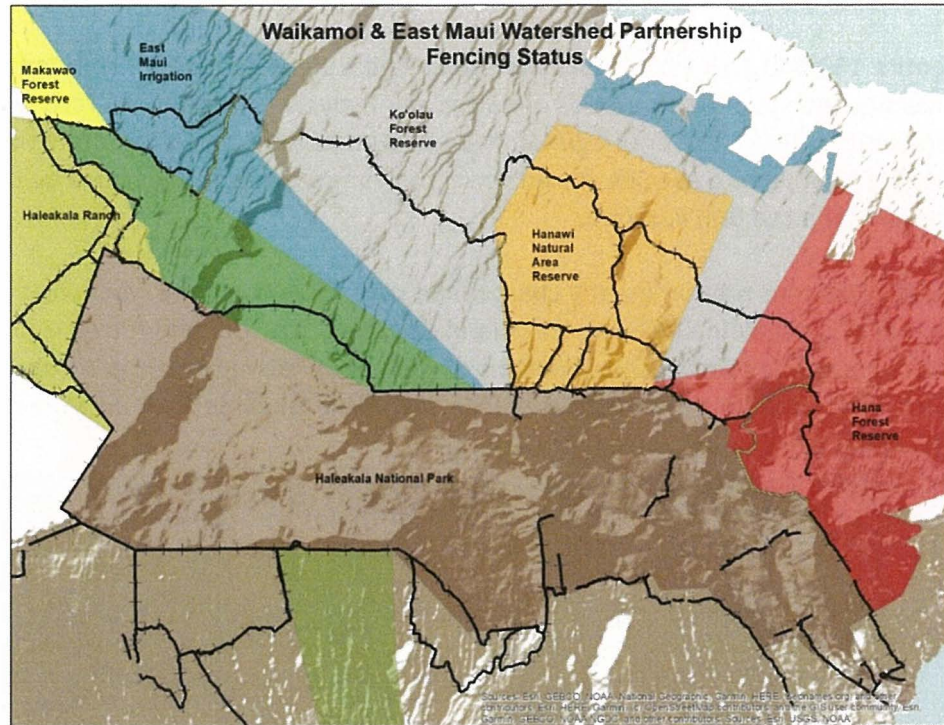
General Setting

The East Maui Irrigation conservation easement includes 3,721 acres and is located mauka (upslope) of the towns of Makawao and Ha'ikū on the island of Maui. The property lies at between 3,700 and 7,800 feet elevation and is marked by rugged terrain. Much of the property is remote and difficult to access unless by helicopter. The climate is cool and wet with an average rainfall that ranges from 118 to 270 inches per year.

The EMI addition is at the center of the 100,000-acre East Maui Watershed Partnership (EMWP) area, which is managed by six major landowners. It is bordered by the State of Hawai'i Ko'olau Forest Reserve, the Hanawā Natural Area Reserve, Haleakalā National Park, and lies immediately below TNC's Waikamoi Preserve, with which it shares a long seven-mile boundary (Figure 1).

Figure 1. Waikamoi, EMI addition and East Maui Watershed existing fences

These managed areas, together with other state and private lands on the northeast slopes of Haleakalā, represent one of the largest intact native rain forests in the state, comprising more than 100,000 acres. The EMI addition also provides essential water



resources for the island of Maui, together with Waikamoi Preserve serving as the headwaters for the majority of the major streams that contribute to the East Maui Watershed’s surface water collection and supply the majority of upcountry and central Maui users’ water (Figure 2).

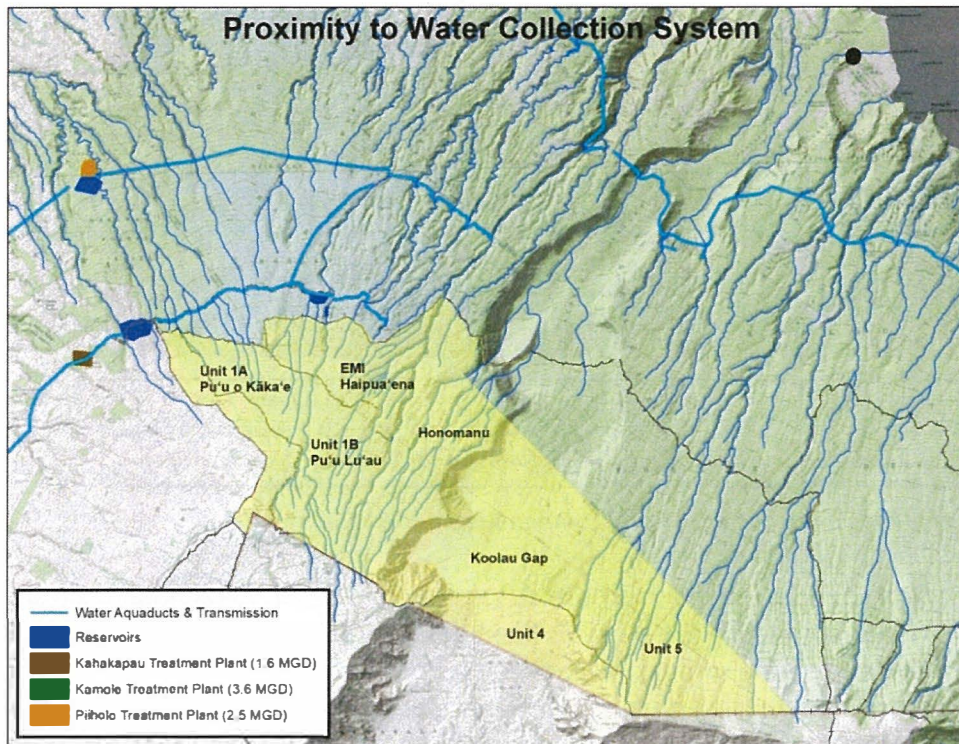


Figure 2. Proximity of Waikamoi Preserve and the Waikamoi Preserve EMI Addition to the upcountry water collection system.

Table 2. Rare plants associated with the EMI Addition area.¹

IUCN listings: V-vulnerable, CR-critically endangered, EN-endangered, EN-endangered

Species Name	Hawaiian/ Common Name	Federal Listing	IUCN status
<i>Asplenium peruvianum</i> var. <i>insulare</i>		E	
<i>Calamagrostis expansa</i>	Maui reedgrass	E	VU
<i>Clermontia oblongifolia</i> subsp. <i>Mauiensis</i>	‘Ōhā; ‘Ōhā Wai	E	CR
<i>Cyanea copelandii</i> subsp. <i>Haleakalaensis</i>	Hāhā	E	EN
<i>Cyanea duvalliorum</i> (?)	Hāhā	E	
<i>Cyanea glabra</i>	‘Ōhā, Hāhā, ‘Ōhā Wai	E	CR
<i>Cyanea hamatiflora</i> subsp. <i>Hamatiflora</i>	Hāhā	E	CR
<i>Cyanea horrida</i>	Holokea, Hāhā nui	E	CR
<i>Cyanea kunthiana</i>	‘Ōhā, Hāhā, ‘Ōhā Wai	E	
<i>Cyanea maritae</i> (outplants)	Haha	E	
<i>Cyanea mcelandowneyi</i>	‘Ōhā, Hāhā, ‘Ōhā Wai	E	CR
<i>Diplazium molokaiense</i>		E	CR
<i>Geranium multiflorum</i>	Noho‘anu	E	
<i>Melicope balloui</i>	Alani	E	EN
<i>Melicope</i> sp. nov. 2	Alani	SOC	
<i>Phyllostegia bracteata</i>		E	
<i>Ranunculus mauiensis</i>	Makou	E	
<i>Sanicula sandwicensis</i>		E	
<i>Schiedea diffusa</i> subsp. <i>diffusa</i>		E	
<i>Wikstroemia villosa</i>	‘Ākia	E	CR

The EMI addition is primary habitat for the endemic i‘iwi (listed as threatened), ‘ākohekohe and kiwikiu (both critically endangered single island endemics; Figure 4), and the ‘alauahio or Maui Creeper, a Maui endemic bird in rapid decline. At least five other bird species are found in the Preserve (Table 2). These birds are among the rarest birds in the United States. Management activities over the past five years include 1,000 acres of previously unmanaged habitat for the kiwikiu, ‘ākohekohe and many rare species (Figure 4). With the removal of feral pigs, TNC’s Waikamoi Preserve now provides a safe haven for species from the threat of increasing climate change impacts such as avian disease, habitat loss and fragmentation.

¹ Listing and abbreviations according to USFWS Species List August 12th 2019. E=Endangered; T= threatened

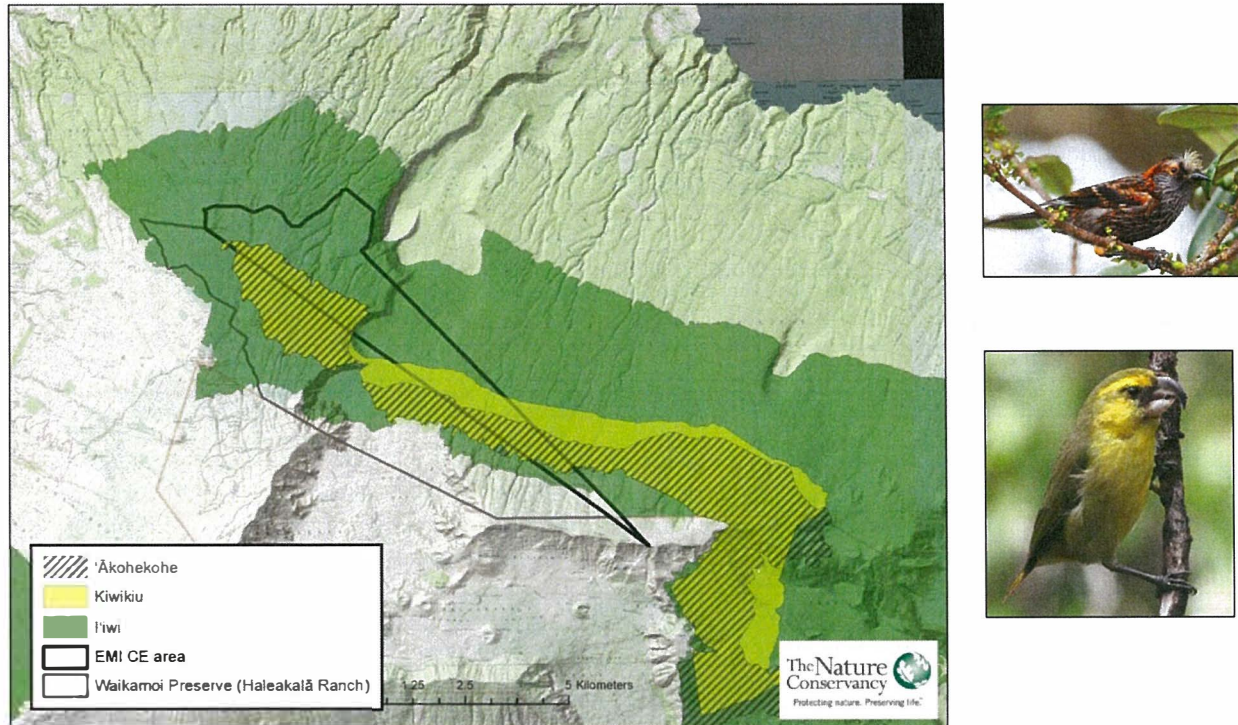


Figure 4. Endangered forest bird ranges in relation to EMI addition area. Updated bird ranges from Judge et al.²

Table 3. Native animals associated with the EMI Addition area.

