

**Kula Forest  
Reserve  
and  
Papa'anui  
Tract  
of  
Kahikinui  
Forest Reserve**

**Management Plan**

**2017**



**State of Hawai'i  
Department of Land and Natural Resources  
Division of Forestry and Wildlife  
Forest Management Section**

## EXECUTIVE SUMMARY

This ten-year management plan for Kula Forest Reserve and the Papa‘anui Tract of Kahikinui Forest Reserve (FR) on Maui is one in a series of site-specific natural resource management plans to be prepared by the Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) for individual forest reserves in the State of Hawai‘i. These plans present a brief history of the specific forest reserve, a complete record of land transactions and boundary changes over time, a description of natural and cultural resources, as well as an account of infrastructure and intended use(s) of the area. These plans serve to: (1) assist in preparation of regulatory compliance documents required to implement management actions outlined in the plan; (2) support DOFAW efforts to secure funding for plan objectives; (3) prioritize implementation of management objectives; (4) solicit requests for proposals or bids to implement plan objectives; and (5) inform the public of short and long-term goals.

According to a report by the Territorial Forester Ralph S. Hosmer, prior to the late 1800’s “there was a belt of heavy forest with dense undergrowth,” in the Kula district (Hosmer 1912, p. 275). By 1912, the effects of grazing resulted in the conversion of the forest to open grass land with the exception of scattered groves of māmane (*Sophora chrysophylla*) and steep sided gulches that provided protection to pockets of forest from cattle. Kula Forest Reserve was established by Governor’s Proclamation on September 11, 1912, with a purpose different from most other forest reserves. The reserve was established with the intent to reforest the area that was converted to pasture after 20 years of grazing. Establishing forest cover around Polipoli Spring, which at the time was considered the only permanent source of water on the southern end of Haleakalā, was one of the underlying reasons for creating Kula Forest Reserve (Hosmer 1912).

The Kahikinui Forest Reserve was established by Governor’s Proclamation on December 22, 1928. In the report that preceded the establishment of Kahikinui FR, the Territorial Forester described how the majority of the boundary was already protected by existing fence lines constructed on neighboring leased and private lands that were being managed by cattle ranchers, and also by natural barriers that limited the ingress of ungulates. He further describes the significant number of goats and the few cattle that were in Kahikinui at the time. The intention was to remove the wild goats and cattle and “give the extensive existing grove of koa (*Acacia koa*) trees on Nakula and Nuua a chance to expand,” (Judd 1928, p. 177). There were also stands of māmane that they hoped would expand through natural recruitment. The overarching goal for Kahikinui FR was to improve the vegetative cover in the area to “prevent excessive runoff and make available for use in the intervening dry periods water on the lower lands, where it is almost always at a premium,” (Judd 1928, p. 177).

DOFAW’s current management activities within Kula Forest Reserves and the Papa‘anui Tract of Kahikinui Forest Reserve are weed management (monitor, map, and control), access road and infrastructure maintenance, boundary fence and rare plant enclosure maintenance, native and threatened and endangered (T&E) outplanting, native plant seed collection and storage (seed banking), firebreak/fuelbreak maintenance, Nā Ala Hele trail maintenance, water unit maintenance for game bird species, predator control (mongoose, rat, and cats), and game habitat management, which includes but is not limited to black wattle (*Acacia mearnsii*) and invasive species removal.

Forest reserve management priorities are divided into eight categories and ranked on a qualitative basis, taking into consideration the natural and cultural resources and public use opportunities of the reserves (see Table 12 for forest reserve management priorities). Summary of management goals for the Kula FR and Papa‘anui are as follows:

- Watershed Values – Increase land holding protected under the Forest Reserve System; erosion reduction and prevention; monitoring forest composition; maintain active role in watershed partnerships; and climate change adaptation.
- Resource Protection – Fire presuppression and mitigation; forest health monitoring (Rapid ‘Ōhi‘a Death, insects and diseases), and monitor weather conditions as they pertain to fire and environmental conditions.
- Game Animal Management – Promote and regulate public hunting through Chapter 122 and 123, Hawai‘i Administrative Rules.
- T&E Species Management – Protection and recovery of rare and endangered plants and animals.
- Native Ecosystems – Determine landscape level needs; re-evaluate DOFAW 2001 Draft Management Guidelines; and ungulate control.
- Invasive Species Control – Reduce impact of invasive species; and manage incipient and established invasive plants and animals.
- Access, Trails and other Public Uses – Maintain public access, infrastructure and recreational fruit collection; and increase public information and awareness.
- Commercial Activity – Generate income from suitable commercial activities in the reserves; and provide opportunities for wood-based forest product collection.

Details of specific tactical goals and action items can be found in Table 13 on page 48 of this plan. This plan is intended to describe short-term resource management planning and implementation strategies, as well to serve as a basis for future updates and modifications to accommodate evolving or additional objectives such as wildfire prevention projects and/or improving access and facilities for Kula FR and Papa‘anui.

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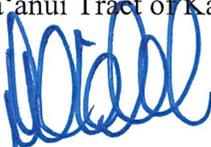
**KULA FOREST RESERVE AND THE  
PAPA‘ANUI TRACT OF KAHIKINUI FOREST RESERVE  
MANAGEMENT PLAN SIGNATURE PAGE**

Maui District certification: This plan was prepared by a team of Division of Forestry and Wildlife (DOFAW) staff to provide a management framework for Kula Forest Reserve and the Papa‘anui Tract of Kahikinui Forest Reserve.

  
\_\_\_\_\_  
Scott Fretz – DOFAW Maui District Manager

10/26/2017  
Date

DOFAW Administrator’s approval: I have reviewed the enclosed Forest Reserve Management Plan and concur with the recommendations herein. I agree that resource management implementation will follow those specified in the Management Plan for Kula Forest Reserve and the Papa‘anui Tract of Kahikinui Forest Reserve.

  
\_\_\_\_\_  
David G. Smith – DOFAW Administrator

11/14/17  
Date

Department of Land and Natural Resources Board approval: This plan is in accordance with the mandates of the State Forest Reserve System which includes Chapter 183, Hawai‘i Revised Statutes, and Chapter 13-104, Hawai‘i Administrative Rules.

  
\_\_\_\_\_  
Suzanne D. Case – BLNR Chairperson

Approved by the Board  
of Land and Natural  
Resources at its meeting  
held October 13, 2017

## DEVELOPMENT PROCESS TIMELINE

Kula Forest Reserve and the Papa‘anui Tract of Kahikinui Forest Reserve, Maui

<b>Stage of Development</b>	<b>Date Achieved</b>	<b>Comments</b>
District review	May 2015	Incorporated
DOFAW review	August 2016	Incorporated
Partner agency consultation	March 2017	Incorporated
Public consultation	August 2017	Incorporated
DOFAW approval	September 2017	None
BLNR approval	October 2017	None

## I. INTRODUCTION

The Division of Forestry and Wildlife (DOFAW) conducts on-going planning efforts to develop and update management plans for all forest reserves across the State. The format and content of the respective reserve plans are generally consistent across the State and serve to guide field operations, assist in budgeting and funding concerns, and make the management process transparent for partner organizations and the public. These plans also help to fulfill certain recommendations made in the Hawai'i Tropical Forest Recovery Action Plan, which came about as a result of the 1992 Federal Hawai'i Tropical Forest Recovery Act.

Each district office of DOFAW will have a comprehensive management plan that addresses overall Forest Reserve System issues, goals and objectives for that district. In addition, management plans will be developed for each individual forest reserve, which will in part reflect the Division's management guidelines specific to that area. This document represents the management plan for Kula Forest Reserve and the Papa'anui Tract of Kahikinui Forest Reserve (Papa'anui), which fits under the comprehensive forest reserve management plan for Maui District. It addresses concerns and strategies only on the public lands within these forest reserves.

This management plan for Kula Forest Reserve and Papa'anui was developed using a variety of methods. Initial development consisted of reviewing and analyzing DOFAW historic and current files (found at the Administrative and Maui District office). Documents were also obtained from other state agencies including the Department of Land and Natural Resources Land Division and Bureau of Conveyances, the Department of Accounting and General Services (DAGS) Survey Division, as well as the State Archives. Hawai'i Statewide Geographic Information System (GIS) data relating to biological, historical, and environmental resources were referenced extensively to develop this plan.

Additional resources utilized for the development of this plan (including other plans that identified the Forest Reserves or the general area), were the Hawaiian Forester and Agriculturalist, Hawai'i Biodiversity and Mapping Program (HBMP), Hawai'i Statewide Assessment of Forest Conditions and Trends, Hawai'i Comprehensive Wildlife Conservation Strategy, biological surveys and others. The plan then evolved into its final iteration through discussions with Division staff from all program areas, both at the district and administrative offices, other Divisions and State agencies, DOFAW partners, and the public.

Once finalized by DOFAW, this Management Plan for Kula Forest Reserve and Papa'anui will be submitted for review and approval by the Board of Land and Natural Resources (Board). If approved by the Board, the following actions may be triggered:

1. Preparation of regulatory compliance documents as required for implementation of management actions as outlined in the plan.
2. DOFAW efforts to secure operational and planning funding for plan objectives.
3. Prioritized implementation of plan objectives by DOFAW.
4. Periodic solicitation of requests for proposals or bids for implementation of plan objectives, including issuance of permits, licenses, or contracts (Chapter 104-22, HAR), as necessary.

## II. FOREST RESERVES DESCRIPTION

**A. Location and Description:** Kula Forest Reserve (FR) is comprised of approximately 4931.35 acres of public land (Table 1) and it is located on the leeward slopes of Haleakalā (Figure 1). Kula FR is bordered primarily by privately owned land with the exception of the mauka boundary which is adjacent to state lands of Papa‘anui, and a small portion of its northeastern boundary that borders Haleakalā National Park. This forest reserve is generally characterized by three ecosystem types: montane mesic forest and shrublands, subalpine dry shrubland and grassland, and alpine desert. The lower slopes of Kula FR are dominated by non-native vegetation and the upper slopes contain native shrubland. Communities in close proximity to this forest reserve include Kēōkea – Waiohuli Homesteads, ‘Alae 3-4 Homesteads, Waiakoa Homesteads, Kealahou Homesteads, Pūlehu Iki Kamehame Iki Homestead, and Ōma‘opio Homestead. Kula FR is included in the Leeward Haleakalā Watershed Restoration Partnership, which was formed in 2003.

Papa‘anui is comprised of approximately 713.57 acres of public land (Table 2) and it is located on the ridge top adjacent to Kula FR (Figure 1). Papa‘anui is bordered almost entirely by other state owned lands with the exception of one privately owned parcel on its northern boundary. This forest reserve is generally characterized by two ecosystem types: subalpine dry shrubland and grassland, and alpine desert. Almost half of Papa‘anui is sparsely vegetated to unvegetated, and the rest of the area is covered by a mixture of native shrublands and alien grasses. The communities in close proximity to this forest reserve include Kēōkea – Waiohuli Homesteads, ‘Alae 3-4 Homesteads, Waiakoa Homesteads, Kealahou Homesteads, Pūlehu Iki Kamehame Iki Homestead, and Ōma‘opio Homestead. Kahikinui FR is also included in the Leeward Haleakalā Watershed Restoration Partnership.

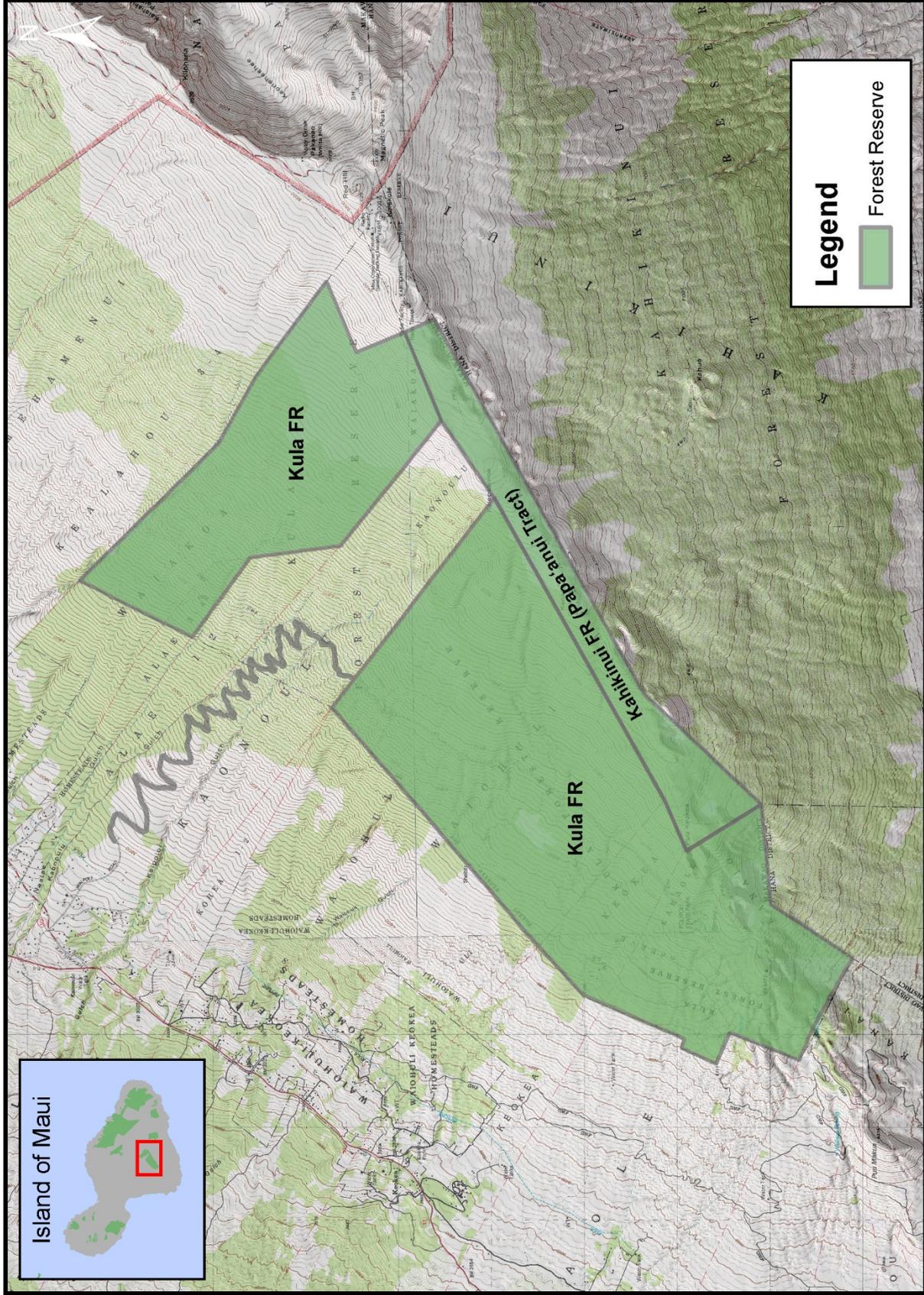
Table 1. Government Tax Map Key (TMK) parcels currently comprising public lands of Kula Forest Reserve. Some TMKs have areas both inside and outside the FR boundary.

<b>TMK Number</b>	<b>Owner</b>	<b>Tax Acres (entire TMK)</b>	<b>GIS Acres (entire TMK)</b>	<b>GIS Forest Reserve Acres</b>
222007001	State of Hawai‘i	5865.87	5610.12	4896.54
222007003	State of Hawai‘i	2.43	3.51	3.51
222006999	State of Hawai‘i	N/A	43.90	20.26
222007999	State of Hawai‘i	N/A	11.04	11.04
<b>TOTAL</b>				<b>4931.35</b>

Table 2. Government TMK parcels currently comprising public lands of the Papa‘anui Tract of Kahikinui Forest Reserve.

<b>TMK Number</b>	<b>Owner</b>	<b>Tax Acres (entire TMK)</b>	<b>GIS Acres (entire TMK)</b>	<b>GIS Forest Reserve Acres</b>
222007001	State of Hawai‘i	5865.87	5610.12	713.57
<b>TOTAL</b>				<b>713.57</b>

Figure 1. Current extent of public lands of Kula Forest Reserve (FR) and the Papa‘anui Tract of the Kahikinui FR



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**B. Geographic Site Data:** The island of Maui consists of two volcanoes: Haleakalā, an active volcano dating from approximately 1.1 million years ago that formed east Maui, and an extinct volcano dating from approximately 1.6 million years ago that forms Mauna Kahalawai (West Maui Mountains). The two volcanoes are separated by a low, flat plain. Haleakalā last erupted as recently as 1790 (Juvik and Juvik 1998). Maui is a part of Maui Nui, which is made up of several volcanoes that once formed a single island. Moloka‘i, Maui, Lāna‘i, and Kaho‘olawe were all a part of this large island until sea levels began to rise about 400,000 years ago (Hawaiian Volcano Observatory 1998).

**C. Physical Site Data:** Kula Forest Reserve and Papa‘anui currently occupy land in the ahupua‘a of Kanaio, Papa‘anui, Kama‘ole, Kēōkea, Waiohuli, Ka‘ono‘ulu, ‘Alae 3-4, and Waiakoa. Elevation and rainfall vary through the reserves. The highest elevation reaches up to approximately 9,500 feet and lower regions slope down to 5,000 feet at the forest line and 3,800 feet at the bottom of the access road. Average rainfall ranges from approximately 33 to 40 inches annually (Figure 2), with fog and cloud interception contributing significantly to total precipitation. Precipitation received in the Kula FR and Papa‘anui charge the Kama‘ole aquifer. The United States Department of Agriculture’s Natural Resource Conservation Service has mapped nine soil types in Kula FR and Papa‘anui (Figure 3). This agency provides online soil maps and data at <https://websoilsurvey.sc.egov.usda.gov>. The majority of the area is covered by Andisol soils, which formed from volcanic ash and cinder. The prominent geological features located within Kula FR and Papa‘anui are Polipoli Spring, Pu‘ukeōkea, and Kanahau.

#### **D. Pre-Reserve and Early Use History:**

##### ***Kula***

The moku (district) of Kula occupies most of the central plains of Maui and is a dry and arid region. The word “kula” itself means plain or open country and is also used as a term to describe dry arid lands. It is believed that kalo (*Colocasia esculenta*) was not grown in Kula, but fishing was good along the coast. The region was also known for its ‘uala (*Ipomoea batatas*), which was the staple crop. These resources supported a considerable population along the lower western slopes of Leeward Haleakalā (Handy and Handy 1991).

Starting in the late 1880’s, crown and government lands in Kula were leased for pasture purposes to Cornwell Ranch. According to a report that preceded the Kula FR designation, prior to being leased the Kula district contained “a belt of heavy forest with dense undergrowth,” (Hosmer 1912, p. 275). The original forest cover was likely dominated by koa (*Acacia koa*), ‘ōhi‘a (*Metrosideros polymorpha*), māmane (*Sophora chrysophylla*), ‘a‘ali‘i (*Dodonaea viscosa*) and pūkiawe (*Leptecophylla tameiameia*). After decades of cattle ranching, Hosmer described how the forest practically disappeared due to grazing. Māmane was harvested in larger numbers for utilization as fence posts up until 1910, after which māmane post were still salvaged from dead trees.

Figure 2: Hydrological features of Kula Forest Reserve (FR) and the Papa'auui Tract of Kahikinui FR

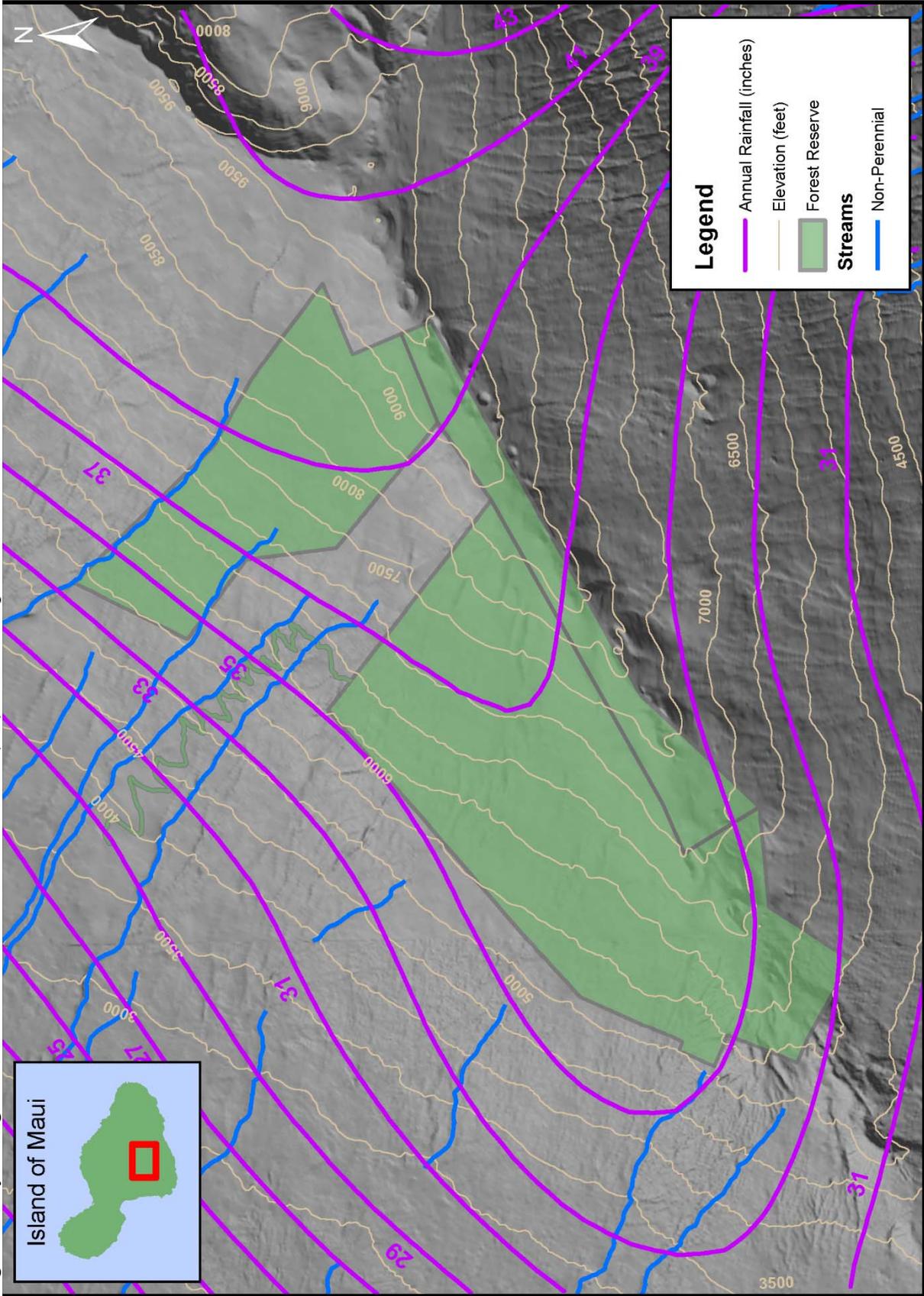
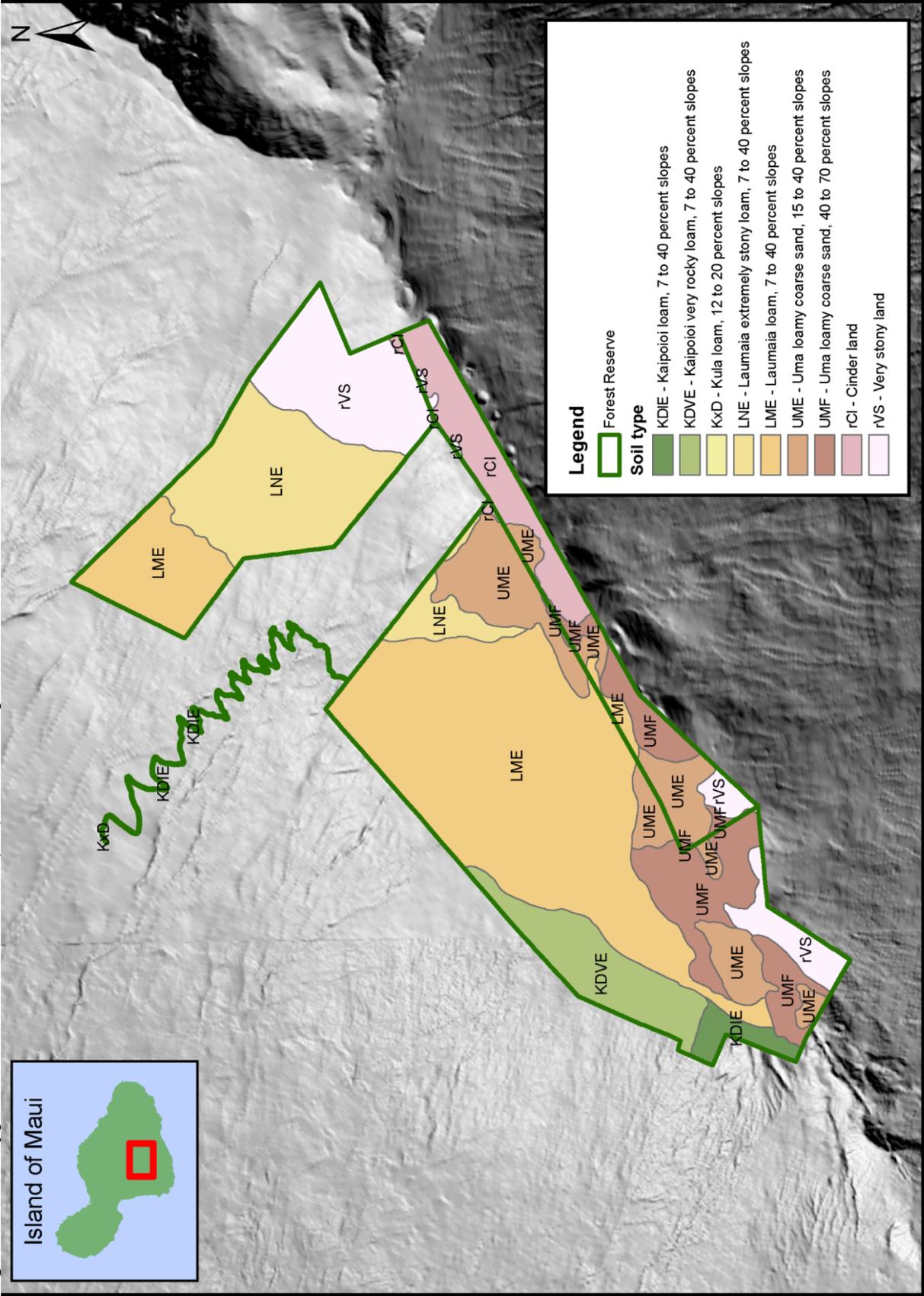


Figure 3: Soils types of Kula Forest Reserve (FR) and the Papa'anui Tract of the Kahikinui FR



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*Figure 4. Old ranger cabin in Kula Forest Reserve before reforestation*

By 1912, the former extent of the forest was still evident by the “dead stubs, small groups of trees in certain steep-sided gulches where they are protected from cattle, and scattered groves of Mamane,” (Hosmer 1912, p. 275). The forest was replaced by a dense ground cover of grass. In 1911, the grazing leases on these government lands were set to expire, and it was decided that it was “best again to lease the strip of grazing land above the corn belt, but that the higher slopes should be reserved,” (Hosmer 1912, p. 275).

