Waikamoi Preserve

East Maui, Hawai‘i

Long-Range Management Plan
Fiscal Years 2019–2024

Submitted to the
Department of Land & Natural Resources
Natural Area Partnership Program

The Nature Conservancy
Protecting nature. Preserving life.™

Submitted by
The Nature Conservancy of Hawaii

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EXECUTIVE SUMMARY

The Nature Conservancy of Hawaiʻi is an affiliate of The Nature Conservancy, 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 directly helped protect more than 200,000 acres of natural lands in Hawaiʻi 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. Waikamoi Preserve was approved for NAPP funding in 1992, and this Waikamoi long-range management plan follows the most recent plan that covered fiscal years (FY) 2013–2018. TNCH is seeking reauthorization of NAPP funding for the next six-year period for the programs described within this *Waikamoi Preserve FY2019–FY2024 Long-Range Management Plan*. 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 plans and environmental assessments. Herein, we request $200,200 annually in matched state funds for the six years spanning FY2019–2024. This plan was prepared in compliance with the NAPP agreement between the state, TNCH, and Hawaiʻi 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.

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

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Table 1. Overview of Waikamoi Preserve Accomplishments by Program, FY 2013–2017 (5 years)

	Indicator	Measure of Success
Ungulate Control	Total animal catches	5 pigs 1 deer
	Total traps checked	All groups checked multiple times annually (between 817 and 1065 individual snares)
	Total hunts conducted	96 total hunts
	Miles of fence inspected, maintained and/or replaced in Waikamoi	19 mi inspected regularly[1] 1 mile of fence replaced
Invasive Plant Control	Acres and total numbers of priority invasive plants treated or removed	587 acres swept for Himalayan ginger, with all target plants treated For all other priority species see Table 4, Weed Control Estimates
Resource Monitoring	Frequency of ungulate sign on ungulate transects	0% activity
	Acres surveyed for plant infestations	~ 300 annually
Rare Species Protection and Research	Number of new rare taxa locations discovered	89 new locations for rare plant species
	Number of species outplanted and recovered	6 rare species outplanted
	Number of research projects supported in Waikamoi	9 bird 32 invertebrate 17 vegetation

RESOURCE SUMMARY

General Setting

The original 5,230-acre Waikamoi Preserve was established in 1983 through a perpetual conservation easement with the landowner, Haleakalā Ranch Company. The preserve lies west of the state's 7,500-acre Hanawī Natural Area Reserve (NAR), and its southern boundary runs along Haleakalā National Park. These managed areas, together with other state and private lands on the northeast slopes of Mt. Haleakalā, represent one of the largest intact native rain forests in the state, comprising more than 100,000-acres of essential watershed forests (Figure 1). Active management of Waikamoi Preserve is essential to protecting the entire 100,000-acre area.

In 2013, the Conservancy obtained a conservation easement over 3,721 acres of East Maui Irrigation Co. Ltd. (EMI) lands adjacent to Waikamoi Preserve. The land is some of the highest quality and weed-free native forest in the state, in addition to being prime forest bird habitat. The parcel is at the center of the 100,000-acre East Maui Watershed Partnership (EMWP) area, and is bordered by the State of Hawaiʻis Koʻolau Forest Reserve, the Hanawī 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). Ungulate and weed management in this parcel has long been a management

[1] Including Deer Management Unit fence (3.4 mi) and one Waikamoi fence that NPS checks (7.9 mi)

priority for Waikamoi preserve and the EMWP, as animals and weeds removed here cannot spread into the preserve. Ample funding for the Waikamoi NAPP program helps to ensure that TNC can devote additionally raised private funds to manage this critical parcel and leverage conservation success across larger landscapes.

Flora and Fauna

Fourteen terrestrial native natural communities are represented in Waikamoi Preserve, two of which are considered rare: *Deschampsia* subalpine mesic grassland and māmane (*Sophora chrysophylla*) subalpine dry forest (Figure 2, Appendix 1). To date, 25 plant species listed as endangered have been reported in the preserve, twelve of which are endemic to East Maui, and eight of which are formally listed as endangered (Appendix 2).

Thirteen native birds have been historically reported from Waikamoi Preserve and of those, eight are federally listed as endangered: ʻākohekohe *(Palmeria dolei*)*,* Maui parrotbill or kiwikiu (*Pseudonestor xanthophrys*), dark-rumped petrel or uʻaʻu (*Pterodroma phaeopygia sandwichensis*), Newell's shearwater or aʻo (*Puffinus auricularis newellii*), nene goose (*Branta sandvicensis*), Maui ʻakepa (*Loxops coccineus ochraceus*), poʻouli (*Melamprosops phaeosoma*), and Maui nukupuʻu (*Hemignathus lucidus affinus*). In September 2017 the ʻiʻiwi (*Vestiaria coccinea*) received protection as a threatened species. ʻIʻiwi occur throughout Waikamoi Preserve. ʻAkepa, Nukupuʻu, and po'ouli haven't been seen in one or two decades. See Appendix 4, Native Birds of Waikamoi Preserve for a list of all birds in the preserve. The endangered Hawaiian hoary bat (*Lasiurus cinereus*) is also found in the preserve.

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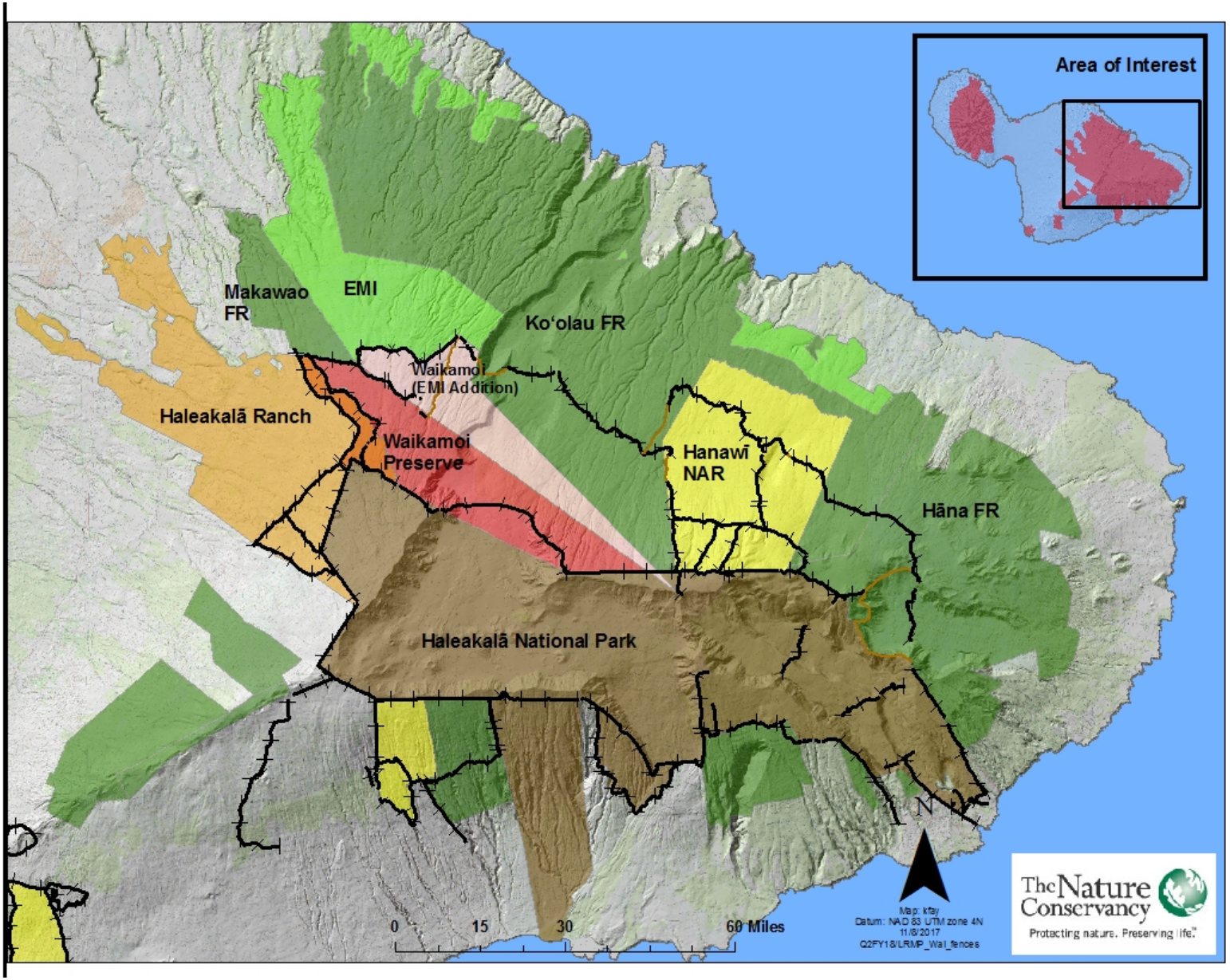

