Moʻomomi 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
Protecting nature. Preserving life.®

Submitted by
The Nature Conservancy of Hawaiʻi

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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 Molokai office includes five forest conservation staff who work to protect Molokai'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.

On Molokaʻi, the Conservancy manages three NAPP Preserves: Moʻomomi (921 acres), Kamakou (2774 acres), and Pelekunu (5,759 acres), and is the coordinator/manager of the EMoWP which is responsible for management of over 40,000 acres in east Molokaʻi. Moʻomomi was first approved for NAPP funding in the FY1995-2000 Long Range Management Plan cycle and has been approved for every cycle since. These previous funding cycles have enabled TNC to be able to make great progress in protecting, stabilizing and enhancing the native natural resources of the Moʻomomi Preserve. This long-range management plan updates the previous long range plan (FY2013-18). 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 Moʻomomi Preserve.

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 Moʻomomi 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 projected costs for each program from FY2019-24 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 Moʻomomi Preserve Accomplishments by Programs, FY 2013-17 (5 Years)

	Indicator	Measure of Success
Ungulate Control	Acres Fenced	175
	No. Fence Maintenance Trips	6
	No. Deer dispatched in fenced unit	4
Predator Control	Predators Removed	116
Invasive Plant Control	Acres of kiawe clumps removed	1.4
	Acres of herbaceous weeds & grasses controlled	30
	Volume of weeds removed	12,000 ft^3
Monitoring and Research	Vegetation Surveys Completed	6
	No. Shearwaters burrows	1,224
	No. Shearwaters banded	1,483
	Number of Endangered Green Sea Turtles Hatched	3,246
Community Outreach & Partners	No. of Field Trips	61
	No. of Field Trip Participants	516
	No. Beach Cleanups	29
	No. Partner and Volunteer Hours	3,323

RESOURCE SUMMARY

General Setting

Moʻomomi Preserve (Figure 1) was established in June of 1988 to protect the most intact coastal sand dune ecosystem in the main Hawaiian Islands. Moʻomomi also contains significant archaeological, paleontological, and cultural resources. The 921-acre preserve is located along the northwest shore of Molokaʻi. Elevation runs from sea level to about 690 feet with annual rainfall estimated at 20 inches throughout the preserve. The westernmost coastline of the preserve is characterized by sea cliffs; the remainder of the two-mile long coastline consists of windswept sand beaches, a prominent foredune (parallels the beach), and rows of unconsolidated upper sand dunes just inland of the beach. The upper dune area of the preserve is known as Keonelele, "the flying sands". Portions of the preserve dunes are lithified (sand dunes that become solidified) and are distinct in geological appearance and native strand vegetation.

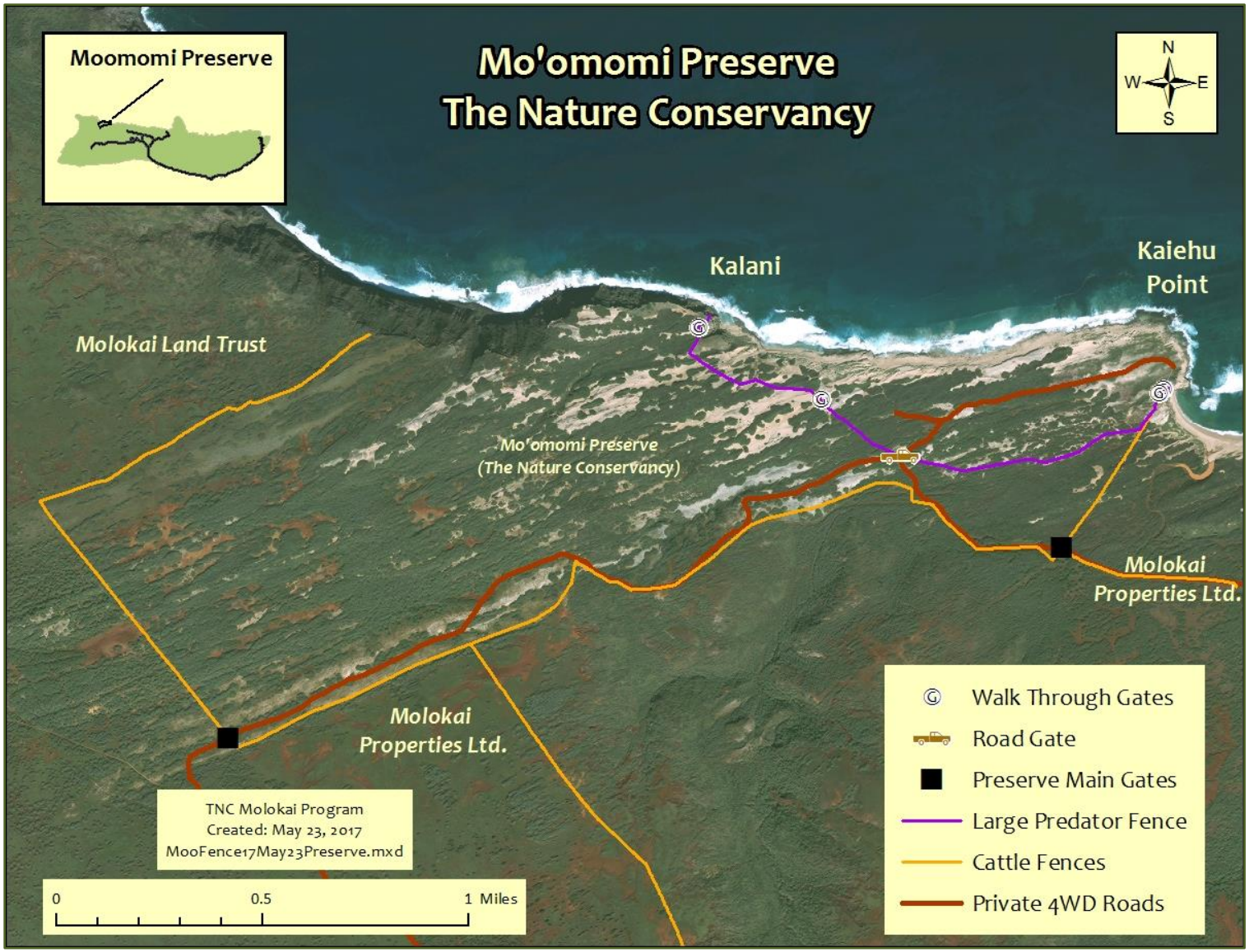


Figure 1. Mo‘omomi Preserve

Flora and Fauna

Moʻomomi Preserve's rich coastal dune ecosystem contains seven native-dominated natural communities (see Figure 2 and Appendix 1). The vegetation on the sea cliffs is primarily comprised of nehe (*Melanthera integrifolia*) and hinahina (*Heliotropium* spp.) coastal dry dwarf-shrublands. The area just inland of the beach contains communities dominated by the native grass ʻakiʻaki (*Sporobolus virginicus*), and the native shrubs naupaka (*Scaevola sericea*), ʻilima (*Sida fallax*), and nehe. Non-native species, especially kiawe, become dominant immediately behind the native vegetation band, extending upslope. Some native communities persist inland, including the rare *Tetramolopium rockii* and ʻakoko (*Chamaesyce skottsbergii* var. *skottsbergii*) coastal dry dwarf-shrublands.

Eight of the 38 native plant taxa reported from the preserve are rare and federally listed as endangered or threatened (see Appendix 2). Three of these eight rare plant taxa are endemic to western Molokaʻi (*Gnaphalium sandwicensium* var. *molokaiense, Tetramolopium rockii* var. *rockii,* and *Tetramolopium rockii* var. *calcisabulorum*). Although *Marsilea villosa* has not been reported from the preserve since the 1970s, populations of this fern have been rediscovered just west of the preserve. One occurrence of *Sesbania tomentosa* has been detected just inside of the preserve's east boundary; however, the majority of known populations occur to the east of the preserve.

In September 1999, a native wedge-tailed shearwater nest (*Puffinus pacificus*) was sighted in the sand dunes of the naupaka coastal dry shrubland. This was the first observation of the species nesting in the preserve since the Conservancy began management in 1988. Since the first sighting in 1999, we have observed a steady increase in the amount of active ground nests in the preserve, indicating that the area provides suitable nesting grounds.

Green sea turtles (*Chelonia mydas*, honu), listed as threatened by the state and federal governments, frequent the coastline of Moʻomomi Preserve. Moʻomomi provides some of the most significant nesting sites in the main Hawaiian Islands for the turtles. Laysan albatrosses (*Phoebastria immutabilis*, mōlī) have visited the preserve and were last seen on May 19, 2017. Monk seals (*Neomonachus schauinslandi*, ʻīlio-holo-i-ka-uaua) frequent the beaches adjacent to the preserve as they are becoming established throughout the coastlines of Molokai. See Appendix 2.