Kula Forest Reserve was created by Governor’s Proclamation in 1912. There was subsequent addition and withdrawal of land since it was established, as documented in Table 3 and Figure 6. When forest reserves were first being established, private lands were also included in these designations to encourage landowners to manage their lands for watershed values. Even though these privately owned parcels were included in the FR boundary, they are not subject to the rules and statutes established for the public lands in the Forest Reserve System. In order for the state to be able to manage private lands in the FR, these parcels must be surrendered by the landowner to the State for use as a forest reserve (Section 183-15, HRS). For this reason, privately owned parcels located within the FR boundary were not considered during the management planning process.

Kula Forest Reserve differed from most other reserves at that time, because it was essentially an area in which the forest cover needed to be re-established. It was decided early on that introduced trees of high economic value would be used to create a forest resource that could potentially be harvested in the future. It was also hoped that increasing the forest cover in an area that was considered to have a scarcity of natural supplies of water would help to secure the fresh water resource provided by the springs that occurred in the district. Establishing forest cover on the area adjacent to Polipoli Spring was one of the underlying reasons for the designation of Kula FR (Hosmer 1912).

An intensive planting program for Kula FR was initiated around 1924, and in the 1930's the Civilian Conservation Corp (CCC) planted stands of tropical ash (*Fraxinus uhdei*), sugi (*Cryptomeria japonica*), redwood (*Sequoia sempervirens*), maritime pine (*Pinus pinaster*), Monterey pine (*Pinus radiata*) and Monterey cypress (*Cupressus macrocarpa*).



Figure 5. Redwoods of Kula FR

Table 3. Summary of lands added and withdrawn (A/W) from Kula Forest Reserve. See Figure 6 for map descriptions. Portions of TMKs are denoted with (por.). Data relating to these items are filed at the DOFAW Administrative Office and the DAGS State Survey Office

Action	Date	A/W	Description	Acres	Copy of Survey Furnished (CSF)	Tax Map Key
Governor's Proclamation	11-Sept-1912	A	Land set aside for establishment of Kula FR	6004.815	2300	222007001 222007003 222007006 222007015
Executive Order 1411	17-Jan-1951	W	Withdrawal of Government lands at Waiakoa for a Repeater and Telephone Station Site	136.50	11116	222007006 222007015
Executive Order 3339	1-July-1986	A	Addition of Polipoli access road at Ka'ono'ulu	33.904	20371	222007999 222006999 (por.)



## *Kahikinui*



*Figure 7. Kahikinui Forest Reserve (5000 ft elevation)*

In the past, the moku of Kahikinui supported scattered isolated communities close to the shoreline or slightly inland and within proximity of fresh water. It is believed that dry kalo and other resources were grown and harvested from the forest, which came down much lower than it does today. Like Kula, decades of cattle grazing resulted in large scale deforestation in the region (Handy and Handy 1991).

The Kahikinui Forest Reserve, which includes Papa‘anui, was established by Governor’s Proclamation in 1928. There were significant withdrawals of land from Kahikinui FR, and they are documented in Table 4 and Figure 8. Only portions of the Papa‘anui and Nakula ahupua‘a are still included within Kahikinui FR. The Papa‘anui Tract will be addressed in this management plan due to its adjacency to Kula FR. The remaining majority of Kahikinui FR (Nakula) will be addressed in a separate plan at a later date.

In the report that preceded the establishment of Kahikinui FR, the Territorial Forester described how the majority of the boundary was already protected by existing fence lines constructed on neighboring leased and private lands that were being managed by cattle ranchers, and also by natural barriers that limited the ingress of ungulates. He also goes on further to describe the significant number of goats and the few cattle that were in Kahikinui at the time. They planned to remove the wild goats and cattle to “give the extensive existing grove of koa trees on Nakula and Nuu a chance to expand,” (Judd 1928, p. 177). There were also stands of māmane that they also hoped would expand through natural recruitment. The overarching goal for Kahikinui FR was to improve the vegetative cover in the area to “prevent excessive runoff and make available for use in the intervening dry periods water on the lower lands, where it is almost always at a premium,” (Judd 1928, p. 177).

The Papa‘anui Tract of Kahikinui FR has always been sparsely vegetated due to environmental conditions. While records of a lease on Papa‘anui to a private entity could not be located, it was surrounded by private and leased pasture lands and was likely affected by these activities. There are many correspondences between Forestry staff and the neighboring ranchers over cattle in the FR and fence construction and maintenance issues.

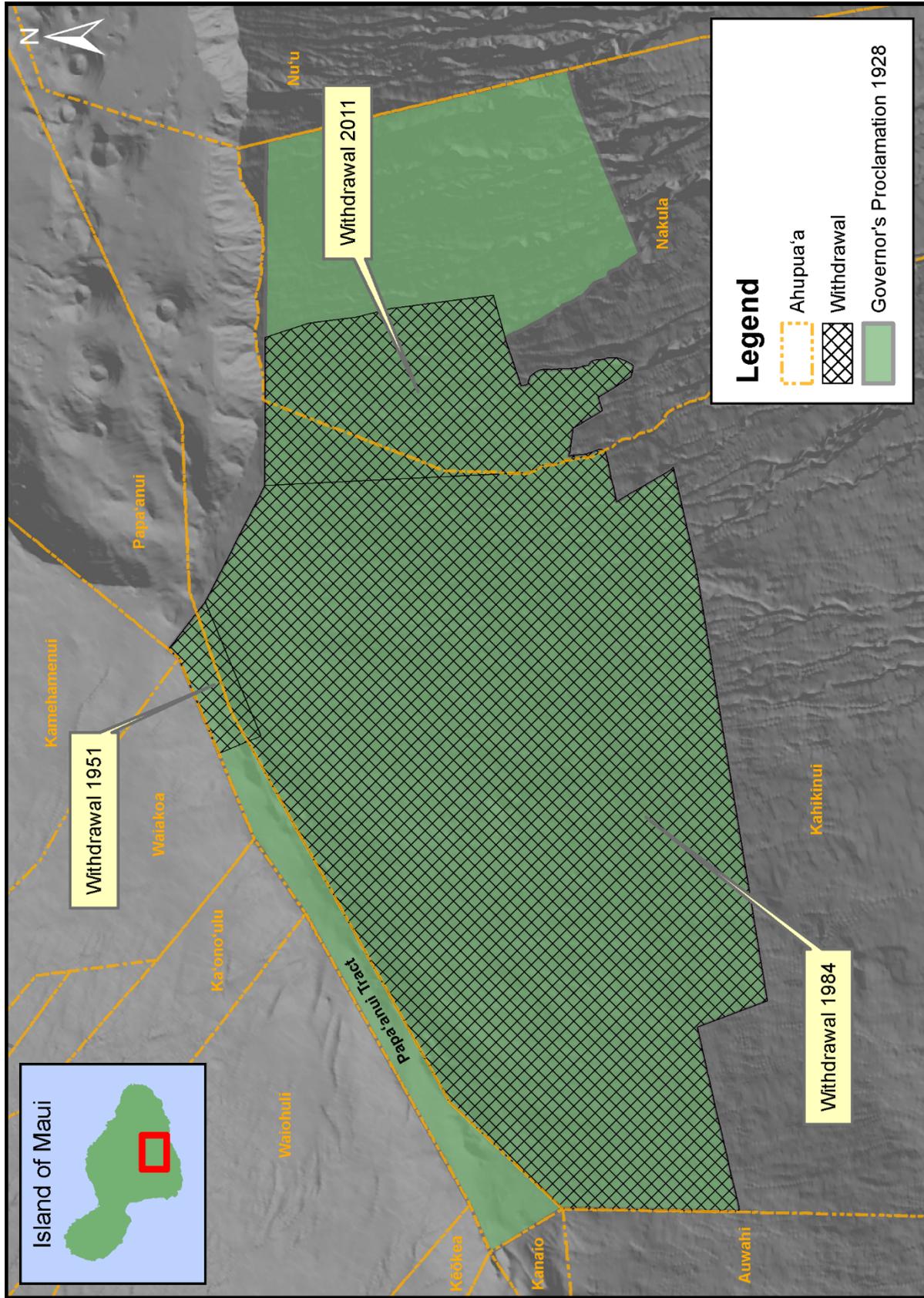
In the 1930's, during intensive reforestation efforts in Kula, there was a relatively flat clearing (believed to be a naturally occurring geological feature) in Papa'anui on Skyline Road where the CCC crew would gather to play baseball and softball during their breaks. To this day this area is still referred to as Ballpark. There are astronomy facilities on the eastern end of Papa'anui, but the site was withdrawn from the FR in 1951.

Table 4. Summary of lands added and withdrawn (A/W) from Kahikinui FR. See Figure 8 for map descriptions. Portions of TMKs are denoted with (por.). Data relating to these items are filed at the DOFAW Administrative Office and the DAGS State Survey Office

Action	Date	A/W	Description	Acres	Copy of Survey Furnished (CSF)	Tax Map Key
Governor's Proclamation	22-Dec-1928	A	Land set aside for establishment of Kahikinui FR	16,013	4902	218001006 218001009 219001003 (por.) 219001007 219001011 222007001 (por.) 222007005 222007007 222007008 (por.) 222007009 222007011 222007012 222007013 222007014 222007016 222007017
Executive Order 1411	17-Jan-1951	W	Withdrawal of Government lands at Papa'anui and Kahikinui for a Repeater and Telephone Station Site	184.20	11117	222007005 222007007 222007008 (por.) 222007009 222007011 222007012 222007013 222007014 222007016 222007017
Executive Order 3270	27-Dec-1984	W	Withdrawal of Government lands at Kahikinui which were set-aside as Hawaiian home lands	8,747	N/A	219001003 (por.) 219001007 219001011
Executive Order 4364	25-Mar-2011	W	Withdrawal of land at Nakula for the establishment of a Natural Area Reserve	1420.4	25,037	218001006 (por.) 218001009

**Kuleana Parcels:** None.

Figure 8. Historical changes to Kahikinui Forest Reserve with the year of addition/withdrawal indicated



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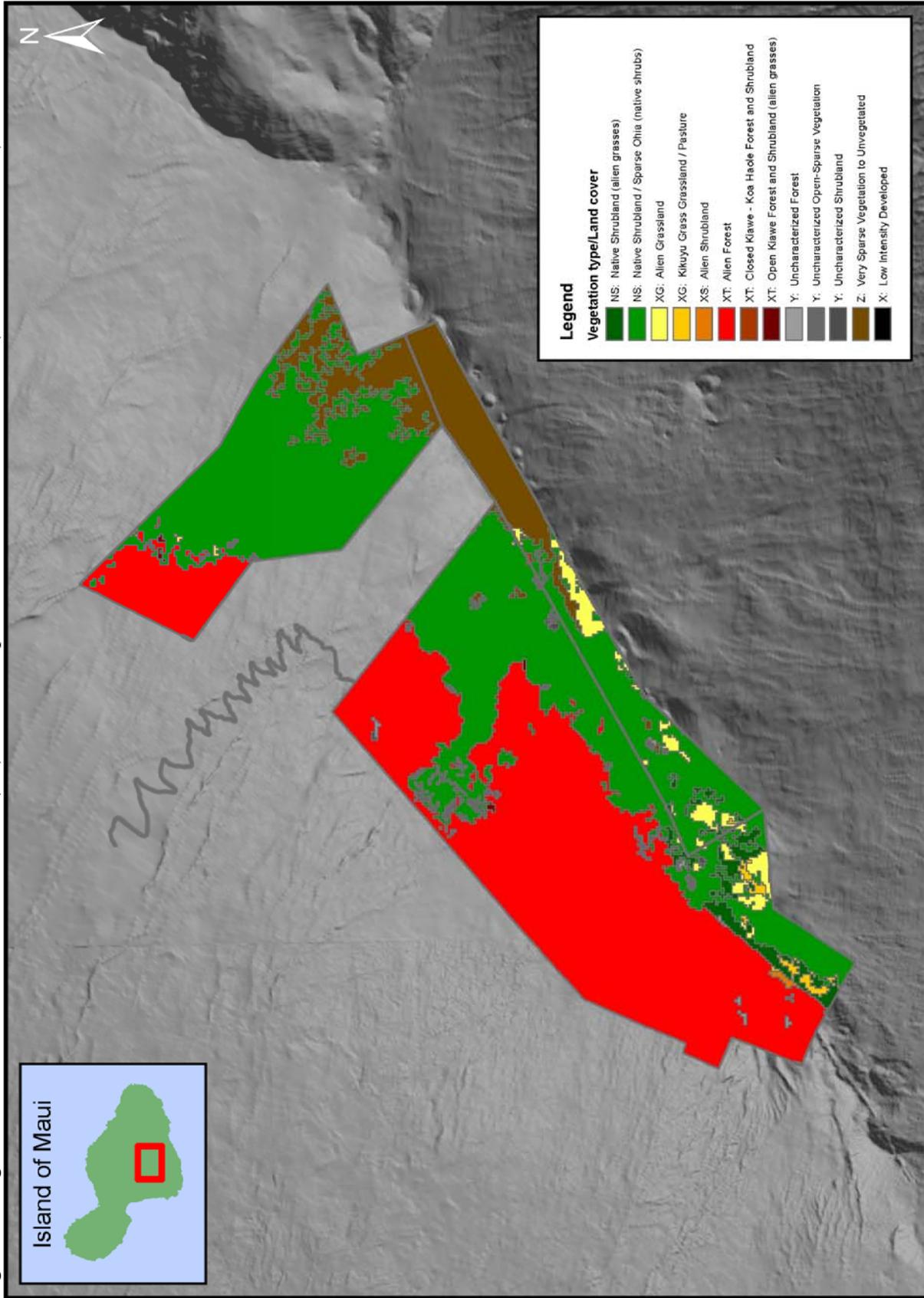
**Documented Activities/Leases/Deeds/Permits:** Information on the historical land use agreement issued for Kula FR are listed in Table 5. Documentation could not be found of land use agreements issued for the Papa‘anui Tract of Kahikinui FR.

Table 5. Historical land use agreements in Kula FR.

Type of Action	Action Number	Duration	Description	Acres	Copy of Survey Furnished (CSF)	Tax Map Key
Lease	N/A	? to 1-Nov-1911	Lease to Cornwell Ranch for grazing purposes	N/A	N/A	N/A
Land License	GL533	12-Aug-1901 to 11-Aug-1921	Henry Waterhouse Trust Co. Ltd., as trustees for James H. Raymond & Phoebe K. Raymond to conduct surplus water from Polipoli Spring to private holdings	N/A	N/A	N/A
Lease	GL542	20-Sept-1902 to 19-Sept-1922	Henry Waterhouse Trust Co. Ltd., as trustees for James H. Raymond & Phoebe K. Raymond granting access to Government lands at Kamaole to construct and maintain water infrastructure	N/A	N/A	N/A
Right of Way	No. 1363	24-Aug-1921 to 23-Aug-1936	ROW issued to J.H. Raymond, C.D. Lufkin & D.H. Case granting them access across Government lands at Kamaole, to construct and maintain water infrastructure to remove water from Polipoli Spring	N/A	N/A	N/A
Lease	GL2518	13-Nov-1936 to 13-Nov-1957	Lease issued to Ulupalakua Ranch, Ltd for a pipeline right of way	2.43	8080	222007003
Permit	RP2412	13-Nov-1957 to 31-Mar-2010	Permit issued to Ulupalakua Ranch, Ltd for a pipeline right of way	2.43	8080	222007003
Permit	RP7581	01-Apr-2010 to Current	Permit issued to Ulupalakua Ranch, Inc. for a pipeline right of way	2.43	8080	222007003

**E. Vegetation:** According the Hawai‘i Gap Analysis Program (GAP), Kula FR and Papa‘anui are dominated by non-native forest (42% of total land cover) and native shrubland (42% of total land cover; Figure 9). Given that reforestation was an underlying reason for designation of Kula FR it is not surprising that the lower elevations are primarily composed of non-native plantation timber that was planted with the intention of developing a resource base for possible future harvest.

Figure 9: Vegetation cover of Kula Forest Reserve (FR) and the Papa‘anui Tract of Kahikinui FR (Hawai‘i GAP 2005)



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Figure 10. Native shrublands of Kula FR

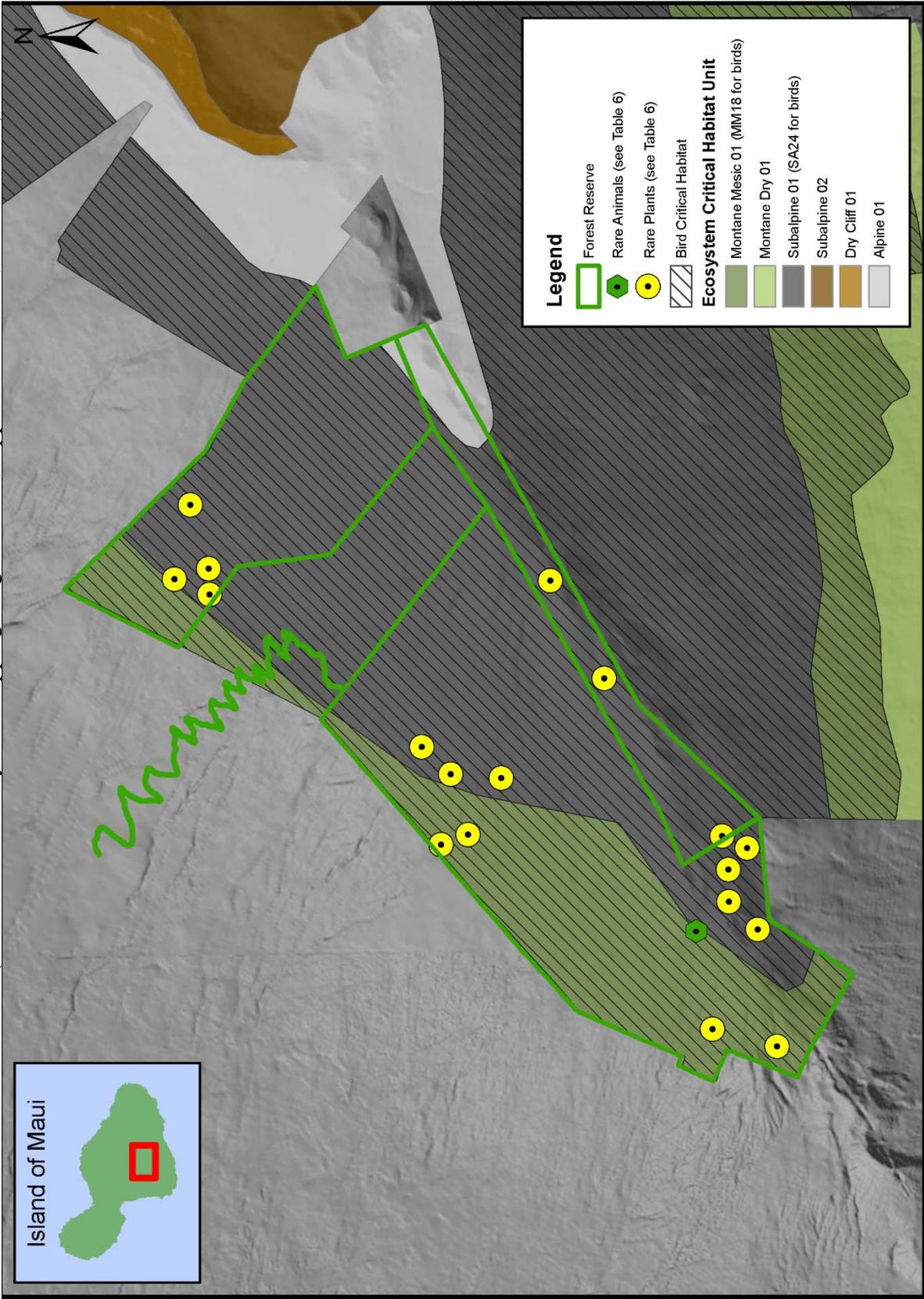
The upper slopes are dominated by native shrublands which are composed primarily of māmane, ‘a‘ali‘i (*Dodonaea viscosa*), pūkiawe (*Leptecophylla tameiameia*), ‘ōhi‘a and koa. Draft DOFAW management guidelines for the native shrubland areas will prevent activities or intensities of use that result in the degradation of native plant or animal communities. The highest reaches of Papa‘anui on the other hand is sparsely vegetated to unvegetated (10% of the total land cover) due to environmental conditions. For a more detailed list of plant species found in both reserves see Appendix A.

**Rare and Endangered Plants:** There is one threatened and four endangered plant species currently known to exist in Kula FR and Papa‘anui (Table 6 and Figure 11). Rare and endangered species in Hawai‘i are listed under and protected by the Federal Endangered Species Act (ESA) and the State Endangered Species Law, Chapter 195D, HRS. Three of these plants species are managed by the Plant Extinction Prevention Program (PEPP) of Hawai‘i. The mission of PEPP is to protect the rarest native Hawaiian plants from extinction. PEPP works to reverse the trend toward extinction by managing existing populations, collecting seeds and establishing new populations with a focus on species that have fewer than 50 plants remaining in the wild. Members of the Hawai‘i Rare Plant Restoration Group, of which DOFAW is a founding member, provide oversight to PEPP and botanical expertise when necessary. PEPP regularly collaborates with over 60 conservation partners and landowners to protect PEPP species under their jurisdiction.

Table 6. Rare and endangered plants and animals observed within Kula FR (HBMP 2008 and Oppenheimer 2015). Observation are considered historical if it occurred more than 30 years ago.

	Species	Current/ Historical	ESA	PEP Species
<b>Plants</b>	<i>Argyroxiphium sandwicense</i> subsp. <i>macrocephalum</i>	Current (outplanted)	Threatened	No
	<i>Asplenium dielerectum</i> ( <i>Diellia erecta</i> )	Current	Endangered	Yes
	<i>Bidens micrantha</i> subsp. <i>kalealaha</i>	Current	Endangered	No
	<i>Cystopteris douglasii</i>	Current		No
	<i>Diplazium molokaiense</i>	Current	Endangered	Yes
	<i>Dubautia platyphylla</i>	Current		No
	<i>Geranium arboreum</i>	Current	Endangered	Yes
	<i>Phyllostegia ambigua</i>	Current		No
	<i>Sanicula sandwicensis</i>	Current		No
	<i>Sicyos cucumerinus</i>	Current		No
	<i>Stenogyne microphylla</i>	Current	Candidate	No
<b>Animals</b>	<i>Lasirus cinereus semotus</i>	Current	Endangered	N/A
	<i>Branta sandwicensis</i>	Current	Endangered	N/A

Figure 11. Threatened and Endangered Species and Critical Habitat in Kula Forest Reserve (FR) and the Papa'auui Tract of Kahikinui FR. Also see Table 6. (Hawaii Biodiversity and Mapping Program 2008; Oppenheimer 2015; USFWS 2016)



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**Plant Critical Habitat:** As outlined by the ESA, Critical Habitat is defined as “specific geographic areas, whether occupied by a listed species or not, that are essential for its conservation and that have been formally designated by rule” (USFWS 2004). The entire Kula Forest Reserve (4931 acres) has been designated as Critical Habitat and contains three ecosystem units that protect a total of 26 plant species. Papa‘anui has also been designated as Critical Habitat (714 acres) and contains two ecosystem units that protects a total of eight plant species (Table 7 and Figure 11).

