KĪPAHULU

FOREST RESERVE

Management Plan 2023

STATE OF HAWAIʻI
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE

EXECUTIVE SUMMARY

This ten-year management plan for Kīpahulu State 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 the 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.

The Kīpahulu State Forest Reserve was established by Governor's Proclamation on August 20, 1914. In the report that preceded the establishment of the reserve, the Territorial Forester stated that the objective was to protect watersheds that were potentially important for the development of the Territory. Hosmer cites the presence of streams that were important sources of water that supplied lo'i kalo in the valley and the Kīpahulu Sugar Plantation.

The report also described the vegetation on the government land between Ka'āpahu and Manawainui. The upper portion was covered with a heavy stand of native forest with 'ie'ie (*Freycinetia arborea*) in the understory. The lower section had a uniform, young stand of koa (*Acacia koa*) estimated to be about 20 years old, regrowth after a wildfire. Strawberry guava (*Psidium cattleyanum*) was also spreading rapidly in the reserve and on the adjoining lands. Now considered highly invasive, strawberry guava was at the time thought to be a valuable tree. The stand in Kīpahulu was described by the forester as "making better development than anywhere else in the Territory," (Hosmer 1914, p. 276).

Kīpahulu State Forest Reserve is currently comprised of approximately 2389.3 acres of public land and is located on the leeward slopes of Haleakalā. The reserve formerly encompass a large contiguous landscape, but after a significant withdrawal of land, it is now composed of four separate tracts located within the ahupua'a of Naholoku (2176.6 acres), Kukui'ula (91.5 and 27.1 acres), and Kīko'o (94.1 acres). Management of Kīpahulu FR is focused on the largest unit in Naholoku. The other three sections are small and two are landlocked and difficult to access. This management plan will largely focus on forest reserve lands located within the ahupua'a of Naholoku in the moku of Kaupō.

Kaupō was once a well-populated district, supported by abundant ocean resources and intensive dryland agriculture of 'uala (sweet potato). There is no documented archaeological evidence of habitation or agricultural activities by early Hawaiian in the high elevation forest of the forest reserve. However, the upland forests were an important place for cultural and religious activities and was also a source of natural resources for subsistence, ceremony, and for the making of implements of varied purposes. Forest resources that were gathered, likely included but is not limited to, construction materials, foliage, natural fibers, dyes, medicinal plants, and feathers from native forest birds.

In the early 1800s, the arrival of foreign diseases resulted in a significant loss of the Hawaiian population. Coupled with the shifting of economic strategies to that of supplying western commercial demands, the need for labor intensive dryland agriculture declined. Populations in places like Kaupō decreased rapidly (Baer 2015). In 1891, the Kingdom of Hawai'i started issuing leases and permits for large tracts of land for grazing. This practice continued through the political and societal turmoil that ensued after the overthrow of the Hawaiian Kingdom in 1893. Ranching became the dominant land use in the district and persisted well into the 20th century.

DOFAW's current management activities within Kīpahulu FR include maintenance of existing fence lines and forest restoration areas, monitoring and control of invasive weeds, ungulate control, native ecosystem management and restoration, including endangered species, vegetation, forest birds, seabirds, and bats, and monitoring and protection.

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 16 for forest reserve management priorities. The summary of management goals for the Kīpahulu State FR is as follows:

- Watershed Values – Erosion reduction and prevention; monitoring forest composition; maintain partner role in watershed partnership; and climate change adaptation.
- Resource Protection – Fire presuppression and mitigation; forest health monitoring (Rapid 'Ōhi'a Death, insects, and diseases); monitor weather conditions as they pertain to fire and other forest health issues; and cultural resource protection.
- Cultural Resources – Protection of cultural resources and traditional and customary practices.
- Game Animal Management – Promote and regulate public game bird and mammal hunting; and provide hunter access.
- T&E Species Management – Protection and recovery of rare plants and animals; conduct surveys for rare species; build fenced enclosures; predator and ungulate control; and assisted colonization of rare species.
- Native Ecosystems – Native ecosystem restoration and protection; monitoring; ungulate control; and climate change adaptation.
- Invasive Species Control – Reduce the impact of invasive species; manage incipient and established invasive plant and animal populations; and support biocontrol and research efforts, and biosecurity.
- Access, Trails, and other Public Uses – Secure public access to the Forest Reserve; and negotiate access agreements or easements.
- Commercial Activity – Generate income from suitable commercial activities to support natural resource management of the forest reserve; and explore ecosystem services revenue streams such as carbon sequestration.

Details of specific tactical goals and action items can be found in Table 16 on page 64 of this plan. This plan is intended to describe short-term resource management planning and implementation strategies, as well as 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 Kīpahulu State FR.

TABLE OF CONTENTS

KĪPAHULU STATE 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 Kīpahulu State Forest Reserve.

Scott Fretz – DOFAW Maui District Manager

Mar 6, 2024

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 Kīpahulu State Forest Reserve.

David G. Smith – DOFAW Administrator

Mar 6, 2024

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 Statues, and Chapter 13-104, Hawai'i Administrative Rules.

Dawn N. S. Chang – BLNR Chairperson

Approved by the Board of Land and Natural Resources at its meeting held on July 14, 2023.

DEVELOPMENT PROCESS TIMELINE

Kīpahulu State Forest Reserve, Maui

Stage of Development	Date Achieved	Comments
District review	January 2023	Incorporated
DOFAW review	February 2023	Incorporated
Partner agency consultation	March 2023	Incorporated
Public consultation	April 2023	Incorporated
DOFAW approval	July 2023	Incorporated
BLNR approval	March 2024	Incorporated

1. INTRODUCTION

The Division of Forestry and Wildlife (DOFAW) conducts ongoing 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.

Forest reserve management plans in part will include information on the natural resources, cultural resources, threats, goals and objectives, and the Division's management priorities for the area. This document represents the management plan for Kīpahulu State Forest Reserve. It addresses concerns and strategies for only the public lands that are included within the boundary of the reserve.

Initial development of this plan consisted of reviewing 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. Relevant data from the Hawai'i Statewide Geographic Information System (GIS) and the Office of Hawaiian Affairs Kipuka Database, relating to biological, cultural, and environmental resources were referenced extensively to develop this plan.

Additional resources utilized for the development of this plan were the Hawaiian Forester and Agriculturalist, Hawai'i Biodiversity and Mapping Program (HBMP), State of Hawai'i Forest Action Plan, Hawai'i's State Wildlife Action Plan, 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 State agencies, DOFAW partners, and the public.

Once finalized by DOFAW, this Management Plan for Kīpahulu State Forest Reserve 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:

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

2. HISTORY

Figure 1. Makai view from Kīpahulu FR

2.1 Kaupō and Kīpahulu

When Kīpahulu FR was first established in 1914, it was a larger landscape (10,600 acres) on the southern slope of Haleakalā that included portions of the moku (district) of Kaupō and Kīpahulu. Kaupō was once a well-populated district, supported by abundant ocean resources and intensive dryland agriculture of ʻuala (sweet potato) which is thought to have covered between 12.5 and 15 square kilometers. Production from these dryland fields is estimated to have been able to support a population of 8,000-10,000 people (Kirsch et al. 2009). In the early 1700s, Aliʻi nui Kekaulike, moved his residence to Kaupō, motivated by his ambition to expand his kingdom beyond Maui. Supported by the productive agricultural fields of Kaupō, Kekaulike launched his attacks on the western coast of the island of Hawaiʻi from the landing at Mokulau (Baer 2015).

In the early 1800s, the arrival of foreign diseases resulted in a significant loss of the Hawaiian population. Coupled with the shifting of economic strategies to that of supplying western commercial demands, the need for labor intensive dryland agriculture declined. Populations in places like Kaupō decreased rapidly (Baer 2015).

By the mid-1800s the majority of Kaupō was controlled by the Aliʻi William Charles Lunalilo. In the Māhele (1848), Lunalilo relinquished Kaupō along with more than half of the land that he controlled to the Mōʻī as government land (Kameʻeleihiwa 1992). In 1891, the Kingdom of Hawaiʻi started issuing leases and permits for large tracts of land for grazing. This practice continued through the political and societal turmoil that ensued after the overthrow of the

Hawaiian Kingdom in 1893. Ranching became the dominant land use in the district and persisted well into the 20th century.

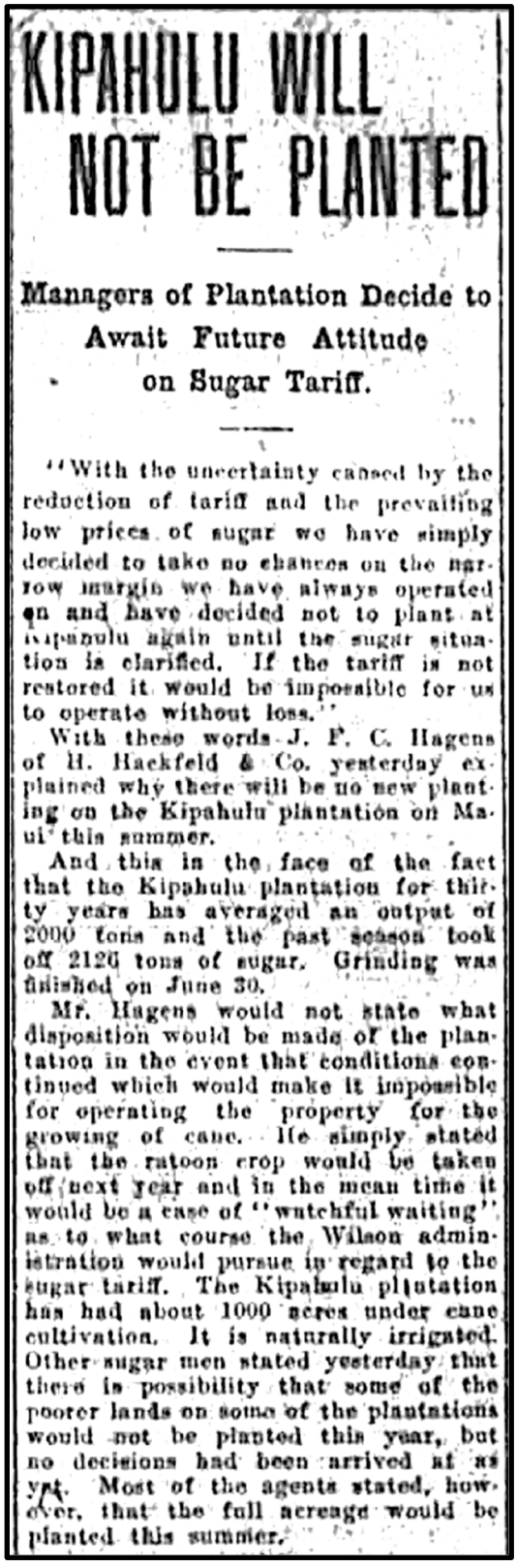
The moku of Kīpahulu was less populated but had thriving settlements along the coast. It was fertile with abundant marine resources, and diverse but scattered agricultural resources including kalo and other Hawaiian food plants (Handy et al. 1972). In the Māhele, Kekauʻōnohi retained the lands of Alaenui but relinquished Alaeiki as government land. The ahupuaʻa of Kikoʻo and Kukuiʻula were also returned to the government by Lunalilo and Keohokālole respectively (Soehren 2022).

By the late 1880s, the sugar industry started to transform the lower landscape of Kīpahulu. The Kīpahulu Sugar company obtained a lease (GL488) for 1,500 acres of government lands in Kīpahulu and Hāna, which included land that became part of the forest reserve (Table 1). Letters contained in Forestry files describe how the plantation used water from ʻOheʻo stream in Kīpahulu or Alaenui Valley for fluming cane and for domestic purposes in the camps. The Government lease was renewed in 1915 (GL881), but was canceled in 1916, and was then replaced by a water license (GL928) in 1917 which did not expire until 1937.

In 1922, Haiku Fruit and Packing Company (HFPC) purchased the Kīpahulu Sugar Company which included the water license and they attempted to plant pineapple in Kīpahulu (Orr 2013). Pineapple did not do well and by 1928, ʻUlupalakua Ranch purchased Alaenui from HFPC and the agricultural industry shifted to cattle.

2.2 Kīpahulu Forest Reserve

The Kīpahulu State Forest Reserve was established by Governor's Proclamation on August 20, 1914 (Figure *4*). In the report that preceded the establishment of the reserve, the Territorial Forester stated that the objective was to protect watersheds that were potentially important for the development of the



KIPAHULU WILL NOT BE PLANTED

Managers of Plantation Decide to Await Future Attitude on Sugar Tariff.

"With the uncertainty caused by the reduction of tariff and the prevailing low prices of sugar we have simply decided to take no chances on the narrow margin we have always operated on and have decided not to plant at Kipahulu again until the sugar situation is clarified. If the tariff is not restored it would be impossible for us to operate without loss."

With these words J. F. C. Hagens of H. Hackfeld & Co. yesterday explained why there will be no new planting on the Kipahulu plantation on Maui this summer.

And this in the face of the fact that the Kipahulu plantation for thirty years has averaged an output of 2000 tons and the past season took off 2126 tons of sugar. Grinding was finished on June 30.

Mr. Hagens would not state what disposition would be made of the plantation in the event that conditions continued which would make it impossible for operating the property for the growing of cane. He simply stated that the ratoon crop would be taken off next year and in the mean time it would be a case of "watchful waiting" as to what course the Wilson administration would pursue in regard to the sugar tariff. The Kipahulu plantation has had about 1000 acres under cane cultivation. It is naturally irrigated. Other sugar men stated yesterday that there is possibility that some of the poorer lands on some of the plantations would not be planted this year, but no decisions had been arrived at as yet. Most of the agents stated, however, that the full acreage would be planted this summer.

Figure 2. Hawaii Gazette - July 10, 1914

Territory. He cites the presence of streams that were important sources of water that supplied loʻi kalo in the valley and the Kīpahulu Sugar Plantation. The report also described the vegetation on the government land between Kaʻāpahu and Manawainui. The upper portion was covered with a heavy stand of native forest with ʻieʻie (*Freycinetia arborea*) in the understory. The lower section had a uniform, young stand of koa (*Acacia koa*) estimated to be about 20 years old which was described as regrowth after a wildfire. Strawberry guava (*Psidium cattleyanum*) was also spreading rapidly in the reserve and on the adjoining lands. Now considered highly invasive, strawberry guava was at the time thought to be a valuable tree. The stand in Kīpahulu was described by the forester as "making better development than anywhere else in the Territory," (Hosmer 1914, p. 276).

Figure 3. ʻIeʻie climbing a koa tree in Kīpahulu FR

Starting in the late 1920s, Territorial Forester C. S. Judd initiated conversations to expand Kīpahulu FR. It culminated in 1953 when Executive Order 1564 effectively canceled the Governor's Proclamation that originally had established the reserve and set aside a largely overlapping but new Kīpahulu Forest Reserve boundary (Table *2* and Figure 5). The size of the reserve was increased to 11,767.62 acres adding land mauka of the Kaupō Homesteads.

When forest reserves were first being established, private lands like Alaenui were included in these designations. Privately owned parcels are not subject to the rules and statutes established for the Forest Reserve System unless the landowner enters into an agreement in which they surrender to the government, the care, custody, and control of their land as a forest reserve. In return, the landowner would not have to pay property taxes as long the area remained exclusively under the control of the government. This is known as a surrender agreement pursuant to Section 183-15, Hawaiʻi Revised Statutes (HRS).

Letters in the Forestry files indicate that there was a Surrender Agreement with ʻUlupalakua Ranch for Alaenui that started on January 1, 1959, for a term of 20 years. A physical copy of a signed agreement could not be found, but when ʻUlupalakua Ranch sold the property in 1963, the Surrender Agreement if it was in place was effectively ended. Alaenui was eventually sold again to The Nature Conservancy in 1968, and it was transferred to the United States Department of the Interior National Park Service for inclusion into Haleakalā National Park. State land was also withdrawn from Kīpahulu FR in 1984 (EO2572) and conveyed to the federal government for the same purpose.

A total of 8,584 acres of both private and public lands were withdrawn from Kīpahulu FR, leaving only 3,183 acres. The remaining public forest reserve lands are situated in the moku of Kaupō in

the ahupuaʻa of Naholoku (2176.6), and in the moku of Kīpahulu in the ahupuaʻa of Kukuiʻula (118.6) and Kikoʻo (94.1 acres). This plan will largely focus on the management of the largest unit in Kaupō as the units in Kīpahulu are small and some are inaccessible slivers of land.

Table 1. Historical land use agreements issued for lands within Kīpahulu FR.

Type	Doc. #	Duration	Description	Acres	Map #[1]	Tax Map Key[2]
Lease	GL488	6-Mar-1895 to 5-Mar-1915	Lease sold at public auction to the Kīpahulu Sugar Company	1,500	CSF 617	(2) 1-5-001:001 (por.) (2) 1-6-001:002 (por.)
Lease	GL881	20-Dec-1915 to 8-May-1916	Lease sold at public auction to the Kīpahulu Sugar Company. Lease was issued for a term of 15 years but was canceled before that.	1,500	CSF 617	(2) 1-5-001:001 (por.) (2) 1-6-001:002 (por.)
License	GL928	5-Sept-1917 to 18-Sept-1937	Water license sold at public auction to the Kīpahulu Sugar Company	1,041	CSF 2871	(2) 1-5-001:001 (por.) (2) 1-6-001:002 (por.)

Table 2. Summary of lands added and withdrawn from Kīpahulu FR

Document[3]	Date	Action[4]	Description	Acres	Map #	Tax Map Key
GP	20-Aug-1914	A	Land set aside for establishment of Kīpahulu FR	10,600	CSF 2545	(2) 1-6-001:001 (2) 1-6-001:002 (2) 1-6-001:003 (2) 1-6-001:004 (2) 1-6-001:005 (2) 1-6-001:006 (2) 1-6-001:007 (2) 1-6-001:008 (2) 1-6-001:009 (2) 1-7-004:006 (por.) (2) 1-7-004:016
EO 1564	1-Jun-1953	M	Withdrew all lands set aside as Kīpahulu FR by the 1914 Governor's Proclamation and established a new Kīpahulu FR boundary.	11,767.62	CSF 11542	(2) 1-6-001:001 (2) 1-6-001:002 (2) 1-6-001:003 (2) 1-6-001:004 (2) 1-6-001:005 (2) 1-6-001:006 (2) 1-6-001:007 (2) 1-6-001:008 (2) 1-6-001:009 (2) 1-7-004:006 (2) 1-7-004:016
EO 2572	30-Jun-1971	W	Withdrawal of land for the Haleakalā National Park.	8,584	CSF 16144	(2) 1-6-001:001 (2) 1-6-001:002 (2) 1-6-001:005 (por.) (2) 1-7-004:016

1 CSF = Copy of Survey Furnished. Maps are available online at http://ags.hawaii.gov/survey/map-search/
2 (por.) = portion; Only a portion of the TMK was included in the FR.
3 Documents: GP = Governor's Proclamation; EO = Executive Order
4 Action: A = Added to the FR; M = Modified the boundary of the FR; W = Withdrawn from the FR

Figure 4. Map of Kīpahulu FR boundary from Governor's Proclamation dated August 20, 1914.

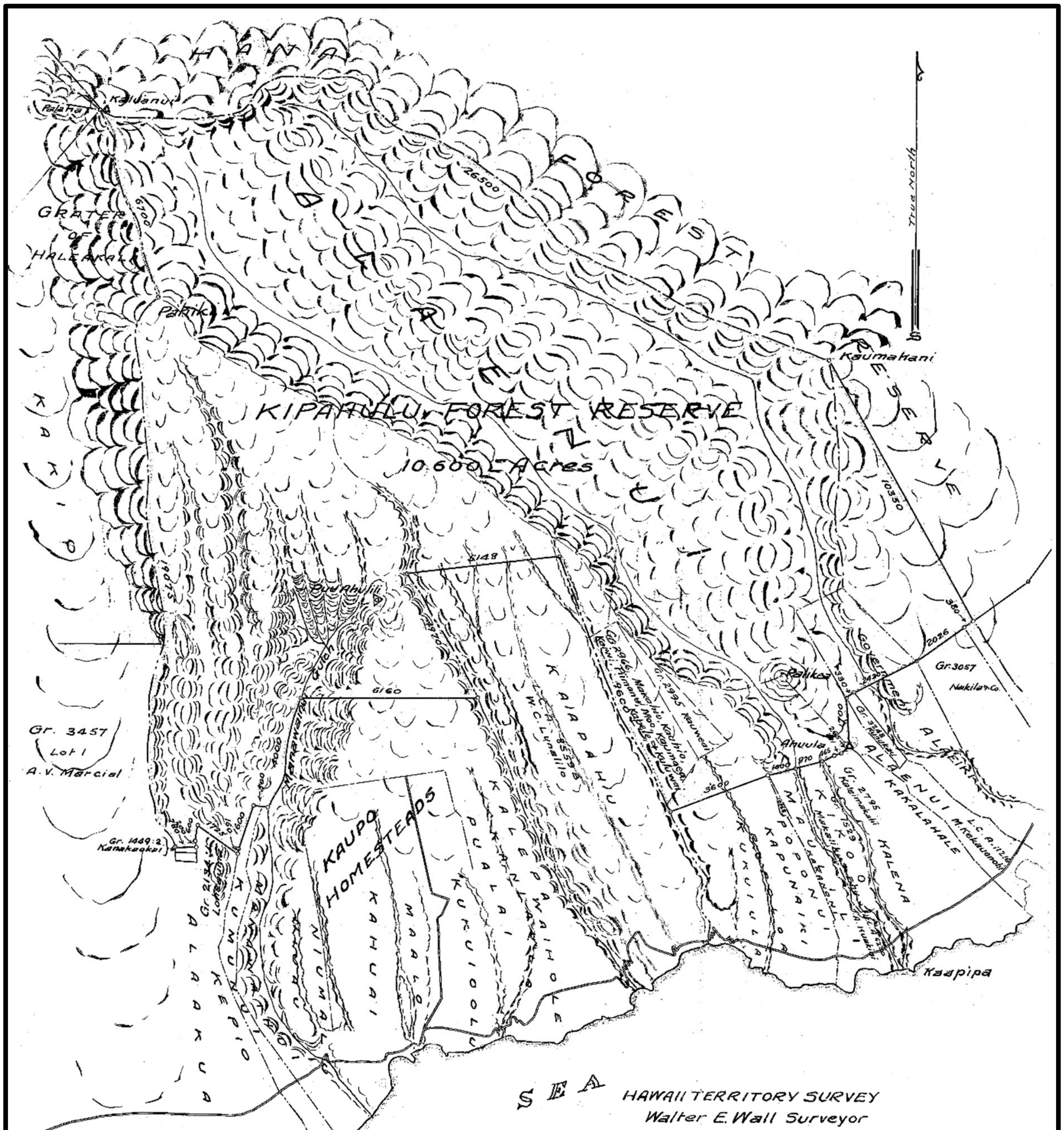
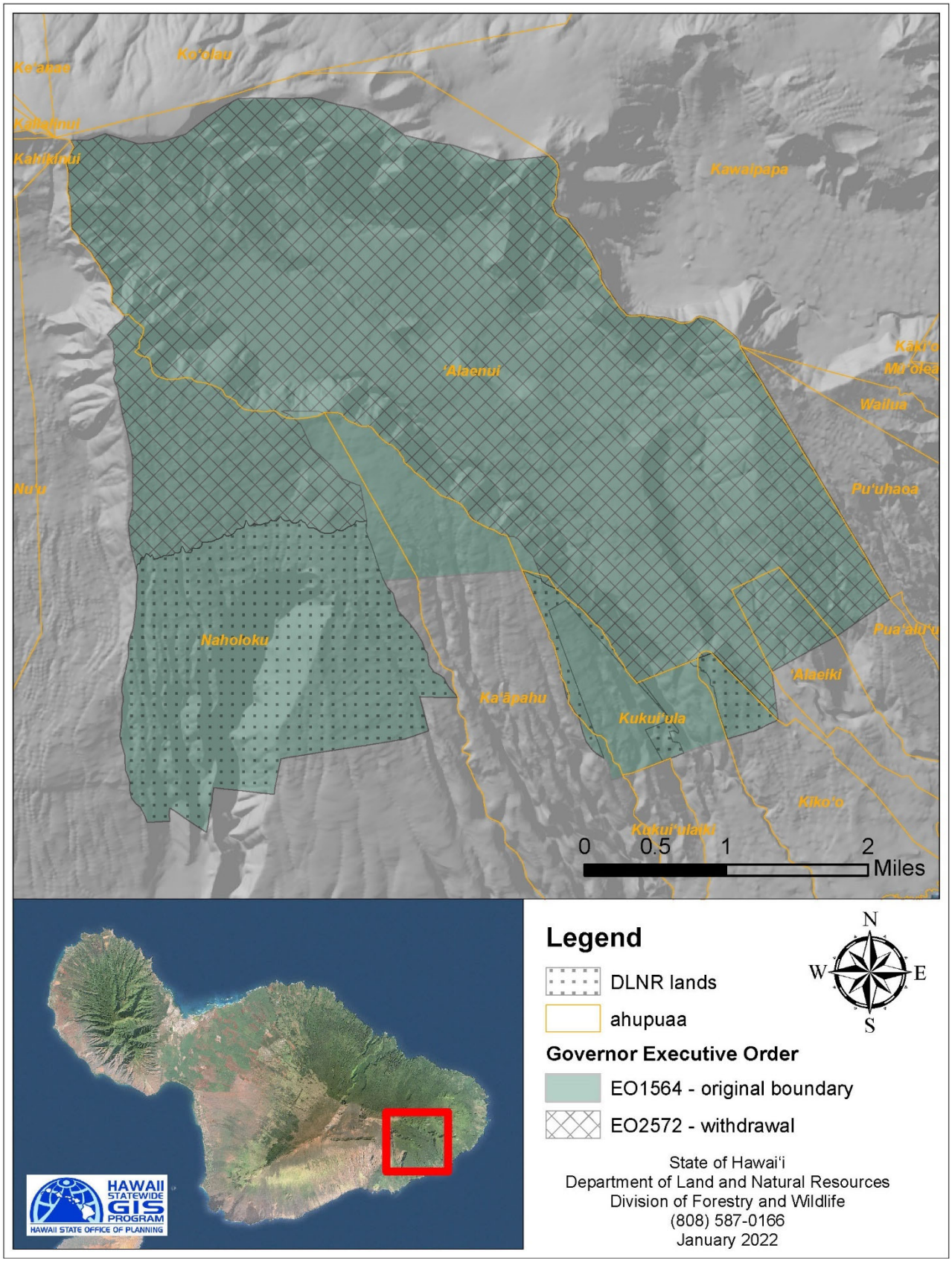


Figure 5. Historical changes to Kīpahulu FR boundary



3. FOREST RESERVES DESCRIPTION

3.1 Location and Description

Kīpahulu Forest Reserve currently occupies land in the moku of Kaupō and Kīpahulu and is comprised of approximately 2389.3 acres (Table 3) of public land. It is located on the southeast slopes of Haleakalā (Figure 7) on the island of Maui, in the Hāna district. The reserve is currently composed of four non-contiguous tracts located within the ahupua'a of Naholoku (2176.6 acres), Kukui'ula (91.5 and 27.1 acres), and Kīko'o (94.1 acres). DOFAW management of Kīpahulu FR is largely focused on the unit in Naholoku. The other three units are small in size and two of them are landlocked and difficult to access. This management plan will largely focus on the Naholoku section of the reserve.

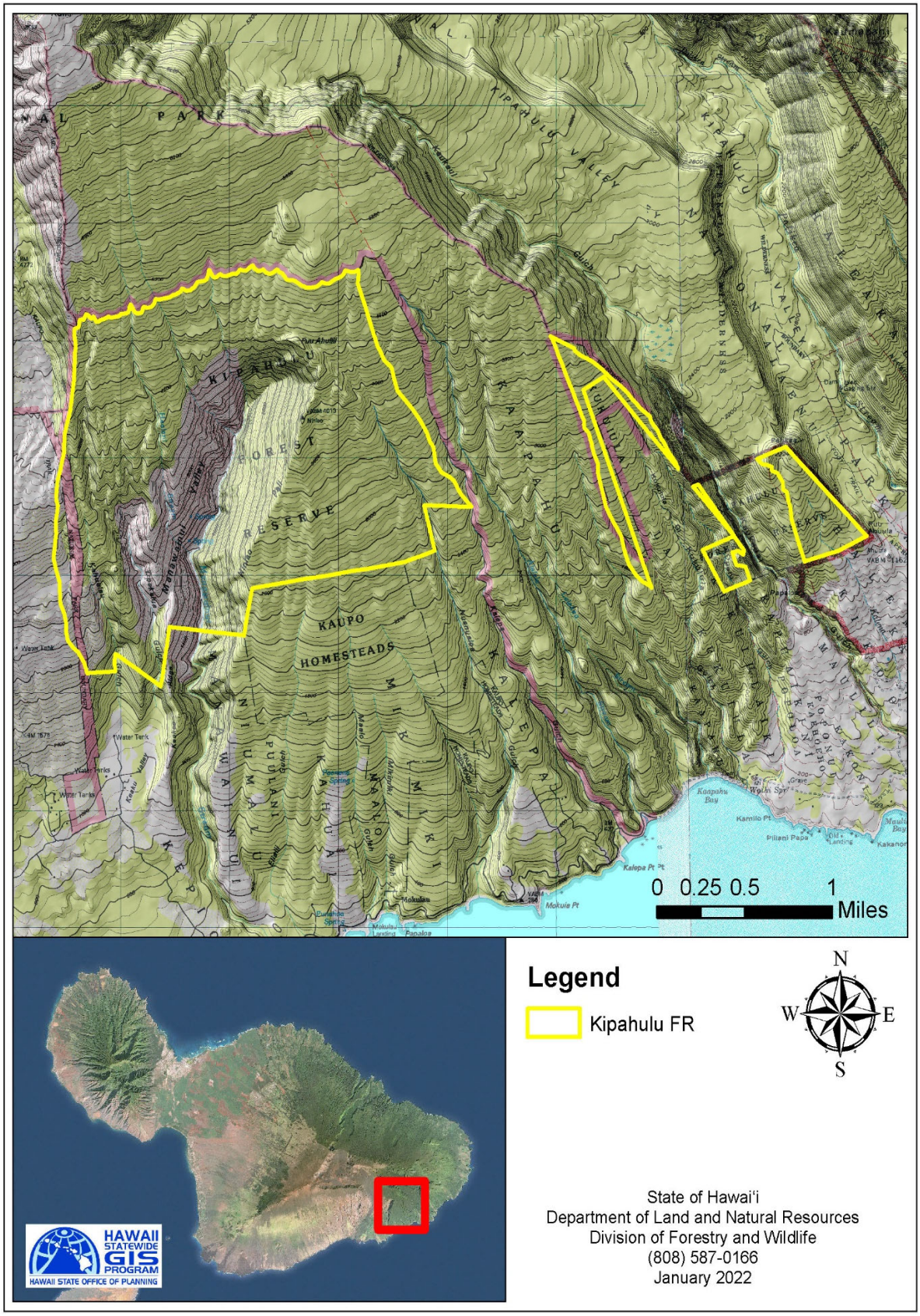
Kīpahulu FR is surrounded by other state, federal, and privately owned lands. It's bounded by the Haleakalā National Park on the north and east, by Kaupō Ranch on the west, and by a mixture of state and private parcels on the south. The communities in closest proximity to this forest reserve include Kahikinui, Kaupō, and Kīpahulu. Elevation of the reserve ranges from approximately 5,000 feet to about 1,000 feet at the bottom of Manawainui gulch. Vegetation is generally characterized by five plant communities: dry grassland, dry forest, mesic grassland, mesic forest, and wet forest.

Figure 6. Kīpahulu FR 'ōhi'a lehua

Table 3. Government Tax Map Key (TMK) parcels comprising public lands of Kīpahulu FR

TMK Number	Owner	Tax Acres (entire TMK)	GIS Acres (entire TMK)	GIS Acre (forest reserve)
(2) 1-7-004:006	State of Hawai'i	2123.7	2176.6	2176.6
(2) 1-6-001:005	State of Hawai'i	135.5	113.5	91.5
(2) 1-6-001:008	State of Hawai'i	24.2	27.1	27.1
(2) 1-6-001:009	State of Hawai'i	89	94.1	94.1
			TOTAL	2389.3

Figure 7. Current extent of public lands of Kīpahulu State Forest Reserve



3.2 Geology

Figure 8. Back of Manawainui valley – Kīpahulu FR

The islands of Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe were all once connected and formed one larger landmass known as Maui Nui. As Maui Nui subsided and sea levels began to rise, the saddles between the volcanoes submerged, isolating them as separate islands. 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 formed Mauna Kahalawai (West Maui Mountains). Kīpahulu FR is located on Haleakalā, which last erupted sometime between the years 1480 and 1600 (Hawaiʻi Volcano Observatory, 2003).

East Maui was formed by three periods of volcanic activity from Haleakalā Volcano that geologists have designated as the Honomanū Basalt, Kula Volcanics, and Hāna Volcanics. Surface geology of Kīpahulu FR consists of lava flows from the Kula Volcanic Series, 140,000 to 950,000 years ago (Sherrod, 2007) during the Middle Pleistocene. Primary geological features (Figure 7) of the forest reserve are Manawainui valley (Figure 8), Kahualau gulch, ʻŌpakalua gulch, Kaʻokaʻo ridge, Niniau Pali, and Puʻu ʻĀhulili. Manawainui valley runs through the center of the reserve and the surrounding area is steep and dissected by many gullies a few of which have running water.

