State of Hawai`i
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Forestry and Wildlife
Honolulu, Hawai`i 96813

April 21, 2011

Chairperson and Members
Board of Land and Natural Resources
State of Hawai`i
Honolulu, Hawai`i

Land Board Members:

SUBJECT: AUTHORIZATION OF FUNDING FOR MAUI LAND & PINEAPPLE COMPANY, INC. FOR $1,546,550 DURING FY12-18 FOR PUU KUKUI WATERSHED PRESERVE CONTINUED ENROLLMENT IN THE NATURAL AREA PARTNERSHIP PROGRAM AND ACCEPTANCE AND APPROVAL OF THE PUU KUKUI WATERSHED PRESERVE LONG RANGE MANAGEMENT PLAN, TMK 4-1-1-17, 4-2-1-1:por, 4-1-4-12:por, 4-1-5-10, 4-1-5-13, 4-1-5-16, 4-1-5-17, 4-3-1-1:por, 4-3-1-17:por, MAUI

SUMMARY:

This submittal requests the Board to authorize matching funding for the management of the 8,660-acre Puu Kukui Watershed Preserve as part of the Natural Area Partnership Program (NAPP). Although Natural Area Partnership agreements are made in perpetuity, funding is authorized on a six-year basis to allow for periodic State and public review. The current contract is scheduled to terminate at the end of this Fiscal Year, and Maui Land & Pineapple Company, Inc. (MLP) has prepared a new six-year management plan for Fiscal Years 2012-2018. The Division of Forestry and Wildlife (DOFAW) recommends the authorization of matching funding, in the amount of $1,546,550, to continue conservation management of the Preserve for Fiscal Years 2012-2018.

BACKGROUND:

Chapter 195-6.5, HRS established the NAPP in 1991 and authorized the Department of Land and Natural Resources (DLNR) to provide state funds on a two-for-one basis with private funds for the management of private lands that are dedicated to conservation. The program seeks to protect, restore, or enhance significant native resources of the state. Puu Kukui Watershed Preserve was the first participant in the NAPP and is one of the largest privately-owned nature preserves in the State, protecting significant watershed, endangered species, and native ecosystem resources. The Long Range Management Plan

(LRMP) (Attachment) provides a more detailed description of proposed activities and maps. MLP will be responsible for the actual implementation of the management plan.

The total budget for Fiscal Years 2012-2018 is $2,319,824. Continuing as a Preserve under the NAPP, the State would provide 2:1 matching funding for the natural area protection efforts outlined in the FY12-17 LRMP. Total State funding requested for Fiscal Years 2011-2016 is $1,546,550; MLP will provide the match of $773,274.

The plan's environmental assessment received a Finding of No Significant Impact in 2011. Conservation District Use Permit MA-2111 permits ongoing watershed and vegetation protection and Site Plan Approval MA-09-07 permits the Axis Deer Fencing Project within the Preserve.

RECOMMENDATION That the Board:

1. continue approval of the activities identified in the Puu Kukui Watershed Preserve FY 2012-2018 Long Range Management Plan;

2. authorize the continued funding for the Puu Kukui Watershed Preserve as part of the Natural Area Partnership Program for Fiscal Years 2012-2018 in the amount requested ($1,546,550);

3. authorize the Chairperson to negotiate and enter into a contract encumbering funds for a Puu Kukui Watershed Preserve Natural Area Partnership Agreement with Maui Land and Pineapple Company, Inc. for Fiscal Years 2012-2018 with the following conditions:

    a. The long range management plan is accepted for a six-year period.

    b. Funding is authorized for the full six-year period as described in the agreement, subject to annual availability of funding and annual budget procedures and approvals, and approval as to form by the attorney general's office.

Respectfully submitted,

Paul J Conry

PAUL J. CONRY, Administrator
Division of Forestry and Wildlife

APPROVED FOR SUBMITTAL:

WILLIAM J. AILA, JR., Chairperson

Pu'u Kukui Watershed Preserve
Fiscal Years 2012-2018 Management Plan

Natural Area Partnership Program

Lobelia gloria-montis
Photo: J. Ward/ML&P ©2009

PREPARED FOR

DIVISION OF FORESTRY & WILDLIFE
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE OF HAWAII
PREPARED BY

MAUI LAND & PINEAPPLE COMPANY, INC.
P. O. BOX 187
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November 2010

Pu'u Kukui Watershed Preserve
Management Plan for Fiscal Years 2012-2018
Maui Land & Pineapple Company, Inc.
Natural Area Partnership Program

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***Argyroxiphium grayanum* (Greensword)**
Photo: E. Romanchak/ML&P ©2004

Pu'u Kukui Watershed Preserve
Management Plan for Fiscal Years 2012-2018
Maui Land & Pineapple Company, Inc.
Natural Area Partnership Program

I. SUMMARY

Project Name: Pu'u Kukui Watershed Preserve (PKW) Natural Area Partnership

Proposing Agency / Applicant:
Division of Forestry and Wildlife
Department of Land and Natural Resources
State of Hawaii

Maui Land & Pineapple Company, Inc.
P. O. Box 187
Kahului, HI 96733-6687

Approving Agency:
Division of Forestry and Wildlife
Department of Land and Natural Resources
State of Hawaii

Project Location:

Pu'u Kukui Watershed Preserve, 8,661 acres in the District of Lahaina, County of Maui, State of Hawaii

Tax Map Key	Acreage
4-1-1-17	5,780.00
4-2-1-1 (portion)	2,450.38
4-1-4-23 (portion)	0.40
4-1-5-10	1.75
4-1-5-13	2.48
4-1-5-16	<0.01
4-1-5-17	<0.01
4-3-1-1 (portion)	92.00
4-3-1-17 (portion)	334.00

II. PROJECT DESCRIPTION

Background

The Pu'u Kukui Watershed Preserve (PKW or Pu'u Kukui Preserve) was established in 1988 to protect watershed forests and associated native plants and animals (Figure 1). At over 8,600 acres, the Pu'u Kukui Preserve is one of the largest privately-owned nature preserves in the state. Maui Pineapple Company, Ltd. (MPC), a subsidiary of Maui Land & Pineapple, Inc. (ML&P), began management programs in August 1988 under a management agreement with The Nature Conservancy of Hawai'i (TNCH). The Nature Conservancy assisted MPC's PKW Preserve manager to implement management programs, and has continued to act as a consultant to the project on an ad hoc basis. In July of 1992, ML&P entered into a six-year contract with the State of Hawai'i as the first private landowner participant in the Department of Land & Natural Resources' (DLNR) Natural Area Partnership (NAP) program; and renewed this contract for FY2006-2011. At this time, the current Pu'u Kukui Preserve contract (FY 2006-2011) is scheduled to be renewed in 2010 for State Fiscal Years 2012-2018; ML&P has prepared this new 6-year management plan as required by the Natural Area Partnership program and State of Hawai'i law.

A separate Environmental Assessment describing the possible impacts of management goals and planned activities for the next six years in the Pu'u Kukui Watershed Preserve has also been created and submitted to various government agencies and non-government organizations for comment and review as required by state law.

The following section of this management plan consists of a brief description of the Pu'u Kukui Preserve, overview of the native resources that are protected, and how those resources complement the Natural Area Reserve System (NARS). In the next section, management considerations that have shaped the management programs are documented. A description of each management program follows, and includes a goal statement, an explanation of the management method chosen, and a detailed timeline.

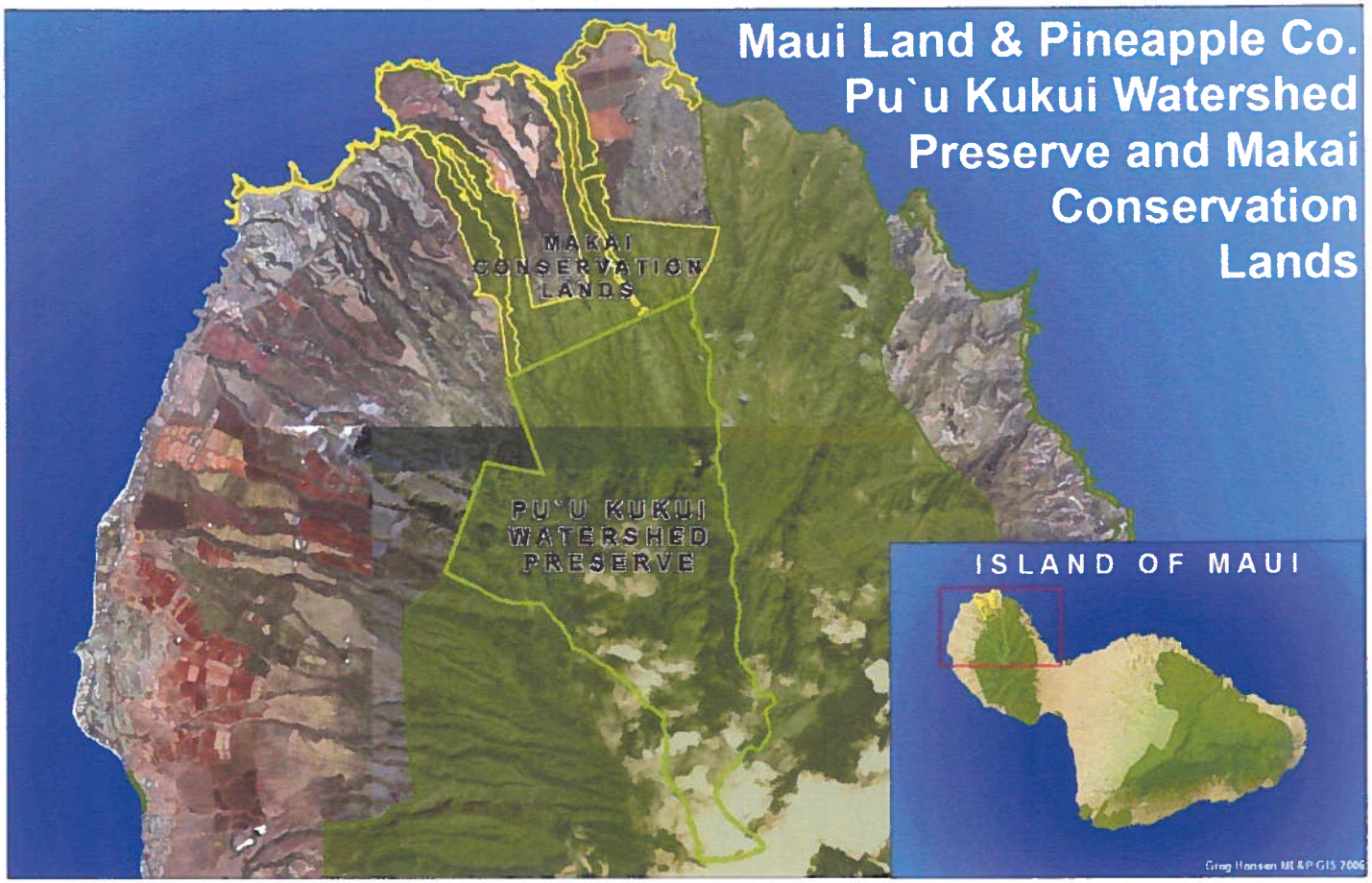


Figure 1. Maui Land & Pineapple Company Inc.'s Pu'u Kukui Watershed Preserve and Makai Conservation Lands

Summary description of the Affected Environment

Location

The Pu'u Kukui Preserve stretches from about 480 feet elevation at Honokohau Stream to the Pu'u Kukui summit - the highest point on Mauna Kahalawai (West Maui) at 5,788 feet elevation. The rain forests, shrub lands, and bogs of the Pu'u Kukui Preserve serve as a significant water source for West Maui residents and industries. ML&P and the West Maui community depends on the watershed to provide aquifer recharge and ensure adequate supply of water is available for agricultural, irrigation and domestic uses in West Maui. Native vegetation is an essential component of this watershed system. Forest cover protects fragile mountain soils from erosion, and acts like an immense sponge that absorbs heavy rains. Water is gradually released into streams and groundwater aquifers, rather than running off the surface in torrents to the sea; subsequently, ML&P's conservation efforts in the Pu'u Kukui Preserve also benefits the shoreline resources of the Honolua - Mokule'ia Marine Life Conservation District. Unique bog and stream ecosystems and native-dominated forests and shrub lands make up the majority of the watershed.