Figure 1. Waikamoi and East Maui Watershed fences

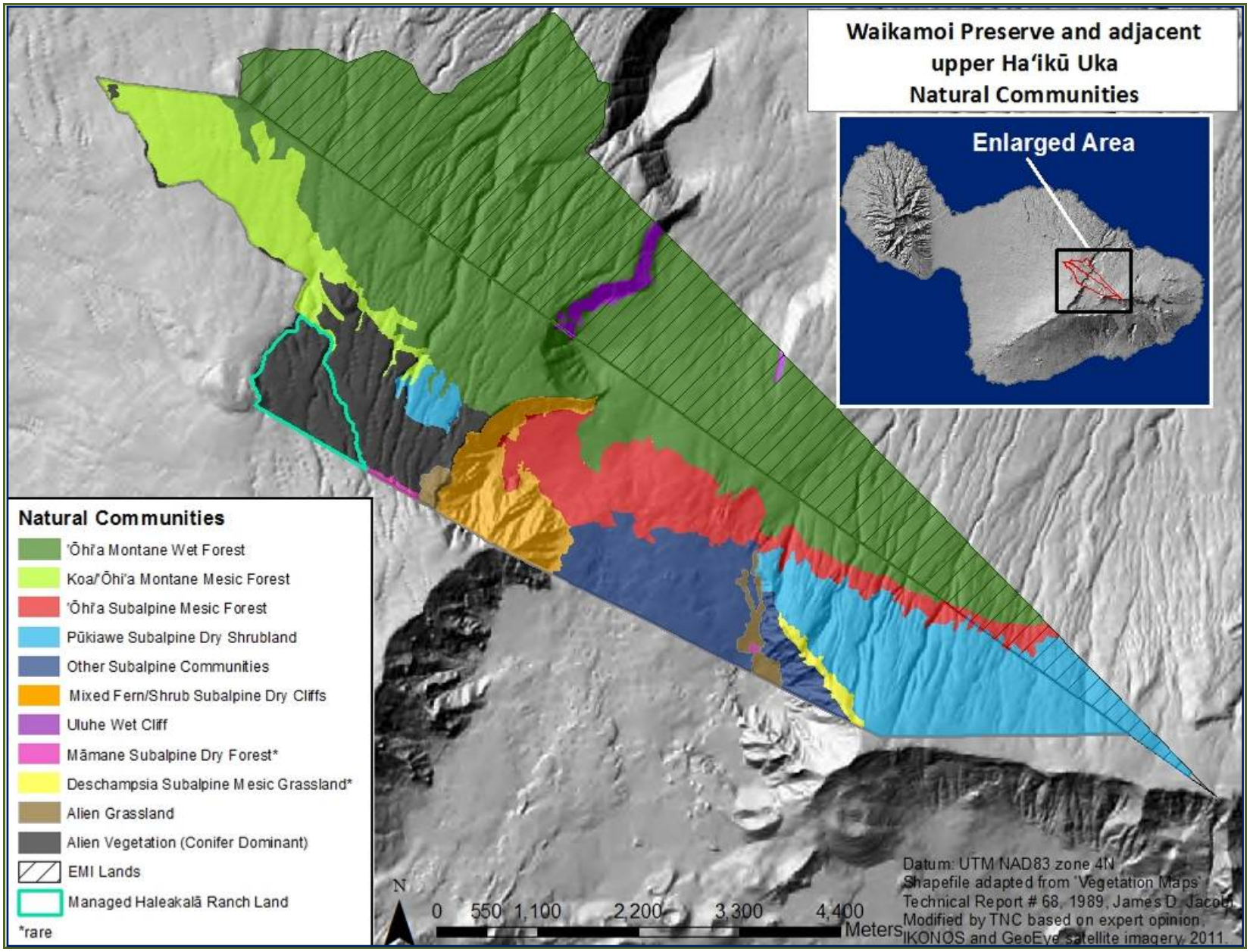

Figure 2. Waikamoi Preserve and adjacent Ha'ikū Uka natural communities

MANAGEMENT

Management Considerations

Waikamoi Preserve is adjacent to four large, managed natural areas: The Nature Conservancy's newest conservation easement – the 3,721 acre "Waikamoi Addition" acquired from EMI, Haleakalā National Park, the state Koʻolau Forest Reserve, and the state's Hanawī NAR. In addition, in 1991 we helped initiate the formation of the East Maui Watershed Partnership (EMWP) with the State Department of Land and Natural Resources, EMI, Haleakalā Ranch Company, County of Maui, Haleakalā National Park, and Hāna Ranch Partners, LLC to implement a unified management plan for the East Maui watershed. Management efforts at Waikamoi complement the EMWP management plan's objectives, and TNC often conducts management on adjacent watershed lands to prevent ungulates and weeds from spreading into Waikamoi. Management activities between the Conservancy and EMWP are coordinated, with staff, equipment, and expertise frequently shared to maximize efficiency.

In the past, the primary strategy for the protection of Waikamoi Preserve was to remove ungulates to reduce damage to native vegetation and soils. We removed six ungulates, including one deer, in Waikamoi in the last six years. There have been no catches since April of 2015. Currently ungulate transects and scouting show zero sign in the preserve. It is important to maintain a strong presence with consistent scouting and monitoring to prevent ingress, while also allowing staff to focus on the next most important threat.

With the exception of about 800 acres of an exotic tree plantation (including blackwood acacia, cedar, *Pinus* spp., and other conifers) adjacent to Haleakalā National Park's Hosmer Grove area, Waikamoi's 5,230 acres are dominated by native species. The Conservancy's weed management activities focus on controlling Himalayan ginger (*Hedychium gardnerianum*), invasive pines (*Pinus* spp.), gorse (*Ulex europaeus*), and ash (*Fraxinus uhdei*), and preventing the establishment of new priority weeds moving from adjacent lands (See Table 2).

A primary management objective is to prevent the introduction of habitat-modifying weeds, pest insects and plant disease. Special care is taken to minimize negative side effects of management activities. Due to *Ceratosystis spp.* (fungus that causes Rapid ʻŌhiʻa Death), visitors are strictly prohibited from entering the preserve if they have been to Hawaiʻi Island within the past six months. Staff follow a strict cleaning protocol for all gear to remove seeds, debris, and insects to prevent accidental introduction of pest species to the preserve.

We will continue to adapt our management to incorporate innovative strategies that are more effective and reduce costs, and that address new or changing threats. Climate change will likely exacerbate invasive species issues and other current threats to the biodiversity. Loss of biodiversity, increases in invasive species, and habitat loss are expected to be the greatest stresses to Hawaiʻi's native ecosystems resulting from climate change. In addition, longer periods of drought could significantly increase wildfire risk, especially in the conifer-dominated portion of the preserve. The strategies outlined in this plan such as maintaining zero tolerance for ungulates and removal of top habitat-modifying weeds should increase ecosystem resilience to climate change impacts.

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We will continue to pursue new technologies that enhance current management practices, though will need to seek additional funding and donations to do so. Examples include GPS tracking for feral animals using trained dogs; remote sensing mapping to detect isolated populations of priority invasive plants; new application technologies that provide effective control of priority weeds using target-specific methods and low rates of herbicides; and supporting exploratory research in countries of origin for our priority invasive plants, including collaboration for well-regulated releases of biocontrol agents onto priority alien pest species.

Currently a portion of the management activities at Waikamoi Preserve are outsourced via subawards and contracts. TNC Hawaii implemented the contract model in an effort to build capacity of partners, streamline operations, and increase efforts toward conservation innovation and technology. TNC staff have "taken back" increasingly more management work over the years since 2010, and continue to collaborate with the subcontractors and monitor outsourced work.

Management Units

Waikamoi is managed in six units (Figure 3). The units are defined by topographic boundaries, similarity of natural community types, and threats. Topographic features determine the placement of fences built by the Conservancy and Haleakalā National Park. The Nature Conservancy's fences tie into the Haleakalā National Park fence at Puʻu Nianiau and Waikamoi's easternmost tip, and extend downward in elevation. Cooperative agreements with Haleakalā National Park, Haleakalā Ranch, EMI, the state, and the EMWP allow the Conservancy to work outside the preserve boundaries. All of the partners of the EMWP, including the Conservancy, collaborate on fencing projects to ensure that the native-dominant core of the East Maui Watershed is protected.

Unit 1A (Puʻu O Kakae Unit) is the westernmost portion of the preserve and the lowest in elevation (4,400–6,000 feet). Its western edge abuts Haleakalā Ranch's open pastureland. It is comprised of koa ʻōhiʻa (*Acacia koa/Metrosideros polymorpha*) montane mesic and ʻōhiʻa montane wet forest (Figure 2). This is one of the most accessible units, and has therefore suffered from some fence vandalism in the past. Ungulate management has been limited to hunting rather than trapping, due to accessibility. The unit is pig free due to the adoption of intense and systematic hunting techniques which employ highly trained hunting dogs outfitted with GPS collars. The unit is entirely fenced except for the eastern boundary, which is formed by the very steep Waikamoi Gulch. Unit 1A contains localized infestations of Himalayan ginger, blackberry, tropical ash, gorse, eucalyptus, and pasture grasses. The mesic aspect of this unit enhances the plant diversity to contain more species of trees, shrubs, vines, herbs, and ferns than found in the other units. Unit 1A also contains a high number of rare plant species.

Unit 1B (Puʻu Luʻau Unit) (5,200–6,200 feet elevation) is primarily ʻōhiʻa montane wet and koa ʻōhiʻa montane mesic forest (Figure 2). Over half of the unit's lower northwest boundary has been fenced on the Waikamoi boundary with the other half protected by fencing on EMI land. This unit contains breeding populations of Maui parrotbill and ʻākohekohe. The upper boundary is bordered by conifers and other alien vegetation, and this unit contains relatively small patches of blackberry, ginger, and eucalyptus.

Unit 2 (Honomanū Mauka Unit), below Haleakalā National Park's Hosmer Grove, is dominated by dense stands of conifers except for 100 acres of native-dominant subalpine shrubland at the lower eastern edge (Figure 2). There is also pūkiawe subalpine dry shrubland, koa/ʻōhiʻa montane mesic, ʻōhiʻa montane wet forest, mixed fern-shrub subalpine wet cliffs, and a small patch of rare māmane subalpine dry forest. The native shrubland contains populations of the Hawaiian dark-rumped petrel near the pali edge. Throughout the conifers are blackwood acacia, and a shrinking population of tropical ash near the western boundary. Gorse has been mapped and treated in this unit, with diminishing seedlings and occasional re-growth; it's on a 7-8 years retreatment cycle. The understory outside the conifer shade is comprised of velvet grass (*Holcus lanatus*) and sweet vernal (*Anthoxanthum odoratum*), as well as other alien grasses, native shrubs, and ferns. This is also where blackberry has invaded, likely from historical cattle grazing. The gulches that cross this unit are often dominated by native vegetation; some contain populations of the endangered *Geranium arboreum*. The area is suitable for restoration should a funding opportunity arise to pay for conifer removal.