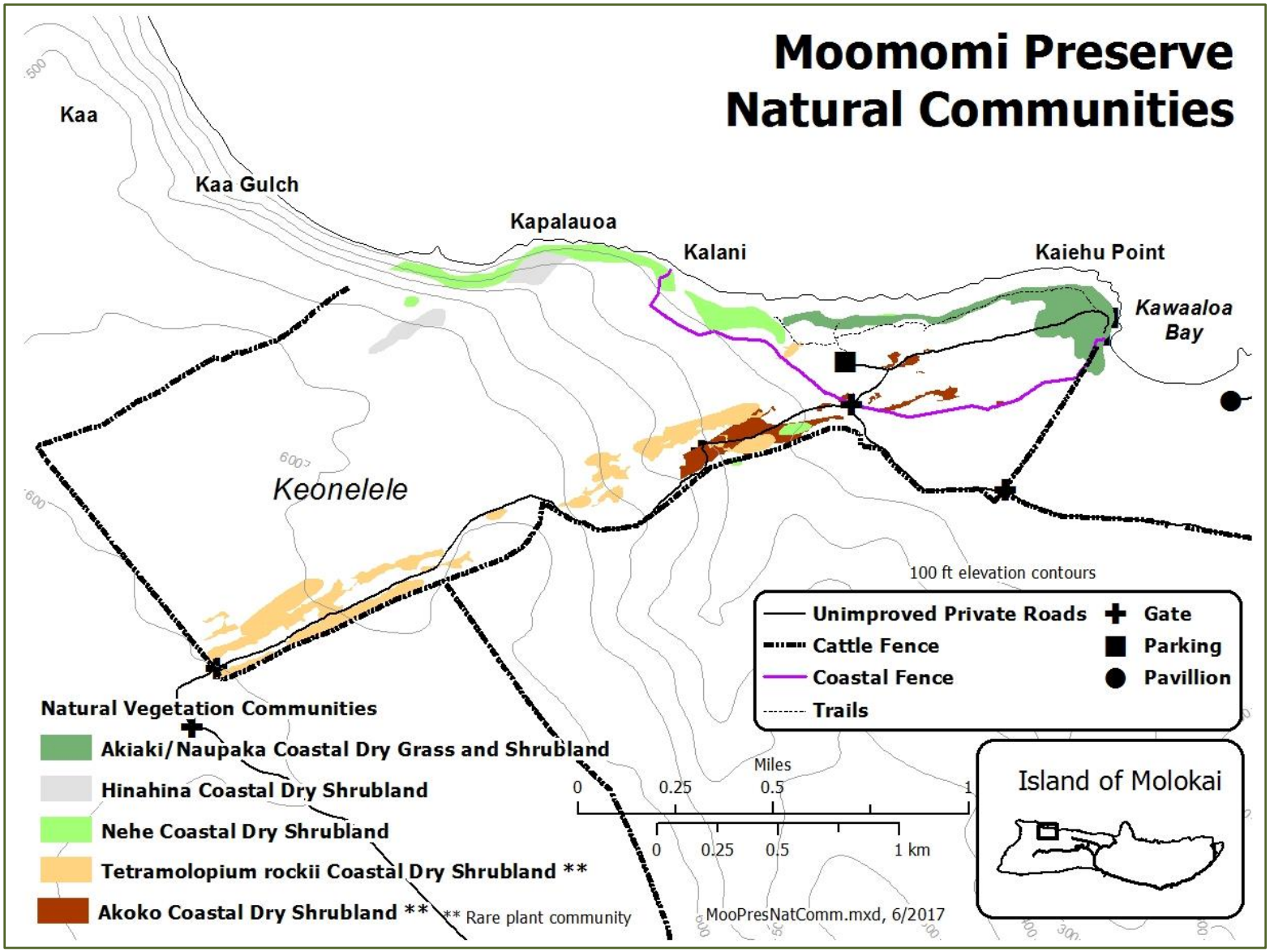


Figure 2. Mo‘omomi Preserve natural communities

MANAGEMENT

Management Considerations

1. In 1988 the Conservancy purchased 921 acres from Molokaʻi Ranch, Ltd., now known as Molokaʻi Properties, Ltd. (MPL), to establish Moʻomomi Preserve. The preserve lands are surrounded by MPL properties (Figure 3). An easement, which is part of the deed, allows the Conservancy access to the preserve on all existing roads. MPL and the Conservancy also have an on-going Fencing Agreement that states that the MPL is responsible for repairing fence breaks and removing any livestock that escape from MPL lands into the preserve within 48 hours. This agreement also recognizes that the fence is not the legal boundary between MPL and Conservancy lands. Cattle fence surveys and repairs will occur if needed.

2. Our primary management activities for protecting the preserve's native plants, animals, and natural communities are to reduce feral and domestic ungulate damage, control predation on nesting sea birds, and limit the spread of non-native, habitat-modifying plants. The removal of kiawe (*Prosopis pallida*) allows for "passive restoration" of the native coastal strand, primarily with ʻakiʻaki grass.

3. Wedge-tailed shearwater ground nesting activity on the preserve has increased the need for control of predators such as cats, dogs, and mongoose.

4. Our priority is to protect Moʻomomi's biological significance. However, Moʻomomi is known for its beauty, wild setting, and cultural significance. This management plan considers the need to protect all of these aspects of Moʻomomi while allowing visitation by the public via interpretive field trips and access via the coastal trail system.

5. Subsistence gathering has been practiced in the Moʻomomi area since ancient times. The coastal and ocean resources gathered at Moʻomomi include: fish, *limu*, crab, lobster, octopus, and salt. These resources are an important food gathering source to community members, especially to the neighboring Hoʻolehua Hawaiian Homesteaders (see Figure 3). The Conservancy and Hui Mālama O Moʻomomi, a traditional Hawaiian subsistence fisheries organization, are working together to protect the natural coastal and marine resources at the Moʻomomi Preserve. We have determined that we will limit vehicular access to the Preserve as part of our ongoing management strategy to improve the health of the coastline and nearshore fisheries. The Conservancy and the Hui encourage the community to use the traditional access trail for gathering and ocean access. Walk through gates on the existing predator/deer coastal fence will remain unlocked in perpetuity to facilitate this access.

6. The main preserve road ends at the coast in the northeastern corner (Kaiehu Point) of the preserve (Figure 1). This road is used for management. A traditional foot trail begins east of the preserve and parallels much of the preserve coastline. The road also

has a branch that accesses the higher elevation (southern side) of the preserve and is for management use only. The southern branch can also be accessed through MPL's Keonelele paddock, off the Maunaloa Highway (Figure 3). TNC has an access easement with MPL.

7. Rich paleontological resources and archaeological sites are scattered throughout the preserve. Staff and hike docents are trained in the appropriate treatment and protection of historic sites, and the adequate supervision of public access to areas containing visible surface archaeological sites. Because Moʻomomi was an important burial site, human bones are sometimes uncovered by the wind. We notify and work with the State Historical Preservation Division and the burial council on re-interring the bones.

8. The Molokaʻi Land Trust (MLT) has been subcontracted to fulfill kiawe removal, weed and predator control deliverables. The Land Trust's Mōkio Preserve is the 1,718 parcel immediately west of the Moʻomomi Preserve, with approximately 5 miles of rugged shoreline, remnant native coastal strand and dune ecosystems, a seasonal wetland, and several ancient Hawaiian archaeological sites (Figure 3). The Land Trust's management there is similar to TNC's but with an emphasis on outplanting native strand.

9. The Mo'omomi coastal fenced unit was completed in March 2016 to keep predators (dogs and cats) and the Axis deer from entering the fenced unit. Currently efforts are focused on removing the last deer and feral cats. The priority is to monitor and respond to any breaches.