A significant amount of fresh water used by West Maui's residents, agriculture, and other commercial businesses comes from this watershed area, and active management by all West Maui landowners is needed to prevent damage to the native forests by feral ungulates (pig, goat & deer) and invading weeds. Nine strategic fences have been built cooperatively by ML&P, the State Division of Forestry & Wildlife (DOFAW), and TNCH staff in the PKW Preserve, Kahakuloa (4 fences) and Honokowai (4 fences) sections of the West Maui NAR, and the Kapunakea (1 fence) Preserve. Additionally, new fences have or are currently being constructed in cooperation with NARS and staff of the West Maui Mountains Watershed Partnership (WMMWP); a joint, public/private partnership between majority landowners of mauka conservation lands on West Maui whose intent is to protect and conserve the water and other native natural resources on their respective properties. These kinds of cooperative projects improve the efficiency of management efforts and benefit the entire Kahalawai/West Maui area.

Access to foot trails leading into the lower edge of the watershed area is mostly along private dirt roads through ML&P agricultural fields. Agricultural activities frequently involve the use of large trucks on unpaved (and often muddy) roads, making access dangerous. This, coupled with the fragile native ecosystems in the watershed, results in a policy of restricted public access to the Pu'u Kukui Preserve. There are only two roads that access the Preserve directly; the road to Haela'au Cabin at 2,980 feet elevation on Kaulalewalewa, and a dirt road east of Honokohau Valley that starts on State owned land leased for pasture use. Both are passable only by four-wheel drive vehicles.

Flora and Fauna

The Pu'u Kukui Preserve contains 15 terrestrial native natural communities (Appendix 1). These natural communities vary from lowland shrub lands to montane forests and bogs. One of these communities is considered rare, as it occurs in fewer than 20 sites worldwide: 'Ohi'a

(Metrosideros) Mixed Montane Bog. Seven of the native natural communities found in the Pu'u Kukui Preserve, including 'Ohi'a Mixed Montane Bog, are also found in the West Maui NAR.

The Pu'u Kukui Preserve is home to at least 36 species of rare plants; three other taxa endemic to West Maui also occur here (Appendix 2). Eight species of rare plants found in the PKW Preserve are listed as Endangered (E) by the U. S. Fish & Wildlife Service (USFWS). One other taxa *Clermontia oblongifolia* subsp. *mauiensis* [oha wai]) listed as Endangered potentially occurs in the Preserve, but require further study to determine their identity. Specimens have been collected and forwarded to local herbaria but the taxa are problematic taxonomically and still undetermined. Twenty-eight other rare plant species are also listed as either Candidate (C) or Species of Concern (SOC) by the USFWS.

Three native forest birds found in the PKW Preserve's forests are also found in the West Maui NAR: the 'Apapane *(Himatione sanguinea sanguinea),* 'Amakihi *(Hemignathus virens wilsoni),*and 'I'iwi *(Vestiaria coccinea).* The PKW Preserve also provides habitat for the Pueo *(Asio flammeus sandwichensis,* Hawaiian Short-eared Owl) - a USFWS Species of Concern, as well as for migratory and sea birds such as Kolea (*Pluvalis fulva*, Pacific Golden Plover), 'Ulili (*Heteroscelus incanus*, Wandering Tattler), Koa'e Kea *(Phaethon lepturus dorotheae,* White-tailed Tropicbird), the endangered 'Ua'u (*Pterodroma phaeopygia,* Hawaiian Petrel), and the Threatened Newell's shearwater or A'o (*Puffinus newellii*). Our endangered State Bird, Nene (*Nesochen sandvicensis*) has been observed several times in recent years due to the State's rearing & release program near Hana'ula, and may someday establish a breeding colony near ML&P's Haela'au Cabin on Kaulalewalewa (2980' asl.).

At least seven species of rare native tree snails and two freshwater species (see Appendix 3) have been observed and recorded in the PKW Preserve since management began in 1988. A snail species not seen on Maui for over a half-a-century; *Newcombia cumingi,* was rediscovered in the PKW Preserve in 1994 by Preserve staff. Others species may also occur within the Preserve, but have remained undetected due to small size or lack of adequate survey. Other rare invertebrate species include an endemic Hawaiian damselfly *(Megalagrion pacificum);* a candidate endangered species, as well as others (see Appendix 3). Also, Hawai'i's only endemic land mammal; the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus)* has been observed by PKW Preserve staff at various locations throughout the Preserve area.

Historical/Archeological and Cultural Sites

Although no comprehensive archaeological surveys have been conducted within the boundaries of the Pu'u Kukui Preserve, no historic sites are known to exist in the area. In the lower elevations, agricultural related structures such as ditches and terraces are likely to be present while in the higher elevations only trails and/or temporary shelters might be expected. After a preliminary review of the proposed management activities by the State Historic Preservation Division (SHPD) followed by a staff discussion between SHP and DOFAW, it was agreed that to ensure the proposed management activities would have negligible or no impact on any possible historic sites, ML&P will contact the SHP prior to the commencement of any of these activities so that SHP may inspect the

project areas if it deems necessary. No survey of the management sites is called for at this time. If PKW Preserve staff encounters any evidence of historic sites at a site of management activity, they will cease all management activity and immediately notify SHP staff to obtain their input and suggestions for any mitigation measures deemed necessary. In general, fencing provides protection for historic resources by eliminating disturbance from ungulates, which degrade sites such as *lo'i kalo* (taro plots) by rooting and trampling, or displacement of these rock walls by alien tree species. Proposed fencing projects which might be considered a source of disturbance will be of relatively short length, require minimal line cutting and will be constructed with metal T-stakes that will pose little risk to potential sites.
Restricted access will also minimize inadvertent disturbance or intentional vandalism. The bulk of the PKW Preserve was considered *wao akua* (lit. forest of the gods) by native Hawaiians and was deemed sacred; with little or no regular access by either the *maka'ainana* (commoners) or the *ali'i* (chiefs). What little access likely to occur was by certain *kahuna* (priests), *kia manu* (those trained to collect native bird feathers for an *ali'i's* cloak) or others with specific collection purposes. These cultural practices are no longer known to occur and are unlikely to be revived given the current rare & threatened status of many of Hawaii's native forest birds. Therefore; no significant negative impact on cultural resources or historic practices by native Hawaiians is anticipated from the actions delineated in this plan. Additionally, the preservation of habitats and natural communities preserve plant and animal species integral to Hawaiian culture. Many of these species are prevalent in Hawaiian song, chant, and legend, and the protection of these species to be accomplished by this management plan will help to ensure a continuing living culture.

Adjacent Natural Resources

The PKW Preserve lies between the Kahakuloa and Honokowai sections of the state's West Maui Natural Area Reserve (Figure 1). These three areas, together with the 1,264 acre Kapunakea Preserve (managed by The Nature Conservancy of Hawai'i), form 13,000 acres of contiguous forests that are protected by the programs of state and private natural area managers. According to DOFAW records, at least seven of the native natural communities found in Pu'u Kukui Preserve, including the 'Ohi'a Mixed Montane Bog, are also found in the West Maui NAR. Of the 36 rare plants found in Pu'u Kukui, 16 are also found in the West Maui NAR. Four species of land snails listed in Appendix 3 are also found in the West Maui NAR.

Additionally, in 1998, other adjacent private & public (e.g. County of Maui Board of Water Supply, State of Hawaii Dept. of Land and Natural Resources) landowners of mauka conservation lands on West Maui (Mauna Kahalawai) agreed to join together to form the West Maui Mountains Watershed Partnership (WMMWP) with the intent to conserve and protect the native biodiversity and natural resources of nearly 50,000 acres (including the Pu'u Kukui Preserve) of their adjoining lands for current and future generations.

Maui Land & Pineapple Co. Inc also owns over 3000 acres of conservation land makai of PKW Preserve (Figure 1). Conservation lands makai of the Pu'u Kukui Watershed Preserve can be addressed in three general categories, each with its own unique features. Forested

sections bordering the Preserve and upland from agricultural land range in elevation from around 640 to 1620 feet above sea level at the mauka boundary; riparian areas along Honokohau and Honolua Streams serve as major drainage ways for surface water flow from developed, agricultural and forested lands; coastal areas stretching 11.5 miles provide an interface between the marine environment and forested, agricultural and developed lands. Although a majority of the vegetation in this area is currently non-native, pockets of native plants and animals exist within the makai conservation lands. ML&P's long term goal is to increase the existing PKW Preserve by incorporating approximately 3,000 acres of conservation lands in the coastal and riparian areas makai of the current project area. The expansion of the Preserve will create one of Hawai'i's largest private mountain-to-the-sea nature preserves. Coastal and marine resources are directly affected by land use practices in the upper watersheds, therefore the inclusion of makai conservation lands will allow management of the entire watershed area, enabling holistic decision making and better protection of natural resources, with increased community outreach opportunities in accessible lands

Sensitive Habitats

The sensitive habitats and resources listed above and in the appendices are found both within and adjacent to the Pu'u Kukui Preserve. The intent of all proposed management activities is to provide long term resource protection to these habitats. Negative effects such as introduction of new weeds along newly constructed fences or monitoring transects are recognized and standardized precautions will be taken to minimize the risks. Management activities that affect adjacent sensitive habitats in State Natural Area Reserves, The Nature Conservancy of Hawai'i's Kapunakea Preserve or on other private lands within the WMMWP will be coordinated with appropriate staff from these organizations to reduce any potential negative impacts (see Appendix 6).

Management Considerations

The management goal for Pu'u Kukui Preserve is to maintain the native ecosystems as intact watershed, and protect the habitat of rare Hawaiian plants and animals. This project is a long term one consisting of several different phases. Maui Land & Pineapple Company, Inc. will be responsible for the completion of the management work. This section describes specific management strategies that will be undertaken to maintain and enhance the PKW Preserve. These strategies are shaped by the following considerations.

- The Pu'u Kukui Preserve encompasses a very large area, much of which is remote and extremely rugged. Inclement weather is the norm in the upper reaches. The Management Units have been defined by biological and topographical features (Figure 1). Priorities for management have been determined for each unit according to the extent of current disturbance, the urgency of other biological threats within and near the unit, and the feasibility of management.

- Feral ungulates remain the primary threat to the watershed, and limiting pig damage and other feral ungulate ingress is the top management priority. Prior to active management efforts, moderate to heavy damage by pigs had occurred throughout most of the watershed. Pig rooting

on the forest floor destroys plants, promotes erosion and weed invasion, threatens the stability of the watershed and introduces silt and disease to West Maui's water supply. Most weeds cannot establish themselves in undisturbed ground, but will readily grow in soil turned by pigs. Standing water collects in pig wallows and encourages the breeding of mosquitoes, which transmit bird diseases which in part, is responsible for the low numbers of native birds on West Maui. With the introduction of Axis deer to West Maui, construction of new fences and retrofit of existing fences to deter any intrusion into the Preserve is a high priority. Additionally, preventing domestic cattle from entering the watershed from adjacent pasturelands, or removal of said cattle from the watershed remains an objective as well.

- Many non-native plants observed in the watershed are shade intolerant and pose no major problem if pigs are removed and the native forest canopy and ground cover remain intact. There are several non-native weed species, however, which form monotypic stands and displace native vegetation over large areas. These habitat modifying weeds are "priority weeds" for management (Appendix 4). Weed control activities will focus on these priority weeds throughout the watershed. Due to the widespread distribution of some weed species, populations will need to be mapped and strategies determined before removal with special attention to removing incipient "satellite" (outlying) weed patches to prevent their spread.

- Access to the entire PKW Preserve area is restricted by ML&P. This policy is intended to minimize trampling of fragile soils and rare plants, prevent the spread of weeds by hikers, and protect public safety. Volunteers or other visitors will be accompanied by appropriate staff and restricted to designated areas and trails in the Preserve. Human traffic in pristine areas, especially the upper elevation bogs, will be kept to the minimum required for watershed protection.

- Management activities in the watershed that affect adjacent NARS will be coordinated with state Natural Area Reserves staff when necessary. Staff of The Nature Conservancy and the West Maui Mountains Watershed Partnership (WMMWP) will assist the PKW Preserve manager with planning and technical advice as requested. These partnerships will maximize the cost effectiveness of management efforts at the Pu'u Kukui Preserve and provide a larger pool of management expertise to draw from.

- The management goals for the makai conservation lands are to preserve and enhance native plant and animal communities, protect nearshore waters from land based pollutants, and increase community stewardship of coastal lands. These efforts compliment and strengthen the continuing efforts in the Pu'u Kukui Watershed Preserve to maintain the native ecosystems as intact watersheds and protect the habitat of rare Hawaiian plants and animals. PKW staff and crew will assist efforts in the makai conservation lands on a limited basis.