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS
<i>Palmeria dolei</i>	'ākohekohe, crested honeycreeper	Critically endangered
<i>Pseudonestor xanthophrys</i>	kiwikiu, Maui parrotbill	Critically endangered
<i>Pterodroma phaeopygia sandwichensis</i>	'ua'u, Hawaiian petrel	Endangered
<i>Branta sandvicensis</i>	nēnē, Hawaiian goose	Endangered
<i>Puffinus auricularis newelli</i> ³	'a'o, Newell's shearwater	Threatened
<i>Vestiaria coccinea</i>	'i'iwi	Threatened
<i>Asio flammeus sandwichensis</i>	pueo	--
<i>Paroreomyza montana</i>	'alauahio	--
<i>Himatione sanguinea</i>	'apapane	--
<i>Hemignathus virens</i>	'amakihī	--
<i>Lasiurus cinereus semotus</i>	'Ōpe'ape'a Hawaiian Hoary Bat	Endangered
<i>Megalagrion nesiotes</i>	Damselfly, pinao 'ula	Endangered

² Judge, S. W., R. J. Camp, C. C. Warren, L. K. Berthold, H. L. Mounce, P. J. Hart, and R. J. Monello. 2019. Pacific island landbird monitoring annual report, Haleakalā National Park and East Maui Island, 2017. Natural Resource Report NPS/PACN/NRR—2019/1949. National Park Service, Fort Collins, Colorado.

Prior to 2014, 2,500 acres of the EMI addition received some TNC and EMWP management primarily to reduce ungulates. From 2014 on, TNC intensively managed the Waikamoi EMI Addition and removed all of the ungulates from the area. TNC management activities since the early 1990s in the far eastern area of the EMI addition and Waikamoi Preserve have dramatically reduced the formerly heavy impact of goats and pigs resulting in a three-fold increase in shrub cover and a 50% reduction in alien grass cover, documented in a vegetation change study conducted by Hughes et al³ (Figure 5).

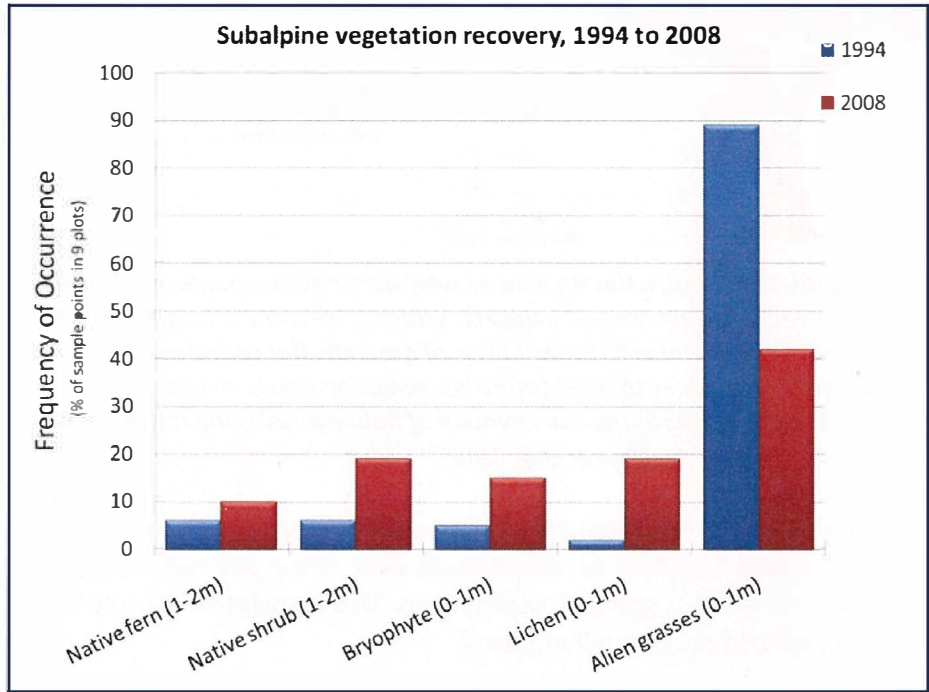


Figure 5. Recovery of native subalpine shrubland habitat documented in the eastern EMI addition and Waikamoi Preserve in 2008.

Watershed Value

It is becoming increasingly important to place a value on the suite of benefits that forests provide outside of biodiversity, including cultural value and ecosystem services such as providing ample clear and clean fresh water. In 2017, TNC partnered with the University of Hawai'i's Economic Research Organization (UHERO) to conduct a return on investment analysis for our watershed management at Waikamoi. The project quantifies the benefits of protecting native forest from conversion to nonnative forest in East Maui in terms of groundwater recharge.

³ Hughes, G., E. Brown, A. Cohan & M. White. 2014. Subalpine vegetation change 14 years after feral animal removal on Windward East Maui, Hawai'i. Pacific Science 68:1.

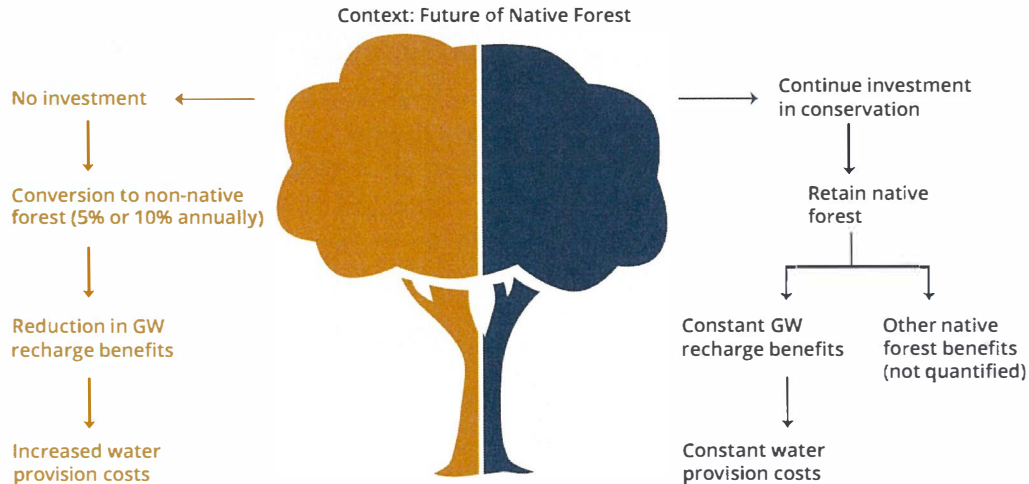


Figure 6. Conceptual framework of analysis where outcomes depend on whether or not management actions and expenditures continue to protect native forest and prevent invasion. Without investment (left; gold) we assume a 5% or 15% spread rate of invasive species, which results in loss of groundwater recharge benefits and increases costs to the utility in providing drinking water to meet future consumption needs. In contrast we assume that continued investment (right; blue) results in the conservation of native forests and the multiple benefits including groundwater recharge. (Adapted from Bremer et al. 2019⁴)

The project documented that the groundwater recharge benefits of planned conservation activities in Waikamoi Preserve reached up to **38.6 billion gallons of water saved over 100 years** depending on the invasion rate, discount rate, and future water scarcity assumptions. This translated in up to **\$137 million of cost savings to the water utility** in present value terms.

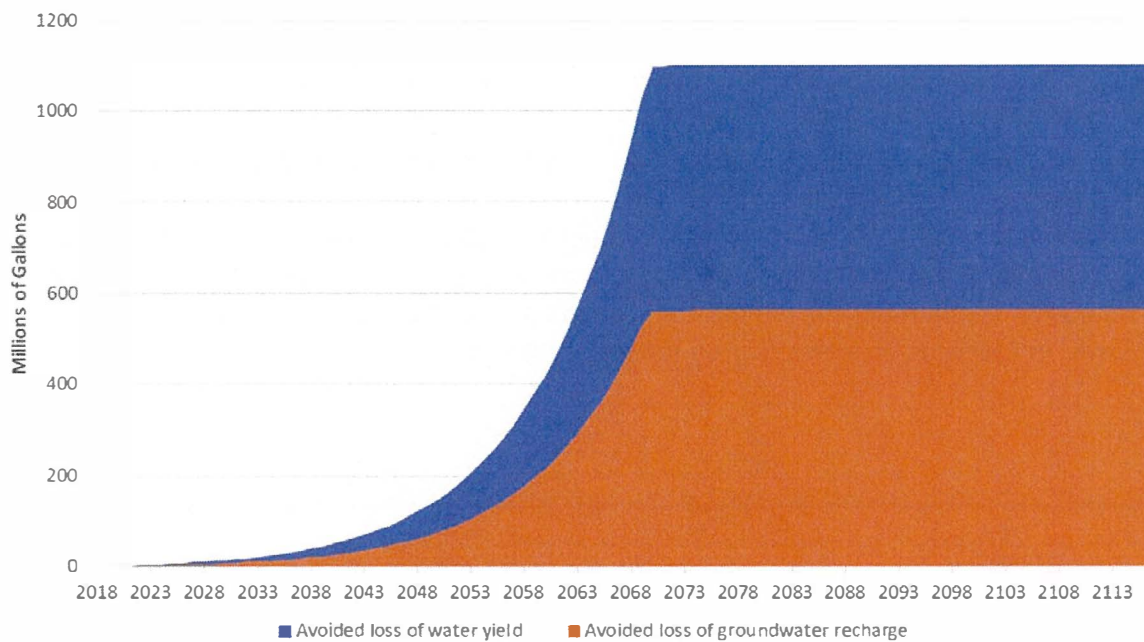


Figure 7. Avoided loss of freshwater yield and groundwater recharge as a result of conservation activities.⁵

⁴ Bremer et al. 2019. Contributions of native forest protection to local water supplies in East Maui. Science of the Total Environment 688: 1422-1432. <https://doi.org/10.1016/j.scitotenv.2019.06.220>

These results coupled with existing knowledge of the multitude of benefits of a healthy forest, including climate change resilience, cultural and recreational value and use, and other ecosystem services such as habitat for endangered species, underscore the importance of not only maintaining protection for healthy forests like Waikamoi, but increasing our investment to secure our future.