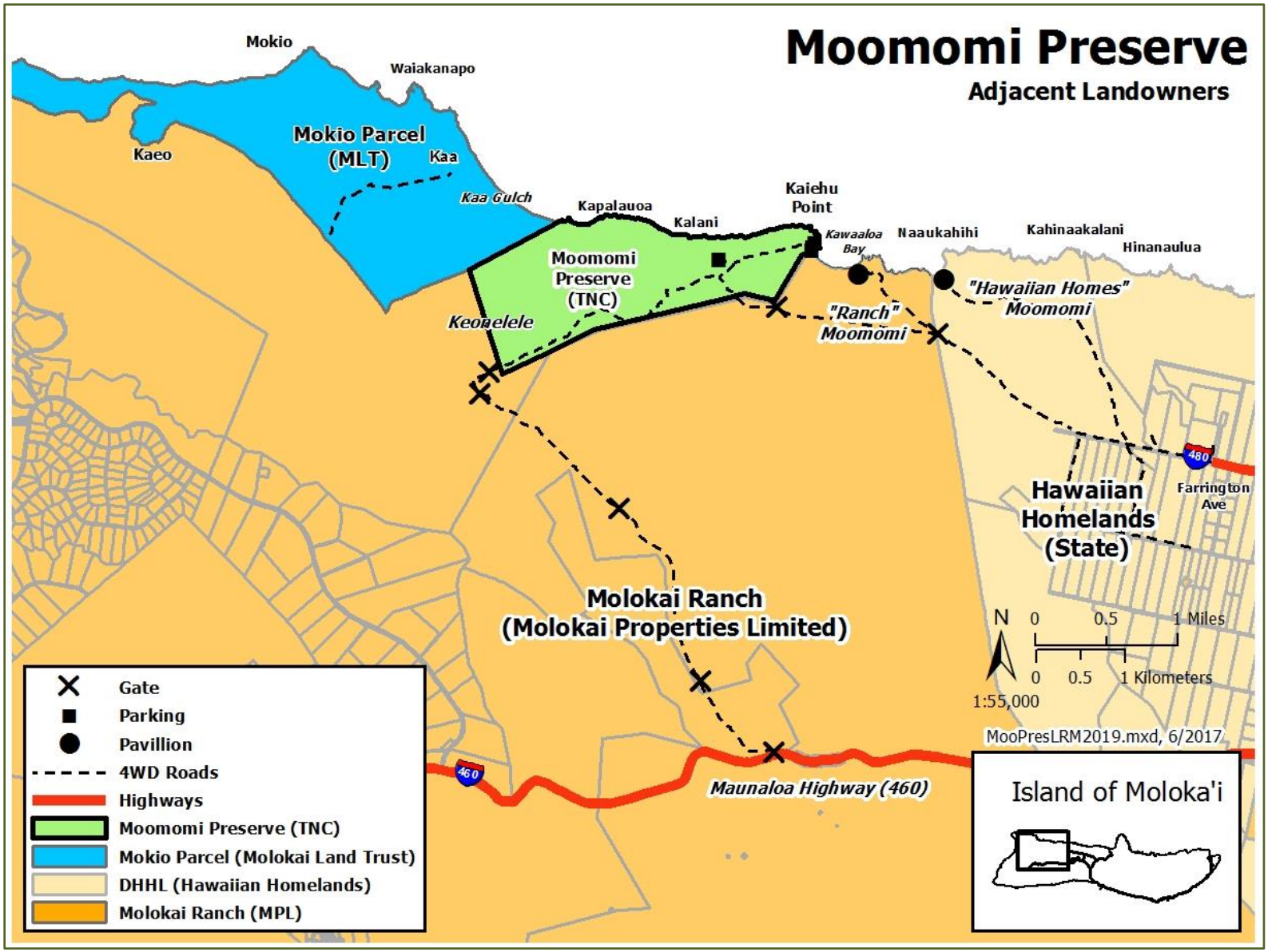


Figure 3. Mo‘omomi Preserve and adjacent landowners

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.

Moʻomomi contains rare plants, natural communities, and other resources susceptible to impacts caused by invasive species.

Program 1: Invasive Species Abatement

A. Invasive Ungulates

Program Goal: To remove all ungulates from fenced units and prevent future invasion.

Program Description: Ungulates cause impacts by browsing, grazing and trampling the preserve's natural resources. There are two fences that protect the preserve's natural resources: a 4.5-mile perimeter fence designed to keep Molokai Ranch's (a.k.a. Molokai Properties Limited) cattle from entering the preserve; and a 1.5-mile coastal fence that extends from Kaiehu to Kalani. This coastal fence is designed to protect 175 acres of the preserve's northeast coast from Axis deer, cats and dogs.

Currently, six game cameras are placed within and along the coastal fenced unit at strategic points to detect the presence of ungulates, cats and dogs. The cameras have played a key role in detection and will continue to be utilized to aid in maintaining an animal-free coastal fenced unit. See picture below showing deer outside the fence.

A deer ramp has been installed at the southwest corner of the coastal fenced unit as a trial

to see if the remaining deer will use the ramp to exit the fenced unit on their own. This exit ramp is also monitored by game cameras.

Invasive Ungulate Goals

Years 1–6 (FY2019–FY2024):

- Conduct fence surveys along the 4.5 mile perimeter fence of the preserve and work with Molokai Ranch to prevent cattle ingress.
- Immediately report cattle ingress or fence breaks to Molokai Ranch.
- Conduct quarterly fence check and repairs along the 1.5 mile coastal fenced unit.
- Conduct fence brush abatement as needed to maintain the coastal fence unit integrity.
- Continue game camera monitoring at key sites along the coastal fence to detect presence of deer, cats and dogs.
- Document deer exit ramp trial and explore other means to help deer exit the coastal fenced unit on their own.
- Explore innovative means of ungulate control and conduct elimination efforts if deer are detected in the coastal fenced unit (e.g. dog sweeps, night and day hunting).

Status of Public Hunting Opportunities: Due to safety concerns, Molokai Ranch's adjacent cattle operations, and the Conservancy's limited resources for administration and enforcement, the Conservancy does not have a public hunting program at Moʻomomi Preserve. In the event we determine that major control work needs to be conducted on feral ungulates, the Conservancy will pursue management in the best interest of the resources and community at large.

This program represents an estimated 20% of the overall effort and budget in this long range management plan.

B. Invasive Predators

Program Goal**:** To protect native seabird colonies from predation.

Program Description: On September 26, 1999, a wedge-tailed shearwater nest was sighted on the east end of Moʻomomi Preserve. Since the nesting was detected, TNC implemented regular predator control to reduce predation on this native seabird population. See Table 2. Predator control in combination with habitat restoration via kiawe removal, has resulted in over 1,400 wedge-tailed shearwater nests occurring in the preserve today. Other sea birds are now visiting the preserve including the Laysan Albatross, which has been seen more frequently and may nest.

Predators like dogs and cats can decimate nesting colonies. For example, in April 2009, a single stray dog killed 70 adult wedge-tailed shearwaters in an estimated 2-3 hour predation spree. Deer are also known to trample nesting seabirds. The Conservancy installed a 1.5-mile fence in March 2016 to create a predator- and deer-free fenced unit in

order to protect native seabird colonies from predation.
Regular game camera monitoring, fence checks and brush removal along the coastal fenceline (covered in the previous section) are necessary to preventing entry by deer and seabird predators like this vigilant feral cat:

TNC will conduct predator control and will assess/adjust trap locations as needed. If needed, trapping will be conducted outside the predator/deer fence and in adjacent lands. TNC will also explore other methods and strategies to control predators.

Table 2. Trapping by calendar year, 2012-2016 (5 years)

	2012	2013	2014	2015	2016
Number cats trapped	9	4	11	14	2
Number mongoose trapped	21	12	15	20	20
Max number traps	20	20	19	20	21

Invasive Predator Goals
Years 1–6 (FY2019–FY2024):

- Conduct predator control when predators are detected in the coastal fenced unit.
- Conduct predator control outside and adjacent to the coastal fenced unit as needed.
- Explore other methods of predator control and prevention.

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

C. Invasive Weeds

Program Goal: Remove 0.2 acres of kiawe stands and 4 acres of all weeds in former kiawe stands annually to allow for passive restoration of the native coastal strand.

Program Description: Management work at Moʻomomi is currently focused on kiawe (*Prosopis pallida)* removal and the removal of secondary weeds such as non-native grasses and a variety of herbaceous species that invade former kiawe removal areas (Table 3). Stands of kiawe have invaded large portions of the sand dune areas, displacing native vegetation, creating a fire hazard, and serving as a staging area for seabird predators. Kiawe removal is the first step in the "passive restoration" (natural regeneration) of the native coastal strand.