3.3 Climate

Average rainfall in Kīpahulu FR ranges from approximately 65 to 200 inches annually (Figure 10) with fog and cloud interception contributing to total precipitation. The northeast corner is the wettest part of the reserve and moisture level declines as you head southwest. Precipitation received in Kīpahulu FR recharges the Kīpahulu aquifer, and there are several intermittent streams and one perennial stream in the reserve. Annual air temperature averages 54-70 degrees Fahrenheit.

Figure 9. Waterfall in Kīpahulu FR

3.4 Soils

The United States Department of Agriculture's Natural Resource Conservation Service (NRCS) has mapped four soil types (Table 4 and Figure 11) in Kīpahulu FR, see Appendix A for soil descriptions. This agency provides online soil maps and data at https://websoilsurvey.sc.egov.usda.gov.

Table 4. Soils of Kīpahulu FR (NRCS Soil Survey Geographic Database, 2018)

Map unit	Name	Acreage	Percent cover
rHT	Hydrandepts-Tropaquods association	1216.2	55.9%
rRT	Rough mountainous land	910.6	41.8%
rRK	Rock Land	30.6	1.4%
rVS	Very stony land	18.9	0.9%

Figure 10. Hydrological features of Kīpahulu Forest Reserve (FR)

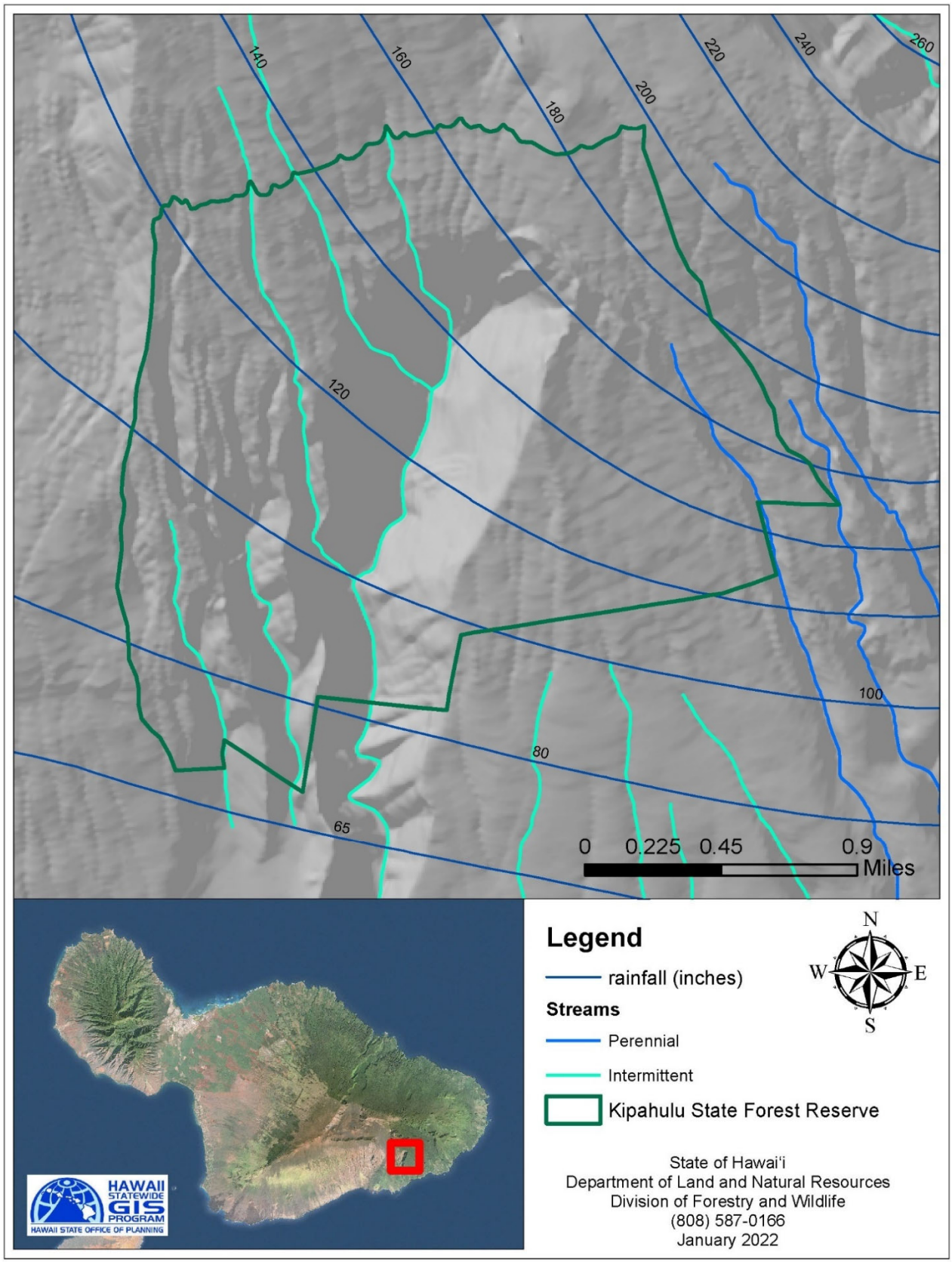


Figure 11. Soils of Kīpahulu FR (NRCS Soil Survey Geographic Database, 2018)

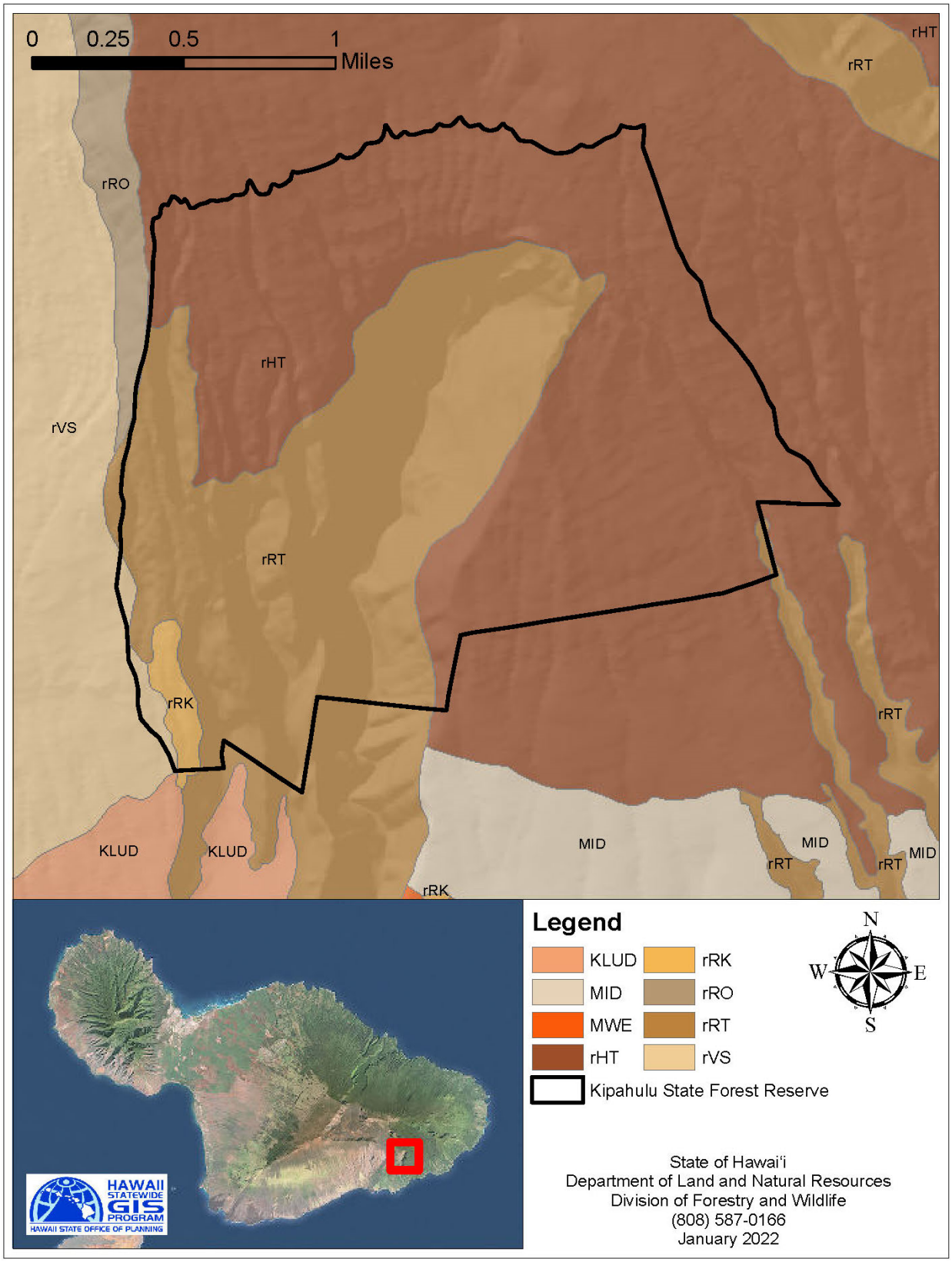


Figure 12. Koa tree on the rim of Manawainui Valley in Kīpahulu FR

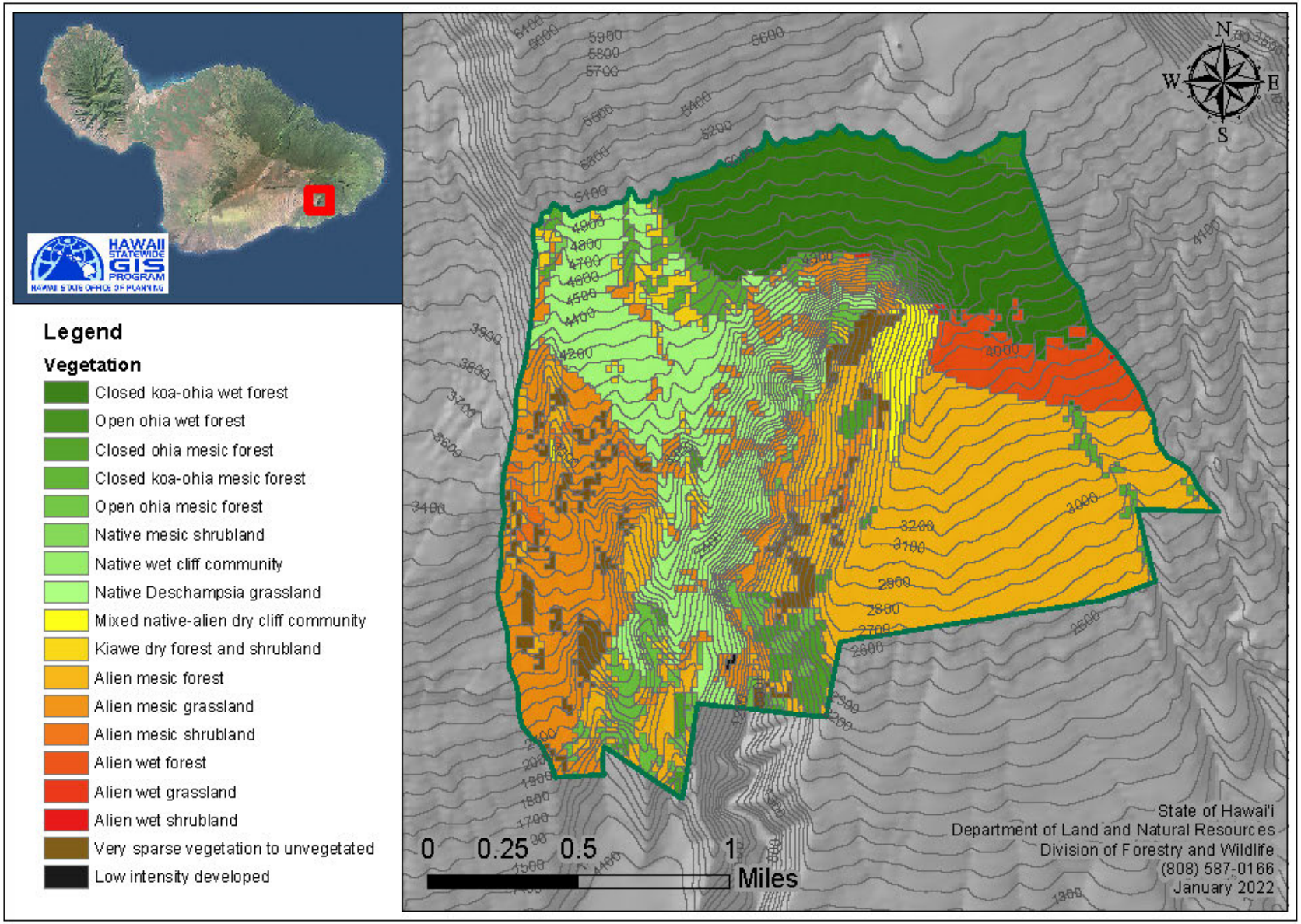
3.5 Vegetation

The vegetation in Kīpahulu FR has been severely altered by grazing animals, primarily feral cattle and goats, and the subsequent spread of introduced, invasive plant species. According to the Carbon Assessment of Hawai'i Land Cover Map (Figure 13), the top four vegetation types that cover Kīpahulu FR are alien mesic forest (28.2%), native *Deschampsia* grassland (18.4%), closed koa-'ōhi'a wet forest (16.4%), and alien mesic grassland (16.0%).

Table 5. Major land cover types of Kīpahulu FR (Jacobi et al. 2017)

Land cover type	Acreage	% Cover
Alien mesic forest	613.8	28.2%
Native *Deschampsia* grassland	400.3	18.4%
Closed koa-'ōhi'a wet forest	357.2	16.4%
Alien mesic grassland	347.6	16.0%
Alien wet forest	88.6	4.1%
Very sparse vegetation to unvegetated	85.3	3.9%
Open 'ōhi'a mesic forest	74.9	3.4%
Closed koa- 'ōhi'a mesic forest	53.6	2.5%
Closed 'ōhi'a mesic forest	48.3	2.2%
Mixed native-alien dry cliff community	39.4	1.8%
Kiawe dry forest and shrubland	34.3	1.6%

Figure 13. Kīpahulu FR vegetation cover (Jacobi et al. 2017)



3.5.1 Dry Forest and Grassland

Figure 14. Kīpahulu FR dry forest and grassland

Non-native dry forest and grasslands cover the portion of the reserve, west of Manawainui valley between 1,000-3,500 ft in elevation. Ridges are dominated by strawberry guava (*Psidium cattleyanum*) and Christmasberry (*Schinus terebinthifolius*) and kukui trees (*Aleurites moluccanus*) grow in the gulch bottoms. Much of the area is heavily grazed and the understory is grass or bare exposed soil. Other non-native trees found in the area include silky oak (*Grevillea robusta*), Java plum (*Syzygium cumini*), and guava (*Psidium guajava*). The only native tree that was found in this zone was one individual alahe‘e (*Psydrax odorata*) at about 2,000 feet in elevation. Much of Manawainui Valley is also within this dry forest zone. The steep walls appear to be dominated by well-grazed molasses grass with clumps of Mauritius hemp (*Furcraea foetida*) near rock bands.

Grassy areas in this zone are dominated by non-native grasses including kikuyu (*Cenchrus clandestinus*), molasses grass (*Melinis minutiflora*), and natal red top (*Melinis repens*). Smaller patches of non-native rattail grass (*Sporobolus indicus*) and broomsedge (*Andropogon virginicus*), and native grasses mānienie ‘ula (*Chrysopogon aciculatus*) and ‘emoloa (*Eragrostis variabilis*) are also present.

Towards the top of the dry forest, non-native shrubs like lantana (*Lantana camara*) and branched porterweed (*Stachytarpheta australis*) form waist to chest-high thickets. Native shrubs in this zone are less abundant but species that have been documented include ‘a‘ali‘i (*Dodonaea viscosa*), pūkiawe (*Leptecophylla tameiameiae*), and ‘ākia (*Wikstroemia monticola*).

The majority of herbs that are found in this zone are non-native. Notable species were the tropical Mexican clover (*Richardia brasiliensis*), fireweed (*Senecio madagascariensis*), and the narrow-leaved plantain (*Plantago lanceolata*). The non-native white passion flower vine (*Passiflora subpeltata*) was occasionally observed climbing on vegetation, especially on steep gulch walls (Starr 2018).

3.5.2 Mesic Forest and Grassland

Figure 15. Kīpahulu FR open koa forest with grass understory

On the western side of the reserve, vegetation transitions to mesic forest and grassland at about 3,500 feet elevation and it extends to the top of the reserve. Koa is the dominant tree, but the area has been heavily grazed resulting in an open stand of mature trees with a short grass understory, and very few shrubs or young trees. ʻŌhiʻa (*Metrosideros polymorpha*) becomes co-dominant as you go higher in elevation and moisture. The steep headwalls (above 3,500 feet in elevation) of Manawainui are also in this zone and contain intact patches of native vegetation which have been protected by the steep terrain.

Dominant grasses are the non-native narrow-leaved carpetgrass (*Axonopus fissifolius*), molasses grass, and Yorkshire fog (*Holcus lanatus*). The few shrubs that were able to survive in the steeper areas include pūkiawe (*Leptecophylla tameiameiae*), ʻaʻaliʻi, and pilo (*Coprosma foliosa*). Ferns in this zone are also more commonly found in steep habitats. Kīlau (*Dryopteris glabra*) is abundant in some areas, and other species that are still present but less abundant include hāpuʻu (Cibotium glaucum), laukahi (*Dryopteris wallichiana*), and ʻiʻi (*Dryopteris fusco-atra*) (Starr 2018).

3.5.3 Wet Forest

Figure 16. Wet forest Kīpahulu FR

The eastern portion of Kīpahulu Forest Reserve receives significantly more rainfall and the vegetation between 5,000 – 3,500 feet in elevation is described as closed canopy native wet forest with a lush fern understory. This is the largest intact and most diverse native ecosystem in the reserve. The dominant canopy tree species are ʻōhiʻa, koa, and ʻōlapa (*Cheirodendron trigynum*). Other native trees found here include kōlea (*Myrsine lessertiana*), olomea (*Perrottetia sandwicensis*), and alani (*Melicope* spp.).

Dominant understory ferns include uluhe (*Dicranopteris linearis* and *Sticherus owhyhensis*), uluhe launui (*Diplopterygium pinnatum*), *Dryopteris* spp., and ʻamaʻu (*Sadleria* spp.). Other less common ferns include *Asplenium* spp., *Elaphoglossum* spp., pala (*Marattia douglasii*), and hāpuʻu (*Cibotium* spp.). The non-native and invasive Australian tree fern (*Sphaeropteris cooperi*) is also spreading and becoming established throughout much of the wet forest.

In some portions of the forest understory, there is a shrub layer composed of pūkiawe (*Leptecophylla tameiameiae*), kanawao (*Hydrangea arguta*), pilo (*Comprosma foliosa*), and ʻōhelo (*Vaccinium calycinum*). Māmaki (*Pipturus albidus*), naupaka (*Scaevola chamissoniana*), ʻākala (*Rubus hawaiensis*), ʻōhā wai (*Clermontia* spp.), haʻiwale (*Cyrtandra* spp.), and hāhā (*Cyanea* spp.) are found occasionally along steep margins. Vines in the area include maile (*Alyxia stellata*), manono (*Kadua affinis*), ʻieʻie (*Freycinetia arborea*), and hoi kuahiwi (*Smilax melastomifolia*).

Dominant grass species in this zone include the non-native Yorkshire fog (*Holcus lanatus*), narrow-leaved carpet grass (*Axonopus fissifolius*), molasses grass (*Melinis minutiflora*), and

Glenwood grass (*Sacciolepis indica*). A few native grasses are also present in small numbers, and usually in hard-to-reach locations. They are he'upueo (*Lachnagrostis filiformis*), hairgrass (*Deschampsia nubigena*), and *Eragrostis grandis*. Native sedges that can be locally abundant include carex (*Carex alligata*), hook sedge (*Uncinia uncinata*), and 'uki (*Machaerina angustifolia*). Also present are small clumps of wood rush (*Luzula hawaiiensis*).

Below 3,500 feet in elevation on the eastern side of the reserve, a severe infestation of the invasive strawberry guava (*Psidium cattleyanum*) dominates, forming a nearly monotypic stand. Some non-native shrubs also found in this zone include Koster's curse (*Miconia crenata*), cane tibouchina (*Tibouchina herbacea*), and thimbleberry (*Rubus rosifolius*) (Starr 2018).

Figure 17. Thicket of strawberry guava (Psidium cattleyanum) in Kīpahulu FR

3.5.4 Rare and Endangered Plants

Since 1947, twelve rare or endangered plant species have been documented in Kīpahulu FR (Table 6). Eleven species, *Ctenitis squamigera*, *Cyanea asplenifolia*, *Cyanea copelandii* ssp. *haleakalaensis*, *Cyanea hamatiflora* ssp. *hamatiflora*, *Cyanea kunthiana*, *Cyrtandra ferripilosa*, *Phlegmariurus mannii*, *Microlepia strigosa* var. *mauiensis*, *Phyllostegia haliakalae*, *Schiedea diffusa* ssp. *diffusa* and *Wikstroemia villosa* are listed as endangered and are protected by both state and federal regulations. *Hillebrandia sandwicensis* is not endangered but is rare and is considered an at-risk species.

Table 6. Rare and endangered plants of Kīpahulu FR (HBMP 2018, Starr 2018, and H. Oppenheimer, personal communication, August 2022).

Species	Common name	Historical[5]	ESA	PEPP Species[6]
Ctenitis squamigera	pauoa	X	Endangered	No
Cyanea asplenifolia[7]	hāhā		Endangered	No
Cyanea copelandii ssp. *haleakalaensis*	hāhā		Endangered	No
Cyanea hamatiflora ssp. *hamatiflora*	hāhā		Endangered	No
Cyanea kunthiana	hāhā		Endangered	No
Cyrtandra ferripilosa	haʻiwale		Endangered	No
Hillebrandia sandwicensis	pua maka nui, ʻakaʻakaʻawa		At-Risk	No
Microlepia strigosa var. *mauiensis*	palapalai		Endangered	Yes
Phlegmariurus mannii			Endangered	No
Phyllostegia haliakalae			Endangered	Yes
Schiedea diffusa ssp. *diffusa*		X	Endangered	Yes
Wikstroemia villosa	ʻākia		Endangered	Yes

Ctenitis squamigera is a perennial fern in the Dryopteridaceae (wood fern) family. It grows in lowland mesic forests and is a medium to large fern with fronds up to 63 inches long. It was listed as an endangered species in 1994 and there are approximately 67 wild individuals left, with the majority of them located on west Maui (USFWS 2021a). It was last observed in Kīpahulu FR in 1947 and is likely no longer present in the reserve. Conservation efforts are focused on populations located on the island of Oʻahu. However, spores have been collected from plants located on Maui. *Ctenitis squamigera* was included in a USFWS Recovery Challenge Grant targeting recovery of four endangered species of ferns all of which occur on the island of Maui (H. Oppenheimer, personal communication, August 2022).

Cyanea asplenifolia is a member of the Campanulaceae (bellflower) family. It is a perennial shrub that grows 4.3 to 6.6 feet tall. It was designated as an endangered species by the USFWS in 2013, and wild populations occur on both west and east Maui. One population is possibly in the forest reserve, but surveys to determine the exact location of the reserve boundary would be needed to confirm if it is. In 2020, there was an estimated 61 individuals left in the wild. They are found in native dominated wet forests at 1,850 to 2,900 feet in elevation. Conservation efforts thus far include monitoring, habitat protection, collection, genetic storage, propagation, and reintroduction (USFWS 2020a).

[5] Species observations that occurred more than 30 years ago are considered historical sightings.

[6] The Plant Extinction Prevention Program (PEPP) was established as the implementation arm of the Hawaiʻi Rare Plant Restoration Group (HRPRG). With guidance from the HRPRG, PEPP conducts in-the-field (in situ) management actions to preserve the rarest plants statewide. PEPP's primary targets are "PEPP species" most which have fewer than 50 plants remaining in the wild. This designation signifies their imminent risk of extinction and a heightened need to protect all remaining plants. The Plant Extinction Prevention Program operates as a project of the Pacific Cooperative Studies Unit of the University of Hawaiʻi at Mānoa and is supported by State and Federal funds, grants, and donations from public and private institutions. http://www.pepphi.org/about-pepp.html

[7] Surveys are needed to determine the exact location of the reserve boundary to figure out if this species is actually located within the Kīpahulu FR boundary.

Cyanea copelandii ssp. *haleakalaensis* is a member of the Campanulaceae family. It is a vine-like shrub that grows one to seven feet tall. It was designated as an endangered species by the USFWS in 1999 and it is endemic to east Maui. It historically occurred from Waikamoi to Kīpahulu in montane wet forests, and in 2018 there were an estimated 300-500 wild individuals left. Conservation efforts thus far include habitat protection, collection, genetic storage, and propagation (USFWS 2018a).

Figure 18. Cyanea hamatiflora ssp. *hamatiflora*

Figure 19. Cyanea kunthiana

Cyanea hamatiflora ssp. *hamatiflora* is a member of the Campanulaceae family. It is a perennial, palm-like tree that grows 10 to 26 feet tall. It was designated as an endangered species by USFWS in 1999 and was historically known to occur on the windward side of Haleakalā from Puʻu o Kākaʻe to Manawainui. In 2018, the total population size was less than 400 individuals. They are found in native dominated wet forests with a ʻōhiʻa or koa canopy, at 2,510 to 5,100 feet in elevation. Conservation efforts thus far include habitat protection and collecting and storing seeds (USFWS 2018b).

Cyanea kunthiana is also a member of the Campanulaceae family. It is a shrub that grows to 1.6 to 5 feet tall, flowers are whitish with longitudinal lilac stripes or are dark purple. It was listed as an endangered species in 2013. *Cyanea kunthiana* was thought to have been dispersed in a contiguous population on the northern and eastern slopes of Haleakalā in wet and mesic mid-elevation forests and in upper elevation forests on Mauna Kahālāwai. Currently, *Cyanea kunthiana* is still widespread on Haleakalā with a total population size of over 450 individuals. The population on Mauna Kahālāwai is estimated at 59 individuals (USFWS 2020b). Primary management actions occurring for this species is habitat protection. Also, PEPP has made numerous seed collections for reintroduction and storage at Lyon Arboretum (H. Oppenheimer, personal communication, August 2022).

Cyrtandra ferripilosa is a perennial shrub in the Gesneriaceae (African violet) family. It has

white flowers and grows 4.9 to 11.5 feet tall. It has only been found growing on east Maui in upper elevation wet to mesic forests. It was listed as endangered in 2013, and in 2020 there were an estimated 56 individuals left in the wild. Seeds have been collected and are stored at Lyon Arboretum and plants have been propagated at Olinda Rare Plant Facility for reintroduction (USFWS 2020c).

Hillebrandia sandwicensis is a perennial herb in the Begoniaceae (begonia) family. It has pink to white flowers and it grows from 1.6 to 5 feet tall. It is the only species in the genus and it grows in ravines in wet forests. It is not listed as an endangered species, but it is considered an at-risk species. It is estimated that there are 1000s of mature individuals left in the wild (Keir et al. 2014)

Figure 20. Hillebrandia sandwicensis

Phlegmariurus mannii is a perennial lycophyte or clubmoss. It is a pendent epiphyte which means a plant that is not rooted to the ground. It has clustered, pink to red stems that are 1.6 to 3.9 inches long and it was listed as an endangered species in 1992. In 2015, the Plant Extinction Prevention Program found four individuals in Kīpahulu FR plants. This was the first observation of this species in the area in more than 40 years. Subsequently, more plants have been found and the current total population on Maui is estimated to be between 64 and 200 individuals. On east Maui they are found growing in ʻōhiʻa and koa in mesic forests at 2,200 to 5,249 feet in elevation. Conservation efforts thus far include habitat protection and a few individuals are being grown at rare plant nurseries (USFWS 2020d).

Microlepia strigosa var. *mauiensis* is a fern in the Dennstaedtiaceae family. It is a rare variety of palapalai, a culturally important fern that is sacred to Laka the Hawaiian goddess of hula. The common variety of palapalai, *Microlepia strigosa* var. *strigosa*, is often placed on hula kuahu

(alter) and worn by hula dancers. *Microlepia strigosa* var. *mauiensis* looks similar to the common palapalai, but this taxon is an extremely hairy variety with the stipes, rachises, costae, and entire fronds covered with uniform, jointed hairs with pointed tips (Palmer 2003). The *mauiensis* variety was listed as endangered in 2016, and there are currently fewer than 300 individuals left in the wild. The largest population is located in Haleakalā National Park which is adjacent to Kīpahulu FR. Conservation efforts thus far include habitat protection, and there is genetic storage (tissue culture) for one individual at Lyon Arboretum (USFWS 2021b).

Phyllostegia haliakalae is a perennial herb in the Lamiaceae (mint) family with mostly white to pink flowers. It grows in mesic and wet forests and also in wet and dry cliff ecosystems. This species was listed as endangered in 2013, and there are currently 67 to 111 wild individuals left. Seeds and propagules have been collected and approximately 290 plants have been reintroduced into 23 subpopulations. Outplantings have been short-lived with some surviving for less than two years (USFWS 2020e). There are no wild plants in Kīpahulu FR but the reserve was one of the PEPP reintroduction sites for this species.

Figure 21. Phyllostegia haliakalae

Schiedea diffusa ssp. *diffusa* is a perennial vine in the Caryophyllaceae (carnation) family. It grows in wet forests and vines are light green to yellowish green. They sprawl over other vegetation and grow from 10 to 33 feet in length. The species is named for the spreading or diffuse inflorescences that are 4 to 20 inches in length and contain from 20 to 90 flowers. This species was listed as endangered in 2016, and currently there are fewer than 30 wild individuals left with the majority of them located on east Maui. This species is likely no longer present in Kīpahulu FR with the last individuals being observed in 1980. Conservation efforts thus far include habitat protection, collecting and storing seeds, living collections in nurseries and tissue culture, and outplanting to establish new, self-sustaining populations (USFWS 2021c).

Figure 22. Wikstroemia villosa

Wikstroemia villosa is a tree in the Thymelaceae family. It grows 9 to 14 feet tall and are found primarily in wet and mesic forests between 3,500 to 5,500 feet in elevation. It was once considered extinct since it had not been seen for decades, but in 2007 a single tree was found on east Maui (Oppenheimer 2011). When the species was listed as endangered in 2013 there were only two known individuals, but since then, targeted surveys have found approximately 100 individuals. Conservation efforts thus far include habitat protection, collecting and storing seeds, and living collections in nurseries and tissue culture. Plants have been outplanted into reintroduction sites in Waikamoi and on Mauna Kahālāwai (USFWS 2020f).

3.6 Wildlife

3.6.1 Native Wildlife

Figure 23. Maui ʻamakihi

Five endangered wildlife species that are protected by both state and federal regulations have been documented to occur in Kīpahulu FR (Table 7). Three species are still present and they are the endangered ʻōpeʻapeʻa or Hawaiian hoary bat (Lasirus cinereus semotus), the nēnē or Hawaiian goose (Branta sandvicensis), and the ʻuaʻu or Hawaiian petrel (Pterodroma phaeopygia sandwichensis). Two other species have been documented in the reserve but have not been observed for decades and are likely not present. They are the ʻākohekohe or crested honeycreeper (Palmeria dolei) and the kiwikiu or the Maui parrotbill (Pseudonestor xanthophrys).

Six additional native birds were also documented (Table 8) during surveys (Scott et al. 1986; Starr 2018), the ʻapapane (*Himatione sanguinea*), ʻiʻiwi (*Vestiaria coccinea*), koaʻe kea or white-tailed tropicbird (*Phaethon lepturus*), Maui ʻalauahio (*Paroreomyza montana*), Maui ʻamakihi (*Chlorodrepanis virens wilsoni*), and the pueo (*Asio flammeus sandwichensis*). Species profiles from the Hawaiʻi State Wildlife Action Plan contain information on their biology, distribution, threats, and conservation actions have all been included in Appendix C of this plan.

The ʻōpeʻapeʻa is one of two endangered mammals endemic to Hawaiʻi and they are found across east Maui. They are regularly observed flying over the reserve at dusk. To better determine their presence bat detectors were deployed in open koa forest on the western side of the reserve near Kaupō Gap at about 4,400 feet in elevation. Data recorded over ten nights show ʻōpeʻapeʻa activity on all days through most of the night with activity peaking in the hours after sunset. On average there were 411 pulses per night ranging from 26-979 pulses. The regularity and level of activity in the hours after sunset suggest that ʻōpeʻapeʻa are roosting in the area.

Figure 24. ʻApapane

The nēnē (*Branta sandvicensis*) also is the only native species of goose currently found in Hawai'i. It is part of the the Anatidae (water birds) family, and has been reported on Hawai'i, Maui, Kaua'i, and Moloka'i from sea level to 7,800 ft in elevation. This species has been observed in a variety of habitats such as coastal dunes, grasslands, shrublands, and lava flows. The largest threats to nēnē are habitat loss and degradation, hunting, and predation by non-native mammals. (Hawai'i's State Wildlife Action Plan, 2015)

The endangered ʻuaʻu, or Hawaiian petrel is one of two seabirds that are endemic to Hawaiʻi. Nesting colonies are known to occur in remote montane habitats, and ʻuaʻu 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 of ʻuaʻu within Kīpahulu Forest Reserve, there have been reports of adults flying over the reserve at night to higher elevation nesting sites.