MANAGEMENT

Management Considerations

TNC Maui has implemented its strategic, science-based approach to eliminating the greatest watershed threats since obtaining the original Haleakalā Ranch conservation easement for 5,230 acres at Waikamoi in 1983. In subsequent years since Waikamoi’s establishment, TNC has successfully maintained the large native-dominated core areas and has prevented the spread of habitat-modifying priority weeds to these areas. In 2009, we successfully eliminated all feral hoofed animals from this area, a success that requires consistent management to be maintained. In 2013, we acquired the East Maui Irrigation conservation easement and fenced its three-mile western boundary within one year. Within 2 years of completing the three-mile boundary fence all feral pigs were removed from the 3,721-acre addition. The extensive management conducted by TNC in the EMI Addition to maintain zero ungulates and low levels of habitat-modifying weeds benefits the Hanawī Natural Area Reserve, Ko’olau Forest Reserve, and Haleakalā National Park.

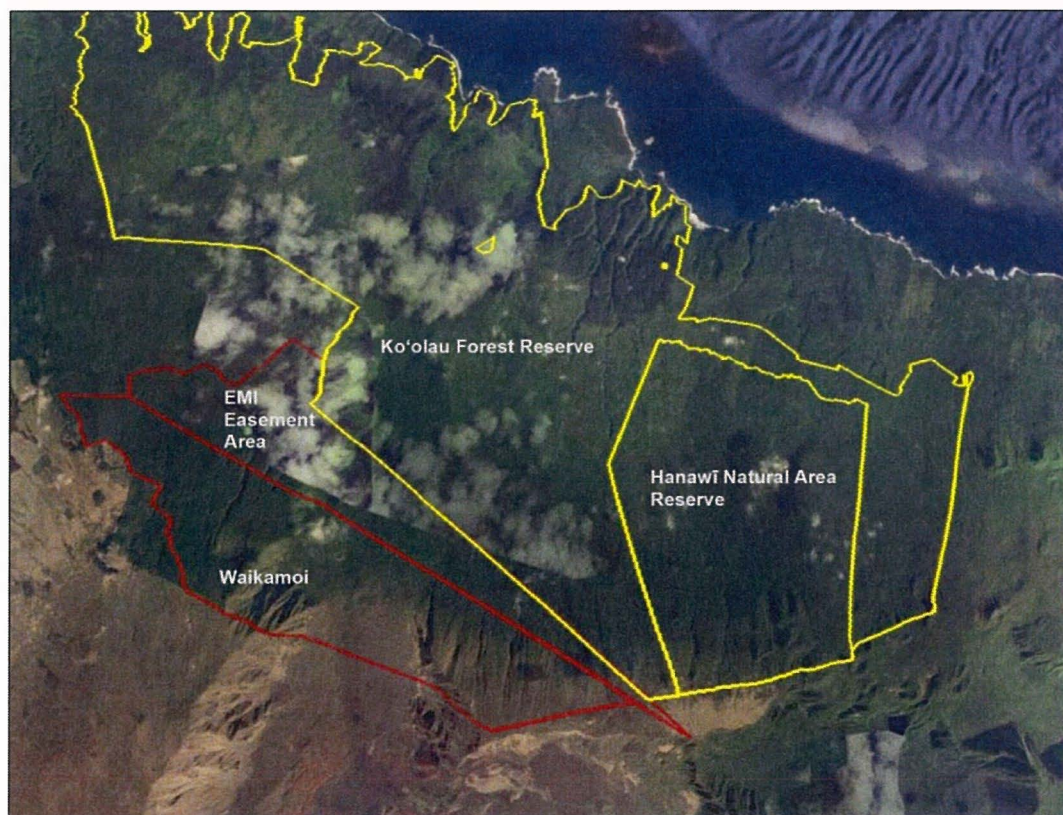


Figure 8. The Waikamoi EMI addition lies just north of Waikamoi Preserve and south of the State Ko’olau Forest Reserve.

The EMI addition is very remote and rugged. Most of the area is primarily accessible via helicopter or extensive hiking. There are no roads that transit the area whatsoever. The most accessible area is the far western area which can only be accessed through private EMI lands and roads. The only structure on the entire 3,721 acre parcel is one approved temporary 8'x 8' remote shelter maintained by TNC, "Camp 6". Fourteen landing zones (LZs) exist throughout the parcel and are maintained by TNC, EMWP, and/or the Maui Invasive Species Committee (MISC).

The property is owned by Mahi Pono and East Maui Irrigation Co., Limited (EMI), a subsidiary of Alexander & Baldwin. A&B/EMI has been an active participant in the EMWP since its formation in 1991, and more so since 2013 as a supportive landowner for the TNC easement. In January 2019, Mahi Pono purchased 15,000 acres of A&B watershed lands, in addition to former sugar cane and other agricultural lands in central Maui. Mahi Pono now has 50% ownership of the East Maui Irrigation company. The Waikamoi Addition conservation easement is perpetual and follows the landowner, so is not impacted by the purchase of A&B lands by Mahi Pono. The former EMI manager that served on the EMWP continues to do so as a Mahi Pono representative.

TNC routinely partners with other Maui and statewide conservation partners including MISC, the State Plant Extinction Prevention Project (PEPP), the Hawaii Invertebrate Program (HIP), and the Maui Forest Bird Recovery Project (MFBRP). MISC is currently controlling highly invasive pampas grass in the lower Honomanū section of the EMI parcel and will continue to do so. The MFBRP has conducted population studies of kiwikiu and 'ākohekohe in Waikamoi in the past, and likely will resume studies and monitoring efforts as a complementary effort to establish a second population of kiwikiu in the Nākula NAR, in addition to increasing our understanding of the current range and population of Maui's endangered forest birds. PEPP and HIP regularly access Waikamoi and the EMI Addition in conjunction with TNC management operations to conduct surveys, monitoring, and outplanting; this work will continue and expand over the next six years.

Management Programs

Although the following management programs are described separately, they form an integrated management approach. For each program listed in the following section, we have indicated a major goal and described the management methods chosen. We discuss the use of innovative tools where most relevant under each program.⁵ Also included are highlights of past and current achievements and key management issues. Finally, key objectives to achieve the goal are listed by year for FY2021–FY2026.

Program 1: Non-Native Species Control

A. Fencing, Ungulate Control & Monitoring

Program Goal: To protect large native-dominated areas and watershed within and adjacent to the EMI addition area by removing all ungulates and preventing future invasion.

Program Description: Ungulate damage to vegetation and the forest floor is the greatest threat to the critical East Maui watershed headwaters and Upper Kula water system drainage area and is therefore the focus of the Waikamoi EMI addition resource management program. The ungulate control program utilizes a combination of fencing, hunting, and snaring to bring pig populations down to zero as rapidly as possible, and to prevent new populations from becoming established in the preserve. Pigs in particular reproduce at

very high rates. During the past six-year period, we completed 3 phases of fence construction resulting in 3 miles of fence that effectively encloses the entire addition (Figure 9). We were also able to locate and fix problems with the existing Honomanū fence, completing a 20 meter extension and decreasing the likelihood of animal ingress from below. Following the fence completion staff began systematically hunting accessible areas utilizing hunter-dog teams equipped with GPS technology to sweep predefined areas in unison in order to track and dispatch pigs (Figure 10). After staff and contractor hunts quickly reduced the pig population, over 1800 traps were installed to complete the removal process in the more remote areas. Staff installed and monitored a M.I.N.E (Manually Initiated Nuisance Elimination) trapping system, for the duration of the removal effort, that was built into the fence with the hope that pigs could be remotely trapped and then would utilize a one way gate that allowing them to enter EMI land to be hunted by the public.



⁵ Innovative tools will be funded by other funds, outside of the NAPP.

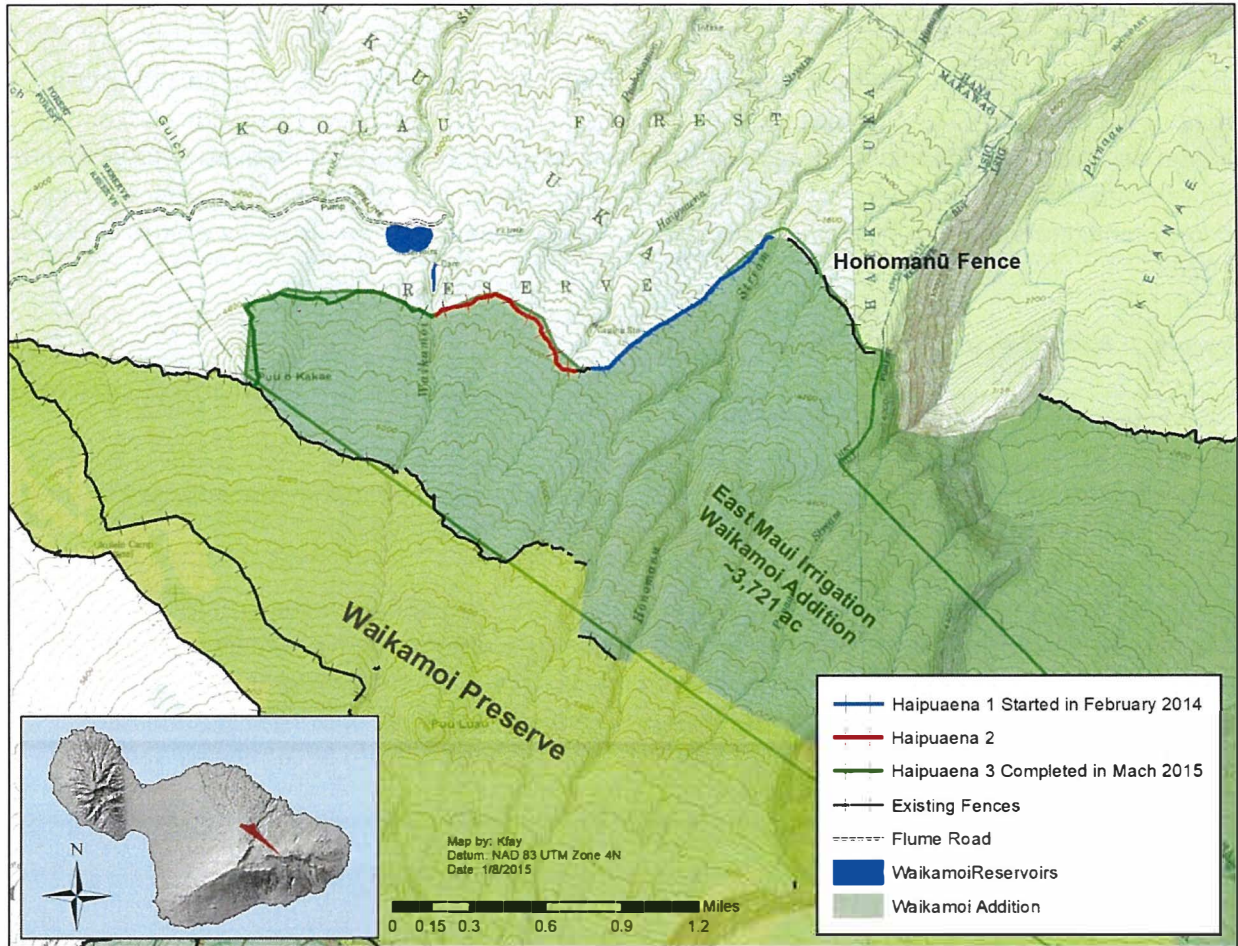


Figure 9. Three-mile fenced installed in 2014-2015 closed off the western edge of the East Maui watershed.