Table 3. Herbaceous weeds and non-native grasses of Moʻomomi Preserve

Common Name	Scientific Name
Golden crownbeard	*Verbesina encelioides*
Nettle-leaved goosefoot	*Chenopodium murale*
Australian saltbush	*Atriplex semibaccata*
Milkweed	*Reichardia tingitana*
Sow thistle	*Sonchus oleraceus*
Scarlet pimpernel	*Anagallis arvensis*
Yellow alder	*Turnera ulmifolia*
Glossy nightshade	*Solanum americanum*
Cherry tomato	*Solanum lycopersicum*
Pigweed	*Portulaca oleracea*
Bristly foxtail grass	*Setaria verticillata*
Buffel grass	*Cenchrus ciliaris*
Bermuda grass	*Cynodon dactylon*
Beach wiregrass	*Dactyloctenium aegyptium*

TNC selects kiawe stands for removal that are smaller, fragmented, isolated, located in areas of high salt spray and adjacent to native vegetation. Workers then cut the kiawe stands in a line perpendicular to trade winds. Cut stumps are treated with herbicide, and

then cut wood is chipped to reduce the litter biomass. The wood chips are then spread over the removal area. Over the next several years, regular alien grass and weed control are completed to prevent an alien seed bank from establishing while allowing surrounding native vegetation to crawl in on its own and eventually recolonize the former kiawe plot (passive restoration). As opportunities and additional funding presents itself, we will augment removal areas with outplantings (active restoration). Experience with kiawe removal, rates of native plant regeneration, and accumulating acreages for weeding from former kiawe plots, and rising fuel and other management costs indicate that removing 0.20 acres of kiawe is an appropriate annual goal given the current funding level. See Table 4 and Figure 4.

Table 4. Kiawe removal, FY13-17(5 years)

Fiscal Year	**2013**	**2014**	**2015**	**2016**	**2017**
Acres of Kiawe removed	**0.26**	**0.26**	**0.26**	**0.3**	**0.38**

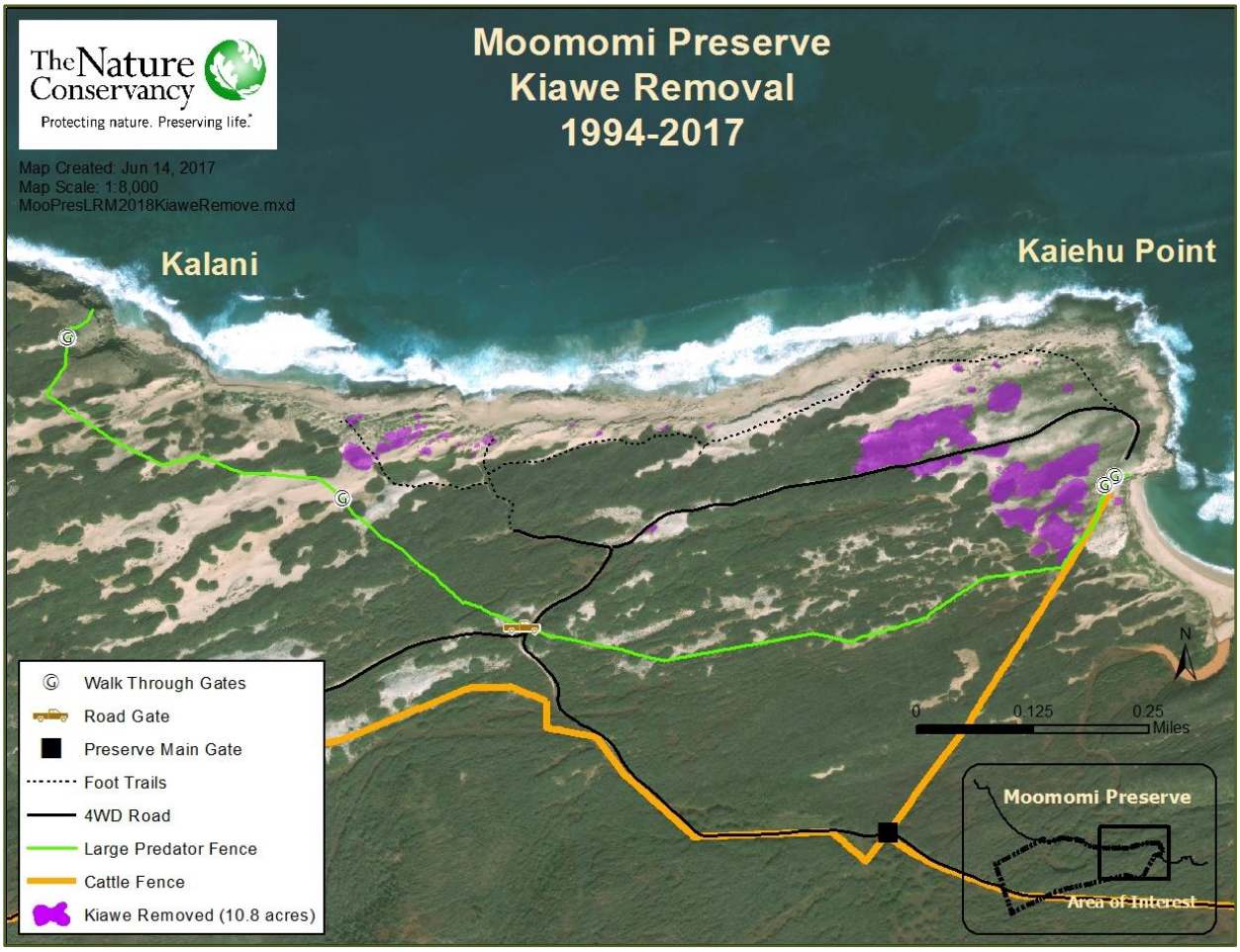


Figure 4. Kiawe removal in Mo'omomi Preserve (1994–2017)

Herbicide use is in full compliance with the State of Hawaii Department of Agriculture (HDOA) Pesticide Enforcement Division, and is used according to the product label and recorded in detail for reference and efficacy monitoring. Staff coordinating weed control are certified through the HDOA Pesticide Enforcement Division.

To date, we have removed about 11 acres of kiawe within the coastal fenced unit (see map, Figure 4). We estimate that there may be an additional 60 acres of kiawe to be removed there. Kiawe removal will continue to be the focus for the next six years. Staff will also notify MoMISC if a new invasive weed species is detected on or adjacent to the preserve.

Invasive Weed Goals

Years 1–6 (FY2019–FY2024):

- Annually remove 0.2 acres of kiawe stands adjacent to native communities.
- Annually remove all weeds from 4 acres of former kiawe stand removal areas.
- Control non-native grasses and herbaceous species in intact native areas and in reclaimed kiawe removal areas.
- If new invasive species are detected, notify MoMISC to develop strategy and conduct removal if warranted.

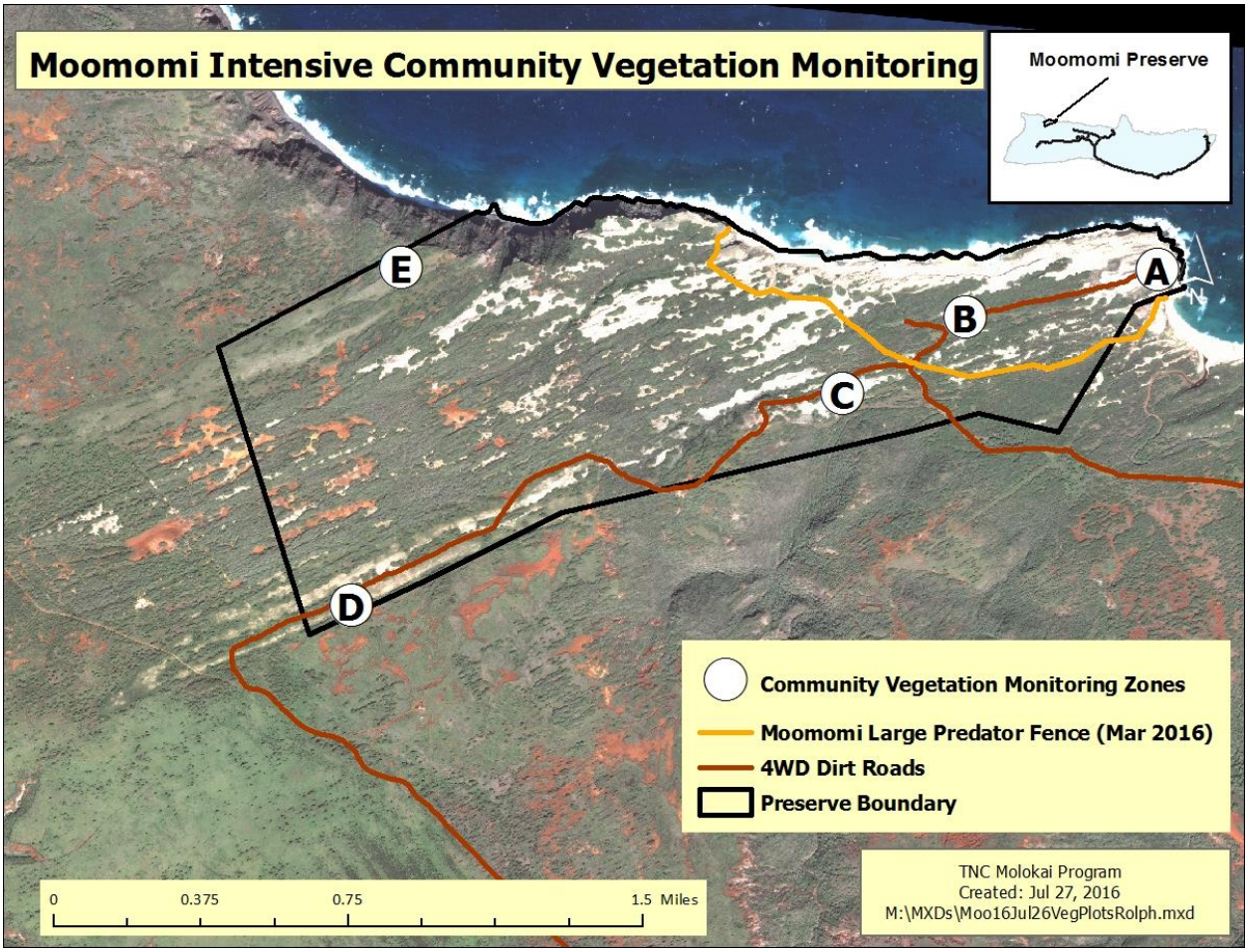
This program represents an estimated 30% of the overall effort and budget in this long-range management plan