Table 7. Ecosystem Critical Habitat Designation in Kula FR and Papa‘anui (USFWS 2016)

Species name	Critical Habitat Ecosystem Unit		
	Montane Mesic 1	Subalpine 1	Alpine 1
<b>Plants</b>			
<i>Argyroxiphium sandwicense</i> ssp. <i>macrocephalum</i>	x	x	x
<i>Asplenium dielerectum</i>	x		
<i>Asplenium peruvianum</i> var. <i>insulare</i>	x	x	
<i>Bidens campylotheca</i> ssp. <i>pentamera</i>	x		
<i>Bidens micrantha</i> ssp. <i>kalealaha</i>	x	x	
<i>Clermontia lindseyana</i>	x		
<i>Cyanea glabra</i>	x		
<i>Cyanea hamatiflora</i> ssp. <i>hamatiflora</i>	x		
<i>Cyanea horrida</i>	x		
<i>Cyanea kunthiana</i>	x		
<i>Cyanea mceldowneyi</i>	x		
<i>Cyanea obtusa</i>	x		
<i>Cyrtandra ferripilosa</i>	x		
<i>Cyrtandra oxybapha</i>	x		
<i>Diplazium molokaiense</i>	x		
<i>Geranium arboreum</i>	x	x	
<i>Geranium multiflorum</i>	x	x	
<i>Huperzia mannii</i>	x		
<i>Melicope adscendens</i>	x		
<i>Neraudia sericea</i>	x		
<i>Phyllostegia bracteata</i>	x	x	
<i>Phyllostegia mannii</i>	x		
<i>Santalum haleakalae</i> var. <i>lanaiense</i>	x		
<i>Schiedea haleakalensis</i>		x	
<i>Wikstroemia villosa</i>	x		
<i>Zanthoxylum hawaiiense</i>	x	x	
<b>Birds</b>	<b>Montane Mesic 18</b>	<b>Subalpine 24</b>	<b>N/A</b>
<i>Palmeria dolei</i>	x	x	
<i>Pseudonestor xanthophrys</i>	x	x	

**Timber Species:** The first commercial forest product industry in Hawai‘i started in 1791, with the harvesting of sandalwood. Sandalwood is prized for its fragrant wood and is a valuable commodity in international trade. There are six endemic species of sandalwood or ‘iliahi (*Santalum* spp.) and by the 1830’s they were depleted from the forests of Hawai‘i (Merlin et al. 1990). Since the sandalwood trade, a sustainable wood-based export market has not developed in Hawai‘i due to less expensive forest products that are available from the Pacific Northwest and Southeast Asia.



Figure 12. ‘iliahi (Kula FR)

There are a number of mid to large-scale timber plantations both on public and private lands throughout the state. In the late 1800’s, ranchers and sugar plantations began replanting efforts to replace the forests that were lost due to fire, cattle grazing, and harvesting for fence posts and fuel wood for whaling ships and sugar mills. The Territorial Government also had a tree planting program in which they utilized both introduced and native trees species. Reforestation was primarily done to protect and replenish fresh water resources, but was also done with commercially valuable timber species planted with the intention of developing a resource base for possible future harvest. In the 1930’s, the CCC greatly expanded watershed reforestation efforts on Maui (Wong et al. 1969). By the 1960’s, Kula Forest Reserve had 63 plantation plots encompassing approximately 1819.12 acres (Figure 14). There are no timber plantation plots in Papa’anui. Species that were planted and are still present in Kula FR include:

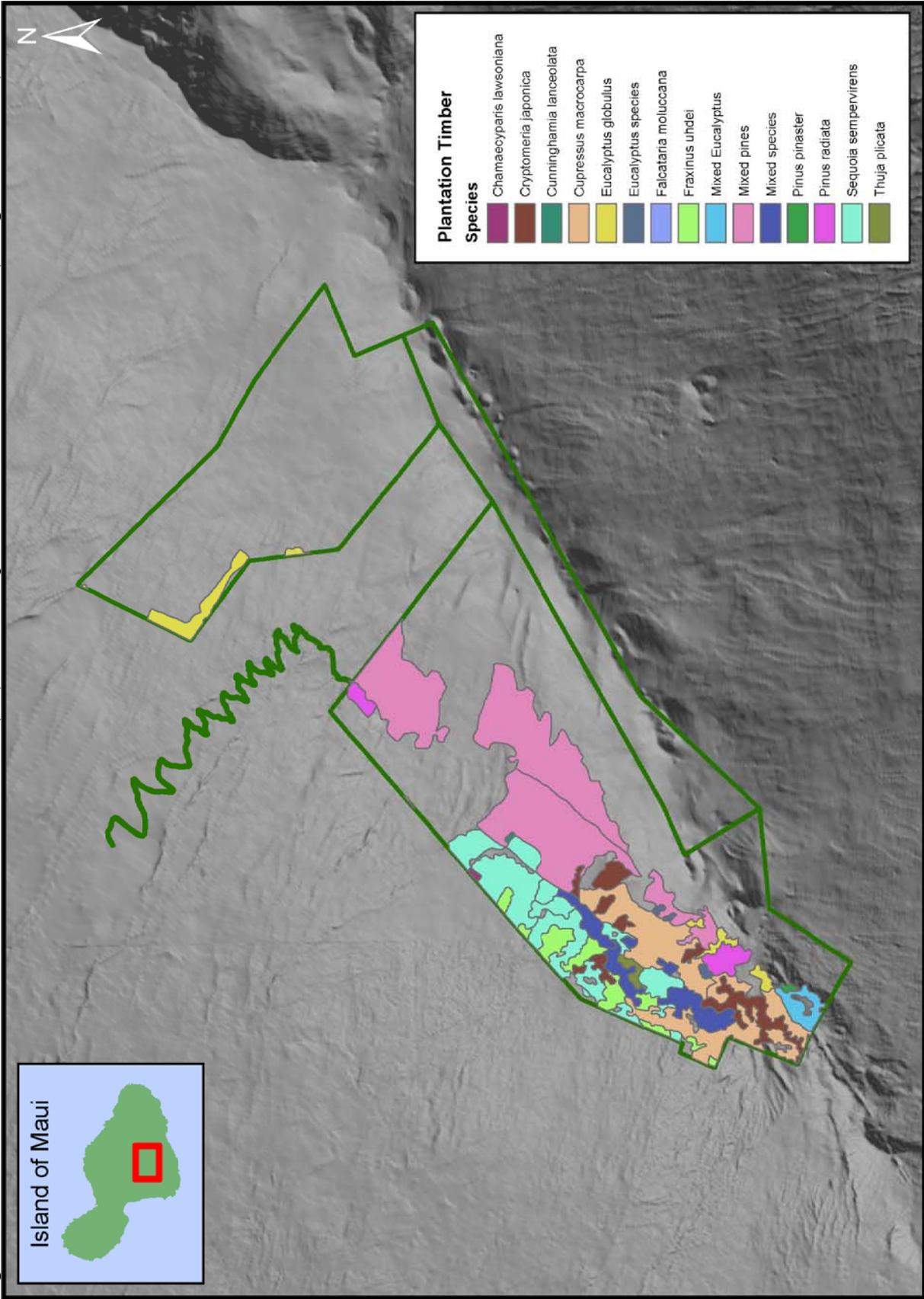
- *Chamaecyparis lawsoniana* (Port Orford cedar)
- *Cryptomeria japonica* (sugi)
- *Cunninghamia lanceolata* (China fir)
- *Cupressus macrocarpa* (Monterey cypress)
- *Eucalyptus globulus* (bluegum)
- *Eucalyptus* spp.
- *Fraxinus uhdei* (tropical ash)
- *Paraserianthes lophantha* subsp. *montana* (plume albizia)
- *Pinus patula* (patula pine)
- *Pinus pinaster* (maritime pine)
- *Pinus radiata* (Monterey pine)
- *Sequoia sempervirens* (redwood)
- *Thuja plicata* (western red cedar)



Figure 13. Salvage harvest of Monterey pine (*Pinus radiata*) in Kula FR

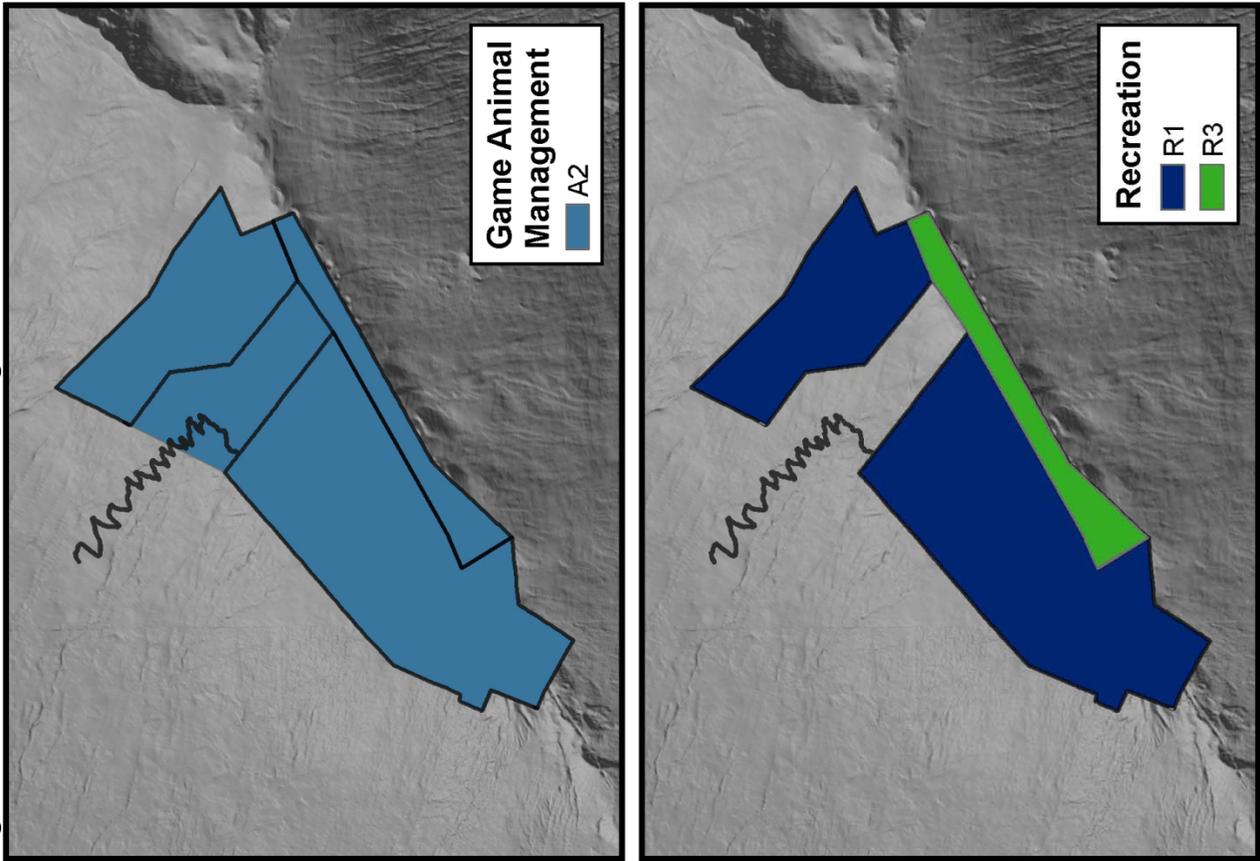
DOFAW’s Draft Management Guidelines classify Forest Product Management into four categories: Large Scale Commercial (F-1), Small Scale Commercial (F-2), Personal Use (F-3), and Restricted (F-4). Kula FR contains two of the four possible Forest Product Management categories (Figure 15). Approximately 2,395 acres are classified as F-2, where limited small-scale (no more than 5% of the total F2 acreage for each forest reserve, annually) commercial timber harvesting or salvage is allowed. Harvesting of non-timber forest products is also allowed. Approximately 2,506 acres are classified as F-4, where forest products are not a

Figure 14. Plantation timber stands in Kula Forest Reserve (FR) and the Papa‘anui Tract of Kahikinui FR (Klingensmith 1969)



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Figure 15. DOFAW 2001 Draft Management Guidelines for Kula Forest Reserve (FR) and the Papa'anui Tract of Kahikinui FR



primary objective. Harvesting of timber products is not allowed. Harvesting of non-timber forest products is generally not allowed and will be considered on a case by case basis for improving forest health, watershed protection, cultural uses and conservation efforts. All of Papa‘anui (714 acres) is also classified as F-4 (Figure 15). All classification levels have restrictions regulated by DOFAW and require appropriate permits and/or licenses. DOFAW is currently in the process of updating its Management Guidelines.

The Division does not have any current plans for large scale timber harvesting in Kula FR or Papa‘anui, but may issue commercial salvage permits for the purpose of purchasing and removing dead or hazardous trees. Each application for a commercial salvage permit shall be considered on its own merits, including its effect on the premises, natural resources and the public’s use and enjoyment of the forest reserve. Permits will not be issued for harvesting forest products for direct resale and the value of the raw material to be harvested cannot exceed \$10,000. The Division currently has no plans for any large-scale species replaced of non-native timber.

#### **F. Wildlife:**



Figure 16. nēnē (left); ‘ōpe‘ape‘a (right)

**Native Wildlife:** Two endangered animal species that are protected by both state and federal regulations have been documented to occur in Kula FR and Papa‘anui (Table 6, Figure 11), the endangered Hawaiian hoary bat ‘ōpe‘ape‘a (*Lasirus cinereus semotus*) and the nēnē or Hawaiian goose (*Branta sandvicensis*). Four additional native forest birds were documented in Kula FR (Table 8) during a comprehensive forest bird survey (Motyka 2013; Appendix B) that was completed in 2013, the Maui ‘alauahio (*Paroreomyza montana newtoni*), ‘apapane (*Himatione sanguinea*), i‘iwi (*Vestiaria coccinea*), and the Hawai‘i ‘amakihi (*Chlorodrepanis virens*). Other

species of Hawaiian birds that have been observed in Kula FR are the pueo (*Asio flammeus sandwichensis*) and the kōlea (*Pluvialis fulva*). The ‘apapane, Hawai‘i ‘amakihi, and kōlea are also known to occur in Papa‘anui (Table 9).

The endangered ‘ua‘u, or Hawaiian petrel (*Pterodroma phaeopygia sandwichensis*) is one of two seabirds that are endemic to Hawai‘i. Nesting colonies are known to occur in remote montane habitats, and ‘ua‘u require dark corridors as they transit to and from the ocean. Artificial lighting causes disorientation, collision, and increased predation when birds are grounded. While there are no documented sightings or nesting colonies of ‘ua‘u within Kula FR and Papa‘anui, given the proximity to existing populations, the availability of suitable habitat and anecdotal accounts of hearing ‘ua‘u calls at Ballpark (Papa‘anui) it is highly probable that they are present in the FR.

Three species of endemic fruit flies (family Tephritidae) in the genus *Trupanea* (*T. crassipes*, *T. cratericola* and *T. limpidapex*) have recently been documented to occur in Papa‘anui. Larvae and pupae of these native flies are commonly found in the seed heads, shoot tips, and stem gall of plants in the Asteraceae family. Native Tephritid surveys in 2010 and 2011, found that the native sub-alpine habitat of East Maui contained the largest population on the island, and four plant genera served as hosts for these native flies, *Artemisia*, *Bidens*, *Dubautia* and *Argyroxiphium*. Native Tephritid flies seem to be restricted to areas with intact native ecosystems and seem to have vanished from the lowlands (Starr 2011).



Figure 17: *Trupanea cratericola* on Haleakalā silversword flowers

**Animal Critical Habitat:** There is currently critical habitat for two species of forest birds, the ‘ākohekohe (*Palmeria dolei*) and the kiwīkiu (*Pseudonestor xanthophrys*) in Kula FR and Papa‘anui (Table 7 and Figure 11).

**Non-Native Wildlife:** A wide variety of introduced birds exist across the island of Maui. Twenty-one non-native forest and game birds (Table 8 and Table 9) are known to occur in Kula FR and Papa‘anui. There are a total of nine non-native mammals that have been documented in these reserves and are listed below in Table 8 and Table 9.

Table 8. Wildlife found in Kula FR

Species	Common name	Native/Non-native	Game species
<b>Birds</b>			
<i>Acridotheres tristis</i>	common myna	Non-native	No
<i>Alauda arvensis</i>	(Eurasian) Skylark	Non-native	No
<i>Alectoris chukar</i>	Chukar	Non-native	Yes
<i>Asio flammeus sandwichensis</i>	pueo	Native	No
<i>Branta sandvicensis</i>	nēnē	Native	No

Table 8. continue

<b>Species</b>	<b>Common name</b>	<b>Native/Non-native</b>	<b>Game species</b>
<i>Callipepla californica</i>	California quail	Non-native	Yes
<i>Cardinalis cardinalis</i>	Northern cardinal	Non-native	No
<i>Chlorodrepanis virens</i>	Hawai‘i ‘amakihi	Native	No
<i>Columbia livia</i>	rock dove	Non-native	No
<i>Francolinus francolinus</i>	black francolin	Non-native	Yes
<i>Francolinus pondicerianus</i>	gray francolin	Non-native	Yes
<i>Garrulax canorus</i>	melodious laughing thrush	Non-native	No
<i>Geopelia striata</i>	barred dove	Non-native	No
<i>Haemorhous mexicanus</i>	house finch	Non-native	No
<i>Himatione sanguinea</i>	‘apapane	Native	No
<i>Horornis diphone</i>	Japanese bush warbler	Non-native	No
<i>Leiothrix lutea</i>	red-billed leiothrix	Non-native	No
<i>Lonchura punctulata</i>	nutmeg mannikin	Non-native	No
<i>Meleagris gallopavo</i>	wild turkey	Non-native	No
<i>Mimus polyglottos</i>	Northern mockingbird	Non-native	No
<i>Paroreomyza montana newtoni</i>	Maui ‘alauahio	Native	No
<i>Phasianus colchicus</i>	common “ring-necked” pheasant	Non-native	Yes
<i>Pluvialis fulva</i>	Pacific golden plover	Native	No
<i>Spilopelia chinensis</i>	spotted dove	Non-native	Yes
<i>Tyto alba</i>	barn owl	Non-native	No
<i>Vestiaria coccinea</i>	‘i‘iwi	Native	No
<i>Zenaida macroura</i>	mourning dove	Non-native	No
<i>Zosterops japonicus</i>	Japanese white-eye	Non-native	No
<b>Mammals</b>			
<i>Axis axis</i>	axis deer	Non-native	Yes
<i>Capra hircus</i>	goat	Non-native	Yes
<i>Felis catus</i>	cat	Non-native	No
<i>Herpestes auropunctatus</i>	mongoose	Non-native	No
<i>Lasirus cinereus semotus</i>	‘ōpe‘ape‘a	Native	No
<i>Mus musculus</i>	House mouse	Non-native	No
<i>Rattus rattus</i>	Black rat	Non-native	No
<i>Rattus exulans</i>	Polynesian rat	Non-native	No
<i>Sus scrofa</i>	pig	Non-native	Yes

Table 9. Wildlife found in Papa‘anui

<b>Species</b>	<b>Common name</b>	<b>Native/Non-native</b>	<b>Game species</b>
<b>Birds</b>			
<i>Alauda arvensis</i>	(Eurasian) Skylark	Non-native	No

Table 9. continue

Species	Common name	Native/Non-native	Game species
<i>Alectoris chukar</i>	Chukar	Non-native	Yes
<i>Branta sandvicensis</i>	nēnē	Native	No
<i>Callipepla californica</i>	California quail	Non-native	Yes
<i>Chlorodrepanis virens</i>	Hawai‘i ‘amakihi	Native	No
<i>Haemorhous mexicanus</i>	house finch	Non-native	No
<i>Himatione sanguinea</i>	‘apapane	Native	No
<i>Mimus polyglottos</i>	Northern mockingbird	Non-native	No
<i>Phasianus colchicus</i>	common “ring-necked” pheasant	Non-native	Yes
<i>Pluvialis fulva</i>	kōlea	Native	No
<i>Zosterops japonicus</i>	Japanese white-eye	Non-native	No
<b>Mammals</b>			
<i>Capra hircus</i>	goat	Non-native	Yes
<i>Felis catus</i>	cat	Non-native	No
<i>Herpestes auropunctatus</i>	mongoose	Non-native	No
<i>Lasirus cinereus semotus</i>	‘ōpe‘ape‘a	Native	No
<i>Mus musculus</i>	House mouse	Non-native	No
<i>Rattus rattus</i>	Black rat	Non-native	No
<i>Rattus exulans</i>	Polynesian rat	Non-native	No
<i>Sus scrofa</i>	pig	Non-native	Yes

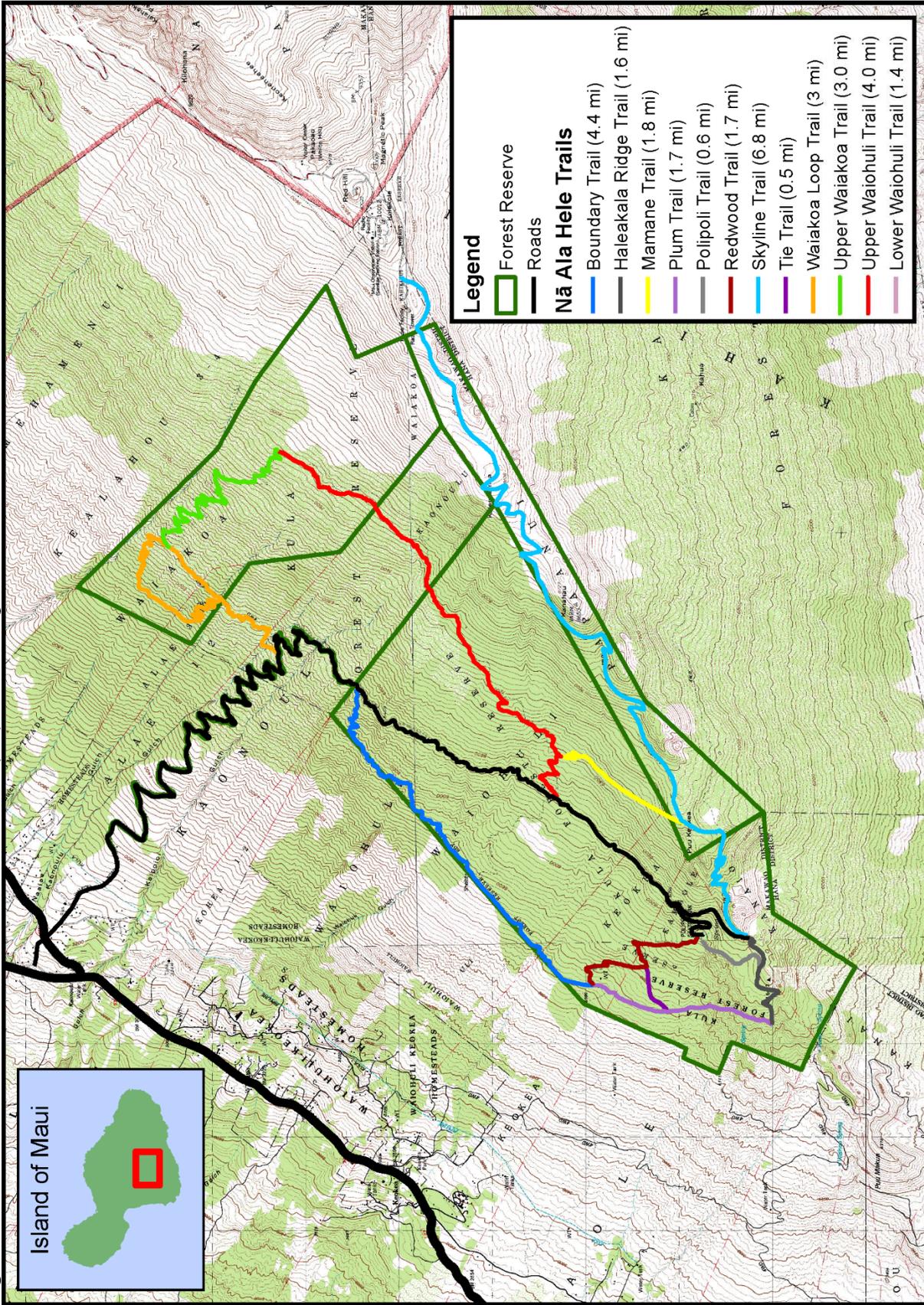
**G. Access:** There is public access to the majority of Kula FR and Papa‘anui (Figure 18).

**Vehicular Access:** Polipoli Access Road (also known as Waipoli Access Road) crosses through private land and provides legal public access through the majority of Kula FR, ending at Kanahau Gate (also known as Yellow Gate). Only street legal 4x4 vehicles are allowed past the FR entrance gate.

**Trails:** Nā Ala Hele, the State of Hawai‘i trail and access program (HawaiiTrails.org) has twelve interconnecting trails that provide additional public access in and around Kula FR and Papa‘anui; Boundary Trail, Redwood Trail, Plum Trail, Tie Trail, Haleakalā Ridge Trail, Skyline Trail, Waiakoa Loop Trail, Upper Waiohuli/Waiakoa Trail, Lower Waiohuli Trail, Māmane Trail, and Polipoli Trail (Figure 18).

