Kamakou Preserve

Molokaʻi, Hawaiʻi

Long-Range Management Plan

Fiscal Years 2019–2024

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

The Nature Conservancy
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Submitted by
The Nature Conservancy of Hawaiʻi
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TABLE OF CONTENTS

EXECUTIVE SUMMARY **1**

RESOURCE SUMMARY **4**

GENERAL SETTING 4
FLORA AND FAUNA 4

MANAGEMENT **4**

MANAGEMENT CONSIDERATIONS 4
MANAGEMENT PROGRAMS 5
Program 1: Invasive Species Abatement *6*
A. Ungulate Abatement 6
B. Invasive Plant Abatement 11
C. Other Invasive Species 14
Program 2: Resource Monitoring, Rare Species Protection, and Research *15*
A. Resource Monitoring 15
B. Rare Species Protection 17
C. Research 17
D. Innovation 18
Program 3: Infrastructure, Emergency, and Safety *20*
Program 4: Community Outreach/Partnerships *21*
BUDGET TABLE 26

APPENDICES **A1**

Appendix 1. Native Natural Communities of Kamakou Preserve A1
Appendix 2. Rare Native Plants of Kamakou Preserve A2
Appendix 3. Rare Native Birds of Kamakou Preserve A4
Appendix 4. Rare Land Snails of Kamakou Preserve A5
Appendix 5. Kamakou Top Weed Priority List A6
Appendix 6. East Molokaʻi Watershed Partnership Fact Sheet A8
Appendix 7. Research conducted at The Nature Conservancy's Molokaʻi Preserves, July 1994-June 2017 ..... A10

List of Figures and Tables

Figure 1. East Molokaʻi Watershed Partnership 1
Figure 2. Kamakou Preserve general map 2
Figure 3. Kamakou Preserve natural communities 3
Figure 4. Kamakou Preserve management areas and fences 9
Figure 5. Ungulate activity in Kamakou, 2011 to present (unfenced transects) 10
Figure 6- Forest condition across Molokai's South Slope 16
Figure 7. Kamakou NAPP Budget/Effort by Program, FY19-FY24 24

Table 1. Overview of Kamakou Preserve Accomplishments by Programs, FY 2013–FY 2017 (5 Years) 2
Table 2. Control Estimates (individuals or acres) for eight weed targets in Kamakou Preserve, FY13-FY17 13
Table 3. Kamakou Preserve hikes 2013-2017 21

Cover photo by Rikki Cooke, 2017.

EXECUTIVE SUMMARY

The Nature Conservancy of Hawaiʻi (TNCH) 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's Hawaiʻi Program has applied its science-driven, collaborative approach to help protect more than 200,000 acres of critical natural lands. Currently we manage 14 preserves statewide and a preserve at Palmyra Atoll. Today, we are taking conservation to a new level in Hawaiʻi by protecting the larger landscapes and biological systems of which our preserves are a part. Together with other public and private landowners, we are protecting over 1.6 million acres of ecologically important lands through voluntary, cooperative partnerships that allow landowners to share expertise and resources and work across ownership boundaries. TNCH's diverse staff work on five islands and include experts in marine and conservation science, finance, communications, policy and philanthropy. Our Molokaʻi office includes five forest conservation staff who work to protect Molokaʻi's native forests through direct management of the South Slope, the eastern South Slope, and Moʻomomi Preserve, in addition to participating in the East Molokai Watershed Partnership (EMoWP) and the Molokaʻi/Maui Invasive Species Committee.

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. For over 13 years, Kamehameha Schools (KS) has provided funds to the EMoWP that have been used as match to the previous Kamakou NAPP LMRPs. Currently KS funds provide about 40% of the required match.

On Molokaʻi, the Conservancy manages three NAPP Preserves: Kamakou, Moʻomomi, and Pelekunu, and is the coordinator/manager of the East Molokaʻi Watershed Partnership (EMoWP) which is directly responsible for management programs in Kawela, Kamalō and Kapualei. In 2013, the EMoWP expanded eastward to the area collectively called the "East" Slope (see Figure 1) in order to continue to protect the best remaining mauka watersheds. The East Slope's priority management unit extends from the east boundary of Kapualei through Kaluaʻaha, called the Pākuʻi Fenced Unit. The three NAPP preserves total just less than 10,000 acres and the EMoWP (including Kamakou and Pelekunu Preserves) encompasses over 44,000 acres. Kamakou was approved for NAPP funding in 1995. This long-range management plan updates the previous long range plan (FY 2013–2018). This plan was prepared in compliance with the Natural Area Partnership agreement between the State and The Nature Conservancy of Hawaiʻi. The FY 2019–2024 plan documents management programs to be undertaken during the next six years at Kamakou Preserve and the adjacent conservation lands and projects.

The state Department of Land and Natural Resources (DLNR), which administers the NAP program, is kept apprised of our progress in the preserve through written reports and an

annual inspection. Operational plans are submitted annually (the Conservancy has adopted a July 1–June 30 fiscal year). In addition, a six-month semiannual report is sent to DLNR each February.

The first section of this plan is a brief overview of the native, natural resources that are protected at Kamakou Preserve. In the second section are management considerations that have shaped our programs. Finally, each management program is discussed in turn. Program goals are followed by an explanation of the management method we have chosen. Annual objectives and costs for each program from FY2019–FY2024 are also listed.
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 Kamakou Preserve Accomplishments by Programs, FY 2013–FY 2017 (5 Years)

	Indicator	Measure of Success
Ungulate Abatement	Total animal sweeps	273
	Total animal catches	143 animals
	Miles of fence inspected, maintained and/or replaced in Kamakou	4.5 miles consistently inspected and maintained
	Number of Ungulate Surveys	10
	Acres Ungulate Free	734
Invasive Plant Control	Acres and number of priority invasive plants treated or removed	2,182 acres swept and 60,625+ invasive plants removed in Kamakou; Supporting 2,900 additional acres swept and 20,000+ more invasive plants removed in other parts of Molokai's south slope
Resource Monitoring, Rare Species Protection and Research	Moloka'i Understory Monitoring surveys	3, all Kamakou wet forest plots in **Very Good** condition (≥90% intact understory)
	Number of endangered plant species in preserve	32
	Number of critically rare plant species in preserve (<50 plants in the world)	23
	Number of critically rare plants outplanted by Molokai Plant Extinction Program	*Clermontia oblongifolia* subsp. *brevipes* (25); *Cyanea procera* (743); *Cyanea profuga* (72); *Cyanea solanacea* (121); *Labordia triflora* (202); *Lysimachia maxima* (41); *Schiedea diffusa* (48); *Schiedea laui* (119); *Phyllostegia hispida* (1202); *Phyllostegia stachyoides* (87)
	Number of research projects supported in Kamakou	32
Community Outreach	Number of hikes/persons	73/518
	Number of volunteers	520

	Total volunteer person hours	2890

RESOURCE SUMMARY

General Setting

Kamakou Preserve was established in September of 1982 to protect the habitat of endemic forest birds. The 2,774-acre preserve is located in the east Molokaʻi mountains and is adjacent to the Olokui and Puʻu Aliʻi Natural Area Reserves (NAR), Kalaupapa National Historical Park, Kamalō, Kapualei and Kawela Plantation lands, and the Conservancy's Pelekunu Preserve (Figures 1 and 2). These managed areas belong to the East Molokaʻi Watershed Partnership (EMoWP) and collectively protect more than 44,000 acres of contiguous ecosystems that range from sea level to 4,970 feet in elevation (Figure 1). The elevation in the preserve ranges from 2,034 to 4,527 feet and the average precipitation ranges from 39 to 118 inches. Kamakou is one of the primary groundwater recharge and surface water source areas feeding the State Department of Agriculture's Molokaʻi Irrigation System. The preserve is open to the public for hiking and hunting, and for educational and cultural activities. During times of extreme fire hazard, unsafe road conditions, or other management activities in accessible areas, portions or all of the preserve may be closed to the public.

Flora and Fauna

Kamakou Preserve contains five vegetation zones, which contain ten natural community types, ranging from lowland mesic shrublands to montane wet forests (Figure 3). There are two rare natural communities: the ʻōhiʻa mixed montane bog community and the montane wet piping cave (known only from Molokaʻi; Appendix 1). The preserve's more common natural communities are also found in Olokuʻi and Puʻu Aliʻi NARs, and in the Kamalō/Kapualei watershed project (Appendix 1).

Kamakou is home to 45 rare plant taxa, 32 of which are listed endangered. Fourteen of Kamakou's 44 rare plants have also been reported from Olokuʻi and/or Puʻu Aliʻi NARs, and seven of the preserve's rare plant taxa have been reported in Kalaupapa National Historical Park (Appendix 2). The Plant Extinction Prevention Program (PEPP) works closely with the Conservancy in Kamakou Preserve to protect the critical rare plant species found there (<50 individual plants in the wild, in the world). In 2009, they hired a permanent on-island staff dedicated to protection of these species.

The American Bird Conservancy reports that native Hawaiian forest is the most endangered bird habitat in the United States (American Bird Conservancy, Spring 2015). Of the five native forest birds historically known from Kamakou since 1960, only ʻapapane (*Himatione sanguinea sanguinea*) and ʻamakihi (*Hemignathus virens wilsoni*) are seen frequently. In 2010, a single solitary ʻiʻiwi (*Vestiaria coccinea*) was seen in Kapualei; other occurrences of ʻiʻiwi were recorded during the 2004 Molokaʻi Forest Bird Project survey in the preserve and in Kapualei. The kākāwahie (Molokaʻi creeper, *Paroreomyza flammea*) has not been seen on Molokaʻi since 1963, and the olomaʻo (Molokaʻi thrush, *Myadestes lanaiensis rutha*) has not been seen on Molokaʻi since 1988 (one was sighted in Kamalō, just east of the preserve) (Appendix 3).

It is anticipated that there is significant invertebrate diversity in Kamakou Preserve. Although more remains to be learned about the molluscan fauna, five species of rare native land snails have been reported in Kamakou Preserve (Appendix 4).

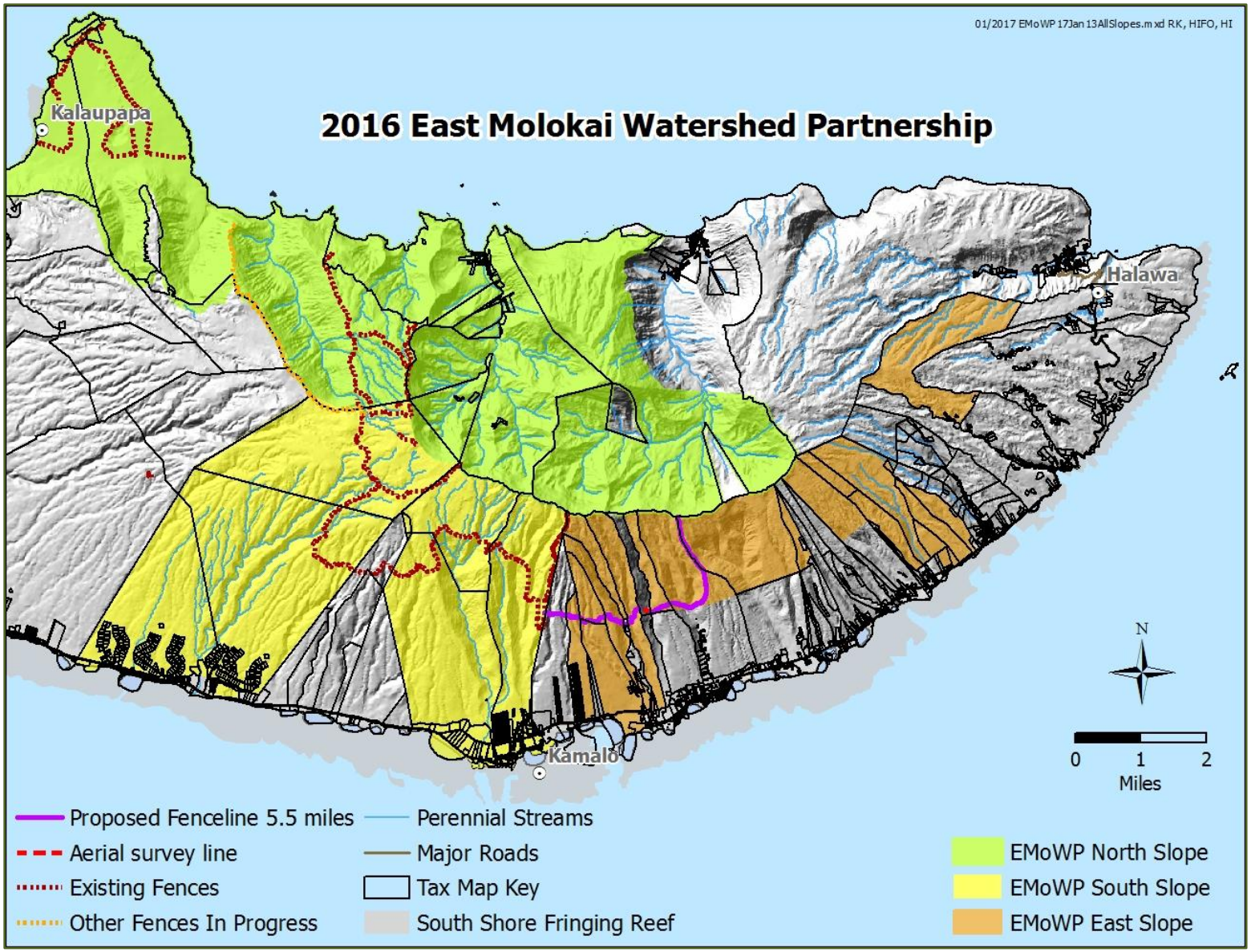


Figure 1. East Moloka‘i Watershed Partnership

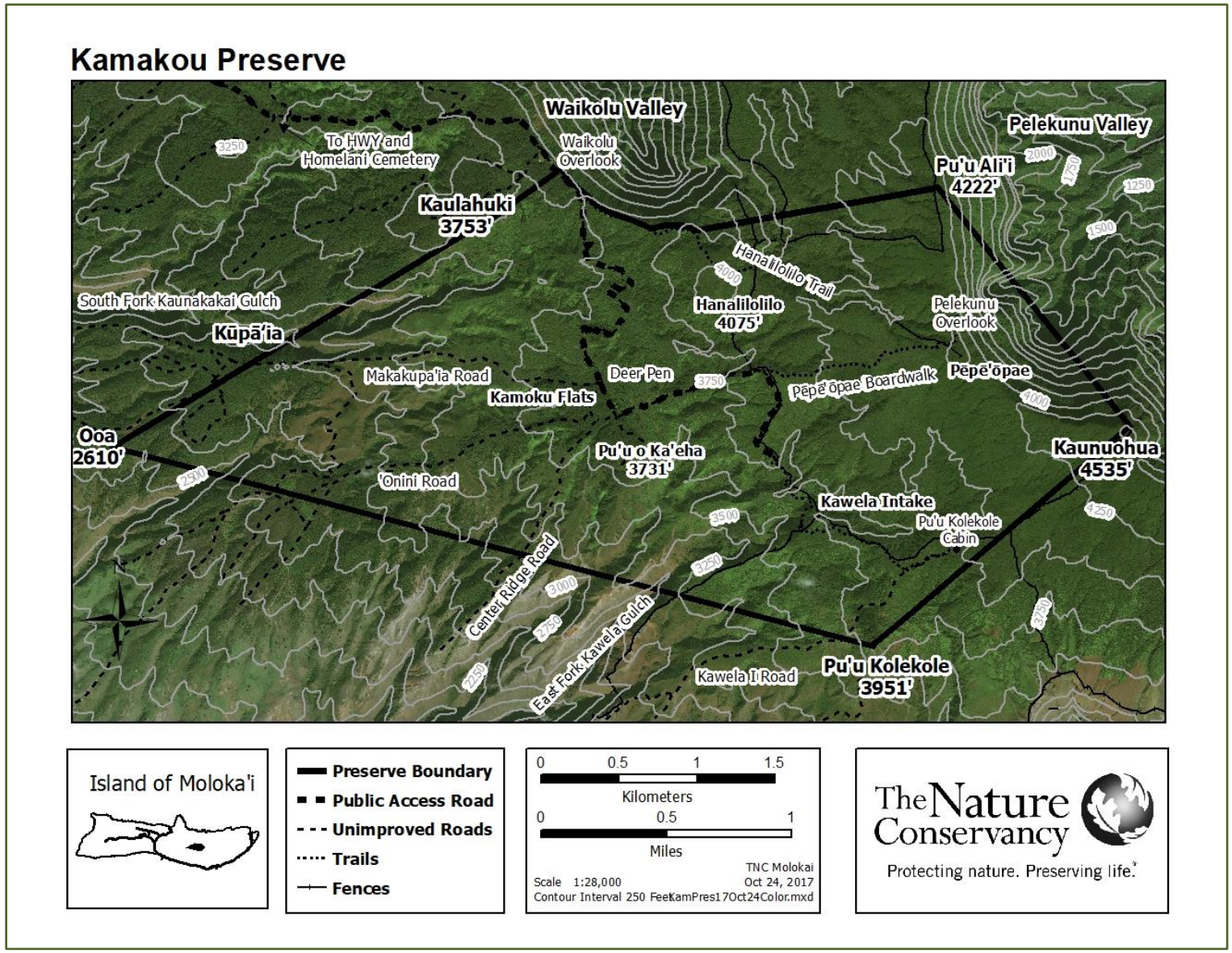
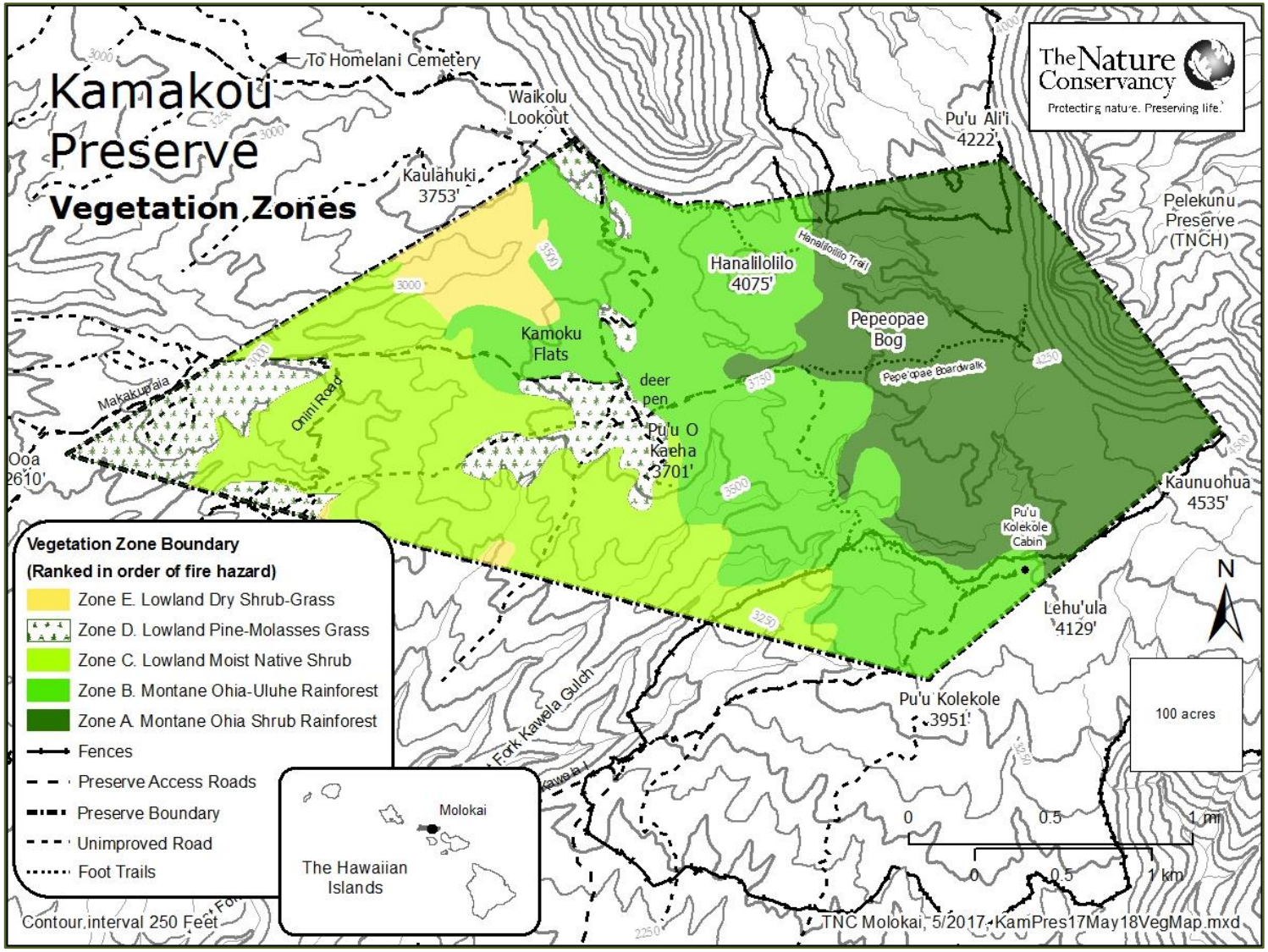