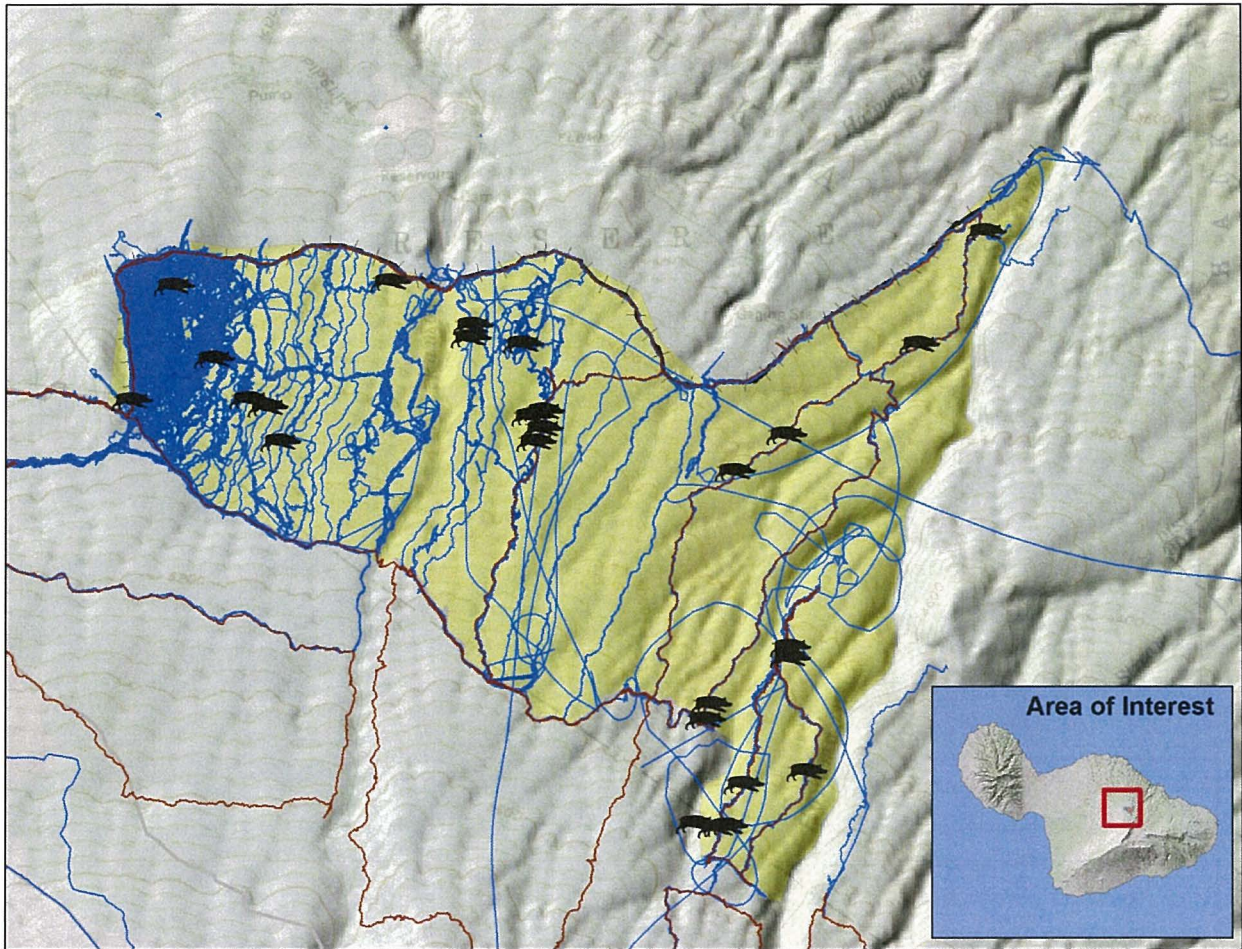


Figure 10. FY14 to FY19 hunt and scout ground effort.

The adjacent Waikamoi Preserve is being managed for zero tolerance ungulates in conjunction with the now ungulate-free EMI addition. We have an excellent in-house dog team for removing pigs in accessible units where snaring is not appropriate and in the unlikely case that ingress occurs. As the number of pigs are near or at zero in both Waikamoi and the EMI addition, the dog program will function on an as-needed basis and will slowly be phased out.

In order to monitor the effectiveness of our ungulate control strategies and assess the threat level of ungulates, we established three 500m transects to measure ungulate activity⁶. We conducted an initial baseline monitoring and monitor the transects semi-annually for signs of ungulate activity in contiguous 5m X 10m plots along 500m-long transects (Figure 11). This monitoring method is used to gauge the effectiveness of our control strategies and techniques. When the ungulate transects were installed, 66% of stations along the transects showed signs of feral pig presence. Initial pig control and fence construction resulted in a rapid decline of sign being seen with as little as 36% of stations showing sign within 8 months (Figure 12). **In 2016 the last pig was removed, and no pig sign has been detected since.**

⁶ "Ungulate activity" is determined by monitoring belt transects for presence or absence of ungulate signs (e.g., tracks, scat, wallows, evidence of browsing). For example, if ungulate sign(s) are present in 10 out of 100 transect stations, the activity level is said to be 10%.

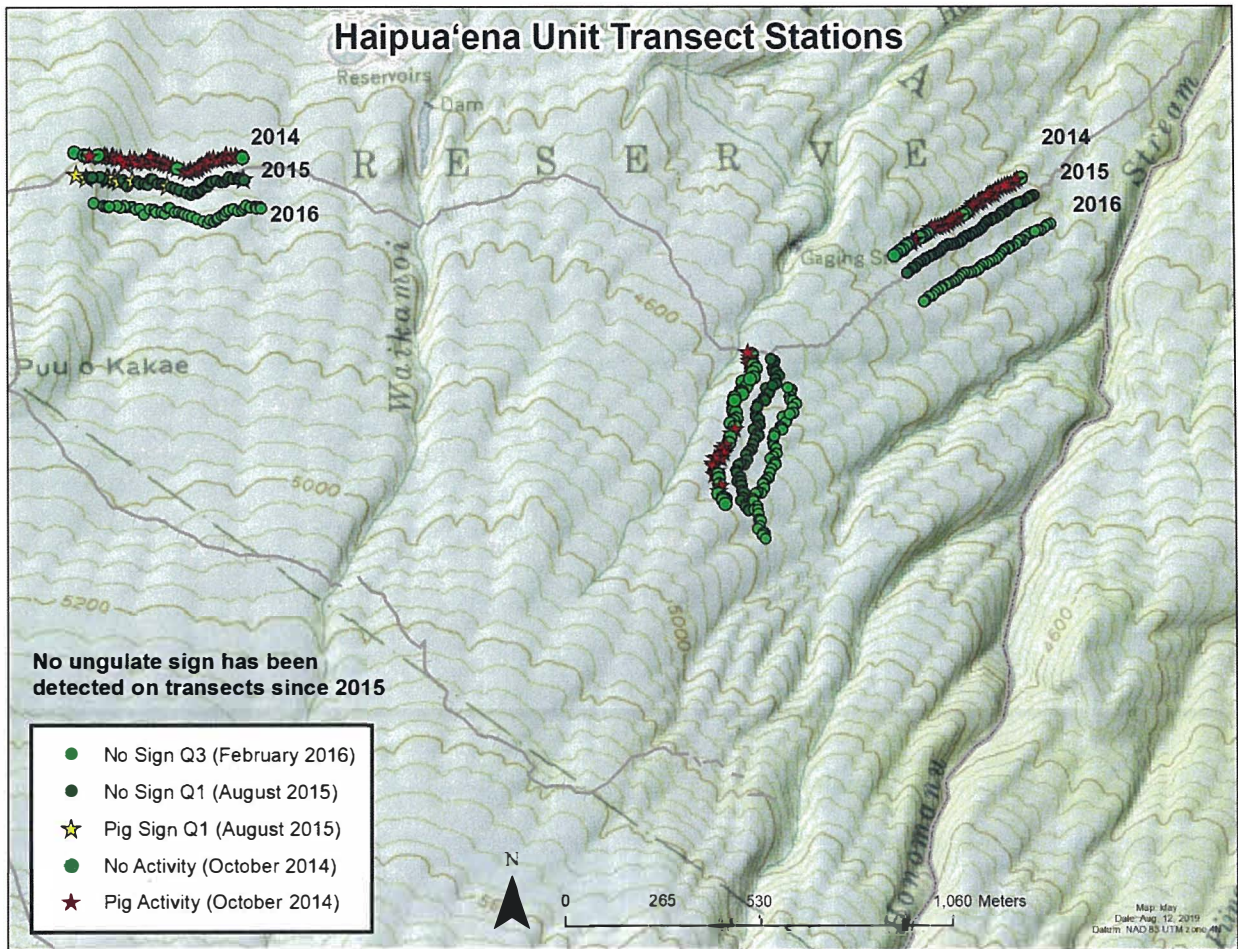


Figure 11. Three monitoring transects were installed and monitored twice a year. No sign was detected after August 2015, although the last pig was removed in 2016.