Boundary Trail is 4.4 miles long, and begins from the Polipoli Access Road (Waipoli Access Road) near the second cattle guard. The trail descends via switchbacks to the lower boundary of the reserve. It then contours above the fence line, and ends at the CCC camp located at a three-way junction with the Redwood and Plum Trail. Bicycles are allowed on Boundary Trail.

Figure 18. Public access routes to Kula Forest Reserve (FR) and the Papa‘anui Tract of Kahikinui FR



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Figure 19. Nā Ala Hele – Redwood Trail

Redwood Trail is 1.7 miles long, and starts at Polipoli Spring State Recreation Area. It winds through stands of redwoods and other conifers ending at the old CCC camp at a three-way junction with Plum and Boundary Trail. Bicycles are allowed on this trail.

Plum Trail is 1.7 miles long, and starts at the old CCC camp at the three-way junction with Redwood and Boundary Trail. It gradually climbs across the mountain passing through numerous plum trees that bear fruit during the summer. The trail ends when it hits the Haleakalā Ridge Trail. This trail is only approved for pedestrian use.

Haleakalā Ridge Trail starts at the end of Plum Trail. It heads west for 1.6 miles and ends where it connects to Skyline Trail. This trail is only approved for pedestrian use.

Skyline Trail is 6.8 miles long and begins along the Science City Access Road past Haleakalā National Park, and crosses the length of Papa‘anui. There are two locked gates along the trail and it ends where it connects to the Haleakalā Ridge Trail. The terrain is rugged and vegetation is sparse as it passes several cinder cones and craters along the length of the rift. Bicycles are allowed on this trail.

Waiakoa Loop Trail is 3 miles long and begins from Polipoli Access Road at the Hunter’s check-in station near the top of the switchbacks. There is a 4-wheel drive only road (which may be impassible) that contours for 0.75 miles to a gate where the loop trail starts.

Upper Waiohuli/Waiakoa Trail is 7 miles long, and begins along Polipoli Access Road at about 6500 feet in elevation. From there it traverses across the mountain side through pine plantations and scrub vegetation. It crosses the private lands of Kaonoulu into Waiakoa, ending where it joins up with the Waiakoa Loop Trail. Bicycles are allowed on these two trails.

Lower Waiohuli Trail is 1.4 miles long and begins along Polipoli Access Road at about 6500 feet in elevation near the Upper Waiohuli/Waiakoa trailhead. The trail proceeds downslope and ends where it connects to the Boundary Trail. This trail is only approved for pedestrian use.

Māmane Trail is 1.8 miles long and passes though mixed native sub-alpine vegetation. To access this trail, take the Upper Waiohuli/Waiakoa Trail, and travel about ½ mile upslope to the trail junction. The trail ends where it connects to Skyline Trail. Bicycles are allowed on this trail.

Polipoli Trail begins at Polipoli Springs State Recreation Area. It passes through plantation stands of cypress, cedars and pines for 0.6 miles and ends where it joins up with Haleakalā Ridge Trail. This trail is only approved for pedestrian use.

With the growth of ecotourism in Hawai‘i, there is an increasing demand for commercial environmental tours that allow visitors to experience the natural resources of Hawai‘i through activities such as hiking. In accordance with Chapter 13-104-14, Hawai‘i Administrative Rules, suitable Nā Ala Hele program trails or accesses may be designated and approved for commercial

tour activities by the BLNR upon recommendation by DOFAW in consultation with the respective Trail and Access Advisory Council. Tour operators must obtain a permit from DOFAW to conduct any commercial activities on designated trails. There are eleven trails (Table 10) within Kula FR that are designated for commercial activity.

Table 10. Designated commercial trails in Kula FR and their established limits

Trail / Access Road	Allowed Activity	Maximum Number of Groups	Maximum Group Size
Boundary Trail	Pedestrian	3	12
Redwood Trail	Pedestrian	3	12
Plum Trail	Pedestrian	3	12
Tie Trail	Pedestrian	3	12
Haleakalā Ridge Trail	Pedestrian	3	12
Waiakoa Loop Trail	Pedestrian	2	12
Upper Waiohuli Trail	Pedestrian	2	12
Upper Waiakoa Trail	Pedestrian	2	12
Lower Waiohuli Trail	Pedestrian	1	12
Māmane Trail	Pedestrian	1	12
Polipoli Trail	Pedestrian	3	12

**Designated Helicopter Landing Zones:** None

**Restricted Watershed:** There are no restricted watershed areas on the island of Maui.

**H. Infrastructure:**



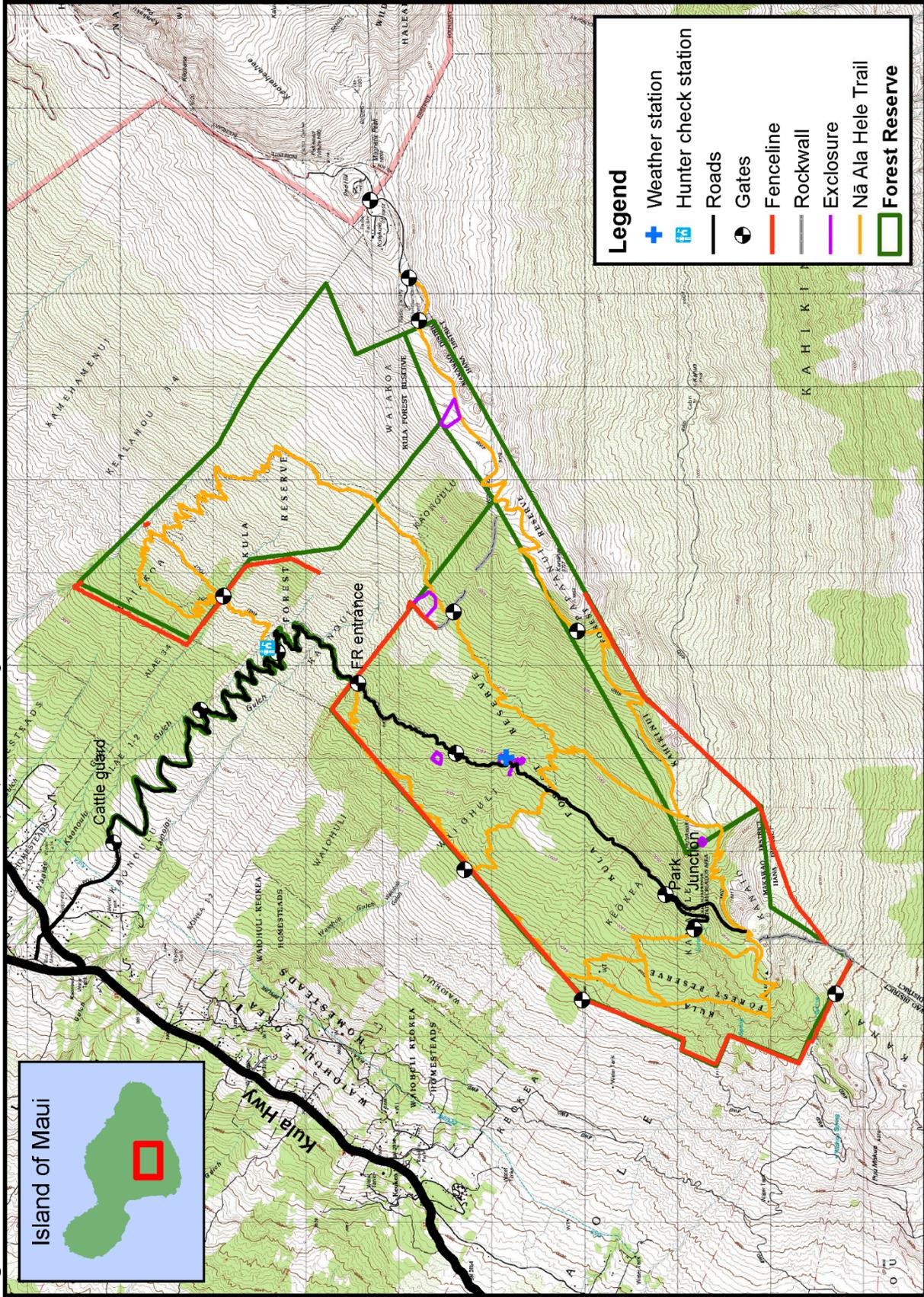
Figure 20. Cabin at Polipoli Spring State Recreation Area

Infrastructure in Kula FR and Papa‘anui (Figure 21) are primarily for public access and recreation. There is a well-developed system of trails and a main access road (Polipoli Access Road) that ends at Kanahau gate (Yellow gate). There are a total of fifteen gates, a hunter check station, a weather station, and many miles of fence line along the FR boundary. There are also a few smaller rare plant enclosures located in both Kula FR and Papa‘anui. The main road also provides

access to the Polipoli Spring State Recreation Area, which is managed and maintained by the Division of State Parks. Facilities at the State Park include a cabin, camping facilities, flushing toilets and non-potable water.

**I. Archaeological and Historical Sites:** There are no documented archaeological sites in either Kula FR or Papa‘anui (DOFAW lands only). There are some rock walls that were built by cattle ranchers more than 50 years ago that are located within the forest reserve. Some of the walls

Figure 21. Infrastructure of Kula Forest Reserve (FR) and the Papa'anui Tract of Kahikinui FR



Polipoli Access Road - Distance	
Cattle guard to hunter check station	4 mi
Hunter check station to FR entrance	1.3 mi
FR Entrance to Park Junction	2.9 mi
Park Junction to Cabin	0.6 mi



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were also built by the forest ranger along the boundary in the early 1920's to keep cattle out of the forest reserve. These structures meet the definition of "historic property" as defined in Section 6E-2, HRS, and any projects that could potentially affect these structures are subject to review by the State Historic Preservation Division (SHPD), pursuant to Section 6E-8, HRS.

In the event, any surface and/or subsurface evidence of historic properties, including cultural deposits or features, human remains, lava tubes, structural remnants or concentrations of artifacts are uncovered during any management activities, work will cease immediately in the area of the discovery. The discovery will be protected from further disturbance, and the SHPD will be consulted regarding appropriate documentation. If historic properties are present which require mitigation, the SHPD will request that a detailed mitigation plan (e.g., archaeological monitoring plan [AMP] or a preservation plan [PP]) be submitted to the SHPD for review and acceptance prior to initiation of project work, along with written and photographic documentation providing verification that appropriate interim protection measures have been implemented.

#### **J. Public Use Opportunities:**

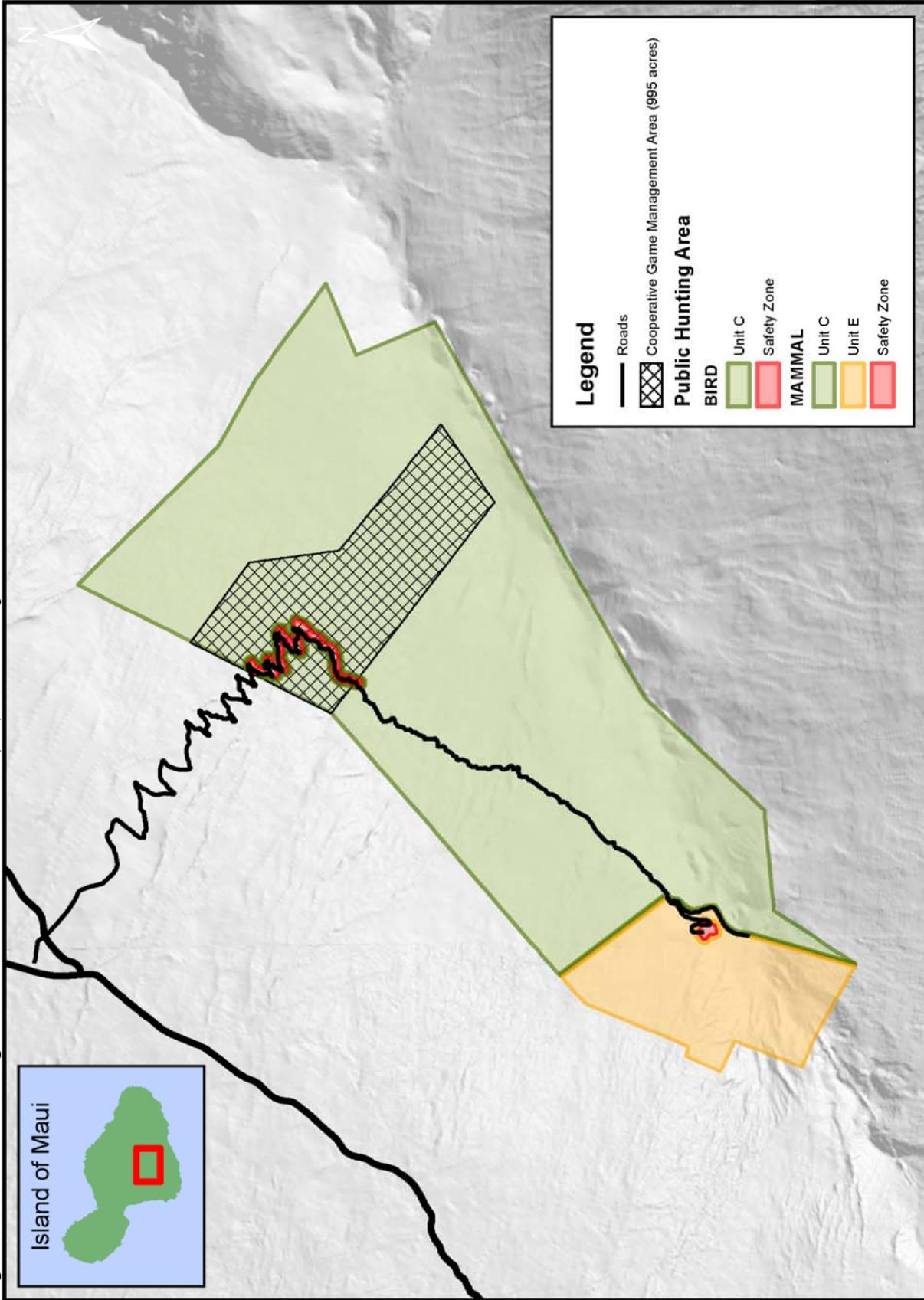


*Figure 22. Chukar (left); goats (right)*

**Hunting:** DOFAW manages public hunting on all forest reserve lands on Maui and regulates hunting days, seasons, bag limits, and means of take. The Division of Conservation and Resources Enforcement (DOCARE) enforces hunting regulations found in Chapter 121, HAR Rules Regulating the Hunting of Wildlife on Public Lands and Other Lands, Chapter 122, HAR Rules Regulating Game Bird Hunting, and Chapter 123, HAR Rules Regulating Game Mammal Hunting.

The state lands that comprise Kula FR are separated into two non-contiguous pieces by privately held land (Figure 23) that is currently owned by Kaonoulu Ranch. In 1955, an agreement was negotiated with the ranch to allow public hunting on the approximately 994 acres of tax map keys (2) 2-2-007:002 and (2) 2-2-007:010. On September 11, 1998, the Board approved a Cooperative Game Management Agreement (CGMA) for the subject area, replacing the original agreement that had expired by that time. DOFAW continues to manage the area as a CGMA.

Figure 23. Public Hunting Area in Kula Forest Reserve (FR) and the Papa 'anui Tract of the Kahikinui FR



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Kula Forest Reserve, Papa‘anui, and the Kaonoulu CGMA are all part of hunting unit C, and a small portion of Kula FR is included within unit E (Figure 23). Game mammals found within these hunting units consist of feral pigs (*Sus scrofa*), goats (*Capra hircus*), and axis deer (*Axis axis*). Game birds in hunting unit C include: Common pheasant (*Phasianus colchicus*), black francolin (*Francolinus francolinus*), chukar partridge (*Alectoris chukar*), gray francolin (*Francolinus pondicerianus*), California quail (*Callipepla californica*), barred doves (*Geopelia striata*), and spotted dove (*Streptopelia chinensis*).

DOFAW’s 2001 Draft Management Guidelines separate Game Animal Management into four categories: Game Production (A-1), Mixed Game and Other Uses (A-2), Game Control (public) (A-3), and Game Control (supervised) (A-4). All lands within Kula FR (4931 acres), Papa‘anui (714 acres), and the CGMA (994) are classified as A-2, where game management is an objective integrated with other uses (Figure 15). DOFAW is currently in the process of updating its Management Guidelines.

**General Recreation:** DOFAW’s 2001 Draft Management Guidelines consist of four categories for Recreation Management: R-1 (Heavy Use Areas), R-2 (Medium Use Areas), R-3 (Light Use Areas), and R-4 (Restricted Areas). The entire Kula Forest Reserve is designated as R-1 (4931 acres); these are areas where outdoor recreation is a primary objective (Figure 15). R-1 areas may have highly developed recreational facilities such as check-in stations, camp sites, utilities and parking lots. Kula Forest Reserve is a popular day use area on Maui; it is easily accessible and has trails that are that are appropriate for all age levels. Papa‘anui is designated as R-3 (714 acres); these are areas where recreation would be limited to certain areas, or occasional levels of use due to impacts on resources programs (Figure 15). Trails would be the main recreational feature, and their use may be restricted. DOFAW is currently in the process of updating its Management Guidelines.

**Camping:** Camping is only allowed at the Polipoli Spring State Recreation Area, which is managed by the DLNR Division of State Park. Camping permits for the state park are available online at <https://camping.ehawaii.gov/>.



Figure 24. Camping grounds at Polipoli Spring State Recreation Area

**Fishing:** No fishing opportunities are available in Kula FR or Papa‘anui.

**Hiking:** There are twelve Nā Ala Hele hiking trails in Kula FR and Papa‘anui. See section G: Access above for more details.

**Horseback Riding:** Horseback riding is not permitted in Kula FR or Papa‘anui. See section G: Access above for more details.

**Dirt Bikes, All Terrain Vehicles (ATVs) and Mountain Bikes:** Starting from the FR Entrance gate (Figure 21), only street legal 4WD vehicles are allowed on Polipoli Access Road through Skyline trail up until Kanahau Gate; non-motorized mountain bikes may be used on Boundary Trail, Māmane Trail, Redwood Trail, Skyline trail, Waiakoa Loop Trail and Upper Waiohuli/Waiakoa Trail.

**Non-Timber Forest Product Collection:**

Non-timber forest products may be collected within the Reserves. Examples include but are not limited to:

- a. Ferns
- b. Flowers
- c. Fruits
- d. Guava poles (*Psidium* spp.)
- e. Bamboo shoots and stalks
- f. Greenery
- g. Pine boughs



Figure 25. Pine cones (Kula FR)

Gathering of material from plant species that are not on federal or state threatened and endangered species lists is permitted and regulated by DOFAW through standard Forest Reserve System permit procedures as described in Chapter 13-104, HAR. Gathering of non-listed species or common materials requested in quantities that are determined by DLNR as representing personal use, is regulated through issuance of a Collection Permit free of charge. If quantities are determined to represent commercial use, a Commercial Harvest Permit may be issued at a fee. Consult the Forest Product Price List on the DOFAW website for information on personal versus commercial use quantities, as well as current commercial use pricing.

<http://dlnr.hawaii.gov/forestry/files/2013/09/Forest-Product-Price-List.pdf>

Collection of:

1. Listed threatened, endangered, or other rare species, or
2. Common invertebrate species, or
3. Any migratory bird species,

are prohibited under state laws Chapter 183D and 195D, HRS and subject to regulation under applicable HAR. Applications for permits for such activities may be submitted to the “Administrator,” at the DOFAW Honolulu office. In these cases, a separate Access Permit may be required which is obtained through the district manager at the DOFAW Maui office. Both addresses follow:

Administrator  
Division of Forestry and Wildlife  
1151 Punchbowl Street, Room 325  
Honolulu, HI 96813  
Phone (808) 587-0166

Maui District Manager  
Division of Forestry and Wildlife  
1955 Main St. Rm 301  
Wailuku, HI 96793  
Phone (808) 984-8100

The collection of any federally listed or migratory bird species is also subject to federal permits. Contact the USFWS for additional information.

**Traditional and Customary Rights:** Traditional and customary rights of the native Hawaiian people are protected under Hawai‘i law. In the Constitution of the State of Hawai‘i, Article XII, Section 7, “The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by ahupua‘a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights.” For any inquiries regarding traditional and customary rights, please contact the Forestry Manager at the DOFAW Maui Office:

Forestry Manager  
Division of Forestry and Wildlife  
1955 Main St. Rm 301  
Wailuku, HI 96793  
Phone (808) 984-8100

**K. Threats:**

**Plants:** Invasive plants are non-native species that can invade natural areas, grow and reproduce rapidly, reduce biodiversity and alter ecosystem functions. Invasive plant species that are present in Kula FR and Papa‘anui that have the potential to disrupt the ecosystem are listed in below in Table 11. For a brief description of each species, their statewide distribution and impacts see Appendix C. Based on potential impacts, distribution in the FR, and available control methods, DOFAW has set a management objective (control, containment or eradication) for each species.



Figure 26. Fireweed (Kula FR)

Invasive plant management objectives:

- Control – Reduce populations and/or the vigor of individuals
- Containment – Stops or minimizes population growth and geographic spread
- Eradication – Elimination of populations within geographic area

Many of these species are also designated as a noxious weed by the Hawai‘i Department of Agriculture. A noxious weed is defined as a plant species which is, or may be likely to become, injurious, harmful, or deleterious to the agricultural industry or natural resources of the state. Selling or transporting noxious weeds, their seeds or vegetative reproductive parts is prohibited under state law Chapter 152, HRS and subject to regulation under Chapter 4-68, HAR.

Table 11: Invasive plants species that occur in Kula FR and Papa‘anui

Species	Common name	DOFAW Objective	Regulatory Status
<i>Acacia mearnsii</i>	black wattle	Containment	Hawai‘i Noxious Weed List
<i>Bocconia frutescens</i>	tree poppy	Eradication	Hawai‘i Noxious Weed List
<i>Cortaderia jubata</i>	pampas grass	Eradication	Hawai‘i Noxious Weed List
<i>Cotoneaster pannosa</i>	silverleaf cotoneaster	Control	None
<i>Morella faya</i>	fire tree	Control	Hawai‘i Noxious Weed List
<i>Passiflora tarminiana</i>	banana poka	Eradication	Hawai‘i Noxious Weed List
<i>Rubus argutus</i>	blackberry	Control	Hawai‘i Noxious Weed List
<i>Rubus niveus</i>	Mysore raspberry	Control	Hawai‘i Noxious Weed List
<i>Senecio madagascariensis</i>	fireweed	Control	Hawai‘i Noxious Weed List
<i>Sphaeropteris cooperi</i>	Australian tree fern	Eradication	None
<i>Ulex europaeus</i>	gorse	Eradication	Hawai‘i Noxious Weed List

**Animals:** Non-native animals that are present in Kula FR and Papa‘anui and have the potential to disrupt the ecosystem include:

- *Axis axis* (axis deer) - Cause vegetation damage/erosion.
- *Canis lupus familiaris* (dogs) - Predate on native birds, game mammals and game birds. Threat to public safety.
- *Capra hircus* (goats) - Cause vegetation damage/erosion.
- *Culex* spp. (mosquitoes – especially *Culex quinquefasciatus*) - Vectors for diseases that are a threat to public safety and native wildlife.
- *Felis catus* (cats) - Predate on native and game birds and are vectors of toxoplasmosis, a zoonotic disease
- *Herpestes auropunctatus* (mongoose) - Predate on native and game birds.
- *Rattus* spp. (rats) - Predate on native plant fruits/seeds and native and game birds.
- *Sus scrofa scrofa* (pigs) - Cause trail and vegetation damage.
- *Tyto alba* (barn owl) - Predate on native and game birds.

**Insects & Disease:** Introduction of insects and disease are a serious threat to the natural areas of Hawai‘i. Of particular concern are those that could cause widespread dieback of predominant forest canopy species such as koa and ‘ōhi‘a. With globalization and an increased dependence on imports, approximately 20 insect species become established in Hawai‘i every year (DOFAW 2010).

Recent notable introduction of insects and disease include a rust species (*Puccinia psidii*) that decimated stands of rose apple (*Syzygium jambos*) and has severely impacted the endangered plant species nīoi (*Eugenia koolauensis*). The erythrina gall wasp (*Quadrastichus erythrinae*) infested introduced and native populations of *Erythrina* or wiliwili to varying degree across the state. Koa wilt (*Fusarium oxysporum* f.sp *koae*) is a soil borne disease that is causing dieback and decline of koa primarily in lowland plantation stands on former agricultural land.

The Eurasian pine aphid (*Pineus pini*) was accidentally introduced and first documented at Waiki‘i on the island of Hawai‘i in 1970. Infestations were known to weaken and sometimes kill various pine species. Pines were used in reforestation efforts throughout Hawai‘i, and concerns of widespread mortality triggered a statewide control effort by state and federal agencies. The Eurasian pine aphid was found at Makawao on Maui in 1971 during population distribution surveys. In 1973, two additional infestations were found at Waihou Spring FR and Kula FR. Aerial application of insecticides were initiated until strong public opposition halted these efforts. Three biological control agents were subsequently introduced to control the pine aphid (*Leucopis nigriluna*, *L. tapiae* and *Scymnus suturalis*). Several of the releases were done at “Polipoli” in Kula FR. Correlation analysis of population densities indicate that *L. tapiae* successfully controlled pine aphid populations to below economically significant levels (Culliney et al. 1988).