Management Unit Descriptions

The Pu'u Kukui Preserve has been divided into 19 Management Units defined by topographical and biological features (Figure 2). This increase in Management Units from 10 included in the FY2006-2011 Management Plan gives a more accurate depiction of management needs based on recorded ungulate activity levels and current fence placement. Descriptions of the units' resources, and threats to these resources, follow.

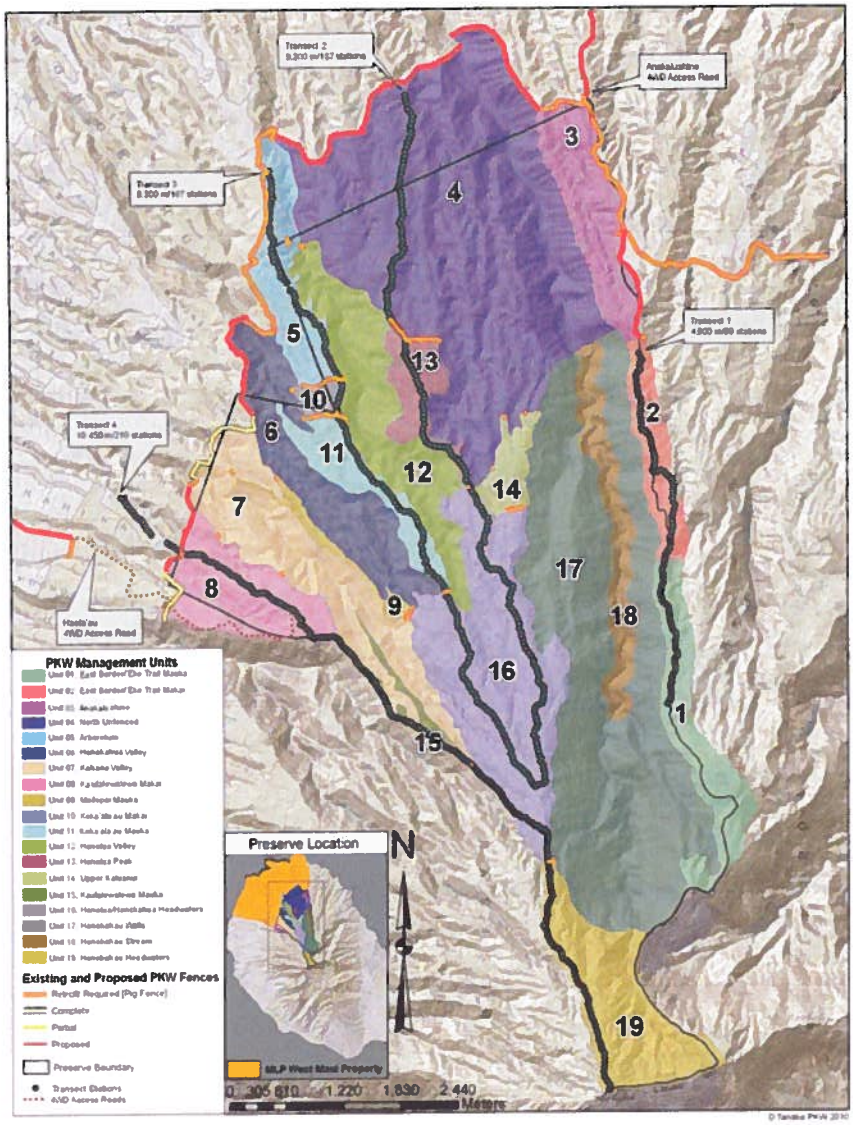


Figure 2. Pu'u Kukui Watershed Preserve Management Units.

Unit 1: East Border/Eke Trail Mauka

The East Border/Eke Trail Mauka unit is 316 acres located in the upper portion of the PKW Preserve. This unit shares most of its eastern boundary with the state's Kahakuloa section of West Maui Natural Area Reserve (NAR). The lower boundary of the unit is a strategic fence scheduled for repair in FY2011. The area has seen no ungulate activity for over 5 years. *Myrsine vacciniodies*, a Species of Concern, is present in this unit, as well as *Gardenia remyi. Tibouchina herbacea* and *Clidemia hirta* (Koster's curse) are the two most invasive weed species in this unit, and are concentrated along the 'Eke Trail. *Psidium cattleianum* is present and management may be possible. Although not yet recorded in the PKW Preserve proper, Andean Pampas grass *(Cortaderia jubata),* is known from the Kahakuloa section of the West Maui NAR immediately adjacent to Units 1-3 and is considered a serious threat to native ecosystems due to its invasive reputation in California and New Zealand. PKW Preserve staff works with the Maui Invasive Species Committee (MISC) to monitor and report new locations. Native plant communities range from montane wet shrublands along the steep upper valley walls to lowland mesic forest at the lowest elevation.

Unit 2: East Border/Eke Trail Makai

East Border/Eke Trail Makai area is 180 acres in area located along the eastern boundary of the Preserve. This area continues to be weedy with *Tibouchina herbacea* and *Clidemia hirta* (Koster's curse) along the 'Eke Trail. Pig fence separating Unit 2 and 3 located at 2200ft is in good repair. Mild pig activity has been seen within the past few years; this is a drastic reduction in pig activity over the past 6 year management period.

Unit 3: Anakaluahine

This unit covers 320 acres in the Honokohau area where heavy pig activity is seen. Although a portion of the unit is fenced, ungulates currently access the area through Honokohau Walls, Unit 17. A strategic fence is needed along Honokohau to protect the area from ungulate intrusion. PKW snaring efforts have resulted in a high number of kills. In general, this is a very weedy area, Native plant communities range from montane wet shrublands along the steep upper valley walls to lowland mesic forest at the lowest elevation.

Unit 4: North Unfenced

This unit is the largest management area at 2090 acres ranging between 1,040 and 2,920 feet elevation. ML&P's Honokohau Ditch system's #1 and #2 intakes collect surface water, respectively located in Honokohau Stream and Kaluanui Stream (the northwest drainage of Honokohau Stream). As the name implies, no fences currently exist along the makai border. Construction of axis deer fence is planned for FY 2012-2015 through a partnership with WMMWP. Formerly heavy pig damage has been reduced through pig control efforts in the past few years, however; continued pig control is needed to remove pigs that come up from lower elevations through the gulches. The

majority of pig activity within PKW occurs in this area. *Tibouchina herbacea* and *Clidemia hirta* are prevalent weeds of Unit 4. Natural communities include a range of wet and mesic community types; several populations of rare plants and animals occur throughout Unit 4. The *Cyanea magnicalyx* exclosure is located in the area; a few *Cyanea asplenifolia* occur along the boundary of Unit 13. PKW Preserve staff has assisted University of Hawai'i Plant Extinction Prevention Program with outplantings of *Cyanea magnicalyx* in this unit.

Unit 5: Arboretum

The Arboretum area covers 270 acres; prominent landmarks include Pu'u Kaeo (1,683 feet elevation). Heavy pig activity occurs below the pig fence. Due to recreational use near the area, ongoing hunting is not allowed, however periodic hunts will be conducted during trail shut downs. Live pig trapping will also be implemented to reduce pressure on the fence. Future modification is planned to retrofit the current pig fence to deer fence. Natural communities contain a variety of lowland mesic and wet forests, including remnant Koa/'Ohi'a mesic forest. Unit 5 contains one designated Special Ecological Area: the *Ctenitis squamigera* (Pauoa) exclosure fence; a USFWS Endangered species. *Tibouchina herbacea, Cinnamomum burmannii, Ardisia elliptica* are major weed species, with a few occurrences of *Rubus argutus* (Prickly Florida blackberry) and *Clidemia hirta.*

Unit 6: Honokahua Valley

The Honokahua Valley Unit is 420 acres in size. As part of future ungulate control, the proposed Phase 4 Axis Deer Fence from Alaeloa to Honokahua will connect into the Arboretum fence. Heavy pig pressure from below the fence is seen. As with the Arboretum Unit, recreational use prohibits hunting on a consistent basis. Natural communities contain a variety of lowland mesic and wet forests including remnant Koa forest.

Unit 7: Kahana Valley

The Kahana Valley unit covers 565 acres and includes the completed Phase 1 of the Axis Deer Fence project which has resulted in drastic reduction of ungulates in the area. A non-native coniferous plantation of *Cryptomeria japonica* (circa 1920) dominates the Pu'u Makani (1,970 feet elevation) summit area. Wet shrub land emerges at the 2,080 foot contour and grades into 'Ohi'a and 'Uluhe dominated wet forest at higher elevations along the ridge. *Santalum freycinetianum* (Sandalwood) occurs along Kahana Ridge which terminates into Kahana Valley. *Strongylodon ruber* occurs in this unit as well as a population of endangered *Cyrtandra munroi.* Off-road motorcycle trespass is a recurring problem in the lower reaches of Unit 7.

Unit 8: Kaulalewalewa Makai

One of only two units with direct 4-wheel drive access, the Kaulalewalewa Makai unit also marks the location of ML&P's Haela'au Cabin on Kaulalewalewa peak (2,980' ASL), and the Pu'u Kukui trail head. The Kaulalewalewa Makai unit encompasses 348 acres and borders state lands and

the Honokowai section of West Maui NAR on the southwest. Pig damage in Unit 8 has been almost nonexistent for the past several years, due to pig control activities over the past ten years. Phase 2 of the Axis Deer Fence is under construction, which extends from Honokowai Valley to Kahana Stream; closing off the valleys of Mahinahina and Kahanaiki to ungulate ingress. The endangered *Cyanea lobata* ssp. *lobata* occurs in Unit 8. *Rubus argutus* (Prickly Florida blackberry), *R. discolor* (Himalayan blackberry), and *Tibouchina herbacea* are the priority weeds; with blackberry infestation the highest of any unit due to its original introduction at Haela'au Cabin. Natural communities include a wide variety of plant community types. Unit 8 also hosts the *Newcombia cumingi* SEA; designated to protect the only known population of a rare native tree snail species rediscovered by PKW Preserve staff in 1994.

Unit 9: Mailepai Mauka

One of the smallest management units at 57 acres, Mailepai Mauka is the ridge between two existing fences. The Alaeloa fence below Unit 7 protects this area

Unit 10: Keka'ala'au Makai

At 42 acres, this management unit falls between strategic fences. The native plant community is comprised of lowland wet forest. Native plants such as *Acacia koa* dominate the upper canopy while the understory is comprised of non-native weed species. *Cinnamomum burmannii* is a predominant weed species. Little ungulate activity is seen in the area due to well maintained fences.

Unit 11: Keka'ala'au Mauka

At 187 acres, the Keka'ala'au Mauka unit contains Pu'u Keka'ala'au (2,358 feet elevation), a Special Ecological Area, comprised of such rare taxa as *Gardenia remyi,* and six endemic tree snail species.

Unit 12: Honolua Valley

Honolua Valley unit is 481 acres. A small strategic fence located in Honolua Stream is in good condition and moderate pig activity is seen mauka of the fence. Natural communities include a range of wet and mesic community types; several populations of rare plants and animals occur throughout Unit 3. Outplantings of *Cyanea magnicalyx* occur along the stream corridor. *Hibiscus kokio* also occurs in the area. Three strategic fences have been built by Preserve staff.

Unit 13: Honolua Peak

This 155 acre unit contains Honolua Peak at 2640 feet elevation. The lower boundary pig fence is in good condition and little pig activity is seen above the fence. The upper portion of the unit includes a small population of *Joinvillea ascendens* subspecies *ascendens. Cyanea aplenifolia* also occurs in the area.

Unit 14: Upper Kaluanui

102 acres of Upper Kaluanui is protected by 4 strategic fences along the makai boundary. No pig activity has been seen for many years. A population of *Cyanea asplenifolia* occurs in the area as well as rare *Gardenia remyi.* Unit 14 contains a large population of the invasive *Clidemia hirta.*

Unit 15: Kaulalewalewa Mauka

Kaulalewalewa Mauka encompases 51 acres and contains a large section of the newly constructed boardwalk. Both *Anoectochilus sandvicensis* and *Eurya sandwicensis*, located along the boardwalk, are listed as Species of Concern by the U.S. Fish & Wildlife Service. *Tibouchina herbacea* occurs along the boardwalk and its removal is a focus of volunteer service trips. This area has been ungulate free for many years.