Unit 3's (Koʻolau Unit) upper area is primarily ʻōhiʻa subalpine mesic forest with a small band of subalpine communities along the upper unit boundary. The lower area is predominately ʻōhiʻa montane wet forest (Figure 2). This unit contains many rare plants and birds, including populations of the Hawaiian dark-rumped petrel along the pali. A small portion of this unit at the base of the ʻĀinahou pali was once used for summer pasture by Haleakalā Ranch, and contains significant patches pasture grasses. The conservation easement with EMI extends Unit 3 down to 3800' elevation; and is comprised of ʻōhiʻa montane wet forest.

Unit 4 (Waikau Unit) is primarily pioneer vegetation on lava flows with subalpine communities and some *Deschampsia* subalpine mesic grassland (Figure 2). The ground is predominately ʻāʻā and pāhoehoe lava (which is relatively rare on Maui). Haleakalā National Park's fence forms Unit 4's north boundary and divides it from the rest of the preserve. Patches of alien grasses can be found throughout Unit 4.

Unit 5 (Hanakauhi Unit) is comprised of ʻōhiʻa montane wet forest in its lower portions, and the larger upper portion is pūkiawe subalpine dry shrubland with a small band of ʻōhiʻa subalpine mesic dry forest in between (Figure 2). This unit extends from 5,600 feet to nearly 8,600 feet elevation. Management activities 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 al.[2] (Figure 4). The EMI Waikamoi addition easement extends Unit 5 down to 4,800' elevation; and is comprised of ʻōhiʻa montane wet forest with small bands of ʻōhiʻa subalpine mesic forest and pūkiawe subalpine dry shrubland communities.

[2] Hughes, Cohan, White & Brown. 2014 Subalpine vegetation change 14 years after feral animal removal on windward East Maui, Hawai'i. Pacific Science 68(1).

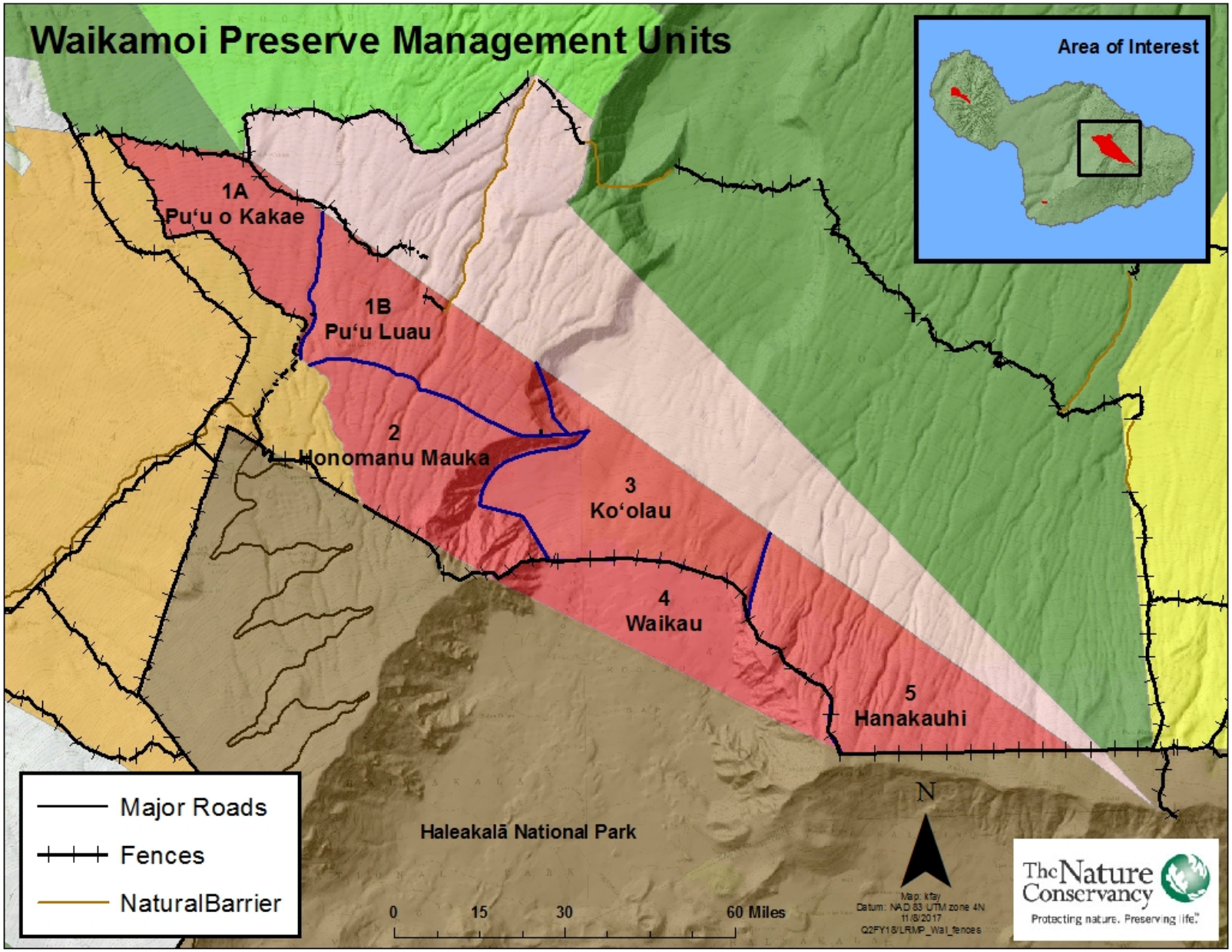

Figure 3. Management Units of Waikamoi Preserve.

Management Programs

Program 1: Non-Native Species Control

A. Ungulate Control

Program Goal**:** To protect large native-dominated areas and watershed within and adjacent to Waikamoi Preserve by removing all ungulates and preventing future invasion.

Program Description: The importance of Waikamoi Preserve as a refuge for native Hawaiian birds, thirty-eight rare plants, and seventeen natural communities cannot be overstated. It is one of the most viable and intact remaining native forests in the state. Ungulate damage is the greatest threat to the preserve and critical East Maui watershed headwaters, but is no longer the focus of the Waikamoi resource management program since we achieved our goal of zero ungulates.

In 2007, TNC and EMWP implemented the Forest Recovery Project, a three-year project designed to dramatically reduce ungulates throughout a 12,000 acre focal area that encompassed Waikamoi Preserve and adjacent EMWP lands. The goal was to achieve near-zero damage and activity levels and set up an ongoing "zero tolerance" management program that maintains near-zero damage and activity levels. During the course of the project, TNC and EMWP installed an extensive system of backcountry management infrastructure consisting of trails, camps, transects and helicopter landing zones. This intensive on-the-ground time allowed field staff to become familiar with all management units and greatly facilitates long-term management of the 12,000 acres.

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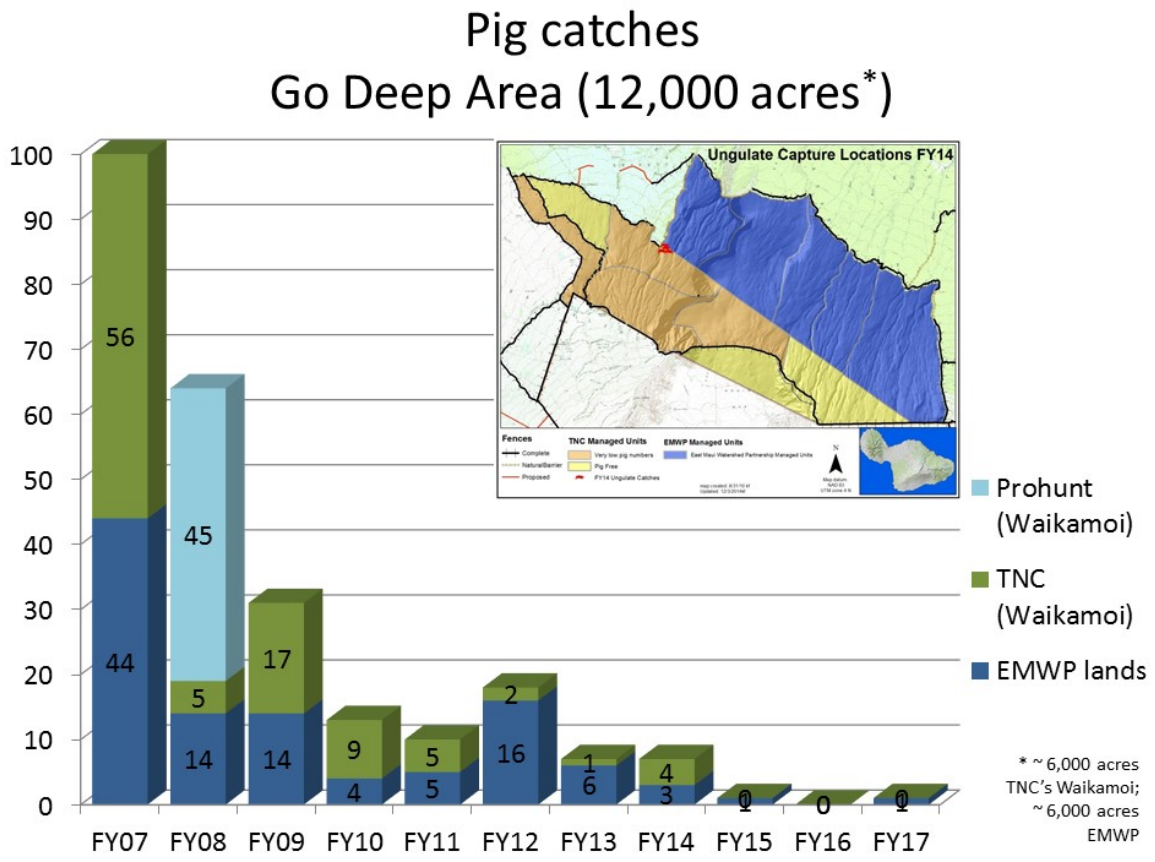