The most recent epidemic that has caused major concern is rapid ‘ōhi‘a death (ROD). ROD is caused by a fungus (*Ceratocystis fimbriata*) and currently has only been confirmed to occur on the island of Hawai‘i. Hundreds of thousands of ‘ōhi‘a trees have been killed by this disease spanning across 75,000 acres of forest. Thus far ROD has not been detected on neighboring islands. An aerial survey for ROD has been completed for the island of Maui ( *Figure 27*). Based on the results of the aerial survey the Division is currently collecting samples from targeted areas

to determine if ROD is present on the island. Visit the ROD website <http://www.rapidohiadeath.org> for more information on what can be done to help prevent the spread.

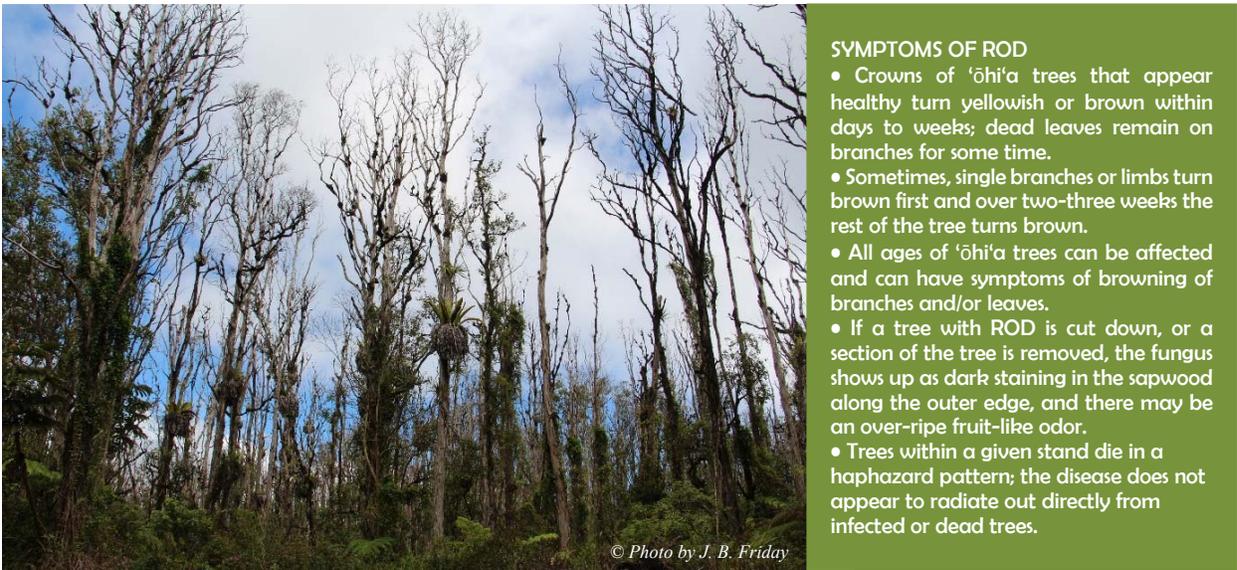


Figure 27: 'Ōhi'a killed by ROD in lower Puna on the island of Hawai'i

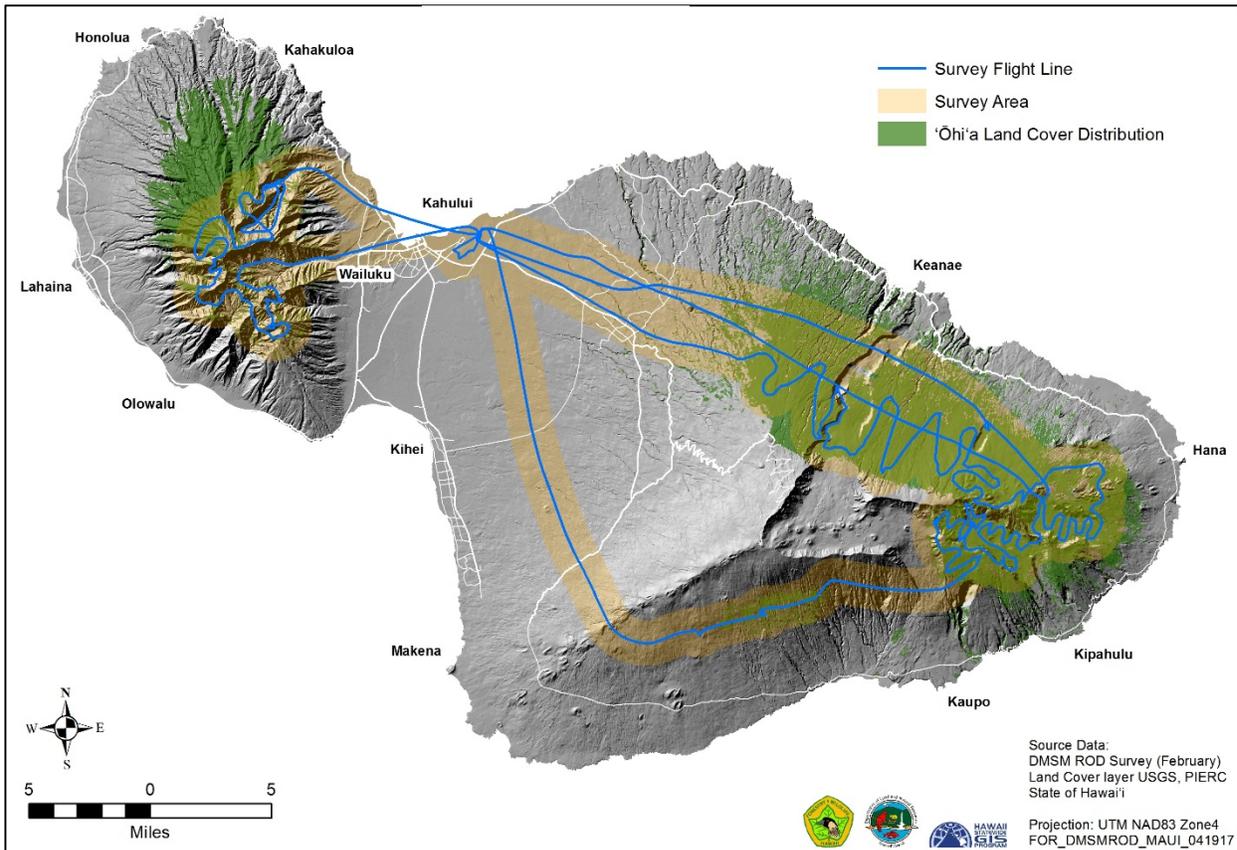


Figure 27. Maui Rapid 'Ōhi'a Death Aerial Surveys (February 2017)

**Fire:** Native ecosystems in Hawai‘i are not adapted to wildfire with the majority of plant species not being able to regenerate after a fire. Introduced fire adapted grasses and shrubs now cover 25% of the total land mass in Hawai‘i (Trauernicht 2014). Combined with an increase in human caused ignition, this has resulted in a fourfold increase of area burned annually by wildfires in Hawai‘i (Trauernicht and Pickett 2016). Wildfires are a serious threat to human safety and property, and impact native ecosystems, watersheds and near shore coastal resources statewide. Given that Kula FR is highly used by the public, and much of the vegetation consists of non-native forest and grasslands, fire risk for the area is high. There have been large fires in Kula FR in 1954, 1984, and 2007, that burned significant portions of the forest reserve.



*Figure 28. Aftermath of 2007 Kula FR wildfire showing burned area and associated soil erosion*

**Flooding:** Road conditions can become hazardous due to damage caused by flooding.

**Climate Change:** According to the 2012 Pacific Islands Regional Climate Assessment (PIRCA) documented indicators of climate change in the region include increasing air temperature (more significant at higher elevation), decrease in rainfall across much of the region, decrease in ground water discharge to streams, changes to frequency and intensity of climatic extremes, mean sea level rise (Western Pacific), changes in species distributions, increasing ocean surface temperature and changing ocean chemistry.

Potential impacts to our communities and natural environments include shifts in rainfall patterns, a decrease in freshwater supplies, increase in extreme weather events, flooding and erosion, increase in non-native biological invasions, increase in frequency and size of wildfires, and an increased risk of species extinction.

The primary mitigation for climate change involves actions to reduce emissions and enhance sinks of greenhouse gases. Maintaining and ideally increasing carbon storage within our forests will help decrease atmospheric carbon. In terms of reducing emissions, Governor David Ige signed into law the most aggressive clean energy goal in the nation. The goal set in 2015, is to achieve energy self sufficiency utilizing 100 percent renewable sources of energy by the year 2045.

Even with the above mitigation actions, forest ecosystems in Hawaii will face new climatic conditions associated with climate change. Individual species and ecosystems types may be more vulnerable to climate change if they are not able to adapt to these new conditions or migrate to suitable habitats. The Pacific Island Climate Change Cooperative (PICCC) has started climate vulnerability assessment for Hawaii species, but additional information is needed at local scales to determine impacts within individual watersheds and forest reserves.

**Other:** There has been an ongoing problem of fenceline, gate (locks) and sign vandalism. Timber theft is infrequent but does take place in Kula FR. Illegal skateboarding that occurs along the Polipoli Access Road is also a problem and safety concern. Additionally, illegal off-road vehicle activity in Kula FR has been damaging the natural resources in this area. Illegal fire pits are being lit at night along the Polipoli Access Road and are an extreme fire hazard.

#### **L. Revenue:**

According to Section 183-1.5, HRS, the Department shall:

“Devise and carry into operation, ways and means by which forests and forest reserves can, with due regard to the main objectives of title 12, be made self-supporting on whole or in part.”

Commercial permits for non-timber forest products and small scale salvaging of dead or down timber are issued for Kula FR. There are other potential sources of future revenue that are under consideration. All trails in Kula FR except Skyline Trail are approved for commercial use. Permits are required for all commercial tour operations. There are no current revenue sources within Papa‘anui.

### **III. MANAGEMENT**

**A. Past Planning:** The Division of Forestry completed the first management plan for Kula Forest Reserve in 1971. The overarching goals of the 1971 management plan were: (1) to retard the rapid run-off of storm flows, prevent soil erosion, improve water quality, prolong periods of stream flow, and aid in recharging underground aquifers, (2) to produce forest products to the extent possible while maintaining conditions favorable for water conservation, recreation, and protection of native flora and fauna, (3) to develop and maintain a favorable environment and necessary facilities for outdoor recreation and wildlife habitat.

**B. Related Plans:** Plans that contain relevant information on the resources and management strategies pertinent to the management of Kula FR and Papa‘anui are listed below.

- Leeward Haleakalā Watershed Restoration Partnership (LHWRP) Management Plan
- Hawai‘i’s State Wildlife Action Plan
- DOFAW Forest Action Plan
- Nā Ala Hele Program Plan

- DOFAW Draft Management Guidelines
- Maui Invasive Species Committee Strategic Plan
- USFWS Endangered Species Recovery Plans

**C. Summary of Existing Management Activities:** Current management activities within Kula FR and Papa‘anui are weed management (monitor, map, and control), biological surveys and monitoring, access road and infrastructure maintenance, boundary fence and rare plant enclosure maintenance, native and T&E outplanting, native plant seed collection and storage (seed banking), firebreak/fuelbreak maintenance, Nā Ala Hele trail maintenance, water unit maintenance for game bird species, predator control (mongoose, rat, and cats), and game habitat management which includes but not limited to black wattle (*Acacia mearnsii*) and invasive species removal.

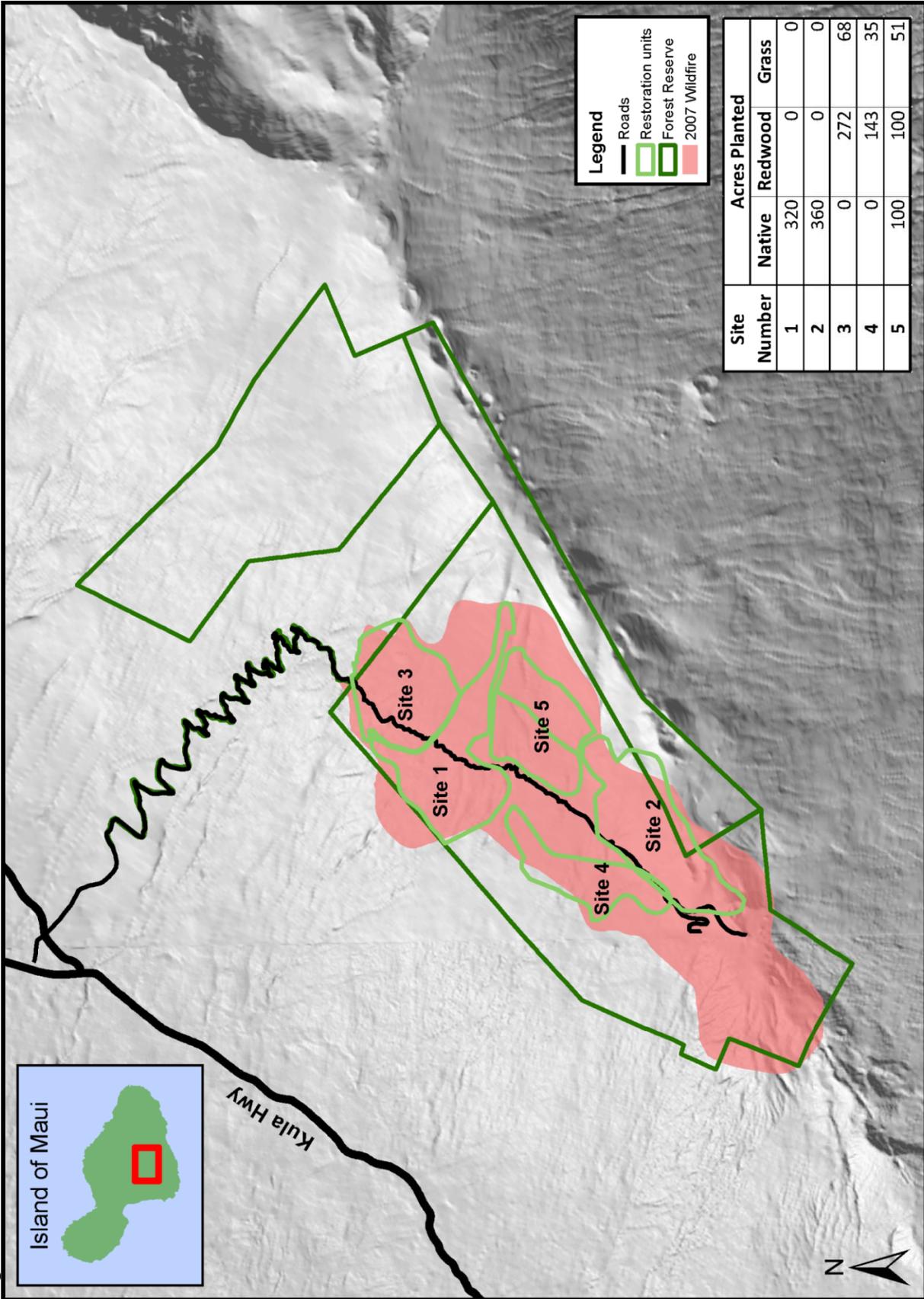


Figure 29. Papa‘anui silversword enclosure and outplanting

In 2007, a large wildfire burned approximately 2,300 acres of forested lands in Kula FR (Figure 30). The burned unit was dominated by mature forests comprised primarily of pines, cypress, and redwoods. This was the most devastating fire to have occurred in Hawai‘i for many decades, and in response DOFAW planned and implemented a hazard reduction and reforestation operation in the aftermath of the Upper Waiohuli wildfire. On February 27, 2007, Governor Linda Lingle signed an Emergency Proclamation to help expedite DOFAW’s mitigation and reforestation efforts.

As a result of the mitigation and restoration effort, DOFAW felled and chipped all hazardous standing or downed trees or debris along Polipoli Access Road from the FR entrance to Polipoli Spring State Recreation Area; repaired 6 miles of damaged fence line; hydromulched 2.9 miles of roadside to stabilize soils with a slurry of annual rye grass (*Lolium perenne*) and orchardgrass (*Dactylis glomerata*) seeds (species were selected based on recommendations by the USFWS); aerial broadcasted the same seed mixture for soil stabilization across 154 acres; planted 780 acres with native tree and shrub species, and planted 515 acres with redwoods to replace the plantation stands that were lost during the fire. A total of 212,000 trees and shrubs were outplanted during reforestation efforts.

Figure 30. Kula Forest Reserve 2007 Wildland Fire and Restoration Effort



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 Department of Land and Natural Resources  
 Division of Forestry and Wildlife  
 (808) 587-0166  
 May 2016

On August 7-9, 2014, Tropical Storm Iselle passed through the Hawaiian Islands, which caused extensive damage to the natural resources and infrastructure in Kula FR. The storm knocked over stands of trees that damaged approximately 3 miles of fence line, 2.5 miles of the Polipoli Access Road, and approximately 7 miles of Nā Ala Hele trails. Repair and hazard mitigation was completed in April 2015, and the forest reserve has since been reopened for public use.

**D. Management Objectives and Goals:** In the Draft Comprehensive Management Plan for each district of the Division, broad management priorities for each forest reserve were derived from the mandates that regulate DOFAW activities, including the Draft Management Guidelines and Administrative Rules, as well as input from district staff. These management priorities were divided into eight categories (listed below) and shall be used to guide management activities within the forest reserve.

- Watershed Values (aquifer recharge and erosion control)
- Native Ecosystems (landscape level protection)
- Resource Protection (fire, insects, and disease)
- Invasive Species Control (incipient and established plants and animals)
- Threatened and Endangered (T&E) Species Management (Federally listed, State listed, and rare plants and animals)
- Access, Trails, and other Public Uses (non-income generating uses, such as recreation, cultural activities, personal gathering, educational or research activities, and events among others)
- Game Animal Management (areas managed for public hunting and/or habitat enhancement for game animals)
- Commercial Activity (income generating activities such as timber, tours, etc.)

Based on the natural and cultural resources and public use opportunities of the reserves, each category has been ranked on a qualitative scale of 1 to 8 with 1 as higher priority and 8 as lower priority. Table 12 is an excerpt from the Maui Forest Reserves Draft Comprehensive Management Plan and lists qualitative rankings of the management priority categories for Kula FR and Papa‘anui.

Table 12. Kula Forest Reserve and Papa‘anui associated management priority categories

Forest Reserve Section Name	Resource Protection	Watershed Values	Invasive Species Control	T&E Species Mgmt.	Native Ecosystems	Game Animal Mgmt.	Commercial Activity	Access, Trails, and other Recreational Uses
Kula	2	1	7	5	6	3	8	4
Papa‘anui	6	1	2	3	5	4	8	7

Table 13 expands on these management priority categories, listing general management actions to address the objectives, along with tactical goals, action items, and estimated cost associated with these actions. As the two Forest Reserves are in close proximity to each other and they have similar management priorities, they are treated as one in the following table.

Table 13. Management objectives and associated plans for Kula FR and Papa‘anui. Estimated cost refers to State funds.

Management Priority	General Management Action	Tactical Goals	Action Items	Estimated Cost
<b>Watershed Values</b>	Increase land holdings protected under the Forest Reserve System	Acquire or negotiate lease for neighboring properties.	Initiate discussions with parcel owners to acquire parcels for possible Forest Reserve designation.  TMK (2) 2-3-005:002	Staff & mgmt. costs; market value
	Reduce the threat and impact of erosion on reserve resources	Maintain forest cover on watershed lands to provide high quality water for residents	Re-establishment of appropriate vegetative cover	\$10K/year + staff costs
		Control ungulate populations at levels consistent with watershed protection needs	Encourage public hunting through outreach	Staff & mgmt. costs only
			Identify sensitive areas suitable for natural resource protection through ungulate exclusion fencing projects	Staff & mgmt. costs only
		Maintain ground cover	Regulate illegal timber and non-timber product harvesting,	Staff & mgmt. costs only
		Post fire mitigation	Collect and store seed stock for various native plant species to be used for post-fire mitigation work	\$5K/year
			conduct post-fire mitigation such seed scatter, aerial broadcast, weed control, soil conditioning and reforestation.	TBD
			Exclude cattle from FR	Maintain boundary fences to comply with HRS Chapter 183
		Exclude cattle from FR	Locate and remove cattle with owner’s assistance	TBD
			Conduct staff controlled operations for non-game mammal species	Staff & mgmt. costs only
		Monitor forest composition over time to determine landscape level needs	Determine permanent systematic monitoring protocol	Establish survey plots and transects.
	Maintain DOFAW’s partner role in the East Maui Watershed Partnership (EMWP) and LHWRP.	Improve communication and coordination between agencies	Establish regular communications, schedules, and protocols with WPs	Staff & mgmt. costs only
			Participate in WPs quarterly meetings	Staff & mgmt. costs only
			Annual renewal of Special Use Permits for EMWP and LHWRP	Staff & mgmt. costs only

<b>Management Priority</b>	<b>General Management Action</b>	<b>Tactical Goals</b>	<b>Action Items</b>	<b>Estimated Cost</b>
	Climate Change Adaptation	Keep current on the latest available information for climate change, modeling and adaptation.	Participate in climate change seminars, meeting and workshops.	Staff & mgmt. costs only
<b>Resource Protection</b>	Fire presuppression and mitigation	Fire presuppression	Development of fire management and fuel reduction plans targeting fire prone and fire adapted plant species.	Staff & mgmt. costs only
			Seek opportunities and technical assistance regarding “small cable yarder” system; Initiate discussions and consultation with system experts to see if viable for fuel loads and terrain in FR	\$7K/year
			Implement fuelbreak/firebreak maintenance projects along access road corridor	\$100K/year
		Fire prevention	Work with State Parks Division to identify defensible spaces especially near camp sites and cabin facilities for programs such as Firewise and Ready Set Go.	Staff & mgmt. costs only
			Post Smokey Bear fire prevention signs at entrances/access point of Kula FR during high fire preparedness level.	Staff & mgmt. costs only
			Conduct traffic stops at entrance/access point into Kula FR during extreme fire preparedness level.	Staff & mgmt. costs only
			If ground conditions present extreme fire threat based on fire preparedness level, staff will conduct fire patrols once a week to extinguish smoldering pits and remove discarded excess fuels (pallets) from illegal fires.	Staff & mgmt. costs only
			If ground conditions present extreme fire threat based on fire preparedness level, DOFAW will close Kula Forest Reserve.	Staff & mgmt. costs only
			Public education and outreach	Participate in specific target outreach activities as appropriate based on fire preparedness levels.

<b>Management Priority</b>	<b>General Management Action</b>	<b>Tactical Goals</b>	<b>Action Items</b>	<b>Estimated Cost</b>	
	Forest Health	Forest health monitoring and implementation of forest management practices	Conduct monthly forest health surveys. Compose and submit annual survey report to Forest Health Coordinator.	Staff & mgmt. costs only	
			Rapid response to mitigate forest health issue.	Staff & mgmt. costs only	
		Rapid ‘Ōhi‘a Death (ROD) Early Detection and Management	Collaborate with partners to secure essential technical information and understanding of the threat	Staff & mgmt. costs only	
			Assist and collaborate with partners to secure new information on mode of transmission	Staff & mgmt. costs only	
			Conduct aerial surveys and trail user information surveys for early detection	\$10K/year	
			Based on the results of the aerial survey notify landowners and request access and or work with landowner to collect samples to test for ROD	TBD	
			Document and report any sightings of dead or dying ‘ōhi‘a trees in the field during routine operations	TBD	
			Adopt sanitation procedures proven to be effective	\$1K/year	
			Develop and implement biosecurity measures in the event that ROD is detected in Maui Nui	Staff & mgmt. costs only	
			Include ROD sanitation and prevention procedures in all permits designated for Kula FR	Staff & mgmt. costs only	
			Increase public information and awareness for Rapid ‘Ōhi‘a Death	Sign installation and replacement as needed	\$5K/year + staff costs
		Monitor weather conditions	Maintain Remote Automated Weather Station (RAWS)	Contract site inspection and instrument rehab annually or as needed	\$2K/year
			Use data to determine district fire preparedness levels	Implement fire preparedness level activities	Staff & mgmt. costs only
			Use data to monitor environmental conditions relating to forest health	Implement appropriate forest management activities	Staff & mgmt. costs only
		<b>Game Animal Management</b>	Promote public hunting through Chapter 122 &	Improve hunter access	Acquire land and/or easements see above

<b>Management Priority</b>	<b>General Management Action</b>	<b>Tactical Goals</b>	<b>Action Items</b>	<b>Estimated Cost</b>
	123, HAR and implement game management actions as provided in the PR Game Management Plan (2016)	Review existing long term strategic goals	Update 2001 DOFAW Animal Management Guidelines	\$10K staff cost
		Determine population trends of game mammals	Conduct annual aerial and ground animal population surveys, harvest surveys and hunter participation surveys. Train incoming staff to collect information.	10K staff and helicopter time
		Public education	Continue hunter education program, other public outreach as required	\$2K staff cost and materials
		Regulate hunting as per Chapter 122 ad 123, HAR	Manage bird and mammal hunting seasons.	Staff & mgmt. costs only
			Conduct pine control in the CGMA to maintain open area for game bird hunting.	Staff & mgmt. costs only
			Sustain game bird populations: construct, maintain, and inspect game bird water units.	\$5000/year
<b>T&amp;E Species Management</b>	Protection and recovery of listed rare plants and animals	Implement management and recovery of T&E species consistent with management guidelines and 2015 SWAP	PEPP staff and state botanists to conduct botanical surveys	Staff & mgmt. costs only
			Conduct surveys and monitoring efforts to obtain baseline data that will be used to help determine specific areas and to protect species of interest	Staff & mgmt. costs only
		Cooperate with PEPP, MFBRP, USFWS, SEPP, MNSRP, and other agencies to prioritize species protection	Build fence and maintain exclosures around wild populations of rare plants. Outplant T&E species into exclosures. Conduct predator and ungulate control as needed.	\$10K each
			Build and maintain exclosures around wild populations of rare animal species. Conduct predator and ungulate control as needed.	\$10K each
			Continue ongoing monitoring, surveys for presence, location, and population estimates of rare animals including Seabirds (Hawaiian petrel) and Hawaiian Hoary Bat	\$10K/year
		Maintain infrastructure for all plant exclosures located within the FR	Inspect and maintain fence exclosure twice per year or as needed. Conduct predator and ungulate control as needed.	\$5K and Staff & mgmt. cost.