Unit 16: Honolua/Honokahua Headwaters

At 847 acres, the Honolua/Honokahua Headwaters unit crosses between Kahana and Honolua streams. Unit 16 centers on an unnamed hill at 3,540 feet elevation, including the 4,503 foot twin peaks of Nakalalua; some upper sections of forest are in nearly pristine condition. Pig damage in Unit 16 has been reduced to zero for over ten years through intensive snaring and four strategic fences constructed between units 9, 11, 13, and 14. The Honokowai section of West Maui NAR neighbors Unit 16 to the southwest. The Pu'u Kukui boardwalk continues through this unit and contains a rain gauge situated along the Pu'u Kukui trail at the base of the upper peak of Nakalalua. Natural communities consist of 'Ohi'a-dominated montane wet forests and shrub lands. *Joinvillea ascendens* subspecies *ascendens* and *Myrsine vacciniodies*, both listed as Species of Concern by US Fish and Wildlife Service, are present in this unit. Unit 16 also includes a rare, remnant 'Ohi'a Mixed Montane Bog community on an exposed ridge at 3,600 feet. *Tibouchina herbacea* and *Rubus argutus* are the prevalent weeds.

Unit 17: Honokohau Walls

The 1675 acre Honokohau Walls unit covers the near-vertical slopes of upper Honokohau Valley wall from the 1,000 foot elevation at Honokohau Stream to the 5,000 foot elevation of the back bowl of Honokohau Valley. Consisting mostly of montane wet forest and shrub land communities, the formerly heavy pig damage has been reduced to zero except for intermittent activity restricted to the lowest reaches of the unit near ML&P's Honokohau Dam. *Tibouchina herbacea* and *Clidemia hirta* are the priority weed invasions.

Unit 18: Honokohau Stream

This 247 acre unit is comprised of Honokohau Stream's riparian corridor. One strategic fence has been built to prevent pigs from moving upslope; locked gates along the ditch hiking trail also discourage human trespass. Moderate trespassing and hunting activity is a concern in this area.

Rare plants such as *Strongylodon rubber, Pritchardia forbesiana,* and *Cyrtandra munroi* occur in the stream corridor.

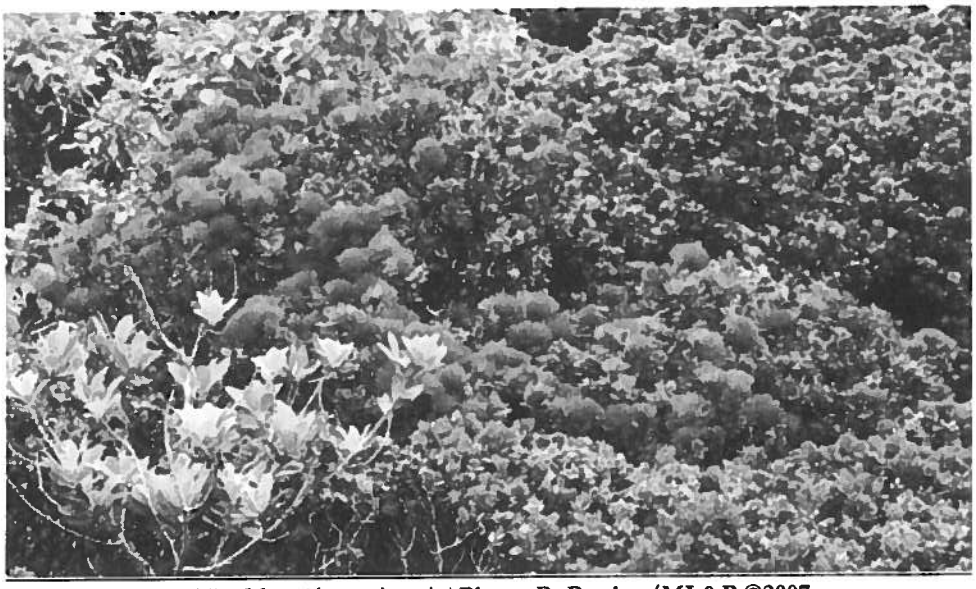
Unit 19: Honokohau Headwaters

Perhaps due to its spectacularly rugged topography, severe weather and isolation, the 471 acre Honokohau Headwaters unit has experienced the least pig damage in the watershed. However, a few pigs have historically reached the 5,788 foot Pu'u Kukui summit of Mauna Kahalawai (West Maui) and the threat of invasion into the unit along the summit approaches from adjacent properties continues to exist. Pigs that have made their way above and around Mauna 'Eke to the narrow ridge between Honokohau and Waihe'e valleys have been removed. Unit 19 ranges in elevation from 4,500 feet to the Pu'u Kukui summit and borders the Honokowai section of the NAR on the west and the Kahakuloa section of the West Maui NAR at Mauna 'Eke. It supports rare Montane Bog communities as well as a number of rare plants found only on West Maui. The 7 kilometer Pu'u Kukui boardwalk now extends through the bogs to the 5,788 foot summit and has already been shown to protect the fragile bog habitat by reducing the impacts of PKW Preserve staff, visiting researchers, and a limited number of eco-tourists traveling through the bogs. A single strategic fence has been built by PKW Preserve staff along the trail to protect Unit 19.

Management Goals & Programs

The long-range goal for each management program is listed below, followed by a brief description of the program strategies and how they will change over the six-year period covered in this plan. The goals and objectives are presented roughly in order of priority, but they fit together to form an integrated management strategy.

The management emphasis for the Pu'u Kukui Preserve in Year 1 will be the continued reduction of pig activity that has been underway for the past 22 years, and prevention of axis deer intrusion into the Preserve. Monitoring for ungulate activity and weed distribution will be maintained via utilization of the four existing transects, as well as informal survey via air and on ground. Creation of 8 ft deer-proof fencing and retrofitting of existing 4 ft pig fencing with 4 ft mesh will be a priority. Weed control in Year 1 will continue to focus on satellite populations of *Clidemia hirta,* African Tulip (*Spathodea campanulata*), and Australian tree fern (*Sphaeropteris cooperi*). Because the wide extent of *Tibouchina herbacea* infestation in the PKW Preserve, manual & chemical control of that species will be limited to select areas; such as the Pu'u Kukui trail, to keep from further vectoring of seeds along high traffic zones. Monthly volunteer service trips will help control this infestation along the trail corridor. Existing priorities to map and control other priority weeds (see Appendix 4) will be reevaluated in Year 1 and mapping undertaken as necessary; control of these other weeds will begin as resources permit.



'Ohi'a *(Metrosideros polymopha)* **Photo: R. Bartlett/ML&P ©2007**

Non-Native Invasive Species Control Program

Feral Ungulate Control

GOAL: Eliminate ungulate activity in all Pu'u Kukui Preserve management units.

ML&P has established a program to prevent pig and deer access to pristine regions and reduce pig numbers in all watershed units to zero. Progress towards this goal will be determined by the following four methods:

- Field observations of PKW Preserve staff
- Alien Threat Monitoring Transect data
- Permit Hunting Program Capture data
- Installation of strategic fencing to protect from ungulate incursion

Since 1988, 35 strategically located fences have been built to block or redirect ungulate movements (Figure 3), and snares set to remove pigs from the watershed. Feral goats, *Axis* deer and cattle have been reported adjacent to the area in past years, although currently no sign has been observed within PKW boundaries. If these animals are detected in the watershed, immediate efforts will be made to remove them. Eight foot high deer-proof fences are scheduled to be constructed at the top of former pineapple fields below the Preserve boundary to help prevent ingress of these destructive animals. Funding for the two of six phases was received through a grant from USFWS, and the Hawai'i State Department of Health has funded an additional third phase through a grant request by West Maui Mountains Watershed Partnership.

Approximately 1687 snares are currently maintained throughout the PKW Preserve, and an additional 315 snares are in adjacent Exterior Units on ML&P lands. Sixty percent of the Preserve has not seen pig activity for 5 years or more. The current monitoring system of four transects will be maintained to continue gathering information on ungulate damage throughout a larger area of the watershed. All transects will be monitored annually to determine preserve-wide levels of pig activity, and to identify areas where increased management is needed. One transect per quarter will be monitored. In addition to transect monitoring, PKW crew will perform periodic snare group maintenance checks to adjust snare numbers accordingly in response to changing levels of pig activity. Additional snares will be set where pig activity is detected, and snares will be maintained based on a schedule consistent with the amount of activity until data from monitoring programs indicate zero pig activity. Snared areas showing high activity with consistent pig kills will be checked quarterly; areas showing low pig activity and kills in less than 5 years will be checked yearly at a minimum; areas having seen no pig sign in over 5 years and the lower area is fenced or inaccessible will be removed from the monitoring program.

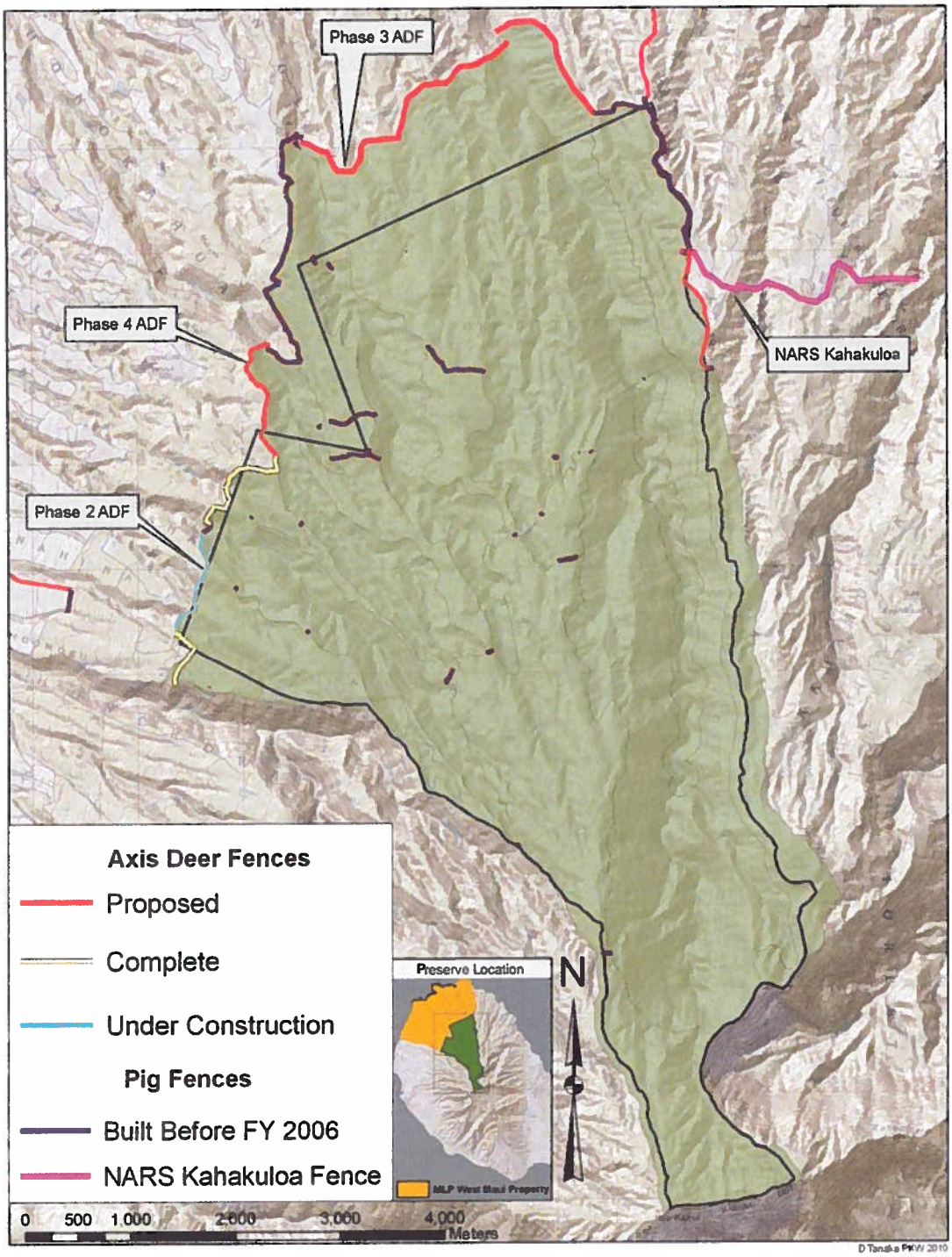


Figure 3. Pu'u Kukui Watershed Preserve Strategic & Proposed Fence Locations

ML&P employees and a limited number of public hunters are given permits to hunt on company lands below the PKW Preserve boundary. Permit hunting helps reduce the pig population below the Preserve and keeps population pressures low enough to keep pigs from moving up into the Preserve from the lower elevations in search of additional food supplies, etc. The PKW Preserve manager will maintain contact with local hunters and remind them of the opportunities for them to hunt for feral pigs on company lands below the Preserve.