We now have the lowest levels of pig activity in Waikamoi Preserve ever achieved, with no pigs detected or removed from the preserve in the last three fiscal years. Over the last six years, five pigs and one deer were removed from the preserve (Figure 6). The deer that was removed (April 2015) from Unit 2 was thought to have been pushed into the preserve by hunting efforts on Haleakalā Ranch. Before that the last last axis deer was removed in 2004. However, axis deer are still found in the Deer Management Unit (DMU). While the goal is to have the DMU be axis deer-free, deer and other ungulates do get in the unit at times because the area is used for grazing cattle by Haleakalā Ranch. Work on a new management plan for the bottom 100 acres of the DMU has begun as of October 2017. The area will be intensively grazed by cattle and then planted with native koa trees, grazed one more time after roughly three years, and then outplanted with native plants. TNC intends to support the project by helping install vegetation recovery plots, hunting the last pigs, taking aerial imagery with the drone, and maintaining the Waikamoi fence.

We work closely with the EMWP to ensure that management efforts are efficient and coordinated. The Conservancy and the EMWP work jointly to establish priorities for management and Waikamoi has greatly benefited from this collaboration. Ungulate ingress into Waikamoi from adjacent lands is very rare due to effective collaborative management between TNC and EMWP.

We monitor 13 transects semi-annually for signs of ungulate activity[‡] in contiguous 5m X 10m plots along 500 meter transects. This monitoring method is used to gauge the effectiveness of our control

[‡] "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%.

strategies and techniques. Trend data indicate that overall pig activity observed has declined from about 33% in 1988 to < 1% in 2004 to 0% percent in 2017 (Figure 6). A TNC study conducted in 2009 revealed dramatic recovery of native vegetation following this large decrease in ungulate activity.

FY19–FY24

The focus of our ungulate control program in FY2019–2024 will be to maintain zero ungulate activity in Waikamoi Preserve. We will continue to streamline, improve, and refine management activities, implement innovative approaches and share our experiences and knowledge with partners.

The current regime of fencing, hunting, and trapping in remote areas for ungulate removal has proven effective. Remote trapping remains an essential tool in an integrated program for ungulate removal and control. Boundary fences are checked and maintained on a regular schedule, and will be repaired and replaced incrementally as needed. We may identify new areas that can benefit from strategic fencing or wing extensions. 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. Notice of any significant changes to the management program will be included in semi-annual progress reporting.

Activities

Years 1–6 (FY2019–2024):

- Inspect all fences on a quarterly basis and make repairs immediately. Internal fencing that shares boundaries with EMI Addition will be checked semi-annually. 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 ungulates throughout Waikamoi. Regularly check and maintain traps, streamlining in areas that have never caught.
- Scout for ungulates routinely and track animal catches. Update pig activity and scout maps annually.
- Annually monitor 13 500 meter transects to monitor for pig ingress.
- Prevent invasion of axis deer into Waikamoi Preserve by supporting Haleakalā Ranch activities to maintain the DMU fence **and assist with hunting and activites within the "Ukelele" project as requested and feasible.**
- **Explore innovative ways to improve ungulate fences**.*
- Monitor TNC Maui dog program effectiveness, including training, handling, and hunting techniques. **Share hunting and dog program knowledge with partners, and hunt partner lands as requested and feasible.** *
- **Test innovative and new monitoring technologies, such as UAV-mounted FLIR cameras or remote IP fencing monitoring systems.** *

* Activities marked with an asterisk will require funding beyond the NAPP scope; TNC will fundraise for additional public and private funds to attempt these deliverables and will report on them regardless of funding source.

This program represents an estimated 30% of the overall effort and budget in this long-range management plan.

B. Invasive Plant Control

Program Goal: To maintain large, native-dominated core areas within Waikamoi Preserve and adjacent areas that are free of the highest priority habitat-modifying weeds, and 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 disturbances to intact native communities, reduce infestation size of priority weeds with a focus on outliers, 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.

We strive towards an Integrated Pest Management (IPM) approach to weed control — consisting of manual/mechanical methods, target-specific herbicide treatments, 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.

Control work is prioritized to target species. As control is achieved at targeted sites for higher priority species, efforts shift to lesser priorities with the goal of reaching control intervals of the lesser priorities every 6 years. Our management efforts are guided by the *East Maui Conservation Site Weed Management Plan* (TNC 2017). The highest priority is the containment and localized eradication of Himalayan ginger (*Hedychium gardnerianum)*, with the next priority being control and containment of invasive pines.

Treatment of other priorities such as *Fraxinus uhdei, Cortaderia jubata,* and *Ulex europeaus* during pre-determined intervals can keep these plants in suppression mode (see Figure 9). Also targeted are known habitat-modifying weeds just beginning to invade Waikamoi, such as *Psidium cattleianum*, *Ilex aquifolium, Tibouchina herbacea*, *Cinnamomum camphora, Setaria palmifolia*, and *Rubus glaucus,* with the goal of preventing establishment. Included last are potentially future priority weeds moving north through Haleakalā Ranch or adjacent lands but not yet established in Waikamoi, including *Passiflora molissima* (banana poka) and *Morella faya* (faya tree). See Table 2, Priority weed species for management at Waikamoi Preserve.

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Table 2. Priority weed species for management at Waikamoi Preserve (in order of priority)

Scientific Name	Common Name
TOP PRIORITY SPECIES	
Hedychium gardnerianum	Himalayan ginger
Ulex europaeus	Gorse
***Pinus* spp.**	Mexican weeping pine, Monterey pine, etc.
Acacia melanoxylon	Blackwood acacia
Fraxinus uhdei	Tropical ash
Cortaderia jubata	Pampas grass
EARLY DETECTION/ RAPID RESPONSE PRIORITY SPECIES	
Psidium cattleianum	Strawberry guava
Ilex aquifolium	English holly
Tibouchina herbacea	Cane tibouchina
Cinnamomun camphora	camphor tree
Rubus glaucus	Climbing/trailing blackberry
Setaria palmifolia	palmgrass

Table 3. Weed species not yet established in Waikamoi Preserve but found in neighboring lands

Scientific Name	Common Name
Asparagus asparagoides	Bridal veil creeper; smilax
Bocconia fructescens	Tree poppy
Clidemia hirta	Clidemia
Cotoneaster pannosus	Bird berry
Cyathea cooperi	Australian tree fern
Hypericum canariense	St. John's wort
Miconia calvescens	Miconia
Morella faya	Firetree
Paspalum conjugatum	Hilo grass
Passiflora mollissima	Banana poka
Rubus niveus	Mysore raspberry
Senecio madagascarensis	Fireweed

In the past, weed threats were assessed via monitoring of non-native vegetation along 30 threat monitoring transects and 5 USFWS transects, in conjunction with ungulate monitoring. Data regarding weed taxa and the overall cumulative percent cover of non-native plants per station were recorded. This data provided an index of species found on transects, however it gave no indication of their extent throughout the preserve and greater watershed. Instead, we have found that aerial and ground surveys, in addition to satellite imagery, provide the best measure of determining the extent of weeds and provide a visual estimate of ecosystem extent and quality.

From 2009 to 2013 staff from TNC Maui chaired the Maui Invasive Species Committee. Duties included representing MISC at HISC and CGAPS meetings. TNC staff will continue to attend MISC meetings as part of the committee, as we were involved in the formation of its' predecessor group Melastome Action Committee in 1991, and MISC's Executive Committee since 2003.

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Invasive pine trees across the subalpine shrubland have become problematic since FY11, believed to have spread from the 2007 Kula Forest Reserve fire. *Pinus patula* and *Pinus radiata* are considered "high risk" invasive plant pests according to the Hawaii Pacific Weed Risk Assessment; "high risk" species are "documented to cause significant ecological or economic harm in Hawaii." Pine species are a threat to native biodiversity due to their ability to change soil chemistry, displace native plants, interrupt native species' food chains, and greatly increase the potential of wildfire. Reducing the density of pines across the subalpine zones of Haleakala and across Waikamoi will greatly reduce the risk of fire in the long-term, and will preserve the integrity of the native ecosystems.

Representatives from TNC, EMWP, Leeward Haleakalā Watershed Resotration Partnership, Haleakalā Ranch, and UH CTAHR held meetings regularly between FY13 to FY18 on pine control and coordinating efforts. The Pine Working Group was formed to strategize control, share information, and monitor progress, with the goal of keeping the upper slopes of Haleakala pine-free.