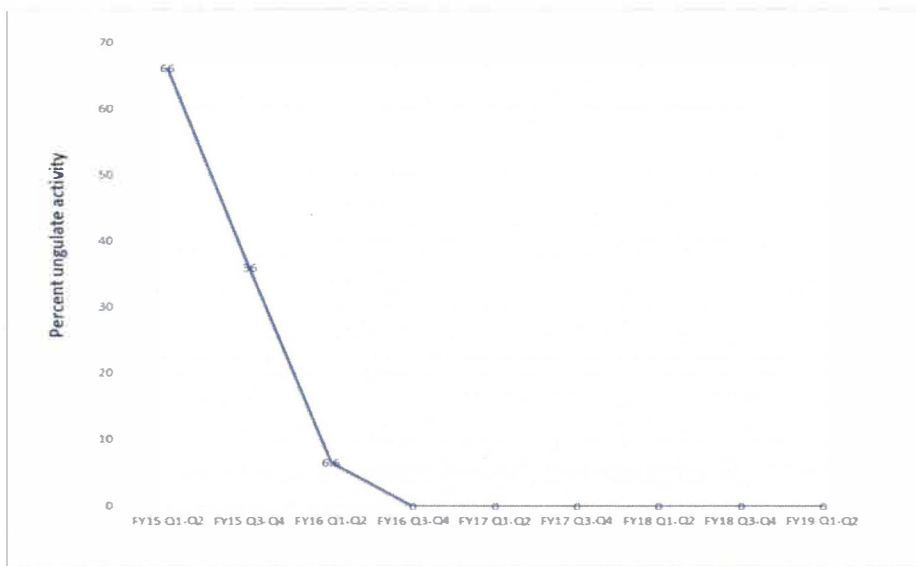


Figure 12. Graph representing the decline over time in overall ungulate activity along EMI addition transects.

In an effort to further capitalize on our monitoring efforts and increase our capacity to achieve and maintain zero tolerance ungulate control, TNC purchased and has been using an industrial strength weather resistant UAS platform that has the ability to accommodate a FLIR camera. We have since used the UAS to monitor for ungulate activity in many of our preserves and guide hunters to animals as they are detected (Figure 13). We will continue to refine this new tool to aid in our ungulate control program and assist partner agencies as needed.

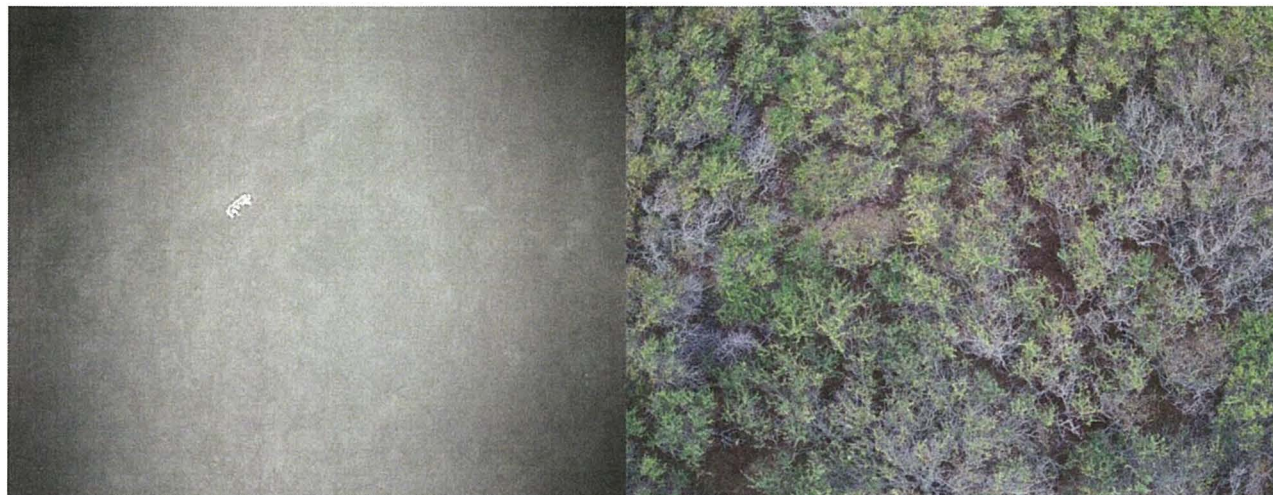


Figure 13. UAV photo showing both FLIR thermal imagery and true color imagery.

To supplement the monitoring transects we established seven photo point monitoring plots. The photo point monitoring plots were chosen based on high amounts of damage from feral pig activity and have helped visually document native plant recovery after feral animals were removed (Figure 14).

Maintaining zero levels of ungulates requires consistent effort, constant vigilance, and the ability to detect incursion right away, and respond immediately. This is a top priority and we will continue a strict fence check and maintenance schedule. Fences are checked and maintained on a regular schedule and will be repaired and replaced incrementally as needed. We will immediately respond to any sign of animal ingress and address the issue as top priority. We will continue to utilize remote traps in areas of the Preserve that are difficult to access, as they serve as insurance should ingress occur without our knowing, traps are placed in areas that had the most recent ungulate activity. Over the next six years, we will explore new strategies and techniques so that our ungulate control program continues to be as effective, efficient and humane as possible.



Figure 14. Photopoint monitoring of photopoint “PPHA11” on February 14, 2014, and the same location on June 26, 2019, depicting recovery following pig removal.

Fencing, Ungulate Control and Monitoring Activities

Years 1–6 (FY2021–2026):

- Inspect western boundary fence quarterly and make repairs immediately. Inspect fences immediately following storms or other natural or suspected events (e.g., vandalism). Identify new fencing needs and add strategic fences as needed.
- Maintain zero tolerance ungulate control. Monitor trap lines semi-annually, and refine as needed.
- Scout for ungulates routinely and track animal catches. Update pig activity and scout maps annually.
- Semiannually monitor three 500 meter transects to track ungulate activity.
- Test innovative and new monitoring technologies, including Forward Looking Infrared (FLIR) and remote game cameras.

B. Invasive Plant Control

Program Goal: To maintain existing large native-dominated core areas within the EMI addition area that are free of the highest priority habitat-modifying weeds, to contain already established populations of habitat-modifiers, and to prevent the introduction and spread of problem weeds to areas where they are not currently established.

Program Description: The most important aspects of our invasive plant control program are to minimize current disturbances to intact native communities, reduce infestation size of priority weeds with a focus on outliers, while first surveying for and controlling their outlying populations, and to prevent the introduction of additional invasive plant species. Ungulate removal significantly reduces the introduction and spread of invasive habitat-modifying weeds. We enforce strict procedures to remove weed seeds, mud, and debris from equipment and clothing before people enter the preserve. Helicopter flights originate from areas free of priority weeds, and all equipment and clothing is inspected and cleaned. See Appendix 1, Prevention Protocols.

We strive towards an Integrated Pest Management (IPM) approach to weed control — consisting of manual/mechanical methods, herbicides, and/or biological control. As biological controls are developed and approved for release on our top priority weeds, we will work cooperatively with agencies mandated to monitor these agents. Cultural control (minimizing soil disturbance and new pest plant introductions) is incorporated into routine field operations through gear sanitation protocols. Herbicide use is in full compliance with the State of Hawai'i Department of Agriculture (HDOA) Pesticide Enforcement Division, used according to the product label, and recorded in detail for reference and efficacy monitoring. Staff coordinating weed control are certified with the HDOA Pesticide Enforcement Division through a Forestry Applicators' exam and card. We may employ other techniques or tools for weed control as they are developed. Any new application methodology used regularly will be coordinated in full compliance with HDOA.

Control work is prioritized to target species. Our management efforts are guided by the *East Maui Conservation Site Weed Management Plan* (TNC 2009) as it applies to the habitat of the EMI addition and the likelihood of listed weed targets getting established there. The highest priority is the containment and localized eradication of Himalayan ginger (*Hedychium gardnerianum*), primarily due

to its established range, rate of spread, and aspects of habitat modification. Other priority weeds with established populations in some areas of the parcel include pampas grass (*Cortaderia jubata*), *Tibouchina herbacea*, *Rubus* spp., *Andropogon virginicus*, and *Setaria palmifolia*. It is suspected that strawberry guava (*Psidium cattleianum*) and *Clidemia* may be found with additional surveys. *Miconia* has not been found on the parcel.

We have found that aerial and ground surveys provide the best measure of determining the extent of weeds and provide a visual estimate of ecosystem extent and quality. We will initially scout the entire area to map populations and outliers of priority habitat-modifying weeds and will then devise specific strategies for each species.

In January of 2015 staff initiated ginger control along the fenceline at the western end of the preserve. Staff surveyed about 2.5 acres of ginger above the new fence in a trial to indicate efficacy. About 1,300 pounds of roots were dug with about 98^{sq} meters controlled. Ultimately this was found to be too time consuming and the location and saturation of the soil prevented use of chemical control.

Due to the discovery of isolated patches of ginger in and around Ko'olau Gap several surveys were conducted around Camp 6 to determine the extent of the population in that area with staff controlling nearly 30 acres and delineating the eastern and western boundaries of the population. In FY2017 and FY18 roughly 100 acres on the western end of the preserve were swept for ginger this time using chemical control due to a different substrate and distance from groundwater infrastructure. Working in conjunction with the East Maui Watershed Partnership and building onto their efforts in Ko'olau Gap 66 acres were swept and treated.

A large population of Himalayan ginger was discovered on the steep wall of Ko'olau Gap just below Halehaku. Staff, in coordination with James Leary, conducted a trial Herbicide Ballistic Technology (HBT) application. The total calculated footprint of treatment is 1,013 sq. meters. About 3,805 projectiles were used and about 43 patches of ginger were treated. Unfortunately, the triclopyr that was available in the paintballs was not effective and only burned the plants. Future use of this technology with Imazapyr is essential to control of ginger on steep slopes. Currently the maker of the paintballs is in negotiations with the Hawai'i Department of Agriculture to work out this technology.