Figure 2. Kamakou Preserve general map

Figure 3. Kamakou Preserve natural communities



MANAGEMENT

Management Considerations

1. Our primary management activities for protecting the preserve's native plants, animals, and natural communities are to reduce feral ungulate damage, limit the spread of non-native, habitat-modifying plants, and prevent wildfire. We are committed to conducting community outreach and providing public access for compatible uses. The Conservancy provides access to the extent required by law for the purpose of allowing traditional practices in the area. Conservancy staff will develop monitoring and management strategies if impacts become apparent due to preserve visitation. Of particular concern is the newly identified pathogen, *Ceratocystis fimbriata*, also known as Rapid ʻŌhiʻa Death (ROD). While no occurrences of ROD have been reported on Molokaʻi, this disease has the potential to kill ʻōhiʻa trees statewide. Conservancy staff are asking members of the public not to use any gear used on Hawaii island in the forest and have posted signs discussing the threat to prevent the introduction of ROD to the preserve.

2. Prior to 1982, the Kamakou Preserve area was part of the State's Molokaʻi Forest Reserve under a surrender agreement with the landowner, Molokaʻi Ranch, Ltd, now called Molokaʻi Properties, Limited (MPL). In 1982, the Conservancy purchased a permanent conservation easement over the property from MPL. This easement supersedes the State's surrender agreement and ensures the Conservancy's rights to manage the preserve for the benefit of native species and ecosystems, and prohibits a wide range of potentially unsuitable activities by the landowner. The document also reserves certain rights for the landowner, including the right to enter and inspect, and to harvest surface water from the established water development systems, which may be expanded within clear limits described in the easement. The Conservancy began an easement compliance monitoring program in FY2005. Conservation easement monitoring is required annually to ensure the Conservancy and MPL are in compliance with the terms outlined in the conservation easement.

3. The State Division of Forestry and Wildlife (DOFAW) provides wildfire suppression, road maintenance, use of Puʻu Kolekole cabin, and assistance with other projects in the preserve. The preserve's main access road (Maunahui Road, also known as the "Forestry Road") is part of the Na Ala Hele trail and access system. The Conservancy continues to allow public access to the preserve and honors the preserve as part of the Molokaʻi Forest Reserve system.

4. In 1999, the East Molokaʻi Watershed Partnership was established through an MOU (See Appendix 5, EMoWP Fact Sheet). The first project of the EMoWP was the construction of a 5.5 mile contour fence in the Kamalō/Kapualei ahupuaʻa. This fence provides a barrier to the large goat herds that have denuded the slopes below the 3,000 foot contour. In April 2003, Kawela Plantation Homeowners Association (KPHA) signed the EMoWP MOU. Additionally, KPHA signed a Memorandum of Agreement with the Conservancy to manage their upper "common lands," which include the 5,000+ acre

area that abuts the Kamakou preserve to the south. The Conservancy has since constructed over two miles of fence, has maintained their mountain access roads and firebreaks, which has increased protection to the Kamakou Preserve from threats that include fire, weeds, and ungulates. Several more landowners have signed on to the partnership since then.

5. Designated areas of the preserve are open for public hunting (see Status of Public Hunting Opportunities on page 9), hiking, and for educational and cultural activities. During times of extreme fire hazard, unsafe road conditions, or other management activities, portions or all of the preserve may be closed to the public. Notification of closure will be made via a sign posted on the forest access road near the Manawainui Bridge and/or by announcements in local newspapers.

6. In 2010, in response to challenging economic conditions, TNCH made a commitment to outsource some of its field work in an effort to build capacity of partners, streamline operations, and focus resources toward conservation innovation and technology. Implementation of animal and weed control for Kamakou Preserve has been contracted out in the past and the budget reflected in this Long Range Management Plan will allow us to continue to do so, along with other EMoWP areas. Additionally awards from Maui County Department of Water Supply (DWS) and the State's Watershed Partnership Planning Grant (WPPG) help augment management in Kamakou Preserve as well as the south and east slopes of the East Molokai Watershed Partnership.

7. USFWS and State CIP funds have helped in the past with fence projects, including: Kamakou fence extension, Kapualei East Boundary extension, and most recently the Kamalo Subunit fence, that divides the Kawela to Kapualei fenced unit into two almost equal subunits (See Figure 4). This long range plan will also look into future fencing for Kamakou Preserve.

8. The Kamakou Fenced unit (See Figure 4) completed in June 2014 is managed for zero tolerance of all invasive hooved animals (ungulates). Zero tolerance was achieved by March 2015, but since then there have been at least two known breaches. It will be a priority to keep this fenced unit ungulate free.

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. 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 FY2019–FY2024.

Program 1: Invasive Species Abatement

A. Ungulate Abatement

Program Goal: To remove all ungulates from fenced areas, respond immediately to fence breaches and keep ungulate activity at 15% fresh sign in unfenced areas (below the fence) in Kamakou Preserve.

Program Description: Feral ungulates have a number of damaging effects to a healthy watershed, degrading habitat for native species through their browsing and trampling, increasing erosion as well as spreading weeds, parasites and disease. Over the past three decades, we have made substantial progress towards reducing ungulate activity and damage through the use of community hunting, snaring, live pig trapping, and fencing. Listed here is a summary of past major strategies and accomplishments in our ungulate control program:

- 1983–1994 (pre-NAPP): Ungulate control was conducted using public and volunteer hunting with dogs and snaring. Ungulate activity survey transects were installed and initial data showed activity levels of greater than 30% prior to snaring. Snaring implemented between 1991–1993 reduced activity levels below 5% in the remote areas where it was applied. The Puʻu Aliʻi south boundary fence was completed in 1992 (Figure 4).

- NAPP Long-Range Management Plan (LRMP) FY1995–2000: The Molokaʻi Hunting Working Group (MHWG) was established to bring activity levels below 10% using volunteer hunting alone. Volunteer hunting was able to maintain activity around 20% in remote areas of Kamakou. The Kamakou east boundary fence was completed in 1995 (Figure 4). The East Molokaʻi Watershed Partnership was established in November 1999. USGS and its partners initiate a study to map Molokai's south shore fringing reef and the sediment loading that occurs there.

- NAPP LRMP FY2001–2006: Live trapping for pigs began in Kamakou in 2001; trapping began showing signs of success in 2002, and was attributed to bringing activity levels below 10% during this period. Live trapping was compatible with public hunting, as hunters help harvest the pigs around the trap or the trapped pigs themselves. Aerial goat surveys that began in 2001 indicate a heavy population of goats in Kamalō and Kapualei's inaccessible steep gulches. The Kamalō/Kapualei contour fence was completed in March 2001 (Figure 4), to prevent goats from moving higher into and further denuding native forest. In May 2003, aerial shooting in Kapualei's steep gulches is implemented to reduce the growing goat problem there, but state takes hiatus to review program.

- NAPP LRMP FY2007–2012: Live trapping was implemented from 2007-2009 with successful results. In FY 2009, traps were suspended due to low capture rates. In 2009, the Prohunt project revolutionized pig hunting techniques with the one dog/one hunter technique, GPS dog collars, systematic sweeps, and specially bred

and trained dogs. TNC trained the next generation of dogs and began implementing the one dog/one hunter sweep methodology. The Kawela section of the fence was completed in 2006 (Figure 4), and the Mākolelau fence section was completed in 2008. USGS published its findings from the study that began in 1999, reporting the cause of excessive erosion along Molokaʻi's south slope is due to overbrowsing by feral ungulates. Aerial shooting resumed in 2009 across the steep gulches of Kawela, Kamalō and Kapualei and in the upper fenced areas. Aerial goat surveys are done annually to detect any changes in the goat populations. The numbers from the 2010 survey indicate a significant drop in goat numbers. In November of 2010, Pono Pacific was awarded a contract to conduct animal sweeps and fence surveys for the south slope areas, including Kamakou Preserve. Fence extensions are proposed to protect wet forest from Kamakou to Kapualei (Figure 4). Zero tolerance of ungulates in these proposed fence units will be the goal over the next long range plan.

- NAPP LRMP FY2013-2018: Contracted fence extensions were completed in December 2012 in Kapualei and in June 2014 in Kamakou Preserve, completely enclosing wet forest areas from Kamakou through Kapualei. Intensive hunt sweeps with dogs were implemented in these fenced units, and in the Kamakou Fenced unit the last pig was caught in October 2015. To allow faster achievement of ungulate free status in the 2,500 acre Kawela to Kapualei fenced unit (which includes a portion of Kamakou Preserve), an innovative fence that used plastic fence mesh was constructed to divide the fenced unit into two subunits (Kawela/Kamalō subunit – 1,220 acres and Kamalō/Kapualei subunit - 1,320 acres). Aerial shooting continued in high priority fenced units and in steep gulches, augmented by Forward Looking InfraRed (FLiR) technology. USGS reported that erosion rates have reduced ten-fold as vegetation has increased from less than 1% cover to over 70% vegetation cover at their Kawela test site (See USGS 2013 Summary). USGS largely attributes the vegetation increase and subsequent decrease in erosion to the dramatic decrease of goats achieved through aerial shooting.

In order to monitor the effectiveness of our ungulate control strategies and assess the threat level of ungulates to Kamakou Preserve, we installed a series of 8 transects in 1984 to measure ungulate activity[1]. Since then these expanded to a total of 13 transects in Kamakou Preserve. We have monitored annually for signs of ungulate activity in contiguous 5m X 10m plots along 500m transects in fenced and unfenced areas, allowing us to gauge the effectiveness of our control strategies and techniques there. Trends indicate that overall pig activity observed declined from about 46% percent in 1990 to less than 6% in 2011 (Figure 5). Starting in 2016, ungulate transect monitoring was no longer used in fenced units that are at or near zero presence. In those locations, animal absence is best confirmed with hunt sweeps with dogs balanced at a frequency that limits the impacts of traffic on recovering vegetation. Ungulate activity has been virtually zero in the Kamakou

[1] "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%.

Fenced unit. However, in Kamakou's unfenced area, activity has increased to greater than 15% fresh ungulate sign (see Figure 5). This is due to the focus on the fenced unit.

During the next six-year period (FY 2019–2024), hunt sweeps will continue to be implemented in all fenced units in response to hotspot detections or to provide detection monitoring in ungulate free areas. Trapping will be increased in the Kamalō to Kapualei fenced subunit to reach zero tolerance. Aerial shooting will continue annually in both fenced units and unfenced areas as funds are available. Hunting and live trapping will be conducted in unfenced areas if feasible and funding is available. Currently, the Conservancy has been meeting with DoFAW to forecast and plan for all future fences on Molokai. We will conduct strategic meetings to evaluate our efforts should they not provide the results toward our ungulate control goals.

Ungulate Abatement Goals

Years 1–6 (FY2019–2024):

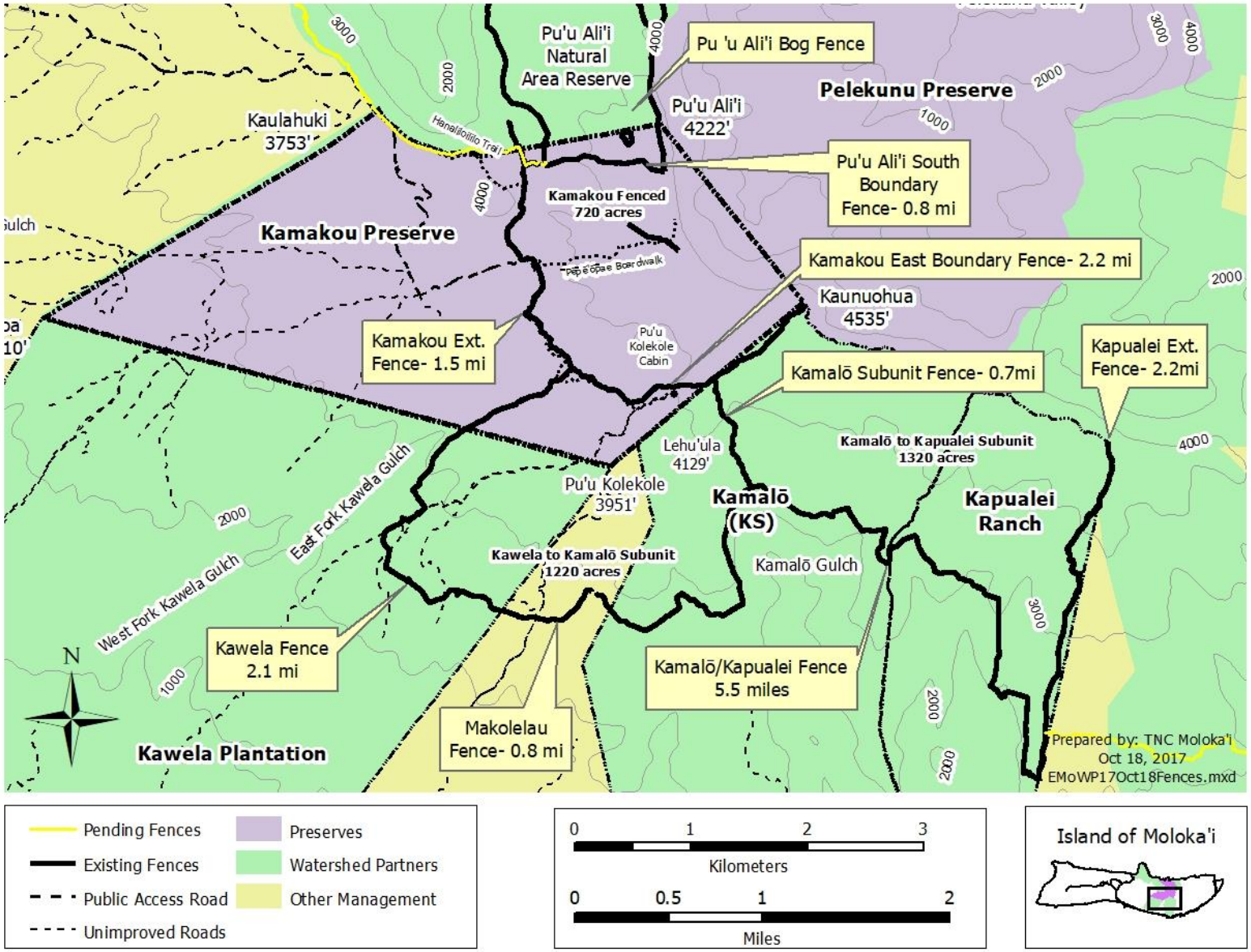
- **Maintain/monitor Kamakou fenced unit zero tolerance through hunt sweeps.**
- **Conduct hunt sweeps in the Kawela to Kamalō subunit fence unit as needed.**
- **Conduct annual survey and repair of the 4.5 miles of Kamakou Preserve.**
- **Complete biannual Kamakou Preserve ungulate survey on the 7 unfenced transects.**
- **Conduct hunt sweeps below the fenced unit to maintain 15% fresh ungulate activity below the fence.**
- **Develop fence plans for lower Kamakou preserve.**

Status of Public Hunting Opportunities

The preserve is open for public hunting where and when this is compatible with management programs. At this time, the preserve is open year-round to hunting of pigs, goats, and axis deer, without a bag limit. During times of extreme fire hazard, unsafe road conditions, or other management activities in areas accessible to the public, portions or all of the preserve may be closed.