Table 7. Rare and endangered animals observed within Kīpahulu FR. Observations are considered historical if they occurred more than 30 years ago. (HBMP 2008 and Starr 2018)

Species	Common name	Current / Historical	ESA
Branta sandvicensis	nēnē		Endangered
Lasirus cinereus semotus	ʻōpeʻapeʻa		Endangered
Palmeria dolei	ʻākohekohe	Historical	Endangered
Pseudonestor xanthophrys	kiwikiu	Historical	Endangered
Pterodroma sandwichensis	ʻuaʻu		Endangered

Table 8. Avian Wildlife found in Kīpahulu FR. (Scott et al. 1986; Starr 2018)

Species	Common name	Native Non-native	Game species	Injurious species[8]	Bird Survey year
Alectoris chukar	Chukar	Non-native	x		1976
Asio flammeus sandwichensis	pueo	Native			Likely present
Branta sandvicensis	nēnē	Native			1976
Cardinal cardinalis	northern cardinal	Non-native			2018
Chlorodrepanis virens wilsoni	Maui ʻamakihi	Native			2018
Garrulax canorus	Chinese hwamei	Non-native			2018
Haemorhous mexicanus	house finch	Non-native			2018
Himatione sanguinea	ʻapapane	Native			2018
Horornis diphone	Japanese bush warbler	Non-native		x	2018
Leiothrix lutea	red-billed leiothrix	Non-native			2018
Lonchura punctulata	scaly-breasted munia	Non-native			2018
Mimus polyglottos	Northern mockingbird	Non-native			2018
Palmeria dolei	ʻākohekohe	Native			1976
Paroreomyza montana	Maui ʻalauahio	Native			1976
Phaethon lepturus	white-tailed tropicbird	Native			2018
Phasianus colchicus	common "ring-necked" pheasant	Non-native	x		2018
Pseudonestor xanthophrys	kiwikiu	Native			1976

[8] Under Hawaii Administrative Rules 13-124-3 (c), no person shall, or attempt to, 1) Release injurious wildlife into the wild; 2) Transport them to islands or locations within the State where they are not already established and living in a wild state; and 3) Export any such species or the dead body or parts thereof, from the State.

Species	Common name	Native Non-native	Game species	Injurious species[8]	Bird Survey year
Pterodroma phaeopygia sandwichensis	ʻuaʻu	Native			likely present
Spilopelia chinensis	spotted dove	Non-native		x	1980
Vestiaria coccinea	ʻiʻiwi	Native			2018
Zosterops japonicus	Japanese white-eye	Non-native		x	2018

3.6.2 Native Invertebrates

While comprehensive invertebrates surveys have not been done for Kīpahulu FR, conspicuous insects, and arachnids were documented during the 2018 biosurvey (Table 9). Native yellow faced bees, (*Hylaeus* spp.) important pollinators for native plant species were once abundant across the Hawaiian Islands but are now mostly restricted to native dominant ecosystems. A group of *Hylaeus difficilis* were observed in open koa forest on the western side of the reserve. They gather nectar and pollen from a wide range of native plants including koa and ʻōhiʻa.

Figure 25. Kamehameha butterfly (left); koa butterfly (right)

There are two species of butterflies (*Figure 25*) that are native to Hawaiʻi and both were observed in Kīpahulu FR. The koa butterfly (*Udara blackburni*) is one inch long with blue on the upper side of its wings and iridescent green on the underside. The larvae are known to feed on koa and ʻaʻaliʻI leaves. They are locally abundant in the open koa forest on the western side of the reserve. The Kamehameha butterfly (*Vanessa tameamea*) is an orange and black butterfly with larvae that feed only on native nettles (Urticaceae) like māmaki (*Pipturus albidus*). Populations of this species appear to be declining as they are no longer found in some areas where they were once abundant. Kamehameha butterflies have been observed in a gulch in Kīpahulu FR, in the transition zone between the wet and mesic forest zones. There are very few sightings of this species from this part of east Maui.

Native damselflies (*Megalagrion* spp.) are brightly colored, predatory flying insects that are closely related to dragonflies but are smaller and more slender. Damselflies fold their wings on their backs when perched while dragonflies rest with their wings open. Males and females of most damselfly species usually have different color patterns, with the males usually being

brighter in color. Most have aquatic larvae (a few Hawaiian species are terrestrial) that live in streams and standing pools of water (Polhemus and Asquith, 1996). There are 23 species of native damselflies in Hawai‘i, three of which have been observed in Kīpahulu FR, *Megalagrion blackburni*, *Megalagrion calliphya* and *Megalagrion hawaiiense*.

Figure 26. M. blackburni adults are bright red and are the largest native damselfly (50-60mm in length) in Hawai‘i. Larvae of this species live in fast moving streams.

Figure 27. M. calliphya adults are 40-47mm in length and predominantly orange-red, with black markings.

Figure 28. M. hawaiiense adults are 39-48 mm in length and have a wide range of color variation. Larvae live in shallow pools of water on mossy rocks, on stream banks, and in acidic pools in bogs.

Native fancy-cased moths (*Hyposmocoma* spp.) are abundant over much of Kīpahulu FR and they live in a broad range of habitat types. With an estimated 400 endemic species, they account for one-third of the moth and butterfly diversity in Hawai‘i and are a great example of evolutionary radiation (Haines et al. 2014). Fancy-cased moth larvae observed in the reserve were found sheltered on larger stones, cliff faces, and under the bark of dead koa.

Figure 29. Native fancy-cased moth larvae (Hyposmocoma spp.) found in Kīpahulu FR

Native leaf roller moths (*Omiodes continuatalis*) were observed in the open koa forest on the western side of the reserve. Once thought to be extinct, this species was “rediscovered” on Hawai‘i island and Maui-Nui during biological surveys conducted in 2003 (Haines et al. 2004). They are locally abundant in certain locations which includes mid-elevation habitats of east Maui. Leaf roller moths bind plant material together with their silk to create a refuge that they shelter in while they feed. The larvae of *O. continuatalis* are known to feed on both native and non-native grasses which has likely contributed to its continued persistence.

Figure 30. Omiodes continuatalis (left); Mecaphesa sp. *(right)*

Other notable native insect species documented in Kīpahulu FR include ‘ōhi‘a psyllids or jumping plant lice (*Pariaconus* spp.). They form galls, or abnormal growths on ‘ōhi‘a leaves, stems, and flower buds. Native planthoppers (*Oliarus* spp.) are locally abundant in mesic and wet habitats. Planthopper nymphs feed on plant roots and rotting fern stems. Spiders are present in low numbers over the entire reserve. Notable are native Tetragnatha spiders, and native crab spiders (*Mecaphesa* sp.) that were camouflaged in ohia flowers, waiting to ambush their prey. Several species of native plant bugs in the family Miridae, some undescribed, were collected off vegetation in the reserve. They were identified as being from the genera *Koanoa*, *Opuna*, *Orthotylus*, and *Sarona*.

Table 9. Invertebrates found in Kahikinui FR (Starr 2018)

Species	Common name	Native/ Non-native
Aedes albopictus	Asian tiger mosquito	Non-native
Aedes japonicus	Asian bush mosquito	Non-native
Gasteracantha mammosa	Asian spiny backed spider	Non-native
Tetragnatha acuta	Hawaiian long-jawed spider	Endemic
Mecaphesa sp.	Crab spider	Endemic
Crytolaemus montrouzieri	Mealybug destroyer	Non-native
Halmus chalybeus	Steel blue ladybird beetle	Non-native
Adoretus sinicus	Chinese rose beetle	Non-native
Naupactus godmani	Fuller's rose weevil	Non-native
Drosophila sp.	Fruit fly	Non-native
Toxomerus marginatus	Hover fly	Non-native
Eutreta xanthochaeta	Lantana gall fly	Non-native
Procecidochares utilis	Maui pamakani stem galler	Non-native
Oliarus sp.	Plant hopper	Endemic
Nysius caledoniae	Caledonia seed bug	Non-native
Nabis capsiformis	Pale damsel bug	Non-native
Pariaconus sp.	ʻŌhiʻa flower bud gall psyllid	Endemic
Pariaconus sp. Nr. *Montgomeri*	ʻŌhiʻa leaf closed gall psyllid	Endemic
Teleonemia scrupulosa	Lantana lace bug	Non-native
Koanoa sp.	Koanoa	Endemic
Opuna sp.	Opuna	Endemic
Orthotylus kassandropsis		Endemic
Sarona sp.		Endemic
Apis mellifera	honey bee	Non-native
Hylaeus difficilis	Yellow faced bee	Endemic
Anoplolepis gracilipes	Long-legged ant	Non-native
Hylaeus nivicola	yellow-faced bee	Endemic
Cardiocondyla nr. *Kagutsuchi*	cardiocondyla ant	Non-native
Ochetellus glaber	black household ant	Non-native
Pheidole megacephala	big-headed ant	Non-native
Carposina sp.		Endemic
Hyposmocoma sp.	Fancy cased moths – burrito case	Endemic
Hyposmocoma sp.	Fancy cased moths – candy wrapper case	Endemic
Hyposmocoma sp.	Fancy cased moths – cigar case/carnivorous	Endemic
Hyposmocoma sp.	Fancy cased moths – flat purse case	Endemic
Herpetogramma licarsisalis	Grass webworm	Non-native
Mestolobes sp.		Endemic
Omiodes continuatalis	Hawaiian grass leafroller	Endemic
Spoladea recurvalis	Beet webworm	Non-native
Scotorythra paludicola	Koa moth	Endemic
Hylephilia phyleus	Fiery skipper	Non-native
Udara blackburni	koa butterfly	Endemic
Danaus plexippus	monarch butterfly	Non-native
Vanessa tameamea	Kamehameha butterfly	Endemic
Vanessa virginiensis	American lady butterfly	Non-native
Schreckensteinia festaliella	Rubus biocontrol	Non-native

3.6.3 Non-Native Wildlife

A wide variety of introduced birds exist across the island of Maui. Eleven non-native forest and game birds are known to occur in Kīpahulu FR and they are all listed in Table 8 above. Additional information for both non-native and native bird species including photographs and bird call recordings can be found on the Nā Ala Hele birding trails website (https://hawaiibirdingtrails.hawaii.gov/bird). Only Hawai'i Island trails are featured on this website, but the bird resource information covers many species that are found statewide.

Figure 31. Goats in Kīpahulu FR

There are a total of eight non-native mammals that have been documented in Kīpahulu FR and all are listed below in Table 10. There are populations of feral goats (*Capra hircus*), deer (*Axis axis*), and pigs (*Sus scrofa*) in the reserve. Goats and deer are most abundant in the drier areas makai of existing fence lines and pigs are more common on the wetter eastern portion of the reserve. Other mammals in the reserve include rats (*Rattus* spp.), mice (*Mus musculus*), cats (*Felis catus*), and mongoose (*Herpestes auropunctatus*).

Figure 32. Axis deer in Kīpahulu FR

Conspicuous non-native insects were also documented during the 2018 biosurvey and are listed in Table 9 above. Most notable are four species of non-native ants, the big-headed ant (*Pheidole megacephala*), long-legged and (*Anoplolepis gracilipes*), glaber ant (*Ochetellus glabra*) and *Cardiocondyla kagetsuchi*. All ants found in Hawai'i are introduced species and can have significant negative impacts on native arthropod biodiversity.

Table 10. Mammals found in Kīpahulu FR

Species	Common name	Native/Non-native	Game species
Axis axis	axis deer	Non-native	X
Capra hircus	goat	Non-native	X
Felis catus	cat	Non-native	
Herpestes auropunctatus	mongoose	Non-native	
Lasirus cinereus semotus	ʻōpeʻapeʻa	Native	
Mus musculus	house mouse	Non-native	
Rattus rattus	black rat	Non-native	
Rattus exulans	Polynesian rat	Non-native	
Sus scrofa	pig	Non-native	X

3.7 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 2017). The majority of Kīpahulu Forest Reserve (2,175 acres) has been designated as Critical Habitat. There are five units (Figure 33) that are defined by ecosystem type, Montane Wet, Montane Mesic, Montane Dry, Lowland Mesic, and Lowland Dry. Overlapping subsets of endangered species are assigned to each unit, and altogether they serve as critical habitat for a total of 57 plant species and two species of forest birds, the ʻākohekohe (*Palmeria dolei)* and the kiwikiu (*Pseudonestor xanthophrys*). See Table 11 for a list of these species and which critical habitat units have been designated for their conservation. Only a few of these species are currently known to occur in Kīpahulu FR.

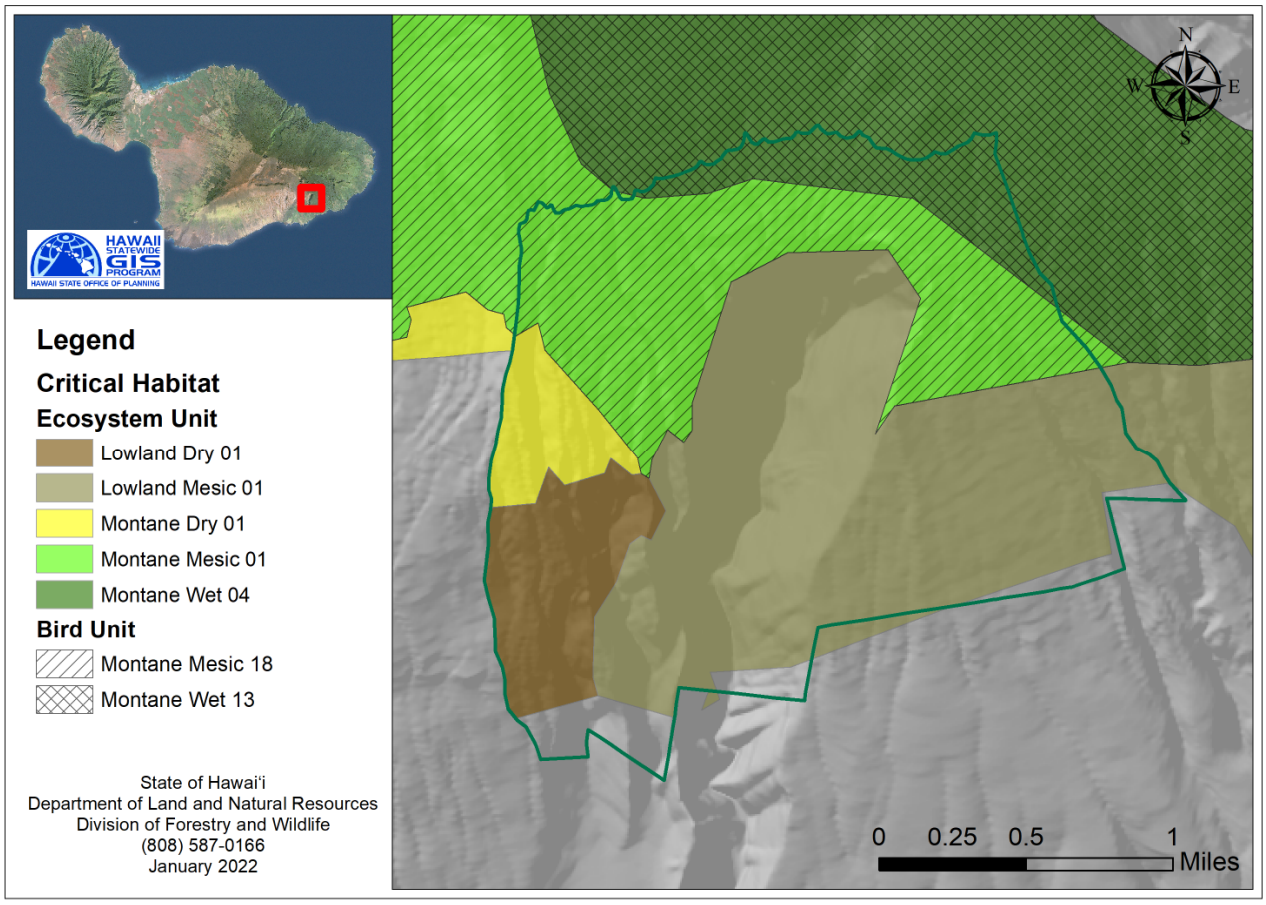
Table 11. Ecosystem Critical Habitat Designation in Kīpahulu FR (USFWS 2016)

Species	Critical Habitat Ecosystem Unit				
Plants	Montane Wet 04	Montane Mesic 01	Montane Dry 01	Lowland Mesic 01	Lowland Dry 01
Alectryon macrococcus		*x*	*x*		*x*
Argyroxiphium sandwicense ssp. *macrocephalum*		*x*			
Adenophorus perens	*x*				
Asplenium dielerectum		*x*			
Asplenium peruvianum var. *insulare*	*x*	*x*			
Bidens campylotheca ssp. P*entamera*	*x*	*x*			
Bidens campylotheca ssp. *waihoiensis*	*x*				
Bidens micrantha ssp. *kalealaha*		*x*			*x*
Bonamia menziesii					*x*
Canavalia pubescens					*x*
Cenchrus agrimonioides					*x*
Clermontia lindseyana		*x*			
Clermontia oblongifolia ssp. *mauiensis*	*x*				
Clermontia samuelii	*x*				

Species	Critical Habitat Ecosystem Unit				
Plants	Montane Wet 04	Montane Mesic 01	Montane Dry 01	Lowland Mesic 01	Lowland Dry 01
Colubrina oppositifolia					x
Ctenitis squamigera				x	x
Cyanea asplenifolia				x	
Cyanea copelandii spp. *haleakalaensis*	x			x	
Cyanea duvalliiorium	x				
Cyanea glabra	x	x			
Cyanea hamatiflora ssp. *hamatiflora*	x	x			
Cyanea horrida	x	x			
Cyanea kunthiana	x	x			
Cyanea maritae	x				
Cyanea mceldowneyi	x	x			
Cyanea obtusa		x			
Cyrtandra ferripilosa	x	x			
Cyrtandra oxybapha		x			
Diplazium molokaiense	x	x			
Flueggea neowawraea					x
Geranium arboreum		x	x		
Geranium hanaense	x				
Geranium multiflorum	x	x			
Hibiscus brackenridgei					x
Melicope adscendens		x			x
Melicope balloui	x				
Melicope knudsenii			x		
Melicope mucronulata			x		x
Melicope ovalis	x				
Neraudia sericea		x			x
Nototrichium humile					x
Peperomia subpetiolata	x				
Phlegmariurus mannii	x	x		x	
Phyllostegia bracteata	x	x			
Phyllostegia haliakalae	x				
Phyllostegia mannii	x	x			
Phyllostegia pilosa	x				
Platanthera holochila	x				
Santalum haleakalae var. *lanaiense*		x	x		x
Schiedea haleakalensis					
Schiedea jacobii	x				
Sesbania tomentosa					x
Solanum incompletum				x	x

Species	Critical Habitat Ecosystem Unit				
Plants	Montane Wet 04	Montane Mesic 01	Montane Dry 01	Lowland Mesic 01	Lowland Dry 01
Spermolepis hawaiiensis					*x*
Wikstroemia villosa	*x*	*x*			
Wollastonia kamolensis					*x*
Zanthoxylum hawaiiense		*x*	*x*		*x*
Birds	Montane Wet 13	Montane Mesic 18	N/A	N/A	N/A
Palmeria dolei	*x*	*x*			
Pseudonestor xanthophrys	*x*	*x*			

Figure 33. Critical Habitat in Kahikinui Forest Reserve (FR) Also see Table 11 (USFWS 2016)



3.8 Archaeological and Historical Sites

There are no documented archaeological sites in Kīpahulu FR. In the event that 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 identified during any management activities, work will cease immediately in the area of the discovery. The cultural feature will be protected from further disturbance, and the State Historic Preservation Division (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 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.

3.9 Access

Kīpahulu FR is landlocked and there is no legal public access through the adjacent private, federal, and state lands. There are no improved public trails in the reserve and no vehicular access. Helicopters are used to access the reserve for management activities. The closest trail is Kaupō Trail which is a state-owned historic trail that runs through private land, parallel to the western boundary of the reserve.

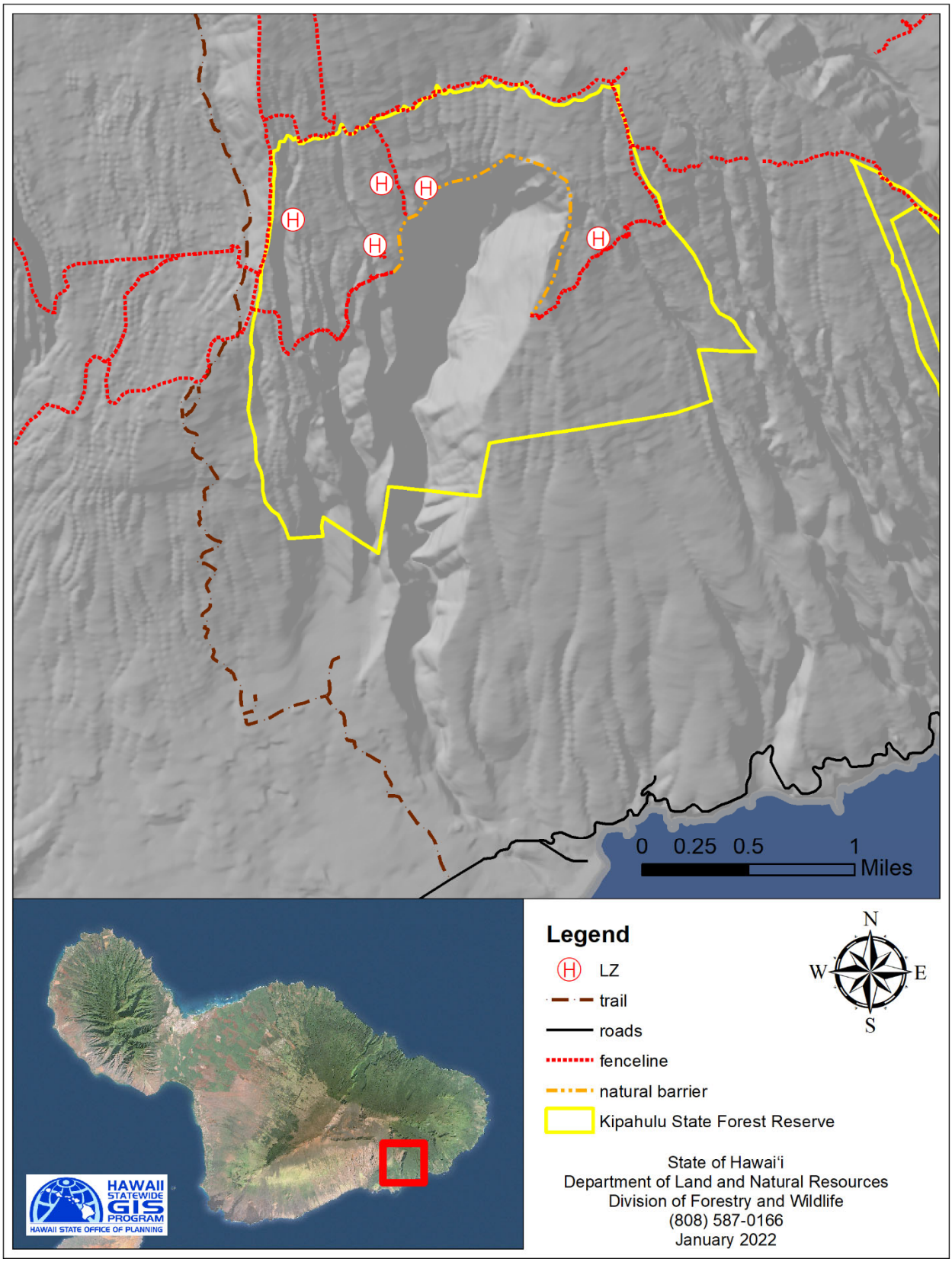
3.10 Infrastructure

Infrastructure in Kīpahulu FR (Figure 34) is minimal and was installed for watershed protection and to support management activities. This includes 6 miles of 8-foot-high ungulate proof fence with fence apron constructed along the reserve boundary to keep out feral cattle, pigs, goats, and axis deer. There is an additional 2,583 feet of fenceline that was constructed to divide the larger exclosure into distinct units. They were built to prevent ungulates from traversing between the Healani (drier open unit) and Ahulili unit (wetter, closed canopy) separating the two vegetatively distinct units. All together these fences are protecting the mauka section of the reserve, approximately 700 acres. There are also five helicopter landing zones that are used to transport staff and materials needed for forest management.

3.11 Public Use Opportunities

Current public use opportunity in Kīpahulu FR is very limited due to its remoteness. There are no public camping grounds or cabins and no improved hiking trails. Horseback riding, off-road vehicles, and bicycles are not allowed. Regulations are in place to allow for public hunting and forest product collection, as described below. However, these uses are impacted by the lack of a legal public access route.

Figure 34. Infrastructure and Access to Kīpahulu State Forest Reserve (FR)



3.11.1 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, Hawai'i Administrative Rules (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. Kīpahulu FR is part of hunting unit A. To obtain a copy of current hunting rules and regulations visit, https://dlnr.hawaii.gov/dofaw/rules/.

Game mammals found in the reserve are feral pigs (*Sus scrofa*), goats (*Capra hirca*), and axis deer (*Axis axis*). Population numbers are low in areas that are fenced and other ungulate control actions are occurring. Game bird hunting is not allowed in Kīpahulu FR.

3.11.2 Forest Product Collection

Non-timber forest products may be gathered from the Forest Reserve System. Examples of items that can be collected include, but are not limited to ferns, flowers, fruits, and greenery. 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-native, non-listed native 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.

https://dlnr.hawaii.gov/forestry/files/2013/09/2018-12-11_DLNR_Forest-Products-Price-List.pdf

Collection of listed threatened, endangered, or other rare species, common invertebrate species, or 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, Hawai'i 96813
Phone (808) 587-0166

Maui District Manager
Division of Forestry and Wildlife
685 Haleakalā Hwy
Kahului, Hawai'i 96732
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. For more information on how to apply for permits for the Forest Reserve System visit the DOFAW permitting webpage:

https://dlnr.hawaii.gov/dofaw/permits/

3.12 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."

As described in section 3.8 of this plan, there are no documented archaeological sites in Kīpahulu Forest Reserve. There is no evidence of habitation or agricultural activities by early Hawaiian in the high elevation forest. However, the upland forests were an important place for cultural and religious activities and was also a source of natural resources for subsistence, ceremony, and for the making of implements of varied purposes. Forest resources that were gathered, likely included but is not limited to, construction materials, foliage, natural fibers, dyes, medicinal plants, and feathers from native forest birds. The management activities outlined in this plan are not expected to impact or diminish these protected traditional and customary rights. However, the collection of listed threatened, endangered, or other rare species, common invertebrate species, or any migratory bird species, are prohibited under state laws Chapter 183D and 195D, HRS, and subject to regulation under applicable HAR. See section 3.11.2 for more information.

Anyone seeking to engage in an activity or collect any forest product from a State Forest Reserve that is normally prohibited by the forest reserve rules, Chapter 13-104, HAR, but are engaging in traditional and customary native Hawaiian cultural activities that are defined in, and protected pursuant to sections 1-1, 7-1, HRS; article XII, section 7 of the Hawai'i State Constitution; and rulings of Hawai'i case law, can apply for a permit. The Hawaiian traditional and customary practices permit application is available on the DOFAW Permits & Guideline webpage (https://dlnr.hawaii.gov/dofaw/permits/) under the State Forest Reserve Section. Completed applications should be submitted to the Branch office that services the district that the forest reserve is located in.

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
685 Haleakalā Hwy
Kahului, Hawai'i 96732
Phone (808) 984-8100

3.13 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 salvage of dead or down timber can be issued for Kīpahulu FR. However, its remote location and lack of vehicular access make it a less desirable location for this activity. 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. The raw material value of any commercial salvage permit issued for Kīpahulu FR cannot exceed $10,000.

DOFAW is exploring options for new revenue streams, including those associated with ecosystem services to supplement funding of natural resource management activities of forests and other natural areas under its jurisdiction. Carbon sequestration, the capture and long-term storage of atmospheric carbon dioxide to mitigate for global climate change, is an ecosystem service for which a market for both compliance and voluntary carbon offsets, already exists.

4. THREATS

4.1 Invasive Plants

Invasive plants are non-native species that can invade natural areas, grow and reproduce rapidly, reduce native biodiversity and alter ecosystem functions. Invasive plant species that are present in Kīpahulu FR that have the potential to disrupt the ecosystem are listed below in Table 12. For a brief description of each species, their statewide distribution and impacts see Appendix D.

Figure 35. Aerial view of strawberry guava (Psidium cattleleianum) in Kīpahulu FR

Based on potential impacts, distribution in the FR, and available control methods, DOFAW has set a management objective for each species, control, containment, eradication or early detection rapid response.

Invasive plant management objectives:

- Control – Reduce populations and/or the vigor of individuals.
- Containment – Stops or minimizes population growth and geographic spread.
- Eradicate – Elimination of populations within a geographic area.
- EDRR (Early detection rapid response) – Species that are not established in the area but are a serious threat to watershed function and/or native ecosystems. Early detection, rapid assessment and response are a critical defense against the establishment of new invasive species.

Some non-native plant 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 likely 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.

Figure 36. Fireweed and molasses grass habitat in Kīpahulu FR

Table 12. Invasive plants species that occur in Kīpahulu FR

Species	Common name	DOFAW Objective	Regulatory Status
Bocconia frutescens	tree poppy	EDRR	Hawai'i Noxious Weed List
Grevillea robusta	Silky oak	Control	None
Hedychium gardnerianum	Himalayan (kāhili) ginger	Control	None
Lantana camara	Lantana	Control	None
Melinis minutiflora	Molasses grass	Containment	None
Miconia calvescens	miconia	EDRR	Hawai'i Noxious Weed List
Miconia crenata	Koster's curse	Containment	Hawai'i Noxious Weed List
Psidium cattleyanum	Strawberry guava, waiawī	Containment	None
Rubus argutus	Florida blackberry	Control	None
Senecio madagascariensis	fireweed	Containment	Hawai'i Noxious Weed List
Schinus terebinthifolius	Christmas berry	Control	None
Spathodea campanulata	African tulip tree	EDRR	None
Sphaeropteris cooperi	Australian tree fern	Containment	None
Tibouchina herbacea	Cane tibouchina	Containment	Hawai'i Noxious Weed List

4.2 Invasive Animals

The Division of Forestry and Wildlife has a dual mandate to, 1) Conserve, manage and protect native and endangered species and their ecosystems, and 2) Preserve, protect and promote public hunting. The hunting program in Hawai'i is based entirely on non-native animal species. Introduced game mammals such as goats (*Capra hircus*), axis deer (*Axis axis*), and pigs (*Sus scrofa*) contribute to the degradation of native ecosystems and watershed health. Impacts of introduced game mammals and other introduced animal species vary across landscapes, dependent on ecosystem type, what animal species are present, their population levels, and the type and intensity of any control measures being used. For a list of animal species present in Kīpahulu FR and their potential environmental impacts see (Table 13).

To minimize native ecosystem impacts by ungulates in Kīpahulu FR fencelines were built to protect the upper 700 acres, encompassing the native wet forest and areas targeted for forest restoration. The management goal for all ungulate species inside the fence is eradication. The lower 1,400 acres of Kīpahulu FR are dominated by non-native dry forest and grassland. This area will remain open for game mammal hunting for the time being. Most concerning is the level of soil erosion in areas being overgrazed by goats. Goat populations are not being controlled to a sustainable level likely due to the lack of easy public access.

Table 13: Animal species that occur in Kīpahulu FR and their potential impacts

Species	Common Name	Potential impacts
Axis axis	axis deer	Vegetation damage and death from browsing and bark stripping.

Species	Common Name	Potential impacts
Capra hircus	feral goats	Goats have had the most destructive impact on native vegetation on the south slope of Haleakalā as a whole. Goats limit the reproduction of most native species, resulting in deforestation and watershed degredation.
Culex spp.	mosquitos	Vectors for diseases that are a threat to public safety and native wildlife (especially *Culex quinquefasciatus*).
Felis catus	feral cats	Predators of native and game birds and are vectors of toxoplasmosis, a zoonotic disease
Herpestes auropunctatus	mongoose	Predators of native and game birds.
Rattus spp.	Rats/mice	Predators of native plant fruits/seeds and native and game birds.
Sus scrofa	feral pigs	Disturb vegetative ground cover by browsing, trampling, rooting and wallowing. In extreme cases this can negatively impact groundwater recharge. They facilitate the invasion and establishment of weedy plant species and create breeding habitat for mosquitos that are vectors for human and avian diseases.

DOFAW has set a management objective for each animal species inside and outside of the fenced unit (Table 14), based on potential impacts, distribution in the FR, and available control methods.

Animal management objectives:

- Game species – Manage population levels to stay within carrying capacity.
- Control – Reduce populations and/or the vigor of individuals.
- Eradicate – Elimination of populations within a geographic area.

Table 14. DOFAW management objectives for animal species in Kīpahulu FR

Species	Common name	DOFAW Management Objective	
		Inside Fenced Unit	Outside Fenced Unit
Axis axis	axis deer	Eradicate	Game species
Capra hircus	goats	Eradicate	Game species
Culex spp.	mosquitoes	Control	Control
Felis catus	feral cats	Eradicate	Control
Herpestes auropunctatus	mongoose	Control	Control
Mus musculus	mouse	Control	Control
Rattus spp.	rats	Control	Control
Sus scrofa	feral pigs	Eradicate	Game species

4.3 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 (State of Hawai‘i 2016).