Program 2: Native Resource Monitoring and Restoration

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 will improve the understanding of the biological elements of the preserve and with the management of the preserve's natural resources.

Vegetation Monitoring

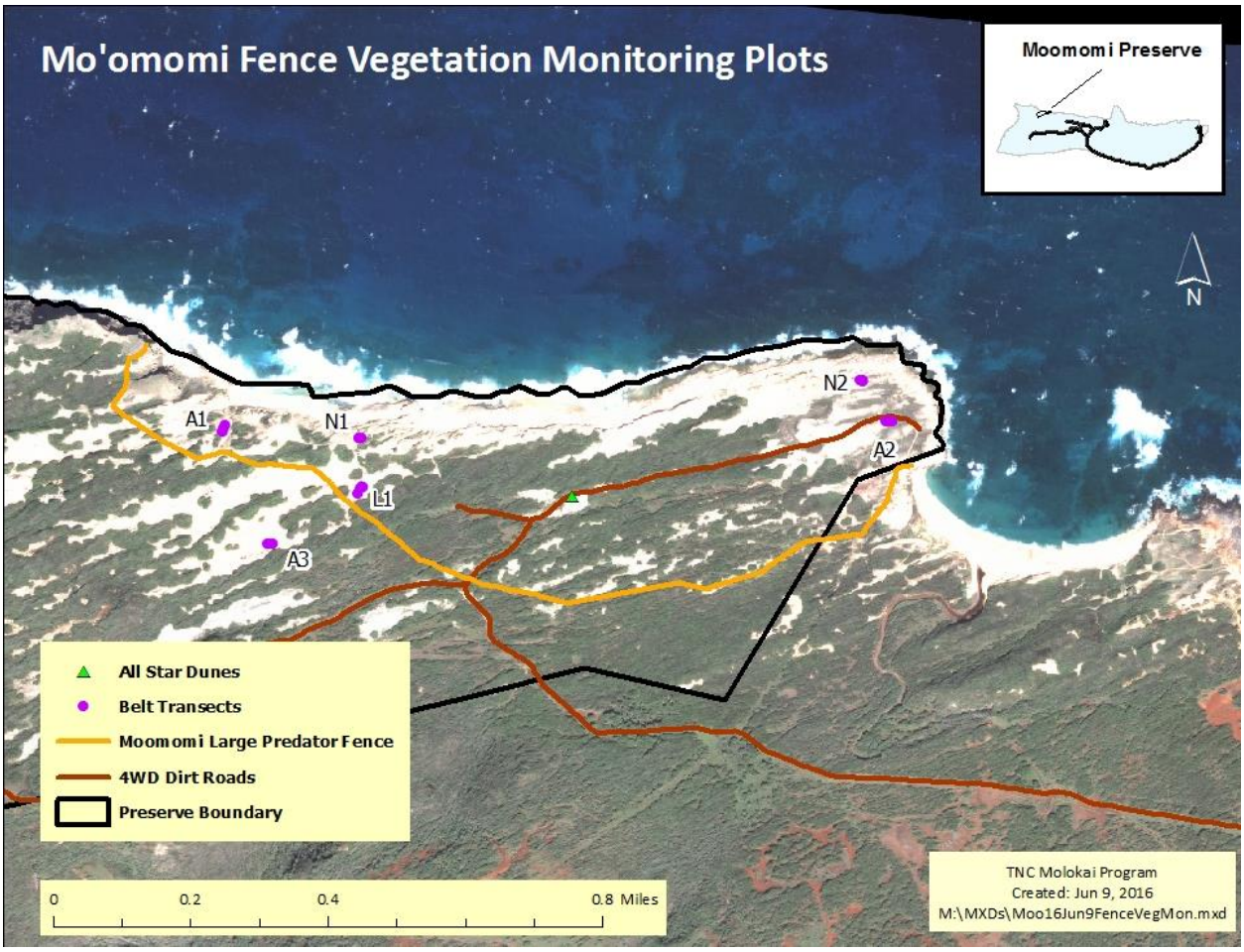
In the early 1990's, a system of intensive vegetation plant community monitoring was developed and implemented. This system incorporated 125 vegetation plots spread across 5 separate zones of the Mo'omomi preserve (See map below). While this system provided a great deal of information about vegetation dynamics, the amount of time it required to implement made it unfeasible to do on a yearly basis. As a result, this type of monitoring will be pursued once every five years.



In the meantime, another multiyear study using fenced/unfenced plots completed in 2012 revealed that deer can and were having a significant negative impact on native coastal dune vegetation. This study, combined with other evidence, such as browsed and trampled native plants and deer-transported alien vegetation, indicated that fencing was the most

effective strategy to protect the dune from the deer impacts. A fence protecting 175 acres of coastal strand, known as the coastal fence, was completed in March 2016.

To measure the impacts of deer and the subsequent recovery of the coastal strand vegetation in their absence, a series of fence vegetation monitoring transects that allow for more rapid assessment of vegetation were set up in 2014 as a coarse but rapid means to identify changes in vegetation cover before and after fence completion. These 20 meter belt transects were placed both inside and outside the coastal fenced unit and cover data will continue to be gathered every 3 years and summarized over the next 6 years. (See map below)



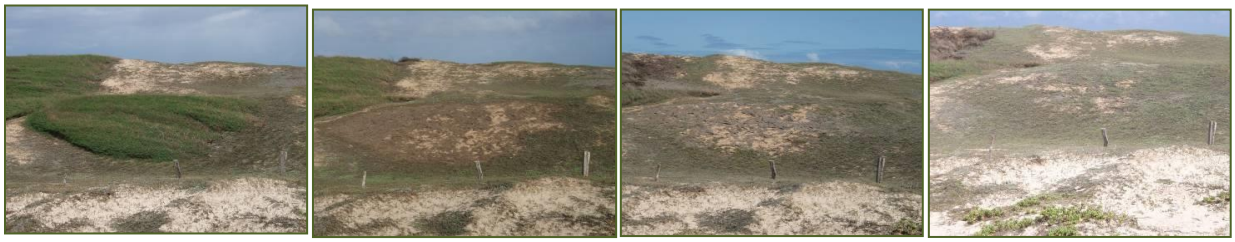
Both the intensive and fence vegetation community monitoring track rare plant species and for which additional elements are tracked, including vigor and life history. The Molokai Plant Extinction Prevention Program (MoPEPP) focuses on plants for which there are only 50 remaining individuals in the wild, in the world, but also monitors species which have become rare across an island or islands. TNC will continue to assist MoPEPP with collection of rare plant species within the preserve as requested, and assess needs for fencing rare plant populations.

Landscape photo-monitoring

Over 10 acres of kiawe stands have been removed from the preserve in the last 24 years. Preserve staff will continue documenting the progression of the kiawe stand removal and subsequent "passive" restoration over the next 6 years.

Photo-monitoring involves taking photographs from the same location in the same direction over time. This type of monitoring is a simple but effective way of demonstrating impacts of management as well as tracking landscape changes visually over time.