This program represents an estimated 25% of the overall effort and budget in this long range management plan.

Figure 4. Kamakou Preserve management areas and fences



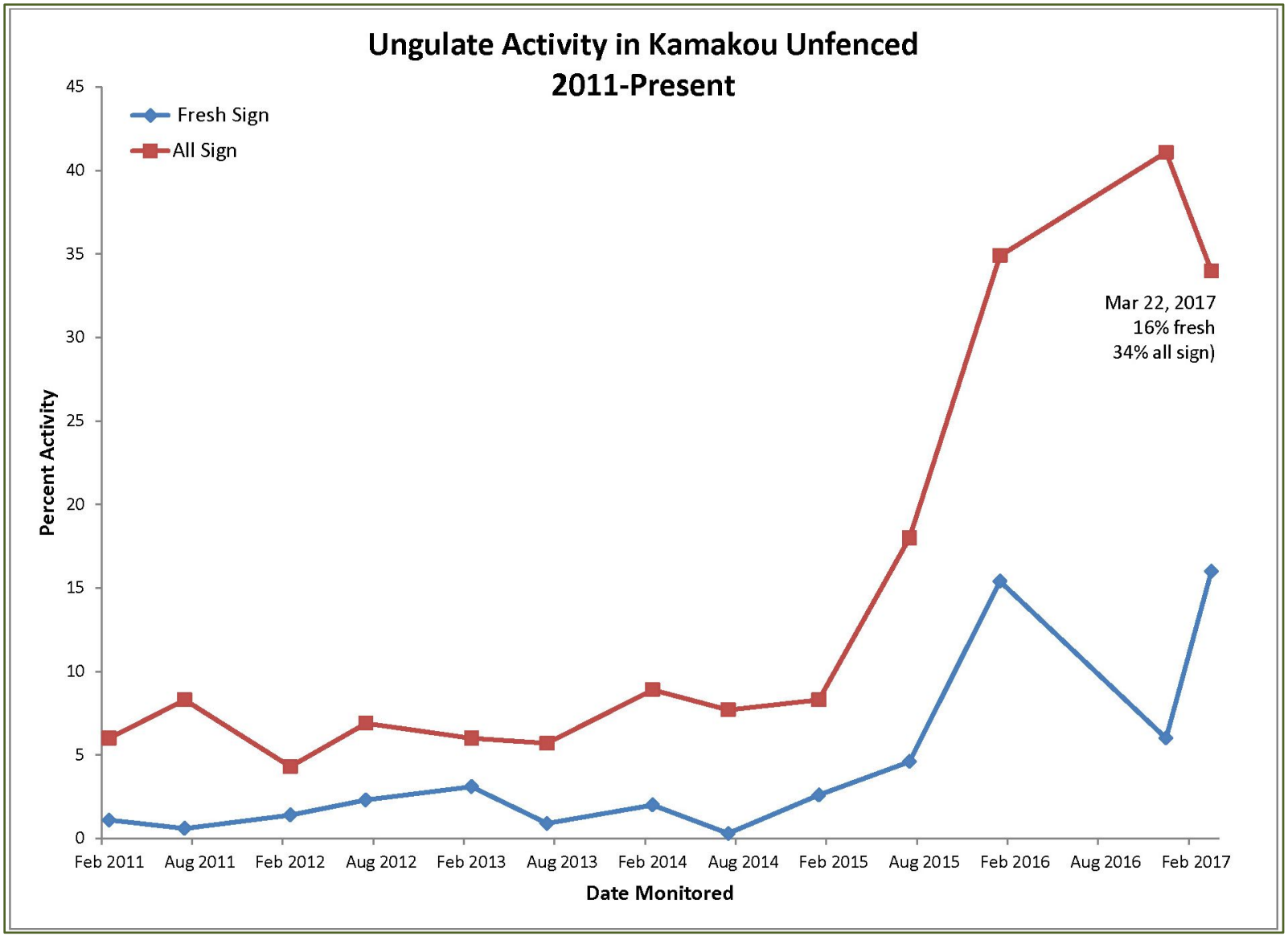


Figure 5. Ungulate activity in Kamakou, 2011 to present (unfenced transects)

B. Invasive Plant Abatement

Program Goal: Improve or maintain the integrity of native ecosystems in selected areas of the preserve by reducing the effects of invasive plants.

Program Description: Invasive plants alter natural habitat conditions and displace native vegetation. Displacement is accelerated by ungulate disturbance. Ungulates, especially pigs, impact the ground by their foraging activities (rooting and digging), and carry and spread unwanted weed seeds. Fire also accelerates invasion by certain weed species. Control of ungulates and wildfire, therefore, are among the most effective means of controlling the introduction and spread of invasive plants in the preserve.

The wet forest is the most intact conservation target in the preserve and eliminating priority invasive plant species from this area is our highest priority. Eliminating or suppressing priority weed species (see Appendix 5) in the adjacent mesic forest and shrubland is also a priority since these ecosystems act as a buffer by keeping weed populations from spreading into the wet forest. For the past six years, weed control efforts have focused on removing eight priority weed species from the wet forest and adjacent mesic forest and shrubland: blackberry (*Rubus argutus*), strawberry guava (*Psidium cattleianum*), New Zealand flax (*Phormium tenax*), karakanut (*Corynocarpus laevigata),* paperbark (*Melaleuca quinquenervia*), *Tibouchina herbacea* (glorybush), *Clidemia hirta* (Koster's curse), and three pine species (*Pinus elliotti*, *Pinus taeda*, *Pinus radiata)*.

Weed control in Kamakou Preserve has developed into an effective program through the use of handheld GPS units, GIS mapping technology, and a compatible database system. Over the past several years, the Conservancy has had success with four of our priority weed species (Table 2). Karakanut (*Corynocarpus laevigata*), paperbark (*Melaleuca quinquenervia*), toog (*Bischofia javanica*) and New Zealand flax (*Phormium tenax*) have been brought down to a level of seed bank detection where staff are finding only a few immature occurrences on an annual basis.

Since 2008, staff has been implementing systematic weed sweeps wherein staff equipped with individual GPS units are spaced 10m apart in a specified area and move in unison while diligently looking for the target weed(s). Track lines and removal data are documented with GIS, which has vastly improved the accountability of the weed removal efforts. Contractors are also required to use this system. See Table 3 priority weed species.

We strive towards an Integrated Pest Management (IPM) approach to weed control — consisting of manual/mechanical methods, herbicides, 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. Contractors and staff are required to have dedicated Molokai gear to prevent off-island introductions. Herbicide use is in full compliance with the State of Hawaiʻi 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.

For weed prevention, staff collaborate with the Molokaʻi/Maui Invasive Species Committee (MoMISC) to prevent, detect, and eliminate incipient invasive weed species that may threaten the preserve. Data regarding new invasive plant and animal introductions will be provided by MoMISC and the information kept in a database that the Conservancy and MoMISC work cooperatively to maintain. We follow 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.

For additional details on the weed management and control in East Molokaʻi, refer to the *East Molokaʻi Watershed Partnership 2015 South Slope Weed Management Plan.*

During the next six-year period (FY 2019–2024), systematic weed sweeps will continue for priority habitat-modifying weeds (Table 2). TNC will continue to collaborate with MoMISC to prevent, detect, and eliminate new incipient invasive weeds.

Invasive Plant Abatement

Years 1–6 (FY2019–FY2024):

- Complete at least 100 weed sweeps on priority weed species in Kamakou preserve.
- Annually control non-native grasses, such as meadow rice grass (*Ehrharta stipoides*) and vasey grass (*Paspalum urvilleii),* that grow along the Pēpēʻōpae boardwalk to prevent the spread of weeds into the adjoining native areas.
- Assist MoMISC with control work and early detection surveys for incipient invasive weed species adjacent to Kamakou Preserve, such as Australian tree fern (*Cyathea cooperi*), mule's foot fern *(Angiopteris evecta),* gorse (*Ulex europaeus*), New Zealand flax (*Phormium tenax*), rubber vine (*Cryptostegia grandiflora*), *Miconia calvescens*, Barbados gooseberry (*Pereskia aculeata*), Himalayan ginger (*Hedychium gardnerianum*), giant reed (*Arundo donax*), Rose *(Rosa sp.)* and fountain grass (*Pennisetum setaceum*) as requested.
- Work with MoMISC advisory council and partners to maintain a response protocol for dealing with incipient populations of alien pests on Molokaʻi, including Conservancy preserves.
- Maintain MoMISC database to track number of priority incipient, invasive species kept off the island and track the eradication of incipient species from the island.

This program represents an estimated 35% of the overall effort and budget in this long range management plan.

Table 2. Control Estimates (individuals or acres) for eight weed targets in Kamakou Preserve, FY13-FY17

Species	Square meters or number of individuals treated/removed (FY13–FY17)
Tibouchina herbacea	18,504 individuals removed
Clidemia hirta	25,396 individuals removed
***Pinus* spp.**	405 individuals removed
Paperbark (*Melaleuca quinquenervia)*	2 individuals removed
Strawberry guava (*Psidium cattleianum)*	16,225 individuals removed
Flax (*Phormium tenax)*	95 individuals removed
Blackberry (*Rubus argutus*)	1/2 acre removed
Karaka nut (*Corynocarpus laevigata)*	1 individual removed

C. Other Invasive Species

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

Program Description: Non-native insects and small mammal damage occurs in Molokaʻi's native ecosystems. Rats, mice, and other rodents pose a threat to rare native tree snails (*Partulina/Perdicella* spp.). Insects such as the aggressive, ground-dwelling carnivorous wasp *Vespula* may prey upon native insects and sting people. Other potential incipient pests, like the coqui frog, may also have unknown effects on native food webs. Perhaps the single greatest threat to Molokai's forest is the Rapid ʻŌhiʻa Death fungus (*Ceratocystis fimbriata*), currently only known from Hawaiʻi island. ROD is still being studied and a lot is being learned, and the latest ROD protocols will be incorporated into our operations.

Other Invasive Species Abatement Goals

Years 1–6 (FY2019–FY2024):

- Continue to collaborate with MoMISC on early detection and rapid response for key species such as coqui frogs and ROD.
- Support viable control programs for small mammals or other pests (e.g., *Vespula)* by our partners.
- Incorporate Rapid ʻŌhiʻa Death protocols.

This program represents an estimated 2% 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.

A. Resource Monitoring

The goal of our resource monitoring program is to track the biological resources in the preserve, and evaluate changes in these resources to guide management programs. Beginning in 2006, staff developed and implemented a rapid vegetation monitoring method known as the Molokaʻi Understory Monitoring (MUM), which involved creating a plant checklist, taking photos, and ranking plot vegetation condition at stations located along known reference trails. Baseline data and followup data has been collected for 6 transects (3 occur in Kamakou), indicating that wet forest locations across the East Molokaʻi Partnership are generally in very good condition (See Figure 6). MUM is an effective tool for capturing coarse changes in the landscape (see photos below, shot from the same location, direction, and camera setting).

May 2008- Kamakou Preserve. MUM Transect 3, Plot 6 view is looking south. Plot rank was **Good** (75-90% native undisturbed understory). Number of native species in plot = 25.	**August 2013**- MUM Transect 3, Plot 6 view is looking south. Plot improves to **Very Good** (>90% native undisturbed understory). Number of native species in plot = 32.

Support will be provided as able for additional monitoring efforts conducted by other agencies such as the Hawaiʻi Forest Bird Project and survey which was conducted on Molokaʻi in 1979, 1988, 1989, 1995, 2004, and 2010. Staff provided logistical support and labor during FY2010 to assist with the completion of the same transects done in 1995.

Resource Monitoring Goals

Years 1–6 (FY2019–FY2024):

- Complete at least one Molokaʻi Understory Monitoring project (MUM) monitoring annually.

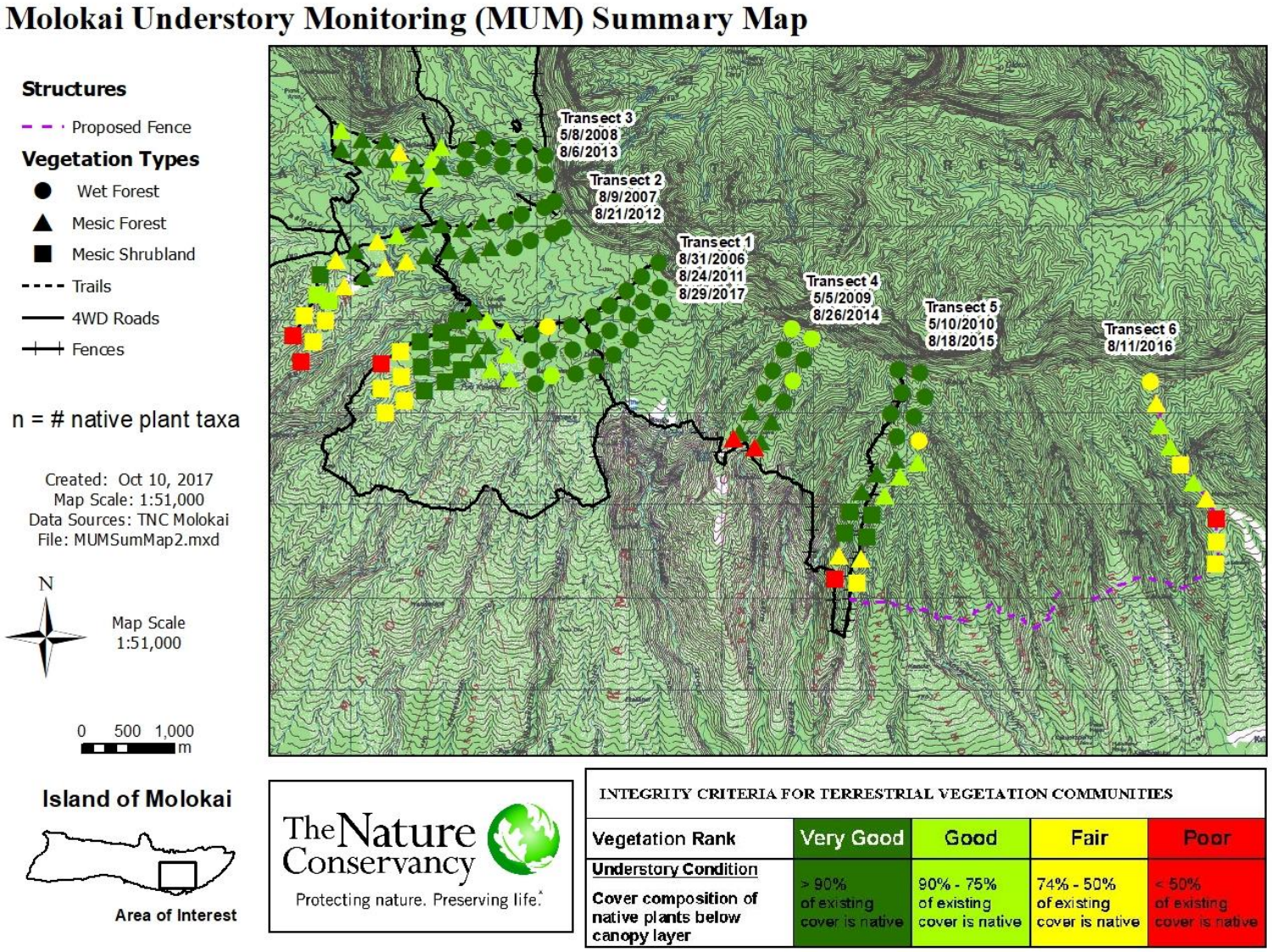


Figure 6- Forest condition across Molokai's South Slope

B. Rare Species Protection

The Plant Extinction Prevention Program (PEPP) is a statewide organization that operates by studying, collecting, propagating, and outplanting critically rare plants, protecting existing wild plants, and surveying for new plants. The goal of rare species protection program is to assist the Molokai branch of the the Plant Extinction Prevention Program (or MoPEPP) in preventing extinction of rare species in the preserve. MoPEPP is dedicated to the recovery of Molokai's critically rare plant species, for which there are less than 50 remaining individuals in the wild, in the world.