<b>Management Priority</b>	<b>General Management Action</b>	<b>Tactical Goals</b>	<b>Action Items</b>	<b>Estimated Cost</b>
<b>Native Ecosystems</b>	Determine landscape level needs	Native ecosystem restoration.	Common native outplanting (low priority action).	\$10K/acre
	Re-evaluate DOFAW's 2001 Draft Management Guidelines regarding V-classifications	Consult with USFWS, TNC, HDOA, EMWP, LHWRP, and other agencies	Work with other agencies and institutions to identify research projects that would address native species management needs specific to FRs	Staff & mgmt. costs only
		Modify boundaries for vegetation classes in updated Management Guidelines	Participate in DOFAW's planning meetings to update Management Guidelines	Staff & mgmt. costs only
	Ungulate control	Remove ungulates from remote, inaccessible areas; unit areas located within ungulate proof fences designated for zero tolerance	Ground control and aerial control work as needed	TBD
<b>Invasive Species Control</b>	Reduce the impact of invasive species/noxious weeds on the Forest Reserve and surrounding areas	Continue to work with cooperating agencies, including MISC, TNC, NRCS, HDOA, UH-CTAHR, EMWP, LHWRP, USFWS, and other cooperators	Invasive species technician and support staff to work with cooperators to monitor and control invasive species in the FR	\$125K/year
		Support biological control efforts in FR and adjacent lands	Support applied research for potential biocontrol agents, including labor and helicopter time	TBD
		Create "weed free" buffer corridor between Kula FR/Kahikinui FR (Papaanui Tract) and leeward Haleakala watershed area (DHHL and Haleakala National Park)	Conduct aerial and ground surveys	\$20K/year
	Conduct aerial and ground control work to remove invasive species from area and prevent further spread to leeward Haleakala		\$50K/year	
	Manage incipient and established invasive plants and animals	Invasive species monitoring and control	Collaborate and support partner research and invasive species control	\$50K/year
			Manual, chemical and mechanical control.	\$50K/year
		Write a comprehensive weed plan	Hire a Protection Forester	\$60K
<b>Access, Trails, and other Public Uses</b>	Maintain public access to the FRs	Maintain and update (as needed) historical access agreements with adjacent landowners	Meet with FAA to formalize agreement as appropriate for Skyline road access	Staff & mgmt. costs only
	Maintain recreational fruit collection	Maintain current level of management for plum tree areas	Weed, fertilize and additional plum tree planting.	\$2000/year

Management Priority	General Management Action	Tactical Goals	Action Items	Estimated Cost
			Install Signage for plum area	\$1000
	Increase public information and awareness	Update and install informational signage	Sign installation and replacement as needed	\$10K/year + staff costs
	Infrastructure management	Maintain road infrastructure	Grading and repairs road as needed, and maintain other road features	\$35K/year
		Maintain trails and other trail infrastructure in accordance to NAH program standards and plans	Maintain and repair trails, shelters and parking lot areas.	\$400K
			Conduct risk assessment for all trails to determine mitigation needs	
		Increase enforcement of Forest Reserve Rules and applicable HAR to protect DOFAW infrastructure.	Secure additional funding for additional night time survey and patrol.	\$30K/year
<b>Commercial Activity</b>	Generate income from suitable commercial activities in the Forest Reserve	Determine future income possibilities – commercial tour permits, collection and commercial harvest permits and film industry.	Determine protocol to manage fee collection	Staff & mgmt. costs only
			Finalize land use agreements for existing commercial activity on Polipoli Access Road (Waipoli Road).	Staff & mgmt. costs only
	Provide opportunities for wood-based forest product collection	Identify potential locations and species	Issue commercial harvest permits for forest products	Staff & mgmt. costs only
			Promote forest product revenue base including biomass sales	Staff & mgmt. costs only
			Work with Hawai'i Forest Industry Association, local woodworker groups, USFS, and others	

**E. Overall Measures of Success:**

Measures of success for individual forest reserve management plans can be derived from the State of Hawai'i annual variance reports. Initial measures of success that may be applicable to Kula FR and Papa'anui include:

- Number of volunteer service projects
- Acres of noxious plants controlled
- Acres of fire protection area
- Miles of fence constructed
- Miles of fence maintained

- Acres of enclosure developed
- Acres of enclosure maintained
- Acres of native forest restored
- Number of rare, threatened, or endangered plant/animal species protected
- Number of cultural resources protected
- Number of commercial leases/licenses/permits issued
- Number of signs replaced
- Number of appurtenant features maintained
- Number of miles of trails maintained
- Number of visitors
- Number of game species harvested (game birds, game mammals)

#### **IV. FUTURE RECOMMENDATIONS**

##### **A. Desired Outcome for the Forest Reserves:**

- Protection and enhancement of watershed quality and quantity.
- Stable populations of threatened and endangered species and native ecosystems.
- Protection of cultural resources.
- Maintain and enhance public access, activities, and recreational experience.
- Stable harvest levels of game birds and mammals.

##### **B. Future Recommendations:**

- Continue to pursue land acquisitions to increase area for public hunting, watershed protection, and natural resource conservation.
- Re-align sections of trails that are fall-line ridge trails to increase trail sustainability.
- Integrate Hawai'i Outdoor Developed Area Accessibility Guidelines standards to meet established ADA requirements.
- Long term funding sources are needed to support fire mitigation projects such as the installation of water/dip tanks to support aerial fire suppression; fuel mitigation along access corridors; and the development of landscape fuel reduction projects such as stand thinning in non-native plantation units.
- Develop alternative funding opportunities that support forest management and sustainable use, such as carbon offset credits or other ecosystem benefit markets.
- Enhance district forestry program capacity of personnel and equipment resources to ensure successful implementation of management plans

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## **VI. APPENDICES**

**Appendix A:** Kula and Papa‘anui Tract of Kahikinui Forest Reserve Plant List

**Appendix B:** The Native Forest Birds of the Kula Forest Reserve 2013 Field Report

**Appendix C:** Hawai‘i Invasive Species Council Plant Species Profiles

Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

Taxonomic Group	Family	Taxon Name	Common Name	Status	FedStat
Angiosperm	Fabaceae	<i>Acacia koa</i> A. Gray	<i>Koa</i>	Endemic	
Angiosperm	Fabaceae	<i>Acacia mearnsii</i> De Wild.	Black Wattle	Introduced	
Angiosperm	Fabaceae	<i>Acacia melanoxylon</i> R. Br. ex Alton	Australian Blackwood	Introduced	
Pteridophyte	Pteridaceae	<i>Adiantum hispidulum</i> Sw.	Rough Maidenhair Fern	Introduced	
Angiosperm	Asteraceae	<i>Ageratina adenophora</i> (Spreng.) R. King & H. Robinson	<i>Maui Pāmakani, Pāmakani Haole</i>	Introduced	
Angiosperm	Poaceae	<i>Agrostis sandawicensis</i> Hillebr.		Endemic	
Angiosperm	Poaceae	<i>Anthoxanthum odoratum</i> L.	Vernalgrass, Sweet Vernalgrass	Introduced	
Angiosperm	Asclepiadaceae	<i>Asclepias physocarpa</i> (E. Mey.) Schltr.	Butterfly Flower, Milkweed, Balloon Plant	Introduced	
Pteridophyte	Aspleniaceae	<i>Asplenium adiantum-nigrum</i> L.	' <i>Iwa'iwa</i>	Indigenous	
Pteridophyte	Aspleniaceae	<i>Asplenium aethiopicum</i> (Burm. f.) Bech.		Indigenous	
Pteridophyte	Aspleniaceae	<i>Asplenium dielerectum</i> Viane		Endemic	Endangered
Pteridophyte	Aspleniaceae	<i>Asplenium macraei</i> Hook. & Grev.	' <i>Iwa'iwa Lau Li'i</i>	Endemic	
Pteridophyte	Aspleniaceae	<i>Asplenium monanthes</i> L.		Indigenous	
Pteridophyte	Aspleniaceae	<i>Asplenium trichomanes</i> L. subsp. <i>densum</i> (Brack.) W.H. Wagner	' <i>Oāli'i</i>	Endemic	
Pteridophyte	Athyriaceae	<i>Athyrium microphyllum</i> (J. Sm.) Alston	' <i>Ākōlea</i>	Endemic	
Angiosperm	Asteraceae	<i>Bidens alba</i> (L.) DC		Introduced	
Angiosperm	Asteraceae	<i>Bidens micrantha</i> Gaudich. subsp. <i>kalealaha</i> Ganders & Nagata	<i>Ko'oko'olau, Kōko'olau</i>	Endemic	Endangered
Angiosperm	Papaveraceae	<i>Bocconia frutescens</i> L.	Plume Poppy, Tree Poppy, Tree Celandine	Introduced	
Angiosperm	Brassicaceae	<i>Brassica nigra</i> (L.) W. D. J. Koch	<i>Mākeke, Black Mustard</i>	Introduced	
Angiosperm	Poaceae	<i>Bromus catharticus</i> Vahl	Rescue Grass	Introduced	
Angiosperm	Brassicaceae	<i>Cardamine flexuosa</i> With.	Wavy Bittercress	Introduced	
Angiosperm	Cyperaceae	<i>Carex alligata</i> Boott		Endemic	
Angiosperm	Cyperaceae	<i>Carex macloviana</i> Dum. d'Urv. subsp. <i>subfusca</i> (W. Boott) T. Koyama		Indigenous	
Angiosperm	Cyperaceae	<i>Carex wahuensis</i> C.A. Mey. subsp. <i>wahuensis</i>		Endemic	
Angiosperm	Fagaceae	<i>Castanea dentata</i> (Marsh.) Borkh.	American Chestnut	Introduced	
Angiosperm	Poaceae	<i>Cenchrus clandestinus</i> (Hochst. ex Chiov.) Morrone	Kikuyu Grass	Introduced	
Angiosperm	Gentianaceae	<i>Centaurium erythraea</i> Raf. subsp. <i>erythraea</i>	European Centaury	Introduced	
Angiosperm	Caryophyllaceae	<i>Cerastium fontanum</i> Baumg. subsp. <i>triviale</i> (Link) Jalas	Big Chickweed	Introduced	
Angiosperm	Araliaceae	<i>Cheirodendron trigynum</i> (Gaudich.) A. Heller subsp. <i>trigynum</i>	' <i>Ōlapa</i>	Endemic	
Pteridophyte	Cibotiaceae	<i>Cibotium</i> sp.	<i>Hāpu'u</i>	Endemic	
Angiosperm	Asteraceae	<i>Cirsium vulgare</i> (Savi) Ten.	Thistle, Bull Thistle	Introduced	
Angiosperm	Campanulaceae	<i>Clermontia kakeana</i> Meyen	<i>Hāhā, 'Ō hā, 'Ōhāwai</i>	Endemic	

Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

Taxonomic Group	Family	Taxon Name	Common Name	Status	FedStat
Pteridophyte	Pteridaceae	<i>Coniogramme pilosa</i> (Brack.) Hieron.	Lo'ulu	Endemic	
Angiosperm	Asteraceae	<i>Conyza bonariensis</i> (L.) Cronq.	Iliohe, Pua Mana, Lani Wela (Ni'ihau), Hairy Horseweed	Introduced	
Angiosperm	Rubiaceae	<i>Coprosma ernodeoides</i> A. Gray	'Aiakanēnē, Kūkaenēnē, Leponēnē, Pūnēnē Pilo	Endemic	
Angiosperm	Rubiaceae	<i>Coprosma foliosa</i> A. Gray	Pilo	Endemic	
Angiosperm	Rubiaceae	<i>Coprosma montana</i> Hillebr.	Pilo	Endemic	
Angiosperm	Rubiaceae	<i>Coprosma ochracea</i> W. Oliver	Pilo	Endemic	
Angiosperm	Poaceae	<i>Cortaderia jubata</i> (Lemoine ex Carrière) Stapf	Pampas Grass	Introduced	
Angiosperm	Rosaceae	<i>Cotoneaster frigida</i> Lindl.		Introduced	
Angiosperm	Rosaceae	<i>Cotoneaster pannosa</i> Franch.	Cotoneaster, Silverleaf Cotoneaster	Introduced	
Gymnosperm	Taxodiaceae	<i>Cryptomeria japonica</i> (L.f.) D. Don	Sugi	Introduced	
Gymnosperm	Cupressaceae	<i>Cupressus macrocarpa</i> Hartweg ex Gordon	Monterey Cypress	Introduced	
Pteridophyte	Thelypteridaceae	<i>Cyclosorus cyatheoides</i> (Kaulf.) Farw.	Kīkawaiō, Kīkawaiōa, Pakīkawaiō	Endemic	
Pteridophyte	Thelypteridaceae	<i>Cyclosorus sandwicensis</i> (Brack.) Copel.	Hō'i'o Kula	Endemic	
Angiosperm	Cyperaceae	<i>Cyperus hillebrandii</i> Boeck. var. <i>hillebrandii</i>		Endemic	
Angiosperm	Gesneriaceae	<i>Cyrtandra cf grayi</i> C.B. Clarke	Ha'iwale	Endemic	
Angiosperm	Gesneriaceae	<i>Cyrtandra hashimotoi</i> Rock		Maui	
Pteridophyte	Dryopteridaceae	<i>Cyrtomium caryotideum</i> (Wall.) C. Presl		Indigenous	
Pteridophyte	Athyriaceae	<i>Cystopteris douglasii</i> Hook.		Endemic	
Angiosperm	Poaceae	<i>Dactylis glomerata</i> L.	Cocksfoot	Introduced	
Pteridophyte	Athyriaceae	<i>Deparia petersenii</i> (Kunze) M. Kato		Introduced	
Angiosperm	Poaceae	<i>Deschampsia nubigena</i> Hillebr.		Endemic	
Angiosperm	Poaceae	<i>Deschampsia caespitosa</i> (L.) P. Beauv. subsp. <i>beringensis</i> (Hultén.) W.E.		Introduced	
Pteridophyte	Athyriaceae	<i>Diplazium molokaiense</i> W. J. Rob		Endemic	Endangered
Pteridophyte	Athyriaceae	<i>Diplazium sandwichianum</i> (C. Presl) Diels		Endemic	
Angiosperm	Sapindaceae	<i>Dodonaea viscosa</i> Jacq.	Hō'i'o, Pohole (Maui)	Endemic	
Pteridophyte	Dryopteridaceae	<i>Dryopteris fusco-atra</i> (Hillebr.) W.J. Rob. var. <i>fusco-atra</i>	'A'alī'i, 'A'alī'i Kū Ma Kua, 'A'alī'i Kū Makani	Indigenous	
Pteridophyte	Dryopteridaceae	<i>Dryopteris glabra</i> (Brack.) Kuntze var. <i>glabra</i>		Endemic	
Pteridophyte	Dryopteridaceae	<i>Dryopteris hawaiiensis</i> (Hillebr.) W.J. Rob.	Hohiu	Endemic	
Pteridophyte	Dryopteridaceae	<i>Dryopteris rubiginosa</i> (Brack.) Kuntze		Endemic	
Pteridophyte	Dryopteridaceae	<i>Dryopteris subbipinnata</i> W.H. Wagner & Hobby		Endemic	
Pteridophyte	Dryopteridaceae	<i>Dryopteris unidentata</i> (Hook. & Arn.) C. Chr.	'Akole	Endemic	

Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

Taxonomic Group	Family	Taxon Name	Common Name	Status	FedStat
Pteridophyte	Dryopteridaceae	<i>Dryopteris wallichiana</i> (Spreng.) Hyl.	'I'o Nui	Indigenous	
Angiosperm	Asteraceae	<i>Dubautia menziesii</i> (A. Gray) D. Keck	Nā'ena'e	Haleakala endemic	
Angiosperm	Asteraceae	<i>Dubautia plantaginea</i> Gaudich. subsp. <i>plantaginea</i>	Nā'ena'e	Endemic	
Angiosperm	Asteraceae	<i>Dubautia platyphylla</i> (A. Gray) D. D. Keck	Nā'ena'e	Haleakala endemic	
Angiosperm	Poaceae	<i>Ehrharta erecta</i> Lam.	Panic Veldtgrass	Introduced	
Pteridophyte	Lomariopsidaceae	<i>Elaphoglossum paleaceum</i> (Hook. & Grev.) Sledge	Māku'e	Indigenous	
Angiosperm	Onagraceae	<i>Epilobium billardierianum</i> Ser. subsp. <i>cinereum</i> (A. Rich.) Raven & Engelhorn	Aboriginal Willowherb	Introduced	
Angiosperm	Onagraceae	<i>Epilobium ciliatum</i> Raf.	Fringed Willowherb	Introduced	
Angiosperm	Asteraceae	<i>Erigeron karvinskianus</i> DC.	Fleabane, Daisy Fleabane	Introduced	
Angiosperm	Rosaceae	<i>Eriobotrya japonica</i> (Thunb.) Lindl.	Loquat	Introduced	
Angiosperm	Myrtaceae	<i>Eucalyptus globulus</i> Labill. subsp. <i>globulus</i>	Bluegum	Introduced	
Angiosperm	Euphorbiaceae	<i>Euphorbia pepilus</i> L.	Spurge, Petty Spurge	Introduced	
Angiosperm	Poaceae	<i>Festuca rubra</i> L.	Fescue, Red Fescue	Introduced	
Angiosperm	Apiaceae	<i>Foeniculum vulgare</i> Mill.	Sweet Fennel	Introduced	
Angiosperm	Rosaceae	<i>Fragaria chiloensis</i> (L.) Duchesne subsp. <i>sandwicensis</i> (Decne.) Staudt	'Ōhelo Papa	Endemic	
Angiosperm	Oleaceae	<i>Fraxinus uhdei</i> (Wenzig) Lingelsh.	Ash, Tropical Ash	Introduced	
Angiosperm	Onagraceae	<i>Fuchsia magellanica</i> Lam.	Kulapepeiao , Hardy Fuchsia	Introduced	
Angiosperm	Geraniaceae	<i>Geranium arboreum</i> A. Gray	Nohaanu, Hinahina	Haleakala endemic	Endangered
Angiosperm	Geraniaceae	<i>Geranium dissectum</i> L.		Introduced	
Angiosperm	Geraniaceae	<i>Geranium hameanum</i> Turcz.		Introduced	
Angiosperm	Rosaceae	<i>Heteromeles arbutifolia</i> (Lindl.) M. Roem.	Toyon	Introduced	
Angiosperm	Poaceae	<i>Holcus lanatus</i> L.	Velvet Grass, Common Velvet Grass, Yorkshire Fog	Introduced	
Angiosperm	Hydrangeaceae	<i>Hydrangea macrophylla</i> (Thunb.) Ser.	French Hydrangea	Introduced	
Angiosperm	Asteraceae	<i>Hypochoeris radicata</i> L.	Cat's Ear, Gosmore, Hairy Cat's Ear	Introduced	
Angiosperm	Aquifoliaceae	<i>Ilex anomala</i> Hook. & Arn.	Kāwa'ū, 'Aiea ( <i>Kaua'i</i> )	Indigenous	
Angiosperm	Rubiaceae	<i>Kadua axillaris</i> (Wawra) W.L. Wagner & Lorence	Manono	Endemic	
Angiosperm	Viscaceae	<i>Korthalsella complanata</i> (Tiegh.) Engl.	Hulumoa, Kaumahana	Indigenous	
Angiosperm	Asteraceae	<i>Lapsana communis</i> L.	Common Nipplewort	Introduced	
Pteridophyte	Polypodiaceae	<i>Lepisorus thunbergianus</i> (Kaulf.) Ching	'Ēkaha 'Ā kōlea, Pākahakaha, Pua'akuhinia	Indigenous	

Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

Taxonomic Group	Family	Taxon Name	Common Name	Status	FedStat
Angiosperm	Epacridaceae	<i>Leptecophylla tameiameia</i> (Cham. & Schltld.) C.M. Weiller	<i>Pūkiawe</i> , 'A'alii'i Mahu, Kanehoa, Kāwa'u (Lana'i), Maieie, Pūpūkiawe	Indigenous	
Angiosperm	Myrtaceae	<i>Leptospermum scoparium</i> J.R. Forster & G. Forster	New Zealand Tea Tree, Tea Tree	Introduced	
Angiosperm	Brassicaceae	<i>Lobularia maritima</i> (L.) Desv.	Sweet Alyssum	Introduced	
Angiosperm	Poaceae	<i>Lolium perenne</i> L.	Ryegrass, Perennial Ryegrass	Introduced	
Angiosperm	Juncaceae	<i>Luzula hawaiiensis</i> Buchenau var. <i>glabrata</i> (Hillebr.) O. Deg. & I. Deg.		Endemic	
Angiosperm	Primulaceae	* <i>Lysimachia arvensis</i> (L.) U. Manns & Anderb.	Scarlet Pimpernel	Introduced	
Angiosperm	Lythraceae	<i>Lythrum maritimum</i> Kunth	<i>Ninika</i> , <i>Pukamole</i> , Purple Loosestrife	Introduced	
Angiosperm	Rosaceae	<i>Malus sylvestris</i> (L.) Mill.	European Crab Apple	Introduced	
Angiosperm	Fabaceae	<i>Medicago lupulina</i> L.	Black Medick	Introduced	
Angiosperm	Rutaceae	<i>Melicope volcanica</i> (A. Gray) T. G. Hartley & B. C. Stone	<i>Alani</i>	Endemic	
Angiosperm	Myrtaceae	<i>Metrosideros polymorpha</i> Gaud. var. <i>incana</i> (H. Lev.) St. John	'Ōhi'a, 'Ōhi'a Lehua	Endemic	
Angiosperm	Myrtaceae	<i>Metrosideros polymorpha</i> Gaud. var. <i>glaberrima</i> (H. Lev.) St. John	'Ōhi'a, 'Ōhi'a Lehua	Endemic	
Pteridophyte	Dennstaedtiaceae	<i>Microlepia strigosa</i> (Thunb.) C. Presl var. <i>strigosa</i>	<i>Palapalai</i>	Indigenous	
Angiosperm	Myricaceae	<i>Morella faya</i> (Aiton) Wilbur	Firetree	Introduced	
Angiosperm	Cyperaceae	<i>Moreletia gahniaeformis</i> Gaudich.		Endemic	
Angiosperm	Myoporaceae	<i>Myoporum sandwicense</i> A. Gray	<i>Naio</i>	Indigenous	
Angiosperm	Myrsinaceae	<i>Myrsine lessertiana</i> A. DC	<i>Kōlea</i>	Endemic	
Angiosperm	Onagraceae	<i>Oenothera stricta</i> Ledeb. ex Link subsp. <i>stricta</i>	Chilean Evening Primrose	Introduced	
Angiosperm	Oleaceae	<i>Olea europaea</i> L. subsp. <i>europaea</i>	Olive	Introduced	
Angiosperm	Rosaceae	<i>Osteomeles anthyllidifolia</i> (Sm.) Lindl.	'Ūlei, <i>Eluehe</i> (Moloka'i)	Indigenous	
Angiosperm	Oxalidaceae	<i>Oxalis corniculata</i> L.	'Ihi, Creeping Woodsorrel	Introduced	
Angiosperm	Fabaceae	<i>Paraserianthes lophantha</i> (Willd.) I. Nielsen subsp. <i>montana</i> (Jungb.) I. Nielsen	Plume Albizia	Introduced	
Angiosperm	Passifloraceae	<i>Passiflora tarminiana</i> Coppens & Barney	Banana Poka	Introduced	
Pteridophyte	Pteridaceae	<i>Pellaea ternifolia</i> (Cav.) Link	<i>Kalamoho</i>	Indigenous	
Angiosperm	Piperaceae	<i>Peperomia cookiana</i> C. DC	'Ala'ala Wai Nui	Endemic	
Angiosperm	Piperaceae	<i>Peperomia macraeana</i> C. DC	'Ala'ala Wai Nui	Endemic	
Angiosperm	Piperaceae	<i>Peperomia membranacea</i> Hook. & Arn.	'Ala'ala Wai Nui	Endemic	
Angiosperm	Lamiaceae	<i>Phyllostegia ambigua</i> (A. Gray) Hillebr.		Endemic	
Angiosperm	Solanaceae	<i>Physalis peruviana</i> L.	<i>Pohā</i> , <i>Pa'ina</i> (Hawai'i), <i>C ape</i> Gooseberry	Introduced	
Angiosperm	Phytolaccaceae	<i>Phytolacca octandra</i> L.	Red Inkplant, Pokeweed	Introduced	