Photo-points will be taken for kiawe removal activities to document succession and recolonization of former kiawe plots. See below for example:



Sept 2006 Before kiawe removal	Oct 24, 2006 (T zero) Cleared and chipped	+9 months Some native recolonization.	+21 months Estimated 75% of plot covered by native growth

Wedge-Tailed Shearwaters

'Ua'u kani, or wedge-tailed shearwaters (*Puffinus pacificus*), are seabirds that spend their life out at sea feeding on fish, squid, and crustaceans, returning to shore in March to construct sand burrows for nesting. They mate in April and young will fledge from the nest by mid-November. Parents leave the nest two to three weeks before their young fledge. At this time, young birds that are not yet capable of flight are highly vulnerable to predation.

On September 26, 1999, a wedge-tailed shearwater nest was sighted on the east end of Mo'omomi Preserve, the first observed nesting since the Conservancy began management. Since that time TNC began implementing:

- Predator control (Section B of "Non-native species control")
- Kiawe removal to restore habitat (Section C of "Non-native species control")
- Education to reduce impacts to the nesting colony by the public

Since implementation of these strategies, the number of nest sites and the population has increased substantially (Figure 6). The presence of the wedge-tailed shearwater population is an indicator of good seabird habitat. Establishment of suitable habitat may allow for more species of seabirds to utilize the preserve for nesting grounds in the future.

Monitoring the viability of the shearwater colony provides the Conservancy both with feedback on threat control success and information about the colony itself. For example, banding allows tracking of the bird's life history and may help to get information on migratory patterns of founding members and later recruits to the colony, as well as how the colony is changing. Initially, birds making up the forming colony consisted primarily of recruits from Oʻahu, Maui, and Lānaʻi. Today, after a few nesting generations, the wedge-tailed shearwater colony is well-established, and based on recapture data, we estimate that upwards of 90% of the birds present there today were born and bred at Moʻomomi Preserve, and that it has become one of the largest nesting wedge-tailed shearwater colonies in the main Hawaiian islands. Adult bird banding takes place in April; fledglings are banded in October. All banding is conducted in cooperation with the state Division of Forestry and Wildlife (DoFAW) and the Maui Nui Seabird Recovery Project. Staff also conduct an annual nest count in August to evaluate the effects of predator trapping.

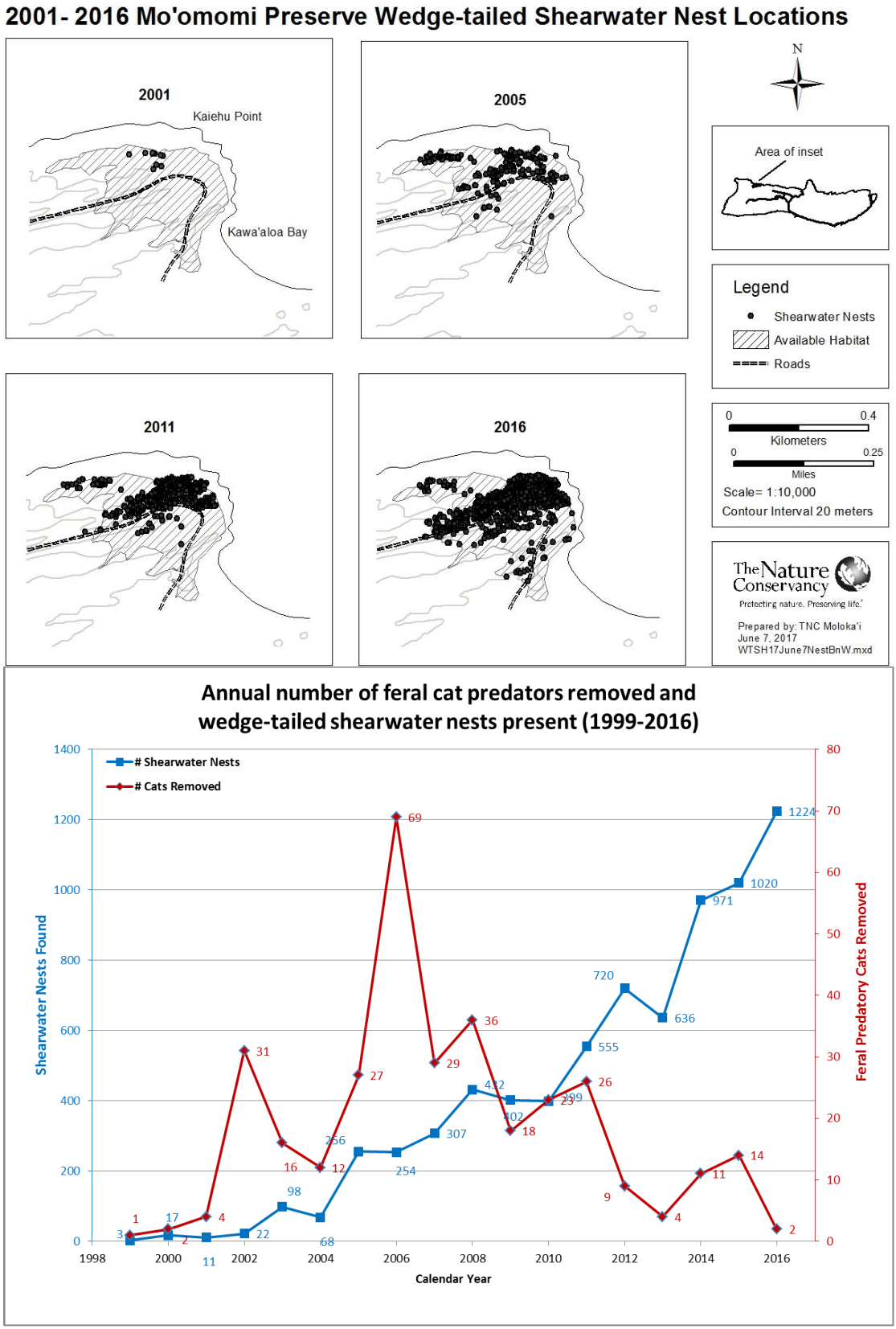


Figure 5. Wedge-tailed shearwaters nests and feral cats removed, 1999-2016.

Green Sea Turtles

Green sea turtle nesting along Kawaʻaloa Bay (adjacent to the preserve) is monitored by volunteers on a daily basis during the nesting season from May to November. The bay is located just outside of the preserve in MPL property. We keep MPL informed of volunteer activities during the nesting season. Additionally, nesting may occur at Kalani beach and will be monitored also. Records are kept of the location of all nesting attempts and hatches are confirmed by tracks on the beach. Volunteers have been essential in conducting turtle monitoring and providing the Conservancy with a report of nesting activity annually.
The Conservancy also conducts beach cleanups at Kawaʻaloa and in the preserve below Kalani Point with volunteers, as debris can hinder successful turtle nesting.

Other Rare Animal Species

Other rare animals, such as the Hawaiian monk seal, Hawaiian yellow-faced bees, and those mentioned in Appendix 2 are often seen in the preserve and reported to authorities.

Other Research

The Conservancy encourages research that will help us better understand and thereby, protect the preserve's resources. Conservancy funding for research is limited; however, when possible, we provide logistical assistance to approved research projects. See Appendix 3 for a detailed listing of research undertaken at all Molokai Preserves, including Moʻomomi Preserve.

Native Resource Monitoring and Restoration Goals

Years 1–6 (FY2019–FY2024):

- Conduct intensive community vegetation monitoring once every 5 years.
- Conduct fence vegetation monitoring once every 3 years.
- Conduct annual photo-monitoring documenting passive restoration.
- Conduct annual nest count of wedge-tailed shearwater burrows.
- Assist the State Maui District DOFAW and Maui Nui Seabird Recovery Project with seabird nesting surveys and banding twice a year (April and October).
- Maintain turtle nesting monitoring under the direction of the National Marine Fisheries Service (NMFS) and the State Division of Aquatic Resources (DAR) and with the help of volunteers.
- Conduct at least one beach cleanup at Kawaʻaloa Bay and within the preserve in April prior to turtle nesting season to protect turtles and other marine life utilizing the coastal community. Conduct additional beach clean ups if necessary.
- Assist Molokai Plant Extinction Prevention Program with rare plant collections as requested.
- Assess the need to fence key rare plant populations.
- Report rare animal species sightings to relevant authorities.
- Provide logistical assistance to approved research when possible.
- Explore opportunities for outplanting native species to enhance strand in coastal fenced unit

This program represents an estimated 20% of the overall effort and budget in this long range management plan.