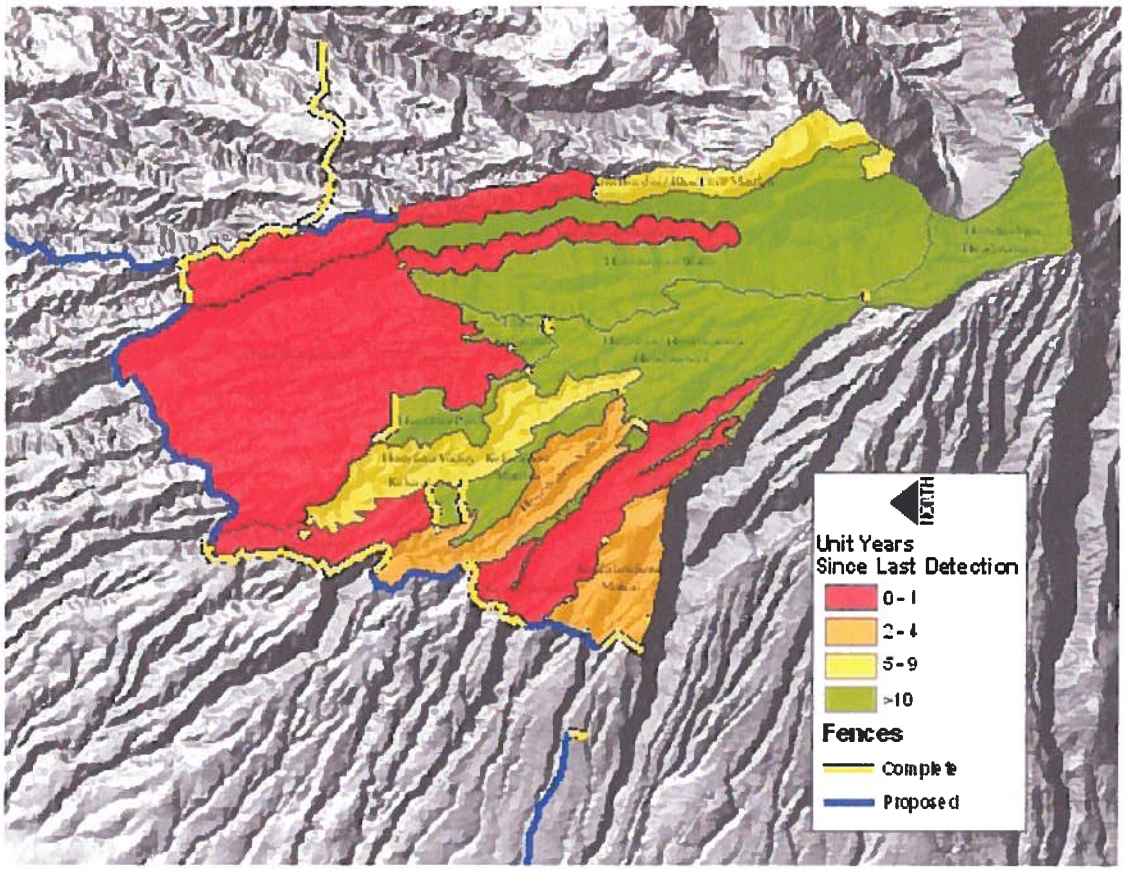


Figure 4. Pu'u Kukui Ungulate Management Units and Years Since Last Ungulate Capture.

Feral Ungulate Control Timeline

Year 1

- Maintain existing snares; replace snares as needed due to breakage, etc., and add or remove snares as necessary on a regular basis by management unit based on snaring criteria.
- Inspect and maintain 100% of 35 strategic fences annually.
- Monitor ungulate damage along 4 existing transects at least once a year.
- Continue permit hunting program below PKW Preserve boundary.
- Continue strategic Fence Project Phase 3 and complete 50%.

Year 2

- Maintain existing snares; replace snares as needed due to breakage, etc., and add or remove snares as necessary on a regular basis by management unit based on snaring criteria.
- Inspect and maintain 100% of 35 strategic fences annually.
- Monitor ungulate damage along 4 existing transects at least once a year.
- Continue permit hunting program below PKW Preserve boundary.
- Complete strategic Fence Project Phase 3.

Year 3

- Maintain existing snares; replace snares as needed due to breakage, etc., and add or remove snares as necessary on a regular basis by management unit based on snaring criteria.
- Inspect and maintain 100% of 36 strategic fences annually.
- Monitor ungulate damage along 4 existing transects at least once a year.
- Continue permit hunting program below PKW Preserve boundary.
- Begin Fence Project Phase 4 and complete 33%.

Year 4

- Maintain existing snares; replace snares as needed due to breakage, etc., and add or remove snares as necessary on a regular basis by management unit based on snaring criteria.
- Inspect and maintain 100% of 36 strategic fences annually.
- Monitor ungulate damage along 4 existing transects at least once a year.
- Continue permit hunting program below PKW Preserve boundary.
- Continue Fence Project Phase 4 and complete 66%.

Years 5/6

- Maintain existing snares; replace snares as needed due to breakage, etc., and add or remove snares as necessary on a regular basis by management unit based on snaring criteria.
- Inspect and maintain 100% of 36 strategic fences annually.
- Monitor ungulate damage along 4 existing transects at least once a year.
- Continue permit hunting program below PKW Preserve boundary.
- Begin Fence Project Phase 4 and complete 100%.

Weed Control

GOAL: Reduce the range of habitat-modifying weeds and prevent introduction of non-native plants.

Progress towards this goal will be met by concentrating weed control efforts in the following areas:

- Mapping of priority weed species, utilizing remote imagery to expand data knowledge.
- Treatment/removal of satellite populations of priority weed species.
- Treatment of incipient populations of new invasive species.
- Removal of *Tibouchina herbacea, Rubus argutus* and *Psidium cattleianum* along lower Pu'u Kukui trail.
- Monitoring of invasive species populations adjacent to PKW Preserve.
- Determining immediate threats to rare taxa or Special Ecological Areas (SEAs).
- Data entry of all control efforts.
- Identification and inventory of all vascular plant species in all PKW Preserve and Exterior Units.

Reducing disturbances to intact native vegetation will be one of the most effective methods to prevent weeds from becoming established. However, there are weeds established in the preserve that require control. The weed control strategy for the Pu'u Kukui Preserve will concentrate on controlling "satellite" populations of priority weeds and preventing further expansion of weeds into pristine areas. Incipient weed populations will be targeted for expedited eradication. Treatment of large, well established weed populations is generally not practical or cost-efficient, and these weeds are controlled only enough to prevent their further spread until existing and future biological control agents can be developed and made available. A clear and measurable weed control plan needs to be established for each species based on current range and possible expansion; weed control efforts will require an integrated program of applying known control methods, monitoring effectiveness, and refining control methods.

The 4 monitoring transects used to measure ungulate damage are also used to note all weed presence and densities using a simple Presence/Absence method. Maps showing ranges of priority weeds can be used to track the location of known populations, and to determine if the weeds are expanding their range. Transect data is entered in the PKW Preserve database (based in MS Access) for further analysis. Existing range maps include; *Acacia mearnsii, Ardisia elliptica, Cinnamomum burmannii, Clidemia hirta, Falcataria moluccana, Morella (Myrica) cerifera, Passiflora ligularis, Rubus argutus,* R. *discolor, Sphaeropteris cooperi, Spathodea campanulata, Tibouchina herbacea*, among others. Existing maps and additional maps of priority weed species will be updated on an annual basis as deemed necessary. PKW will participate with West Maui Mountains Watershed Partnership to undergo imagery analysis and training led by Hawai'i Resource Mapping.

The use of chemical control methods will be minimized and only herbicides approved for use in watersheds will be used. All staff will undergo required pesticide application training to maintain their existing Hawai'i Department of Agriculture (HDOA) Commercial Pesticide Applicator licenses. Weed control is labor-intensive and benefits from technologically sophisticated techniques, and will require technical support from the University of Hawai'i Cooperative Extension Service, the National Park Service, and other researchers. The development of biological control methods for priority weeds by programs underway in the U. S. Forest Service, National Park Service and at the HDOA will be encouraged by making study sites available as requested. Deployment of these control agents will be made whenever they are available. PKW Preserve staff will continue to discuss and map weed species, locations, and control methods with TNCH & WMMWP.

ML&P will continue its ongoing policy of field equipment & gear sanitization to prevent the introduction and spread of new and/or established weeds in the PKW Preserve. Those who enter the watershed area will be required to clean their clothing, boots, equipment and camping gear of soil and plant material to prevent weed introduction. Wherever possible, helicopter flights into the watershed will originate from weed free areas such as wooden platforms or pavement, and all materials hauled into the watershed will be inspected and cleaned to remove soil, plant material, and insects. Helicopter landing sites and areas frequented by staff will be inspected for new weed species each trip.

A 7 kilometer boardwalk has been built over severely damaged sections of the Pu'u Kukui trail to reduce the spread of weeds into the pristine bog areas of Units 15, 16 and 19. Much of the higher elevation trail crosses boggy areas with very fragile ground cover. In some areas hikers had created 20 foot wide paths to avoid sinking in the deep mud. Delicate native ground-cover and rare endemic plants were being destroyed and weeds were spreading along the disturbed trail corridor. The newly extended boardwalk now runs from Haela'au cabin to the summit of Pu'u Kukui. Pu'u Kukui Preserve staff and volunteers continue to manually remove all *Tibouchina* in a narrow 5 meter wide corridor along the first mile of Pu'u Kukui Trail during volunteer service trips.

Although the extent of *Tibouchina herbacea* infiltration of the Pu'u Kukui Preserve has rendered manual and chemical controls in large part futile, the Preserve staff will continue to treat satellite populations that are found in the SEAs, immediately surrounding rare taxa, and along the lower Pu'u Kukui trail.

Weed Control Timeline

Year 1

- Continue participation in MISC to promote biological control solutions to widespread *Tibouchina herbacea* and other eradication strategies for other priority invasive species in the PKW Preserve.
- Continue implementing biological control agents as available targeting any aggressive invasive species.
- Continue satellite population control of priority weed species as opportunities present themselves.
- Continue control of weeds threatening rare taxa or SEAs. Treat as opportunities present themselves.
- Continue eradication of incipient populations of invasive weeds in and immediately adjacent to the Preserve on ML&P lands and/or with approval from adjacent landowners.
- Continue control of priority weed species along Pu'u Kukui trail corridor. Treat 25% of trail corridor annually.
- Continue monitoring weed presence along 4 existing transects (see ungulate control section, complete 1 transect per quarter).
- Update 100% of lists & range maps of prevalent and priority weeds annually.
- Update control efforts in the PKW Preserve Database on a weekly basis.

Year 2

- Continue participation in MISC to promote biological control solutions to widespread *Tibouchina herbacea* and other eradication strategies for other priority invasive species in the PKW Preserve.
- Continue implementing biological control agents as available targeting any aggressive invasive species.
- Continue satellite population control of priority weed species as opportunities present themselves.
- Continue control of weeds threatening rare taxa or SEAs. Treat as opportunities present themselves.
- Continue eradication of incipient populations of invasive weeds in and immediately adjacent to the Preserve on ML&P lands and/or with approval from adjacent landowners.
- Continue control of priority weed species along Pu'u Kukui trail corridor. Treat 25% of trail corridor annually.
- Continue monitoring weed presence along 4 existing transects (see ungulate control section, complete 1 transect per quarter).
- Update 100% of lists & range maps of prevalent and priority weeds annually.

- Update control efforts in the PKW Preserve Database on a weekly basis.

Years 3 / 4

- Continue participation in MISC to promote biological control solutions to widespread *Tibouchina herbacea* and other eradication strategies for other priority invasive species in the PKW Preserve.
- Continue implementing biological control agents as available targeting any aggressive invasive species.
- Continue satellite population control of priority weed species as opportunities present themselves.
- Continue control of weeds threatening rare taxa or SEAs. Treat as opportunities present themselves.
- Continue eradication of incipient populations of invasive weeds in and immediately adjacent to the PKW Preserve on ML&P lands and/or with approval from adjacent landowners.
- Continue control of priority weed species along Pu'u Kukui trail corridor. Treat 25% of trail corridor annually. Continue monitoring weed presence along 4 existing transects (see ungulate control section, complete 1 transect per quarter).
- Update 100% of lists & range maps of prevalent and priority weeds annually.
- Update control efforts in the PKW Preserve Database on a weekly basis.