Kamakou Preserve is home to 44 rare plant taxa, and at least twenty are critically rare (MoPEPP) species. In 2009, they hired a permanent on-island staff dedicated to protection of these species. Logistical assistance is provided to PEPP when possible, to coordinate outplanting, construct rare plant exclosures, or assist with rare plant surveys.

Small enclosures have been created by TNC as needed to protect critically rare species from browsing ungulates: e.g., *Phyllostegia mannii, Platanthera holochila, Melicope mucronulata, Stenogyne bifida*. Even greater opportunity for the recovery of critically rare species has been afforded by the Conservancy's completion of the 1.5 mile Kamakou fenced unit (723 acres) in June 2014 which is currently thought to be ungulate free. Since then, MoPEPP has been able to accelerate their efforts to outplant critically rare species there.

We will continue to look for opportunities to work with partners to identify key rare plant species that would be appropriate to restore back into the preserve. Any reintroductions would be done through partnerships and would be located within fenced areas or enclosures for protection from grazing animals. We will work cooperatively with neighboring land owners and managers to develop strategies for areas adjacent to the preserve.

No regular survey of rare invertebrates is done by the Conservancy, but partner researchers have conducted surveys in the past and we will rely on them to provide the Conservancy with management recommendations. We have and will continue to attach an updated list of research projects to our annual plan and progress report.

<u>Rare Species Protection Goals</u>
Years 1–6 (FY2019–FY2024):

- Assist MoPEPP in rare plant propagule collecting, monitoring and outplanting.
- Assist MoPEPP in maintaining and documenting rare planting sites.
- Assist MoPEPP with plant surveys as requested.

C. Research

The Conservancy encourages research that will help us better understand and thereby protect the preserve's resources. Conservancy funding for research is limited. Therefore, whenever possible, we provide logistical assistance to approved research projects by other

agencies or individuals. We would like Kamakou to remain a major research site for studies dealing with conservation and protective land management in Hawai'i. See Appendix 7 for a list of research conducted at Kamakou Preserve.

Research Goals
Years 1–6 (FY2019–FY2024):

- Provide logistical assistance for approved research and apply research conclusions as warranted to management activities.
- Support 'ōhi'a (*Metrosideros* spp.) seed collection efforts.

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

D. Innovation

The Conservancy is always exploring ways to augment or refine current management efforts by applying techniques, designs or technologies to new to conservation. Internally, we call this process "Innovation," and while these innovations may require an initial investment, they have the potential to reduce time or cost of basic conservation tasks, accelerate progress toward or achieve previously unobtainable outcomes within our management programs. Innovation projects may continue but are dependent on funds outside the NAPP. Innovation projects that have been launched in the past include:

1) using **FLIR (Forward Looking Infrared)** to enhance animal detection during aerial hunts;

2) using the **Surface Pro tablet** to record aerial shoot data with GPS locations and to guide helicopter in the right shoot zones;

3) using **plastic deer mesh** to divide a large fence unit into two more manageable subunits;

4) using **GPS dog collars** in weed sweeps to ensure accurate and safe coverage of the areas covered.

5) 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.

Innovation Goals

Years 1–6 (FY2019–FY2024):

- Ungulate Abatement: Continue to use FLIR to aid in animal detection during aerial hunts and explore improved FLIR technology.
- Ungulate Abatement: Continue to use Surface Pro tablet for accurate, efficient data collecting and GIS map summaries for ACETA missions.
- Ungulate Abatement: Regularly survey Kamalo Subunit plastic mesh fence and document successes, adjustments or improvements needed for future fence design.
- Invasive Plant/Ungulate Abatement: Continue to use dog collars for weed and animal control to assist with survey efficacies and provide GIS mapping.
- Resource Monitoring, Rare Species Protection, and Research: Explore changing technology for possible new models similar to the Surface Pro that can be used in forest vegetation monitoring where wet conditions currently make it unfeasible.
- Resource Monitoring, Rare Species Protection, and Research: Explore use of UAVs to aid in detection/documentation of weeds, rare plants, and landscape scale changes.
- Explore new innovations that apply to our management.
- 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 0% of the overall effort and budget in this long range management plan.

Program 3: Infrastructure, Emergency, and Safety

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

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

The Molokai office and baseyard has become a conservation nexus for other partners of the East Molokai Watershed Partnership and the partners of Moʻomomi Preserve. TNC funds most office expenses. NAPP helps to fund field supplies, equipment, and road maintenance, as the main access to the preserve is via dirt roads that also serve as fire breaks. Roads and trails are maintained to provide safe access to and with the preserve.

TNC owns and maintains four vehicles that are used for a variety of management activities but mainly for transport to and from the Kamakou and Moʻomomi Preserves. Vehicles are usually replaced every 10 years through an internal TNC CIP trust fund. With respect to vehicles, the NAPP helps fund maintenance, repairs, and fuel costs.

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.

TNC is part of and helps to facilitate the Molokaʻi Fire Task Force (MFTF). MFTF is made up of agencies and organizations that bring knowledge and resources to aid the fire authorities (DOFAW and County of Maui Fire Department) in wildland fire prevention, pre-suppression and suppression activities. Kamakou Preserve's fire plans are embedded within The Nature Conservancy's *Moloka`i Wildland Fire Management Plan*.

Infrastructure, Emergency, and Safety Goals

Years 1–6 (FY2019–FY2024):

- Provide emergency and Wildland Fire training to keep staff current with First Aid/CPR and S130/190 certifications.
- Conduct annual first aid kit inventory and resupply.
- Annually update the TNC *Molokaʻi Wildland Fire Management Plan*.
- Purchase equipment as needed to allow immediate response to fire threats.
- Respond to emergencies or fire threats as requested.
- Conduct road repair on Preserve's access roads.

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

Program 4: Community Outreach/Partnerships

A. Community Outreach

Program Goal: To build community support and awareness for the conservation of native natural resources, and to implement effective conservation practices that are culturally sensitive.

Program Description: The Conservancy's Molokaʻi community outreach programs goes far beyond the boundaries of any single conservation site; therefore there is considerable overlap in our community outreach program among the three preserves and other projects. We have taken a multi-faceted, comprehensive approach that help bring awareness and engagement to the community about the importance of preserving Molokaʻi's natural resources and the Conservancy's role in managing those resources.

We work with a variety of conservation partners, schools, community groups, government and private funders, employment training organizations and programs, and individual volunteers and volunteer groups. NAPP helps to fund meeting/field trip supplies, printing costs, and the annual Earth Day event. NAPP also funds portions of travel costs to attend necessary meetings, workshops, and trainings.

Community Outreach/Public Awareness Activities:

- Monthly Preserve hikes are offered from March to October. No hikes are conducted from November to February as the seasonal winter rains make the roads impassable and unsafe. Our hike strategy will be directed to an island and statewide audience to increase local appreciation and awareness of Hawaiʻi's unique natural history, special areas and what is being done to protect its remaining intact native ecosystems. Additional school and community field trips will be done as requested.

Table 3. Kamakou Preserve hikes 2013-2017

Year	Number of Hikes	Persons Reached
2013	17	122
2014	15	101
2015	11	89
2016	16	98
2017	14	108

- The Molokaʻi Earth Day Celebration occurs annually in April to coincide with the National Earth Day and has become the Conservancy's biggest public awareness event on Molokaʻi. The event engages local conservation and cultural agencies, organizations, and groups who bring awareness and engagement to their projects on Molokaʻi through interactive exhibits. The event attracts about 1,000–1,200 community members annually.

- Volunteer/Internships – Hike docents and turtle monitors directly help with

learning programs at Kamakou. Volunteers also assist with administrative needs and events like Earth Day. Interns are recruited as available and/or needed. Past interns were recruited from AmeriCorp, Alu Like and the Youth Conservation Corp.

- Nature's Newsflash is a semiannual publication that updates the community of the Conservancy's activities on Molokaʻi. The Newsflash also recognizes community members who volunteer and/or contribute to the Molokaʻi program. It is bulk mailed to every address on Molokaʻi.

Community Outreach Goals

Years 1–6 (FY2019–FY2024):

- Produce and distribute the semiannual *Nature's Newsflash*.
- Conduct monthly and special community group hikes at Kamakou Preserve.
- Coordinate and organize annual Molokaʻi Earth Day Celebration Event.
- Maintain and develop intern, docent, and volunteer engagement, and conduct training sessions as needed.
- Support partner groups including EMoWP, MoMISC, and Molokaʻi Fire Task Force.

B. Partnerships

Program Goal: To build community support and awareness for the conservation of native natural resources, to implement effective conservation practices that are culturally sensitive, and to collaborate with partners to leverage conservation action.

Program Description:

1. The East Molokai Watershed Partnership (EMoWP) was formed in 1999 through a community-wide strategic planning process of the U.S. Department of Agriculture (USDA) Empowerment Zone Program in response to the ongoing loss of native forests on the island. Through this process, TNC's Molokaʻi Program became the coordinator of the EMoWP. The EMoWP is a voluntary alliance of 24 landowners, community and conservation groups, and funders who support actions to improve and take care of Molokaʻi's native forests coordinated by the Conservancy. The EMoWP has 14 land-based partners and manages approximately 44,100 acres, which includes Kamakou Preserve leveraging conservation actions in a coast to coast profile (Appendix 6). The EMoWP's first project, the Kamalō/Kapualei Watershed Project, constructed a 5.5 mile contour fence (at 3000'–3500' elevation) below the native forest edge above the denuded landscape of Kamalō and Kapualei. Completed in April 2001, the fence prevented large goat herds from damaging the native rainforest, and the area above the fence showed immediate vegetation improvement. In FY2004, plans were initiated to extend the fence across Kawela lands and join the Kamakou Preserve east boundary fence. A contested case was filed by a community member who opposed the building of the fence stalling the progress

until December 2005 when the BLNR accepted the recommendations of the hearing officer to allow the fence extension with some stipulations. Construction of the Kawela portion of the fence was initiated in January 2006. Watershed partnerships are designed to leverage efforts between conservation partners. The Kawela to Kapualei fence is a great example of leveraging efforts between partners. Extensions off the original contour fence were completed through FY2009, and by the end of FY14, the wet forest of the partnership's southern slope were completely enclosed, effectively protecting over 3,200 acres from feral pig, deer, and goat ingress. Over the years the EMoWP has gradually expanded forest protection. Most recently, in 2013 nine landowner partners, totaling 17 new watershed areas, were added to the EMoWP, and together, now comprise the East Slope management area. As the coordinator of EMoWP, the Conservancy will continue to work with partners to promote stewardship activities in forest and watershed regions of Molokaʻi. Prior to 2008, Kawela ahupuaʻa was experiencing erosion rates 100x the natural rate on account of feral goats, which had browsed the area down to a moonscape. The latest studies by the U.S. Geological Survey indicate that the EMoWP has been able to reduce erosion in Kawela 10-fold since implementing its animal control strategies (fencing and supporting state aerial shoot efforts).

2. Other Partners

- Molokaʻi Advisory Council – gives advice on controversial issues to the Conservancy and helps support and advocate decisions. MAC is made up of long-time, local community leaders and cultural practitioners.

- Molokaʻi/Maui Invasive Species Committee (MoMISC). MoMISC's goal is to prevent incipient invasive pests from becoming established or widespread on Molokaʻi. MoMISC's Island-wide activities are to detect, respond and eliminate incipient invasive pests. MoMISC's outreach and awareness activities are critical to the detection and reporting of new invasive species by the public. TNC facilitates the quarterly committee meetings that decide how to eliminate key pests.

- Molokaʻi Fire Task Force – TNC facilitates the Task Force meetings that bring community resources to the aid of the County Fire Department and State Division of Forestry and Wildlife for wildland fires. TNC helped form the Task Force in 2003 through the "LAS-local action strategy", administered by the Molokaʻi Lānaʻi Soil and Water Conservation District as part of the national Coral Reef Task Force Program.

- Papahana Kuaola Lelekamanu (Penny Martin) – Since the early 1990's, Papahana Kuaola Lelekamanu has been TNC's main environmental and cultural educator partner. Penny helps lead school field trips at Moʻomomi.

Years 1–6 (FY2019–FY2024):

- Coordinate activities of the EMoWP.
- Update the 2020 East Molokai Watershed Partnership Management Action Plan in
- Facilitate, host and/or record partner meetings.

<u>This program represents an estimated 25% of the overall effort of the 5 staff that are funded through the NAP programs for Kamakou and Pelekunu Preserves on the island of Molokaʻi.</u>

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BUDGET SUMMARY

The FY2019-2024 Long Range management reflects a slight decrease from the FY2013-2018 plan (which was a significant decrease from the FY2007-FY2012 long range management plan).

The table in the next section summarizes the six-year budget for the Kamakou Preserve 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.

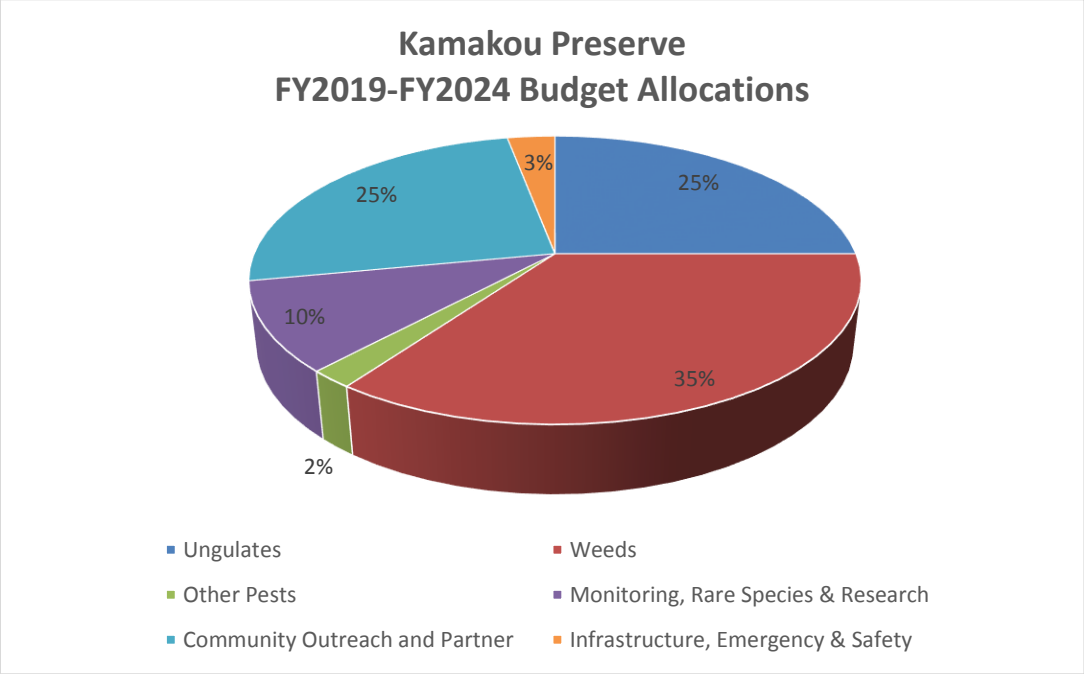


Figure 7. Kamakou NAPP Budget/Effort by Program, FY19-FY24

The Conservancy's Molokaʻi Program maintains a staff of 4.7 FTE. A portion of our staff's salary is covered by this grant. Additionally, other personnel (e.g., interns) are covered in this budget. The Molokaʻi Program is now part of Maui Nui and reports to the Maui Program Director, consequently, technical and annual planning support is provided by both the Honolulu and Maui offices of the Conservancy. As budget and needs allow, these

support staff members 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.

The budget includes: field and office supplies; vehicle fuel and repairs; equipment and tools; hunting dog care and supplies; cost of hosting meetings. The budget includes cost of contracts to management, which can include internships, helicopter, and road repairs. The budget includes providing training and travel to staff to collaborate with other TNC programs and with partners/agencies needed to fulfill the deliverables of this plan. 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.

Budgetary Considerations: All objectives above will be covered by the NAPP funds. If we are able, Innovation projects may continue within the NAPP funding (see Innovations section). We will report on progress on all accomplishments in Kamakou Preserve and on adjacent lands regardless of funding source, however we will only report on Kamakou management activities in the reporting spreadsheet. If NAPP reduces the annual funding amount, we will have to adjust our deliverables.

BUDGET TABLE

	Year 1 FY2019	Year 2 FY2020	Year 3 FY2021	Year 4 FY2022	Year 5 FY2023	Year 6 FY2024	Totals
Labor & Benefits	115,000	115,000	115,000	115,000	115,000	115,000	690,000
Contractual	130,000	130,000	130,000	130,000	130,000	130,000	780,000
Travel	1,500	1,500	1,500	1,500	1,500	1,500	9,000
Supplies	9,000	9,000	9,000	9,000	9,000	9,000	54,000
Other	5,500	5,500	5,500	5,500	5,500	5,500	33,000
Subtotal	*261,000*	*261,000*	*261,000*	*261,000*	*261,000*	*261,000*	*1,566,000*
Overhead	26,100	26,100	26,100	26,100	26,100	26,100	156,600
TOTAL	**287,100**	**287,100**	**287,100**	**287,100**	**287,100**	**287,100**	**1,722,600**
TNC 1/3 Match	**95,700**	**95,700**	**95,700**	**95,700**	**95,700**	**95,700**	**574,200**
NAPP 2/3 Request	**191,400**	**191,400**	**191,400**	**191,400**	**191,400**	**191,400**	**1,148,400**

TNC's approved ICR rate is currently at 23.31%. TNC considers the 13.31% as unrecovered ICR and may use portions of this a match as needed.