Program 3: Innovation Projects

The Conservancy is always exploring ways to augment or refine current management efforts by applying techniques, designs or technologies 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 unattainable outcomes. Innovation projects may continue dependent on funds which are not covered under this NAPP. Innovation projects that have been launched in the past at Moʻomomi include:

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

2) Using the **Surface Pro tablet** to record vegetation and rare plant data with GPS locations, which saves downloading and processing time, which may equate to about one half to a whole day for each field exercise;

3) Using **plastic deer mesh fence** to prevent intrusion of Axis deer, cats and dogs to the coastal beach strand and wedged-tail shearwater nesting colony. Combining the plastic mesh with wooden posts presented an alternative to the very expensive stainless steel coastal fences in Hawaii, coupled with the fact that traditional galvanized fence and T-post cannot withstand the rust and corrosion from coastal salt air. Thus far, the coastal plastic fence at Moʻomomi has proven to be effective and we anticipate it lasting a long while because of its non-corrosive properties. This is the first coastal fence constructed from these non-metallic materials and we are hoping that it provides another tool for coastal fencing.;

4) A **deer ramp** was constructed to facilitate the exit of the last remaining deer in the coastal fenced unit on their own. The cost of constructing the ramp was minimal (less than $500 in materials) and provides another tool for zero tolerance; and

5) State-of-the-art **game cameras** were installed to document the presence of Axis deer, cats and dogs. Thus far, we have hundreds of documented presence of deer, mostly outside the fence, and we estimate from our detection, that there may be 3-4 deer left in the fenced unit. Additionally, we have placed two cameras at the deer ramp site.

6) Currently, our Maui Nui Team is learning to use **drones**. We have begun to strategize using the drone technology to help locate the last remaining deer in the coastal fenced unit and to help facilitate their dispatch.

Innovation Goals

Years 1–6 (FY2019–FY2024):

- Invasive Ungulates: Continue to use FLIR to aid in animal control activities
- Invasive Ungulates: Regularly survey the coastal plastic mesh fence and document successes, adjustments or improvements needed for future fence design.
- Invasive Ungulates: Continue to use and upgrade game cameras to monitor Axis deer, cat and dog presence in the coastal fenced unit to improve animal control efforts (e.g., deer ramp)
- Native Resource Monitoring and Restoration: Continue to use Surface Pro to refine data collection for vegetation and rare plant monitoring.
- Invasive Ungulates: Explore use of UAVs for scouting and monitoring for deer and predator presence, and potentially during hunts.
- Explore new innovations that apply to our management.
- Transfer application of innovation projects to partners (Molokai Land Trust, DoFAW/NARS, 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 4: Community Outreach/Partnerships

A. Community Outreach

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: The Conservancy's Molokaʻi community outreach program 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 helps 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.

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 Hawai‘i’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 conducted as requested and resources allow.

Table 5. Mo‘omomi preserve hikes, FY2013-2017 (5 years)

Year	Number of Hikes	Persons Reached
2013	15	122
2014	8	89
2015	14	89
2016	10	83
2017	14	133

- The Moloka‘i 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 Moloka‘i. The event engages local conservation and cultural agencies, organizations, and groups who bring awareness and engagement to their projects on Moloka‘i 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 Mo'omomi. 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.

- Volunteer service trips – Staff collaborate with on and off-island volunteer and school groups ranging from 5–30 participants who want to learn about Hawaii’s conservation effort by engaging in actual management activities. Management activities include weed control, beach cleanups, road maintenance, or native seed collecting. Trips often include an interpretive hike through the preserve to bring awareness of the area’s natural history and biological diversity.

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

B. Community-Based Subsistence Fishing Area (CBSFA)

Program Goal: To work together with the state and community partners to increase the sustainability of ocean resources.

Program Description: According to the 1993 Moloka'i Subsistence study, roughly one third of all that comes to the dinner table on Moloka'i is gathered through subsistence hunting,

fishing or farming. For centuries, the Moʻomomi area has been an *ipukai* (source of sustenance) providing a range of ocean food sources (seaweed, salt, fish, etc.) for Moloka'i and her people. Over 23 years ago, the Hui Mālama o Moʻomomi, a local non-profit, began a grassroots initiative called "The Community-Based Subsistence Fishing Area" to insure the sustainability of ocean food sources along16 miles of Moloka'i's northwestern coastline, stretching from ʻĪlio Point to Nihoa, on which Moloka'i's people and in particular, the Hoʻolehua Homestead Community, rely. The Hui has spent over two decades conducting management activities and public outreach on *lawaiʻa pono* (which includes compatible fishing techniques, attitudes, norms, studies of spawning cycles, abundance, distribution, and more), including documenting the decline of some key species due to overharvest and lack of *lawaiʻa pono*. The Hui and community members are now looking for the State to codify sustainability efforts with a special designation for the area, protecting the area in perpetuity for subsistence, and most importantly, sustainable use. The Conservancy, as one of five landowners with proposed area, is supporting this community-driven process to protect the adjacent marine areas. TNC has provided landowner support, resource information and GIS layers and maps during the process.

C. Partnerships

Program Goal: To collaborate with partners to leverage action over conservation programs.

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

2. Hui Malama o Moʻomomi – Local marine subsistence/sustainability grassroots organization, assisting with management on the state's neighboring Hawaiian Homelands. The Hui provides guidance on access with regards to marine subsistence gathering and sustainability practices.

3. Molokaʻi Land Trust – MLT is a conservation/cultural land trust committed to protecting land, rural lifestyle, natural areas, cultural practices and ancient sites. MLT's Mokio Preserve is adjacent to the Moʻomomi Preserve on the west boundary. Mokio has similar coastal beach strand and the land trust is implementing similar management practices. In 2007, The Conservancy played a key role in the formation of MLT and committed to building their capacity. The Conservancy, on a daily basis, provides a place for MLT staff and volunteers to meet and park their vehicles and equipment. The Conservancy since 2010 has contracted MLT to do annual kiawe removal, weed control, and predator control. The Conservancy also provides technical support (GIS) and logistical assistance to the Land Trust.

4. 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 best to eliminate key pests.

5. 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.

6. East Molokaʻi Watershed Partnership (EMoWP) – The EMoWP conducts watershed management on the East Molokaʻi slopes. The EMoWP is mentioned in this plan because TNC Molokaʻi Program serves as the Coordinator.

7. Moʻomomi Coastal Forest Restoration Project (Bill Garnett) – This project is focused on bringing back rare coastal plants that historically occurred at Moʻomomi. A single yellow seeded wiliwili (*Erythrina sandwichensis*) tree that previously occurred on location was the catalyst of this project. The project is funded and administered by Bill Garnett.

8. Papahana Kuaola Lelekamanu (Penny Martin) – Papahana Kuaola Lelekamanu has been TNC's main environmental and cultural educator partner, helping to lead school field trips at Moʻomomi.

9. Kualapuʻu Ranch – Initially involved with clearing the area of kiawe for the Moʻomomi Coastal Forest Restoration project, the ranch also donates staff time and equipment to improve the main access road after the seasonal winter rains.

10. Molokaʻi Properties Limited (MPL) – Formerly known as Molokaʻi Ranch, MPL's lands are adjacent to the south and east boundaries of the preserve. TNC communicates regularly on matters of trespassing, cattle leases, cattle intrusion, access easement and locked gates. TNC also has a perpetual conservation easement with MPL on the Kamakou Preserve lands.

Community Outreach Goals

Years 1–6 (FY2019–FY2024):

- Continue to provide support to the Hui Malama O Moʻomomi CBSFA's efforts to make the adjacent ocean resources sustainable.
- Conduct monthly and special community group hikes at Moʻomomi Preserve.
- Coordinate and lead volunteer and school group service trips as requested and resources allow.
- Produce and distribute the semiannual *Nature's Newsflash*.
- Coordinate and organize annual Molokaʻi Earth Day Celebration Event.
- Support partner activities including MoMISC, Molokaʻi Fire Task Force, Hui Malama O Moʻomomi and Molokaʻi Land Trust, especially with logistical support to adjacent areas to the preserve.

This program represents an estimated 15% of the overall effort and budget in this long-range management plan.

Program 5: Infrastructure, Emergency and Safety

Program Goal: Provide staff with infrastructure, emergency and safety training 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 road maintenance, field supplies, and equipment. 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. Moʻomomi's Preserve's fire plans are embedded within The Nature Conservancy's *Moloka`i Wildland Fire Management Plan*.

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 within the preserve. Kualapuʻu Ranch donates their equipment and staff time to maintain the main road after the rainy season. 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. Moʻomomi Preserve's fire plans are embedded within The Nature Conservancy's *Molokaʻi Wildland Fire Plans*.