Koa wilt is a soil borne disease that causes dieback and decline of koa primarily in lowland plantation stands on former agricultural land. It is a vascular disease that affects the xylem tissue and water transport capabilities of koa trees and can eventually lead to tree mortality. The first sign of infection is usually a yellowing or wilting of leaves on a single branch or part of the tree’s canopy. If an infected branch is cut, there are usually dark stains in the sapwood. The disease is caused by the soil borne fungal pathogen *Fusarium oxysporum* f. sp. *koae* that invades susceptible plants through the root system. This disease can severely impact koa reforestation at most low to mid-elevation locations (sea level to approximately 1,000m elevation) with mortality rates commonly exceeding 75% (Dudley et. al 2017).

Koa wilt has not been observed in Kīpahulu FR and it is likely the high elevation and cool ambient soil temperatures are not optimal for the growth of the fungal pathogen. Nonetheless, with climate change and the potential for increasing soil temperatures, koa trees in the reserve should be monitored for signs of disease.

Myrtle rust (*Austropuccinia psidii*) is another non-native plant pathogen that was detected in Hawai‘i in 2005. Rust species are usually host specific, but myrtle rust has a broad host range within the plant family Myrtaceae. This fungal disease causes bright yellow powdery circular eruptions on leaf and stem surfaces. They expand and become necrotic, spreading over the entire surface and can lead to leaf and stem deformities and die back of growing tips and could eventually lead to tree death.

An outbreak of myrtle rust decimated stands of rose apple (*Syzygium jambos*) across the state and it has severely impacted the endangered plant species nīoi (*Eugenia koolauensis*). ‘Ōhi‘a, a major forest canopy species in Hawai‘i is also a Myrtaceae but was largely unaffected and seems to be only a minor host (Burnett et. al 2012). Signs of myrtle rust have been observed on ‘ōhi‘a trees in the reserve, but only slight damage to leaves was observed. The characteristic yellow fungal spore masses were not observed.

Figure 37. Strawberry guava dieback below Kīpahulu FR

Also of concern is a large landscape scale dieback of strawberry guava just below the boundary of the forest reserve, between Niniao Pali and Kalepa Gulch. A scale insect *Tectococcus ovatus* has been released in Hawai‘i as a biocontrol agent for strawberry guava, but it has already been determined that it is not the cause of this dieback. Based on the appearance it looks like it may be the result of a spreading plant pathogen. In December 2021, Dr. Mark Hughes along with DOFAW staff collected samples at three locations including the site below Kīpahulu FR to try and determine the exact cause of the dieback. According to his preliminary assessment, trees are suffering from two maladies, 1) insect girdling near stem crotches, and 2) Stem canker/necrosis on smaller diameter stems. It is currently difficult to determine which is the primary or secondary agent. Damage appears to be localized and not systemic.

Figure 38. Yellow ‘ōhi‘a lehua in Kīpahulu FR

The largest epidemic threatening the forests of Hawai‘i is rapid ‘ōhi‘a death (ROD). ROD has been found on Hawai‘i Island, Kaua‘i, Maui and O‘ahu and is caused by two pathogenic fungi, *Ceratocystis lukuohia* and *Ceratocystis huliohia*. The highly aggressive *C. lukuohia* has been detected on Hawai‘i Island and Kaua‘i and the less aggressive *C. huliohia* has been found on all four islands. Hundreds of thousands of ‘ōhi‘a trees have been killed by this disease and over 135,000 acres of ‘ōhi‘a forest have been affected.

Through various ROD surveys and monitoring efforts, managers have recognized a few strong patterns of disease occurrence on the landscape. Storm and wind events that wound ʻōhiʻa trees can lead to infection by the fungus. Typically, after a storm event there is a spike in tree mortality, followed by a decreased but continuing mortality. Trees with crowns emerging from the canopy or on the edge of a forest have been anecdotally seen to be more prone to ROD.

Ambrosia beetles which bore into ʻōhiʻa trees are responsible for releasing frass that contains fungal spores into the environment. Entomologists have conducted controlled studies demonstrating that beetles can carry the fungus on their bodies and directly infect living ʻōhiʻa seedlings (Cannon et al. 2022). However, beetles normally attack dead and dying trees, and scientists do not think that beetles serve as the main disease vector.

Another pattern that has been more recently observed is the higher incidence of *C. lukuohia* detections in areas where hoofed animals are present, compared to adjacent areas where animals have been removed (Peroy et al. 2021). In one area that was previously ungulate-free, managers saw a sharp uptick in both symptomatic trees and positive detections for *C. lukuohia* when fences were damaged allowing animal ingress. The mechanisms are not fully understood, but it is thought that by wounding trees, animals might cause tree infection if spores are present. It is also possible that animals are moving spores of the fungus contained in soil, and research on animals directly spreading ROD are underway.

The relationship to feral animals offers potential management tools for preventing wounding and possible spread of the disease by removing animals from the landscape. It is not currently clear which animals are responsible, but the pattern has been seen in forests with high populations of cattle and pigs, the former which strip bark from ʻōhiʻa trees and the latter which damage roots when digging for food. To protect important ʻōhiʻa stands and forests, managers can utilize ungulate management (exclusion fences, hunting, or animal removal) to reduce the incidence of ROD. This may be the most effective tool we have for managing ROD, but this only removes one potential vector and cannot prevent storm damage that leads to wounds and ROD. Areas that are animal free are still likely to have ROD show up, but the rate of infection over time is likely to be reduced.

Aerial surveys for ROD are being done statewide and they initially were done semi-annually on Maui starting in 2016. Field staff collect samples from accessible symptomatic trees spotted during surveys. Samples are sent to a lab to confirm the presence of *Ceratocystis*. In July 2019, *C. huliohia* was detected on Maui in a single tree located 53 miles east of Wailuku. Response was quick and the tree was destroyed. Aerial surveys for east Maui and leeward Haleakalā are now being done quarterly and thus far there haven't been any new detections of ROD on the island. For more information on what can be done to help prevent the spread of ROD, visit http://www.rapidohiadeath.org.

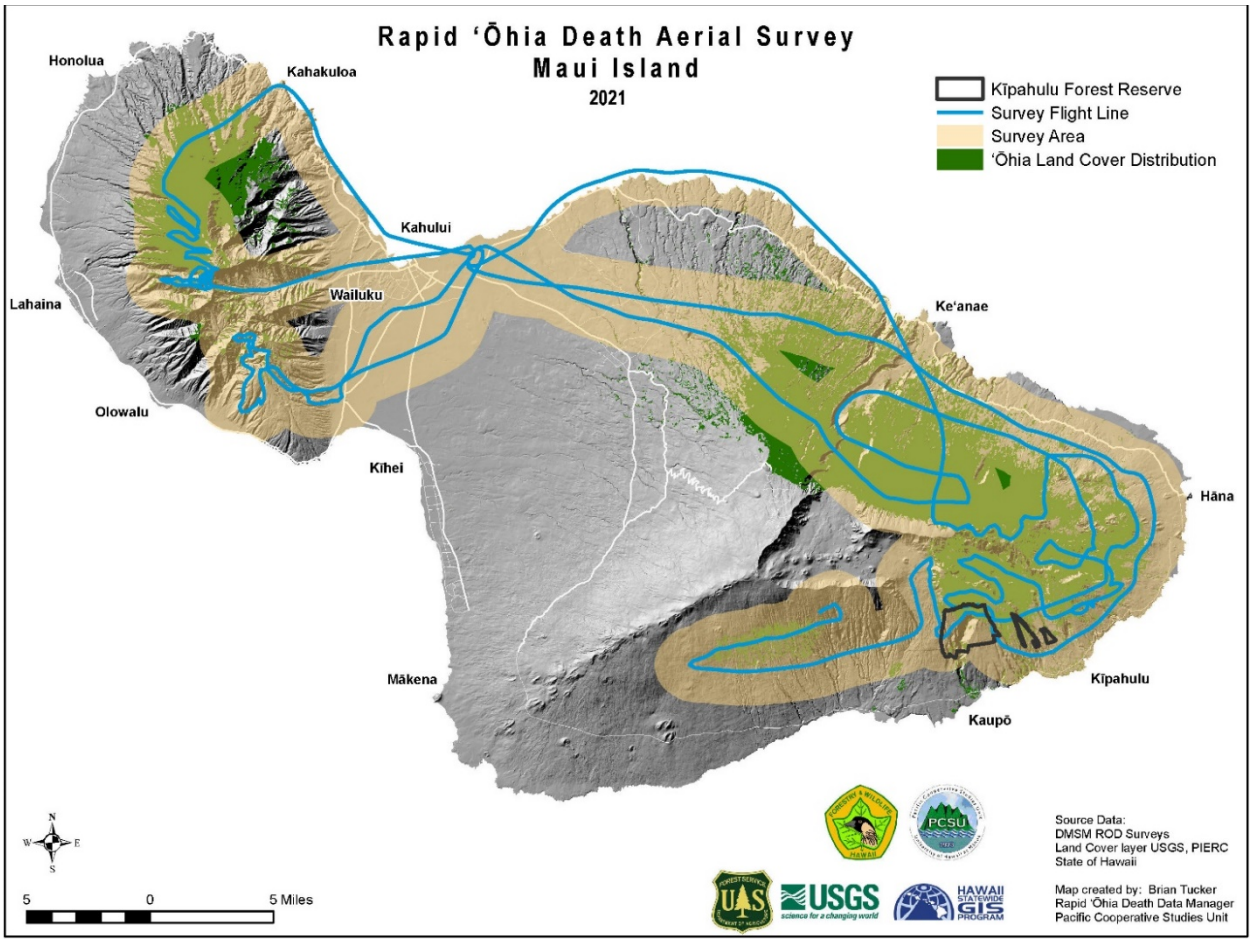


Figure 39. Maui Rapid ʻŌhiʻa Death Aerial Surveys

Based on potential impacts, distribution in the FR, and available control methods, DOFAW has set a management objective for insects and diseases (Table *15*) that are of concern:

- Control – Reduce populations and/or the vigor of individuals.
- Containment – Stops or minimizes population growth and geographic spread.
- Eradicate – Elimination of populations within a geographic area.
- EDRR (Early detection rapid response) – Species that are not established in the area but are a serious threat to watershed function and/or native ecosystems. Early detection, rapid assessment and response are a critical defense against the establishment of new species.

Table 15. DOFAW management objectives for insects and disease in Kīpahulu FR

Species	Common Name	DOFAW Objective
Austropuccinia psidii	myrtle rust	Control
Ceratocystis huliohia; Ceratocystis lukuohia	rapid ʻōhiʻa death	EDRR
Fusarium oxysporum f.sp *koae*	koa wilt	EDRR
unknown	strawberry guava dieback	EDRR

Figure 40. ʻŌhiʻa killed by ROD in lower Puna on the island of Hawaiʻi

4.4 Fire

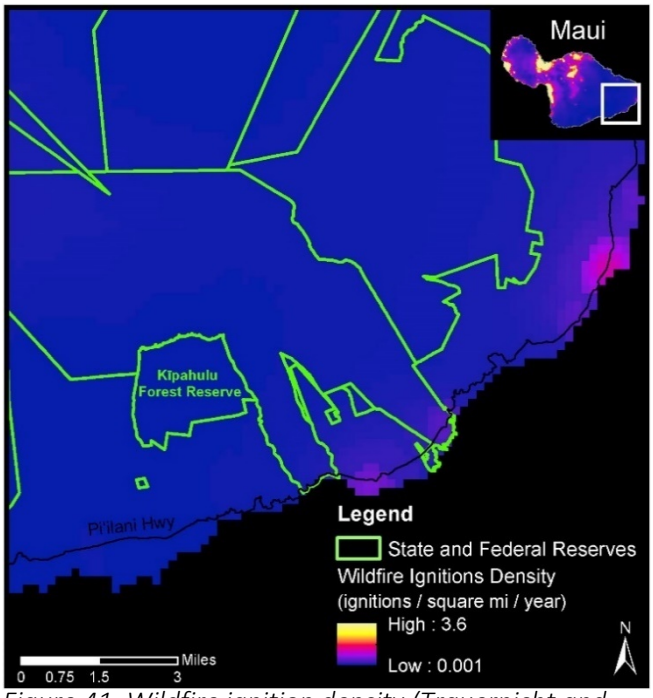


Figure 41. Wildfire ignition density (Trauernicht and Lucas 2016)

Wildfires are a serious threat to human safety and property, and they impact native ecosystems, watersheds and near shore coastal environments statewide. Native terrestrial ecosystems are not adapted to wildfire and are often replaced by fire adapted, non-native species of grasses and shrubs. Approximately 25% of the total land mass in Hawaiʻi (Trauernicht 2014) are now covered by these fire-prone fuels. This combined with an increase in human caused ignition has resulted in a fourfold increase in area burned by wildfires in Hawaiʻi annually (Trauernicht and Pickett 2016).

The risk of wildfire ignition within Kīpahulu FR is relatively low due to its remote location and difficulty of access (Figure 41). There are no recorded wildfires in Kīpahulu FR, but the threat of wildfire is still present. Ignition density is low, but brush fires have occurred along Piʻilani Hwy less than three miles from the reserve. The slopes below the forest reserve are covered with flammable grasses and shrubs. Prevailing winds make it unlikely that wildfire would travel upslope to the forest reserve, but it is still possible under certain weather conditions. Wildfire risk in the reserve is also increasing as ungulate population are reduced. Staff observed a significant increase in molasses grass biomass

after being released from grazing pressure, and thick mats of this species would easily burn if ignited.

Figure 42. Molasses grass on a ridgetop in Kīpahulu FR.

4.5 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 elevations), 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, an increase in extreme weather events, flooding and erosion, an increase in non-native biological invasions, an increase in frequency and size of wildfires, and an increased risk of species extinction (Keener et al. 2012).

The primary mitigation for climate change is reduction in emissions and enhancement of carbon sinks. Maintaining and 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. To achieve energy self-sufficiency utilizing 100% renewable sources by 2045. In 2018, the State of Hawai‘i took this commitment further by pledging to achieve carbon neutrality, also by 2045.

Forest ecosystems in Hawai‘i will face new climatic conditions associated with climate change. Individual species and ecosystem types may be more vulnerable to climate change if they are not able to adapt or migrate to suitable habitats. Researchers have started climate vulnerability assessment for Hawai‘i species, but additional information is needed at local scales to determine impacts within individual watersheds and forest reserves.

In 2018, the Pacific Island Climate Change Cooperative (PICCC) and EcoAdapt completed the Hawaiian Islands Climate Vulnerability and Adaptation Synthesis (Figure 43). Through literature reviews, expert elicitation, vulnerability mapping, and workshops with resource managers and conservation planners, the synthesis provides information to improve understanding of climate change impacts, increase capacity to reduce impacts, and facilitate decision-making by land managers (Gregg 2018).

The climate synthesis contains summaries of adaptation strategies and actions for habitat types and ecosystem services. Summaries that are relevant for Kīpahulu FR (dry forest, mesic and wet forests, cultural knowledge and values, flood and erosion control, fresh water and food and fiber). To anticipate and mitigate climate change impacts, all strategies and action items were reviewed and if applicable, incorporated into management objectives for the reserve.

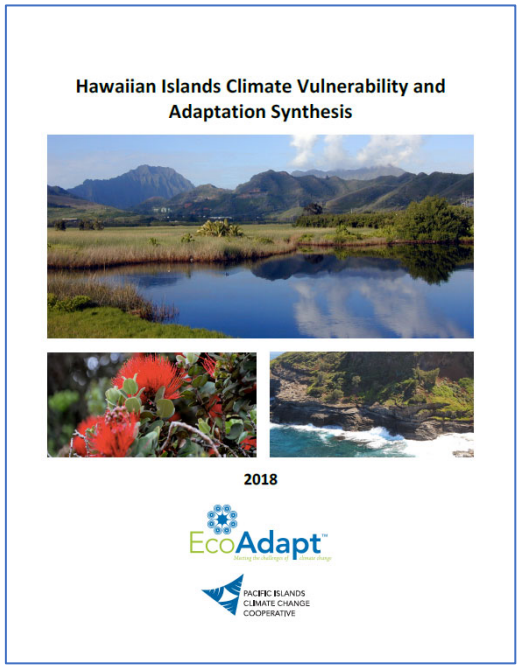


Figure 43. Hawai'i climate synthesis: http://piccc.net/project/climate-synthesis-supporting-the-hitai/

5. MANAGEMENT

5.1 Past Planning

This is the first management plan that the Division of Forestry has completed for Kīpahulu State Forest Reserve. It has never been included in any of the landscape watershed planning processes, but it has been included in other state action plans.

Related Plans: Plans that contain relevant information on the resources and management strategies pertinent to the management of Kīpahulu FR are listed below.

- Hawai'i's State Wildlife Action Plan
- State of Hawai'i Forest Action Plan
- DOFAW Draft Management Guidelines
- Kahikinui State Forest Reserve Management Plan
- Nakula Natural Area Reserve Management Plan
- Maui Invasive Species Committee Strategic Plan
- USFWS Endangered Species Recovery Plans

5.2 Summary of Management Activities

5.2.1 Early Management

Early management of Kīpahulu FR centered on fencing and removal of cattle from the reserve. In the early 1930s, ʻUlupalakua Ranch built a fence in Alaenui at about 1,200 feet contour to keep cattle out of the valley. Correspondence in forestry records document that cattle from the ranch were still grazing on the government lands west of Alaenui. The Territory allocated funds to buy materials to build additional fences in cooperation with the ranch to protect the forest on government land in Kīpahulu FR. Confirmation that these additional fence lines were built was not found.

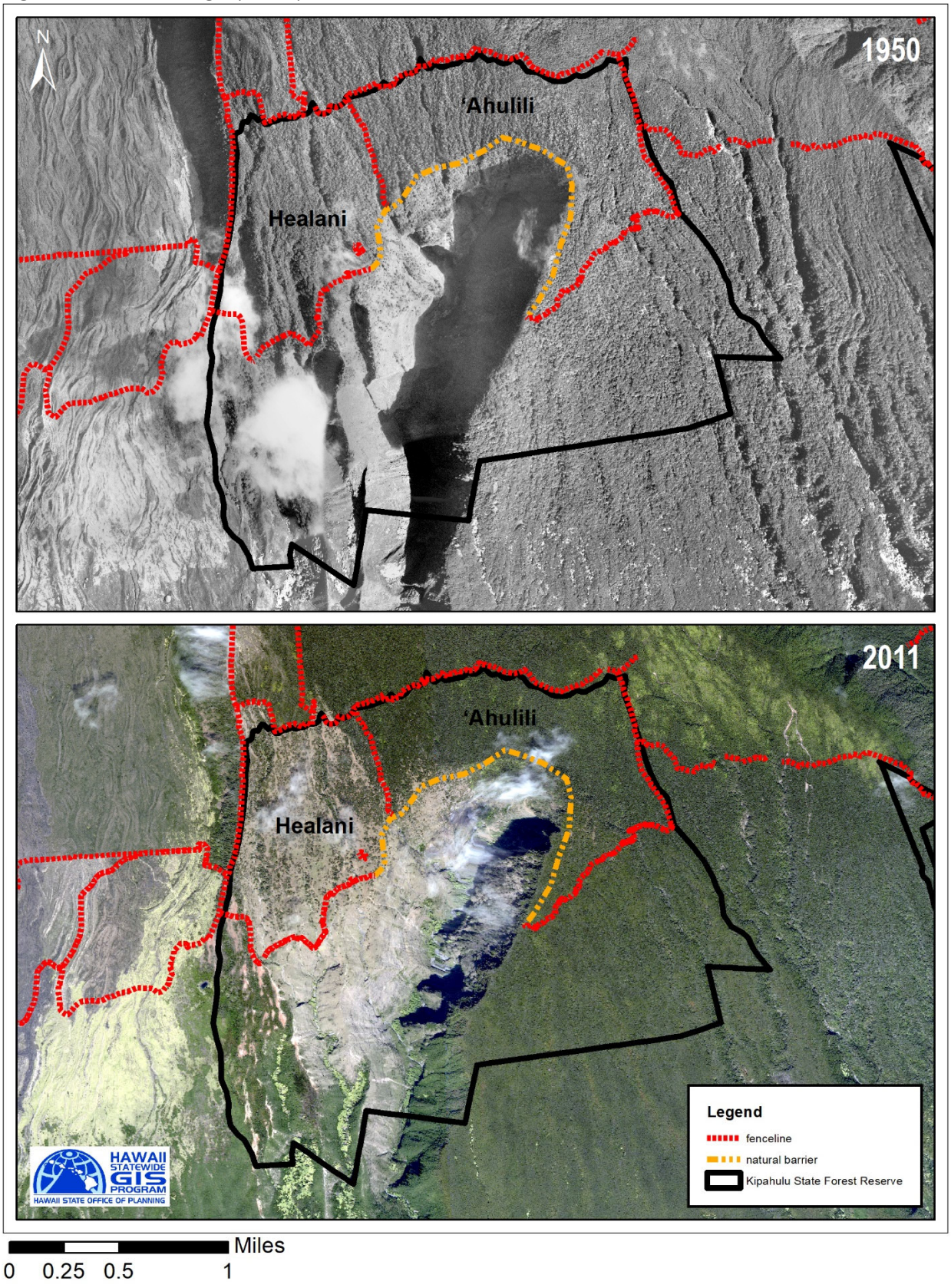
The Healani unit of Kīpahulu FR was once covered by native koa (*Acacia koa*) and ʻōhiʻa (*Metrosideros polymorpha*) montane mesic and wet forest. Despite early efforts, decades of uncontrolled grazing by animals (ungulates) have severely impacted native ecosystems. They have largely been eliminated across much of the western portion of the remaining government lands in the forest reserve. It has been replaced by fire adapted, invasive, non-native grasses and shrubs. Comparison of aerial imagery from 1950 and 2011 show the severity of the deforestation (Figure 44). The eastern portion of the reserve is still densely vegetated, but below 4,800 feet in elevation, it is dominated by a near monotypic stand of the highly invasive strawberry guava (*Psidium cattleyanum*), which may have significant negative impacts on groundwater recharge (Takashi et al. 2011).

In 2003, the Leeward Haleakalā Watershed Restoration Partnership (LHWRP) was formed, invigorating reforestation efforts on the south facing slopes of Haleakalā. The overarching goal of the partnership is to restore the “mauna lei”, the band of forest that once encompassed Haleakalā. Reforestation at Kīpahulu is one of several projects that are occurring across the landscape. The Division of Forestry and Wildlife and its partners are expanding the native forest, restoring critical watershed function as well as contributing to other important ecosystem services. Reforestation can increase groundwater recharge as well as enhance carbon sequestration, oxygen production, reduce erosion and associated downstream impacts, re-establish endangered species habitat, mitigate wildfire threats by removing fire adapted invasive plants, as well as enhancing many other natural and cultural resources.

To protect and restore the mauka forest, 6 miles of watershed fencing has already been installed around Kīpahulu FR by DOFAW and partners. The fences do not completely enclose the mauka section of the reserve as there is a gap along the steep cliffs of Manawainui Valley which functions as a natural barrier for most ungulates. The fences and natural barriers protect 712 acres of the reserve, and one of the middle fences runs roughly along the transition between mesic and wet forest splits the area into two units, the Healani unit (326 acres) and the ʻAhulili unit (386 acres).

Fence lines in Kīpahulu FR are inspected at least twice a year and after every major storm. Fence integrity has been difficult to maintain due to storm damage and erosion. There was also significant damage caused by vandalism in 2019. Someone illegally cut and removed the bottom four feet of the fence for a 150-foot section. Fence repairs have also been difficult to complete

Figure 44. Aerial imagery of Kīpahulu FR from 1950 and 2011



due to COVID-19 protocols and a severe reduction in operating funds due to the economic impacts of the pandemic. As a result, ungulate numbers inside the fence have increased over the last two years. With the pandemic restrictions easing and the funding situation improving, the Division has been able to increase fence maintenance and ungulate control operations back to pre-pandemic levels.

5.2.2 Healani Unit

The Healani unit as mentioned above has largely been deforested by browsing ungulates. With fence lines in place, the primary method being used to remove ungulates from inside the Healani unit is ACETA (aerial capture, eradication and tagging of animals). All ACETA operations were conducted in accordance with an approved aerial shooting/ungulate control plan (State of Hawai'i 2017). Since 2017, over 975 animals were removed from the unit and native plant species (canopy and understory) have already started to naturally regenerate from the soil seed bank.

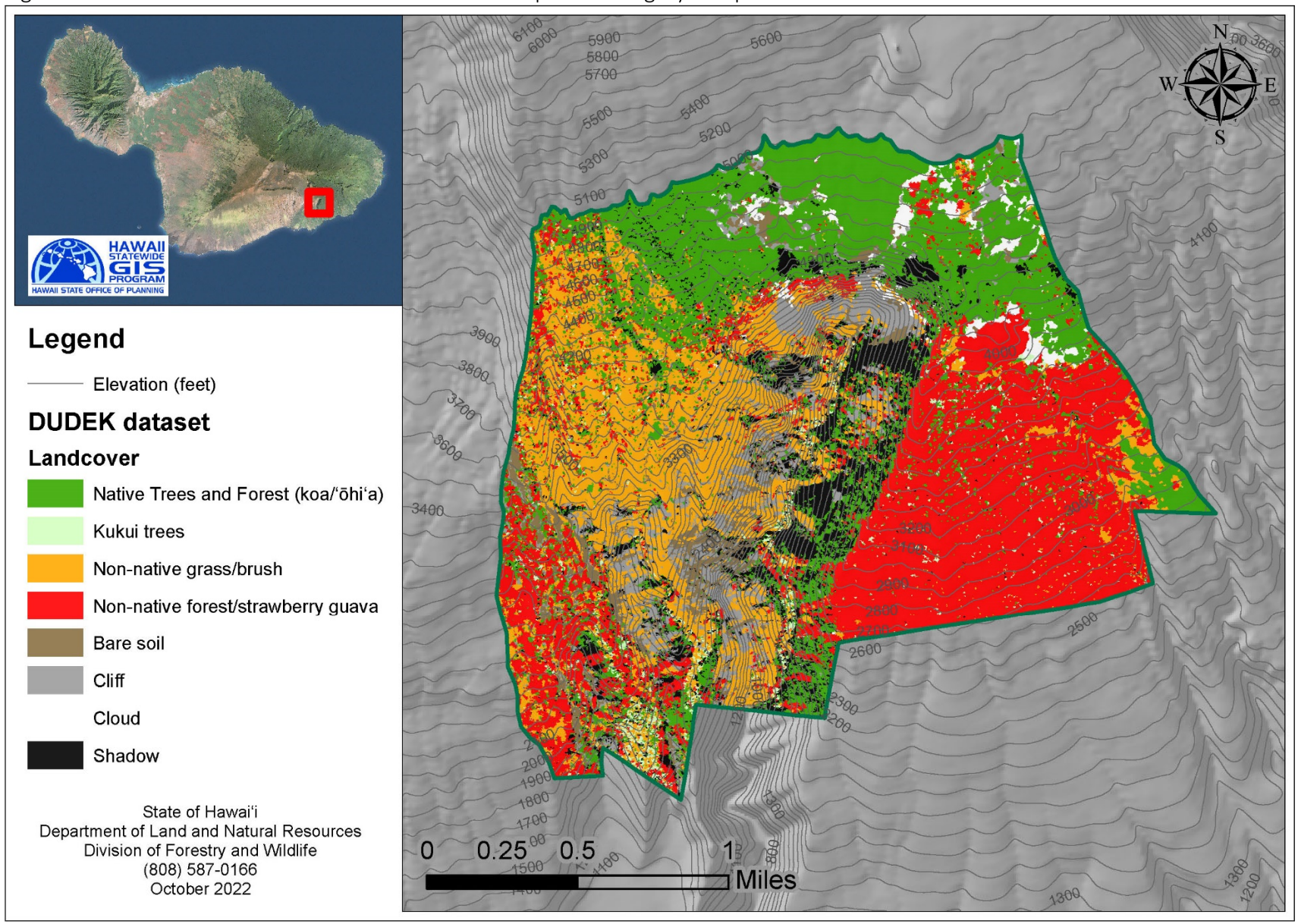
With keystone native species like koa naturally regenerating, in lieu of large-scale native species outplanting DOFAW has decided to do strategic supplemental planting to augment biodiversity. Common native trees and shrubs that are known to naturally occur in the reserve will be outplanted in areas as needed. The goal of increasing biodiversity in the forest is to restore natural levels of native species diversity and abundance to provide a more resilient multi-level forest system, which studies show captures water more efficiently, promotes more rapid deep movement of water, and increases the amount of soil water available for aquifer recharge (Perkins et al. 2014).

Some of the native species that will be outplanted in the unit are 'ākia (*Wikstroemia* spp.), 'ūlei (*Osteomeles anthyllidifolia*), pāpala kēpau (*Ceodes*/*Rockia* spp.) and pilo (*Coprosma* spp.). Seeds are collected from the south slopes of Haleakalā and are grown at the DOFAW Forestry nursery on Maui. An endemic alpine hairgrass (*Deschampsia nubigena*) will be planted in erosion scars, which are difficult to re-vegetate due to the loss of topsoil. If the grass can establish and thrive, over time it will rehabilitate the soil by increasing organic matter and soil moisture. Fertilizer application based on soil analysis results will be considered as trials in Kahikinui FR demonstrated that this significantly improved grass establishment.

There are also highly invasive plant species present in the reforestation unit and to ensure the establishment of a native forest canopy, regular weed control operations are necessary. If left uncontrolled invasive plant species can outcompete native plants and slow or impair native forest restoration. Focusing on the Healani unit, weeklong trips will be done 4-5 times a year to control targeted invasive species.

To monitor ecosystem response to management activities, multispectral imagery was obtained for Kīpahulu FR in 2019. Post processing of the data utilizing a geographic information system (GIS) platform was done to map out baseline landcover classification for the entire landscape (Figure *45*). In the next five to ten years, another set of multispectral imagery will be taken to monitor the success of invasive species control and other forest restoration efforts. This

Figure 45. Landcover classification derived from multispectral imagery completed in 2019



59

innovative and quantitative analysis of land management activities will be used to guide decision making for all future actions, informing an adaptive management process.

5.2.3 ʻAhulili Unit

The eastern portion of the reserve is still densely vegetated, but a significant portion of the ʻAhulili unit is covered by the highly invasive strawberry guava. Introduced to Hawaiʻi in 1825, strawberry guava has the ability to invade and replace native ecosystems. It is a significant threat to the reforestation efforts in the Healani unit, and also to the native ecosystems in Kīpahulu FR and on neighboring state and federal reserves. A University of Hawaii study estimated that strawberry guava invaded forests lose 27-53% more water into the atmosphere than native ʻōhiʻa forests (Takahashi et al. 2011).

Agencies have used conventional chemical and mechanical methods to manage strawberry guava for many years, but the fecundity of this species makes application of these methods across hundreds of thousands of acres extremely expensive and impractical. The U.S. Forest Service (USFS), in partnership with land managers, have researched and released the biocontrol agent *Tectococcus ovatus*, a leaf galling insect that is anticipated to slow the spread of strawberry guava by reducing fruit production. The overarching objective is to reduce reproduction of strawberry guava to levels that will make removal logistically more feasible.

DOFAW has released *Tectococcus* in Kīpahulu FR, and it has only dispersed 200-300 feet from the release site since 2017. Land managers are currently working on new techniques to increase the rate of spread. Additional releases are needed to establish *Tectococcus* to levels required to slow the spread of this invasive species in the reserve.

Ungulate control in the reserve is currently focused in the Healani unit since the primary method currently being used is ACETA. The dense vegetation of the ʻAhulili unit makes aerial control less effective. Once numbers in Healani are reduced, there are plans to deploy pig traps and/or snares to control ungulates in the fenced ʻAhulili unit.