Appendices

Appendix 1. Native Natural Communities of Kamakou Preserve

NATURAL COMMUNITY	GLOBAL RANK(a)
Lowland	
ʻŌhiʻa/Uluhe (*Metrosideros/Dicranopteris*) Lowland Wet Forest[1,2]	G3
Uluhe (*Dicranopteris*) Lowland Wet Shrubland[1,2]	G4
ʻŌhiʻa (*Metrosideros*) Lowland Mesic Shrubland	G3
Montane	
ʻŌhiʻa/ʻŌlapa (*Metrosideros/Cheirodendron*) Montane Wet Forest[1,2]	G3
ʻŌhiʻa (*Metrosideros*) Mixed Montane Bog Dwarf-shrubland	G2
ʻŌhiʻa (*Metrosideros*) Mixed Shrub Montane Wet Forest[1,2]	G3
ʻŌhiʻa (*Metrosideros*) Montane Wet Dwarf-shrubland	G3
Hawaiian Mixed Fern and Shrub Assemblage on Montane Wet Cliffs	G3
Aquatic Community	
Hawaiian Continuous Perennial Stream	G1
Hawaiian Intermittent Stream[1,2]	G4
Subterranean Community	
Small-eyed Rock Centipede/Ground Beetle (*Lithobius*/*Carabid*) Montane Wet Piping Cave	G1

1 =Known also from Puʻu Aliʻi NAR
2 =Known also from Olokuʻi NAR

(a) Key to Global Ranks as defined by NatureServe.org:
G1 = **Critically imperiled**: Very high risk of extinction due to extreme rarity (typically 1-5 populations).
G2 = **Imperiled**: High risk of extinction or elimination due to restricted range, few populations, steep declines, or other factors.
G3 = **Vulnerable:** Moderate risk of extinction or elimination due to restricted range, relatively few populations, recent and widespread declines, or other factors.
G4 = **Apparently Secure:** Uncommon but not rare; some cause for long-term concern due to declines or other factors.

Appendix 2. Rare Native Plants of Kamakou Preserve

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK (a)	FEDERAL STATUS (b)
Adenophorus periens [*Oligadenus periens*]		G1	E
Alectryon macrococcus var. *macrococcus*[3]	ʻalaʻalahua, māhoe	G1T1	E
Bidens wiebkei	koʻokoʻolau, kōkoʻolau	G1	E
Canavalia molokaiensis[3]	ʻāwikiwiki, puakauhi	G1	E
Clermontia oblongifolia ssp. *brevipes*[1]	ʻōhā, ʻōhā wai	G3T1	E
Cyanea mannii	ʻōhā, hāhā, ʻōhā wai	G2	E
Cyanea procera[1]	ʻōhā, hāhā, ʻōhā wai	G1	E
Cyanea profuga	hāhā	G1	E
Cyanea solanacea[1,2]	pōpolo, hāhā	G1	E
Cyanea solenocalyx[1,2]	pua kala, hāhā	G2	SOC
Cyperus fauriei	-	G1	E
Cyrtandra halawensis[2]	haʻiwale, kanawao keʻokeʻo	G1	SOC
Cyrtandra hematos[2]	haʻiwale, kanawao keʻokeʻo	G1	E
Cyrtandra macrocalyx	haʻiwale, kanawao keʻokeʻo	G2	SOC
Diellia erecta	-	G1	E
Dissochondrus biflorus	-	G2	SOC
Eurya sandwicensis[1,2]	ānini	G2	SOC
Exocarpos gaudichaudii[3]	heau	G1	SOC
Hedyotis mannii[3]	-	G1	E
Hillebrandia sandwicensis	ʻakaʻakaʻawa	G2	
Joinvillea ascendens ssp. *ascendens*[2]	ʻohe	G5T1	E
Lobelia dunbariae ssp. *paniculata*	ʻōhā, hāhā, ʻōhā wai	G1T1	SOC
Lobelia hypoleuca	ʻōpelu, liua, moʻowahie	G3	
Lysimachia maxima[1]		G1	E
Melicope hawaiensis	alani, manena	G2	
Melicope mucronulata	alani	G1	E
Melicope reflexa	alani	G1	E
Nothocestrum latifolium	ʻaiea	G1	E
Phyllostegia hispida[1]		G1	E
Phyllostegia mannii[1]	-	G1	E
Phyllostegia pilosa[4]	-	G1	E
Phyllostegia stachyoides	-	G1	E
Plantago princeps var. *laxiflora*[2,3]	laukahi kuahiwi, ale	G1T1	E
Platanthera holochila	-	G1	E
Ranunculus mauiensis[1,3]	makou	G2	E
Schiedea diffusa	-	G1	E
Schiedea laui	-	G1	E
Schiedea nuttallii	-	G1	E
Schiedea pubescens	-	G2	PS
Schiedea sarmentosa	-	G1	E

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK (a)	FEDERAL STATUS (b)
Sicyos cucumerinus	ʻānunu, kūpala	G1	SOC
Stenogyne bifida[1]	-	G1	E
Vigna o-wahuensis	-	G1	E
Zanthoxylum kauaense	heaʻe, aʻe	G2	
Zanthoxylum hawaiiense[3]	heaʻe, aʻe	G1	E

Number of Rare Plant Species in Kamakou: 45
1 = Also known (currently or historically) from Puʻu Aliʻi NAR
2 = Also known (currently or historically) from Olokuʻi NAR
3 = Also known (currently or historically) from Kalaupapa National Historical Park
4 = Formerly known as *Phyllostegia mollis*.

(a) Key to Global Ranks as defined by NatureServe.org:
G1 = **Critically imperiled**: Very high risk of extinction due to extreme rarity (typically 1-5 populations).
G2 = **Imperiled**: High risk of extinction or elimination due to restricted range, few populations, steep declines, or other factors.
G3 = **Vulnerable:** Moderate risk of extinction or elimination due to restricted range, relatively few populations, recent and widespread declines, or other factors.
GH = **Possibly Extinct**, little known about species, still some hope of rediscovery
T1 = Subspecies or variety critically imperiled globally.
T2 = Subspecies or variety imperiled globally (typically 6-20 current occurrences).
PS = Partial status. Endangered only across a portion of the range, referring to an infraspecific taxon.

(b) Key to Status (Federal):
E = Taxa formally listed as Endangered under Endangered Species Act.
T = Taxa formally listed as Threatened under Endangered Species Act.
C = Taxa proposed for listing as threatened or endangered under Endangered Species Act.
SOC = Taxa not formally listed, but concerns remain over the long-term viability of the species.

Last updated: May 22, 2017

Appendix 3. Rare Native Birds of Kamakou Preserve

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK (a)	FEDERAL STATUS (b)
Myadestes lanaiensis rutha	Olomaʻo, Molokaʻi thrush	GHTH	LE
Paroreomyza flammea	Kākāwahie, Molokaʻi creeper	GH	LE
Vestiaria coccinea	ʻIʻiwi	G4T1	SE,-

(a) Key to Global Ranks as defined by the Hawaiʻi Biodiversity and Mapping Program, Aug 2001:
G4 = Widespread, abundant, and apparently secure, but with cause for long-term concern.
GH = Historical. No recent observations, but there remains a chance of rediscovery.
T1 = Subspecific taxa critically imperiled globally; 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
TH = Subspecific taxa historical. No recent observations, but there remains a chance of rediscovery.

(b) Federal Status:
LE = Taxa formally listed as endangered.
SE = Molokaʻi population considered endangered by the state only.
- = No federal status.

Appendix 4. Rare Land Snails of Kamakou Preserve

SCIENTIFIC NAME	COMMON NAME	Biodiversity and Mapping RANK (a)	FEDERAL STATUS (b)
Partulina mighelsiana[1,2]	Achatinellid Land Snail	G1	SOC
Partulina proxima[1]	Achatinellid Land Snail	G1	SOC
Partulina redfieldii[1]	Achatinellid Land Snail	G1	SOC
Partulina tessellata[1,2]	Achatinellid Land Snail	G1	SOC
Perdicella helena	Achatinellid Land Snail	G1	SOC

1= Also known (currently or historically) from Pu‘u Ali‘i NAR
2= Also known (currently or historically) from Oloku‘i NAR

(a) Key to Global Ranks as defined by the Hawai‘i Biodiversity and Mapping Program, Aug 2001:
G1 = Critically imperiled globally; 1-5 occurrences and/or fewer than 1,000 individuals remaining; or more abundant but facing extremely serious threats range-wide.
(b) Federal Status:
SOC = Taxa that available information does meet the criteria for concern and the possibility to recommend as candidate.

Appendix 5. Kamakou Top Weed Priority List

The Nature Conservancy's office on Molokai began re-evaluating its weed priorities and developing the ranking system below in FY2018. While the following is not a comprehensive list and is subject to change based on ground conditions, the ranking system itself provides a framework for evaluating top weed threats to the highest priority areas in east Molokai, with a focus in and around Kamakou Preserve. The system is based on a 35-point scale covering three general criteria: **Invasiveness (INV)**, which refers to a number of the weed's intrinsic qualities, e.g., reproductive capacity, dispersal methods, allelopathy, fire tolerance, etc (13 points). **Presence in a Priority Area (PPA)** refers the weed's presence in TNC Molokai's priority ranked areas (i.e., fenced wet forest being the highest ranked area, 10 points). **Treatment Methods and Resources Available (TMRA)** addresses known methods of treatment and control potential (12 points). The three categories are summed for an overall rank.

Invasiveness (13 points)
Ecological Competence/Environmental Versatility- tolerates a wide range of environmental conditions. Yes (1), No (0)
Monotypes- capable of forming single-species stands, Yes (1), No (0)
Disturbance Unnecessary – plant does not need disturbance to invade, Yes (1), No, disturbance required (0)
Initiates secondary invasions – Allows or facilitates other weeds to infest site. Yes (1), No (0)
High Seed Producer – Yes, >1000 per meter square, No (0).
Multiple Means of Reproduction- More than one way to reproduce, e.g., rhizomes, etc. Yes (1), No (0)
Frequency of Reproduction- Year round or more than once a year (1), annual or otherwise infrequent (0)
Time to Maturity- Short (less than 3 years, 1pt), Long (>3 years)
Seed Bank Longevity- Evidence that a persistent seed bank is formed: Yes (1), No (0)
Dispersal Distance- Disperses by wind, birds or other animals (1), No disperser aid, germinates close to parent plant (0)
Allelopathy – Suppresses growth of nearby plants (1); No, does not exhibit allelopathy (0).
Shade Tolerant- tolerates shade at some point in its life cycle (1), no tolerance (0).
Fire tolerant – tolerates, accelerates, or benefits from fire or fire cycle (1). No, does not (0)

Presence in TNC's Priority Areas (PPA)
10 = Montane Wet Forest Fenced
9 = Montane Wet Forest Unfenced
8 = Montane Mesic Forest Shrub Fenced
7 = Montane Mesic Forest Shrub Unfenced
6 = Lowland Wet Forest Fenced
5 = Lowland Wet Forest Unfenced
4 = Lowland Mesic Forest Shrub Fenced
3 = Lowland Mesic Forest Shrub Unfenced
2 = Lowland Dry Forest Fenced
1 = Lowland Dry Forest Unfenced

Treatment Methods and Resources Available (TMRA, 12 points)
Number of Treatment Methods Known/Available- More than one (2 points), One (1), None (0)
Efficacy Rate- High (2), Medium (1), Low (0) efficacy of treatment
Staff Time- Minimal (2), Average/Normal (1), Extensive (0)
Retreatment Unnecessary- Yes (2), Sometimes (1), No, never (0)
Funds available- Enough to make significant progress (2), some control possible (1), not nearly enough to control (0)
Natural enemies present- Natural enemies are present in locale (2), natural enemies present in Hawaii, but not present on Molokai (1), not present (0)

Scientific Name	Common Name	INV	PPA	TMRA	Sum	Rank
Clidemia hirta	Koster's curse	11	10	8	29	1
Psidium cattleianum	strawberry guava, waiawī	10	10	8	28	2
Rubus argutus	prickly Florida blackberry	11	10	7	28	2
Passiflora sp.	passion fruit, passion	8	10	9	27	3
Phormium tenax	New Zealand flax	8	10	8	26	4
Schinus terebinthifolius	Christmas berry	11	10	5	26	4
Senecio madagascariensis	fireweed	9	8	9	26	4
Lantana camara	lantana	9	8	8	25	5
Pluchea carolinensis	sourbush	9	7	9	25	5
Psidium guajava	common guava	9	7	9	25	5
Buddleia asiatica	dog tail	6	10	8	24	6
Cirsium vulgare	bull thistle	4	10	10	24	6
Eucalyptus robusta	swamp mahogany,	9	7	8	24	6
Fraxinus uhdei	tropical ash	9	8	7	24	6
Melaleuca quinquenervia	paperbark	10	7	7	24	6
Phytolacca octandra	Pokeweed	7	10	7	24	6
Pinus spp.	loblolly, slash, Monterey	7	10	7	24	6
Acacia mearnsii	black wattle	10	7	6	23	7
Corynocarpus laevigata	karaka nut	6	7	10	23	7
Syzgium cumini	Java plum	6	8	9	23	7
Tibouchina herbacea	glorybush, cane Tibouchina	9	10	4	23	7
Ageratina riparia	Hamakua pāmakani	9	10	3	22	8
Cupressus macrocarpa	Monterey cypress	6	8	8	22	8
Rosa multiflora	multiflora rose	7	7	8	22	8
Rubus rosifolius	Thimbleberry	7	10	5	22	8
Ulex europaeus	Gorse	7	7	8	22	8
Ageratina adenophora	Maui pamakani (upright)	9	10	4	21	9
Casuarina equisetifolia	Ironwood	9	8	4	21	9
Leucena leucocephala	Koa haole	9	4	8	21	9
*Cyathea cooperi**	Australian Tree fern	9	7	4	20	10
*Hedychium gardenarium**	Himalayan ginger, kahili	9	5	6	20	10
Melinis minutiflora	molasses grass	9	10	1	20	10

*Individual weeds may suddenly increase in rank depending on presence in Kamakou Preserve.

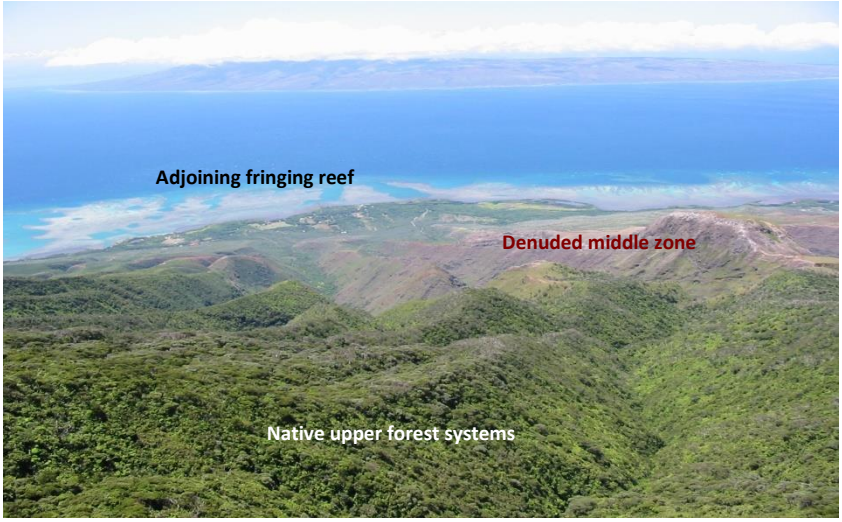
Appendix 6. East Molokaʻi Watershed Partnership Fact Sheet

East Molokaʻi Watershed Partnership (EMoWP)

The East Molokaʻi Watershed Partnership was formed in November 1999, to protect the best remaining native forest watershed areas on the East Molokaʻi Mountains. A grass roots community effort which eventually led to Molokaʻi being designated an USDA "Enterprise Community (EC)" designation, played a key role in the formation of the partnership. The EC also called, "Ke Aupuni Lokahi (KAL)" helped kick off the partnership's first project, the Kamalō/Kapualei Watershed Project. The Nature Conservancy's Molokaʻi Program is the coordinator of the EMoWP.

Our Approach

The partnership uses the traditional Hawaiian land division, or ahupuaʻa, approach to protecting the EMoWP watershed landscapes, with the upper native forests systems as the highest priority. Such an approach tries to protect watershed areas from the mountain top to the sea. Controlling threats such as hoofed animals and invasive weeds are key strategies to protecting the best remaining native forest areas and to increase vegetation to the highly denuded, eroding mid-elevation slopes and thus reducing the sedimentation rate that severely impacts the adjoining fringing reefs.