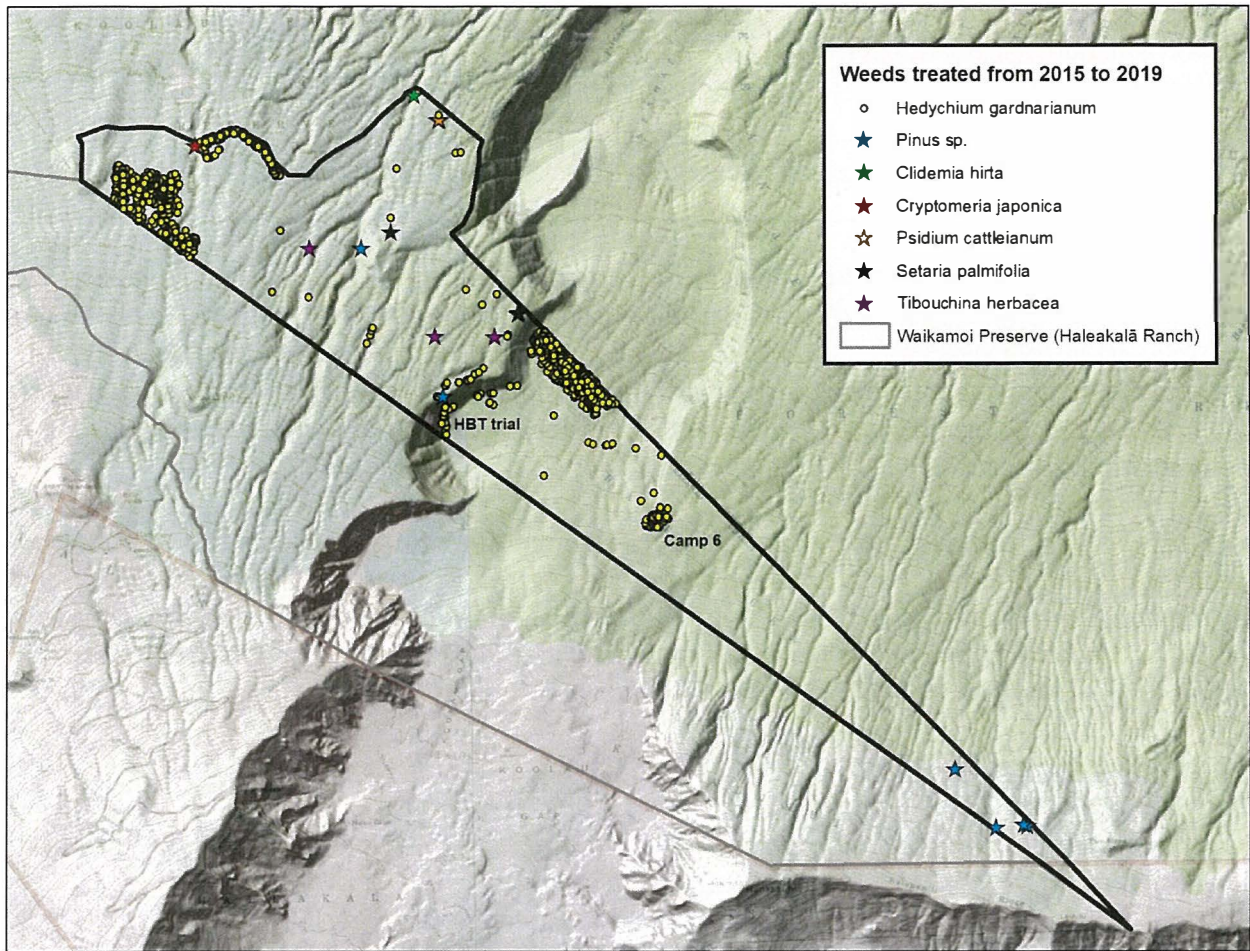


Figure 15. Weed locations found and treated in the EMI Addition parcel.

Table 3. Priority weed species for management in the EMI Addition

Scientific Name	Common Name
TOP PRIORITY SPECIES	
<i>Hedychium gardnerianum</i>	Himalayan ginger
<i>Acacia melanoxylon</i>	Blackwood acacia
<i>Cortaderia jubata</i>	Pampas grass
EARLY DETECTION/ RAPID RESPONSE PRIORITY SPECIES	
<i>Psidium cattleianum</i>	Strawberry guava
<i>Cyathea cooperi</i>	Australian tree fern
<i>Ulex europaeus</i>	Gorse
<i>Angiopteris evecta</i>	Mulesfoot fern
<i>Clidemia hirta</i>	Clidemia
<i>Pinus spp.</i>	Mexican weeping pine, Monterey pine, etc.

Table 3. Weed species not yet established in the EMI Addition

Scientific Name	Common Name
<i>Cyathea cooperi</i>	Australian tree fern
<i>Miconia calvescens</i>	Miconia
<i>Paspalum conjugatum</i>	Hilo grass
<i>Delaria odorata</i>	German ivy

The latest multispectral imagery from Resource Mapping Hawai'i, Inc. (RMH) and imagery taken from TNC's sUAS (small unmanned aerial system) will be used to produce detailed maps of the distribution and abundance of select invasive plant species. Maps produced with this imagery will be used to guide staff to target areas for follow-up control missions. In addition to RMH imagery TNC will utilize UAV mapping technology to obtain high resolution imagery of priority control areas aiding in long-term monitoring efforts.

Staff from TNC also attend the Maui Invasive Species Committee's (MISC) miconia and pampas grass operations meetings, which focus exclusively on crew progress, improvements in methodology, and new detections. This enables TNC to be better informed on the status of such priority weed targets within or approaching native-dominant watershed, and may involve future cooperative projects between TNC-EMWP and MISC field crews.

Invasive Plant Control Activities

Years 1–6 (FY2021–2026):

- Scout and map priority habitat-modifying weeds during all management activities throughout the area.
- Support and utilize the use of HBT to treat weeds on steep slopes and cliffs.
- Map priority weed species with sUAS and multispectral camera.
- Initiate weed control on select priority species, focusing on treatment of outliers.
- Sweep and control Himalayan ginger throughout the native-dominant areas, focusing on outliers; maintain control of the leading edge of ginger invasion from adjacent EMI lands and the Makawao Forest Reserve.
- Conduct routine weed monitoring and control of habitat-modifying weeds at landing zones, fences, and camp infrastructure.
- Improve and establish infrastructure (i.e. trails, LZ's, and a camp) in Pi'inaau to combat future incipient weed problems. Prevent other incipient weed establishment by continuing strict inspection and cleaning procedures to prevent their introduction.
- Support the Maui Invasive Species Committee (MISC) in their work to contain serious habitat-modifying weeds.
- Collaborate with MISC on pampas grass control and Miconia surveys.
- Evaluate currently flown Resource Mapping high resolution imagery and ground scouts to refine priority weed locations.
- Utilize maps generated by Resource Mapping analyses to conduct rapid response removal of top target weeds, especially when identified as outliers.

C. Small Mammal, Invertebrate Pest, and Pathogen Prevention and Control

Program Goal: To prevent the introduction and spread of small mammals, non-native insects, mollusks, pathogens, and other pests deemed to be a significant threat, and reduce their negative impact where possible.

Program Description: Non-native insects and small mammal damage is evident throughout Maui's native ecosystems. For example, the non-native argentine ant (*Iridomyrmex humilis*) is currently the greatest threat to the survival of the Haleakalā silversword (*Argyroxiphium sandwicense* ssp. *macrocephalum*); it decimates the native yellow faced bee (*Hylaeus volcanica*) that pollinates the plant. Rats, mice, cats, and mongoose pose a threat to many native birds including the endangered ground nesting nēnē. Prior research and management attempts have shown intensive rat control to exceed realistic budgets in terms of staff and logistics. In addition, the long-term impact from maintaining intensive rat trapping can cause significant damage to native plant communities. However, TNC supports a long-term program aiming at protecting larger landscapes from small mammal depredation and has contributed toward trials that may result in the aerial application of rodenticide. We also implement protocols for cleaning and monitoring to prevent the accidental introduction of new alien species.

The state of Hawai'i has recently mapped over 148,000 acres of Rapid 'Ōhi'a Death (ROD) symptomatic 'ōhi'a forests⁷ on Hawai'i Island. One strain of the fungal pathogen that causes ROD has been detected on Kaua'i, O'ahu and Maui in 2019. TNC is implementing strict sanitation protocols and restricting access to Maui preserves. TNC is also a founding member of the Maui Nui ROD working group, that currently meets at least semiannually to share knowledge and develop key strategies for preventing and responding to ROD invasion.

Lack of resources precludes a full-scale predator control program. We will follow strict established protocols for cleaning and monitoring to prevent the accidental introduction of new alien species. We will also support partners on developments toward aerial application of rodenticides and consider other partner led predator control strategies should they become feasible.

Small Mammal, Invertebrate Pest, and Pathogen Prevention and Control Activities

Years 1–6 (FY2021–FY2026):

- Support viable control programs for small mammals or other pests by our partners.
- Map and respond immediately to control *Vespula* or ant nests when found in preserve. Map significant pest locations and sign as found through routine scouting.
- Support research on *Puccinia rust* or other forest pathogens.

⁷ Forest Ecology and Management 448 (2019) 376–385. The Evolving threat of Rapid Ohia Death (ROD) to Hawai'i's native ecosystems and rare plant species. Lucas B. Fortini, Lauren R. Kaiser, Lisa M. Keith, Jonathan Price, R. Flint Hughes, James D. Jacobi, J.B. Friday

Program 2: Resource Monitoring, Rare Species Protection, and Research

Program Goal: Conduct and support monitoring and research to track the status of biological and physical resources of the EMI addition, especially rare species, while encouraging and assisting with research that increases our understanding and management of the area's natural resources.

Program Description: The goal of our resource monitoring program is to track biological and physical resources of the preserve, evaluate changes in these resources over time, and improve efficacy of management responses.

TNCH uses data from the U.S. Fish and Wildlife Service, the agency responsible for administering the federal Endangered Species Act, to identify rare and endangered species and those that are listed as "candidate" or "special concern" species. Biological surveys have shown that the preserve protects numerous rare species, many of which are federally listed as endangered. Although protecting essential habitat is our main strategy to their protection, we also inventory the rarest species and take measures to protect them. The Plant Extinction Prevention Program (PEPP) and the Hawai'i Invertebrate Program (HIP), administered through the Pacific Cooperative Studies Unit (PCSU) and coordinated by DOFAW, is actively visiting known locations of rare plants and rare snails finding more as mapping and vigor data is being taken. PEPP is focused on target species throughout the East Maui Watershed, with the intent to collect seed for future propagation of rare plants. Accurate mapping and documentation of vigor of these populations is a byproduct of the PEPP work. We work closely with PEPP and HIP and support their efforts to protect and restore rare and endangered species found in the preserve.

Within the past six years 416 location points of 35 different plant species have been identified. Of those at least ten are listed endangered and the rest are tracked by PEPP because they are range restricted, rare in the preserve or island endemics. In addition to mapping locations, PEPP, along with TNC staff, have outplanted at least three different endangered plants back into the preserve.

Restoration of high elevation habitat for forest birds has been recommend by Hawai'i climate change scientists and managers and is recommended as a key strategy for the recovery of the kiwikiu, 'ākohekohe, and other rare birds threatened by avian disease due to climate change and rising temperatures. Recent modeling on climate change and related avian malarial impacts indicate that kiwikiu are expected to lose 90% of their current range on windward East Maui by 2100, declining from current primary habitat of 69 km² to only 7 km².⁸ Unfortunately disease moving upslope is not the only threat to native birds posed by climate change⁹. It is likely that changes in frequency of occurrence and altitudinal location of the trade wind inversion (TWI) will also affect forest bird habitat, possibly resulting in extreme weather events, drought, and fire. Restoring conifer-invaded areas adjacent to native habitat will give our native forest birds a chance to adapt to climate change through increased available disease-free habitat and ecosystem resilience. In addition, protecting the resiliency of both EMI easement and Waikamoi's native ecosystems will continue to provide refugia habitat for rare and endangered species. Recent research by the Maui Forest Bird Recovery Project

⁸ Fortini et al. 2015. Large-scale range collapse of Hawaiian forest birds under climate change and the need for 21st century conservation options. PLoS ONE 10(10).