5.3 Management Priorities, Objectives and Goals

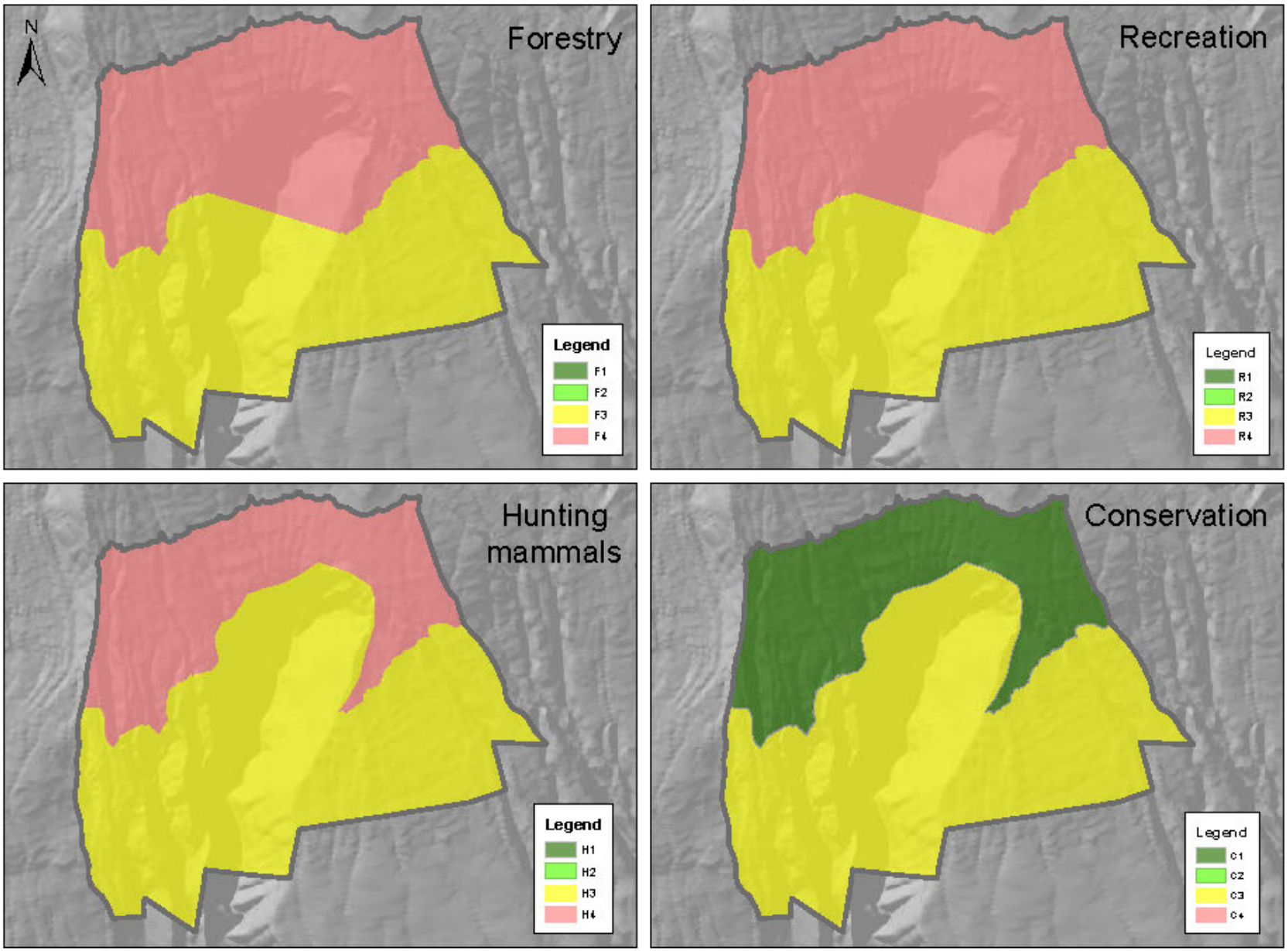
5.3.1 DOFAW Management Guidelines

DOFAW has developed a set of draft management guidelines and associated maps (Figure 46) to assist in evaluating and balancing human activities and resource management objectives on lands under DOFAW jurisdiction. The purpose of the guidelines is to provide administrative policy direction and prioritize resource management activities based on the integrity of existing natural resources and social needs in four principal classifications: Conservation Resources, Forest Products Management, Recreation Management and Hunting Management. Detailed definitions of these classifications and their associated management strategies can be found in Appendix E.

Forest Products Management Guideline

DOFAW's Management Guidelines separate forest products management into four classifications: Large Scale Commercial (F-1), Small Scale Commercial (F-2), Personal Use (F-3), and Restricted (F-4). The fenced portion of Kīpahulu FR and the back of Manawainui valley is

Figure 46. Kīpahulu FR DOFAW Management Guidelines



State of Hawai'i
Department of Land and Natural Resources
Division of Forestry and Wildlife
(808) 587-0166
June 2022

classified F-4 or Restricted, where natural resource protection is the highest priority. Any forest product utilization activities allowed are minimally disruptive, or focused on improving forest and watershed health, native ecosystems, and other conservation efforts. Harvesting of timber will only be considered if such activities improve other priority resource outcomes. Permits for harvesting non-timber forest products will be considered on a case-by-case basis for research and education, improving forest science and health, watershed protection, traditional and customary practices, and conservation efforts.

The makai portion of the reserve below the fenceline is classified F-3 or Personal Use, where harvest of forest products will be accommodated for sustainable personal use. Any impacts to native species and ecosystems are to be minimized. Non-commercial timber harvesting and targeted commercial timber salvage are allowed but balanced with other priority land use objectives. Permits for non-timber forest products will be issued on a case-by-case basis.

Hunting Management Guideline

DOFAW's Management Guidelines separate hunting management into four classifications: Active Hunting Management (H-1), Moderate Hunting Management (H-2), Low Intensity Hunting Management (H-3), and No Hunting Management (H-4). Due to the difference in environmental impacts of game bird versus mammals, they were given separate hunting classifications. However, according to Chapter 122 HAR, game bird hunting is not allowed in Kīpahulu FR, as such management guidelines were set for game mammals only.

The fenced portion of Kīpahulu FR is classified as H-4 for mammals due to the area being unsuitable for open public hunting due to environmental sensitivity and the lack of legal public access. Public hunting is not a primary land objective and there will be no active management for public hunting. Animal control will be done by DOFAW staff.

The makai, unfenced portion of the reserve below the fenceline is classified H-3 for mammals. While the lack of public access is still an issue, the area is dominated by non-native vegetation and would be suitable for public hunting. Public hunting management for this classification includes providing and maintaining public access and monitoring hunter effort and success. Game enhancement and habitat management to increase animal densities will not be done in this area and hunting regulations should be liberal to maximize public hunting opportunity to limit animal environmental impacts.

Recreation Management Guideline

DOFAW's Management Guidelines separate recreation management into four classifications: R-1 (High Recreation Management), R-2 (Medium Recreation Management), R-3 (Low Recreation Management), and R-4 (Restricted Access). The fenced portion of Kīpahulu FR and the back of Manawainui gulch is classified as R-4, where outdoor recreation is restricted or controlled due to hazardous conditions and for ecosystem protection. Access to the area will primarily be for management purposes, and/or limited programmatic recreational or educational uses. Facilities and improvements are limited and are generally associated with resource management. The makai portion of the reserve is classified as R-3, where outdoor recreation is of low intensity. Public access and recreation in this area are contingent on securing access through adjacent

lands. Trails if established will likely receive limited use due to remoteness and will require levels of maintenance relative to their use.

Conservation Resource Guideline

DOFAW's Management Guidelines separate conservation resources into four classifications: C-1 (High Conservation Resources), C-2 (Medium Conservation Resources), C-3 (Low Conservation Resources), and C-4 (Little to No Conservations Resources). The upper elevations of Kīpahulu FR are classified as C-1, because it is an important restoration area for endangered plants, native forest bird and bat habitat. There is also a high level of recovery potential as current forest restoration efforts of the Leeward Haleakalā landscape have been highly successful. Management activities in C-1 areas include animal exclusion fencing, predator control, weed control, outplanting of native vegetation and reintroduction of native wildlife. The makai, unfenced portion of the reserve is classified as C-3, as the area is dominated by non-native ecosystems with low levels of native biological diversity. Conservation management activities would be focused on small remnant patches as appropriate.

5.3.2 Management Priorities

Broad management priorities for each forest reserve were derived from the mandates that regulate DOFAW activities, including Hawai'i Revised Statutes, Administrative Rule, Draft DOFAW Management Guidelines, as well as input from Maui DOFAW district managers. These management priorities were divided into eight categories (listed below) and are used to guide management activities within the forest reserve.

- Watershed Values – Maintain or increase quantity and or quality of aquifer recharge and soil erosion control.
- Native Ecosystems – Maintain and restore native ecosystems by establishing viable populations of native species in natural patterns of abundance and distribution. Restore ecological function, ecosystem services, evolutionary processes and adapt to the impacts of climate change.
- Resource Protection – Protection of forest ecosystems from wildfire, insects, and disease.
- Cultural Resources – Protection of cultural resources and traditional and customary practices.
- Invasive Species Control - Monitor and control incipient and established invasive plants and animals that negatively impact ecosystems.
- Threatened and Endangered (T&E) Species Management – Protection of federally and state listed, 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.
- Game Animal Management – Management of public hunting areas and game animals.
- Commercial Activity – Sustainable income generating activities such as carbon credits, timber, ecotourism, ecosystem services, etc.

5.3.3 Management Objectives

Expanding on the management priority categories defined above, general management goals, along with objectives, action items, and estimated costs associated with these actions for the management of Kīpahulu FR are presented in Table 16.

Table 16. Management of Kīpahulu FR

Management Priority	Management Goal	Management Objective	Action Items	Estimated Cost
Watershed Values	Reduce the threat and impact of erosion on reserve resources	Maintain forest cover on watershed lands to provide high quality water for communities of Maui	Re-establishment of appropriate vegetative cover	$25K/year + staff costs
		Exclude cattle from FR	Maintain fences to comply with HRS Chapter 183	$10K/year
			Locate and remove cattle with owner's assistance.	$10k/year
		Control all other ungulate populations at levels consistent with watershed protection needs	Continue to monitor and control ungulate population inside existing fenced enclosures (ACETA).	$25K/year
			Update Maui District Kīpahulu FR Aerial Shooting /Ungulate Control plan – Every 5 years	Staff & mgmt. costs only
			Assess future strategic fence placement options to best enhance water quality.	Staff & mgmt. costs only
		Post fire mitigation	Collect and store seed stock for various native plant species to be used for post-fire mitigation/ revegetation	$15K/year
			Conduct post-fire mitigation such as seed scatter, aerial broadcast, weed control, soil conditioning and reforestation.	TBD
			Build fire-resilient native communities to stabilize soils following wildfires to prevent post-burn erosion.	$20k/year
	Monitor forest composition over time to determine landscape level needs	Determine permanent systematic monitoring protocol	Establish new photo vegetative monitoring photo plots and continue to monitor already established photo plots.	$20K/year

			Continue to assess forest monitoring effectiveness and needs. Establish new protocols as needed.	Staff & mgmt. costs only
			In the next three to five years, re-run multispectral imagery/asset mapping with post processing utilizing GIS to monitor the success of forest restoration efforts.	$30K
	Collaboration	Maintain DOFAW's partner role in the Leeward Haleakalā Watershed Restoration Partnership (LHWRP).	Assist with restructuring and re-establishing the LHWRP.	Staff & mgmt. costs only
			Improve communication and coordination between agencies.	Staff & mgmt. costs only
			Establish regular communications, schedules, and protocols with WP.	Staff & mgmt. costs only
			Participate in WP quarterly meetings.	Staff & mgmt. costs only
			Annual renewal of LHWRP Forest Reserve Special Use Permits.	Staff & mgmt. costs only
	Climate Change Adaptation	Monitor latest publication and available information for climate change, vulnerability, modeling, and adaptation.	Participate in climate change seminars, meetings and workshops.	Staff & mgmt. costs only
		Increase collaborative efforts to conserve streams and watersheds	Expand watershed conservation to lower elevations by enhancing watershed partnerships and seeking legislative changes at the state and local levels	Staff & mgmt. costs only
		Protect forests to increase recharge and water retention.	Support healthy forests through forest restoration.	TBD
Resource Protection	Wildfire management and prevention	Fire presuppression	Development of fire management plan	$30k
			Re-evaluate CWPP plan every 5 years	Staff & mgmt. costs only
			Scope sites for potential water storage tanks and dip tanks/reservoir	Staff & mgmt. costs only

			Install water storage and dip tanks for use during wildfire suppression activities	TBD
			Maintain firebreak along the Healani ungulate proof fenceline section via aerial herbicide spray to limit potential fire spread and severity.	$10k/year
		Public education and outreach	Participate in specific target outreach activities as appropriate based on fire preparedness levels.	Staff & mgmt. costs only
		Monitor weather conditions	Install Remote Automated Weather Station (RAWS)	$25K
			Annual maintenance of RAWS	$5K/year
			Use data to determine district fire preparedness levels and implement fire preparedness level activities	Staff & mgmt. costs only
			Use data (Keetch-Byram Drought Index) to monitor environmental conditions relating to forest health and implement appropriate forest management activities according to the Fire preparedness matrix.	Staff & mgmt. costs only
	Forest health monitoring and protection for insects and disease.	Early detection and rapid response of insect and disease outbreaks in the reserve.	Conduct monthly forest health surveys. Compose and submit annual survey report to Forest Health Coordinator.	Staff & mgmt. costs only
			Coordinate rapid response to mitigate forest health issues.	Staff & mgmt. costs only
		Rapid ʻŌhiʻa Death (ROD) Early Detection and Management	Collaborate with partners to secure essential technical information to understand the transmission and impacts of ROD.	Staff & mgmt. costs only
			Assist and collaborate with partners to secure new information on the mode of transmission	Staff & mgmt. costs only

			Conduct aerial surveys for early detection quarterly, or as needed.	$10K/year
			Based on the results of the aerial survey, notify landowners/land managers and request access and or work with landowners to collect samples to test for ROD	TBD
			Document and report any sightings of dead or dying ʻōhiʻa trees in the field during routine operations	TBD
			Implement sanitation procedures to minimize the risk of transporting pathogens.	$5K/year
			Implement 'ROD Rapid Response Plan' if ROD is detected in Maui Nui, including rapid response to contain and eradicate	TBD
			Include ROD sanitation and prevention procedures in all permits issued for Kīpahulu FR	Staff & mgmt. costs only
		Increase public information and awareness for ROD	Continue to participate in outreach activities targeting ROD	$5K/year + staff costs
		Strawberry guava (*Psidium* cattleyanum) biocontrol	Additional releases of *Tectococcus ovatus* to increase spread as needed.	5K/year
			Continue to monitor *Tectococcus ovatus* release sites for effectiveness and spread.	5K/year
Cultural Resources	Cultural Resource Protection	Increase understanding of cultural resources in need of protection	Collect data from the community in order to better protect cultural resources	Staff & mgmt. costs only
		Prioritize and pair habitat restoration with cultural resource management	Restore culturally significant habitats from mauka to makai (e.g., loʻi, forests, beaches)	TBD
	Protect traditional and customary practices	Protect cultural practices (e.g., forest product gathering, farming, fiber collection and processing)	Protect/create dedicated spaces for cultural practices	Staff & mgmt. costs only

		Maintain permit and application process for protected cultural activities that require a forest reserve permit.	Maintain and update cultural application process.	Staff & mgmt. costs only
			Review applications and issue applicable forest reserve permit(s) if approved.	Staff & mgmt. costs only
Game Animal Management	Promote public hunting and implement game mammal management actions as provided in the PR Game Management Plan (2016)	Provide hunter access to Kīpahulu FR	Acquire land and/or access easements. Work with NPS and Kaupō Ranch to access Kīpahulu FR through the Haleakalā National Park from mauka access.	Staff & mgmt. costs only
			Work with Kaupō Ranch to access the lower portion of Kīpahulu FR (makai of the ungulate proof fence) from Pi'ilani Hwy.	
		Review existing long term strategic goals set by the DOFAW Management Guidelines	Evaluate every five years	Staff & mgmt. costs only
		Public education	Continue hunter education program, and other public outreach as appropriate.	Staff & mgmt. costs only
		Regulate and manage public hunting as per Chapters 121 and 123, HAR	Maintain game mammal hunting opportunity below fenced areas in the event public access is made available.	Staff & mgmt. costs only
T&E Species Management	Protection and recovery of listed rare plants and animals	Cooperate with PEPP, USFWS and other rare plant agencies to prioritize rare plant species protection	PEPP staff and state botanists to conduct botanical surveys.	Staff & mgmt. costs only
			Conduct surveys and monitoring efforts to collect baseline data that will be used to help determine priority areas to protect species of interest	Staff & mgmt. costs only
		Implement management and recovery of T&E plant species consistent with management guidelines and applicable recovery and management plans	Build fences and maintain enclosures around wild populations of rare plants. Outplant T&E species into enclosures. Conduct predator and ungulate control as needed.	$10K each

		With assistance from MFBRP, MNSRP, SEP, USFWS and other agencies prioritize endangered wildlife species protection	Continue ongoing monitoring, surveys for presence, location, and population estimates of rare birds including seabirds (Hawaiian petrel) and nēnē	$10K/year
		Implement management and recovery of T&E wildlife species consistent with management guidelines and applicable recovery plans	Build and maintain enclosures around wild populations of rare animal species. Conduct predator and ungulate control as needed.	$10K each
			Inspect and maintain existing fence exclosure twice per year or as needed. Conduct predator and ungulate control as needed.	$20K and Staff & mgmt. cost.
			Devise and implement predator control strategy. Install, maintain and monitor predator control traps (A24)	$20K/year
			Install ʻŌpeʻapeʻa acoustic monitoring units in the Healani unit.	$10K/year
		Assisted colonization to restore rare species	Identify and prioritize suitable habitat for the release of rare species. Incorporate climate change scenarios into the decision-making process.	Staff & mgmt. costs only
			Protect and prepare habitat for rare species introduction by increasing habitat quality and reducing threats (e.g., predators, invasive species, human disturbance)	$20k/year
			Release rare species into suitable habitat and monitor survival, dispersal, reproductive success, abundance, and genetic diversity	$20k/year

Native Ecosystems	Maintain and restore, 1) native ecosystem types, 2) viable populations of all native species in natural patterns of abundance and distribution, 3) ecological function and ecosystem services, 4) carbon sequestration by natural ecosystems, and 5) evolutionary processes and adapt to the impacts of climate change.	Ungulate control	Remove ungulates from unit areas located within ungulate proof fences designated for near zero tolerance Ground control and aerial control work as needed	$25k/year
		Revegetation	Before proceeding with intensive native planting program, assess the potential for natural regeneration from the soil seed bank.	Staff & mgmt. costs only
			Actively restore high-priority sites inside the fence. Consider selecting surrogate species that are potentially more tolerant of changing climate conditions	$20k/year
			Small-scale common native outplanting	$10K/acre
		Monitoring	Survey and monitor native species richness and diversity to establish a baseline and track long-term trends.	$10K/year
			Establish animal surveys using ground and aerial methods.	$20K/year
	Climate change adaptation	Anticipate and facilitate habitat migration	Conduct a cost-benefit analysis for a range of management alternatives based on climate change vulnerability assessments and prioritization processes	Staff & mgmt. costs only
			Use common garden experiments (outplanting along elevational/moisture gradient) to identify species applicability under changing climatic conditions.	TBD
			Prioritize the planting of native species that thrive in a wide variety of conditions (i.e., generalists, resilient native/endemic species)	Staff & mgmt. costs only

			Plant native species to create habitat and facilitate biome shift.	$50k
			Monitor abundance of native and invasive species as temperature rises and precipitation changes.	Staff & mgmt. costs only
			Map transitional areas between different habitats (i.e., mesic to dry) to identify and prioritize protection for areas that may transition to a drier habitat.	$10k/year
			Consider climate projections in the timing and seasonality of planting to promote natural recruitment	Staff & mgmt. costs only
		Improve silvicultural practices for priority native species	Improve seed storage capacity, seed propagation methods, and silvicultural planting methods (i.e., seed collection, composition, spacing)	$10k/year
Invasive Species Control	Reduce the impact of invasive plant species on the Forest Reserve and surrounding areas	Manage incipient and established invasive plants and animals.	Conduct aerial and ground surveys to monitor invasive plant species	$20K/year
			Write a comprehensive weed plan	$35K
			Prioritize invasive plant removal, focusing on areas with high diversity or rare species	Staff & mgmt. costs only
			Conduct aerial and ground control work to remove invasive species from the area and prevent further spread to adjacent properties	$50K/year
			Increase Maui Forestry invasive species control capacity. Establish 6-8 civil service positions.	$600K/year
		Continue to work with cooperating agencies, including MISC, TNC, NRCS, HDOA, UH-CTAHR, EMWP, LHWRP, USFWS, and other	Invasive species technician and support staff to work with cooperators to monitor and control invasive species in the FR	$125K/ year

		cooperators	Improve data sharing within and between agencies	Staff & mgmt. costs only
			Collaborate and support partner research and invasive species control	$50K/year
		Support biological control efforts in FR and adjacent lands	Participate in applied research for potential biocontrol agents, including labor and helicopter time	TBD
		Conduct research to support adaptive policies and technology that increase landscape-level protection and restoration	Research and develop new/improved methods of small predator control	Staff & mgmt. costs only
			Research and develop new/improved methods of weed control	Staff & mgmt. costs only
	Biosecurity	Prevent introduction of invasive insects, plants, and animals, new diseases and pathogens by increasing biosecurity controls	Implement quarantines, interisland policies, and optional vs. mandatory restrictions.	Staff & mgmt. costs only
Access, Trails, and other Public Uses	Secure public access to the FR	Negotiate access agreements or easements with neighboring landowners	Work with NPS and Kaupō Ranch on an access agreement to Kīpahulu FR through the Haleakalā National Park from mauka access.	Staff & mgmt. costs only
			Work with Kaupō Ranch on access agreement to the lower portion of Kīpahulu FR (makai of ungulate proof fence) from Piʻilani Hwy.	Staff & mgmt. costs only
Commercial Activity	Generate income from suitable commercial activities in the Forest Reserve to supplement funding of natural resource management activities	Explore ecosystem services revenue streams	Examine the feasibility of expanding on existing certification of Maui reforestation projects (Kahikinui and Nakula) under a Voluntary Carbon Standard.	$250K

5.4 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 Kīpahulu FR include:

- Acres of invasive plants controlled
- Number of invasive animals removed
- Acres of fire protection area
- Miles of fence maintained (both ungulate proof and boundary fences)
- Acres of native forest restored through passive and active restoration
- Number of native plants planted
- Survivorship of outplantings
- Number of rare, threatened, or endangered plant/animal species protected
- Number of cultural resources protected
- Number of cultural activity permits issued
- Amount of funds leveraged through competitive grant writing

6. FUTURE RECOMMENDATIONS

6.1 Desired Outcome for the Forest Reserves:

- Protection and enhancement of watershed quality and quantity.
- Continued maintenance of existing ungulate proof fencing and forest restoration areas.
- Stable to increasing populations of threatened and endangered species.
- Healthy native ecosystems.
- Protection of cultural resources.
- Negotiate cooperative agreements with neighboring landowners to secure management and public access in perpetuity.
- Development of alternative revenue opportunities to support the management needs of the forest reserve.

6.2 Future Recommendations

- Continue to pursue land acquisitions to increase area for watershed protection, natural resource conservation and public hunting.
- Long-term funding sources are needed to support watershed protection, natural resource conservation and public hunting.
- Long-term funding sources needed to support fire mitigation projects such as the installation of water/dip tanks to support aerial fire suppression; fuel mitigation along fencelines; and the development (in cooperation with adjacent landowners) of landscape fuel reduction projects adjacent to forest reserve boundaries.

7. REFERENCES

Baer, A.B. 2015. Dissertation: On the Cloak of Kings: Agriculture, Power, and Community in Kaupō, Maui. University of California, Berkeley.

Burnett, K., S. D'Evelyn, L. Loope, and C. Wada. 2012. An economic approach to assessing import policies designed to prevent the arrival of invasive species: the case of *Puccinia psidii* in Hawai'i. Environmental Science & Policy. 19-20: 158-168.

Cannon, P., Friday, J.B., Harrington, T., Keith, L., Hughes, M., Hauff, R., Hughes, F., Perroy, R., Benitez, D., Roy, K., Peck, R., Smith, S., Luiz, B., Cordell, S., Giardina, C., Juzwik, J., Yelenik, S, & Cook, Z. 2022. Chapter 15 Rapid Ohia Death. In F.O. Asiegbu, & A. Kovalchuk (Eds.). *In Forest Microbiology*. (pp. 267-289). Academic press. https://doi.org/10.1016/B978-0-323-85042-1.00013-6.

Dudley, N., T. Jones, R. James, R. Sniezko, J. Wright, C. Liang, P. Gugger, and P. Cannon. 2017. Applied genetic conservation of Hawaiian Acacia koa: an eco-regional approach. USDA Forest Service General Technical Report PNW-GTR-963.

Gregg, R.M., editor. 2018. Hawaiian Islands Climate Vulnerability and Adaptation Synthesis. EcoAdapt, Bainbridge Island, WA.

Haines, W. P., J. Giffin, & D. Foote. 2004. Rediscovery of five species of *Omiodes* Guenée (Lepidoptera: Crambidae) on Hawai'i Island. Bishop Museum Occasional Papers 79: 45–49.

Haines, W., Schmitz, P. & D. Rubinoff. 2014. Ancient diversification of *Hyposmocoma* moths in Hawai'i. Nature Communications. 5, 3502. https://doi.org/10.1038/ncomms4502

Handy, E. S. Craighill, Elizabeth Green Handy, Mary Pukui Kawena. 1991. Native Planters in Old Hawaii. Honolulu: Bishop Museum Press, p 508-511.

Hawai'i Biodiversity and Mapping Program. 2018. Natural Diversity Database. Center for Conservation Research and Training. University of Hawai'i at Mānoa.

Hawaiian Volcano Observatory. 2003. Volcano Watch - Once a big island, Maui County now four smaller islands. United States Geological Survey.

Hosmer, Ralph S. 1914. Kīpahulu Forest Reserve: Report of the Superintendent of Forestry. The Hawaiian Forester and Agriculturalist Vol. X1, No. 9. Honolulu: Advertiser Publishing Co., Ltd., p 274-278. -

Jacobi, J.D., Price, J.P., Fortini, L.B., Gon III, S.M., and Berkowitz, Paul, 2017, Hawai'i Land Cover and Habitat Status: U.S. Geological Survey data release, https://doi.org/10.5066/F7DB80B9.

Kame'eleihiwa, Lilikalā. 1992. Native Land and Foreign Desires Pehea Lā E Pono Ai?. Honolulu, Hawai'i. Bishop Museum Press.

Keener, V.W., Marra, J.J., Finucane M.L., Spooner, D., & Smith, M.H. (Eds.). 2012. Climate Change and Pacific Islands: Indicators and Impacts. Report for the 2012 Pacific Islands Regional Climate Assessment (PIRCA). Washington, D.C.: Island Press.

Keir, Matthew and Weisenberger, Lauren. 2014. Hawai'i Strategy for Plant Conservation Phase 1: increasing *in situ* collecting and *ex situ* capacity. Hawai'i Plant Conservation Network.

Kipahulu will not be Planted: Managers of Plantation Decided to Await Future Attitude on Sugar Tariff. 1914, July 10. Hawaiian Gazette. p. 7.

Kirch, P. V., J. Holson, and A. Baer. 2009. Intensive Dryland Agriculture in Kaupō, Maui, Hawaiian Islands. Asian Perspectives 48(2): 265-290.

Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed [01/17/2018].

Oppenheimer, Hank. 2011. New Hawaiian plant records for 2009. Bishop Museum Occasional Papers 110: 5-10.

Orr, Maria K. 2013. Maui Veterans Cemetery Expansion Cultural Impact Assessment. Kaimipono Consulting Services LLC.

Palmer, D.D. 2003. Hawai'i's ferns and fern allies. University of Hawai'i Press, Honolulu. 324 pp.

Perkins KS, Nimmo JR, Medeiros AC, Szutu DJ, von Allmen E, 2014. Assessing effects of native forest restoration on soil moisture dynamics and potential aquifer recharge, Auwahi, Maui. Ecohydrology 7(5): 1437-1451.

Perroy, R.L.; Sullivan, T.; Benitez, D.; Hughes, R.F.; Keith, L.M.; Brill, E.; Kissinger, K.; Duda, D. Spatial Patterns of ʻOˉ hiʻa Mortality Associated with Rapid ʻOˉ hiʻa Death and Ungulate Presence. Forests 2021, 12, 1035. https://doi.org/10.3390/f12081035

Polhemus, D. A., and A. Asquith. 1996. Hawaiian damselflies: A field identification guide. Bishop Museum Press, Honolulu

Scott, J.M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler. 1986. Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Studies Avian Biol. 9:1-431.

Sherrod, D. R., Sinton, J. M., Watkins, S. E., and Brunt, K. M. 2007. Geologic map of the State of Hawai'i: U.S. Geological Survey Open-File Report 2007-1089 [http://pubs.usgs.gov/of/2007/1089/].

Soehren, Lloyd J. "Hawaiian Place Names", Ulukau: The Hawaiian Electronic Library, http://ulukau.org/cgi-bin/hpn?l=en. Accessed 8 August 2022.

Starr, F and K. Starr. 2018. Botanical and Faunal Survey Kipahulu Forest Reserve, Maui. Starr Environmental.

State of Hawai'i Department of Land and Natural Resources Division of Forestry and Wildlife. 2016. Hawai'i Forest Action Plan.

State of Hawai‘i Department of Land and Natural Resources Division of Forestry and Wildlife. 2017. Maui District: Kīpahulu State Forest Reserve (Manawainui Section) Aerial Shooting/Ungulate Control Plan.

Takahashi M, Giambelluca TW, Mudd RG, DeLay JK, Nullet MA. Asner GP, 2011. Rainfall partitioning and cloud water interception in native forest and invaded forest in Hawai‘i Volcanoes National Park. Hydrological Processes 25: 448–464.

Trauernicht, C. 2014. Wildfire in Hawai‘i. Honolulu, HI: Pacific Fire Exchange Fact Sheet #1.

Trauernicht, Clay, and Matthew P. Lucas. 2016. Wildfire Ignition Density Maps for Hawai‘i. University of Hawai‘i at Mānoa. College of Tropical Agriculture and Human Resource. Forest and Natural Resource Management Publication RM-21.

Trauernicht, Clay, and Elizabeth Pickett. 2016. Pre-Fire Planning Guide for Resource Managers and Landowners in Hawai‘i and Pacific Islands. University of Hawai‘i at Mānoa. College of Tropical Agriculture and Human Resource. Forest and Natural Resource Management Publication RM-20.

United States Fish and Wildlife Service. 2016. Endangered and Threatened Wildlife and Plants; Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species; Final Rule. Federal Register. Volume 81; Number 61. p. 17790-18110.

United States Fish and Wildlife Service. 2017. Critical Habitat Fact Sheet. Available from: https://www.fws.gov/sites/default/files/documents/critical-habitat-fact-sheet.pdf.

United States Fish and Wildlife Service. 2018a. 5-Year Review Short Form Summary: *Cyanea copelandii* subsp. *haleakalaensis* (hāhā).

United States Fish and Wildlife Service. 2018b. 5-Year Review Short Form Summary: *Cyanea hamatiflora* subsp. *hamatiflora* (hāhā).

United States Fish and Wildlife Service. 2020a. *Cyanea asplenifolia* (hāha) 5-Year Review Summary and Evaluation.

United States Fish and Wildlife Service. 2020b. *Cyanea kunthiana* (hāhā) 5-Year Review Summary and Evaluation.

United States Fish and Wildlife Service. 2020c. *Cyrtandra ferripilosa* (ha‘iwale) 5-Year Review Summary and Evaluation.

United States Fish and Wildlife Service. 2020d. 5-Year Review Short Form Summary: *Huperzia mannii* (wāwae‘iole).

United States Fish and Wildlife Service. 2020e. *Phyllostegia haliakalae* 5-Year Review Summary and Evaluation.

United States Fish and Wildlife Service. 2020f. *Wikstroemia villosa* (‘ākia) 5-Year Review Summary and Evaluation.

United States Fish and Wildlife Service. 2021a. 5-Year Review Short Form Summary: *Ctenitis squamigera* (pauoa).

United States Fish and Wildlife Service. 2021b. *Microlepia strigose* var. *mauiensis* (palapalai) 5-Year Review Summary and Evaluation

United States Fish and Wildlife Service. 2021c. *Schiedea diffusa* subsp. *diffusa* 5-Year Review Summary and Evaluation.

Place names according to:

Pukui, Mary Kawena, Elbert, Samuel H., and Mookini, Esther T. 1974. Place Names of Hawai‘i. University of Hawai‘i Press, 289 pages.