Key Strategies

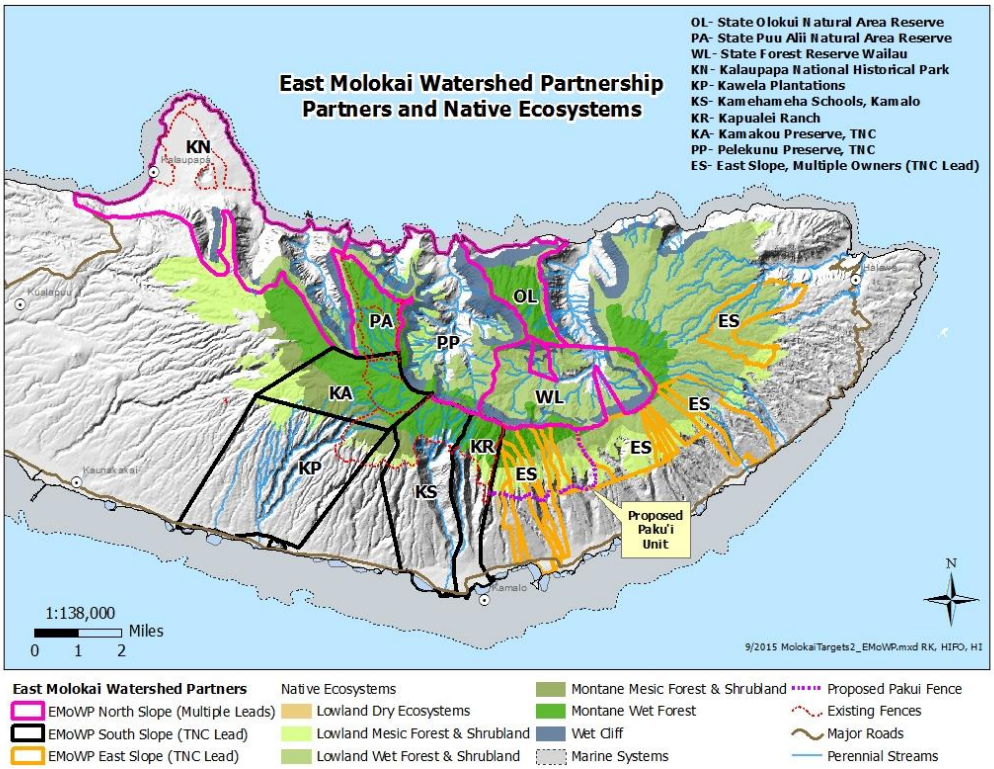
- Fences to protect the upper forest systems.
- Reduction of feral animal populations
- Monitoring systems that help guide and document management actions.
- Community outreach that engages, educates and gains the support of the local communities.
- Continual development of the partnership through fundraising, capacity building and landowner expansion.
- Involvement with fire (Molokaʻi Fire Task Force) and island invasive species efforts (Molokaʻi subcommittee of the Maui Invasive Species Committee).

Land-based Partners (44,100 acres)

- Kamehameha Schools Bishop Estate, Kamalō Ahupuaʻa (3,566 acres); Keawanui Ahupuaʻa (192 acres)
- Kapualei Ranch, Kapualei Ahupuaʻa (1680 acres)
- Kawela Plantation Homeowner's Association, Kawela Ahupuaʻa (5,500 acres)
- State Division of Forestry and Wildlife, Puʻu Aliʻi (1,330 acres) and Olokui (1,620 acres) Natural Area Reserves. and the Molokai Forest Reserve East ʻŌhiʻa (220 acres), ʻUalapuʻe (194 acres), Pukoʻo (124 acres), Honouliwai and Keopukaloa (1,188 acres)
- National Parks Service, Kalaupapa National Historical Park (10,800 acres)
- The Nature Conservancy, Kamakou (2,774 acres) and Pelekunu Preserves (5,714 acres)
- The Thacker Corporation, Kaʻamola Ahupuaʻa (33 acres)
- Pedro and Wond, West ʻŌhiʻa Ahupuaʻa (170 acres)
- Vernon Suzuki, Manawai Ahupuaʻa (200 acres)
- Dunnam Trusts, Kaluaʻaha Ahupuaʻa (700 acres)
- Ilima Partnership, Mapulehu Ahupuaʻa (1,159 acres)
- Moloka'i Land Trust, Kawaikapu Ahupuaʻa (200 acres)
- Dunbar Ranch Partners, Kainalu Ahupuaʻa (400 acres)

Agency Partners

- Ke Aupuni Lokahi, Enterprise Community Governance Board – community, funder
- Maui County (DWS & OED) -- funders
- Molokaʻi/Lanai Soil and Water Conservation District - erosion experts
- USDA Natural Resource Conservation Services -- erosion experts, funder
- US Fish & Wildlife Service – funder, rare species/ecosystem experts
- US Geological Services, Hydrological, erosion and sedimentation experts
- EPA – non-point source pollution expert, funder
- Hawaiʻi Department of Health, non-point source pollution expert, funder



Contact: The Nature Conservancy Molokaʻi Program, 808 553-5236, emisaki@tnc.org

Key Plans: EMoWP 2020 South Slope Management Action Plan; Pelekunu Preserve Long Term Management Plan; Kamakou Preserve Long-Range Management Plan

Appendix 7. Research conducted at The Nature Conservancy's Molokaʻi Preserves, July 1994-June 2017

Ongoing Projects

Long term climate change and carbon sequestration in Hawaiian mountain bogs: Pēpēʻōpae, Molokai.
Dr. David W. Beilman, UH Manoa, Geography Dept. with collaboration from Niklas Schneider, Axel Timmerman (Oceanography) and assistance from Karl Hsu and Derek Ford.

Pepeʻopae Bog represents a very rare community type, the Hawaiian montane bog. Aside from harboring a specific set of plants, bog systems are critical sites of long term carbon storage and provide a window to understanding past climate changes. Dave Beilman began research there on May 28th, 2013 to look at past changes to that bog and others statewide. According to his research, the bog's inception was roughly 12,000 years ago, which has since been punctuated by pulses of organic matter accumulation. Bogs contain dateable carbon records of past climates and may provide more information about the impacts of climate change. Pēpēʻopae Bog on Molokai is a particularly important bog because it lies geographically in the middle of the Hawaiian Island Chain and may thus give information about general impacts across the chain.

Lineage diversification in the Hawaiian flowering plant genus *Astelia* (Astelicaceae)
Joanne L. Birch PhD Candidate, UH Mānoa, Botany Dept.

Research began June 22, 2007. Study of the evolutionary relationships of Hawaiian *Astelia* sp.

Role of orb web-building in the adaptive radiation of the Hawaiian Tetragnatha (Tetragnathiadae) and Cyclosa (Araneidae) spider.
Dr. Todd Blackledge, University of California, Berkeley. Blackledge_todd@hotmail.com

Research began Aug. 7-9, 2000. Kamakou Preserve. Collected *Tetragnatha* sp. And *Cyclosa* sp. and made photo vouchers of webs. Collections to be deposited in the Essig Museum of Entomology, University of California, Berkeley. Holotype material to be deposited at Bishop Museum. Initial results supports the hypothesis that evolutionary diversification of web building has been an important contributor to the speciation of Hawaiian *Tetragnatha*. Continued study will determine the factors contributing to the biodiversity of Hawaiian spiders and how they function in Hawaiian ecosystems.

Evolutionary relationships and ecology of the endemic Hawaiian tephritid flies in the genus *Trupanea*.
Dr. Johnathan Brown, *Grinnell College*. brownj@grinnell.edu

Research began in May 2002. Last visit was October 21-22, 2010. Kamakou Preserve. Collections will be deposited at Bishop Museum. The goals are to understand the evolution of host plant use, including any role that host switching has had on speciation, and the rate of evolution in behavioral and morphological characters that distinguish species of flies. The seed predators' hosts include endemic Hawaiian plants from at least 3 radiations: the silversword alliance (*Dubautia, Agyroxiphium*), *Bidens*, and *Artemisia.* Dimorphism identified on the wings of the *Trupanea* and a difference in diet, indicate that there may be a Molokaʻi endemic species which infests seed heads of *Dubautia plantaginea*. DNA comparison pending.

Microhabitat selection and morphological constraint in the insect visual system
Butler-Higa, Marguerite and Jeffrey Scales, University of Hawaiʻi at Mānoa

Study began April 5, 2011, looking at morphological differences in the eye structure of *Megalagrion* damselflies. Collections were made in March 2015 in Kamakou. Body reflectance

was measured along with habitat, perch and light data.

Genetic lineage of the Hawaiian dragonfly (*Anax strenuous*)
Seth Bybee, Brigham Young University, Dept. of Biology.

Research began at Kamakou Preserve in August 2012, comparing genetic sequences between samples on Molokai to others statewide to learn about potential colonization patterns.

Genetic differences in the Hawaiian Coprosma (Family Rubiaceae).
Jason Cantley, UH Manoa, Dept of Botany.

Molokai is home to four species of *Coprosma*, or in Hawaiian, pilo, a common native forest shrubs. These shrubs also commonly hybridize, making their identification challenging. Collections were made in Kamakou Preserve on March 2013 by Jason Cantley, UH Manoa for DNA analysis. Research thus far suggests new varieties and species possibly unique to Molokai exist. Cantley is now pursuing a larger review of the entire genus across the Hawaiian archipelago in a post-doctorate project.

Understanding the way that organic matter moves from the organic litter layer to the underlying mineral soil.
Oliver Chadwick, University of California

Research began June 19, 2007 and is an extension of soil studies being conducted by Peter Vitousek.

Color variation and species distributions of *Megalagrion* damselflies.
Idelle Cooper, Zoology Dept, Michigan State University

Study began in Sept 2010. Collections of *M. calliphya* and *M. hawaiiense*, indicate that color morphs of the same species vary between different islands in the main Hawaiian islands. A publication in the European Society for Evolutionary Biology was produced, indicating that the red coloration in these damselflies is associated with greater exposure to solar radiation (less canopy cover). Additional investigation is taking place into antioxidant properties found in those pigments which may function as UV sunscreens. Further investigation is also examining larval gill shape with respect to other factors in the aquatic environment.

Community Assembly in Hawaiian Spiders, Adaptive Radiation in *Tetragnatha* & *Ariamnes* and Molecular Genetics & Evolution of the Hawaiian Happy Face Spider.
Cotoras, Darko, William Roderick, Andrew Rominger and Rosemary Gillespie

Investigation into adaptive radiation of many native spider species. Field research began in Kamakou preserve in June 2012. Several new species of spiders are likely to be described.

A study of Aquatic insects as indicators of stream health in Pelekunu Valley.
Dr. Ron Englund, Bishop Museum.

Research initiated May 24-25, 2000 and is expected to continue annually. Pelekunu Preserve. Collections of aquatic insects as a part of Pelekunu stream monitoring effort in conjunction with TNCH and State Dept. of Aquatic Resources (DAR). Final deposition of collected specimen at Bishop Museum.

Vespula project
Megalagrion damselfly survey
David Foote (Hawai'i Volcanoes National Park).

Vespula research began August 1998.

Megalagrion damselfly surveys were conducted in August 2005 and August 2006.

Hawaiʻi Forest Bird Interagency Database Project.

Dr. Scott Fretz, et. al., Hawaiʻi Department of Land and Natural Resources, Division of Fish and Wildlife.

Research last conducted 2009. Kamakou and Pelekunu Preserves. Forest Bird surveys are conducted on each of the five main islands on a five year rotation basis in key native forest bird habitat including those lands being actively managed to enhance forest bird habitat. Data is entered into a centralized database and analyzed for trends. Web site information is available at http://biology.usgs.gov/pierc/HFBIDSite/HFBIDPHome.htm

Networks of Parasitoid Wasps (family Ichneumonidae and Brachonidae) and their hosts in Hawaiian Forests.

Graham, Natalie, UC Berkley

Parasitoid wasps belonging to the families Ichneumonidae and Brachonidae include both introduced species and those unique to the Hawaiian islands. Introduced parasitoid wasps have recently been found to create trophic chain reactions and alter food webs by impacting the native moths in which they lay their eggs and thus native bird populations. Graham is looking to investigate differences in host relationships in native and non-native parasitoid wasps throughout the islands.

Origin and stabilization mechanisms of organic nitrogen forms in soil.

Dr. Georg Guggenberger, Martin Luther University Halle-Wittenberg, Germany

Research began June 19, 2007 and is an extension of soil studies being conducted by Peter Vitousek.

Mark and recapture of *Partulina redfieldi* and *Perdicella helena* (tree snails) at Kamakou Preserve.

Dr. Mike Hadfield, Department of Zoology, University of Hawaiʻi.

Research began January 1984 and is in progress. Last visit May 2006 Kamakou Preserve. Long-term monitoring of populations of *P. redfieldi* on and at the base of five trees has occurred for 20 years and is critical to major conservation planning for the entire group. Monitoring results guide management actions.

Captive breeding of *Partulina redfieldii* and release at Kamakou Preserve.

Dr. Mike Hadfield, Department of Zoology, University of Hawaiʻi.

Research began January 1984 and is in progress.

Collecting Hawaiian *Omiodes* moths from TNCH Molokaʻi Preserves

William Haines, Graduate student , University of Hawaiʻi at Mānoa

Collections began July 2005, Last visit was December 31, 2005. The objective of this project is to relocate populations of presumed extinct species of *Omiodes* moths, as well as those species considered "species of concern". This project will result in a rigorous assessment of the taxonomic and conservation status of this genus in Hawaiʻi. If surviving populations of extinct *Omiodes* are discovered, further steps can be taken towards determining population health and developing a management plan for Hawaiian leafroller moths.

Surveying for the Kamehameha butterfly *Vanessa tameamea* at Kamakou Preserve

William Haines, Graduate student , University of Hawaiʻi at Mānoa

Collections began in May 2014. The objective of this project is to identify the current extent of

the Hawaiian endemic Kamehameha butterfly across Hawaii. The Hawaiian nettles (family Urticaceae) on which they exclusively feed and nest were examined for signs including eggs, caterpillars and feeding damage.

Functional Trait evolution in the Hawaiian endemic *Planchonella sandwicensis*

Chris Havran, Graduate Student, *Campbell University and Ulf Swenson, Dept. of Botany in Stockholm.*

Research began in June 2012 into the morphology of ʻālaʻa (*Planchonella sandwicensis*), a Hawaiian endemic hardwood. Examines relationship between leaf traits and local rainfall. Fruit shape, leaf size and stomatal density correlate positively with rainfall (larger leaves in wetter areas). Further collection/collaboration planned with Ulf Swenson, Senior Research Scientist, Dept of Botany in Stockholm took place in FY2016 to look at its evolutionary lineage and taxonomy. Curent evidence uncovered by Swenson and Havran suggests that there are actually two species of *Planchonella* in the islands, one that is purple-fruited and the other that is yellow-fruited.

Reconstructing the patterns of host-plant utilization in the evolutionary history of *Nesosydne* planthoppers.

Gerald Luke Hasty, University of California, Berkeley, Ph.D. program.

Research began March 24-27, 2001. Kamakou Preserve. Collections will be deposited at the Bernice P. Bishop Museum or E.O. Essig Museum, Berkeley, CA. Diversification in host-plant use in Nesosydne planthoppers was important for the proliferation of species found in Hawaiʻi.

Prostostelids of Hawaiʻi

Drs. Don Hemmes; Fred Spiegel

Research began January 3, 2007. Report pending.

Succinea caduca sampling at Moʻomomi Preserve

Dr. Brenden Holland and Dr. Robert Cowie, Center for Conservation Research and Training
University of Hawaiʻi, Mānoa bholland@hawaii.edu

Collections occurred on March 10, 2005. As part of an ongoing NSF-funded evolutionary biology study of the endemic succineid land snail fauna of the Hawaiian Islands. Collections will be deposited in the Malacology Collection at the Bishop Museum.

Taxonomy and ecology of Hawaiian Rotifera: a contribution to the biodiversity and zoogeography of oceanic islands.

Dr. Christian D. Jersabek, Academy of Natural Sciences. Jerswabek@acnatsci.org

Research began March 5-6, 2001. Kamakou Preserve. Assess the biodiversity of freshwater invertebrates (micrometazoa) in wetland ecosystems that are currently considered to be at special risk.

Evolutionary biology, genetics, ecology, and behavior of Hawaiian Drosophilidae.

Dr. Ken Kaneshiro, University of Hawaiʻi. kykaneshi@hawaii.edu

Research began 1963 and is in progress. On a March 1999 trip, *D. differens* was collected at a higher elevation than previously collected. Until now, this unique Molokaʻi species had not been seen in over 15 years. Combined with other data from the Big Island, this significant finding indicates that some *Drosophila* species may be "moving" upland, perhaps in response to environmental changes.

Reproductive Biology of Solanum nelsonii in the Moʻomomi Preserve, Hawaiʻi.
Emi Kuroiwa, University of Illinois at Chicago

Research began March 23, 2011, looking breeding systems, pollination and population structure in *Solanum nelsonii* at Moʻomomi Preserve. Research showed that despite relatively small numbers of these plants, preserve populations remain rather genetically diverse. Natural populations of the plant exist only on southwest Hawaii island, northwest Molokai, and the northwest Hawaiian Islands.

A Comparative Approach to the Evolutionary Biology of Hawaiian Insects: Population Genetic and Phylogenetic Studies
Rick LaPoint,UC Berkeley

Research began Jan 10, 2011, studying speciation in leafhoppers and flys, with potentially 5 new species discovered in the genus *Campsicnemus*.

Taxonomic studies of Hawaiian predatory ground beetles (Carabidae).
James Lieberr, Cornell University & Dan Polhemus, U.S. National Museum of Natural History, Smithsonian Institution.

Research initiated in Spring 1991. Last visit on May 10-16, 2005. Hawaiʻi hosts about 350 native Carabid beetle species exclusive to the islands – 55 species are exclusive to Molokaʻi. Species distributions on Molokaʻi exist in two natural areas including Kawela-Puʻu Kolekole and Wailau-Kainalu. Speciation has occurred repeatedly between these areas and this study will investigate how these species behave in their natural habitats. Voucher specimen will be deposited at Cornell University, Bishop Museum, or the Smithsonian.

Hawaiian Monk Seal Foraging and Epidemiology Study
Charles Littnan, Ph.D.Research Ecologist Hawaiian Monk Seal Research Program
Pacific Islands Fisheries Science Center, NOAA Fisheries

Research began April 12, 2004. Last research conducted September 18- 22, 2005 Moʻomomi Preserve. Flipper tag, health screen, seals to get a better idea of population size and health of seals in the main Hawaiian Islands.