Years 5 / 6

- Continue participation in MISC to promote biological control solutions to widespread *Tibouchina herbacea* and other eradication strategies for other priority invasive species in the PKW Preserve.
- Continue implementing biological control agents as available targeting any aggressive invasive species.
- Continue satellite population control of priority weed species as opportunities present themselves.
- Continue control of weeds threatening rare taxa or SEAs. Treat as opportunities present themselves.
- Continue eradication of incipient populations of invasive weeds in and immediately adjacent to PKW Preserve on ML&P lands and/or with approval from adjacent landowners.
- Continue control of priority weed species along Pu'u Kukui trail corridor. Treat 25% of trail corridor annually.
- Continue monitoring weed presence along 4 existing transects (see ungulate control section, complete 1 transect per quarter).
- Update lists & range maps of prevalent and priority weeds annually.
- Update control efforts in the PKW Preserve Database on a weekly basis.

Monitoring and Research

GOAL: ***To track biological and physical resources in the watershed and evaluate changes in these resources over time; to identify new threats to the watershed; to provide logistical support to approved research projects that will improve management understanding of the watershed's resources.***

Scientific monitoring is needed to measure the effectiveness of management programs, and the condition of natural resources within the watershed. The monitoring transects mentioned in the non-native species control sections evaluate those programs as well as 17 long-range monitoring vegetation plots and over a dozen photo-point monitoring stations established over the past 16 years. Additional monitoring which may be needed to track the major resources and threats to these resources within the watershed may be implemented. The PKW Preserve staff will participate in joint USFWS/DOFAW forest bird census training exercises as well as actual monitoring of forest bird resources on Mauna Kahalawai (West Maui); assisting with Haleakala (East Maui), and Moloka'i censuses as time allows. PKW Preserve staff will also continue data collection and maintenance of its database and biological inventory. USGS maintains a weather station at the summit of Pu'u Kukui. PKW staff maintains and monitors two rain gauges at Nakalalua and Kaulalewalewa on a monthly basis.

Scientific research in Pu'u Kukui Preserve benefits ML&P; in that increased knowledge should result in better management decisions by Preserve staff to protect the Preserve's natural resources, as well as society in general; as a better understanding of our planet's complex biodiversity could result in better management decisions that should ultimately serve to protect Earth's natural resources for generations to come. However, unfettered research access could have negative impacts on Preserve resources. Therefore; all scientific research will be allowed on a permit basis only. The PKW Preserve manager & staff will evaluate all research proposals for potential direct and indirect impacts on the watershed and its resources. Proposed projects will also be evaluated based on the pertinence of the research. Only those projects deemed safe to the resources and of high priority will be allowed. Only researchers from accredited and valid organizations and agencies will be permitted access to the Preserve and its natural resources.

USGS weather station @ Pu'ukukui, Mauna Kahalawai, Maui, Hawai'i
Photo: G. Hansen/ML&P ©2004

Monitoring and Research Timeline

Year 1

- Continue providing logistical support, on a noninterference basis, for approved research projects in the watershed.
- Continue updating photo-monitoring point stations as schedule allows.
- Conduct at least one remote survey trip annually to identify & inventory native resources and threats to same.
- Maintain two rain gauge stations at Nakalalua and Kaulalewalewa on a monthly basis.
- Continue to gather GPS coordinates for all infrastructure, rare element occurrences, priority weeds, etc. for inclusion in the PKW GIS.
- Participate in USFWS/DOFAW forest bird census on Maui.

Year 2

- Continue providing logistical support, on a noninterference basis, for approved research projects in the watershed.
- Continue updating photo-monitoring point stations as schedule allows.
- Conduct at least one remote survey trip annually to identify & inventory native resources and threats to same.
- Maintain two rain gauge stations at Nakalalua and Kaulalewalewa on a monthly basis. Continue to gather GPS coordinates for all infrastructure, rare element occurrences, priority weeds, etc. for inclusion in the PKW GIS.
- Participate in USFWS/DOFAW forest bird census on Maui.

Years 3/4

- Continue providing logistical support, on a noninterference basis, for approved research projects in the watershed.
- Continue updating photo-monitoring point stations as schedule allows.
- Conduct at least one remote survey trip annually to identify & inventory native resources and threats to same.
- Maintain two rain gauge stations at Nakalalua and Kaulalewalewa on a monthly basis. Continue to gather GPS coordinates for all infrastructure, rare element occurrences, priority weeds, etc. for inclusion in the PKW GIS.
- Participate in USFWS/DOFAW forest bird census on Maui.

Years 5/6

- Continue providing logistical support, on a noninterference basis, for approved research projects in the watershed.
- Continue updating photo-monitoring point stations as schedule allows.
- Conduct at least one remote survey trip annually to identify & inventory native resources and threats to same.
- Maintain two rain gauge stations at Nakalalua and Kaulalewalewa on a monthly basis. Continue to gather GPS coordinates for all infrastructure, rare element occurrences, priority weeds, etc. for inclusion in the PKW GIS.
- Participate in USFWS/DOFAW forest bird census on Maui.

Rare Species Protection

GOAL: To prevent the extinction of rare species in the watershed.

Protection of the Pu'u Kukui Preserve's natural communities is essential to protecting the rare native species that depend on these ecosystems for survival. In addition, more rare species may be discovered in new areas of the watershed with further exploration. However, particularly rare plants and animals may need more immediate attention and direct management than current habitat protection measures and programs provide.

The goal of this program is to identify the rarest species and threats to them, and implement management to prevent their loss. Surveys of flora and fauna will be conducted in-house by PKW Preserve staff and visiting biologists at substantial savings over contracted consultants, however; the PKW Preserve manager will not hesitate to hire appropriate expert consultants as needed to assist the Preserve staff in protecting rare taxa from the threat of extinction. Programs such as *in situ* exclosure fences, *ex situ* propagation and restoration of rare taxa will be implemented as determined necessary or as opportunities arise to enhance the viability of rare species. PKW staff will work with the Maui PEP coordinator as requested and as staff time allows. Access for PEP management will continue as requested. PKW efforts will also focus on protection of aquatic flora and fauna such as *Lentipes concolor* (Hawaiian Red-Tailed Goby), a US Fish & Wildlife Listed Species of Concern. Opportunities will be explored for riparian improvements or modifications to current in stream structures to facilitate and improve passage for native fish and invertebrates.

Non-native insects, mollusks and small mammals (rats, mongooses, feral cats, etc.) are poorly understood but widely acknowledged threats to native species and ecosystem stability. Ants, yellow jackets (*Vespula* spp.) and snails like *Euglandina rosea* (Rosy wolf snail) have displaced native invertebrate fauna at lower elevations. PKW crew will continue to monitor for species and note elevation gains of threats such as *Euglandina rosea* (Rosy wolf snail), with control of populations where appropriate and possible such as treatment of *Vespula* nests.

Endangered *Ctenitis squamigera* (Pauoa fern)
Photo: H. Oppenheimer/ML&P ©2004

Rare Species Protection Timeline

Year 1

- Collection & delivery of appropriate taxa propagules to appropriate facilities (e.g. University of Hawaii's Lyon Arboretum, National Tropical Botanical Garden [NTBG]).
- Maintain information exchanges with leading conservation organizations regarding biological resources and threats on Maui.
- Continue to survey for new plant & animal populations with in-house staff.
- Perform biological monitoring of Honolua and Honokohau stream systems and assess feasibility of riparian and stream improvements or modifications to improve native fish and invertebrate passage.
- Note presence of non-native insects, mollusks and small mammals and control satellite populations when possible.
- Continue to map rare species and include in PKW GIS. 100% of known rare species mapped annually.
- Maintain PKW Preserve Database of rare species on a biweekly basis.
- Continue maintenance of *Ctenitis squamigera* SEA on a biannual basis.

Year 2

- Continue collection & delivery of appropriate taxa propagules to appropriate facilities (e.g. University of Hawaii's Lyon Arboretum, NTBG).
- Maintain information exchanges with leading conservation organizations regarding biological resources and threats on Maui.
- Continue to survey for new plant & animal populations with in-house staff.
- Obtain permits and funding to support riparian and stream improvements or modifications to improve native fish and invertebrate passage.
- Continue to map rare species and include in PKW GIS. 100% of known rare species mapped annually.
- Note presence of non-native insects, mollusks and small mammals and control satellite populations when possible.
- Maintain PKW Preserve database of rare species on a biweekly basis.
- Continue maintenance of *Ctenitis squamigera* SEA on a biannual basis.

Years 3/4

- Continue collection & delivery of appropriate taxa propagules to appropriate facilities (e.g. University of Hawaii's Lyon Arboretum, NTBG).
- Maintain information exchanges with leading conservation organizations regarding biological resources and threats on Maui.
- Continue to survey for new plant & animal populations with in-house staff.

- Installation of riparian and stream improvements or modifications to improve native fish and invertebrate passage.
- Continue to map rare species and include in PKW GIS. 100% of rare species mapped annually.
- Note presence of non-native insects, mollusks and small mammals and control satellite populations when possible.
- Maintain PKW Preserve Database of rare species on a biweekly basis.
- Continue maintenance of *Ctenitis squamigera* SEA on a biannual basis.

Years 5/6

- Continue collection & delivery of appropriate taxa propagules to appropriate facilities (e.g. University of Hawaii's Lyon Arboretum, NTBG).
- Maintain information exchanges with leading conservation organizations regarding biological resources and threats on Maui.
- Continue to survey for new plant & animal populations with in-house staff.
- Conduct biological monitoring of Honolua and Honokohau stream systems to determine impacts of riparian and stream improvements or modifications to improve native fish and invertebrate passage.
- Continue to map rare species and include in PKW GIS. 100% of known rare species mapped annually.
- Note presence of non-native insects, mollusks and small mammals and control satellite populations when possible.
- Maintain PKW Preserve Database of rare species on a biweekly basis.
- Continue maintenance of *Ctenitis squamigera* SEA on a biannual basis.
- Continue maintenance of *Newcombia cumingi* SEA on a biannual basis.

Community Outreach and Educational Opportunities

Goal: ***To expose the community to projects focusing on preserving and enhance native plant and animal communities.***

Because community exposure to Pu'u Kukui Watershed Preserve is restricted to monthly volunteer service trips and scheduled hikes, limited opportunities exist to engage the community in hands on activities. Establishing and enhancing native plant and animal communities in the makai conservation areas has multiple benefits to the PKW Preserve. As mentioned previously, the long term goal is to expand the PKW Preserve to include these makai conservation areas to create a complete mountain-to-sea system enabling management decisions based on the entire watershed area. Engaging the community as stewards for reestablishment of native habitat through restoration projects and the control of invasive plant and animal species benefits overall watershed health with minimal input required from the PKW crew. Most of the makai conservation projects are grant based or privately funded and rely on volunteer labor and greatly benefit from PKW crews' experience and expertise. Projects based in the makai conservation lands allow for greater exposure of conservation efforts to a wider audience. We plan to offer educational and volunteer opportunities through these reforestation efforts as a chance to increase both community stewardship and awareness of conservation efforts throughout ML&P lands.

One example of restoration projects is a Forestry Stewardship Project in the Honolua ahupua'a; which focuses on restoring a 30 acre pineapple field to native dryland forest. By establishing permanent native groundcover we hope to improve watershed functions by minimize erosion, provide filtration for runoff and give added protection to riparian areas. Reestablishing native forest will positively impact native wildlife in the area by enhancing and increasing habitat. An additional benefit is increasing the seed bank for native plants at various elevations throughout the watershed.

Another outreach opportunity focuses on the wedge-tailed shearwater or *'ua'u kani* (*Puffinus pacificus*) colony at Hawea Point. It is one of the largest colonies in Maui Nui, partly due to protection efforts of ML&P. Daily trapping to remove feral cats and mongoose has been ongoing for the past few years by ML&P staff. Coastal restoration projects involving community stewardship have also been undertaken to restore nesting habitat for the migratory seabirds. PKW crew has offered support to these efforts on a limited basis. To maintain the success of the nesting colony, ML&P will continue to participate in community outreach events, predator control, invasive species removal and native planting projects as well as assisting DLNR with biannual 'ua'u kani banding efforts and colony monitoring.

Community Outreach and Educational Opportunities Timeline

Year 1

- Lead monthly volunteer service trip for community volunteers
- Protection of 'ua'u kani colony at Hawea Point through support of reforestation projects, predator control and assisting DLNR with ongoing monitoring.
- Assist quarterly with native reforestation projects in makai conservation lands.

Year 2

- Lead monthly volunteer service trip for community volunteers
- Protection of 'ua'u kani colony at Hawea Point through support of reforestation projects, predator control and assisting DLNR with ongoing monitoring.
- Assist quarterly with native reforestation projects in makai conservation lands.