\* *Anagallis arvensis* (L.) U. Manns & Anderd. (synonym)

Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

Taxonomic Group	Family	Taxon Name	Common Name	Status	FedStat
Gymnosperm	Pinaceae	<i>Pinus patula</i> Schiede ex Schltdl. & Cham.	Patula Pine	Introduced	
Gymnosperm	Pinaceae	<i>Pinus pinaster</i> Ait.	Maritime Pine	Introduced	
Gymnosperm	Pinaceae	<i>Pinus radiata</i> D. Don	Monterey Pine	Introduced	
Angiosperm	Urticaceae	<i>Pipturus albidus</i> (Hook. & Arnott) A. Gray	Māmaki	Endemic	
Angiosperm	Plantaginaceae	<i>Plantago lanceolata</i> L.	Narrow-leaved Plantain	Introduced	
Angiosperm	Plantaginaceae	<i>Plantago major</i> L.	Laukahi, Kūhēkili , Common Plantain	Introduced	
Angiosperm	Poaceae	<i>Poa annua</i> L.	Annual Bluegrass	Introduced	
Angiosperm	Caryophyllaceae	<i>Polycarpon tetraphyllum</i> (L.) L.	Fourleaf Manyseed	Introduced	
Angiosperm	Polygalaceae	<i>Polygala paniculata</i> L.		Introduced	
Pteridophyte	Polypodiaceae	<i>Polypodium pellucidum</i> Kaulf. var. <i>pellucidum</i>	'Ae, 'Ae Lau Nui	Endemic	
Angiosperm	Araliaceae	<i>Polyscias kavaensis</i> (H. Mann) Lowry & G. M. Plunkett	'Ohe 'ohe	Endemic	
Pteridophyte	Dryopteridaceae	<i>Polystichum bonseyi</i> W.H. Wagner & Hobby		Endemic	
Pteridophyte	Dryopteridaceae	<i>Polystichum haleakalense</i> Brack.		Endemic	
Pteridophyte	Dryopteridaceae	<i>Polystichum hillebrandii</i> Carruth.	Ka'upu, Papa'oi	Endemic	
Angiosperm	Lamiaceae	<i>Prunella vulgaris</i> L.		Introduced	
Angiosperm	Rosaceae	<i>Prunus cerasifera</i> Ehrh. x <i>P. salicina</i> Lindl.		Introduced	
Angiosperm	Rosaceae	<i>Prunus persica</i> (L.) Batsch var. <i>nucipersica</i> (Suckow) C.K. Schneider		Introduced	
Angiosperm	Rosaceae	<i>Prunus persica</i> (L.) Batsch var. <i>persica</i>		Introduced	
Angiosperm	Asteraceae	<i>Pseudognaphalium sandwicense</i> (Gaudich.) A. Anderb.		Endemic	
Pteridophyte	Thelypteridaceae	<i>Pseudophegopteris keraudreniana</i> (Gaudich.) Holttum		Endemic	
Pteridophyte	Psilotaceae	<i>Psilotum nudum</i> (L.) P. Beauv.	Moa, Moa Nāhehele, Moa Nahele, Pipi	Indigenous	
Pteridophyte	Dennstaedtiaceae	<i>Pteridium aquilinum</i> (L.) Kuhn subsp. <i>decompositum</i> (Gaudich.) Lamoureux ex J. A. Thomson	Kīlau a Pueo, Kīlau Pueo, Pa'i	Endemic	
Pteridophyte	Pteridaceae	<i>Pteris cretica</i> L.		Indigenous	
Pteridophyte	Pteridaceae	<i>Pteris terminalis</i> Wallich ex J. Aagaardh	Waimakanui	Indigenous	
Pteridophyte	Pteridaceae	<i>Pteris irregularis</i> Kaulf.	Mānā, 'Iwa Pua Kea, 'Iwa Puakea	Endemic	
Pteridophyte	Pteridaceae	<i>Pteris hillebrandii</i> Copel.		Endemic	
Angiosperm	Rosaceae	<i>Pyracantha angustifolia</i> (Franch.) C.K. Schneid.		Introduced	
Angiosperm	Poaceae	<i>Rhynchospora pilosum</i> (R. Br.) Connor & Edgar	Hairy Wallaby Grass	Introduced	
Angiosperm	Rosaceae	<i>Rubus argutus</i> Link	Blackberry	Introduced	
Angiosperm	Rosaceae	<i>Rubus hawaiiensis</i> A. Gray	'Ākaka, 'Ākaka'ala	Endemic	
Angiosperm	Rosaceae	<i>Rubus niveus</i> Thunb.	Mysore Raspberry	Introduced	

Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

Taxonomic Group	Family	Taxon Name	Common Name	Status	FedStat
Angiosperm	Rosaceae	<i>Rubus rosifolius</i> Sm.	Thimbleberry	Introduced	
Angiosperm	Polygonaceae	<i>Rumex acetosella</i> L.	Sheep Sorrel	Introduced	
Pteridophyte	Blechnaceae	<i>Sadleria cyatheoides</i> Kaulf.	'Ama'u	Endemic	
Angiosperm	Apiaceae	<i>Sanicula sandwicensis</i> A. Gray		Endemic	
Angiosperm	Santalaceae	<i>Santalum haleakalae</i> Hillebr. var. <i>haleakalae</i>	'Iliahi	Haleakala endemic	
Pteridophyte	Selaginellaceae	<i>Selaginella arbuscula</i> (Kaulf.) Spring		Indigenous	
Angiosperm	Asteraceae	<i>Senecio madagascariensis</i> Poir.	Fireweed	Introduced	
Angiosperm	Asteraceae	<i>Senecio sylvaticus</i> L.	Wood Groundsel	Introduced	
Gymnosperm	Taxodiaceae	<i>Sequoia sempervirens</i> (D. Don) Endl.	Redwood	Introduced	
Angiosperm	Cucurbitaceae	<i>Sicyos cucumerinus</i> A. Gray	'Anunu, Panunu Kuahiwī	Endemic	
Angiosperm	Caryophyllaceae	<i>Silene gallica</i> L.	Common Catchfly, Small-flowered Catchfly	Introduced	
Angiosperm	Caryophyllaceae	<i>Silene struthioloides</i> A. Gray		Endemic	
Angiosperm	Smilacaceae	<i>Smilax melastomifolia</i> Sm.	Hoi Kuahiwī, Aka'awa	Endemic	
Angiosperm	Solanaceae	<i>Solanum americanum</i> Mill.	Pōpōlo, Polopolo, Glossy Nightshade	Indigenous	
Angiosperm	Asteraceae	<i>Sonchus oleraceus</i> L.	Pualele, Sow Thistle	Introduced	
Angiosperm	Fabaceae	<i>Sophora chrysophylla</i> (Salisb.) Seem.	Māmane	Endemic	
Pteridophyte	Cyatheaceae	<i>Sphaopteris cooperi</i> (Hook. ex F. Muell.) R.M. Tryon	Australian Tree Fern	Introduced	
Angiosperm	Poaceae	<i>Sporobolus africanus</i> (Poir.) Robyns & Tournay	African Dropseed, Rattail Grass	Introduced	
Angiosperm	Caryophyllaceae	<i>Stellaria media</i> (L.) Vill.	Common Chickweed	Introduced	
Angiosperm	Lamiaceae	<i>Stenogyne microphylla</i> Benth.		Endemic	
Angiosperm	Asteraceae	<i>Taraxacum officinale</i> W. W. Weber ex F. H. Wigg.	Lauiele, Common Dandelion	Introduced	
Angiosperm	Fabaceae	<i>Trifolium arvense</i> L. var. <i>arvense</i>	Rabbit-foot Clover	Introduced	
Angiosperm	Fabaceae	<i>Trifolium repens</i> L. var. <i>repens</i>	White Clover	Introduced	
Angiosperm	Fabaceae	<i>Ulex europaeus</i> L.	Gorse	Introduced	
Angiosperm	Urticaceae	<i>Urera glabra</i> (Hook. & Arn.) Wedd.	Ōpuhe	Endemic	
Angiosperm	Ericaceae	<i>Vaccinium calycinum</i> Sm.	'Ōhelo	Endemic	
Angiosperm	Ericaceae	<i>Vaccinium dentatum</i> Sm.	'Ōhelo	Endemic	
Angiosperm	Ericaceae	<i>Vaccinium reticulatum</i> Sm.	'Ōhelo	Endemic	
Angiosperm	Verbenaceae	<i>Verbena littoralis</i> Kunth	Seashore Vervain	Introduced	
Angiosperm	Scrophulariaceae	<i>Veronica arvensis</i> L.	Corn Speedwell	Introduced	
Angiosperm	Fabaceae	<i>Vicia sativa</i> L. subsp. <i>nigra</i> (L.) Ehrh.	Vetch	Introduced	
Angiosperm	Campanulaceae	<i>Wahlenbergia marginata</i> (Thunb.) A. DC	Southern Rockbell	Introduced	

**Appendix A: Kula and Papa'anui Section of Kahikinui Forest Reserve Plant List**

Compiled by Hank Oppenheimer, Maui Nui PEPP Coordinator

<b>Taxonomic Group</b>	<b>Family</b>	<b>Taxon Name</b>	<b>Common Name</b>	<b>Status</b>	<b>FedStat</b>
Angiosperm	Thymelaeaceae	<i>Wikstroemia monticola</i> Skotts.	'Ākia	Haleakala endemic	
Angiosperm	Asteraceae	<i>Youngia japonica</i> (L.) DC	Oriental Hawksbeard	Introduced	

# The Native Forest Birds of the Kula Forest Reserve

2013 Field Report



A native Maui Alauahio delivers spider silk to its nest in a non-native Monterey cypress tree

## Peter Motyka

Northern Arizona University

Maui Forest Bird Recovery Project

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## SUMMARY

During the 2013 season, we conducted point transect surveys for birds and vegetation at 127 points throughout the Kula Forest Reserve on the island of Maui, Hawaii. We measured bird density using distance sampling methods consistent with the Hawaiian Forest Bird Survey (Scott et al. 1986). These surveys also provided presence/absence data that we used to examine the distribution of the birds and plants. At each point, we measured the percent cover of each plant species present in five height classes. Our goal was to investigate correlations of forest structure and composition with bird densities and occupancy.

We also observed smaller scale habitat associations of one native Hawaiian Honeycreeper, Maui Alauahio (*Paroreomyza montana*). By investigating how these birds use this habitat for foraging and nesting, we sought to explain the ecological interactions between the native birds and the non-native habitat.

With three observers, we surveyed each of our 127 points 4 times between March and July of 2013. With repeated surveys, we aimed to minimize observer bias and maximize the statistical rigor of our data. Our 2013 surveys yielded 6588 individual bird detections of 24 different species. The species with the most detections were Hawaii Amakihi (1210), Red-billed Leoithrix (1043), Apapane (962), House Finch (719), Japanese White-eye (632), I'iwi (478), and Maui Alauahio (434).

We found the most birds in the western and southern portions of the forest in habitats adjacent to the Haleakala Ridge Trail, Plum Trail, Tie Trail, and Waiohuli Trail. These parts of the forest may have been more resilient to the fire of 2007 and maintain a relatively diverse ecosystem. Our research plots (Figure 1) represent what we suspect to be the highest quality bird habitat in the reserve.

Our preliminary density estimates for the four native honeycreepers in the forest reserve are: Maui Alauahio 326 birds/km<sup>2</sup>, Iiwi 102 birds/km<sup>2</sup>, Apapane 400 birds/km<sup>2</sup>, and Hawaii Amakihi 421 birds/km<sup>2</sup>. Stratified per point estimates were highly variable, yet they allowed us to compare the habitat characteristics of points with higher or lower densities. Further analyses are needed for more reliable estimates.

We observed the native honeycreepers using the non-native vegetation as foraging and nesting habitat. The birds acquire nectar mostly from eucalyptus trees (*Eucalyptus* spp), mountain albizia (*Paraseriaenthes lapantha*), and black wattle (*Acacia mearnsii*), and we observed gleaning of arthropods from many species, but mostly in shrubby understories of mountain albizia, black wattle, and tropical



Hawaii Amakihi feeds on nectar from mountain albizia (*Paraseriaenthes lapantha*)

ash. We found Maui Alauahio nests in a variety of substrates including Monterey cypress (*Cupressus macrocarpa*), redwood (*Sequoia sempervirens*), and fire tree (*Morella faya*).

Future research will include another year of sampling , which will increase the precision and accuracy of our density estimates, and better explain the habitat associations that we have observed.

## INTRODUCTION

A variable suite of non-native trees and shrubs dominate the Kula Forest Reserve on the island of Maui, yet four native Hawaiian forest birds occupy the area. With forested habitat ranging from 1500m to 2100m in elevation, the Kula Forest Reserve provides crucial habitat to these birds with minimal threat from mosquito-borne diseases. Disease-free forested habitat is limited in Hawaii and is vital to the persistence of the native forest birds (Pratt et al. 2009). Despite the high conservation value that this forest offers, the birds here are not well-studied. We will contribute to a better understanding of the birds' status in the forest reserve and also how these native birds are using this non-native habitat. We used sampling methods consistent with established protocols for surveying birds in Hawaii with the goal of contributing to the larger database used by state and federal agencies for the conservation of Hawaii's forest birds.

This project is being conducted as a master's thesis by Peter Motyka at Northern Arizona University under the advisement of Dr. Jeff Foster. We also receive logistical support from the Maui Forest Bird Recovery Project. This is a summary of data collected from our first field season in 2013. The second field season will commence in the spring of 2014.

## OBJECTIVES

1. Observe the four native Hawaiian Honeycreepers in the Kula Forest Reserve and document their densities, distribution, and use of non-native habitat.
2. Investigate habitat characteristics that may influence the distribution and density of the birds.
3. Identify and map areas within the Kula Forest Reserve that offer the highest quality habitat to the native honeycreepers.
4. Document the foraging and nesting substrates used by Maui Alauahio in non-native vegetation.
5. Contribute towards a better understanding of ecological dynamics within the Kula Forest Reserve and inform potential management of the forest.
6. Evaluate the Kula Forest Reserve as a site for active conservation of native Hawaiian forest birds.

## METHODS

We conducted distance sampling surveys for birds at 127 systematically random points within and throughout the Kula Forest Reserve. Each point was surveyed four times between March and July of 2013. These included 51 points that were surveyed in 1980 for the original Hawaii Forest Bird Survey. A survey consists of an observer standing at the point for 8 minutes and recording each bird detected along with detection method and distance from observer to the bird, which was measured using a range finder. We collected data on every bird species observed, including non-natives, but they were not considered in the analysis at this time.

At each of these 127 transect points, we also conducted a vegetation survey. In each of five height classes (0-0.5m, 0.5-2m, 2-5m, 5-10m, and >10m), we estimated the percent cover of each plant species present within a 50m radius of the point.

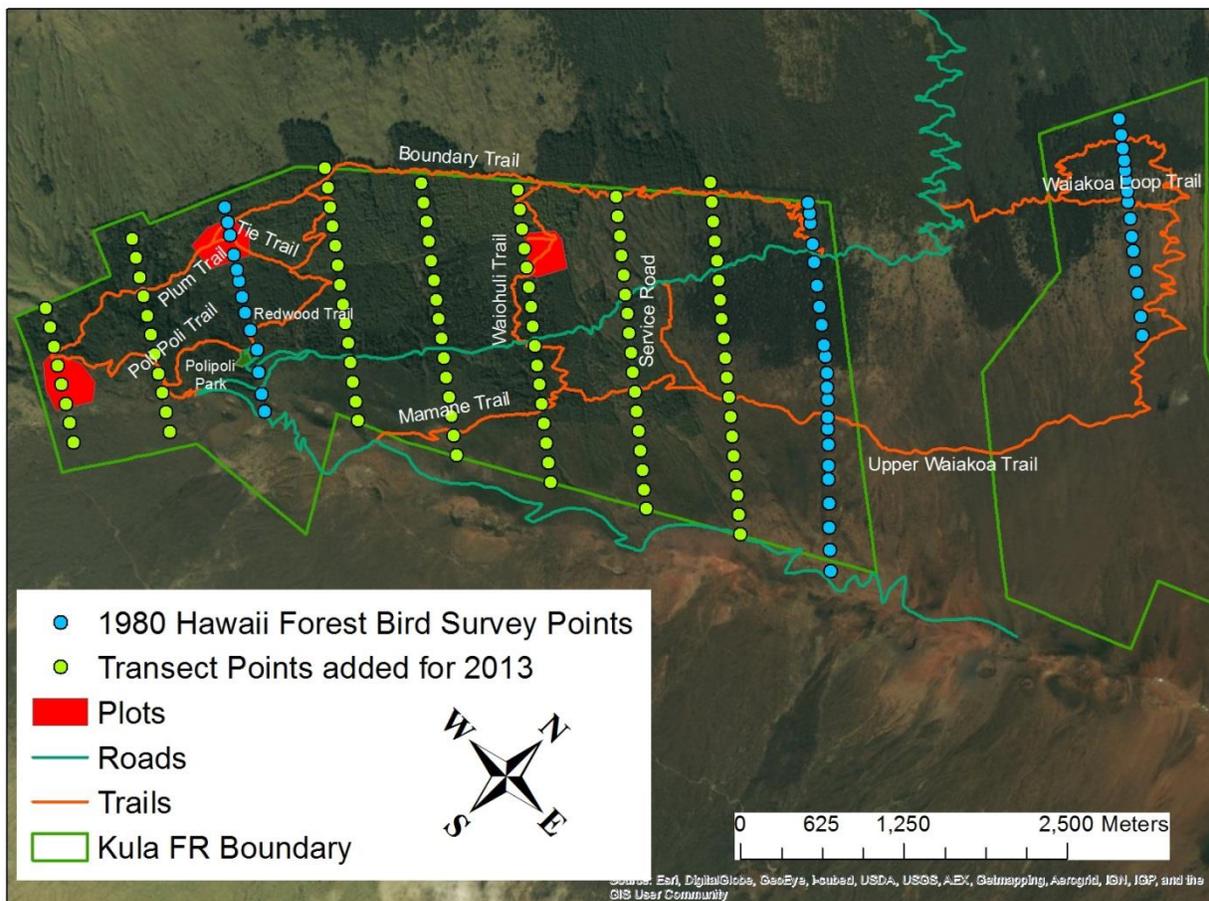


Figure 1: This map of the Kula Forest Reserve shows our transect points and research plots relative to the trails, roads, and other landmarks within the reserve. The blue dots represent transect 29, 30, and 31 from the Hawaii Forest Bird Survey, which were last surveyed in 1980. In 2013, we surveyed these again, plus seven additional transects within the reserve.

Our density estimates were calculated in Program Distance 6.0. A global detection function for each species was derived by pooling untruncated distance measurements from the four surveys (Survey effort = 4). We ran four models to determine the detection function and selected one based on the lowest AIC value. The four models we compared were: hazard-rate simple polynomial, hazard-rate cosine, half-normal simple polynomial, and half-normal hermite. We then post-stratified by sample to obtain point-specific density estimates. Future analyses will account for observer bias and effective detection radius.

We mapped the birds' distribution (Figure 2) using a binary detection matrix for each species, in which each point was designated a 1 (species was detected) or a 0 (species was not detected) for each of the four surveys. We took the number of surveys that detected the species for each point and plotted the values on maps using ArcGIS 10.1. Points where we detected species in four surveys will have a higher probability of occupancy than points where we detected the species in only one survey.

We also observed smaller scale habitat use by Maui Alauahio, and collected data on nesting, foraging, and home ranges. Using mist-nets, we captured, color-banded, and released 63 Maui Alauahio. For each marked bird resighted, observers recorded a GPS location, substrate, height, and general behavior (foraging, courting, etc.). We also searched for Maui Alauahio nests. For each nest found, we recorded the GPS location, nest fate, and small-scale habitat characteristics of the nest site.

In 2013, the majority of our Maui Alauahio observations were concentrated in one 10ha plot on the southwestern edge of the reserve. We will expand our efforts in 2014 and include two additional plots of similar size (Figure 2). Each plot represents a distinct forest type and our goal will be to investigate any disproportionate use of the different foraging and nesting substrates available in each area.

## RESULTS AND DISCUSSION

### Vegetation

The Kula Forest Reserve hosts a wide variety of habitats from forest to shrubland to bare lava rock with only scattered vegetation. We recorded over 50 different plant species on our surveys which included trees, shrubs, and some dominant forbs. After reviewing the vegetation composition of points with the highest densities of birds, we identified 6 dominant plant species that most of these points have in common. These are mountain albizia (*Paraserianthes lapantha*), black wattle (*Acacia mearnsii*), redwood (*Sequoia*

Plant Species	Number of points where species was detected	Percentage of all points (127) occupied by species
Non-native Plants		
Mountain albizia ( <i>Paraserianthes lapantha</i> )	16	13%
Black wattle ( <i>Acacia mearnsii</i> )	34	27%
Tropical ash ( <i>Fraxinus uhdei</i> )	23	18%
Monterey cypress ( <i>Cupressus macrocarpa</i> )	30	24%
Redwood ( <i>Sequoia sempervirens</i> )	33	26%
Eucalyptus ( <i>Eucalyptus</i> spp)	24	19%
Monterey pine ( <i>Pinus radiata</i> )	72	57%
Cluster pine ( <i>Pinus pinaster</i> )	47	37%
Fire tree ( <i>Morella faya</i> )	31	24%
Hill raspberry ( <i>Rubus niveus</i> )	49	39%
Blackwood acacia ( <i>Acacia melanoxylon</i> )	5	4%
Banana poka ( <i>Passiflora tarminiana</i> )	22	17%
Native Plants		
Mamane ( <i>Sophora chrysophylla</i> )	66	52%
Pukiawe ( <i>Styphelia tameiacaeeae</i> )	68	54%
Ohelo ( <i>Vaccinium</i> spp)	57	45%
Pilo ( <i>Coprosma montana</i> )	37	29%
Akala ( <i>Rubus hawaiiensis</i> )	21	17%
Aalii ( <i>Dodonaea viscosa</i> )	40	31%
Ohia ( <i>Metrosideros polymorpha</i> )	7	6%
Koa ( <i>Acacia koa</i> )	8	6%

Table 1 This table includes the native plants and the dominant non-native plants recorded during our surveys. A point was included if the plant species was detected there at all, regardless of density.

*sempervirens*), Monterey cypress (*Cupressus macrocarpa*), tropical ash (*Fraxinus uhdei*), and a suite of eucalyptus trees that we have pooled as *Eucalyptus* spp. Each of these non-native species occur at a quarter or less of the total number of points we surveyed (Table 1), but they appear to compose some of the best forest bird habitat available in the forest reserve.

Native shrubs are fairly common throughout the forest reserve, and the upper slopes contain some of the more intact native Hawaiian shrubland on Maui. The native mamane (*Sophora chrysophylla*) occurs throughout much of the forest reserve, and may facilitate the widespread distribution of Amakihi, but it does not occur at many of the points with higher densities of other birds. We have confirmed that all of the native birds are using the non-native plants that dominate the forested habitat. We observed the birds foraging and nesting in the non-native vegetation, and recorded them occupying areas completely void of any native plants.

We initially proposed to survey over 150 points within the forest reserve, but some areas were inaccessible due to dangerous forest conditions. Steep slopes with large downed trees and very dense thickets of young pine trees and hill raspberry rendered some areas nearly impenetrable. Escape from these areas in an emergency, such as a fire, would be very difficult. We eliminated 20 points from our initial plan because of these safety concerns. Although this habitat type is not well represented in our study, our personal observations suggest that it supports a lower density of birds than other habitats in the reserve.

Birds

Number of Point Count Detections by Species

We recorded 6588 bird detections during our point transect surveys. The total number of detections per species is listed in Table 2.

Our statistical analyses for density need some fine-tuning, but our current estimates seem representative of patterns we have observed in the field.

Maui Alauahio

We estimated the average density of Maui Alauahio to be approximately 326 birds/km<sup>2</sup>. Yet, point specific densities

showed high variation. We detected Alauahio at 71 points out of 127 (56%). At the remaining 56 points, we detected no Alauahio, and therefore the density was calculated as 0 birds/km<sup>2</sup> at these points. Five points in the southwestern portion of the forest yielded densities of over 1300 birds/km<sup>2</sup>. A short visit to any of these areas will confirm to the observer that these birds occur at high densities.