Collecting *Hylaeus* yellow-faced bees in Kamakou and Moʻomomi Preserves to determine which species are extant.
***Karl Magnacca, Cornell University*.**

Research began in March 1999. Kamakou and Moʻomomi Preserve. Collections are deposited at the Cornell University Insect Collection and the Bishop Museum. Conduct phylogenetic studies using molecular and morphological methods, and determine feeding preferences by examination of pollen in larval provisions. Conservation aspect of study is to determine extant species of Nesoprosopis and their distribution in protected areas. Collected in June, August 1999, June 2001. The four known species of *Hylaeus* at Moomomi Preserve are federally listed as endangered as of 2017. Magnacca has aided with TNC staff identification of *Hylaeus* to the genus level at locations in upper Kawela and at Kawaaloa Bay, Molokai in FY13-14, and Magnacca's recent visit to the Moomomi preserve on June 9, 2017 confirmed the continued presence of *Hylaeus anthracinus*.

The Utility of DNA Barcoding in Hawaiian Insects.
Karl Magnacca and Donald Price, University of Hawaiʻi-Hilo,

Began field work Dec 14-16, 2010. Research to see if the Hawaiian *Drosophila* (fruit flies) can be

identified using various processes of DNA/mitochondrial analysis. Collections in and around Kamakou Preserve in Dec 2010 resulted in 2 new island records: *D. odontophallus* and *D. orphnopeza*, and relocation of the rare Maui Nui species, *D. sodomae*.

Inter-island population genetics of *Dubautia laxa* within the Hawaiian Archipelago.
***Mitchell McGlaughlin, Rancho Santa Ana Botanic Garden / Claremont Graduate University, Ph.D. program*.**

Research initiated Sept. 27-30, 2002. Kamakou Preserve. Document the extent of genetic variability and sub-division among populations and islands to formulate hypotheses about D. laxa diversification and adaptation over time. Also gathering data on the number and location of extant populations and major threats.

Community dynamics and long-term conservation potential of Moʻomomi dunes (NW Molokaʻi) and related strand areas of Maui County.
Arthur C. Medeiros, Pacific Island Ecosystem Research Center.

Research initiated June 21, 2004. Moʻomomi Preserve. Document long-term changes in vegetation communities and document the current stand structure of the plant communities to be used as a proposed template for restoration of coastal sites in various substrate types elsewhere in Maui County. Collected propagules will be grown in collaboration with Maui Nui Botanical Gardens, and used as a gene bank for restoration of other Maui County sites.

Biogeography and Repeated Evolution of Flightlessness in Cave and Alpine Hawaiian Moths.
Matt Medeiros, UC Berkeley, Dept. of Integrative Biology PhD dissertation.

Revising two genera of Hawaiian moths, *Shrankia* (Noctuidae) and *Thyrocopa* (Oecophoridae). Mites (Parasitengona: Trombellidae) appear to be infecting larger moth species (esp., *Scotorythra*). Researcher to contact TNC if control method is identified.

Comparative fern diversity at Kamakou preserve, Molokaʻi
Dr. Klaus Mehltreter.

Project executed May 24-30, 2010. Fern diversity surveyed on 10 transects in Kamakou Preserve around the Pēpēʻōpae Boardwalk. No introduced fern species were found on transects. The fern species richness index of 33 species/1000 m^2 in the study is among the highest in the Hawaiian Islands, only comparable with some sites on Maui with 35-42 species on sampled areas twice as large as in Kamakou. Nineteen fern species were vouchered and deposited at UH Mānoa.

Phylogeny and geographical relation in the fern genus Elaphaglossum.
Dr. John Mickel, New York Botanical Garden, Robbin Moran, Timothy Motley.

Project initiated Feb. 4, 2004. Kamakou Preserve. Determine the phylogenetic and geographical relationships of the genus world-wide using molecular techniques. The Hawaiʻi origins are likely from the South Pacific but one species may originate from Mexico. Project support from the National Science Foundation. Voucher specimen deposited at the New York Botanical Garden herbarium.

Breeding ecology and oviposition preferences of the Hawaiian Drosophilidae.
Drs. Steven L. Montgomery, Michael Kambysellis, and Elysse Craddock, and David Baer. University of Hawaiʻi, NY University, University of NY. (808) 676-4974

Research began July 1998 and is in progress. Kamakou Preserve.

Evaluation of native invertebrates at Moʻomomi for listing under the Endangered Species Act.
Dr. Steven L. Montgomery, Anita Manning. (808) 676-4974

Research began December 1997 and is in progress. Collections of specimens will be deposited in Bishop Museum (Honolulu).

Catalog of Hawaiian Drosophilidae and their host plants and study of the phylogenetic relationships among the major groups of the family Drosophilidae.
Dr. Patrick O'Grady

Research began in April 2002 and is in progress. Kamakou Preserve. The research goals are: (1) to catalog of the endemic Hawaiian Drosophilidae and their host plants, making specific notes on abundance, distribution, and ecological associations; (2) to infer the phylogenetic relationships among the major groups of the family Drosophilidae, especially the endemic Hawaiian species, using molecular character data and phylogenetic methodology.

Plant Extinction Prevention Program
Ane Bakutis, Hank Oppenheimer

This project began in May 2006. The Maui Nui Genetic Safety Net, now the Plant Extinction Prevention Program (PEPP), focuses on stabilizing, seed collection and storage and propagation of endangered plants on the brink of extinction (less than fifty plants in the wild, in the world). PEPP has a part-time staff on Molokai dedicated to the preservation of these plants.

Collection of propagules and/or status updates of the following plant species from Molokaʻi: *Adenophorus periens, Cyanea dunbarii, Cyanea procera, Gouania hillebrandii, Phyllostegia manii (or P. hispida), Platanthera holochila, Stenogyne bifida, Pritchardia munroi.*
Steve Perlman, Natalia Tangalin, Ken Wood of National Tropical Botanical Garden.

Plant propagules collected for ex-situ propagation at the National Tropical Botatical Gardens on Kauaʻi and other appropriate facilities. Collection trips began in February 1991. Collections are on-going. "Genetic Safety Net" Program began in Jan 2001 and later became the Plant Extinction Prevention Program.

Nesting behavior in native solitary yellow-faced bees (*Hylaeus*)
Plentovich, Sheldon (USFWS) and Jason Graham

Very little is known about the Hawaiian yellow-faced solitary bees (a.k.a. YFB, genus *Hylaeus*), much less their nesting behavior. At the coast, where they are most endangered, YFB do not nest in hives, but lay individual eggs in dead, hollowed out branches of naupaka (*Scaevola* spp.). Because this is difficult to observe, Graham and Plentovich have created artificial YFB nesting habitat from drilled pieces of 2x4 lumber with removable pieces of clear plastic tubing sized to that of the dead naupaka. The efforts would allow scientists to transport nests to restock other locales where YFB have become far rarer.

Survey of *Metrosideros polymorpha* arthropod fauna across the long substrate age gradient in the Hawaiian Islands.
***Dr. Dan A. Polhemus, Daniel S. Gruner, Curtis P. Ewing, Smithsonian Institution, Bishop Museum and University of Hawaiʻi joint research project*.**

Research began in October 1997 and is in progress. Kamakou Preserve.

Systematics, evolution and conservation of the Hawaiian noctuids (Lepidoptera: Noctuidae)
Prestes, Andersonn, University of Hawaii at Manoa and Will Haines

Though noctuids are the largest family of Lepidoptera (moths and butterflies) and 73 Hawaiian endemic species exist, little information on abundance, distribution or conservation status is known, and some of the Hawaiian species are reportedly extinct. Collections began in Kamakou Preserve in September 2014 and will begin to provide basic information such as geographical range, biology, ecology and evolution for species in this poorly understood family.

^{15}N Natural abundance of soil microbial biomass as a tool for assessing controls on N-cycling processes in ecosystems.
Egbert Schwartz, Paul Dijkstra, Steve Hart & Bruce Hungate, Northern Arizona University.

Research initiated Oct 10, 2004 and will be in progress for the next 3 years. Kamakou Preserve. This study will research the effect of substrate age on the natural abundance stable N isotope composition of the soil microbial biomass and will relate this to ecosystem level N-cycling processes. Results from this project will open a window in soil microbial activity and provide a better understanding of how ecosystem processes of disturbance, alien invasion and succession (ecosystem and soil health) affect soil microbial life, and *vice versa*. Support provided by the National Science Foundation (DEB-0416223) and in collaboration with Peter Vitousek.

Biodiversity Survey of Freshwater Algae of the Hawaiian Islands
Alison Sherwood, UH Mānoa, Botany Dept.

Part of a National Science Foundation project to inventory freshwater algae of the Hawaiian Islands. Areas surveyed on Molokaʻi include Hālawa Valley, Pelekunu and Kamakou Preserves. First study to inventory freshwater algae in Hawaiʻi in over 50 years. Kamakou Preserve collections began in May 2010. Specimens being analyzed to determine species.

***Partulina redfieldii* around Puu Kolekole, Molokai.**
David Sischo, UH Manoa

Began in March 2012. Survey outside the area known as "Snail Meadow" in Kamakou Preserve comparing meadow and connected-forest habitat to determine if habitat fragmentation has an effect on genetic diversity, inbreeding, and population structure of this Hawaiian tree snail.

Moore DNA Barcoding Project for *Clermontia*, *Cyrtandra,* and *Metrosideros*
Elizabeth Stacy and Donald Price, Project Technician: Jennifer Johansen, UH Hilo.

Examination of DNA sequences from *Clermontia, Cyrtandra,* and *Metrosideros* species to establish DNA barcoding as a means to facilitate plant species identification. Three species of *Cyrtandra* (*C. procera*, *C. macrocalyx*, and a taxonomically unclear *Cyrtandra*) and three species of *Clermontia* (*C. pallida*, *C. kakeana*, and *C. arborescens waikoluensis*) were sampled, and approximately ten taxa of *Metrosideros*.

Biological survey of endangered species throughout the Hawaiian archipelago.
Ken Wood, National Tropical Botanical Garden [Conservation Dept.] kenwood@ntbg.org

Research began in Dec. 1997. The main goal is to establish conservation collections of all endangered taxa in order to conserve their unique line of evolutionary divergence. Biological survey focus on the collection of endangered species throughout the Hawaiian archipelago including the collection of seed, tissue, and genetic collections. This project is being funded by the Weathertop Foundation.

On-going Projects (unsure of status)

The critically endangered endemic fern genus Diellia (Aspleniaceae): its population structure and ecology.

Ruth Aguraiuja, Institute of Botany and Ecology, University of Tartu.

Research began in July 8-11, 2003. Kamakou Preserve. Population stage structure will describe the condition of all local population for the endemic fern taxa of Diellia on the Hawaiian Islands and will be used to understand the regional dynamics of the species. Since these species are endangered, this information is needed for conservation purposes. No final report on file.

Multi-temporal, hyperspectral mapping of landforms, surface deposits, and vegetation in the Moʻomomi Dunes Preserve.

Dr. Ray E. Arvidson, Thomas Stein, Maggie Grabow, Julie Mintzer, Eric Frye, Meredith Berwick, Rachel Torrey, Washington University.

Research began on August 18-27, 2004. Moʻomomi Preserve. This project is supported by the Pathfinder Program in Environmental Sustainability in which 5 undergraduate senior year thesis projects will be completed at the end of this year. Their analyses of digital images and maps acquired from spectrometry (MASTER, AVIRIS, and ASTER) will result in a better understanding of nature and distribution of landforms, deposits and vegetative covers on the dunes. Analyses of maps from 20 years ago will show how the dunes changed over time.

Defining units of conservation: Genetic distinctiveness of the Molokaʻi Amakihi.

Dr. Robert Fleischer and Cheryl Tarr, National Zoological Park, Smithsonian Institution.

Objectives: 1) assess the extent of genetic differentiation between the Molokaʻi amakihi and other amakihi populations (primarily Maui) through analysis of nucleotide sequence variation in a hypervariable region of mitochondrial DNA; 2) determine the level of variability within the Molokaʻi amakihi population relative to other amakihi populations; and 3) compare the differentiation between populations to the average divergence within populations. If the Molokaʻi amakihi is distinct, then the average divergence between it and its sister population (presumably Maui) will exceed the average divergence within each population. Research began March 1995 and is in progress.

The impact of Tropical ash (*Fraxinus uhdei*) on understory vegetation composition in a native forest on Molokaʻi and prospects for management of this invasive species.

Lyman Perry, Geography Department, University of Hawaiʻi at Mānoa

Research began in 1992 and is in progress (draft summary to be sent, Dec. 2000). Kamakou Preserve.

Hawaiian Bristletails.

Alan De Quieroz, University of Nevada, Reno (Dept. of Biology)

Very little is known about the Hawaiian bristletails, cousins to the insects known collectively as silverfish (order Archaeognatha). Bristletails were collected from Kamakou preserve by lead researcher Alan de Quieroz in early September 2012. Preliminary results

suggest that the genus is highly variable, and a Molokai endemic species may exist.

Mycofloristic, revisionary, and monographic studies in the Xylariaceae.
Dr. Jack D. Rodgers, Washington State University

This mycofloristic study of this family of fungus (Xylariaceae) was proposed in order to assess this mycobiota while it is still available. Research began in January 1996 and is in progress.

Ecological Diversity, Systematics and Conservation of Hyposmocoma (Cosmopterigidae).
Daniel Rubinoff, University of Hawaiʻi.

Research initiated May 18-20, 2004. Kamakou Preserve. Develop a systematic framework for examining ecological and phylogenetic patterns of ecological diversification, and enable a conservation assessment to be made for the group. Vouchers will be deposited at the University of Hawaiʻi Insect Museum.

Characterization of the diversity of egg-case morphologies from Hawaiʻi *Tetragnatha* species.
Joseph Spagna, University of California, Berkeley, Ph.D. program.

Research began March 24-26, 2001. Kamakou Preserve. Voucher specimen will be deposited at the Essig Museum of Entomology, UC Berkeley. This study will characterize the diversity of egg-case morphologies from Hawaiʻi Tetragnatha species and placement of this data in phylogenetic and biogeographical contexts.

Population genetic study of the Hawaiian endemic *Hillebrandia sandwicensis* (Begoniaceae).
Dr. Mark Tebbitt, Brooklyn Botanic Garden; Dr. Susan Swenson, Ithaca College;
Dr. James Yeadon, Brooklyn Botanic Garden; Zeke Nims, Ithaca College student;
Wendy Clement, Ithaca College student.

Research initiated May 19, 2000 and is in progress. Kamakou Preserve. Collected leaf samples of *Hillebrandia sandwicensis*. One herbarium specimen deposited at Bishop Museum; Silica dried material will be deposited at Brooklyn Botanical Garden.

The diet of the invasive Jackson Chameleon (*Chameleo jacksonii*) in native Hawaiian dominated systems
Van Kleek, Melissa, Hawaiian Tree Snail Conservation Lab, University of Hawaii at Mānoa.

Jackson Chameleons are household pets abdicated by their caretakers and released into the wild that have since begun to feed on native species including native tree snails (kāhuli) and native insects including the native damselflies. Van Kleek is collecting these invasive lizards to identify their diet and potential impacts to native food webs and communities.

Evaluation of below-ground patterns of primary succession and community development in the Hawaiian archipelago.
Dr. David Wardle, Landcare Research Surface; Dr. Richard Bardgett, Landcasle University; Gustavo Hormiga.

Research initiated on June 22, 2000. Kamakou Preserve. Collections of soil and plant litter from site near Puʻu Kolekole cabin.

Terrestrial Orchid Conservation by Symbiotic Seed Germination.
Dr. Larry W. Zettler, Illinois College. lwzettle@hilltop.ic.edu

Research initiated Aug. 8, 2003. Kamakou Preserve. Set up field trials for *Platanthera holochila* seed germination with naturally occurring symbiotic mycorrhizal fungi, with goal of improving propagation efforts to ensure that orchids persist in the natural setting. Zettler reports that growing Platanthera with non-native fungi was successful, as was growing the orchid in a sterile medium. Growing with the associated Hawaiian fungi was not successful. Nine seedlings of the rare orchid were reintroduced from Dr. Zettler's lab to an unoccupied exclosure in the Kamakou Preserve in March 2011.

Completed Projects and Pending Reports

Inventory and documentation of the current distribution and systematic status of a few Molokaʻi plants with screening for novel therapeutic activity.

Carol Annable, New York Botanical Garden. (808) 261-7397

Research began February 1998 and is complete. Kamakou and Moʻomomi Preserve. Collections to be deposited in NYBG, BPBM. Collected *Clermontia grandiflora, Alnus nepalensis, Lycopodium venustulun* at Kamakou*; Chamaesyce degeneri, Heliotropium anomalum var. argenteum*, and *Fimbristylis cymosa* at Moʻomomi. No published report will be made.

Systematics and Evolution of Hawaiian Planthoppers (Insecta: Hemiptera: Fulgoromorpha: Delphacidae and Cixiidae).

Drs. Manfred Asche, Hannelore Hoch, Museum fur Naturkunde Berlin manfred.asche@rz.hu-berlin.de

Research began March 1998. Evaluation of song patterns is in progress. Kamakou Preserve. Collected *Oliarus* sp.aff *hevahva, O. morai, O. similis molokaiana, Iolania* sp*., Leialoha* sp. aff *mauiensis, Nesosydne* sp., *Siphanta acuta*. Collections to be deposited in Bishop Museum (Honolulu), Museum fur Naturkunde Berlin. Created "Love songs from Paradise" compact disk (Hawaiian planthopper mating calls from 5 islands; copy at Molokaʻi and HFO).