8. APPENDICES

Appendix A: NRCS SSURGO Soil Map Unit Descriptions

Appendix B: Botanical and Faunal Survey Kīpahulu Forest Reserve, Maui

Appendix C: State of Hawai‘i Wildlife Action Plan Species Profiles

Appendix D: Invasive Plant Species Profiles

Appendix E: DOFAW Management Guideline Classification Definitions

Appendix A: NRCS SSURGO Soil Map Unit Descriptions

Island of Maui, Hawaii

rHT—Hydrandepts-Tropaquods association

Map Unit Setting

National map unit symbol: hqcn
Elevation: 1,000 to 6,000 feet
Mean annual precipitation: 100 to 350 inches
Mean annual air temperature: 55 to 70 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Hydrandepts and similar soils: 60 percent
Tropaquods and similar soils: 30 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hydrandepts

Setting

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Hydrandept

Typical profile

A - 0 to 11 inches: silty clay loam
B - 11 to 37 inches: silty clay loam
Cr - 37 to 60 inches: cobbly loam
H4 - 60 to 70 inches: bedrock

Properties and qualities

Slope: 7 to 30 percent
Depth to restrictive feature: 59 to 60 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 11.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Tropaquods

Setting

Landform: Plateaus
Landform position (three-dimensional): Mountainflank, side slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Basalt

Typical profile

Oi - 0 to 4 inches: peat
Ag - 4 to 10 inches: silty clay loam
H3 - 10 to 11 inches: cemented material
H4 - 11 to 40 inches: very cobbly silt loam
H5 - 40 to 60 inches: bedrock

Properties and qualities

Slope: 7 to 20 percent
Depth to restrictive feature: 10 to 20 inches to placic; 40 to 60 inches to paralithic bedrock
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Tropaquods, high water table

Percent of map unit: 10 percent
Landform: Bogs
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 19, Sep 15, 2021

Island of Maui, Hawaii

rRT—Rough mountainous land

Map Unit Setting

National map unit symbol: hqcv
Elevation: 0 to 6,000 feet
Mean annual precipitation: 70 to 400 inches
Mean annual air temperature: 57 to 72 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Rough mountainous land and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rough Mountainous Land

Setting

Landform: Gulches
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope, rise
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium and colluvium

Typical profile

H1 - 0 to 5 inches: silty clay loam
H2 - 5 to 25 inches: very cobbly clay loam
H3 - 25 to 29 inches: bedrock

Properties and qualities

Slope: 50 to 99 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8e
Hydrologic Soil Group: B

Hydric soil rating: No

Data Source Information

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 19, Sep 15, 2021

Island of Maui, Hawaii

rRK—Rock land

Map Unit Setting

National map unit symbol: hqcq
Elevation: 0 to 6,000 feet
Mean annual precipitation: 15 to 60 inches
Mean annual air temperature: 57 to 75 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock land and similar soils: 55 percent
Rock outcrop: 45 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Land

Setting

Landform: Pahoehoe lava flows
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope, riser, rise
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Basalt

Typical profile

H1 - 0 to 4 inches: silty clay loam
H2 - 4 to 8 inches: silty clay
H3 - 8 to 20 inches: bedrock

Properties and qualities

Slope: 0 to 70 percent
Depth to restrictive feature: 4 to 10 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

H1 - 0 to 60 inches: bedrock

Properties and qualities

Slope: 10 to 70 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.00 to 0.06 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Data Source Information

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 19, Sep 15, 2021

Island of Maui, Hawaii

rVS—Very stony land

Map Unit Setting

National map unit symbol: hqcx
Elevation: 0 to 13,000 feet
Mean annual precipitation: 10 to 150 inches
Mean annual air temperature: 39 to 73 degrees F
Frost-free period: 365 days
Farmland classification: Not prime farmland

Map Unit Composition

Very stony land and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Very Stony Land

Setting

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Mountaintop
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Aa lava and volcanic ash

Typical profile

H1 - 0 to 10 inches: extremely stony very fine sandy loam
H2 - 10 to 60 inches: cobbles

Properties and qualities

Slope: 7 to 30 percent
Depth to restrictive feature: 40 to 60 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A

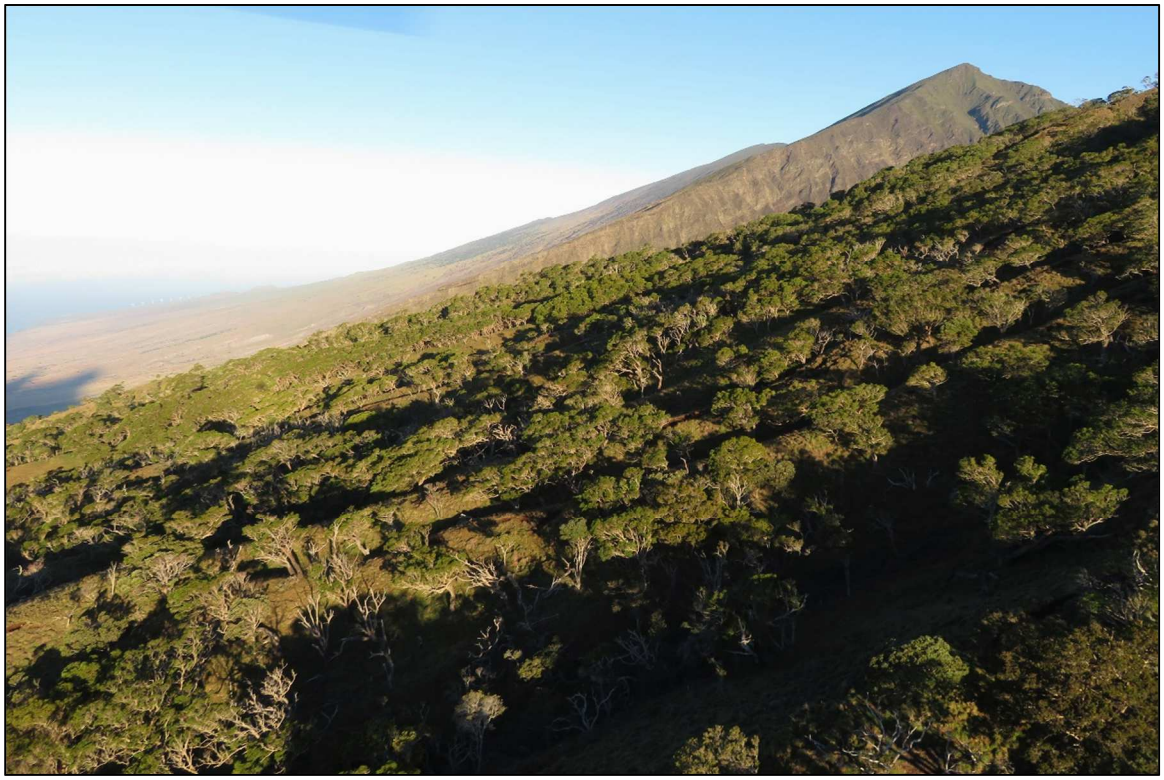
Hydric soil rating: No

Data Source Information

Soil Survey Area: Island of Maui, Hawaii
Survey Area Data: Version 19, Sep 15, 2021

Appendix B: Botanical and Faunal Survey Kīpahulu Forest Reserve, Maui

BOTANICAL AND FAUNAL SURVEY
KIPAHULU FOREST RESERVE, MAUI



Prepared By:
FOREST & KIM STARR

Prepared For:
DIVISION OF FORESTRY AND WILDLIFE
DEPARTMENT OF LAND AND NATURAL RESOURCES

2018

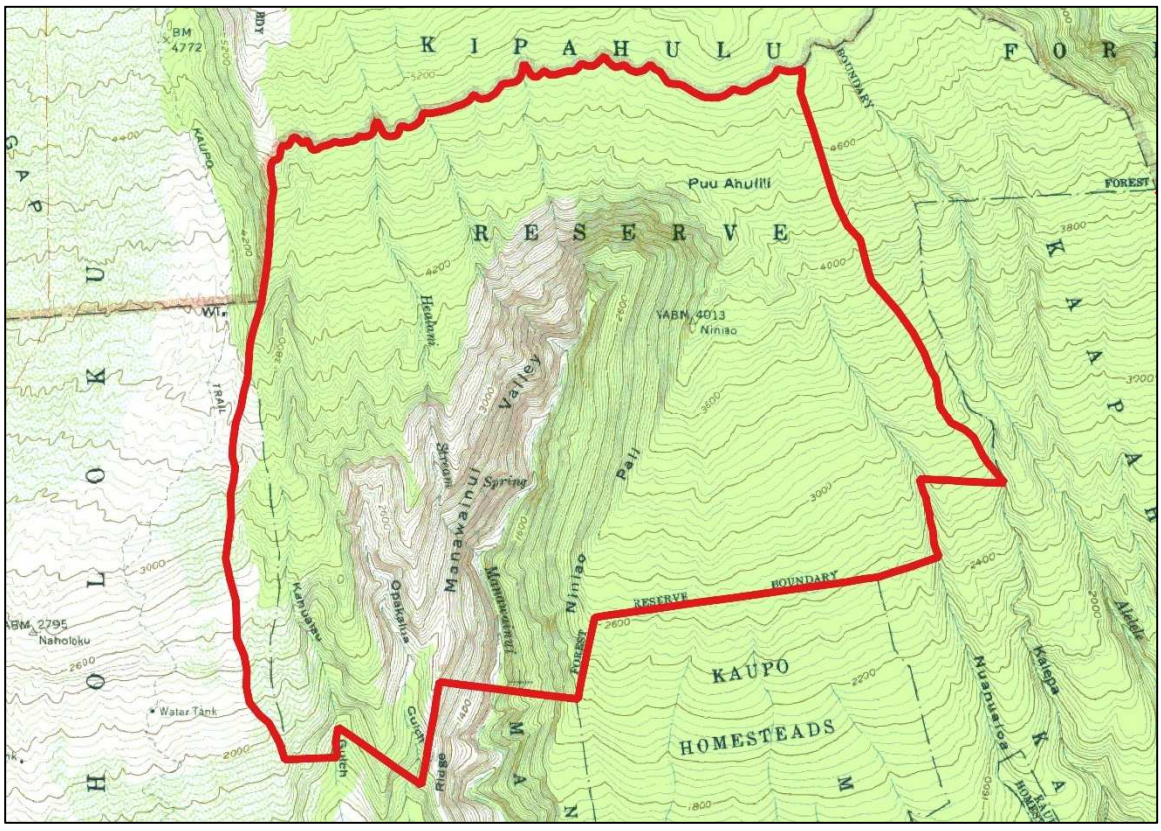
BOTANICAL AND FAUNAL SURVEY
KIPAHULU FOREST RESERVE, MAUI

INTRODUCTION

The Kipahulu Forest Reserve Manawainui Section (TMK 170040060000) encompasses about 2,175 acres. The reserve is on the southeast part of East Maui. The mauka (upslope) boundary is at the 5,000 ft. level, bordering Haleakala National Park (HALE). The eastern boundary also borders HALE, near Kalepa Gulch. Kaupo Gap marks the western edge of the reserve, bordering HALE and Kaupo Ranch. Kaupo Ranch also borders the reserve on the makai (downslope) boundary, along with additional state land. The goal of this survey was to inventory the flora and fauna in the area, to provide current information to be included in a management plan for the reserve.

SITE DESCRIPTION

The project area is the Manawainui Section of the Kipahulu Forest Reserve. The land is steep, dissected by many gullies, some of which have running water. Manawainui valley runs through the center of the reserve. The project elevation ranges from 1,000 to 5,000 feet above sea level. Annual rainfall averages 65-200 inches. Annual air temperature averages 54-70 degrees Fahrenheit.



Project area, Kipahulu Forest Reserve, Manawainui Section, Maui.

BIOLOGICAL HISTORY

The original vegetation on the site would have ranged from a diverse dryland forest in the lower elevations, through mesic and wet forest in the higher elevation of the reserve.

Typical dry forest canopy species would have included halapepe (*Chrysodracon auwahiensis*) and olopua (*Nestegis sandwicensis*). Mesic to wet forest areas would have been dominated by koa (*Acacia koa*) and ohia (*Metrosideros polymorpha*).

After the arrival of humans, a series of forces including fire along with introduced plants, animals, and diseases transformed the site to predominantly non-native vegetation in the lowest reaches, grading to more native dominated vegetation in the highest elevations. Given the remote location and rugged terrain, the land has not seen many uses over the years, mostly ranching, hunting, and hiking.

SURVEY OBJECTIVE

The main objectives of the survey were to:

- Document what plant (terrestrial vascular flora) and animal (birds, bats, mammals, insects) species occur in the reserve or may likely occur in the existing habitat.

- Write up findings in a report that includes checklists of species, along with images and discussion of some of the more conspicuous and noteworthy elements of the flora and fauna in the reserve.

Remnant koa tree on edge of Manawainui Valley.

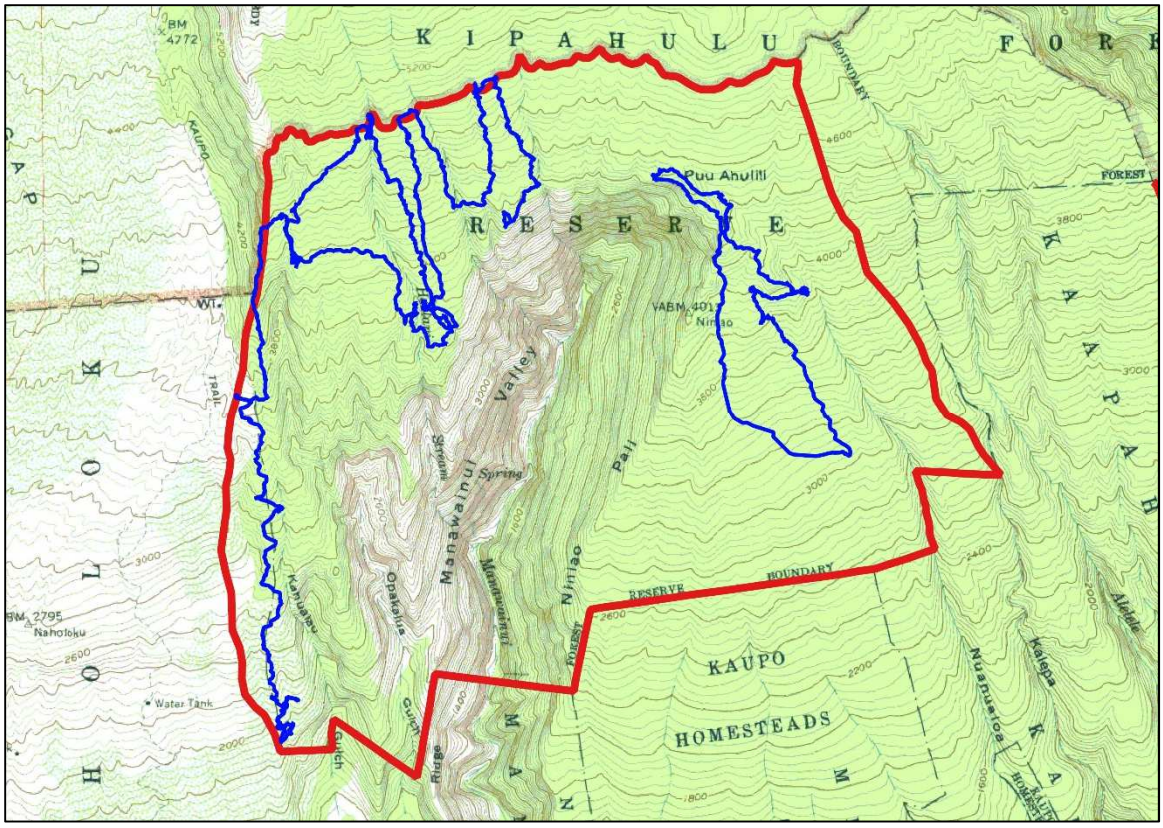
BOTANICAL SURVEY

SURVEY METHODS

A walk-through botanical survey method was used over representative areas of the reserve. Extra emphasis was placed on areas with high diversity, such as moist steep gullies and areas of remnant native plants. Binoculars and helicopters were used to survey areas too difficult or dangerous to survey on foot. Notes were made on plant species, distribution and abundance. The reserve was surveyed in July and August of 2018.

To help prepare, the 1976 Manawainui Research Project report was reviewed. The report summarized a two month survey of the Manawainui planeze, including much of the Kipahulu Forest Reserve. Additionally we interviewed Paul Higashino, head botanist on the 1976 project, about terrain, methods, and insights into the vegetation 42 years ago. DOFAW staff also provided maps and insights about current fencelines, landing zones, and general terrain of the reserve.

Taking notes on the flora and fauna. West rim of Manawainui Valley, Kipahulu Forest Reserve.



Area surveyed (blue lines).

Surveying in the Kipahulu Forest Reserve.

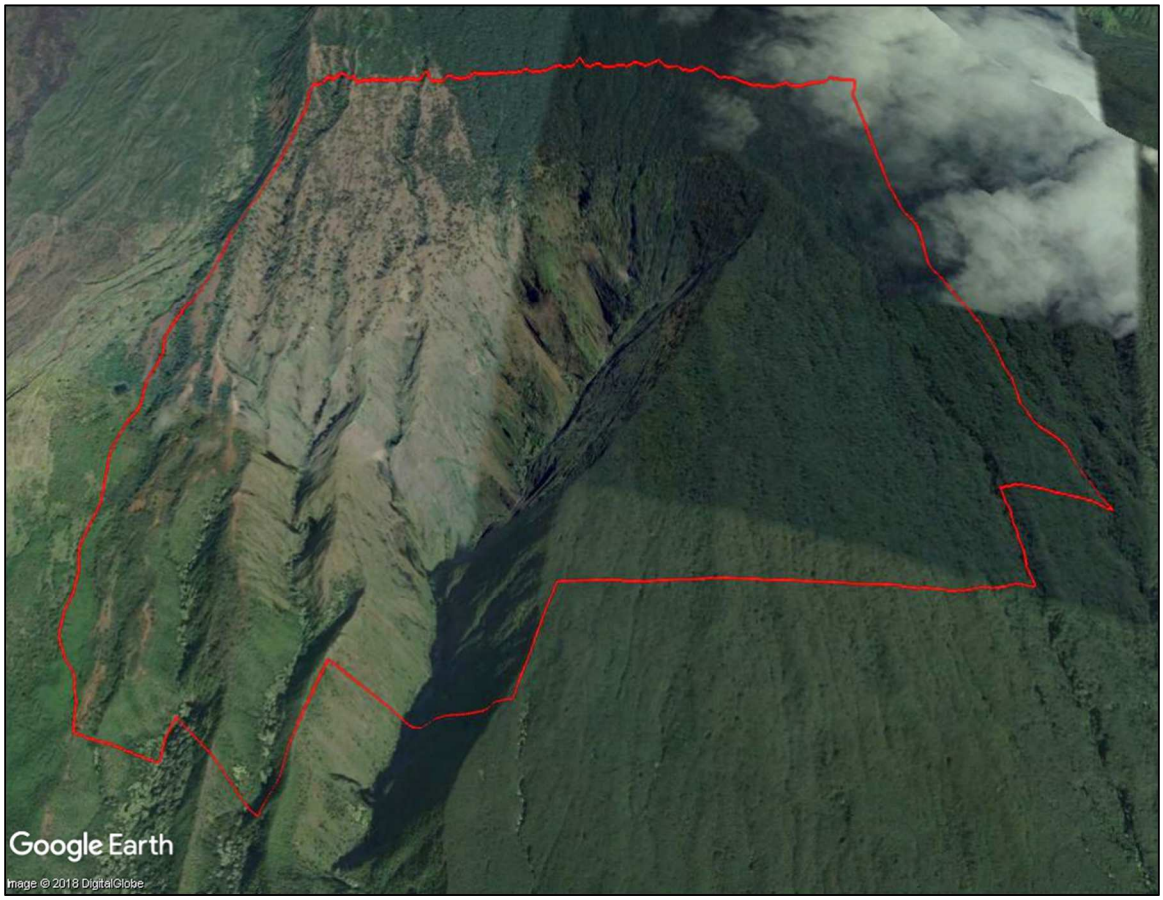
DESCRIPTION OF VEGETATION

There is a range of vegetation types within the Kipahulu Forest Reserve.

Dry Forest & Grassland: The lowest elevations, from 1,000-3,500 ft. on the western part of the reserve are vegetated with predominantly non-native plant species. Trees are supported in some areas, while much of the area is open grassland.

Mesic Forest & Grassland: From 3,500-5,000 ft. on the western part of the reserve and in much of Manawainui Valley koa dominates. The heavily ungulate pressure in this area has resulted in an open koa forest with a grass understory and very few shrubs. Some of the gulches in this area support higher plant diversity including numerous ferns and shrubs. Going higher and east, ohia starts to become co-dominant.

Wet Forest: The eastern portion of the reserve is extremely wet. In the lower elevations 2,000-3,500 ft. strawberry guava is dominant, overtaking remnant koa and ohia. In the higher elevations (3,500-5,000 ft.), a diverse koa, ohia, olapa forest persists. In areas where pigs are not abundant, there is a lush understory of ferns and diverse native plants.



Kipahulu Forest Reserve.

MESIC FOREST & GRASSLAND

Open koa forest, Kipahulu Forest Reserve. Kaupo is visible in the distance.

Often referred to as the "koa parkland", the open koa (*Acacia koa*) forest from 3,500-5,000 ft. on the western part of the reserve is what most folks associate with the Kipahulu Forest Reserve, and is where the bulk of the management is currently occurring.

Koa is the dominant tree in this area, which is heavily grazed, resulting in open stands of mature koa trees with a short grass understory and very few shrubs or young trees. Ohia (*Metrosideros polymorpha*) is co-dominant in the moister and higher elevation portions of the koa parkland. Occasional kawau (*Ilex anomala*) and naio (*Myoporum sandwicense*) trees are also present.

The few shrubs that are able to survive in the steeper areas include pukiawe (*Leptecophylla tameiameiae*), aalii (*Dodonaea viscosa*), and pilo (*Coprosma foliosa*).

Ferns are found in the steeper, moister areas. Kilau (*Dryopteris glabra*) is abundant in some places. Less abundant, but still persisting are hapuu (*Cibotium glaucum*), laukahi (*Dryopteris wallichiana*) and ii (*Dryopteris fusco-atra*).

The understory is dominated by heavily browsed non-native grasses, especially narrow-leaved carpetgrass (*Axonopus fissifolius*), molasses grass (*Melinis minutiflora*), and Yorkshire fog (*Holcus lanatus*).

The upper reaches of the koa parkland are mostly an open koa forest with a grass understory. The area has many ridges and gullies dissecting the land. Haleakala Peak in distance.

The lower elevations of the koa parkland become progressively more open, with less trees and more grasses. A newly constructed ungulate fence is visible. It will protect the bulk of the koa parkland.

Most of the koa parkland consists of mature koa trees with a grass understory. The high number of ungulates in the area results in very few shrubs or small trees. Lower reaches of Healani Stream.

Ferns are mostly restricted to the steeper and moister areas of the koa parkland. Healani Stream.

The lower, drier portions of the koa parkland are increasingly open, trending more towards a grassland than a forest.

The higher, wetter portions of the koa parkland trend into a more closed-canopy, mixed forest with diverse understory of shrubs and ferns. Upper reaches of Healani Stream on the right.

Canopy of koa trees, Kipahulu Forest Reserve.

Lichen covered koa trees, Kipahulu Forest Reserve.

The steep headwalls of Manawainui Valley are dominated by open mesic koa forest from about 3,500-4,000 ft. elevation. This is one of the more intact patches, protected by the steep terrain.

Ohia (*Metrosideros polymorpha*) is locally abundant in the mesic forest, especially in the wetter and higher elevation areas.

Kawau (*Ilex anomala*) trees dot the mesic forest.

Kilau (*Dryopteris glabra*) is locally common in the mesic forest.

Opelu (*Lobelia hypoleuca*) persists only in the steepest, wettest portions of the mesic forest.

Alaala wai nui (*Peperomia cookiana*) can be found tucked in nooks where ungulates can't reach.

Many koa branches are adorned with pakahakaha ferns (*Lepisorus thunbergiana*).

WET FOREST

Wet forest, Kipahulu Forest Reserve.

The eastern portion of the reserve receives a lot more rainfall than the western side, and the vegetation is dominated by a more closed canopy forest with lush fern understory. This is the area that holds the greatest native plant diversity within the reserve.

The dominant canopy trees in the upper part of the wet forest, above about 3,500 ft., are ohia (*Metrosideros polymorpha*), koa (*Acacia koa*), and olapa (*Cheirodendron trigynum*). In the lower reaches, below 3,500 ft., non-native strawberry guava (*Psidium cattleianum*) dominates, excluding virtually all other plants.

Other native trees found in the wet forest here include kolea (*Myrsine lessertiana*), olomea (*Perrottetia sandwicensis*) and alani (*Melicope* spp.).

In areas where there isn't strawberry guava or large ungulate populations, there is a shrub layer that includes pukiawe (*Leptecophylla tameiameiae*), kanawao (*Broussaisia arguta*), pilo (*Coprosma foliosa*), and ohelo (*Vaccinium calycinum*).

Mamaki (*Pipturus albidus*) is occasionally present along steep stream margins, as is naupaka (*Scaevola chamissoniana*), akala (*Rubus hawaiensis*), ohe (*Clermontia* spp.), haiwale (*Cyrtandra* spp.), and haha (*Cyanea* spp.).

Non-native shrubs are most abundant in the lower elevations and include Coster's curse (*Clidemia hirta*), cane tibouchina (*Tibouchina herbacea*) and thimbleberry (*Rubus rosifolius*).

Vines in the area include maile (*Alyxia stellata*), manono (*Kadua affinis*), ieie (*Freycinetia arborea*) and hoi kuahiwi (*Smilax melastomifolia*).

Tucked into protected areas are the native herbs alaala wai nui (*Peperomia* spp.), nettle (*Pilea peploides*), and painiu (*Astelia menziesiana*).

Dominant understory ferns include uluhe (*Dicranopteris linearis* and *Sticherus owhyhensis*), uluhe lau nui (*Diplopterygium pinnatum*), *Dryopteris* spp., and amau (*Sadleria* spp.). Other, less common ferns include *Asplenium* spp., *Elaphoglossum* spp., pala (*Marattia douglasii*), and hapuu (*Cibotium* spp.).

The non-native Australian tree fern (*Sphaeropteris cooperi*) is starting to take hold over much of the wet forest.

Dominant grasses, all of which are non-native, include Yorkshire fog (*Holcus lanatus*), narrow-leaved carpetgrass (*Axonopus fissifolius*), molasses grass (*Melinis minutiflora*), and Glenwood grass (*Sacciolepis indica*).

A few native grasses are present in low numbers, often in hard to reach locations. These include heupueo (*Lachnagrostis filiformis*), hairgrass (*Deschampsia nubigena*), and *Eragrostis grandis.* Native sedges are locally common and include carex (*Carex alligata*), hook sedge (*Uncinia uncinata*), and uki (*Machaerina angustifolia*), along with small clumps of wood rush (*Luzula hawaiiensis*).

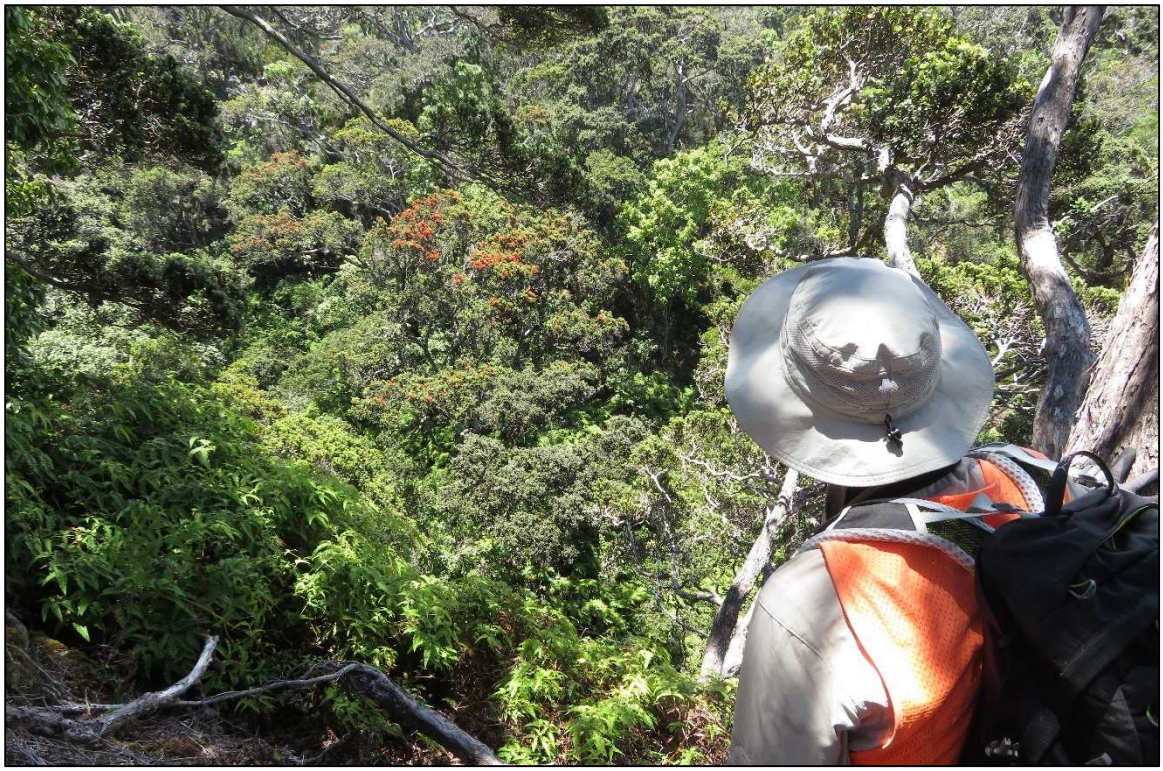
Lush fern understory and native canopy trees in the wet forest of Kipahulu Forest Reserve.

The upper elevations of the wet forest section have a mixed canopy of native koa, ohia, and olapa. Puu Ahulili on the right. This cinder cone remnant sits at the headwall of Manawainui Valley.

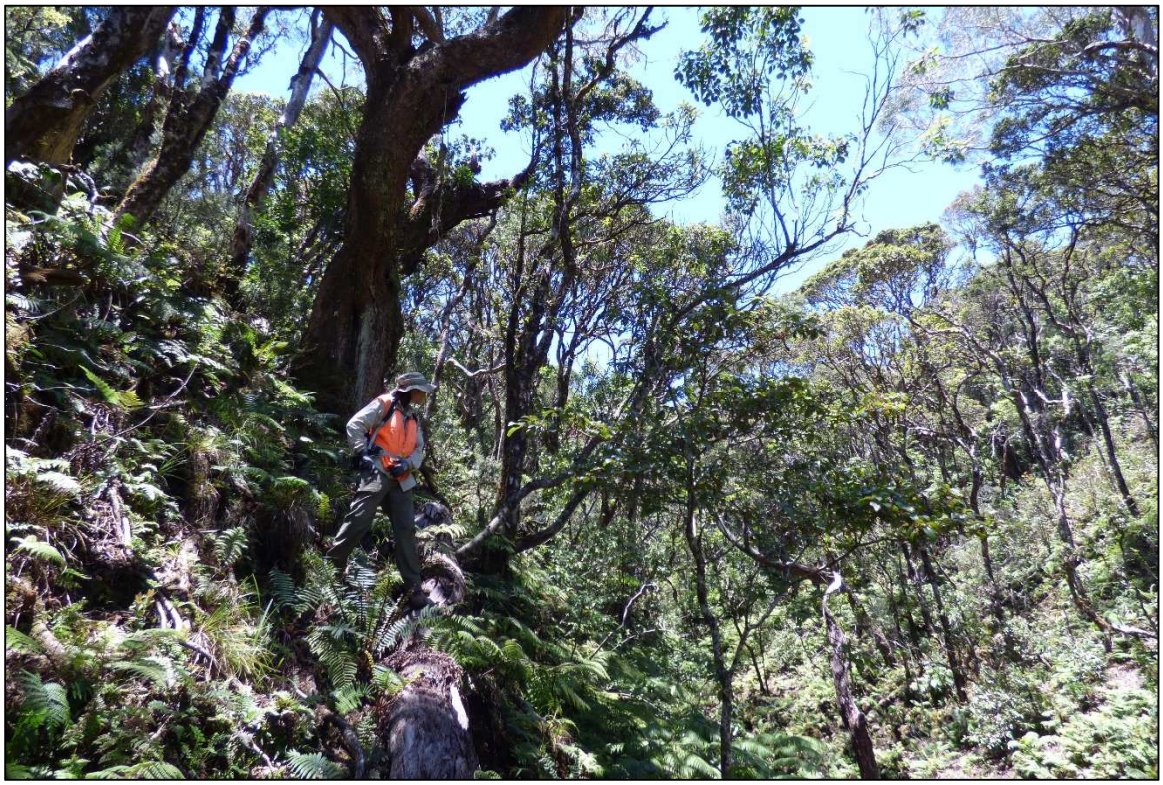
Further downslope strawberry guava dominates, with only the oldest and largest remnant native trees still peeking up above the canopy. In the vicinity of Nuanualoa Gulch.

Much of the wet forest section of the reserve has a mixed canopy of koa, ohia, and olapa. Haleakala Peak is visible in the distance.

The wet forest also has a thick multi-layered understory of ferns, shrubs, and small trees. This is along the boundary with Haleakala National Park.



Wet forest section dominated by ohia trees and an understory of uluhe (*Dicranopteris linearis*).



Wet forest section with a mix of koa, ohia, and olapa (*Cheirodendron trigynum*) canopy trees, and a fern understory of (*Dryopteris* spp.) and amau (*Sadleria pallida*). Puu Ahulili.

Numerous ravines with streams and pools run through the wet forest section.

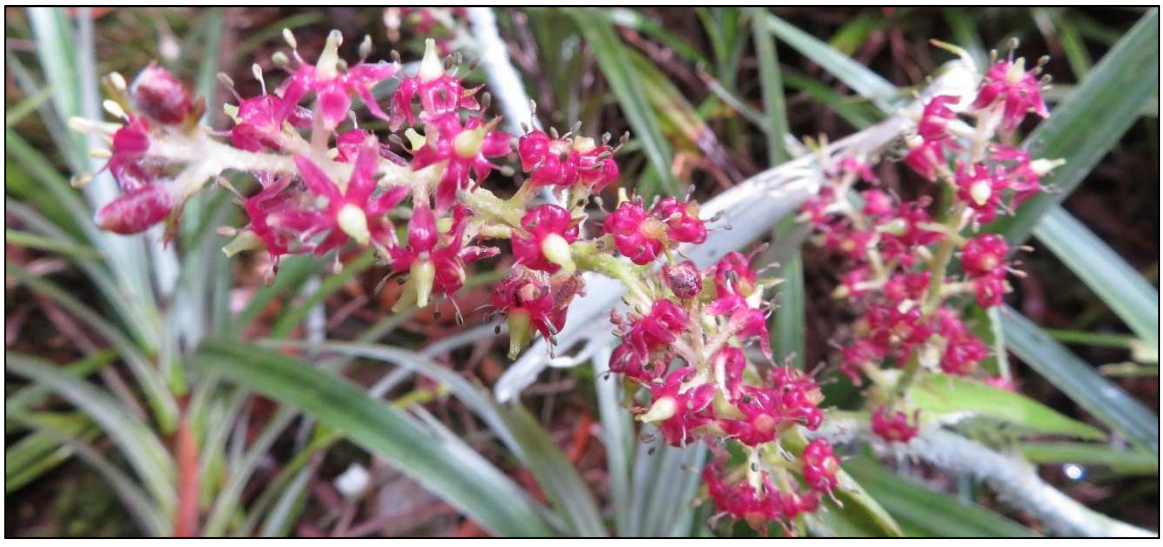
Steep ravines provide a different habitat type and refuge from feral ungulates. It is in these steep areas that many of the rarer remnant native plants persist.