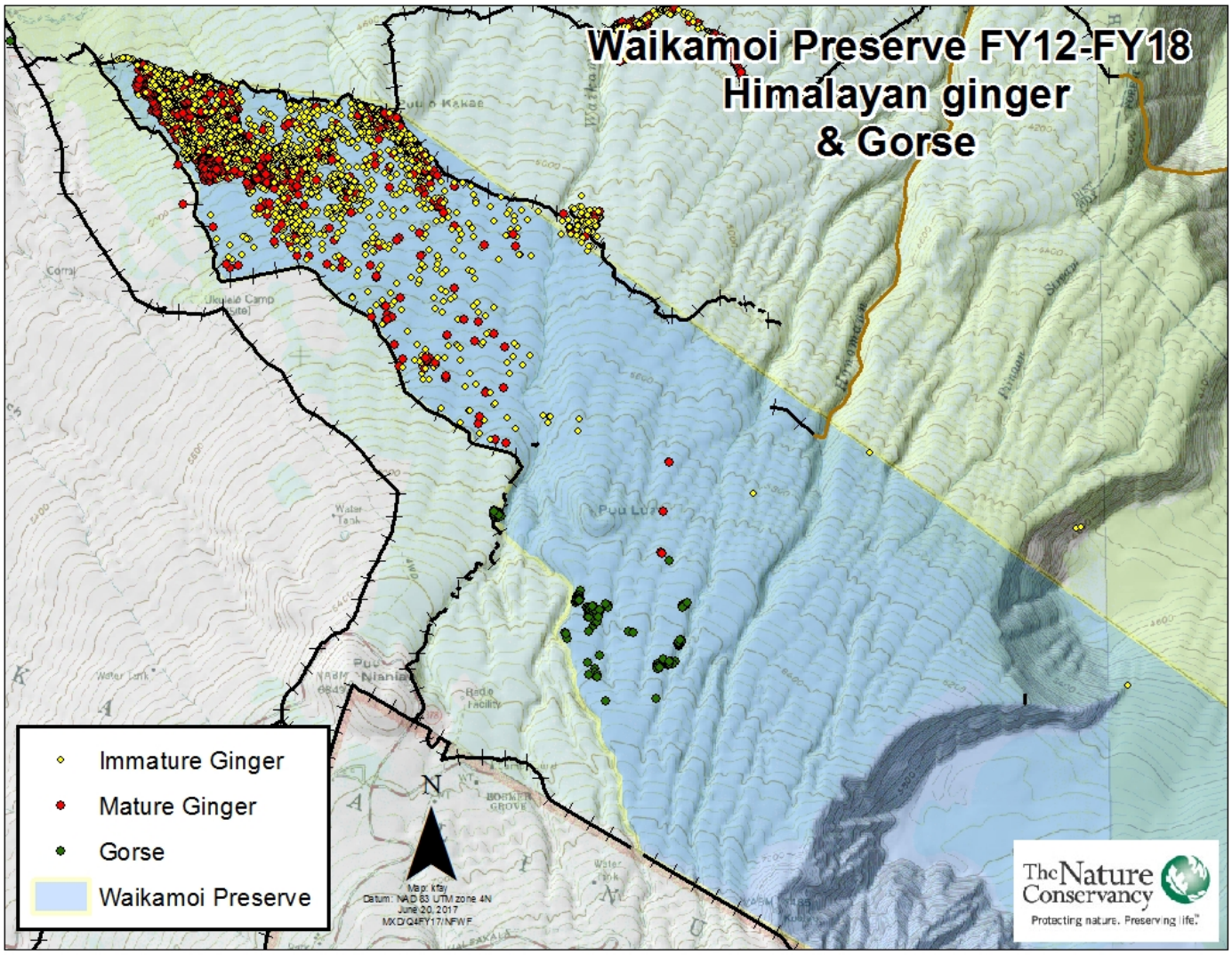

Figure 4. Waikamoi Himalayan ginger and gorse control, FY12–FY18

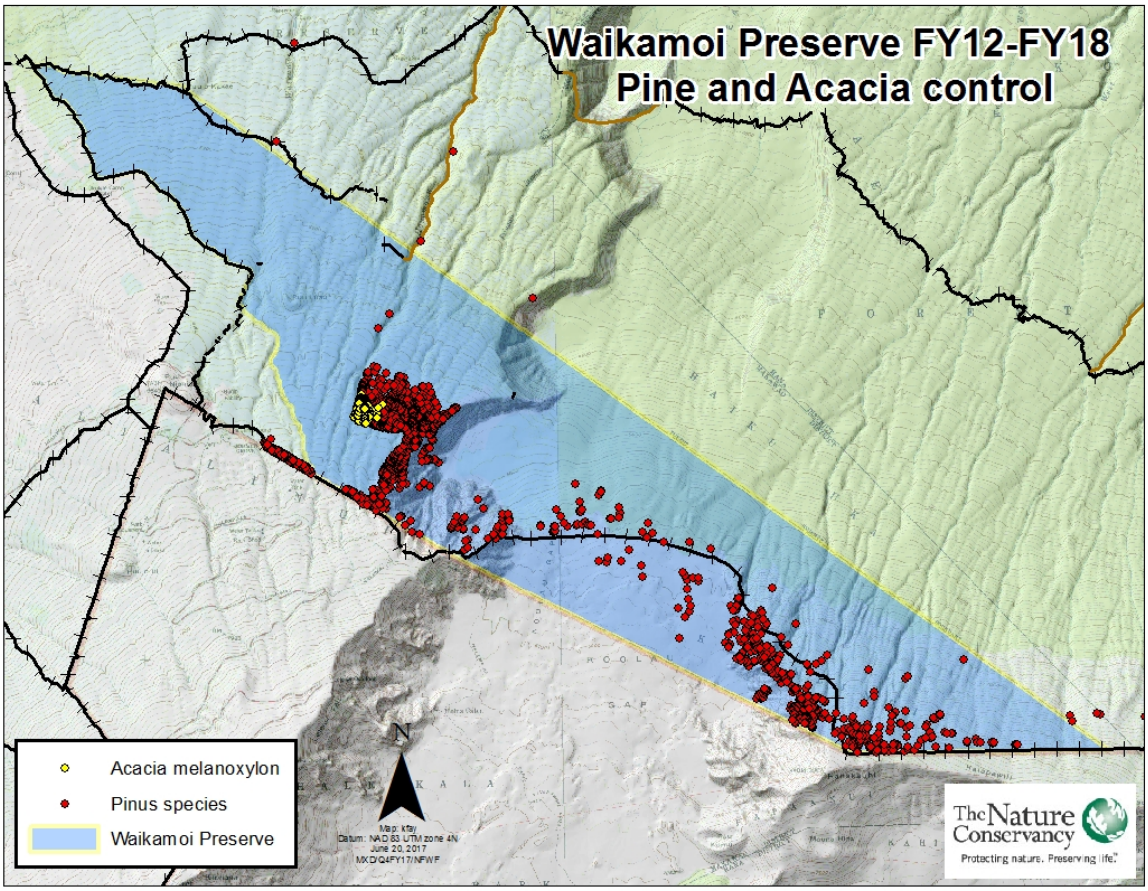

Figure 5. Waikamoi Pinus spp. and Acacia control, FY12–FY18

<u>Invasive Plant Control, 2019–2024</u>

We will continue surveying, mapping, and controlling the most serious habitat-modifying weed species in Waikamoi Preserve. We will work with EMWP, MISC, DOFAW, Haleakalā National Park and Haleakalā Ranch on a coordinated weed approach for adjacent lands of known targets.

<u>Activities</u>

Years 1–6 (FY2019–2024):

- 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.
- Scout for, map, and monitor potential habitat-modifying invasive plants, and monitor efficacy of treatments. Implement other vegetation and/or weed surveys if cost-effective methods are available.
- **Use and support innovative approaches to control and monitor weeds including Herbicide Ballistic Technology, targeted aerial spraying, monitoring via UAV or remote cameras, etc.***
- **Support and share innovative approaches with partners and landowners.***
- Prevent other incipient weed or pathogen 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.
- **Continue interaction with HISC to provide support for biocontrol funding, especially for Himalayan ginger.***

This program represents an estimated 45% of the overall effort and budget in this long range management plan.

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

Program Goal: To prevent the introduction 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. m*acrocephalum*); it decimates the native yellow faced bee (*Hylaeus volcanica)* that pollinates the plant.

In 2015 a predator control program was started in Waikamoi in collaboration with the Maui Forest Bird Recovery Project to reduce predation on endangered bird populations, particularly the kiwikiu. Rats, mice, cats, and mongoose pose a threat to many native birds including the endangered ground nesting nēnē, kiwikiu, akohekohe and iiwi. Rats and mice also depredate seeds of endangered plants.

Rapid Ohia Death (ROD) has affected 75,000 acres on Hawaii Island as of December 2017,. It has not been found on any other island yet. TNC is implementing strict sanitation protocols and restricting access to the preserve. 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 prevening and responding to ROD invasion.

Small Mammal and Other Invasive Control FY19–FY24
A reduction in NAPP funds 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.

Activities
Years 1–6 (FY2019–FY2024):
- Support/establish viable control programs for small mammals.
- 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.
- Attend Maui ROD working group meetings.*
- Implement TNC ROD prevetntion protocol. Respond immediately to ROD threat by having suspect trees sampled as deemed necessary.
- Set the standard and ensure strict enforcement of ROD prevention protocols with the possibility of restricting access to the preserve.

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This program represents an estimated 3% of the overall effort and budget in this long range management plan.

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 preserve, especially rare species, while encouraging and assisting with research that increases our understanding and management of the preserve'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 (Appendices 2 - 4). 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), administered through the Pacific Cooperative Studies Unit (PCSU) and coordinated by DOFAW, is actively visiting known locations of rare species. PEPP is focused on target species at Waikamoi, with the intent to collect seed for future propagation of rare plants. Accurate mapping and vigor of these populations is a byproduct of the PEPP work. We work closely with PEPP and support their efforts to protect and restore rare and endangered species found in the preserve.

We also encourage and support independent research aimed at answering important resource and management questions. Key questions include: What is the status of forest birds in Waikamoi, and how can we promote their survival? How do we best control Himalayan ginger in remote areas? How is climate change affecting the biological resources of the preserve, and how can we adapt to climate change?