⁹ E.g., Giambelluca et al. 2008; Timm and Diaz 2009; also see Fletcher 2010

(MFBRP) has demonstrated that only one mosquito (*Aedes vexans*, not the avian-malaria carrying *Culex*) was captured in over 167 trap nights in upper Waikamoi – and that one mosquito tested negative for the avian malaria parasite *Plasmodium*.¹⁰

In the past six year period three research projects were supported by escorting researchers and helping to collect plant material in the preserve. The US Forest Service were provided orientation to an area selected for long term monitoring as part of USFS Forest Inventory and Analysis Program. This project recorded details of vegetation composition and structure in plots, as well as disturbances from feral pigs (none of which was found during their visit), with the intent to use the data as a baseline for future re-measurements of forests. Read more about it here: <http://www.fia.fs.fed.us/>. In FY17 a PhD candidate from the University of Hawaii at Manoa collected four species of *Oreogrammitis* ferns to aid in development of a phylogeny for grammatids that identifies evolutionary, genetic diversity, and lineage aspects of these tiny epiphytic ferns, allowing for the possibility of the discovery of new species in this complex. DNA sequencing will be used along with morphological datasets to determine any potential species variation among the selected taxa. Finally, in FY18, researchers from the University of Hawaii Economic Research Organization (UHERO) visited the EMI addition parcel to get a visual of the preserve. Their work however covered the watershed as a whole and explored the economic valuation of ecosystem services protected by investments made in forest conservation at The Nature Conservancy's East Maui site. See the report here: <https://uhero.hawaii.edu/assets/TNCWaikamoiPreserve.pdf>

Resource Monitoring, Rare Species Protection, and Research Activities

Years 1–6 (FY2021–FY2026):

- Collaborate with EMWP and MFBRP for landscape scale management and forest bird protection.
- Continue to support and collaborate with PEPP/HIP by conducting occasional in house search and assessment of rare species populations to determine protection needs and to reduce threats.
- Maintain and update current maps of rare species populations. Update database as necessary.
- Review and provide technical guidance to research proposals as necessary.
- Perform occasional in-house rare plant surveys in new areas when possible.

Program 3: Community Engagement

Program Goal: Support partners, especially the East Maui Watershed Partnership and the Maui Invasive Species Committee (MISC), where cooperative management activities mutually benefit TNC Preserves and partners. Work with partners to leverage our impact on community education and outreach to ultimately build public understanding and support for the preservation of natural areas.

Program Description: Sustaining biologically significant native ecosystems throughout the state requires an educated, empowered and mobilized public and private constituency. Our main goal is to increase conservation and advocacy for these areas through an understanding of the importance, threats, and protection efforts at Waikamoi Preserve, the EMI addition, and the East Maui watershed. TNC carries out an outreach program because it is important for raising public awareness and

¹⁰ MFBRP. Avian disease and mosquito sampling in The Nature Conservancy's Waikamoi Preserve, Maui. Dec. 11, 2017 project report t

garnering support for conservation programs and their funding. Being an accessible natural area, Waikamoi Preserve serves as an excellent staging area for our East Maui conservation partners who may not have a site to exemplify the aspects of natural area protection to their outreach clientele. We can directly translate the experience visitors have in Waikamoi Preserve to the adjacent EMI addition area. Therefore, we have no plans to conduct public hikes in the EMI addition. However, we will likely have some limited hiking opportunities for funders, partners, donors, volunteers, and other supporters who support management of the EMI addition.

Along these lines, our major public outreach tool will be leading monthly, interpretive hikes in the Waikamoi Preserve, although we also cultivate one-on-one contacts, present slide shows, and lead hikes and volunteer work trips. The Conservancy-trained hike docents lead small custom hikes for community and school groups, donors, and community leaders. The Waikamoi Boardwalk trail is accessible only via hikes by TNC and our partners, and provides access to pristine native forest. Routine maintenance on the other trails also helps minimize impacts as well as enhancing interpretive value.

The primary audience of public access to Waikamoi Preserve is the local community and others who can increase our effectiveness in stewardship. We do not engage in any practice or use that is inconsistent with the long-term survival of vulnerable native species or ecosystems. All donations generated by these activities are used in support of our management.

Other outreach activities include participation at local community events, such as the East Maui Taro Festival, and the Maui Ag Fest. There is also consistent interaction with UH Maui College Natural Resources department through field trips or class presentations.

TNC Maui consistently hosts Americorps KUPU, Pacific Internship Programs for Exploring Science, and Nā Hua Ho'ohuli i ka Pono interns for periods ranging from 12 weeks to 1 year. Interns provide an integral role assisting TNC staff with the on the ground management activities necessary to meet our conservation goals.

Community Engagement Activities

Years 1–6 (FY2021–FY2026):

- Support outreach efforts of partners such as HALE, MISC, and EMWP by providing access and staff resources as available
- Utilize volunteers as available to further conservation goals and bring environmental awareness to the local community.
- Participate in one or two community events per year to encourage constituents to support our work, such as East Maui Taro Festival in Hāna.
- Coordinate and periodically train docents to accommodate special community hikes.

Program 4: Fire, Emergency, and Safety

Program Goal: Provide staff with training and equipment that will allow them to assist primary fire and rescue agencies during a fire or emergency on or adjacent to the preserve.

Program Description: All staff are trained in basic first aid and CPR. Other training may include advanced wilderness first aid, fire suppression and pre-suppression, helicopter safety, and hunter's education. Field staff are provided with first aid kits and required to use proper personal protective equipment (PPE) when conducting field work. The TNC Maui fire plan enables an immediate multi-agency response to wildfires within and adjacent to Waikamoi Preserve including the EMI CE area.

Fire, Emergency, and Safety Activities:

Years 1–6 (FY2021–FY2026):

- Provide emergency training opportunities for staff including but not limited to maintaining current Wilderness First Aid and CPR certifications.
- Conduct annual first aid kit inventory and resupply.
- Maintain fire suppression training for key staff.
- Purchase equipment as needed to allow immediate response to fire threats.
- Respond to emergencies or fire threats.*
- Maintain and improve access roads in high risk areas of preserve.
- Maintain and improve fire cameras.

Program 5. Watershed and Invasive Species Partnerships

Program Goal: Support the East Maui Watershed Partnership and the Maui Invasive Species Committee (MISC) where cooperative management activities mutually benefit Waikamoi, EMI addition and adjacent lands.

Program Description: The EMWP provides protection for about 100,000 acres on East Maui and is administered by a coordinator and field crew. Activities include fencing, ungulate removal, invasive plant removal, and resource monitoring programs for all of East Maui's native forests. TNC Maui helped to form and has actively participated in Partnership activities from the beginning in 1991. As a partner, we helped set management priorities, fundraise and administer projects. Initially, we supervised and trained EMWP crews in ungulate and weed removal, monitoring techniques, fence building, and a wide array of safety procedures including rappelling, helicopter travel, and wilderness survival. We continue to work closely with EMWP, as they have been awarded a subcontract to conduct management some activities for Waikamoi Preserve. We meet regularly with EMWP staff and crew to discuss priorities, strategies, and management actions and techniques. The Program Director serves on the Executive Committee of the EMWP. TNC staff regularly provide guidance and support to EMWP, and we participate in management activities on partnership lands as needed.

Watershed and Invasive Species Partnerships Activities

Years 1–6 (FY2021–FY2026):

- Participate and provide leadership to the EMWP.

- Support EMWP and MISC in accomplishing fundraising and resource management priorities.
- Provide EMWP and MISC access to the EMI addition to accomplish outreach and volunteer activities on a mutually cooperative basis.
- Participate in the Maui Conservation Alliance.
- Participate in statewide initiatives to further Hawaii conservation priorities as opportunities arise, including but not limited to the Rapid Ohia Death working group.

BUDGET SUMMARY

The table in the next section summarizes the six-year budget for the Waikamoi EMI Addition project. Through the NAPP program, the state pays two-thirds of the management costs outlined in this long-range plan and TNC funds (from private and other government sources) the remaining one-third. The EMI Addition NAPP budget currently represents approximately 40% of the overall operation at the TNC Waikamoi EMI Addition. Continued management at our current level will be contingent upon TNC’s ability to fundraise for the remaining 60% from other sources.

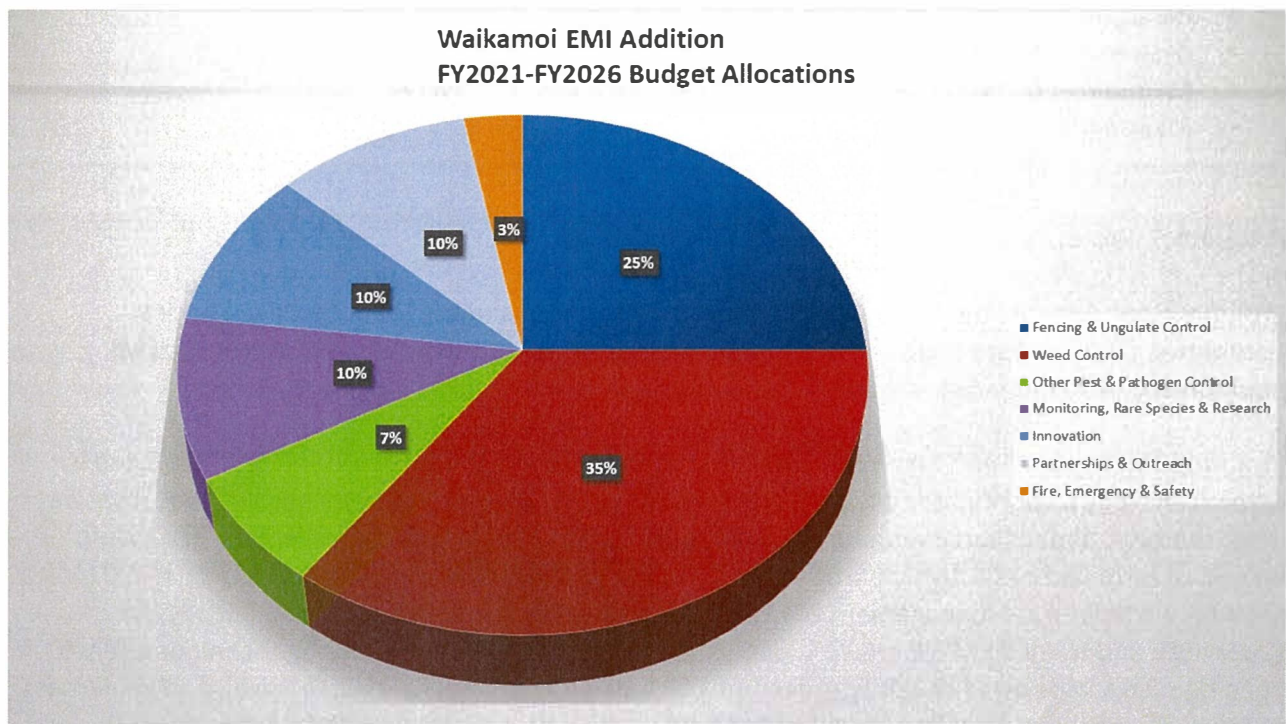


Figure 13. Waikamoi EMI Addition Approximate Budget/Effort by Program, FY16-FY21

The Conservancy’s Maui operation maintains a full time base staff of six. These staff also periodically work on Lāna’i and Molokai. An estimated .75 FTE of Maui base personnel costs for managing the Waikamoi EMI Addition are funded by the Waikamoi EMI Addition NAPP budget. However, this number may fluctuate depending on the use of contractors vs. staff to complete deliverables. Technical and annual planning support is also included, and other island support staff may charge a small portion of their time to this project. The Nature Conservancy's annually negotiated fringe benefits rate will also accrue on all salary costs.