Risk Assessment for selected avian diseases in Hawaiian and Pacific Parks.

Dr. Carter Atkinson, Dr. Denis A. LaPointe, Sam Aruch, USGS-BRD, Pacific Island Ecosystem Research Center.

Research was conducted January 2003- November 2003 and is completed. Kamakou and Pelekunu Preserves, Kalaupapa National Historical Park, Haleakalā National Park (NP), and the NP of American Samoa. Assess severity and urgency of avian disease risks at the three national parks and feasibility of controlling mosquito vectors. Report pending.

Origin and evolutionary diversification of the Hawaiian silversword alliance (Argyroxiphium, Dubautia, Wilkesia).

Dr. Bruce Baldwin, University of California, Berkeley. Bbaldwin@uclink4.berkeley.edu

Research began June 2002. Kamakou Preserve. Voucher specimen will be deposited at the University of California, Berkeley and Jepson Herbaria. Evidence from comparisons of nuclear rDNA and chloroplast DNA show that introgressive hybridization and even hybrid speciation have occurred on Kauaʻi but the degree to which these phenomena have influenced evolution of the group on the younger islands remains uncertain. Comparing unlinked molecular markers between populations on different islands is a powerful method for detecting whether hybridization has had a lasting impact on the genetic composition of populations. Research has lead to identification of two new species: a Molokaʻi endemic, *Dubautia carrii*, and a Maui endemic, *Dubautia hanaulaensis*.

Status and Biogeography of *Rhyncogonus* weevils in the Pacific.
Elin Claridge, Dr. George Roderick, U.C. Berkeley, Ph.D. program.

Research initiated June 28-July 1, 2003. Kamakou and Moʻomomi Preserves. Conducting phylogenetic analysis of the group to understand the processes of ecological diversification and colonization processes on islands. Final deposition of collected specimen at Bishop Museum.

Genetic diversity and population structure of *Sesbania tomentosa*
David Cole, Pacific Island Ecosystem Research Center, USGS-BRD

Research Conducted February 7, 2006. Moʻomomi Preserve.
Use randomly amplified polymorphic DNA (RAPD) marker analysis to address the following questions: How much genetic variability exists (remains) in HAVO populations of *S. tomentosa*, as compared against a wider geographical sampling? Are all relic populations and taxonomic varieties equally diverse (how is genetic variability structured)? How genetically similar or dissimilar are the six existing population nodes and the varieties they contain? How does this population structure relate to the occurrence of the species on the islands of Maui and Oahu? The results and conclusions are expected by December 2007 and will be used to design an augmentation and recovery plan for *S. tomentosa*.

Documentation of distribution and taxonomic resolution of reptile and amphibian fauna in Hawaiʻi.
Ron Crombie, National Museum of Natural History.

Research began February 1998 and is complete. Kamakou and Moʻomomi Preserve. Collections to be deposited in the SI herp collection at USNM. Collected one gecko from near TNC office. No published report will be made.

Japanese Bush-Warbler: Population growth spread and impacts.
Jeffrey Foster, University of Illinois.

Research initiated July 17, 2004 and field collection has been completed. Kamakou Preserve and Molokaʻi Forest Reserve. This study will assess the degree of morphological and genetic adaptation that occurs following founder events, and will provide insight into the population ecology of the invading bird species, Japanese bush-warbler (*Cettia diphone)*. Analysis of the bird's diet will be done to assess the potential for resource competition with native bird species.

Taxonomic study and phylogenetic relationships among species of Hawaiian *Dryopteris* (Dryopteridaceae) ferns.
Jennifer Geiger, University of Colorado at Boulder, Ph.D. program.

Research began June 14, 2001. Kamakou Preserve. Collections will be deposited at NTBG and the University of Colorado herbarium (COLO). Morphological and molecular data will be used to delimit species of *Dryopteris*. This study will determine the actual number and distributions of *Dryopteris* species in Hawaiʻi.

Phylogenetic relationships and breeding system evolution of insular Pacific *Pittosporum* (Pittosporaceae).
Dr. Chrissen Gemmil, Postdoctoral visiting scientist at Smithsonian Institution, working with Drs. Warren L. Wagner and Elizabeth Zimmer.

Research began June 1997. Kamakou Preserve. Collections *of P. argentifolium* specimens will be deposited at US and/or BISH.

Remote Sensing in Tropical Dry Forests in Hawaiʻi

Dr. Thomas W. Gillespie University of California, Los Angeles

Research was conducted from June 26- July 27 2005. Kamakou preserve. There is currently no comparative data on species richness, floristic composition, or the conservation status of woody plant species or remaining fragments of tropical dry forest. Therefore, this endangered forest type is ideal for testing a number of remote sensing, biogeographic, and conservation theories related to such parameters in severely endangered and fragmented systems. At the stand level, data on species richness, floristic composition, and forest structure at each study site was collected will following Gentry (1982, 1988). Woody plant biodiversity will be quantified at the stand and patch level in tropical dry forests of the Pacific.

Evolutionary Relationships, Interisland Biogeography, and Molecular Evolution in the Hawaiian Violets (Viola: Violaceae). American Journal of Botany 96(11):2087-2099. 2009

J. Christopher Havran, Kenneth J. Sytsma, and Harvey E. Ballard, Jr.

Reviews relationships in evolution among the Hawaiian violets, proposing four taxa of violets found on Molokai.

Reproductive biology, ecology, and genetics of Hawaiian violets

Chris Havran, Graduate Student, *Ohio University Dept. of Environmental and Plant Biology*

Research began July 2006 and is ongoing. The study is looking at environmental characterization, reproductive characterization, physiological characterization, and ecological genomics. Four species have been identified on Molokai. See publication section.

Collection and documentation of fungi in Kamakou Preserve.

Drs. Don Hemmes (University of Hawaiʻi at Hilo), Robert Gilbertson (University of Arizona), Jack Rogers (Washington State University), and Fred Spiegel (University of Arkansas).

Studies are a part of surveys and inventories to document the types of fungi that are found in Hawaiʻi. Collected wood rotting species polypores and Xylariaceae. Collected January 2000; final report pending.

Biological pattern of diversification of Hawaiian linyphiid spiders of the genus *Labulla.*

Drs. Gustavo Hormiga, Jonathan A. Coddington, Rosemary Gillespie (collaborator in Hawaiʻi), Department of Entomology, National Museum of Natural History, Smithsonian Institution

This research required the collection of a small number of adults of *Labulla* spp. for detailed studies of their morphological features and if possible, their DNA sequence character information. Research included one field trip on Molokaʻi in August 1995; report pending.

Taxonomic and phylogenetic studies of Cryptograms (bryophytes).

Hiroyuki Kashiwadani, Masanobu Higuchi, Tatsuwo Furuki, Yoshihito Ohumura, Dr. Clifford Smith, University of Tokyo, National Science Museum, University of Hawaiʻi. hkashiwa@kahaku.go.jp

Research began July 1997 and is in progress. Kamakou Preserve. Collections of bryophytes will be deposited in National Science Museum, Bishop Museum (Honolulu).

Identifying key environmental factors that might influence the parasitoid community and parasitism levels of the endemic non target moth, *Udea stellata*

Leyla V. Kaufman Graduate Research Assistant Plant & Environmental Protection Sciences University of Hawaiʻi at Mānoa leyla@hawaii.edu

Research began April 2006 in Kamakou preserve and is in progress. Species to be deposited at University of Hawaiʻi at Mānoa - Insect Museum. This study aims to identify key environmental

factors that might influence the parasitoid community and parasitism levels of the endemic non target moth, *Udea stellata* (Butler) (Lepidoptera: Crambidae), by purposely introduced biological control agents and adventive parasitoids in remote native habitats in Hawaiʻi. *Pipturus* spp. (Urticacea), are the host plants of *U. stellata*. These endemic plant species are distributed across a wide range of habitats in Hawaiʻi, creating the opportunity to investigate various environmental gradients that might influence the infiltration of exotic parasitoids into natural ecosystems, and their parasitism levels and potential impact on non-target species. By doing this they aim to elucidate the factors that might be playing a role in the infiltration of exotic biocontrol agents on native areas.

Genetic diversity within and among populations of *Sophora chrysophylla* across the Hawaiian Islands.
Shelley Lammers, Dr. Clifford Morden, University of Hawaiʻi, M.S. Program.

Research initiated Oct. 21-22, 2002. Kamakou Preserve. Characterization of genetic diversity within and among populations of *mamane* (*Sophora chrysophylla)* across the Hawaiian Islands to elucidate patterns of evolution. DNA will be accessioned in the Hawaiian Plant DNA Library at the University of Hawaiʻi, Mānoa. Voucher specimen will be deposited at the UH Botany Dept. herbarium.

Field survey and collection of the rare *Hillebrandia sandwicensis* (Begoniaceae) in Hawaiʻi.
Maya LeGrande, Nellie Sugii, University of Hawaiʻi / Harold L. Lyon Arboretum.

Research initiated Oct. 21-22, 2002. Kamakou Preserve. Survey existing populations and document the number of individuals, locality, general health and threats. The plant material will be propagated and established as *ex situ* accessions within Lyon Arboretum greenhouse, garden plantings at the Arboretum, or as *in vitro* cultures as a part of the Micropropagation Laboratory-Hawaiian Rare Plant Project. DNA samples will be accessioned in the Hawaiian Plant DNA Library at the University of Hawaiʻi, Mānoa. Voucher specimen will be deposited at the UH Botany Dept. herbarium. Excess seed will be given to the Hawaiʻi Seed Storage Facility at Lyon Arboretum for storage trials.

Invasive arthropods in Hawaiʻi: closing the biotic gap
Russell Messing, and Mark Wright, University of Hawaiʻi at Mānoa.

Collection conducted on March 18, 2005 Kamakou Preserve. Collected samples for use in a semi-quantitative ranking method to analyze and prioritize target pest species for biological control. This will be based on four main criteria: biological feasibility; economic assessment; institutional assessment; and risk assessment. Results will provide a roadmap for focusing biocontrol resources, and a system for rapid evaluation of new invasive species.

Evolution of breeding systems in Hawaiian *Psychotria*: A phylogenetic approach.
Drs. Molly Nepokroeff and Kenneth J. Sytsma (PI), Department of Botany, University of Wisconsin-Madison

National Science foundation Doctoral Systematic Biology Dissertation Improvement Program. This research required the collection of *Psychotria* spp. leaves for genetic work. Research included one field trip on Molokaʻi in July 1995. Suggests a pattern for radiation of the various species of *Psychotria*.

Phylogenetic studies on Cydia (Lepidoptera: Tortricidae) moths.

Peter Oboyski, University of California, Berkeley, CA. poboyski@nature.berkeley.edu

Research initiated July 24-28, 2003. Kamakou Preserve. Moths will be analyzed for morphological and molecular characters that provide evidence for relationships among species. Phylogeny will be constructed and biological characters assessed to determine the likely processes that lead to the diversification of this genus. Collections will be deposited in the Entomology collection at Bishop Museum.

Collecting samples of *Drosophila* species at Kamakou to examine patterns of ovarian development and ovipostition behavior, and determining phyllogenetic relationships from DNA and morphology. (collaborative effort with Dr. Kaneshiro.)

Drs. Patrick O'Grady, Michael Kambysellis, and Elysse Craddock.

Began in September 1997. Collected in July.

Predicting invasiveness of non-native plants in Hawai'i.

Drs. Gordon Orians and Sarah Reichert, Washington State University

Ecosystem Research Program-funded project. Research included one field trip in July 1995; report pending.

Relationship between the relative abundance of introduced ungulates and their adverse impacts on indigenous forest ecosystems in Hawai'i.

Mr. Graham O'Reilly-Nugent, Landcare Research, New Zealand; Dr. Peter Sweetapple, Landcare Research, New Zealand; Dr. Peter Bellingham, Landcare Research, New Zealand.

Research is developed and funded in part by TNC Ecosystem Research Program. Research initiated May 1998 and is in progress. Kamakou Preserve, Pu'u Ali'i NAR, and Pu'u O Hoku Ranch. Final report received in 2001 through Secretariat for Conservation Biology; "A Simple Method for Assessing Ungulate Impacts and the Relationship Between Ungulate Densities and Impacts in Hawaiian Forests."

Monographic revision of representatives of the Protistan order Saprolegniales (watermolds).

Dr. David Padgett, The University of North Carolina at Wilmington. Padgett@uncw.edu

Research began in July 2004 and is in progress. Kamakou Preserve. Samples taken in 1970's from Moloka'i indicates that there is a rich and diverse watermold flora. The Moloka'i specimen will be used to expand the universities' collection of representatives of the Protistan order Saprolegniales from worldwide sources for monographic revision of the order. Samples will be sent to the American Type Culture Collection in Maryland for cryopreservation. Project completion is scheduled to be completed in 2008. This research is funded by the US National Science Foundation (grant # DEB 0328316).

Collection of ferns in Kamakou Preserve for taxonomic classification.

Dr. Dan Palmer.

Looking at *Dryopteris podosorus, D. unidentata, Polypodium pellucidum, Microlepia strigosa, M. speluncae* and their hybrids to determine status of these ferns. Collected in October 1999; report pending.

Floral trait evolution and pollination ecology in the Hawaiian lobelia genus, *Clermontia* (Campanulaceae)

Richard Pender, Dept of Botany, UH Manoa

Kamakou Preserve; research began in July 2011 and completed in 2013. Doctoral dissertation

completed in July 2013, examined genetic variation among *Clermontia* species, their floral characteristics identified their morphologically effective bird pollinators. Molokai has 5 species of *Clermontia- C. arborescens, C. kakeana, C. grandiflora, C. pallida and C. oblongifolia* subspecies *brevipes*. DNA analysis suggests that the critically rare *Clermontia oblongifolia* subspecies *brevipes* only present in east Molokai should be removed from its current subgenus status and reclassified as its own, separate species. Its closest relative is another Molokai endemic lobeliod, *Clermontia pallida*. Results to the pollinator study suggest that the only effective bird pollinator of the all Molokai *Clermontia*, the ʻiʻiwi (*Vestiaria coccinea*), is now functionally extinct there.

Diversity and radiation in Australasian and Pacific Triozidae (Psylloidea, Hemiptera): evidence from morphological, molecular, behavioral and acoustic data.
Dr. Diana Percy, SCIRO Entomology, Australia, and University of California, Berkeley. Diana.percy@csiro.au

Research initiated Aug. 17-18, 2003. Kamakou Preserve. Endemic psyllids are closely associated with the endemic Hawaiian flora. This project will investigate the extent to which the psyllid insects and plants may have co-diversified or co-evolved. Collections will be deposited at Bernice

Study of Hawaiian Orangeblack Damselfly (*Megalagrion xanthomelas*) in Pelekunu Valley and Leeward Coastal Systems of Molokaʻi.
Dr. Dan A. Polhemus and David Preston, Bernice Pauahi Bishop Museum

Survey included one field trip on Molokaʻi in August 1995; report pending.

Nutrient limitations in Hawaiian forests.
Stephen Porder, Brown University, Field Assistant Heraldo Farrington.

Research began at Kamakou Preserve in May 2011 and concluded March 2013. Soils found in Hawaiian forests are often low in nitrogen and/or phosphorus which may affect plant growth. Experiment examined the effect of fertilization on Hawaiian forests through minimally-invasive mini-root ingrowth samples. Despite published literature suggesting the contrary, Porder found the control group's media was high in available phosphorus. New bags with nitrogen, phosphorus or no added nutrients were placed in the field in March 2013. In July 2013, all sample root bags were removed and root growth was measured. No additional root growth was noted over control bags, suggesting that the soils at the site are limited by neither of these nutrients or co-limited by both sets of nutrients at the same time.

Speciation in genus Cyrtandra.
James Smith (Biology Department, Boise State University).

Studying the process of speciation in genus Cyrtandra. Kamakou Preserve. Collected *Cyrtandra procera* specimen in October 1999 along Pēpēʻōpae boardwalk; final report pending.

Evaluation of below-ground patterns of primary succession and community development in the Hawaiian archipelago.
Dr. David Wardle, Landcare Research Surface; Dr. Richard Bardgett, Landcasle University; Gustavo Hormiga.

Research initiated on June 22, 2000. Kamakou Preserve. Collections of soil and plant litter from site near Puʻu Kolekole cabin.

Reproductive systems in the Hawaiian *Bobea* **and** *Psychotria*
Watanabe, Kenta, Dept. of Botany, University of Hawaii at Mānoa.

Watanabe began studying and collecting native species of the tree genera *Psychotria* along the boardwalk in April 2016. The effort is looking at pollinators, reproductive systems and taxonomy of the genera.

Collection of assorted fleshy fungi from Kamakou Preserve.
Drs. George Wong (Department of Botany, University of Hawaiʻi at Mānoa), Don Hemmes (Department of Biology, University of Hawaiʻi at Hilo), and Dennis Desjardin (Department of Biology, San Francisco State University)

Research began in March 1991 and completed January 1996; final report pending.

FINAL REPORTS (may be PUBLISHED)

Aguraiuja, R. & K.R. Wood. The Critically Endangered Endemic Fern Genus *Diellia* Brack. In Hawaiʻi: Its Population Structure and Distribution. *Fern Gaz*. 16(6, 7, & 8): 330-334, 2002.

Aguraiuja, R., Moora, M, & M. Zobel. Population Stage Structure of Hawaiian Endemic Fern Taxa of *Diellia* (Aspleniaceae): Implications for Monitoring and Regional Dynamics. *Can. J. Bot.* 82: 1438-1445, 2004.

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