Resource Monitoring, Rare Species Protection And Research FY19-FY24
We may employ new passive monitoring technologies such as remote sensing, high resolution aerial photography for vegetation monitoring, and remote photomonitoring for fire, ungulates and/or ungulate traps. Other monitoring tools may be employed as they are developed and become available.

Staff will continue to identify, map, and recover rare plant populations during routine management activities. When available, fruit will be collected and given to PEPP for propagation. We will continue to support and assist PEPP with outplanting and monitoring of rare plants, in addition to sharing GIS data on rare plant locations in Waikamoi and on adjacent lands.

We will continue to encourage independent research in Waikamoi by offering necessary application materials to researchers online. Although no Conservancy funding for research is provided to

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projects, wherever possible**,** we provide technical guidance and logistical support to approved research.

Restoration of high elevation habitat for forest birds has been recommend by Hawaii climate change scientists and managers, and is recommended as a key strategy for the recovery of the kiwikiu, akohekohe, 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 km^2 to only 7 km^2.[4] Unfortunately disease moving upslope is not the only threat to native birds posed by climate change[5]. 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 Waikamoi's native ecosystems will continue to provide refugia habitat for rare and endangered species. Recent research by the Maui Forest Bird Recovery Project (MFBRP) has demonstrated that only one mosquito (*Aedes vexans*, not the avian-malaria carrying *Culex*) was captured in over 167 trap nights in Waikamoi – and that one mosquito tested negative for the avian malaria parasite *Plasmodium*.[6]

<u>Activities</u>
Years 1–6 (FY2019–FY2024):

- Continue to support PEPP in 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 or other biological resource surveys in new areas when possible**.*
- **Establish and monitor test plots conifer-invaded habitat tion to document the success of passive active restoration efforts to create and expand mosquito-free forest bird habitat.***

<u>This program represents an estimated 5% of the overall effort and budget in this long range management plan.</u>

Program 3: Innovation

The Conservancy is always exploring ways to augment or refine current management efforts by applying techniques, designs or technologies new to conservation. Such innovations have the potential to reduce time or costs of basic conservation tasks, and accelerate progress toward or achieve previously unobtainable outcomes within our management programs.

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[4] 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).
[5] E.g., Giambelluca et al. 2008; Timm and Diaz 2009; also see Fletcher 2010
[6] MFBRP. Avian disease and mosquito sampling in The Nature Conservancy's Waikamoi Preserve, Maui. Dec. 11, 2017 project report to TNC.

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Innovation projects that have been launched in the past include:

- using FLIR (Forward Looking Infrared) to enhance animal detection during aerial hunts;
- using the Surface Pro tablet to record aerial shoot data with GPS locations and to guide helicopter in the right shoot zones;
- using plastic deer mesh to more effectively remova animals while requiring less resources to install; and
- using GPS dog collars in weed sweeps to ensure accurate and safe coverage of the areas covered.

Currently, our Maui Nui Team is learning to use drones (Unmanned Aerial Vehicles or UAVs). We are currently exploring the use of drones with our Maui Nui team to help with location of weeds, rare plants, or documentation of landscape scale changes.

Activities

Years 1-6 (FY2019-FY2024)*[7]:

- Test innovative and new monitoring technologies, such as UAV-mounted FLIR cameras or remote IP fencing monitoring systems. [1]
- Continue to use FLIR to aid in animal detection during aerial hunts and explore improved FLIR technology.
- Regularly survey efficacy of plastic mesh and and document successes, adjustments or improvements needed for future fence design
- Continue to use dog collars for weed and animal control to assist with survey efficacies an provide GIS mapping
- Explore innovative ways to improve ungulate fences
- Monitor effectiveness of TNC Maui dog program effectiveness, and share hunting and dog program knowledge with partners
- Use and support innovative approaches to control and monitor weeds including Herbicide Ballistic Technology, targeted aerial spraying, monitoring via UAV or remote cameras, etc.
- Support and share innovative approaches with partners and landowners.
- Continue interaction with HISC to provide support for biocontrol funding, especially for Himalayan ginger.
- Attend Maui ROD working group meetings.
- Establish and monitor test plots conifer-invaded habitat tion to document the success of passive active restoration efforts to create and expand mosquito-free forest bird habitat.
- Explore use of UAVs to aid in detection/documentation of weeds, rare plants, and landscape scale changes.
- Maintain and improve remote cameras and wireless systems
- Transfer application of innovation projects to partners (DoFAW/NARS, private landowners, National Parks, Invasive Species Committees, Plant Extinction Prevention Program etc.)

This program represents an estimated 10% of the overall effort and budget in this long range management plan.

***[7] These activities extend beyond the scope of the NAPP budget, but will be carried out if additional funds can be raised.**

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Program 4: Partnerships & Outreach

Program Goal: Support partners, especially the East Maui Watershed Partnership and the Maui Invasive Species Committee (MISC), where cooperative management activities mutually benefit Waikamoi Preserve and the 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: 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's Maui Field Office 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 TNC has awarded EMWP a subcontract to conduct some management activities in Waikamoi. We meet regularly with EMWP staff and crew to discuss priorities, strategies, and management actions and techniques.

EMWP has a thriving community outreach program that is focused on the local schools and community through their annual Malama Wao Akua art event. TNC offers Waikamoi Preserve as a venue for educational hikes for schoolgroups and for "art hikes" to provide inspiration and education to the community. We strive to increase conservation and advocacy for native-dominant ecosystems through an understanding of the importance, threats, and protection efforts of Waikamoi Preserve and the East Maui watershed. 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.

The major public outreach tool is hiking in the 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 once per month. Other VIP, donor , or cultural group hikes may be offered as opportunities arise. The Waikamoi boardwalk trail provides access to pristine native forest and increases interpretation opportunities to an otherwise sensitive ecosystem. Routine maintenance on the other trails also helps minimize impacts as well as enhancing interpretive value.

Other outreach activities include participation at local community events, such as the East Maui Taro Festival or Maui Ag Fest.

Partnerships & Outreach FY19-FY24

The Nature Conservancy now offers a monthly hike to the Waikamoi Boardwalk, and a quarterly volunteer service trip for community members which allows access into areas opf the preserve that are normally inaccessible. Public access to Waikamoi Preserve as a venue for public outreach by appropriate agencies will be utilized as a strategy to highlight the importance of protection efforts.

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Access will depend upon TNC staff or docent availability, current threats or issues impacting restriction of access (e.g., ROD), and a consistent assessment of the impacts to the Preserve resources.

Activities
Years 1–6 (FY2019–FY2024):

- Participate and provide leadership to the EMWP.
- Support EMWP and MISC in accomplishing fundraising and resource management priorities.
- Provide EMWP and MISC access to Waikamoi to accomplish outreach and volunteer activities on a mutually cooperative basis,.
- Support outreach efforts of partners 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 lead community hikes.

This program represents an estimated 10% of the overall effort and budget in this long range management plan.

Program 5: Infrastructure, Emergency, and Safety

Program Goal: Provide staff with infrastructure, emergency and safety training, and equipment that will aid management activities and equip staff to respond to emergency situations such as fire and rescue.

Program Description: Infrastructure includes the Maui office and baseyard, vehicles, equipment and tools, radio, phone and IT systems, cabins, helipads, roads and trails.

TNC owns and maintains three trucks and one ATV that are used for a variety of management activities but mainly for transport to and from the Waikamoi, EMI Addition, and Kapunakea Preserves. NAPP funds may be used for vehicle maintenance, repairs, and fuel costs.

All staff are trained in Wilderness First Aid and CPR. Other training may include fire suppression and pre-suppression, helicopter safety, hunter's education, and rapelling. Field staff are provided with first aid kits and required to use proper personal protective equipment (PPE) when conducting field work. Waikamoi Preserve's fire plan enables an immediate multi-agency response to wildfires within and adjacent to Waikamoi Preserve.

Infrastructure, Emergency, & Safety Activities
Years 1–6 (FY2019–FY2024):

- Update the TNC *Maui Wildland Fire Management Plan* at least every two years.
- Provide emergency training opportunities for staff including but not limited to maintaining current First Aid and CPR certifications.

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- Conduct annual first aid kit inventory and resupply.
- Purchase equipment as needed to allow immediate response to fire threats
- Respond to emergencies or fire threats
- Conduct road repair on Preserve's access roads.

This program represents an estimated 2% of the overall effort and budget in this long range management plan.

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BUDGET SUMMARY

The table in the next section summarizes the six-year budget for the Waikamoi NAPP 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 total Waikamoi NAPP budget currently represents approximately 35% of the overall operation at the Conservancy's Waikamoi Preserve and adjacent management efforts in the East Maui Watershed. Continued management at our current level will be contingent upon TNC's ability to fundraise for the remaining 65% from other sources.