<b>Maui Alauahio</b>	<b>434</b>	Mourning Dove	15
<b>Apapane</b>	<b>962</b>	Rock Dove	2
<b>I'iwi</b>	<b>478</b>	Spotted Dove	14
<b>Hawaii Amakihi</b>	<b>1210</b>	Zebra Dove	3
Japanese Bush-warbler	172	California Quail	14
Japanese White-eye	632	Chukar	45
House Finch	719	Ring-necked Pheasant	377
Red-billed Leothrix	1043	Gambel's Quail	6
Northern Cardinal	218	Gray Francolin	11
Northern Mockingbird	135	Pacific Golden Plover	2
Common Myna	2	Sky Lark	83
Melodious		Pueo	3
Laughingthrush	6	Unknown	2
		<b>Total # of Surveys: 4</b>	
		<b>Total # of Points: 127</b>	
		<b>Total # of Species: 24</b>	
		<b>Total # of Detections: 6588</b>	

Table 2: Total number of detections per species pooled from 4 surveys. The native Hawaiian Honeycreepers are in bold.

We observed 16 Maui Alauahio nests in 2013. Eleven of these were found in Monterey cypress. We also found nests in Blackwood acacia(2), Fire Tree(1), Redwood(1), and Monterey pine(1). Young birds from ten of these nests fledged successfully. The causes of failure for the other nests are unknown, except for one nest that was in a Monterey cypress that fell down around the time nest-building was being completed. The photograph on the cover of this report shows that nest, the day before the tree fell down.

We recorded 320 resights from 32 color-banded birds, with GPS locations and substrate for each. We observed Maui Alauahio in mountain albizia more than other plants. Since we conducted most of our searches in areas with high densities of Mountain albizia, we cannot infer a selective preference at this time, yet we can confirm that these birds are successfully using this plant species as foraging habitat. We observed Alauahio gleaning arthropods from most other plant species in the forest as well.



A color-banded Maui Alauahio forages in black wattle (*Acacia mearnsii*)

Home range dynamics of Maui Alauahio are highly variable and extracting any inference about habitat quality from these data would be difficult. We will contribute our data to larger datasets for further analyses in the future.

Maui Alauahio may be more sensitive to forest structure than the other native honeycreepers. High densities of birds were found in areas with a dense understory of mountain albizia, black wattle, or young trees under a tall canopy of eucalyptus, tropical ash, and/or conifers. Alauahio occurs at lower densities, or not at all, in areas that are lacking tall trees and/or a shrubby understory.

### liwi

We estimated an average density of 102 birds/km<sup>2</sup> for liwi, and we detected them at 95 points out of 127 (75%). At 10 points, we found densities ranging from 250-350 birds/km<sup>2</sup>. The 1980 Hawaii Forest Bird Survey, which was the only other time the Kula FR was surveyed for birds, estimated liwi occurring at 24 birds/km<sup>2</sup> in introduced trees (Scott et al. 1986). We hesitate to infer a trend from these data, but we are optimistic about the success of liwi in this non-native habitat.

liwi acquires much of its nectar from the blossoms of the eucalyptus trees, mountain albizia, and black wattle.

## Apapane

We estimated an average density of 400 birds/km<sup>2</sup> for Apapane, and we detected them at 114 points out of 127 (90%). At 7 points, we found densities ranging from 1000-1400 birds/km<sup>2</sup>.

Apapane also appears to acquire much of its nectar from the blossoms of the eucalyptus trees, mountain albizia, and black wattle.

## Hawaii Amakihi

We estimated an average density of 421 birds/km<sup>2</sup> for Amakihi, and we detected them at 124 points out of 127 (98%). Amakihi showed the least variability in density and occupancy out of the native honeycreepers. Results from point-stratified analyses follow a normal distribution around the mean, with the highest points around 800 birds/km<sup>2</sup>. We noted the extensive distribution of Amakihi. This generalist appears to be exploiting nearly all available habitat in the Kula Forest Reserve.

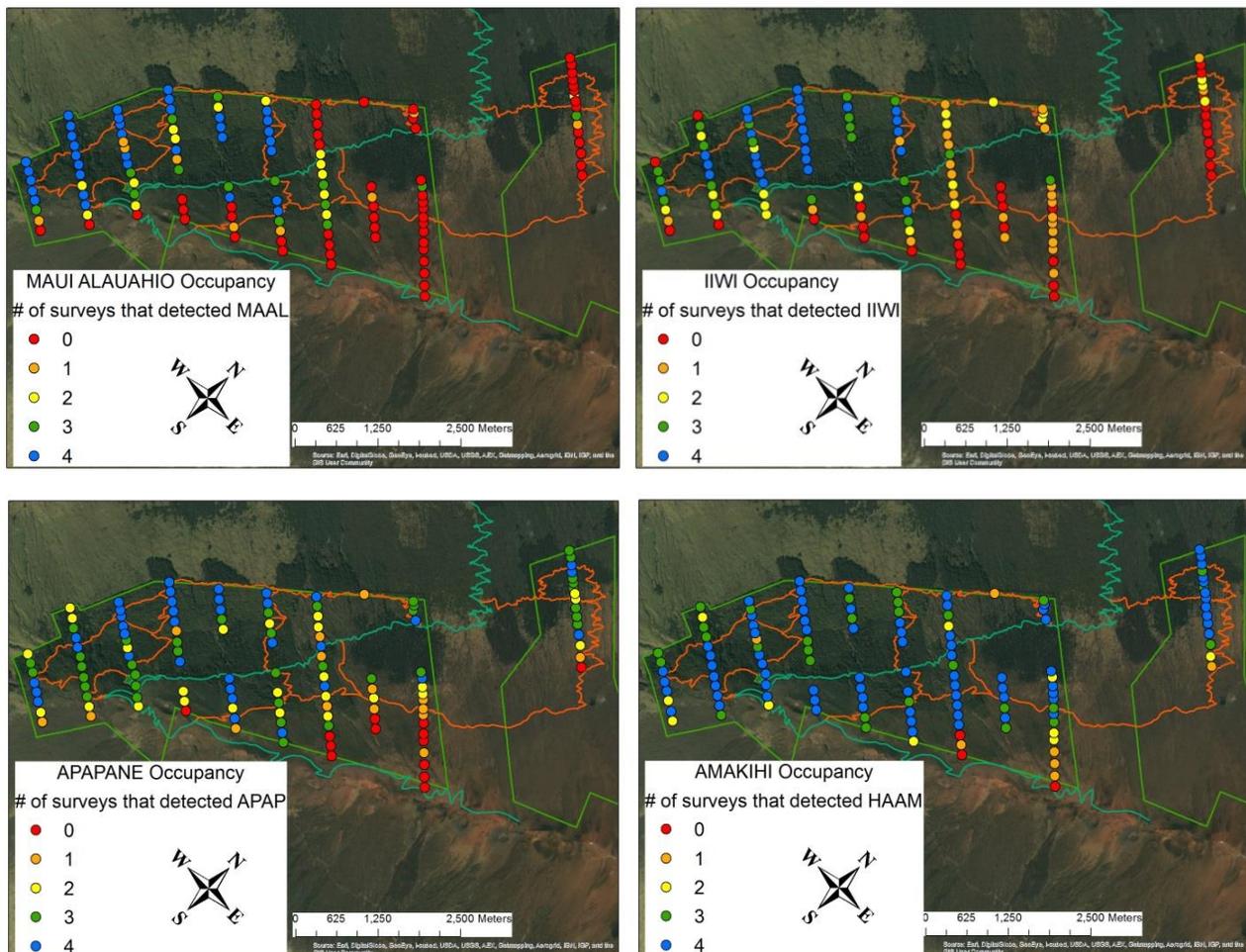


Figure 2 These maps represent the distribution of the four native honeycreepers. Birds are most likely to be found at blue dots and least likely to be found at red dots. Each point was surveyed 4 times during the field season. The different colors represent the number of those surveys in which the species was detected at that point. For example, at the blue dots, we detected the species all 4 times that point was surveyed. At red dots, we did not detect the species during any of our surveys.

## FUTURE DIRECTIONS

Bird extinctions in Hawaii are a contemporary and continuing process. We have lost 10 endemic bird species in the last 30 years, and many remaining species are in decline (Pratt et al. 2009). Conservation priorities for the remaining species include mitigation of avian disease and habitat restoration (USFWS 2006). Habitat restoration will facilitate an increase in bird populations, which will in turn, mitigate against disease. Forest management in the Kula Forest Reserve could result in an increase in bird populations. Our goal is to work with managers to develop a feasible work plan to manage for the conservation of the Hawaii's native forest birds.

Non-native trees and shrubs in the Kula Forest Reserve are providing ecosystem functions that are required by the native birds. By better understanding the interactions between these birds and their non-native habitat, we can offer more effective strategies to provide the habitat characteristics that these birds require. More research is required to better explain the habitat associations that we are observing in this forest.

Future research will include more surveys and observations. Higher sample sizes will yield the most accurate density estimates, and increase our power of inference. We will repeat our vegetation surveys to incorporate some slight revisions and reduce observer bias. We will also expand our efforts to observe habitat use of Maui Alauahio, which includes banding, resighting, and nest-searching. We expect more patterns to emerge with continued observations.

There are extensive opportunities for further research in the Kula Forest Reserve. With the baseline data already acquired, we can monitor the birds' populations and their responses to any changes that may occur in the forest, whether through management or natural disturbance. Also, considering the extinction crisis that these birds face, there is a lot that we do not know. A better understanding of their ecology, including their habitat associations, spatial and temporal movement patterns, and diseases, would contribute to conservation efforts. The Kula Forest Reserve offers a rare opportunity to study and observe Hawaii's native forest birds, and this opportunity should be embraced.

## ACKNOWLEDGEMENTS

This project has been a collaborative effort and I greatly appreciate the work of everyone involved. Thank you to my committee, Dr. Jeff Foster, Dr. Tad Theimer, and Dr. Carol Chambers, and all the faculty, staff, students, and mentors at Northern Arizona University. Thanks to Hanna Mounce, the Maui Forest Bird Recovery Project, Aaron Spidal, Erick Lundgren, the State of Hawaii's Department of Land and Natural Resources, and Hawaii's entire conservation community. Mahalo nui loa to my family and friends, and to everyone else that have shared ideas and offered support. All photographs, maps, and figures used in this report are by Peter Motyka.

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Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### ***BLACK WATTLE (Acacia mearnsii)***

**Hawaii Pacific Weed Risk Assessment:** 15 High Risk  
**Regulatory Status:** Hawaii Noxious Weed List  
**Prevention and Control Category:**

#### **Description**

Fast growing tree. All parts finely hairy. Hairs of new growth is golden in color. Leaves are dark olive-green and also finely hairy, bipinnate; leaflets short (1.5 – 4mm) and crowded. Raised glands occur at and between the junctions of pinnae pairs. Flowers form in large globular clusters and are pale yellow or cream colored. Fruits are dark brown pods.



#### **Impacts**

- It threatens native habitats by competing with indigenous vegetation, replacing grass communities, and reducing native biodiversity
- Increases water loss from riparian zones due to high transpiration rates
- Long lived seeds readily germinate after fire

#### **Distribution**

Distribution in Hawaii is currently unknown





## PLUME POPPY (*Bocconia frutescens*)



**Hawaii Pacific Weed Risk Assessment:** None  
**Regulatory Status:** Hawaii Noxious Weed List (HAR 68)  
**Prevention and Control Category:** None

### Description

- Shrub to small (20 ft) tall tree
- Native to Central and South America, introduced to Hawaii as an ornamental garden plant

### Impacts

- Aggressive invader of dry forests. Forms dense stands that crowd out and compete with native plants, keeping them from growing
- Each plant can produce thousands of seeds that are particularly attractive to birds, which spread them long distances.
- Mechanical and chemical control of this species is difficult. Plants often resprout after control and persistence is required to completely control plume poppy.



### Distribution

- Kauai: Not present. Please [contact KISC](#) if you see this plant on Kauai.
- Oahu: Present, but not an OISC target. Landowners are encouraged to control this pest.

- Maui: Serious invader in native dry and mesic forests of East Maui with dense infestations from Kula to Kahikinui. It is not believed to be controllable or eradicable on an island-wide basis. Landowners are asked to control where possible.
- Molokai: None known.
- Lanai: None known.
- Kahoolawe: None known.
- Big Island: Infestations in Wood Valley, Kau Forest Reserve, Honomalino and Manuka on the Big Island. BIISC has worked to control this plant in cooperation with landowners and community groups, but has no current funding to continue work. Please call 643-PEST if you see this plant, especially in the Honomalino area.





Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### PAMPAS GRASS (*Cortaderia jubata*, *Cortaderia selloana*)

**Hawaii Pacific Weed Risk Assessment Score:** *C. jubata* – 26 High Risk. *C. selloana* – 24 High Risk.

**Regulatory Status:** Hawaii Noxious Weed (HAR 68)

**Prevention and Control Category:** KISC Target Species. OISC Target Species. MISC Target Species. BIISC Target Species

#### Description

Pampas grass is an erect giant bunch grass with long, slender, bright green, saw-toothed leaves. At its base are dried, corkscrew-shaped leaves. It has large showy flower plumes that extend 2-3' beyond the foliage. Two species of pampas grass are found in Hawaii, *Cortaderia selloana* and *C. jubata*, which are difficult to tell apart. Both reach heights of 9-10' and have loosely clumped pinkish-white seed heads. They flower from July through November. Spent flower stalks are sometimes persistent for several years



#### Impacts

Pampas grass grows rapidly, produces thousands of seeds per flower plume, and can accumulate large amounts of fire prone biomass. Seeds are viable for 4-6 months, but field evidence from Hawaii suggests viability could be greater. It can crowd out native species, impede access, degrade grazing lands, and create fire hazards.

#### Distribution

Native to South America, pampas grass was introduced to Hawaii as an ornamental. On Maui, this plant has escaped cultivation and spread into pristine, upland native forests. It is found in pastures, gulches, yards, along road cuts. *Cortaderia* are found in residential and remote areas of Maui and O'ahu.

#### What you can do

If you see this species, call 643-PEST, call your local ISC, and/or visit [www.reportapest.org](http://www.reportapest.org). It is important NOT to pull and move the plant, as proper removal and disposal are essential to prevent spreading seeds and re-sprouting.



## Look-alike Species

**Sugarcane (*Saccharum officinarum*):** is a Polynesian introduced plant that has a similar seed plume as pampas but the plume is not as dense and sugarcane does not have corkscrew leaves.

**Native Hawaiian sedges (*Cyperaceae sp.*):** These can be confused with young pampas grass. They do not produce corkscrew leaves, tall flowering stalks, or large showy seed plumes. Most Hawaiian sedge leaves are not as sharp.



Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### COTONEASTER (*Cotoneaster pannosus*)

**Hawaii Pacific Weed Risk Assessment:** 11 High Risk  
**Regulatory Status:** Hawaii Noxious Weed List  
**Prevention and Control Category:**

#### Description

Multi-stemmed shrub with arching branches. Can grow up to 10' tall. Flowers are white with five petals. Oblong leaves are 0.5 in – 1 in long and are a green-grey color. Fruit are a dull red when ripe and contain 1-3 seeds.



#### Impacts

- Invades pasture lands and native rain forests. Highly adaptable and germinates readily in shade.

#### Distribution

- Kauai: Waimea Canyon, Koke'e State Park and Pu'u Ka Pele Forest Reserve
- Maui: East Maui, Kula, Keokea and Polipoli.





Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### FIRE TREE, FIRETREE, FAYA BUSH (*Morella faya*)

**Hawaii Pacific Weed Risk Assessment:** 17 High Risk  
**Regulatory Status:** Hawaii Noxious Weed List (HAR 68)  
**Prevention and Control Category:** None

#### Description

- Evergreen shrub or small tree up to 8 m tall (26 ft)
- Fruit are pink to red or blackish when mature, and appear bumpy.
- Native to the Azores, Madeira and Canary Islands, introduced to Hawaii as an ornamental and backyard food crop (berry wine) by Portuguese laborers in the 1800's and spread as a reforestation tree in the 1920's.



#### Impacts

- Out-competes native plant species and capable of forming dense, single-species stands, devoid of other plant life.
- Modifies forest habitat by significantly increasing nitrogen levels in the soil, which makes the area inhospitable to native plants, but more suitable for other invasive species.
- Seeds spread by animals.
- Able to colonize a wide range of habitats due to its ability to alter soil chemistry.

#### Distribution

- Kauai: Present in Waimea Canyon and Kokee State Park. Landowners are encouraged to control where possible.
- Oahu: Established in the southern Waianae mountains where Oahu Army Natural Resources Program controls populations. There are no known trees in the Koolau mountains.
- Maui: Present in large numbers on the slopes of Haleakala. Not considered eradicable by MISC. Landowners are encouraged to control where possible. The only known plants on West Maui have been controlled.
- Molokai: Presence/absence unknown
- Lanai: Presence/absence unknown
- Kahoolawe: None known
- Big Island: Widespread on the Big Island where hundreds of acres are already infested. Not considered eradicable by BIISC. However, landowners are encouraged to control wherever possible.



Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### BANANA POKA (*Passiflora tarminiana*)

**Hawaii Pacific Weed Risk Assessment:** 24 High Risk  
**Regulatory Status:** Hawaii Noxious Weed List  
**Prevention and Control Category:**

#### Description

Fast growing climbing vine. Large showy pink flowers. Produces many elongated fruit that are yellow in color when ripe. Fruit contain an orange pulp with hundreds of seeds. leaves are dark green and have three distinct lobes.



#### Impacts

Found in disturbed areas, open fields and around fresh water habitats. *P. tarminiana* will readily climb and smother trees. Fruit provides a food source for non-native animals. Seeds are dispersed by birds and feral pigs. Dense curtains of the vine can extend to the ground from canopy branches, sometimes causing branches to break and toppling trees during storms. Where the canopy has been opened, dense mats of vines also mantle the understory trees and shrubs and inhibit regeneration of the native trees (Mueller-Dombois et al. 1980).

#### Distribution

- Kauai: Widespread in the Koke'e area
- Maui: Currently restricted to the Kula area
- Big Island: Widespread





## FLORIDA BLACKBERRY (*Rubus argutus*)

**Hawaii Pacific Weed Risk Assessment:** 21.5 HIGH RISK

**Regulatory Status:** none

**Prevention and Control Category:** none

### Description

- Erect or arching thorny shrub. Stiff stems usually stand upright in open areas. Hooked or straight prickles up to 6mm in length. Leaves are compound and have three or five leaflets. Flowers are white in color with five petals. Fruit are black when ripe.

### Impacts

- Forms dense, impenetrable thickets that exclude other native plant species
- Seeds are spread by fruit-eating birds and mammals, also spreads vegetatively
- Thickets also make access difficult for hunters, hikers and other visitors to forest
- Can infest a variety of sites including grasslands, forest edges, stream banks, and boggy areas

### Distribution

- Present on Hawaii, Maui, Molokai, Oahu, and Kauai
- Lanai: presence/absence unknown





## MYSORE RASPBERRY (*Rubus niveus*)

**Hawaii Pacific Weed Risk Assessment:** 19 HIGH RISK  
**Regulatory Status:** Hawaii Noxious Weed List  
**Prevention and Control Category:** none

### Description

- Spiny, woody bramble that grows as a sprawling bush, but may reach heights of 4 m (13 ft)
- White flowers that become shiny black fruit when ripe
- Native to South-eastern United States, introduced to Hawaii as an ornamental and backyard food crop



### Impacts

- Forms dense, impenetrable thickets that exclude other native plant species
- Seeds are spread by fruit-eating birds and mammals, also spreads vegetatively
- Thickets also make access difficult for hunters, hikers and other visitors to forest
- Infestations can produce 7,000-13,000 seeds per square meter, which can remain dormant in the soil for several years



### Distribution

- Kauai: Form A is found on Kauai
- Maui: On Maui, there are two forms known, form a, which is likely the form Wagner et al. (1999) were referring to, and form b, first discussed in Gerrish et al. (1992). *Rubus niveus* form b is well established in disturbed urban areas of Kula as well as in a variety of habitats in Polipoli, including native and non-native mesic forests, alpine shrubland, degraded pastures, and along trails and roads, at elevations from 3,000-6,500 ft (914-1,981 m).
- Big Island: Form A is found on Hawaii Island



Photo by Forest & Kim Starr



Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### FIREWEED (*Senecio madagascariensis*)



**Hawaii Pacific Weed Risk Assessment:** 23, High Risk.

**Regulatory Status:** Hawaii Noxious Weed List (HAR 68)

**Prevention and Control Category:** KISC Target Species. OISC Target Species. MoMISC Target Species.

### Description

Fireweed is already widespread on the islands of Maui, Oahu, Lanai, and Hawaii, but can be prevented from invading Kauai. Fireweed is a daisy-like herb that grows up to 2' high. The stem is upright and slender with bright green leaves. The leaves are smooth, very narrow (only 1/4" wide), have serrated edges, and they reach about 5" long. The small yellow flowers have 13 petals and are about the size of a nickel. The mature flowers turn into white thistle-like downy seed balls.



### Impacts

Fireweed invades pastures, disturbed areas, and roadsides. It is very toxic to cattle, horses and other livestock. When ingested it causes illness, slow overall growth, liver-malfunction and even death in severe cases. In Australia, fireweed costs over \$2 million per year in losses and control.

### Distribution

Fireweed is native to Madagascar and South Africa. Fireweed was first discovered on the Big Island in the 1900's and is now too widespread for control there. This pest can also be found on Maui and Lanai. On Kauai, known infestations from hydro-mulched areas near Halfway Bridge and in Kalihiwai were controlled by KISC and HDOA. Kauai, Oahu, and Molokai continue to be monitored for new infestation areas. The preferred habitat for this weed is disturbed grasslands, abandoned pastures and roadsides. Fireweed grows on a wide range of soils in sub-humid to humid subtropical woodland.

## Look-alike Species

**Spanish needle (*Bidens pilosa*):** Spanish needle is a widespread invasive herb on Kaua'i. It has tiny yellow flower clusters unlike fireweed's daisy-like flowers. Spanish needle also grows much taller; up to 6 feet. **THIS LOOK-ALIKE IS ALSO A PEST!**

**Wedelia (*Sphagneticola trilobata*):** Wedelia is another widespread invasive herb that is commonly planted as an ornamental groundcover. It can be distinguished from fireweed by its larger yellow flowers which grow 1-2" wide. It also has a variable amount of pedals, unlike fireweed's constant 13. **THIS LOOK-ALIKE IS ALSO A PEST!**



Cabinet-level direction on invasive species issues

**Hawaii Invasive Species Council**

## AUSTRALIAN TREE FERN (*Sphaeopteris cooperi*)



**Hawaii Pacific Weed Risk Assessment:** 16, High Risk

**Regulatory Status:** None

**Prevention and Control Category:** MoMISC Target Species

### Description

- Large tree fern up to 12 m (40ft) tall with large (up to 6m long) triangular leaves, lacy blades
- Scaly, brown stems fall off when dead, leaving oval scars
- White hairs on stalks (unlike native hapuu, which has red hairs)
- Trunk doesn't have the thick, soft fiber wrapping like the native hapuu
- Native to Australia, introduced to Hawaii as an ornamental

### Impacts

- Wind spread spores can travel over 12 km (7 miles) from parent plant, as seen when plants from Hana nurseries spread to Kipahulu Valley.
- Fast growing and aggressively outcompetes native plants in the forest understory
- Displaces native ferns, including the slower growing hapuu

### Distribution

- Kauai: Spreading in native forests including Hanalei, Koloa, and Kokee. Landowners are asked to plant non-invasive alternates instead.
- Oahu: Spreading in the Koolau and Waianae mountains. Landowners are asked to plant non-invasive alternates instead.
- Maui: Widely cultivated and naturalized. Infesting Kipahulu Valley, Peahi, Haiku, and areas in West Maui.

- Molokai: No infestations known in the wild, although planted in landscaped areas at several residences. MoMISC is working to educate community members to remove these plants and select non-invasive alternates.
- Lanai: Presence/absence unknown
- Kahoolawe: None known.
- Big Island: Spreading from landscaped areas in Volcano, Laupahoehoe, Kona and other areas. Landowners are asked to plant non-invasive alternatives instead of non-native tree ferns.



Cabinet-level direction on invasive species issues

## Hawaii Invasive Species Council

### GORSE (*Ulex europaeus*)



**Hawaii Pacific Weed Risk Assessment:** 20 High Risk  
**Regulatory Status:** Hawaii Noxious Weed List (HA 68)  
**Prevention and Control Category:** None

#### Description

- Thorny shrub, up to 2 meters (6 ft) tall, with inch-long spines
- Bright yellow flowers that smell faintly of coconut
- Native to Western Europe, introduced as food plant for sheep and as a “living fence”



#### Impacts

- Forms dense, impenetrable thickets that allow nothing else to grow
- Seeds can remain viable in the soil for more than 30 years
- Deep roots help this plant survive fires, and fire helps the seeds sprout

#### Distribution

- Kauai: Present. Not currently a KISC target for control.
- Oahu: Present. Not currently an OISC target for control.
- Maui: Infestations in higher altitude pastures and natural areas, including Haleakala. Landowners are asked to control gorse wherever possible.
- Molokai: Small population present at Kamiloloa. MoMISC is working to eradicate this from Molokai.

- Lanai: Presence/absence unknown.
- Big Island: Infests higher altitude pastures and natural areas, including Hakalau and Puu Oo. BIISC does not target this plant, but will control in some locations. Landowners are asked to control gorse on their property wherever possible.