Infrastructure, Emergency and Safety

Years 1–6 (FY2019–FY2024):

- Maintain vehicles needed to access the preserve for all programs.
- Annual update of the TNC Molokaʻi Wildland Fire Management Plan.
- Annually provide emergency training opportunities for staff including but not limited to keeping Fire, First Aid and CPR certifications current.
- Conduct annual first aid kit inventory and resupply.
- Purchase equipment as needed to sustain all programs.
- Assist government authorities in emergencies.

- Maintain preserve roads as needed.

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

BUDGET SUMMARY

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

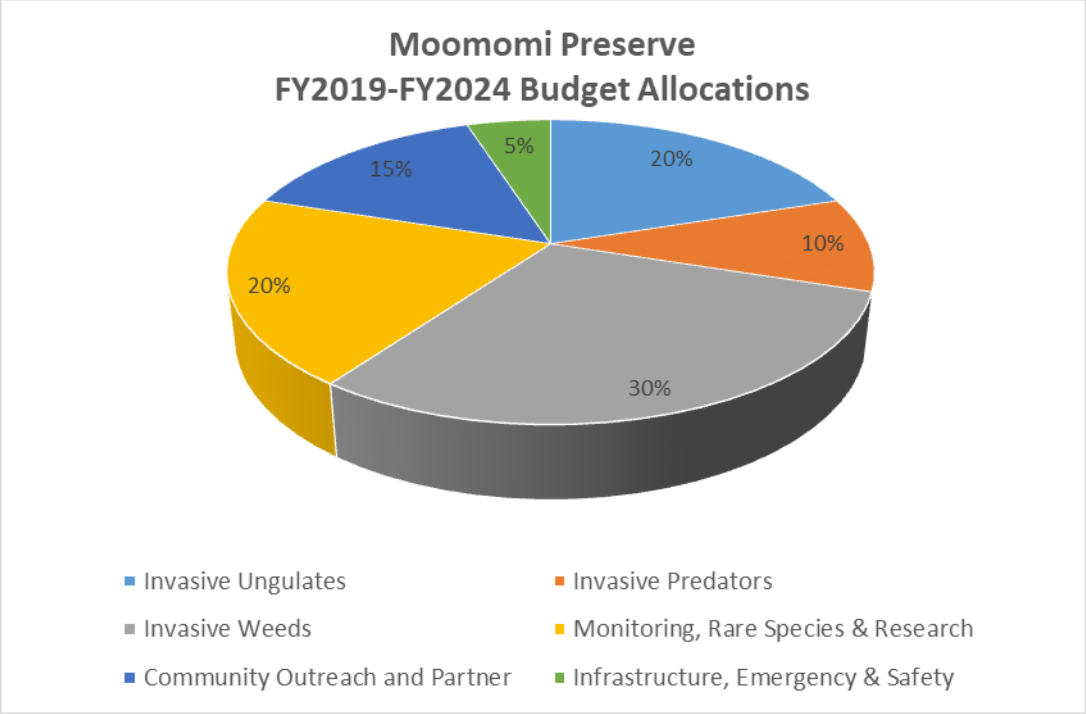


Figure 6. Moʻomomi NAPP Budget/Effort by Program, FY19–FY24

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 included 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; supplies; cost of hosting meetings. The budget includes cost of contracts to management, 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 rate (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%.

Budgetary Considerations: This Moʻomomi FY19-24 NAPP budget remains flat since the last LRMP (2013–2018), despite increased costs of inflation (fuel, etc), increased management and innovation costs since the coastal fence was installed. Should additional NAPP funding be available, it will be applied to costs identified in this Long Range Management Plan. We will report on progress on all accomplishments in Moʻomomi Preserve regardless of funding source. If NAPP reduces the annual funding amount, we will have to adjust our deliverables.

BUDGET TABLE

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
	FY2019	**FY2020**	**FY2021**	**FY2022**	**FY2023**	**FY2024**	**TOTAL**
Labor & Benefits	31,517	31,517	31,517	31,517	31,517	31,517	189,102
Contractual	30,000	30,000	30,000	30,000	30,000	30,000	180,000
Travel	500	500	500	500	500	500	3,000
Supplies	3,000	3,000	3,000	3,000	3,000	3,000	18,000
Other	600	600	600	600	600	600	3,600
Subtotal	**65,617**	**65,617**	**65,617**	**65,617**	**65,617**	**65,617**	**393,702**
Overhead	6,562	6,562	6,562	6,562	6,562	6,562	39,370
TOTAL	**72,179**	**72,179**	**72,179**	**72,179**	**72,179**	**72,179**	**433,072**
TNC 1/3 Match	24,060	24,060	24,060	24,060	24,060	24,060	144,357
Total NAPP Request (2/3)	**48,119**	**48,119**	**48,119**	**48,119**	**48,119**	**48,119**	**288,715**

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 Moʻomomi Preserve[1]

Native Natural Community	Global Rank (a)
ʻAkiʻaki *(Sporobolus virginicus)* Coastal Dry Grassland	G4
ʻAkoko (*Chamaesyce skottsbergii var. skottsbergii*) Coastal Dry Dwarf-Shrubland*	G2T2*
Hinahina (*Heliotropium anomalum*) Coastal Dry Dwarf-Shrubland	G3
ʻIlima (*Sida fallax*) Coastal Dry Dwarf-Shrubland	G3
Naupaka Kahakai (*Scaevola sericea*) Coastal Dry Shrubland	G4
Nehe (*Melanthera spp*) Coastal Dry Dwarf-Shrubland	G3
Tetramolopium rockii Coastal Dry Dwarf-Shrubland[1]	G1

[1]Rare natural community
* Currently, this community type is not tracked by NatureServe; the global ranking of the community dominated by this rare variety of ʻakoko (*Chamaesyce skottsbergii* var. *skottsbergii*) was inferred from the global ranking of the species (see Appendix 2).

(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.

[1] Last Updated: Feb 22, 2011

Appendix 2. Rare Species of Moʻomomi Preserve

Plants[1]

Scientific Name	Hawaiian/Common Name	Global Rank (a)	Status (b)
Centaurium sebaeoides	ʻāwiwi	G2	E
Chamaesyce skottsbergii var. *skottsbergii*	ʻakoko, koko, kōkōmālei	G2T2	E
Gnaphalium sandwicensium var. *molokaiense*	ʻenaʻena	G3T1	E
Marsilea villosa[2]	ʻihiʻihi, ʻihi lāʻau	G1	E
Sesbania tomentosa	ʻōhai	G2	E
Solanum nelsonii	popolo	G2	E
Tetramolopium rockii var. *calcisabulorum*	pamakani	G1T1	T
Tetramolopium rockii var. *rockii*	pamakani	G1T1	T

Animals

Chelonia mydas	honu, green sea turtle	G3	T
Eretmochelys imbricata [3]	Hawksbill sea turtle	G3	E
Neomonachus schauinslandi	Hawaiian monk seal	G2	E
Phoebastria immutabilis	Laysan albatross	G3	N/A

Invertebrates

Hylaeus anthricinus [4]	Yellow-faced bee	Present, unknown	E
Hylaeus assimulans [4]	Yellow-faced bee	GH	E
Hylaeus hilaris [4]	Yellow-faced bee	GH	E
Hylaeus longiceps [4]	Yellow-faced bee	Present, unknown	E

[1] Rare plant species occurring only outside of Moʻomomi Preserve are not included in the table below; e.g., *Chamaesyce skottsbergii* var. *vaccinioides* was reported southeast of Moʻomomi sand dunes in 1928. *Schiedea globosa* was reported near the preserve in 1915.
[2] Reported in preserve in 1970s; may still occur in preserve.
[3] Based on historical accounts by residents, occurrence not confirmed.
[4] Source: *H. anthracinus* and *H. longiceps* were observed at Moʻomomi preserve on May 19, 2017 by Sheldon Plentovich (USFWS), Jason Graham, Butch Haase, and Jeannine Rossa. The others were last reported by Karl Magnacca in his Report to The Nature Conservancy, Aug. 1999.

(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).
(b) Key to Status (Federal):
E = Taxa formally listed as endangered under the Endangered Species Act.
T = Taxa formally listed as threatened under the Endangered Species Act.
C = Taxa proposed for listing as threatened or endangered under the Endangered Species Act.

Appendix 3. Research conducted at The Nature Conservancy's Molokai 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 Moloka'i: *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 Kaua'i 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 Hawai'i 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.

<u>On-going Projects (unsure of status)</u>

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.

<u>Completed Projects and Pending Reports</u>

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 Hawai'i.

Ron Crombie, National Museum of Natural History.

Research began February 1998 and is complete. Kamakou and Mo'omomi 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 Moloka'i 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 Hawai'i.

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 Hawai'i

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 Hawaiʻi.
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 ‘i‘iwi (*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.

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