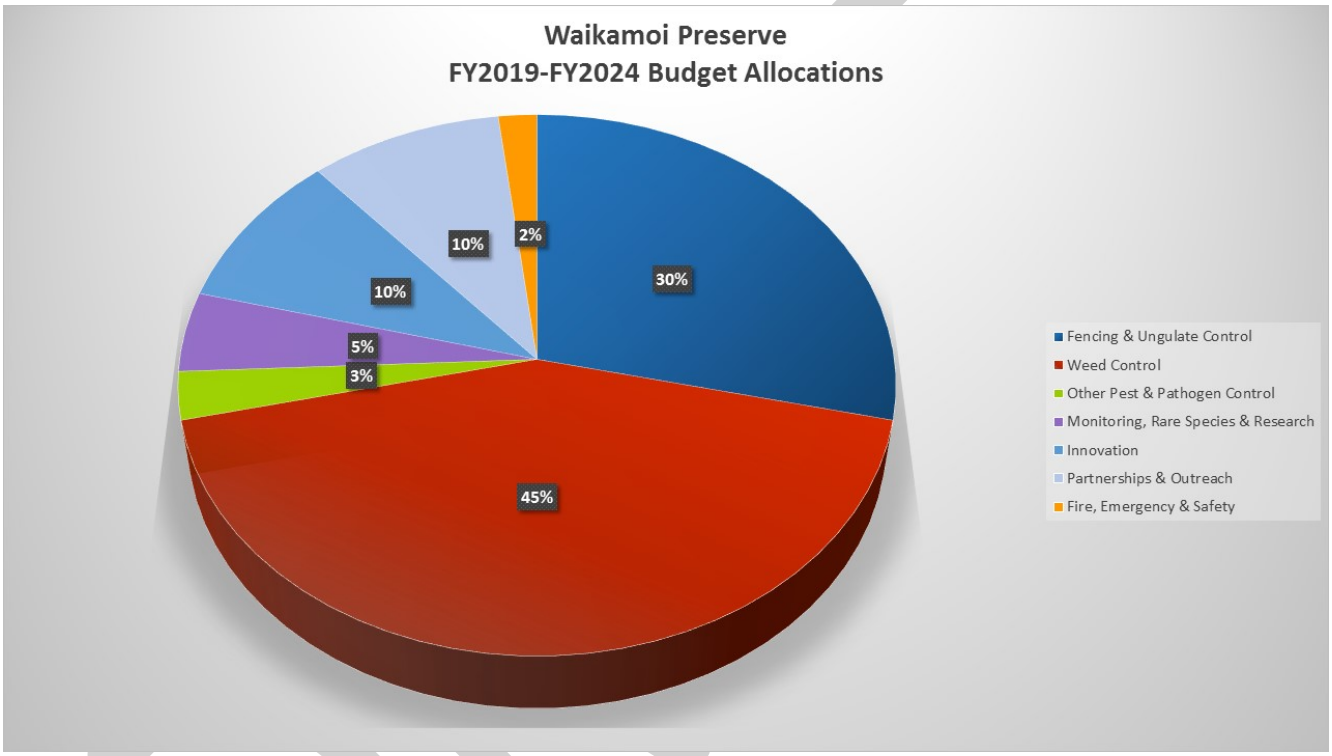

Figure 6. Waikamoi NAPP Budget/Effort by Program, FY19–FY24

The Conservancy's Maui operation maintains a full time base staff of 6.5 FTE. These staff also periodically work on Lana'i and Molokai whose programs are supervised by the Maui Nui office. An estimated 2 FTE of Maui base personnel costs for managing Waikamoi Preserve are funded by the Waikamoi NAPP budget. However, this number may fluctuate depending on the use of contractors vs. staff to complete deliverables. Other part-time, short-term, or year-to-year personnel, in addition to staff overtime, are covered in this budget and will be utilized as project needs warrant. 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.

This budget includes project-related supplies and tools; contract expenses for management practices to conduct fence work, invasive species removal, and helicopter transport; and other miscellaneous project-related costs including vehicle expenses, equipment leases, and costs related to partner capacity building and professional development training. The "Other" category of the budget, is needed to cover a portion of insurance, information technology (IT), printing and copying costs.

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. Although the Conservancy's overhead (Indirect Cost Rate or ICR) is currently 23.31% (the annual rate changes each year per negotiations with DOI), the NAPP program will currently pay only 10%, leaving the remainder (13.31%) as unrecovered ICR. TNC considers the 13.31% as unrecovered ICR and may use portions of this as match as needed.

Budgetary Considerations: The Waikamoi NAPP project has seen a reduction in funding of 35% over the past 15 years. The FY2013-FY2018 NAPP contract represented a 9% decrease from the previous contract, and subsequent further budgets cuts - ranging from 5-10% - were put in place by DLNR some years. With this reduction in funds over the years, we have had to scale back and/or cut various programs like community outreach, predator control, and resource and threat monitoring programs.

The objectives outlined in this plan include deliverables that will fall outside the scope of NAPP funding for which we will have to privately fundraise; we hope to complete these deliverables by leveraging DLNR NAPP funding to acquire additional grants and private funds. We will report on progress on all accomplishments in Waikamoi Preserve and on adjacent lands regardless of funding source. If NAPP reduces the annual funding amount, we will have to adjust our deliverables.

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BUDGET TABLE

	FY 2019	2020	2021	2022	2023	2024	TOTAL
Labor and Fringe	131,000	131,000	131,000	131,000	131,000	131,000	**786,000**
Contractual	131,000	131,000	131,000	131,000	131,000	131,000	**786,000**
Communications	0	0	0	0	0	0	**0**
Travel	1,000	1,000	1,000	1,000	1,000	1,000	**6,000**
Supplies	10,000	10,000	10,000	10,000	10,000	10,000	**60,000**
Other							**0**
Subtotal	*273,000*	*273,000*	*273,000*	*273,000*	*273,000*	*273,000*	***1,638,000***
Overhead @ current negotiated rate	27,300	27,300	27,300	27,300	27,300	27,300	**163,800**
TOTAL	300,300	300,300	300,300	300,300	300,300	300,300	**1,801,800**
	Year 1	**Year 1**	**Year 1**	**Year 1**	**Year 1**	**Year 1**	**Total**
Waikamoi budget	300,300	300,300	300,300	300,300	300,300	300,300	**1,801,800**
Match (1/3 of total)	100,100	100,100	100,100	100,100	100,100	100,100	**600,600**
TOTAL NAPP REQUEST (2/3)	**200,200**	**200,200**	**200,200**	**200,200**	**200,200**	**200,200**	**1,201,200**

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Appendices

Appendix 1. Native Natural Communities Of Waikamoi Preserve

NATURAL COMMUNITY NAME	GLOBAL RANK
Lowland	
Uluhe (*Dicranopteris linearis*) Lowland Wet Shrubland	G4
Montane	
ʻĀkala (*Rubus hawaiiensis*) Montane Wet Shrubland #	G3
Carex Montane Wet Grassland #	G3
Koa/ʻŌhiʻa (*Acacia koa*/*Metrosideros polymorpha*) Montane Wet Forest #	G3
Mixed Fern/Mixed Shrub Montane Wet Shrubland #	G3
ʻŌhiʻa /Hāpuʻu (*Metrosideros polymorpha*/*Cibotium* spp.) Montane Wet Forest	G3
ʻŌhiʻa (*Metrosideros polymorpha*)/Mixed Shrub Montane Wet Forest #	G3
ʻŌhiʻa /ʻŌlapa (*Metrosideros polymorpha*/*Cheirodendron* spp.) Montane Wet Forest	G3
ʻŌhiʻa /Uluhe (*Metrosideros polymorpha*/*Dicranopteris*) Montane Wet Forest #	G3
Subalpine	
Deschampsia nubigena Subalpine Mesic Grassland* #	G2
Māmane (*Sophora chrysophylla*) Subalpine Dry Forest*	G2
ʻŌhiʻa (*Metrosideros polymorpha*) Subalpine Mesic Forest #	G3
Pūkiawe (*Styphelia tameiameiae*) Mixed Subalpine Dry Shrubland	G3

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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 Hanawh 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).

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Appendix 2. Rare Native Plants of Waikamoi Preserve

SCIENTIFIC NAME	COMMON NAME	PEPP target/ Rare On Island[8]	Single Island Endemic (SIE) or Single Mountain SME (SME)	FEDERAL STATUS
Asplenium peruvianum var. insulare		ROI		LE
Bidens campylotheca* ssp. *pentamera +	koʻokoʻolau, kokoʻolau		SIE	LE
Calamagrostis expansa #				LE
Cyanea duvallorium	hāhā	Yes	SME	LE
Cyanea hamatiflora ssp. hamatiflora	hāhā			LE
Cyanea horrida* #	holokea	Yes	SME	LE
Cyanea kunthiana +	ʻōhā, hāhā, ʻōhā wai		SIE	LE
Cyanea maritae		Yes	SIE	LE
Cyanea mceldowneyi			SIE	LE
Diplazium molokaiense		Yes		LE
Geranium arboreum*	hinahina, nohoanu	Yes	SME	LE
Geranium multiflorum* #	hinahina, nohoanu		SME	LE
Hillebrandia sandwicensis	pua maka nui			
Joinvillea ascendens ascendens	ʻohe			LE
Melicope balloui *	alani		SME	LE
Microlepia strigosa* var. *mauiensis	palapalai			LE
Peperomia subpetiolata*	ʻalaʻala wai nui	Yes	SME	LE
Phyllostegia bracteata + #		Yes	SIE	LE
Phyllostegia pilosa		Yes	SME	LE
Plantago princeps* var. *laxifolia	ale	Yes		LE
Platanthera holochila #		Yes		LE
Ranunculus mauiensis	makou	Yes		LE

[8] PEPP targets have 50 or less individuals state-wide; ROI is Rare on Island - less than 50 for one island but more than 50 State-wide.