Years 3/4

- Lead monthly volunteer service trip for community volunteers
- Protection of 'ua'u kani colony at Hawea Point through support of reforestation projects, predator control and assisting DLNR with ongoing monitoring.
- Assist quarterly with native reforestation projects in makai conservation lands.

Years 5/6

- Lead monthly volunteer service trip for community volunteers
- Protection of 'ua'u kani colony at Hawea Point through support of reforestation projects, predator control and assisting DLNR with ongoing monitoring.
- Assist quarterly with native reforestation projects in makai conservation lands.

Watershed Partnerships

GOAL: ***To assist the long-term management of the native ecosystems of West Maui by the West Maui Mountains Watershed Partnership***

Maui Land & Pineapple Co. Inc has been an active partner of the West Maui Mountain Watershed Partnership since it's creation in 1998. The WMMWP provides protection for about 50,000 acres on West Maui administered by a coordinator and field crew; program activities such as fencing, ungulate removal, weed control and resource monitoring closely mirror PKW management. As such, PKW will continue to offer support by collaborating on projects that meet the common goals of the partnership and actively participating in partnership meetings to set priorities for WMMWP. Specifically, PKW will partner with WMMWP field crew to construct Axis Deer Fence Phase 3 along the Preserve's makai boundary from Honolua to Honokohau streams (Figure 3). The staff will continue to exchange technical knowledge to improve capacity of the partnership as a whole. Costs associated with this management goal are covered under other management programs such as invasive species control, monitoring and outreach and education.

As part of interagency collaboration, the PKW crew also supports efforts of watershed partnerships throughout the state and takes opportunities to work together to promote the exchange of ideas and resource sharing. PKW will continue to pursue opportunities with East Maui Watershed Partnership, the Leeward Haleakala Watershed Restoration Partnership, and the West Maui Mountains Watershed Partnership as well as other watershed management entities.

PKW Preserve Boardwalk **Photo: C. Jersabek ©2001-04**

Facilities and Operating Expenses

GOAL: To provide adequate manpower and equipment to meet the goals and objectives of this plan.

The Pu'u Kukui Preserve manager is responsible for the implementation of this plan. The volume of work outlined in this plan requires the PKW Preserve manager to be assisted by one Field Operations Supervisor and three full-time Field Technicians. The current staffing level consists of one management position and three full-time PKW Preserve Field Technicians. In order to complete goals and objectives outlined in this plan, additional staff will need to be hired. The addition of a Field Operations Supervisor to the existing staff in Year 2 and a summer intern hired for a three month period during Year 1, Year 5 and Year 6 will help ensure that schedules can be met and longer trips can be made into the remote watershed areas, reducing helicopter time and creating more efficient working schedules. Contract labor may also be utilized to provide more than one additional person at a time, for labor-intensive trips, such as fence, boardwalk or platform/shelter construction and installations. Planning and Technical Assistance funds budgeted will cover consultant fees for technical assistance

PKW Preserve staff will attend regularly scheduled emergency training courses offered by ML&P, DOFAW, National Park Service, and the American Red Cross. Staff will attend refresher emergency training courses on an annual basis or as required to maintain certifications.

Volunteers can help reduce management costs of labor-intensive tasks such as fence construction, weed control, and trail maintenance. However, working conditions in remote sections of the Pu'u Kukui Preserve can be hazardous and adequate safety training and supervision for volunteers must be provided. Also, sufficient insurance coverage should be in place for all volunteers (additional insurance costs are not shown in the following volunteer costs). The PKW Preserve staff will cultivate and schedule volunteers to assist with appropriate watershed projects. Within the PKW Preserve, volunteer group size will be limited to minimize impact on fragile trails or habitat and volunteers will be escorted by Preserve staff in order to support the policy of keeping the watershed closed to the general public. Volunteer trips to the makai conservation lands will be utilized for larger groups and those unable to manage uneven terrain and strenuous activity, such as school children and elderly participants.

ML&P currently provides space for the Pu'u Kukui Preserve staff and equipment storage needs, and associated costs as "facilities". Other facilities in the PKW Preserve are needed to improve management efficiency. The Haela'au Cabin, located at the top of a 4-wheel drive road to the Pu'u Kukui trailhead at Kaulalewalewa, is used by PKW Preserve staff, volunteers and visiting researchers for lower elevation work. Annual maintenance of the cabin is needed to keep the building (built circa 1925) in usable condition. Seven (6 - 20'x20', 1 - 12'x12') wooden helicopter landing platforms have been established provide safe landing zones, to protect fragile vegetation from helicopter landings, and to prevent the establishment of additional weeds. Maintenance of the platforms will be performed on an as needed basis; additional camp platforms/helicopter landing

zones (LZ) may be installed as needed. Two LZ platforms have been placed along the Pu'u Kukui trail at "1st" Bog (8'x12') and at the Pu'u Kukui summit bog (12'x16') to provide safer helicopter operations as well as reducing the impacts of such landings on the fragile bog vegetation. All construction in the Conservation District will comply with current state regulations and NAP program rules.

Currently, the PKW Preserve has three dedicated 4-wheel drive vehicles to provide access to the watershed's lower areas and helicopter pickup sites by Preserve staff and manager. As new staffing is added to fulfill expanded Preserve operational requirements, additional 4-wheel drive vehicles dedicated to the Preserve's management may be needed to ensure regular transportation to and from work sites.

Road and trail maintenance is needed to keep the main ground access routes to the watershed open; principally the 4-wheel drive to Haela'au Cabin, and the Pu'u Kukui Trail on the watershed's southwest boundary. Heavy winter rains cause erosion and washouts on the road, and periodic maintenance is needed to fill potholes and improve drainage to lessen erosion on the only regularly used vehicle access to the watershed. The lower portion of the 7 kilometer boardwalk over the length of the Pu'u Kukui trail has recently been completed and is in great shape. The entire boardwalk is in good condition and routine maintenance and repair will be performed as necessary.

Socioeconomic

This project currently provides full-time employment for four ML&P employees with a projected increase to five full-time PKW Preserve staff as well as temporary interns. Additionally, the bulk of project expenditures are projected to stay in the local economy. Services, such as helicopter charter, are with locally owned & operated companies. Supplies are purchased locally whenever possible.

In addition, the rain forests and bogs of Pu'u Kukui serve as a stable water source for West Maui residents and industries. As stated previously, ML&P and the West Maui Community depend on the watershed to provide aquifer recharge and ensure adequate supply of water is available for agricultural, irrigation and domestic uses in West Maui. Native vegetation is an essential component of this watershed system. Forest cover protects fragile mountain soils from erosion, and acts like an immense sponge that absorbs heavy rains. Water is gradually released into streams and groundwater aquifers, rather than running off the surface in torrents to the sea. Subsequently, ML&P's conservation efforts in the Pu'u Kukui Preserve are also expected to benefit both the recreational and natural resources of the Honolua - Mokulei'a Marine Life Conservation District.

Preservation of biodiversity has been recognized as a legitimate and necessary goal for society. This project provides multiple opportunities to protect and preserve examples of unique natural ecosystems and endemic native species. When appropriate, volunteers will be utilized in various management projects thus providing educational and recreational opportunities for the

general public. Additionally, the Public Hunting Program provides recreational opportunities for those that qualify to participate, and allows local families to supplement their diet with wild game.

Environmental

This project is expected to create positive impacts on the environment in the form of maintaining or enhancing water quality, maintaining or enhancing native ecosystem habitats, maintaining or enhancing biological diversity. The maintenance of natural "view planes" will enhance the aesthetics of the area. A short term increase in noise levels will occur when helicopters are used to transport staff and supplies to remote areas. Pilots will be instructed to follow flight paths that avoid residential areas according to FAA guidelines.

III. BUDGET SUMMARY

PKW Budget Summary	Effort	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Ungulate Control	(50%)	174,871	181,865	189,140	196,706	204,574	212,757
Monitoring & Research	(20%)	69,948	72,746	75,656	78,682	81,830	85,103
Weed Control	(10%)	34,974	36,373	37,828	39,341	40,915	42,551
Rare Species Protection	(5%)	17,487	18,187	18,914	19,671	20,457	21,276
Outreach & Education	(5%)	17,487	18,187	18,914	19,671	20,457	21,276
Facilities & Operating Expenses	(10%)	34,974	36,373	37,828	39,341	40,915	42,551
TOTAL		**$349,741**	**363,731**	**378,280**	**393,411**	**409,148**	**425,513**

NAP Program Match	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
PKW Preserve Budget	**$349,741**	**363,731**	**378,280**	**393,411**	**409,148**	**425,513**
Private Match (1/3 of total)	-116,580	-121,244	-126,093	-131,137	-136,383	-141,838
TOTAL NAP REQUEST (2/3)	**$233,161**	**242,487**	**252,187**	**262,274**	**272,765**	**283,676**

Trematolobelia macrostachys **(Koli'i) Photo: E. Romanchak/ML&P ©2004**

IV. LIST OF PREPARERS

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This Pu'u Kukui Watershed Preserve Long Range Management Plan was prepared by ML&P's Pu'u Kukui Watershed department staff. This plan has been submitted to the Natural Area Reserves System Commission for consideration as a Natural Area Partnership Program (NAPP) project for state fiscal years 2012 through 2018.

Strongylodon ruber (Nuku'i'iwi)
Photo: David Liittschwager & Susan Middleton ©2004
"Remains of a Rainbow"

APPENDIX 1

Natural Plant Communities of the Pu'u Kukui Watershed Preserve

As described by Gagne and Cuddihy in the *Manual of the Flowering Plants of Hawai'i,* the floristic composition of the islands can be classified according to environmental situation and the dominance of particular components. *Principal community types* - presented here in **boldface** -are general groupings based on elevation, moisture and physiognomy regimes. Within the principal community types are found unique plant communities, which are named according to their respective dominant components. Seventeen unique plant communities within eight principal community types are found within the lowland and montane regions of the PKW Preserve. Only native dominated communities are listed here:

Lowland Mesic Shrubland
- *'Ohi'a (Metrosideros)* Lowland Mesic Shrubland
- *Pukiawe/A'ali'i (Styphelia/Dodonaea)* Lowland Mesic Shrubland

Lowland Mesic Forest
- *'Ohi'a (Metrosideros)* Lowland Mesic Forest
- *Papala/Papala kepau (Charpentiera/Pisonia)* Riparian Forest
- *Lama/'Ohi'a* (Diospyros/Metrosideros) Lowland Mesic Forest

Lowland Wet Shrubland
- *Mamaki (Pipturus)* Wet Shrubland

Lowland Wet Forest
- *'Ohi'a/Uluhe (Metrosideros/Dicranopteris)* Fern Forest
- *'Ohi'a (Metrosideros)* Lowland Wet Forest
- *'Ohi'a/Olapa (Metrosideros/Cheirodendron)* Lowland Wet Forest
- *Koa/'Ohi'a (Acacia/Metrosideros)* Lowland Forest

Montane Wet Sedgelands
- *Carex* Sedgeland

Montane Wet Mixed Communities
- *'Ohi'a (Metrosideros)* Montane Wet Mixed Community
  - Subtype: *'Ohi'a/Kuolohia/Oreobolus* Mixed Bog

Montane Wet Shrubland
- Mixed Fern Shrubland
- *'Ohi'a (Metrosideros)* Montane Wet Shrubland

Montane Wet Forest
- *'Ohi'a (Metrosideros)* Montane Wet Forest

APPENDIX 2.1

Rare Plants of the Pu'u Kukui Watershed Preserve As Listed by the U.S. Fish & Wildlife Service

Endangered:

1. *Alectryon macrococcus* var. *macrococcus*(Mahoe)
2. *Ctenitis squamigera* (Pauoa)
3. *Cyanea lobata* subsp. *lobata* (Haha)* PEP
4. *Cyanea magnicalyx* (Haha)* PEP
5. *Cyrtandra munroi* (Ha'iwale)
6. *Hesperomannia arborescens*
7. *Pteris lidgatei* PEP
8. *Sanicula purpurea* (Snakeroot)

Candidates:

1. *Bidens conjuncta* (Ko'oko'olau)
2. *Calamagrostis expansa* (Reed grass)
3. *Calamagrostis hillebrandii* (Reed grass)
4. *Cyanea asplenifolia* (Haha)+
5. *Cyrtandra filipes* (Ha'iwale)
6. *Cyanea kunthiana* (Haha)+
7. *Gardenia remyi* (Nanu)
8. *Geranium hillebrandii* (Nohoanu)*
9. *Myrsine vaccinioides* (Kolea)*

Species of Concern:

1. *Alphitonia ponderosa* (Kauila)
2. *Anoectochilus sandwicensis* (Honohono)
3. *Argyroxiphium caliginis* (`Eke silversword)*
4. *Cyrtandra lydgatei* (Ha'iwale)
5. *Dicanthelium koolauensis*
6. *Doodia lyonii*
7. *Eurya sandwicensis* (Anini)
8. *Exocarpos gaudichaudii* (Hulumoa)
9. *Kadua formosa**
10. *Hibiscus kokio* subsp. *kokio* (Koki'o ula)
11. *Hillebrandia sandwicensis* (Pua maka nui)
12. *Joinvillea ascendens* subsp. *ascendens* ('Ohe)
13. *Keysseria maviensis* (Howaiaulu)
14. *Liparis hawaiensis* (Awapuhiakanaloa)

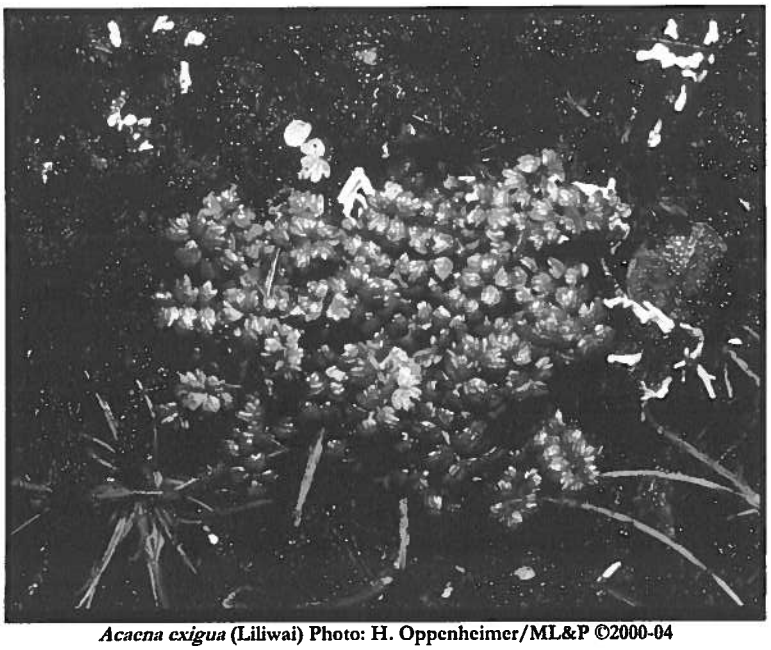
APPENDIX 2.2

15. *Phyllostegia stachyoides* PEP
16. *Pritchardia forbesiana* (Loulu)*
17. *Sicyos cucumerinis* (Panunu kuahiwi)
18. *Strongylodon ruber* (Nuku i'iwi)
19. *Wikstroemia bicornuta* ('Akia)

* Indicates plants that are endemic to West Maui
+ Indicates plants that are endemic to Maui
** Last known individual seen Jan., 2000 by Preserve staff
PEP Indicates a target species for Plant Extinction Prevention Program

Plants with no current USFWS Status that are **Endemic** to Mauna Kahalawai (West Maui) and are found in PKW Preserve:

1. *Cyanea scabra* (Haha)
2. *Metrosideros polymorpha* var. *pseudorugosa* ('Ohi'a)
3. *Sphagnum wheeleri* (Wheeler's Sphagnum moss)



Acaena exigua **(Liliwai) Photo: H. Oppenheimer/ML&P ©2000-04**

Pu'u Kukui Watershed Preserve
Management Plan for Fiscal Years 2012-2018
Maui Land & Pineapple Company, Inc.
Natural Area Partnership Program

APPENDIX 3

Rare Animals of the Pu'u Kukui Watershed Preserve As Listed by the U.S. Fish & Wildlife Service

Endangered:

Vertebrate:

Lasiurus cinereus semotus ('Ope'ape'a / Hawaiian Hoary Bat)
Pterodroma phaeopygia sandwichensis ('Ua'u / Dark-Rumped Petrel)

Threatened:

Vertebrate:

Puffinus newelli ('A'o / Newell's Shearwater)

Candidate:

Invertebrate:

Megalagrion pacificum (Hawaiian Damselfly)

Species of Concern:

Vertebrate:

Asio flammeus sandwichensis (Pueo / Hawaiian Short-Eared Owl)
Lentipes concolor (O'opu alamo'o / Hawaiian Red-Tailed Goby)

Invertebrate:

Megalagrion nigrohamatum (Hawaiian Damselfly)
Coleotichus blackburniae (Koa bug)
Nesotocus giffardii
Plagithmysus alani
Plagithmysus cf. *laticollis*
Rhynchogonus lahainae (beetle)
Catinella baldwinii (Amber snail)
Lymnaea aulacospira
Neritina granosa (Hihiwai)
Newcombia cumingi (Cuming's Newcombia tree snail)
Partulina perdix (Pupu kani oe / Maui tree snail)
Partulina splendida (Pupu kani oe / Maui tree snail)
Partulina tappaniana (Pupu kani oe / Maui tree snail)
Perdicella kuhnsi (Pupu kani oe / Maui tree snail)
Philonesia spp.

APPENDIX 4

PREVALENT HABITAT-MODIFYING WEED SPECIES OF THE PKW PRESERVE & ADJACENT AREAS
(PKW PRESERVE PRIORITY WEED CONTROL SPECIES in boldface)*

1. Formosan koa	*Acacia confusa* (Ex PKW)
2. Tasmanian black wood	*Acacia melanoxylon* (Ex PKW)
3. Maui pamakani	*Ageratina adenophora*
4. Kukui	*Aleurites moluccana*
5. Broom sedge	*Andropogon virginicus*
6. Sweet vernal grass	*Anthoxanthum odoratum*
7. Shoe button, Inkberry*	*Ardisia elliptica*
8. *Hammock* fern	*Blechnum appendiculatum*
9. Butterfly bush	*Buddleia asiatica*
10. Padang cassia*	*Cinnamomum burmannii*
11. Koster's curse*	***Clidemia hirta***
12. Andean pampas grass*	*Cortaderia jubata* (Ex PKW)
13. Albizia*	*Falcataria moluccana* (Ex PKW)
14. Tropical ash*	*Fraxinus uhdei* (Ex PKW)
15. Velvet grass*	*Holcus lanatus*
16. Moonflower	*Ipomoea alba*
17. Japanese bog rush*	*Juncus effusus*
18. rush*	*Juncus planifolius*
19. Molasses grass*	*Melinis minutiflora*
20. **Wax myrtle***	***Morella (Myrica) cerifera* (PKW)**
21. Hilo grass	*Paspalum conjugatum*
22. Vasey grass	*Paspalum urvillei*
23. Sweet Granadilla	*Passiflora ligularis*
24. Waiawi, Strawberry guava*	***Psidium cattleianum***
25. Guava	*Psidium guajava*
26. Prickly Florida blackberry*	***Rubus argutus***
27. Himalayan blackberry*	***Rubus discolor***
28. Thimbleberry	*Rubus rosifolius*
29. Glenwood grass	*Sacciolepis indica*
30. Brazilian pepper	*Schinus terebinthifolius* (Ex PKW)
31. African tulip*	***Spathodea campanulata***
32. Australian Tree Fern*	***Sphaeropteris cooperi***
33. Cane *Tibouchina**	***Tibouchina herbacea***

APPENDIX 5.1

Prevention of Alien Species Introduction

Protocol for Entry into Maui Land & Pineapple Company's Pu'u Kukui Watershed Preserve (PKW/Pu'u Kukui Preserve), including Haela'au Cabin, Honokohau Ditch Trail & Honokohau Dam.

TO: Maui Land & Pineapple Company (ML&P)/Kapalua Land Company (KLC) employees, Harmer Communications Co., volunteers, researchers, visitors, guests and any and all others entering the PKW Preserve.

It has been well documented that, along with habitat destruction, alien species of plants and animals (including insects, mammals, birds, reptiles, fish, etc.) have had severe negative impacts on Hawaii's unique native ecosystems. Maui Land & Pineapple Company (ML&P) is committed to the protection of these ecosystems (forests, scrublands, bogs, etc.) recognizing their vital role as the best possible watershed cover. Control of established alien species and ***prevention*** of introducing new ones is the top priority as set forth in the Pu'u Kukui Preserve Management Plan. Due to limited resources, we ask that all those entering the PKW Preserve spend a little time and effort to make certain that all gear, clothing, materials, vehicles, etc. are clean and clear of non-native organisms that may inadvertently be transported and introduced. Please help us to be a part of the solution and not part of the problem. As the saying goes "An ounce of prevention is worth a pound of cure".

Here's what *YOU* can do to help:

For those driving to Haela'au Cabin, wash the underside of your vehicle. All ML&P /KLC employees should use the high-pressure hose at the wash rack at Honolua Plantation baseyard. Others should ask the PKW Preserve manager/staff about its use. Tires, wheel wells, bumpers, truck beds, etc. should be hosed down to remove mud that may have seeds or spores of non- native plants. Materials and gear should be checked (including tools, lumber, firewood, etc.) and cleaned. PKW Preserve staff may inspect anything entering the Preserve and may deny access/entry if it is contaminated. A can of Raid or other insecticidal spray can be handy for ants or other insects/spiders that may have escaped detection. It also helps to sweep out the inside of the vehicle as well. Coolers, dishes, food and containers can all carry unwanted hitchhikers. If an item is heavily infested it is better to discard and/or replace it rather than clean it only partially. **Waivers *must* be signed; minors *must* have their parents or legal guardian's signature.**
For those entering the PKW Preserve via helicopter, the Landing Zone (LZ) at the point of departure should be as weed free as possible. Cement or asphalt is preferable to grass or dirt. There is a cement slab LZ at the Honolua baseyard "ball- field". If gear and supplies are to be transported via sling or cargo net, these must be inspected prior to packing, not only for contaminants but also for any damages that may compromise the security of the material and the safety of the pilot and the people on the ground. It is best to assume that something is stuck in the netting and hose it down. Bucket bottoms can be hosed or cleaned with a stiff fiber or nylon brush. It is usually easier to clean

gear and materials when they are dry. Camping and hiking gear is particularly prone to carrying hitchhikers. Tents can be turned inside-out; tubular framed cots and chairs should be checked for clods of dirt at open ends; mesh or netting on clothing or backpacks are good places for weed seeds to attach themselves and need to be inspected carefully. Footwear seems to be the easiest way for weeds to catch a ride into new areas. A stiff fiber brush is very effective for cleaning; a knife may be needed for stubborn areas such as treads and lugs. Be sure to inspect your shoelaces, as well the insides of boots and shoes.

PKW Preserve staff should monitor all LZs and campsites for weed presence, noting any new introductions. For those who will be moving across large areas of the Preserve, it is always best to work from higher elevations that are usually more weed free, down to lower and usually weedier elevations. The best scenario is to have gear and clothing dedicated to pristine areas (usually designated as a Special Ecological Area or SEA). Another quick and effective practice is to empty all bags and backpacks, turn them upside-down, and shake out any debris which may include weed seeds/spores and/or insects/eggs. Try to avoid eating food the day before which has tiny seeds such as tomatoes, guava, lilikoi, etc.

Pack out **all** trash-organic trash such as banana skins, orange peels, apple cores, etc. can have seeds or insects/eggs or more inconspicuous and potentially harmful bacteria, blight, pathogens, disease, etc. When "nature calls" stay away from streams and streambeds. Bury your waste. For those staying overnight in remote backcountry locations, ask Preserve staff for a portable waste disposal system. Food wastes also feed rats and other undesirable animals and should be taken out - if you brought it in you can take it out.

If you are allergic to bee stings or have any medical condition that requires medications, bring enough medication along; the group leader and Preserve staff should also be notified. Smoking is strongly discouraged; campfires and fireworks are strictly prohibited.

It is recommended that a cellular phone or two-way radio be taken in the event of emergency (injury, fire, etc.) or change in logistics such as pickup time or place. The PKW Preserve staff #'s are listed below. For those using two-way radios, a check time and channel should be prearranged. Please report anything unusual such as animal sightings, trespassers, fence damage, etc. as soon as possible.

Keys are the responsibility of those who have signed for them or received them from MLP/PKW Preserve staff.

Remember after leaving the Preserve that it is also your responsibility to avoid transporting potentially harmful non-native species to the next place. Many researchers and visitors are on busy schedules and go from one island to another. It must be remembered that not all alien species are on all islands or in all areas of the same island; *Miconia* is on East Maui but not West Maui; *Tibouchina* is not yet on Kauai. Natural area managers have enough problems to deal with; please help by not adding to them.

For Emergency Use *Only*

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