NAPP funds will cover some project-related field supplies and a portion of subcontract/subaward expenses to conduct ungulate and/or weed control. Note that the contractual line item includes some helicopter time. The Conservancy routinely provides trainings for staff to improve job performance, and in addition to these trainings, supervisory staff attend meetings in Honolulu on occasion.

An overhead rate is included (subject to slight change each year) to recognize the Conservancy's indirect costs for facilities, accounting, legal, and other administrative support. The NAPP program will pay only 10% of the Conservancy's overhead rate of 24.34% (FY20), leaving the remainder as a portion of the Conservancy's one-third match. Note that the budget is subject to change based on the renegotiated indirect cost rate.

EMI WAIKAMOI ADDITION BUDGET, FY2021-FY2026

Column1	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026	TOTAL
Labor and Fringe	\$69,500	\$68,234	\$68,234	\$68,234	\$68,234	\$68,234	\$410,670
Contractual	\$47,500	\$45,000	\$45,000	\$45,000	\$45,000	\$45,000	\$272,500
Travel	\$750	\$750	\$750	\$750	\$750	\$750	\$4,500
Supplies	\$3,300	\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	\$18,300
Subtotal	\$121,050	\$116,984	\$116,984	\$116,984	\$116,984	\$116,984	\$705,970
Overhead (<i>capped at 16%</i>)	\$19,368	\$18,717	\$18,717	\$18,717	\$18,717	\$18,717	\$112,955
TOTAL	\$140,418	\$135,701	\$135,701	\$135,701	\$135,701	\$135,701	\$818,925
	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	
EMI Addition budget	\$140,418	\$135,701	\$135,701	\$135,701	\$135,701	\$135,701	\$818,925
TNC Match (1/3 of total)	\$46,806	\$45,234	\$45,234	\$45,234	\$45,234	\$45,234	\$272,975
NAPP Request (2/3 of total)	\$93,612	\$90,468	\$90,468	\$90,468	\$90,468	\$90,468	\$545,950

Appendices

Appendix 1. Gear Sanitation Protocols

Hawai'i's natural resources management crews work in a variety of habitats in the course of their conservation work. These different habitats likely have weed strata that reflect the climate, elevation, or relatively pristine nature of the sites.

As a result, managers should be keenly aware of the composition of those various weed strata, especially in terms of priority invasive plants.

While other people besides conservation workers may frequent these assorted places, and possibly transport weeds seeds in their gear, it is imperative that conservation workers hold a much higher standard that reflects their value to protect natural areas. Any complacency in this regard only will undermine the huge effort made to preserve native ecosystems.

FOOTWEAR: When working in areas where seeds of highly invasive plants are likely to be in the soil, footwear should be inspected and cleaned (on site when possible) prior to entering vehicles.

This can be done with water and a shoe brush, disposing of the debris in 1) a known contaminated site, 2) a site that will have continued monitoring, or 3) trash receptacles, all depending on the severity of the species.

While the extremely tiny seeds of plants like melastomes are one of the greatest concerns, they may need mud or fruit pulp to adhere to footwear.

Grass seeds, on the other hand, are notorious for sticking to even dry boots.

An often overlooked aspect of cleaning footwear is the collection of seeds (especially grasses) inside the tongue and laces of boots. This requires a thorough inspection of laced footwear and is the main reason that rubber boots are often suggested.

In all cases, the insides of footwear should be inspected and brushed as well.

RAINGEAR: The seams of most raingear make them susceptible to hiding tiny seeds within the flap. Even raingear that is dedicated to certain sites known to harbor highly invasive plants should be periodically washed. This can be done in a tub containing 5% bleach in water, with disposal going into a place routinely monitored for any seedlings.

For less severe species, a hose can be directed at the seams, or they can be dry brushed. Also make a point of cleaning any pockets. The guidelines for where any debris is disposed of can be similar to that of footwear.

PANTS: Cloth pants are more difficult to separate as gear than rainpants, and therefore should be viewed in the same context as other working gear. They could be easily overlooked when removing and cleaning other gear, and contaminated pants could even be inadvertently worn inside vehicles. At some sites, it is not always practical or modest to be removing pants upon return to the vehicle. Provisions should be made to anticipate removal of pants (also shirts, hats, and socks) contaminated with mud from an area with highly invasive plants, such as wearing shorts underneath.

Again, depending on the severity of the weed and potential for contamination, change of clothing should be waiting for workers upon return to the vehicle.

PACKS: One of the most overlooked aspects of sanitation procedures is the pack.

Some workers make special effort to hang their packs above ground, while many other set them down in contaminated mud or weed debris.

As in raingear, packs contain many seams or netting material that readily adhere seeds. All sections of the pack, including the inside, should be examined for hitchhiking seeds or mud. Disposal guidelines as listed above.

GLOVES: If gloves are worn in areas where tiny seeds of invasive plants could be in mud or debris, they should be separated and washed as recommended above. In some cases, gloves should be dedicated gear per specific weed.

TOOLS: Machetes, hip chains, flagging tape, radios, GPS, spray bottles, and other supplies and tools that accompany crews into invasive plant work sites are sometimes just as susceptible in carrying unwanted seeds as personal gear. An example is the machete scabbard, which has an interior that no one looks at (cleaning a used scabbard will reveal dirt that has been hidden for some time).

According to the site and severity of the weed, this gear should be designated for use on a specific plant, or at the least, routinely inspected and cleaned.

Extra precaution should be taken for any camping gear used at such sites.

Disposal areas for debris the same as listed above.

GEAR CONTAINMENT: Once work is completed at a site and personnel return to the vehicle, provisions should be made for storage of the potentially contaminated gear. Gear designated for use on a particular species should be stored as such, with clear writing indicating the use. Large poly tubs are practical storage for these items, and plastic trash bags may provide an additional layer to contain boots, packs, and muddy clothes. This procedure minimizes the potential to contaminate the work vehicle.

VEHICLES: Vehicle sanitation is a concern only if 1) it is driven into the infested site, or 2) if contaminated gear enters the vehicle.

Mud should be rinsed from the undersides of the vehicle by washing under the wheel wells and bumpers with high pressure. Once the vehicle cools, the differential, driveshaft, splash pan, and other components that may hold mud or debris, can be hosed. Vacuum or brush inside floors, pockets, and seats. Sweep and hose out the pickup bed.

The disposal area would be relative to the severity of the weed, but should be routinely monitored to see what seedlings sprout in the wash.

INSECTS ETC.: Also be aware when entering natural areas to avoid carrying roaches, ants, spiders, etc., in packs and supplies. Gear and food items should be inspected prior to going into natural areas.

COMMON SENSE: This task becomes much easier when personnel anticipate what challenges they will encounter when following sanitation procedures.

Each crew should have the same understanding of the priority weeds and their locations.

Knowing aspects of the target plant, such as seed size and likelihood to be in the soil or air, can help crews address the necessary precautions. As crews become confident in following these procedures, they can also be confident they are part of the solution and not the problem of vectoring priority weeds.

Appendix 2. Native Natural Communities Of Waikamoi Preserve and EMI Addition.

NATURAL COMMUNITY NAME	GLOBAL RANK
Lowland	
Uluhe (<i>Dicranopteris linearis</i>) Lowland Wet Shrubland	G4
Montane	
‘Ākala (<i>Rubus hawaiiensis</i>) Montane Wet Shrubland #	G3
<i>Carex</i> Montane Wet Grassland #	G3
Koa/‘Ōhi‘a (<i>Acacia koa</i> / <i>Metrosideros polymorpha</i>) Montane Wet Forest #	G3
Mixed Fern/Mixed Shrub Montane Wet Shrubland #	G3
‘Ōhi‘a /Hāpu‘u (<i>Metrosideros polymorpha</i> / <i>Cibotium</i> spp.) Montane Wet Forest	G3
‘Ōhi‘a (<i>Metrosideros polymorpha</i>)/Mixed Shrub Montane Wet Forest #	G3
‘Ōhi‘a /‘Ōlapa (<i>Metrosideros polymorpha</i> / <i>Cheirodendron</i> spp.) Montane Wet Forest	G3
‘Ōhi‘a /Uluhe (<i>Metrosideros polymorpha</i> / <i>Dicranopteris</i>) Montane Wet Forest #	G3
Subalpine	
<i>Deschampsia nubigena</i> Subalpine Mesic Grassland* #	G2
Māmane (<i>Sophora chrysophylla</i>) Subalpine Dry Forest*	G2
‘Ōhi‘a (<i>Metrosideros polymorpha</i>) Subalpine Mesic Forest #	G3
Pūkiawe (<i>Styphelia tameiameia</i>) Mixed Subalpine Dry Shrubland	G3
Multizonal	
Pioneer Vegetation on Lava Flow	G3
Subterranean Communities	
Uncharacterized Montane Lava Tube*	GU
Uncharacterized Subalpine Lava Tube*	G1G2
Aquatic Communities	
Hawaiian Intermittent Stream	G4

* Rare natural community # Also known from Hanawī NAR

Key to Global Ranks as defined by Heritage Program:

G2 = Imperiled globally (typically 6-20 current occurrences).

G3 = Restricted range (typically 21-100 current occurrences).

G4 = Apparently secure globally (> 100 occurrences).

GU = Natural community rank uncertain (rank uncertain, provisionally considered rare).