SCIENTIFIC NAME	COMMON NAME	PEPP target/ Rare On Island[8]	Single Island Endemic (SIE) or Single Mountain SME (SME)	FEDERAL STATUS
Rubus macraei	ʻākala, ʻākalakala			
Sanicula sandwicensis		ROI		LE
Santalum haleakalae* var. *haleakalae	ʻiliahi		SME	LE
Schiedea diffusa* subsp. *diffusa		Yes	SIE	LE
Wikstroemia villosa +	ʻakia	Yes	SIE	LE

+ Known only from Maui * Known only from East Maui **#** Also known from Hanawi NAR

Key to Federal Status:
LE = Taxa formally listed as endangered

SCIENTIFIC NAME	COMMON NAME	PEPP target/ Rare On Island[9]	Single Island Endemic (SIE) or Single Mountain SME (SME)	FEDERAL STATUS
Anoectochilus sandwicensis	honohono			
Asplenium fragile var. insulare		ROI		LE
Asplenium haleakalense				
Bidens campylotheca* ssp. *pentamera +	koʻokoʻolau, kokoʻolau		SIE	LE
Calamagrostis expansa #				LE
Clermontia tuberculata*	ʻōhā, hāhā, ʻōhā wai		SME	
Cyanea duvallorium	hāhā	Yes	SME	LE
Cyanea horrida* #	holokea	Yes	SME	LE
Cyanea kunthiana +	ʻōhā, hāhā, ʻōhā wai		SIE	LE
Cystopteris douglasii				
Diplazium molokaiense		Yes		LE
Dryopteris tetrapinnata	iʻo nui		SME	
Dubautia platyphylla	kupaoa		SME	
Dubautia reticulata	naenae		SME	

[9] PEPP targets have 50 or less individuals state-wide; ROI is Rare on Island - less than 50 for one island but more than 50 State-wide.

SCIENTIFIC NAME	COMMON NAME	PEPP target/ Rare On Island[9]	Single Island Endemic (SIE) or Single Mountain SME (SME)	FEDERAL STATUS
Fragaria chiloensis* subsp. *sandwicensis				
Geranium arboreum*	hinahina, nohoanu	Yes	SME	LE
Geranium multiflorum* #	hinahina, nohoanu		SME	LE
Hillebrandia sandwicensis	pua maka nui			
Lagenifera maviensis	hōwaiaulu			SOC
Liparis hawaiensis	awapuhia kanaloa			
Melicope balloui *	alani		SME	LE
Melicope haleakalae *	alani		SME	
Microlepia strigosa* var. *mauiensis	palapalai			LE
Peperomia subpetiolata*	ʻalaʻala wai nui	Yes	SME	LE
Phyllostegia ambigua				
***Phyllostegia bracteata + *** #		Yes	SIE	LE
Phyllostegia pilosa		Yes	SME	LE
Plantago princeps* var. *laxifolia	ale	Yes		LE
Platanthera holochila #		Yes		LE
Ranunculus hawaiiensis	makou	Yes		LE
Ranunculus mauiensis	makou	Yes		LE
Rubus macraei	ʻākala, ʻākalakala			
Sanicula sandwicensis		ROI		LE
Santalum haleakalae* var. *lanaiense*	ʻiliahi		SME	LE
Sicyos cucumerinus	ʻānunu, kūpala			
Sisyrinchium acre	mauʻu laʻili, mauʻu hoʻula ʻili			
Schiedea diffusa* subsp. *diffusa		Yes	SIE	LE
Wikstroemia villosa +	ʻakia	Yes	SIE	LE

+ Known only from Maui * Known only from East Maui **#** Also known from Hanawi NAR

Key to Federal Status:

LE = Taxa formally listed as endangered
SOC = Species of Concern

Additional rare native plants found only in on adjacent EMI lands[10]:

SCIENTIFIC NAME	COMMON NAME	Single Island Endemic (SIE) or Single Mountain SME (SME)	FEDERAL STATUS
Cyanea hamatiflora	hāhā	SIE	LE
Pritchardia arecina	loulu	SME	
Joinvillea ascendens	ʻohe		LE

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[10] Additional rare species are likely to be discovered once a formal survey of the area is completed.

Appendix 3. Native Birds of Waikamoi Preserve

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATUS	AUDUBON STATUS*
Hemignathus lucidus affinus*◊	Maui nukupuʻu	Listed endangered; last seen 1996	🔴
Loxops coccineus ochraceus*	Maui ʻākepa	Listed endangered; Last seen 1995[1]	🔴
Melamprosops phaeosoma†*	poʻouli	Listed endangered; Last seen 2004[2]	🔴
Palmeria dolei	ʻākohekohe, crested honeycreeper	Endangered	🔴
Pseudonestor xanthophrys	kiwikiu, Maui parrotbill	Endangered	🔴
Pterodroma phaeopygia sandwichensis	ʻuaʻu, Hawaiian petrel	Endangered	🔴
Branta sandvicensis	nēnē, Hawaiian goose	Endangered	🔴
Puffinus auricularis newelli[3]	ʻaʻo, Newell's shearwater	Threatened	🔴
Paroreomyza montana	ʻalauahio	--	🔴
Vestiaria coccinea	ʻiʻiwi	Threatened	🔴
Asio flammeus sandwichensis	pueo	--	🟠
Himatione sanguinea	ʻapapane	--	--
Hemignathus virens	ʻamakihi	--	--

◊ Known in adjacent areas; thought to occur in Waikamoi
† Unconfirmed sighting; known from adjacent Hanawī NAR
1 Natural Diversity Database and Forest Bird Survey data
2 Gorreson et al., 2009
3 Possibly in Waikamoi Preserve (see Wood and Bily 2008)
* Audubon and the American Bird Conservancy analyzed the most recent scientific and citizen data nationwide to determine the species that are most in need of immediate conservation help (Watchlist 2007)

🔴 Red–Species in this category are declining rapidly and/or have very small populations or limited ranges, and face major conservation threats. These typically are species of global conservation concern.

🟠 Orange–this category includes species that are either declining or rare. These typically are species of national conservation concern.

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Appendix 4. Summary of Supported Research In Waikamoi Preserve FY13-17

Research Topic	Research Team	Year
Phylogenetic analysis of *Clermontia tuberculata*	David Pender, UH Manoa	FY2013
Morphological analysis of *Philodoria* a leaf mining moth	Chris Johns, U of Florida	FY2013-FY2015
Hawaiian lobelioid and insect associations	Innana Carter, Harvard University	FY2013-FY2014
Dispersal of juvenile`akohekohe	Alex Wang, UH Hilo	FY2013-FY2014
Evolutionary relationships of lichens	Dr. Robert Lucking, The Field Museum, Chicago, IL	FY2013
Niche specialization of native drosophilids	Didem Sarikaya, Harvard University	FY2013-FY2014
Morphological, behavior and developmental plasticity in Hawaiian spiders *Tetragnatha*, *Theridion*, and *Argyrodes*	Rosemary Gillespie, UC Berkley	FY2013-current
PEPP support	Hank Oppenheimer, Plant Extinction Prevention	FY2013 - current
Maui parrotbill (*Psuedonestor xanthophyrs*) distribution and density study	Maui Forest Bird Recovery Project	FY2013 - current
Host plant and site preference of picture wing flies	Dr. Steven Montgomery	FY2013
Arthropod abundance and food resources study for Kiwikiu	Robert Peck, USGS and UH Cooperative Studies Unit	FY2013
ʻōhiʻa population structure	Dr. Kasey Barton and Tiffany Knight, UH Mānoa and Washington University	FY2014-FY2017
Koa samples for herbivory test for Scotorythra paludicola	Dr. Kasey Barton, UH Mānoa	FY2014
Niche use in *Tetragnatha* spiders	Susan Kennedy, UC Berkeley	FY2014-FY2015
Mitochondrial differences between Hawaii Island and Maui *Tetragnatha*	Darko Cotaras, UC Berkeley	FY2014
Seabird census and mapping	SWCA Environmental Consultants	FY2014
Tests for mycorrhizal specificity in *Anoectochilus sandwicensis*	Dr. Nicole Hynson, UH Mānoa	FY2014-FY2015
Color variations in endemic *Megalagrion*	Idelle Cooper, Michigan State University	FY2014-FY2016
Hawaiian land snail surveys	Dr. Norine Yeung, Bishop Museum	FY2014
DNA studies from native Noctuid moths	Andersonn Prestes, UH Mānoa	FY2014
Population genetic comparisons of Nesosydne planthoppers	Kari Goodman, UC Berkeley	FY2015

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Arthropod and branch collections for the Dimensions of Biodiversity project	Andy Rominger, UC Berkeley	FY2014-FY2017
Survey of picture wind flies	Durrel Kapan and Steve Montgomery, UH Mānoa	FY2015
Study on endemic moss	Dr. Jairo Patino, Liege University, Belgium	FY2015
Leaf sample collections to examin fungal foliar endophytes	Anthony Amend, UH Mānoa	FY2015
Deployed automated acoustic monitoring devices for seabird detection	Maui Nui Seabird Project	FY2015-FY2016
Blood samples from āmakihi for avian malaria	Eben Paxton, USGS	FY2016
Evolution of *Tetragnatha*	Angela Alicea Serrano, University of Akron	FY2016
Genetic studies of *Peperomia*	Jun Ying Lim, UC Berkeley	FY2016
Clarification of taxonomic relationships among *Psychotria* sp.	Josh Serrano, UH Mānoa	FY2016
USFWS Hawaiian Forest Bird Surveys		FY2017
Chemical ecology and behavior of Tetragnatha and impacts of Himalayan ginger on native arthropods	Ashley Adams, UC Berkeley	FY2017

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Appendix 5. Summary of Organization and Event Participation in Public Outreach

- March for Science
- UH Maui College Career Day
- Trilogy Excursions Blue ʻĀina
- Kihei Charter School
- Maui County Arborist Committee
- Honolulu Waldorf School
- Kamehameha Schools
- Hāna High School
- East Maui Taro Festival
- Hula Hālau from Hāna
- Maui Association of Professional Landscapers
- Haleakalā National Park Interpretive staff for Rock the ParkMaui Nui Botanical Garden
- Maui Nui Marine Resources Council
- Haleakalā National Park
- Haleakalā Waldorf School
- Montessori School
- UH Maui College Weed Science class
- Maui Invasive Species Committee
- Hawaii Agricultural Leadership Program
- Ka Ipu Kukui Fellowship
- Hawaiʻi Water Works Association Conference
- Maui Mauka Conservation Awareness Training
- Skyline Eco Adventure

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