Remnant koa (*Acacia koa*) tree in the lower reaches of the wet forest. A few tall koa trees is all that remains of the previous native forest, which has been overrun by strawberry guava and ungulates.

Australian tree fern (*Sphaeropteris cooperi*) in lower reaches of the wet forest.

Naupaka kuahiwi (*Scaevola chamissoniana*).

Hoi kuahiwi (*Smilax melastomifolia*).



Painiu (*Astelia menziesiana*).

***Asplenium contiguum*.**

Pala (*Marattia douglasii*).

Amau (*Sadleria pallida*).

Prickly-flowered haha (*Cyanea aculeatiflora*).

Maile (*Alyxia stellata*).

Oha wai nui (*Clermontia arborescens* subsp. *waihiae*).

DRY FOREST & GRASSLAND

Dry forest & grassland, Kipahulu Forest Reserve.

The lowest reaches of the western half of the reserve are drier and would have supported a native dry forest. Today, the area is dominated by strawberry guava (*Psidium cattleianum*) and Christmasberry (*Schinus terebinthifolius*) on the ridges and kukui nut trees (*Aleurites moluccana*) in the gully bottoms. Most of the area is heavily grazed and the understory is usually grasses or bare dirt.

Other non-native trees found in the dry forest include silky oak (*Grevillea robusta*), Java plum (*Syzygium cumini*), and guava (*Psidium guajava*). One avocado (*Persea americana*) was found in a gully near the lower fenceline.

As one transitions out of the koa parkland and into the dry forest, native koa (*Acacia koa*) trees start to be less abundant, becoming overrun by strawberry guava, other aggressive non-native trees and ungulates. Towards the bottom of the reserve, near 2,000 ft., alahee (*Psydrax odorata*) is the only native tree we came across.

Native shrubs in the dry forest section include aalii (*Dodonaea viscosa*), pukiawe (*Leptecophylla tameiameiae*), and akia (*Wikstroemia monticola*).

Towards the top of the dry forest, non-native shrubs are able to create waist to chest-high thickets of lantana (*Lantana camara*) and vervain (*Stachytarpheta australis*). Lower down, the high ungulate pressure eliminates much of this shrub layer.

Not many native herbs are found here, but there was a small, browsed alaala wai nui (*Peperomia blanda*) hiding under a rock in a gully. Non-native herbs are also grazed down to small nubbins, include *Richardia brasiliensis*, fireweed (*Senecio madagascariensis*), and lance-leaved plantain (*Plantago lanceolata*).

The non-native white passion flower vine (*Passiflora subpeltata*) is occasionally observed climbing on vegetation, especially on steep gully walls.

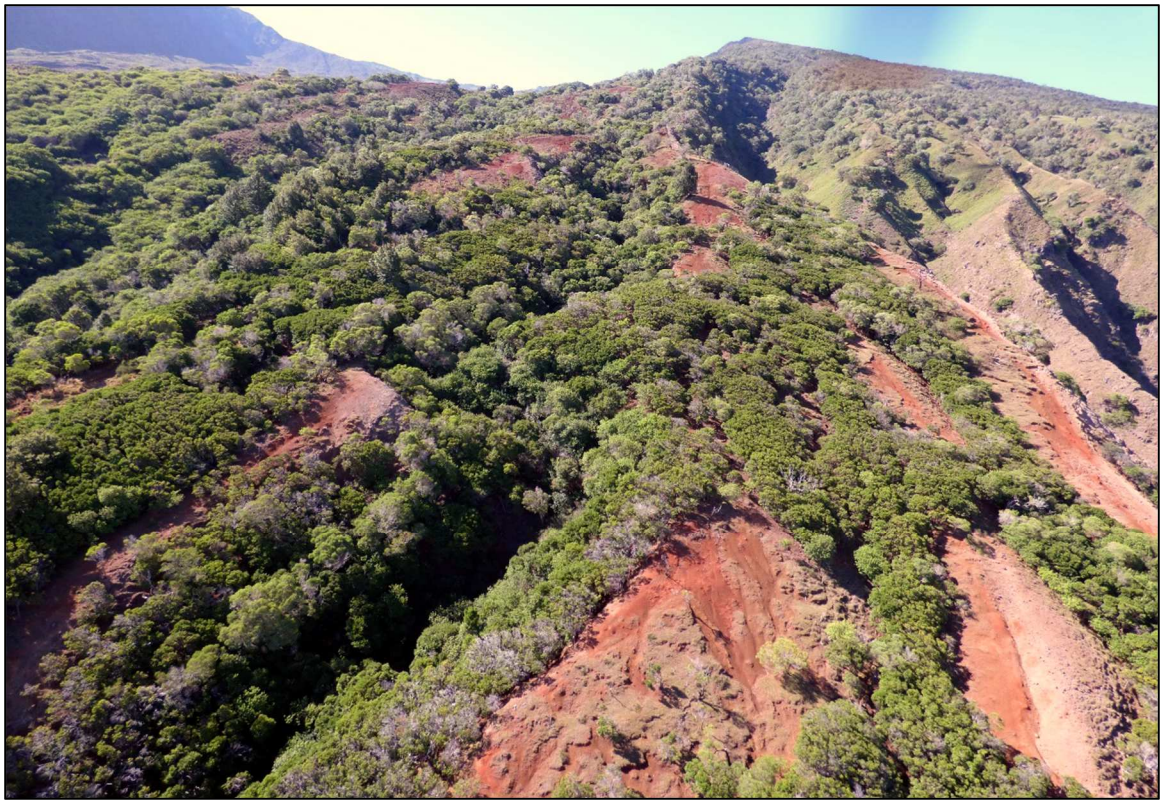
Ferns are not common in this area. But the native bracken fern (*Pteridium aquilinum* subsp. *decompositum*) persists, as does the non-native golden fern (*Pityrogramma austroamericana*).

Dominant non-native grasses in this zone include kikuyu (*Cenchrus clandestinus*) in the upper areas of the dry forest zone, along with molasses grass (*Melinis minutiflora*), and natal red top (*Melinis repens*). Also found are patches of rattail grass (*Sporobolus indicus*) and broomsedge (*Andropogon virginicus*), and the native grasses manienie ula (*Chrysopogon aciculatus*) and emoloa (*Eragrostis variabilis*).

Much of Manawainui Valley is also within this dry forest zone. It was not surveyed on the ground, due to the unstable nature of the cliffs above it. However, it was scanned with binoculars from nearby gulch rims, and an aerial reconnaissance was done by helicopter.

The vegetation in Manawainui Valley looks similar to other low elevation dry forest sections in the reserve, with strawberry guava, Christmasberry, and silky oak as the dominant trees on the steeper areas, and kukui nut in the valley bottoms. The understory is well grazed, especially steep gulch walls, and appears to be dominated by molasses grass. There are also clumps of Mauritius hemp (*Furcraea foetida*) near rock bands.

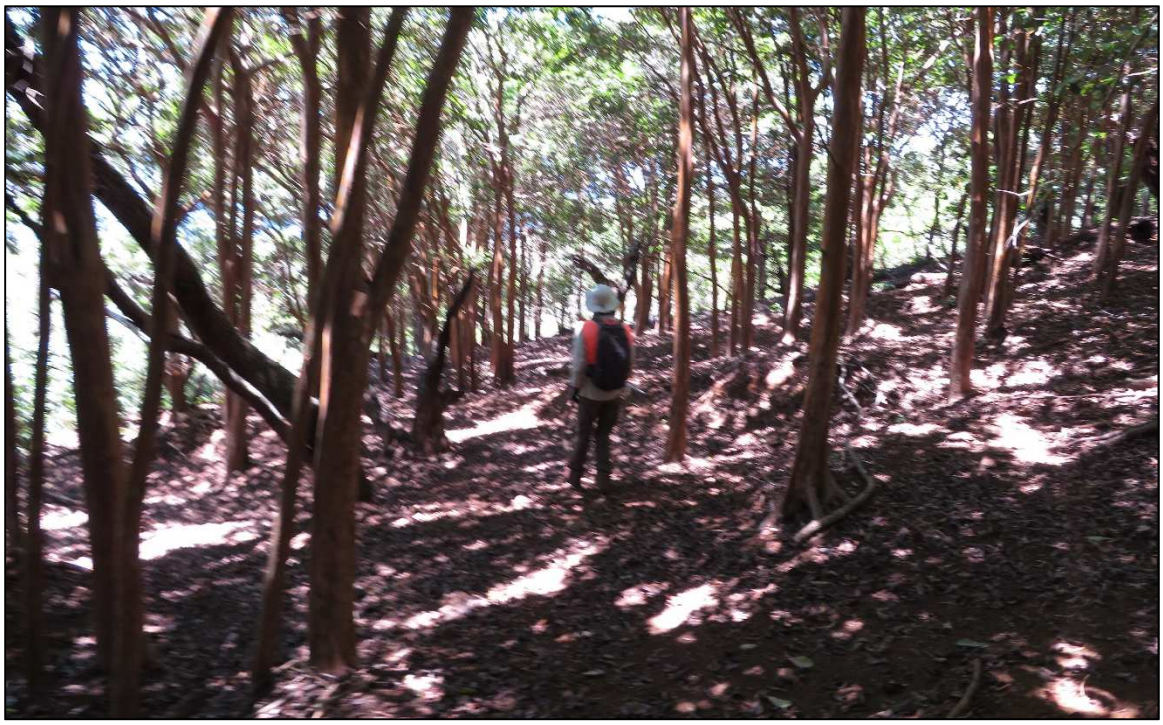
Dry ridge on western part of reserve. Kaupo Gap and Haleakala Peak visible in distance.



Barren ridges with strawberry guava and Christmasberry forest in the gullies typifies much of the western portion of the dry forest section of the Kipahulu Forest Reserve.

Further towards Manawainui Valley the large valley walls are mostly devoid of trees and the valley bottoms support a forest of kukui nut trees. Opakalua Gulch and Kaokao Ridge.

In the upper elevations of the dry forest, koa starts to become less abundant, strawberry guava becomes more prevalent, and the ground becomes more barren.



In the lower elevations of the dry forest, strawberry guava is dominant in many places, where it displaces virtually all other plant species. Very high ungulate pressure eliminates all understory plants, even young strawberry guava, with large areas of bare dirt and a light leaf layer.

Many of the ridges are barren or have very short grass cover. A few remnant koa trees can be seen, being overrun by a sea of Christmasberry and other non-native trees.

In some areas, the erosion is becoming severe and the topsoil layer is being lost.

Dead koa tree trunks are some of the last remnants of the native forest that once occurred here.

Other remnants include alahee (*Psydrax odorata*), which persists in small groves on gulch walls.

In the larger gulches towards Manawainui Valley, the ridge tops continue to be mostly barren, much of the canopy is dominated by Christmasberry, and kukui nut appears in the gully bottoms.

The same holds true in the deepest parts of Manawainui Valley, much of which is sparsely vegetated.

There are both red and yellow fruited forms of strawberry guava (*Psidium cattleianum*) here.

***Richardia brasiliensis*.**

Golden fern (*Pityrogramma austroamericana*).

Manienie ula (*Chrysopogon aciculatus*).

Akia (*Wikstroemia monticola*).

Alaala wai nui (*Peperomia blanda*).

INVASIVE PLANTS

Many non-native plants in the Kipahulu Forest Reserve have the potential to displace native plants. Most formidable is strawberry guava (*Psidium cattleianum*), which is already well established, has displaced much native forest, and will likely continue to march up the mountain.

Molasses grass (*Melinis minutiflora*) is well established in the mesic and dry areas, and likely will become more abundant, at least temporarily, once ungulates are removed. Perhaps as tree canopies close it will then lose dominance.

Other species that are well established in the reserve and likely will become more common in the future include cane tibouchina (*Tibouchina herbacea*), clidemia (*Clidemia hirta*), and Australian tree fern (*Sphaeropteris cooperi*).

Just starting to get established is kahili ginger (*Hedychium gardnerianum*), that is being spread to the reserve from nearby areas by birds.

Controlling satellite locations of these species will help slow their spread.

Monotypic stand of strawberry guava (*Psidium cattleianum*), Kipahulu Forest Reserve.

Cane tibouchina (*Tibouchina herbacea*).

Clidemia (*Clidemia hirta*).

Australian tree fern (*Sphaeropteris cooperi*).

Kahili ginger (*Hedychium gardnerianum*).

PLANT PATHOGENS

Native and non-native pathogens were observed in the reserve. What appears to be the native koa gall rust (*Atelocauda digitata*) was in multiple locations, showing brown powdery fungal spore masses on leaves and deformed branch tips. Slight damage to ohia leaves from what appeared to be non-native ohia rust (*Austropuccinia psidii*) was observed, though no yellow fungal spore masses were observed.

Rapid ohia death (*Ceratocystis* spp.) is killing vast areas of ohia trees on the Big Island, with locations as close to Kipahulu as the Kohala Mountains. Thankfully no signs of rapid ohia death were observed. If rapid ohia death were to arrive to the reserve, the main hope would be that some of the ohia strains in the area would show resistance. Fencing and removal of ungulates should help decrease mechanical injury to ohia. This will then decrease the threat of infection through those wounds by rapid ohia death.

Rust on koa leaf, possibly gall rust (*Atelocauda digitata*).

Possible ohia rust (*Austropuccinia psidii*), or insect damage, on ohia leaf.

A large dieback of strawberry guava just below the reserve boundary, between Niniao Pali and Kalepa Gulch, resembles pathogen damage, but the cause has yet to be determined.

The dieback of strawberry guava shows the vast area it covers. Large, monotypic stands of any plant species, native or non-native, are susceptible to attack by pathogens and other plant pests.

RESTORATION

The Kipahulu Forest Reserve has been heavily impacted by ungulates over the years. Recently, efforts have been made to protect and restore the native flora and fauna through selective fencing and eventually removal of ungulates from parts of the reserve.

Recently installed fence at the bottom of the koa parkland. Similar fencing efforts elsewhere on East Maui have resulted in landscape level regeneration of koa and other native plants.

Aalii (*Dodonaea viscosa*) is germinating in much of the koa parkland, but is currently being eaten before it can mature. Once installation of fences and removal of ungulates is complete, it is likely a large cohort of aalii will quickly begin filling the understory along with koa.

PLANT SPECIES LIST

Following is a checklist of vascular plant species inventoried during our survey. The list also includes plants observed by Hank Oppenheimer with the Plant Extinction Prevention Program, who did two weeks of dedicated plant surveys in the reserve. Plants observed by Hank and not us are marked with an (x) and have no abundance notes.

For each species, the following information is provided:

- Family, Scientific, and Common names.

- Bio-geographical status / nativity
  - Endemic = Native to Hawaii; not naturally occurring anywhere else in the world.
  - Indigenous = Native to Hawaii and also to one or more other geographic area(s).
  - Non-native = Brought to Hawaii intentionally or accidentally by humans.

- Abundance of each species within the project area. Provided only for plants we personally encountered.
  - Dominant = Forming a major part of the vegetation within the project area.
  - Common = Widely scattered throughout the area or locally abundant within a portion of it.
  - Occasional = Scattered sparsely throughout the area or occurring in a few small patches.
  - Rare = Only a few isolated individuals within the project area.

Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Fabaceae	*Acacia koa*	Koa	Endemic	Dominant	
Polypodiaceae	*Adenophorus hymenophylloides*	Pai	Endemic		x
Polypodiaceae	*Adenophorus pinnatifidus* var. *pinnatifidus*	Wahine noho mauna	Endemic	Occasional	
Polypodiaceae	*Adenophorus pinnatifidus* var. *rockii*	Wahine noho mauna	Endemic		x
Polypodiaceae	*Adenophorus tamariscinus*	Wahine noho mauna	Endemic	Occasional	
Polypodiaceae	*Adenophorus tenellus*	Kolokolo	Endemic	Occasional	
Pteridaceae	*Adiantum hispidulum*	Rough maidenhair fern	Non-native	Occasional	
Pteridaceae	*Adiantum raddianum*	Maidenhair fern	Non-native	Occasional	
Asteraceae	*Ageratina adenophora*	Maui pamakani	Non-native	Occasional	
Asteraceae	*Ageratina riparia*	Hamakua pamakani	Non-native	Occasional	
Asteraceae	*Ageratum conyzoides*	Billygoat weed	Non-native	Occasional	
Euphorbiaceae	*Aleurites moluccana*	Kukui nut	Non-native	Rare	
Apocynaceae	*Alyxia stellata*	Maile	Indigenous	Rare	
Thelypteridaceae	*Amauropelta globulifera*	Palapalai a Kamapuaa	Endemic		x

Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Primulaceae	*Anagallis arvensis*	Scarlet pimpernel	Non-native	Occasional	
Poaceae	*Andropogon virginicus*	Broomsedge	Non-native	Occasional	
Poaceae	*Anthoxanthum odoratum*	Sweet vernal grass	Non-native	Occasional	
Caryophyllaceae	*Arenaria serpyllifolia*	Thyme-leaved sandwort	Non-native	Occasional	
Apocynaceae	*Asclepias physocarpa*	Balloon plant	Non-native	Occasional	
Aspleniaceae	*Asplenium acuminatum*	Lola	Endemic	Occasional	
Aspleniaceae	*Asplenium contiguum*	Asplenium	Endemic	Occasional	
Aspleniaceae	*Asplenium insiticium*	Piipii lau manamana	Indigenous	Occasional	
Aspleniaceae	*Asplenium macraei*	Iwaiwa lau lii	Endemic?	Occasional	
Aspleniaceae	*Asplenium normale*	Asplenium	Indigenous	Occasional	
Aspleniaceae	*Asplenium polyodon*	Punana manu	Indigenous		x
Aspleniaceae	*Asplenium unilaterale*	Pamoho	Indigenous	Occasional	
Aspleniaceae	*Asplenium x flagrum*	Asplenium	Endemic		x
Asteliaceae	*Astelia menziesiana*	Painiu	Endemic	Occasional	
Woodsiaceae	*Athyrium microphyllum*	Akolea	Endemic	Occasional	
Poaceae	*Axonopus fissifolius*	Narrow-leaved carpetgrass	Non-native	Common	
Asteraceae	*Bidens pilosa*	Spanish needle	Non-native	Occasional	
Blechnaceae	*Blechnum appendiculatum*	Blechnum	Non-native	Occasional	
Hydrangeaceae	*Broussaisia arguta*	Kanawao	Endemic	Occasional	
Hymenophyllaceae	*Callistopteris baldwinii*	Callistopteris	Endemic		x
Cyperaceae	*Carex alligata*	Carex	Endemic	Occasional	
Cyperaceae	*Carex longii*	Carex	Non-native	Occasional	
Cyperaceae	*Carex meyenii*	Carex	Indigenous		x
Cyperaceae	*Carex wahuensis*	Carex	Endemic	Occasional	
Scrophulariaceae	*Castlleja arvensis*	Indian paintbrush	Non-native		x
Poaceae	*Cenchrus clandestinus*	Kikuyu grass	Non-native	Occasional	
Caryophyllaceae	*Cerastium fontanum* subsp. *vulgare*	Mouse-ear chickweed	Non-native	Rare	
Fabaceae	*Chamaecrista nictitans*	Partridge pea	Non-native	Occasional	
Araliaceae	*Cheirodendron trigynum*	Olapa	Endemic	Common	
Poaceae	*Chrysopogon aciculatus*	Manienie ula	Indigenous	Occasional	
Dicksoniaceae	*Cibotium glaucum*	Hapuu	Endemic	Occasional	
Dicksoniaceae	*Cibotium menziesii*	Hapuu ii	Endemic	Occasional	
Asteraceae	*Cirsium vulgare*	Bull thistle	Non-native	Occasional	
Campanulaceae	*Clermontia arborescens* subsp. *waihiae*	Oha wai nui	Endemic	Occasional	
Campanulaceae	*Clermontia grandiflora*	Oha wai nui	Endemic		x
Melastomataceae	*Clidemia hirta*	Coster's curse	Non-native	Occasional	
Pteridaceae	*Coniogramme pilosa*	Loulu	Endemic	Occasional	
Asteraceae	*Conyza bonariensis*	Hairy horseweed	Non-native	Occasional	
Asteraceae	*Conyza canadensis* var. *pusilla*	Horseweed	Non-native	Occasional	

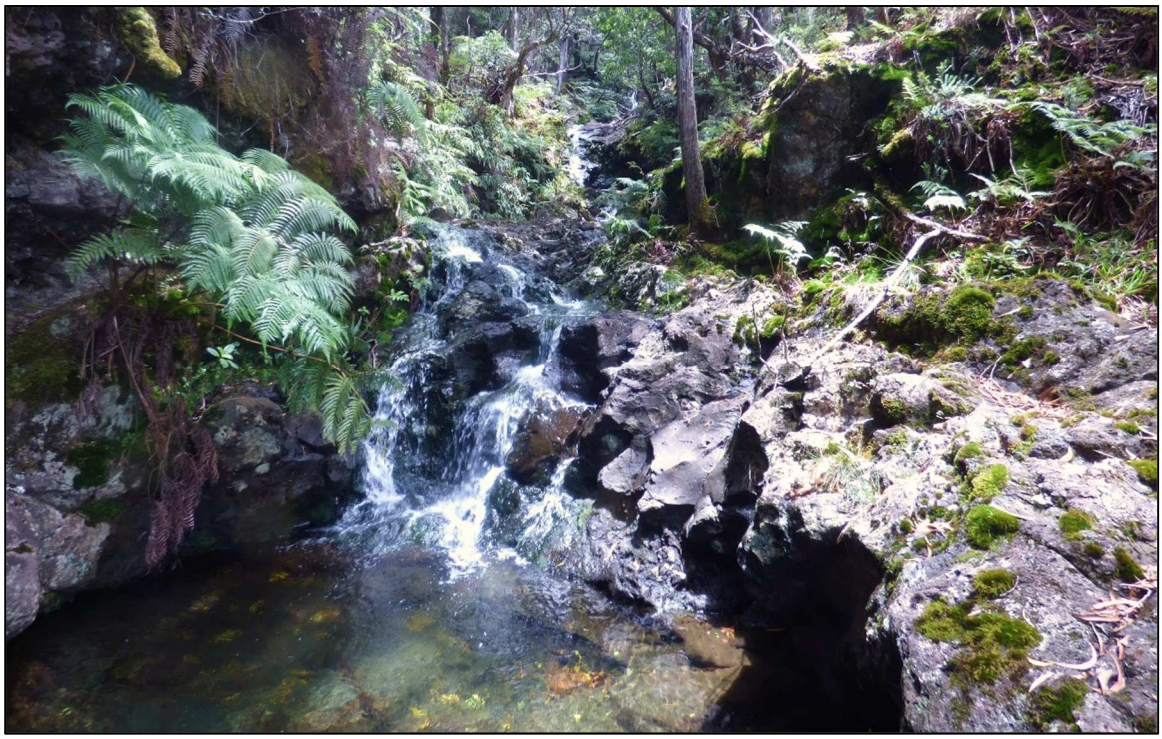
Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Rubiaceae	*Coprosma ernodeoides*	Kukaenene	Endemic	Occasional	
Rubiaceae	*Coprosma foliosa*	Pilo	Endemic	Common	
Rubiaceae	*Coprosma ochracea*	Pilo	Endemic	Rare	
Fabaceae	*Crotalaria* sp.	Rattle pod	Non-native	Rare	
Dryopteridaceae	*Ctenitis latifrons*	Akolea	Endemic		x
Lythraceae	*Cuphea carthagenensis*	Cuphea	Non-native	Occasional	
Campanulaceae	*Cyanea aculeatiflora*	Haha	Endemic	Rare	
Campanulaceae	*Cyanea hamatiflora*	Haha	Endemic		x
Campanulaceae	*Cyanea kunthiana*	Haha	Endemic		x
Campanulaceae	*Cyanea macrostegia*	Haha	Endemic		x
Asteraceae	*Cyanthillium cinereum*	Little ironweed	Non-native	Rare	
Thelypteridaceae	*Cyclosorus cyatheoides*	Kikawaio	Endemic	Occasional	
Thelypteridaceae	*Cyclosorus sandwicensis*	Hoio kula	Endemic	Occasional	
Poaceae	*Cynodon dactylon*	Bermuda grass	Non-native	Rare	
Gesneriaceae	*Cyrtandra grayi*	Haiwale	Endemic		x
Gesneriaceae	*Cyrtandra hashimotoi*	Haiwale	Endemic		x
Gesneriaceae	*Cyrtandra platyphylla*	Ilihia	Endemic		x
Gesneriaceae	*Cyrtandra* sp.	Haiwale	Endemic	Rare	
Athyriaceae	*Deparia petersenii*	Deparia	Non-native	Common	
Athyriaceae	*Deparia prolifera*	Deparia	Endemic		x
Poaceae	*Deschampsia nubigena*	Hairgrass	Endemic	Common	
Fabaceae	*Desmodium incanum*	Desmodium	Non-native	Rare	
Asphodelaceae	*Dianella sandwicensis*	Ukiuki	Indigenous		x
Gleicheniaceae	*Dicranopteris linearis*	Uluhe	Indigenous	Rare	
Poaceae	*Digitaria ciliaris*	Henry's crabgrass	Non-native	Rare	
Poaceae	*Digitaria violascens*	Violet crab grass	Non-native	Occasional	
Woodsiaceae	*Diplazium sandwichianum*	Pohole	Endemic	Common	
Gleicheniaceae	*Diplopterygium pinnatum*	Uluhe lau nui	Endemic	Common	
Sapindaceae	*Dodonaea viscosa*	Aalii	Indigenous	Occasional	
Blechnaceae	*Doodia kunthiana*	Okupukupu	Endemic	Occasional	
Caryophyllaceae	*Drymaria cordata* var. *pacifica*	West Indian chickweed	Non-native	Occasional	
Dryopteridaceae	*Dryopteris fusco-atra*	Dryopteris	Endemic	Common	
Dryopteridaceae	*Dryopteris glabra*	Kilau	Endemic	Common	
Dryopteridaceae	*Dryopteris rubiginosa*	Dryopteris	Endemic		x
Dryopteridaceae	*Dryopteris unidentata* var. *unidentata*	Akole	Endemic		x
Dryopteridaceae	*Dryopteris wallichiana*	Laukahi	Indigenous	Common	
Asteraceae	*Dubautia plantaginea* subsp. *plantaginea*	Naenae	Endemic		x
Dryopteridaceae	*Elaphoglossum crassifolium*	Hoe a Maui	Endemic	Occasional	
Dryopteridaceae	*Elaphoglossum paleaceum*	Makue	Indigenous	Occasional	
Elaphoglossaceae	*Elaphoglossum parvisquameum*	Hoe a Maui	Endemic		x

Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Elaphoglossaceae	*Elaphoglossum wawrae*	Laukahi	Endemic		x
Myrsinaceae	*Embelia pacifica*	Kilioe	Endemic		x
Poaceae	*Eragrostis brownei*	Sheepgrass	Non-native	Occasional	
Poaceae	*Eragrostis grandis*	Eragrostis	Endemic	Rare	
Poaceae	*Eragrostis variabilis*	Emoloa	Endemic	Rare	
Asteraceae	*Erechtites valerianifolia*	Fireweed	Non-native	Occasional	
Asteraceae	*Euchiton japonicus*	Euchiton	Non-native		x
Poaceae	*Festuca myuros*	Rat tail fescue	Non-native	Occasional	
Poaceae	*Festuca rubra*	Red fescue	Non-native		x
Pandanaceae	*Freycinetia arborea*	Ieie	Indigenous	Occasional	
Asteraceae	*Gamochaeta* sp.	Gamochaeta	Non-native	Occasional	
Geraniaceae	*Geranium homeanum*	Cranesbill	Non-native	Occasional	
Proteaceae	*Grevillea robusta*	Silky oak	Non-native	Occasional	
Zingiberaceae	*Hedychium gardnerianum*	Kahili ginger	Non-native	Occasional	
Begoniaceae	*Hillebrandia sandwicensis*	Pua maka nui	Endemic		x
Poaceae	*Holcus lanatus*	Yorkshire fog	Non-native	Common	
Lycopodiaceae	*Huperzia mannii*	Huperzia	Endemic		x
Lycopodiaceae	*Huperzia pyhllantha*	Huperzia	Indigenous	Occasional	
Hymenophyllaceae	*Hymenophyllum lanceolatum*	Palai hinahina	Endemic	Occasional	
Hymenophyllaceae	*Hymenophyllum recurvum*	Ohia ku	endemic	Occasional	
Asteraceae	*Hypochoeris radicata*	Hairy cats ear	Non-native	Occasional	
Dennstaedtiaceae	*Hypolepis hawaiiensis* var. *hawaiiensis*	Olua	Endemic		x
Aquifoliaceae	*Ilex anomala*	Kawau	Indigenous	Occasional	
Fabaceae	*Indigofera suffruticosa*	Indigo	Non-native	Occasional	
Rubiaceae	*Kadua affinis*	Manono	Endemic	Occasional	
Rubiaceae	*Kadua axillaris*	Manono	Endemic		x
Rubiaceae	*Kadua centranthoides*	Manono	Endemic	Rare	
Santalaceae	*Korthalsella* cf. *latissima*	Hulumoa	Endemic		x
Santalaceae	*Korthalsella complanata*	Hulumoa	Indigenous	Rare	
Santalaceae	*Korthalsella cylindrica*	Hulumoa	Endemic	Rare	
Cyperaceae	*Kyllinga brevifolia*	Green kyllinga	Non-native	Occasional	
Loganiaceae	*Labordia hirtella*	Kamakahala	Endemic		x
Loganiaceae	*Labordia venosa*	Kamakahala	Endemic		x
Poaceae	*Lachnagrostis filiformis*	Huepueo	Indigenous	Occasional	
Verbenaceae	*Lantana camara*	Lantana	Non-native	Common	
Asteraceae	*Lapsana communis*	Nipplewort	Non-native	Occasional	
Polypodiaceae	*Lepisorus thunbergianus*	Pakahakaha	Indigenous	Rare	
Ericaceae	*Leptecophylla tameiameiae*	Pukiawe	Indigenous	Dominant	
Campanulaceae	*Lobelia hypoleuca*	Lobelia	Endemic	Rare	
Juncaceae	*Luzula hawaiiensis*	Luzula	Endemic	Rare	
Lycopodiaceae	*Lycopodiella cernua*	Wawaeiole	Indigenous	Occasional	
Lythraceae	*Lythrum maritimum*	Lythrum	Non-native	Occasional	
Cyperaceae	*Machaerina angustifolia*	Uki	Endemic	Rare	

Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Marattiaceae	*Marattia douglasii*	Pala	Endemic	Occasional	
Rutaceae	*Melicope* cf. *volcanica*	Alani	Endemic		x
Rutaceae	*Melicope clusiifolia*	Alani	Endemic	Occasional	
Rutaceae	*Melicope molokaiensis*	Alani	Endemic	Occasional	
Rutaceae	*Melicope* sp.	Alani	Endemic	Occasional	
Poaceae	*Melinis minutiflora*	Molasses grass	Non-native	Occasional	
Poaceae	*Melinis repens*	Natal red top	Non-native	Occasional	
Myrtaceae	*Metrosideros polymorpha* var. *glaberrima*	Ohia	Endemic	Dominant	
Myrtaceae	*Metrosideros polymorpha* var. *incana*	Ohia	Endemic	Dominant	
Dennstaedtiaceae	*Microlepia strigosa* var. *mauiensis*	Hairy palapalai	Endemic		x
Dennstaedtiaceae	*Microlepia strigosa* var. *strigosa*	Palapalai	Endemic	Occasional	
Myoporaceae	*Myoporum sandwicensis*	Naio	Endemic	Rare	
Primulaceae	*Myrsine lessertiana*	Kolea lau nui	Endemic	Occasional	
Lomariopsidaceae	*Nephrolepis brownii*	Asian sword fern	Non-native	Occasional	
Lomariopsidaceae	*Nephrolepis cordifolia*	Kupukupu lau lii	Indigenous	Rare	
Rubiaceae	*Nertera granadensis*	Makole	Indigenous		x
Lindsaeaceae	*Odontosoria chinensis*	Palaa	Indigenous	Common	
Grammitidaceae	*Oreogrammitis hookeri*	Makue lau lii	Endemic		x
Oxalidaceae	*Oxalis corniculata*	Yellow wood sorrel	Non-native	Occasional	
Poaceae	*Paspalum conjugatum*	Hilo grass	Non-native	Rare	
Passifloraceae	*Passiflora edulis*	Passionvine	Non-native	Rare	
Passifloraceae	*Passiflora subpeltata*	White passion flower	Non-native	Occasional	
Piperaceae	*Peperomia blanda*	Alaala wai nui	Indigenous	Occasional	
Piperaceae	*Peperomia cookiana*	Alaala wai nui	Endemic	Occasional	
Piperaceae	*Peperomia hirtipetiola*	Alaala wai nui	Endemic		x
Piperaceae	*Peperomia latifolia*	Alaala wai nui	Endemic		x
Piperaceae	*Peperomia macraeana*	Alaala wai nui	Endemic	Occasional	
Piperaceae	*Peperomia tetraphylla*	Alaala wai nui	Indigenous	Occasional	
Dipentodontaceae	*Perrottetia sandwicensis*	Olomea	Endemic	Occasional	
Lauraceae	*Persea americana*	Avocado	Non-native	Rare	
Caryophyllaceae	*Petrorhagia velutina*	Childing pink	Non-native	Rare	
Polypodiaceae	*Phlebodium aureum*	Lauae haole	Non-native	Rare	
Solanaceae	*Physalis peruviana*	Poha	Non-native	Occasional	
Phytolaccaceae	*Phytolacca sandwicensis*	Popolo ku mai	Endemic	Rare	
Urticaceae	*Pilea peploides*	Nettle	Indigenous	Occasional	
Urticaceae	*Pipturus albidus*	Mamaki	Endemic	Occasional	
Pittosporaceae	*Pittosporum glabrum*	Hoawa	Endemic		x
Pteridaceae	*Pityrogramma austroamericana*	Golden fern	Non-native	Occasional	
Polypodiaceae	*Polypodium pellucidum*	Ae	Endemic	Rare	
Araliaceae	*Polyscias oahuensis*	Ohe	Endemic	Rare	

Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Lamiaceae	*Prunella vulgaris*	Selfheal	Non-native	Occasional	
Thelypteridaceae	*Pseudophegopteris keraudreniana*	Waimakanui	Endemic		x
Myrtaceae	*Psidium cattleianum*	Strawberry guava	Non-native	Dominant	
Myrtaceae	*Psidium guajava*	Guava	Non-native	Occasional	
Psilotaceae	*Psilotum complanatum*	Moa nahele	Indigenous	Occasional	
Psilotaceae	*Psilotum nudum*	Moa	Indigenous	Occasional	
Rubiaceae	*Psychotria hawaiiensis*	Kopiko	Endemic	Rare	
Rubiaceae	*Psychotria kaduana*	Kopiko kea	Endemic		x
Rubiaceae	*Psydrax odorata*	Alahee	Indigenous	Rare	
Hypolepidaceae	*Pteridium aquilinum* subsp. *decompositum*	Kilau, bracken fern	Indigenous	Occasional	
Pteridaceae	*Pteris cretica*	Cretan brake	Indigenous	Occasional	
Pteridaceae	*Pteris irregularis*	Mana	Endemic		x
Pteridaceae	*Pteris terminalis*	Waimakanui	Indigenous		x
Rubiaceae	*Richardia brasiliensis*	Richardia	Non-native	Occasional	
Euphorbiaceae	*Ricinus communis*	Castor bean	Non-native	Occasional	
Rosaceae	*Rubus argutus*	Prickly Florida blackberry	Non-native		x
Rosaceae	*Rubus hawaiensis*	Akala	Endemic	Occasional	
Rosaceae	*Rubus rosifolius*	Thimble berry	Non-native	Common	
Poaceae	*Sacciolepis indica*	Glenwood grass	Non-native	Occasional	
Blechnaceae	*Sadleria cyatheoides*	Amau	Endemic	Common	
Blechnaceae	*Sadleria pallida*	Amau	Endemic	Common	
Blechnaceae	*Sadleria souleyetiana*	Amau	Endemic		x
Blechnaceae	*Sadleria squarrosa*	Amau	Endemic	Rare	
Goodeniaceae	*Scaevola chamissoniana*	Naupaka kuahiwi	Endemic	Occasional	
Anacardiaceae	*Schinus terebinthifolius*	Christmasberry	Non-native	Dominant	
Selaginellaceae	*Selaginella arbuscula*	Lepelepe a moa	Endemic	Occasional	
Asteraceae	*Senecio madagascariensis*	Fireweed	Non-native	Occasional	
Asteraceae	*Senecio sylvaticus*	Wood groundsel	Non-native	Occasional	
Fabaceae	*Senna septemtrionalis*	Senna	Non-native	Occasional	
Poaceae	*Setaria parviflora*	Yellow foxtail	Non-native	Occasional	
Smilacaceae	*Smilax melastomifolia*	Hoi kuahiwi	Endemic	Occasional	
Solanaceae	*Solanum americanum*	Popolo	Indigenous ?		x
Solanaceae	*Solanum linnaeanum*	Apple of Sodom	Non-native	Occasional	
Asteraceae	*Sonchus oleraceus*	Sow thistle	Non-native		x
Fabaceae	*Sophora chrysophylla*	Mamane	Endemic		x
Rubiaceae	*Spermacoce assurgens*	Buttonweed	Non-native	Rare	
Cyatheaceae	*Sphaeropteris cooperi*	Australian tree fern	Non-native	Occasional	
Poaceae	*Sporobolus indicus*	Smut grass	Non-native	Common	
Verbenaceae	*Stachytarpheta australis*	Vervain	Non-native	Occasional	

Family	Scientific Name	Common Name	Nativity	Abundance	Hank
Verbenaceae	*Stachytarpheta jamaicensis*	Jamaica vervain	Non-native		x
Grammitidaceae	*Stenogrammitis saffordii*	Kihe	Endemic		x
Lamiaceae	*Stenogyne kamehamehae*	Kamakahala	Endemic		x
Gleicheniaceae	*Sticherus owhyhensis*	Uluhe	Endemic	Occasional	
Myrtaceae	*Syzygium cumini*	Java plum	Non-native	Occasional	
Asteraceae	*Taraxacum officinale*	Common dandelion	Non-native	Occasional	
Dryopteridaceae	*Tectaria gaudichaudii*	Iwaiwa lau nui	Endemic		x
Melastomataceae	*Tibouchina herbacea*	Cane tibouchina	Non-native	Occasional	
Poaceae	*Trisetum glomeratum*	Pili uka	Endemic	Occasional	
Malvaceae	*Triumfetta semitriloba*	Sacramento bur	Non-native	Rare	
Cyperaceae	*Uncinia uncinata*	Hook sedge	Indigenous	Occasional	
Urticaceae	*Urera glabra*	Opuhe	Endemic		x
Ericaceae	*Vaccinium calycinum*	Ohelo	Endemic	Occasional	
Ericaceae	*Vaccinium dentatum*	Ohelo	Endemic		x
Ericaceae	*Vaccinium reticulatum*	Ohelo	Endemic	Occasional	
Hymenophyllaceae	*Vandenboschia cyrtotheca*	Vandenboschia	Endemic		x
Hymenophyllaceae	*Vandenboschia davallioides*	Palai hihi	Endemic	Occasional	
Thymeliaceae	*Wikstroemia monticola*	Akia	Endemic	Occasional	
Thymeleaceae	*Wikstroemia villosa*	Akia	Endemic		x
Asteraceae	*Youngia japonica*	Oriental hawksbeard	Non-native	Occasional	



Lush mix of native plants along wet forest stream in the Kipahulu Forest Reserve.

Additional Plants From 1976 Survey

Paul Higashino and Geary Mizuno were the botanists on the 1976 Manawainui Research Project, which spent two months surveying plants in the area. Their survey area included Manawainui Valley, a section of the reserve recent surveys have not been to, due to the danger of falling rocks from the towering unstable cliffs above the stream.

The vegetation types were about the same in 1976 as they are now. However, the upper elevation of dense strawberry guava (*Psidium cattleianum*) has crept higher. Also, 42 years of ungulate browsing between the two surveys has reduced the native vegetation and allowed inroads for weeds into the more intact areas of the reserve.

The plants listed below were previously reported from the 1976 survey, but were not observed in more recent surveys by ourselves and Hank Oppenheimer. Many of these were in the Manawainui Valley section, which we did not survey. Though others were in habitat types that were more recently surveyed. Beyond the Manawainui Valley section we didn't survey, it is unknown if the plants no longer persist, were overlooked, or are in a location that was not visited by more recent surveys.

Natives
Anoectochilus sandvicensis (Honohono)
Artemisia mauiensis (Hinahina)
Cocculus orbiculatus [*ferrandianus*] (Hue hue)
Liparis hawaiiensis (Awapuhi a Kanaloa)
Nothocestrum sp. (Aiea)
Osteomeles anthyllidifolia (Ulei)
Pisonia brunoniana (Papala kepau)
Pouteria [*Planchonella*] *sandwicensis* (Alaa)

Non-natives
Alocasia sp.
Coix lacryma-jobi (Job's tears)
Mangifera indica (Mango)
Melia azedarach (Pride of India)
Verbena litoralis (Vervain)

Red, orange, and yellow ohia blooms in the Kipahulu Forest Reserve.

FAUNAL SURVEY

SURVEY METHODS

A walk-through survey method was conducted in conjunction with the botanical survey. Field observations were made with the aid of binoculars and by listening to vocalizations. A series of five minute point counts for birds were made across various habitats. The reserve was surveyed in July and August of 2018.

Notes were made on species, abundance, activities and location as well as observations of trails, tracks, scat and signs of feeding. Conspicuous insects were noted and a sweep net was used to get closer looks at cryptic species. An Anabat Express passive bat detector that records ultrasonic bat calls in zero-crossing format was also deployed to gather information on Hawaiian Hoary Bats (*Lasiurus cinereus semotus*).

In addition, the 1976 Manawainui Research Project report was reviewed. This report, from a two month long survey of the Manawainui planeze area, included chapters on mammals, birds, and insects, which provided insights into faunal similarities and differences in the Kipahulu Forest Reserve over time.

Looking and listening for wildlife during five minute point count in Kipahulu Forest Reserve.

Sweeping vegetation for insects.

Bat detector deployed to record ultrasonic bat pulses at night.

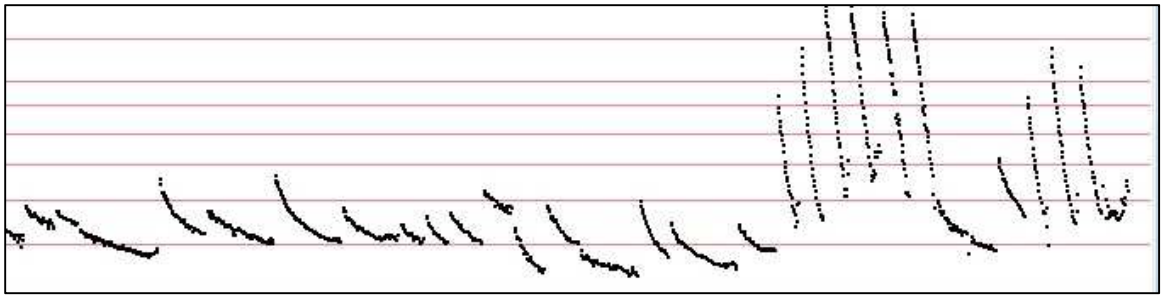
BATS

Native Hawaiian Hoary Bats (*Lasiurus cinereus semotus*) are present over all of East Maui, and some of their highest numbers occur in forested sections of the mid-elevations. The 1976 Manawainui Research Project saw one bat at dusk near their camp on the edge of Kaupo Gap. And more recently, DOFAW staff report regularly seeing bats at dusk in the reserve, especially towards the Kaupo Gap side.

To confirm and better determine bat presence in the reserve, we deployed a bat detector at "Cow Pie LZ", on the western part of the reserve, near Kaupo Gap at about 4,400 ft. elevation, in open koa forest facing a large gulch.

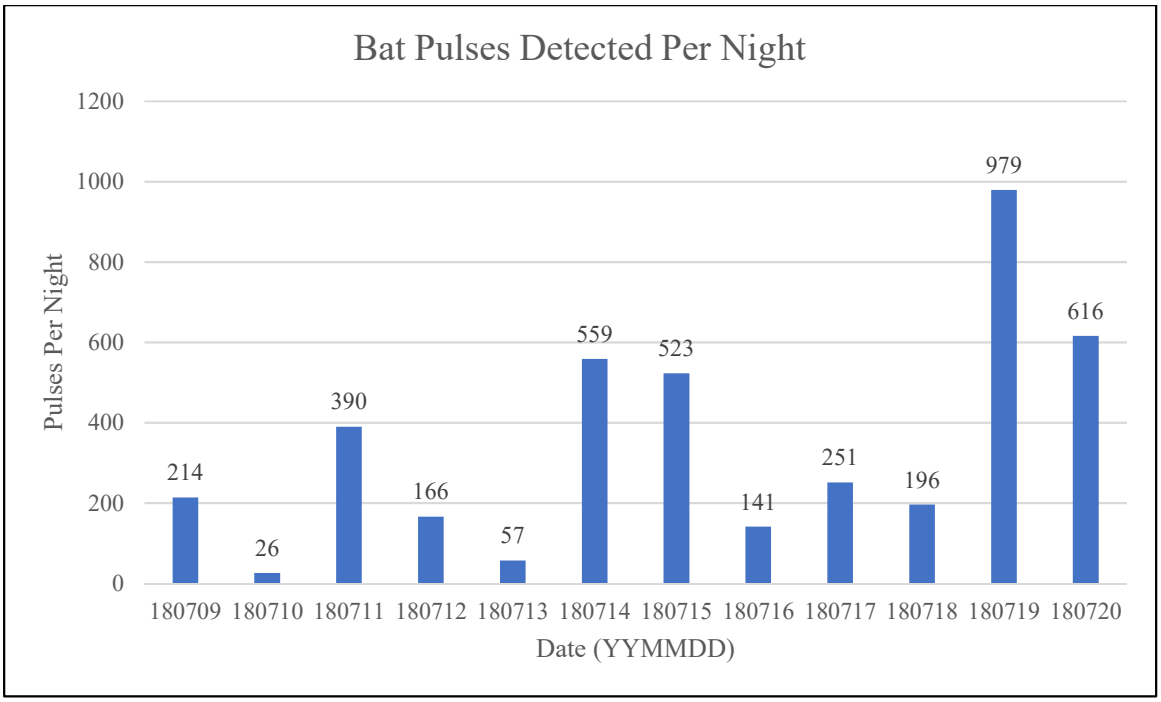
Results of ten nights of data show bats are in the reserve every night. The bats were active all night, especially in the hours after sunset. The regular detection of bat calls very near sunset suggests the bats are roosting in the area.

There were 4,118 pulses detected in ten nights, for an average of 411 pulses per night. Detections varied from 26 to 979 pulses each night. There were both long, drawn-out, lower-pitch transiting pulses, as well as quicker, higher-pitched feeding buzzes.

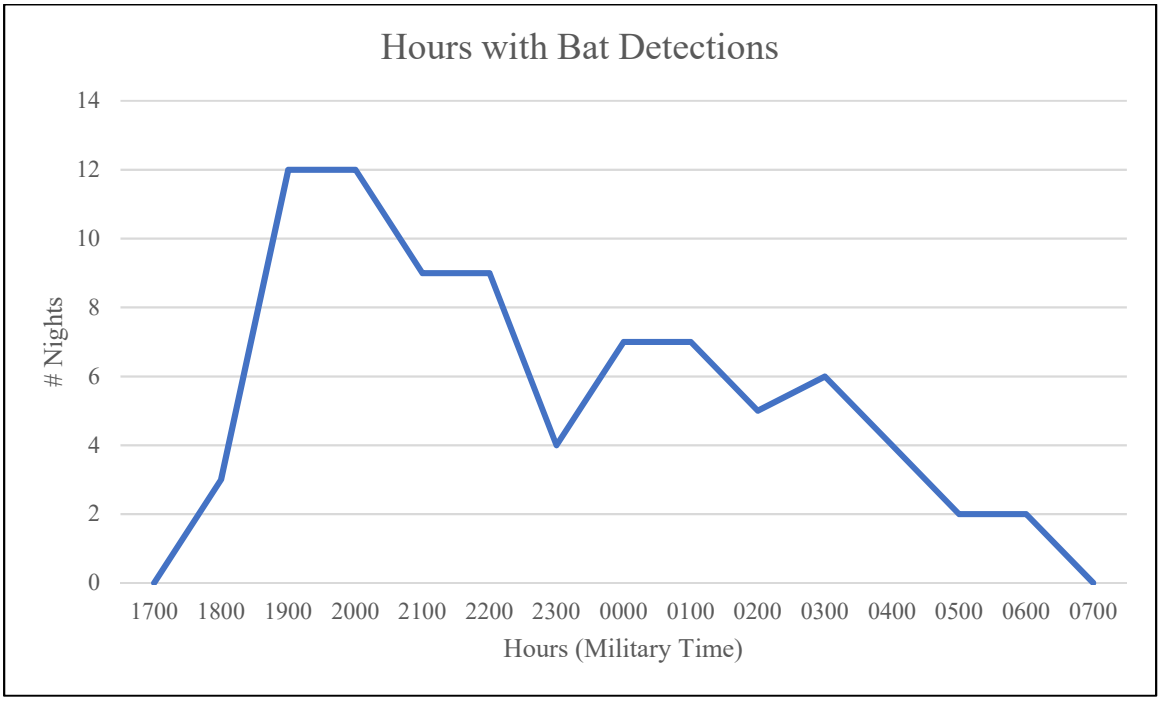


Time compressed sonogram of ultrasonic bat calls recorded at Kipahulu Forest Reserve.

Hawaiian Hoary Bat, Olinda, Maui.



Number of bat pulses detected each night. The 411 average pulses per night is comparable to similar areas with abundant bats in mesic open forest on East Maui. It's also much higher than recorded in nearby Kahikinui Forest Reserve, which only averaged 37 pulses per night, though that study lasted much longer, and seasonal variation in bat detections is likely.



Number of nights that each hour had bat detections. Bats were most active immediately after sunset and became less active as the night progressed. By dawn bat activity ceased. This is similar to other areas on East Maui where bats are abundant.

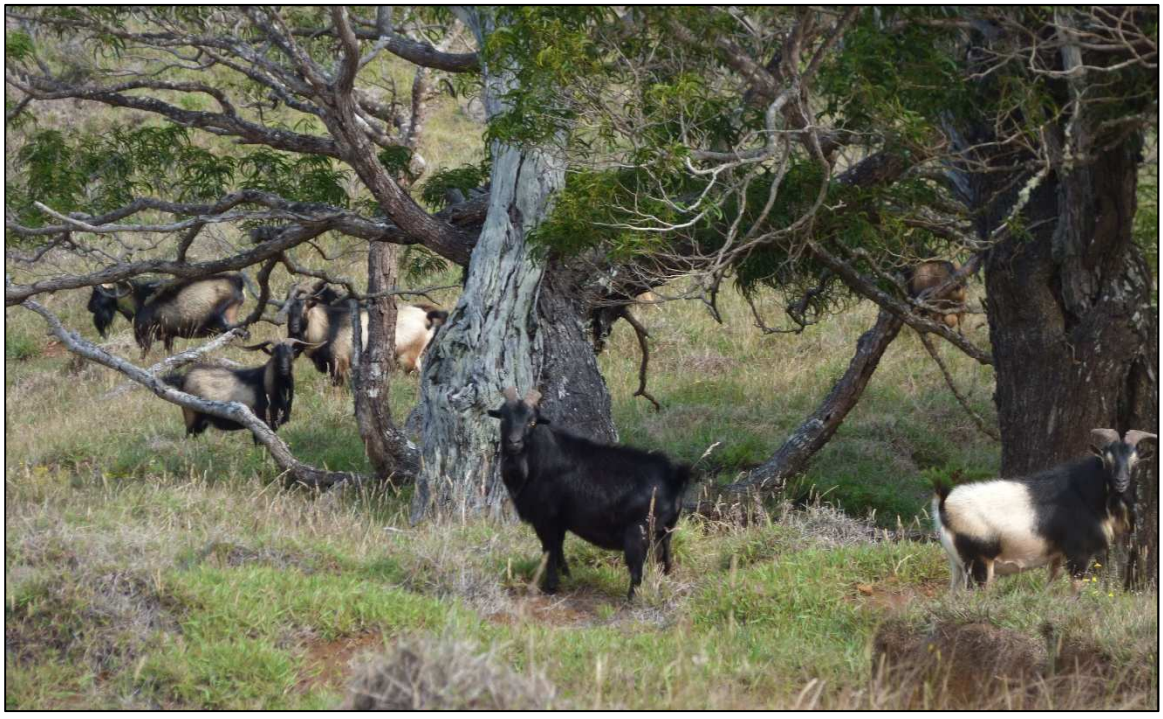
NON-NATIVE MAMMALS

The Kipahulu Forest Reserve has numerous feral goats (*Capra hircus*), pigs (*Sus scrofa*), and axis deer (*Axis axis*). The goats and deer are most abundant in drier areas, with pigs most prevalent in wetter areas. Along with large groups of goats, pigs, and deer, there was abundant ungulate scat, and much of the area reeked of animals. Dried up cow (*Bos taurus*) scat was present in the reserve, but no cows were observed.

A dog (*Canis lupus familiaris*) was observed running into a woody thicket near the bottom of the reserve. What appeared to be dog scat was observed in the koa parkland. Rat (*Rattus* spp.) damage on seeds, along with seed caches were visible. Other mammals likely to utilize this property, but which were not observed or heard include mice (*Mus domesticus*), cats (*Felis domesticus*), and mongooses (*Herpestes javanicus*).

Damage by feral ungulates is evident over most of the reserve, especially in the lower elevation and drier areas. An ungulate fence is being installed to exclude ungulates from the bulk of the remnant native vegetation, while allowing for continued hunting in areas that have been converted to predominantly non-native vegetation.

Sam Gon was the mammologist in the 1976 Manawainui Research Project. His accounts are similar to what we encountered, with the exception of axis deer, which are present now, but were absent in 1976. Back then there were still goats and pigs within most of adjacent Haleakala National Park. Today HALE is mostly fenced and ungulate-free, and it appears much of the Kipahulu Forest Reserve will soon be that way as well.



Feral goats in the koa parkland of Kipahulu Forest Reserve.

Ungulate damage to a kolea (*Myrsine lessertiana*) tree. Note also the lack of understory shrubs.

Ohia tree with roots exposed by ungulates, Kipahulu Forest Reserve.

Area of soil erosion in overgrazed area of the koa parkland in the Kipahulu Forest Reserve.

Pig dug area within the wet forest portion of the Kipahulu Forest Reserve.

Boundary with Haleakala National Park, with lush native forest on the Park side above the fence, and heavily grazed open grassland on the Kipahulu Forest Reserve side below the fence. This area within the reserve will soon be protected by an ungulate fence.

Axis deer on outside of recently constructed ungulate fence in the Kipahulu Forest Reserve. The fence is designed to exclude ungulates from the areas of greatest remnant native plants, while providing hunting opportunities outside the fence in the more degraded portions of the reserve.

BIRDS

Native forest birds are present, but not in large numbers. They were most abundant in the higher elevation, wetter parts of the reserve. The most common native forest birds were Apapane (*Himatione sanguinea*) and Maui Amakihi (*Chlorodrepanis virens* var. *wilsoni*). A few Iiwi (*Vestiaria coccinea*) were present near the top of the reserve at about 5,000 ft.

White-tailed Tropicbirds (*Phaethon lepturus*) were observed multiple times in the vicinity of Manawainui Valley. They nest in similar terrain elsewhere in Hawaii.

Non-native Japanese White-eye (*Zosterops japonicus*) was the most common bird species in the reserve. They were observed and heard over the entire reserve, from 2,000-5,000 ft. elevation in all habitat types. Like Japanese White-eye, Red-billed Leiothrix (*Leiothrix lutea*) were also heard and observed in all habitats and elevations of the reserve.

Scaly-breasted Munia (*Lonchura punctulata*) had the highest bird numbers, with a high count of 40 birds in a large flock in the koa parkland. They appear mostly restricted to the drier, more open, grassier areas of the reserve.

Other non-native birds encountered include Japanese Bush-warbler (*Cettia diphone*), House Finch (*Haemorhous mexicanus*), Northern Mockingbird (*Mimus polyglottos*), Northern Cardinal (*Cardinalis cardinalis*), Chinese Hwamei (*Garrulax canorus*), and Ring-necked Pheasant (*Phasianus colchicus*).

No Hawaiian Geese or Nene (*Branta sandvicensis*) were encountered, but likely could utilize the koa parkland. Hawaiian Owls or Pueo (*Asio flammeus sandwichensis*) were also not observed, but are also likely able to utilize the koa parkland. Though not encountered, Hawaiian Petrels (*Pterodroma sandwichensis*) have been reported flying over the reserve at night to nesting sites higher up the mountain.

Red-billed Leiothrix (*Leiothrix lutea*) in koa tree, Kipahulu Forest Reserve.

Comparison With 1976 Bird Survey

Maile Stemmerman was the ornithologist on the 1976 Manawainui Research Project and spent two months monitoring birds in parts of the Kipahulu Forest Reserve.

In general, the birds seem similar in 2018 to how they were in 1976, with the native passerines most abundant at the higher elevation sites with the least impact.

Birds encountered in 2018, but not in 1976 include Japanese Bush-Warblers (*Horornis diphone*), which were absent on Maui back in 1976, and Northern Mockingbirds (*Mimus polyglottos*) which were locally conspicuous in 2018, but not reported in 1976.

Though we did not encounter Nene (*Branta sandvicensis*) in 2018, the habitat in the reserve seems potentially suitable for them. In 1976, Nene were observed in the area, rarely, as low as 3,600 ft. The same is true for Chukars (*Alectoris chukar*), which were observed near Kaupo Gap in 1976, but not encountered in 2018

Other birds encountered in 1967, but not 2018, include Maui Creeper (*Paroreomyza montana*), which was observed in the denser native areas, generally not in areas with koa, and Spotted Doves (*Spilopelia chinensis*), which were observed in Manawainui Valley.

Though Pueo would seemingly be able to utilize the grassy regions of the reserve, they were not encountered in 2018 or 1976.

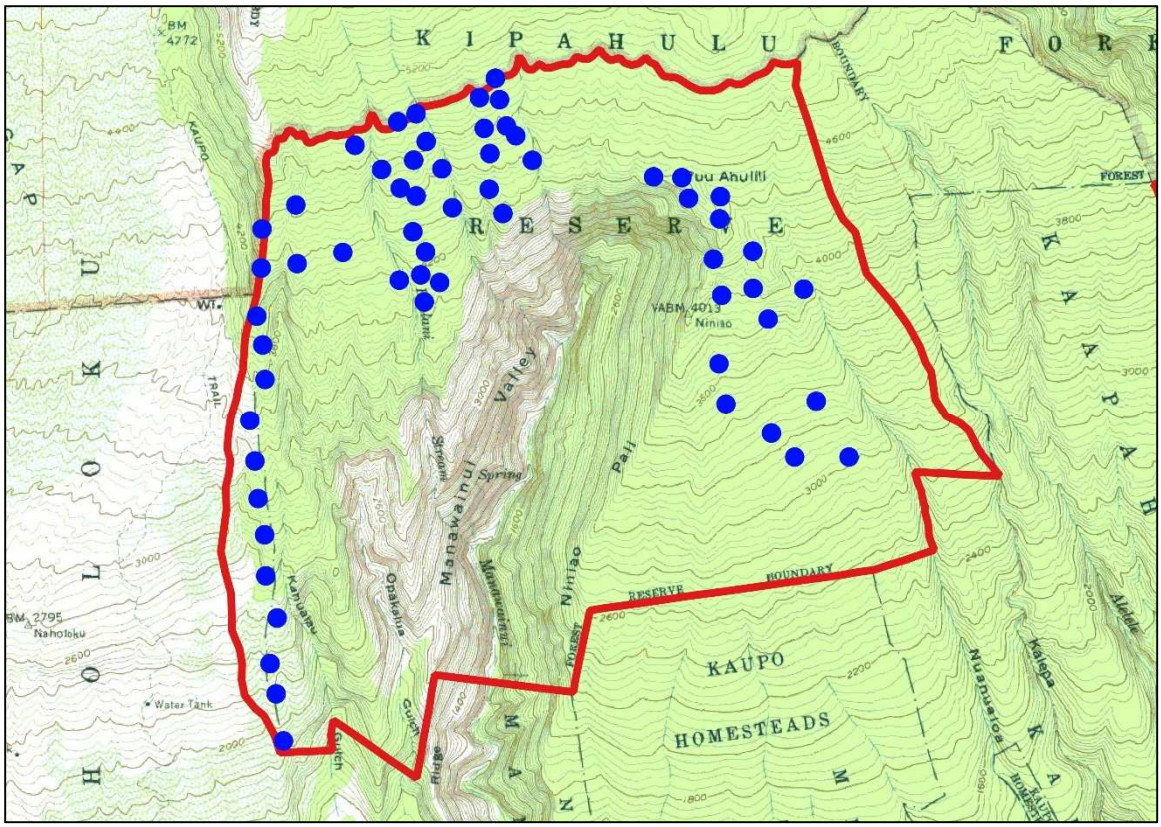
In 1976, Maile was hoping to encounter species she described as "rare", but are now considered "extinct". They were Maui Akepa (*Loxops ochraceus*), Maui Nukupuu (*Hemignathis lucidus affinis*), and Poouli (*Melamprosops phaeosoma*). We did not encounter any of these.

We also did not encounter the still extant Akohekohe (*Palmeria dolei*), which Maile did not see in the reserve, but did observe regularly just above the reserve boundary. Nor did we encounter Maui Parrotbill or Kiwikiu (*Pseudonestor xanthophrys*), which Maile also did not encounter anywhere on the Manawainui planeze.

Higher elevation, native dominated wet forest. This is where the native forest birds are most abundant in the Kipahulu Forest Reserve.

BIRD POINT COUNTS

A series of five minute point counts were done across a range of habitat types and elevations. All birds observed or heard for an unlimited distance were recorded.

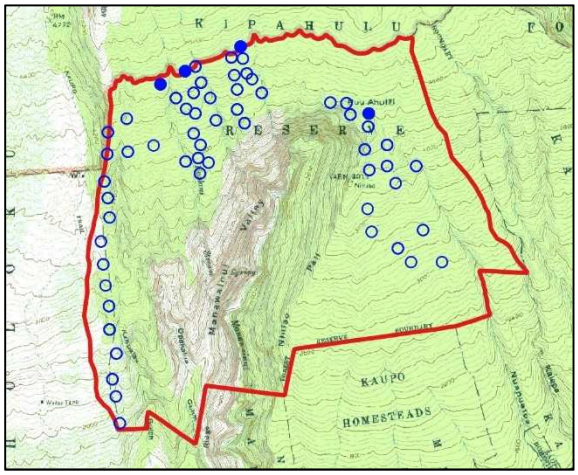


Bird point count locations.

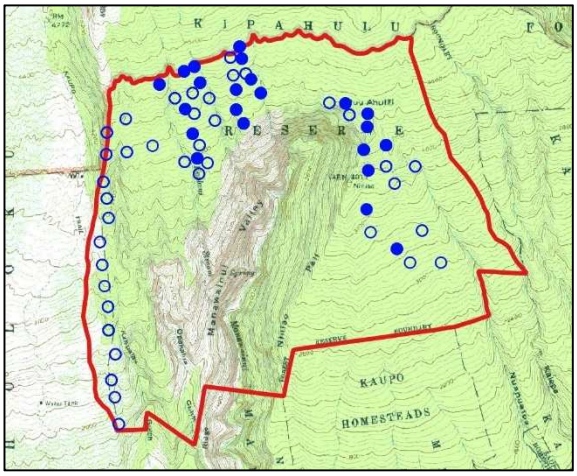
Looking and listening for birds during point count in the Kipahulu Forest Reserve.

BIRD DISTRIBUTION MAPS

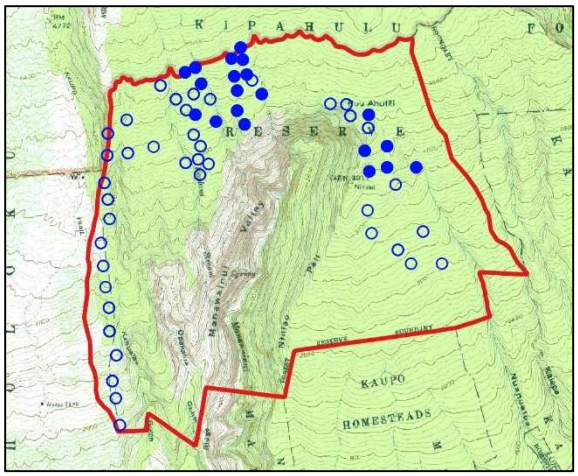
Solid blue circles indicate detection, open blue circles indicate no detection.



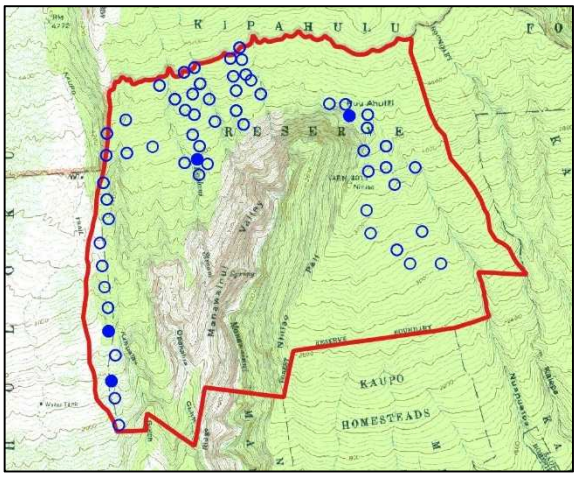
Iiwi



Apapane

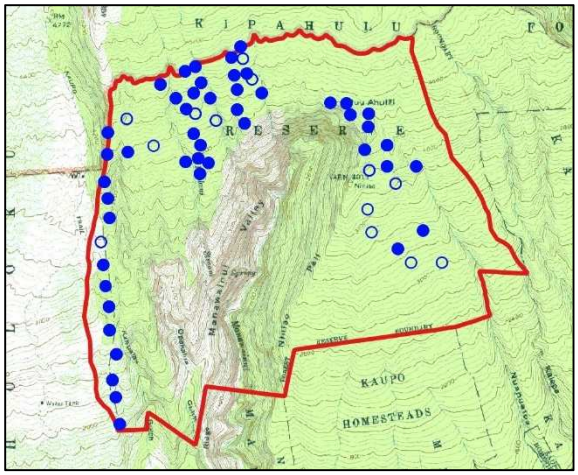


Maui Amakihi

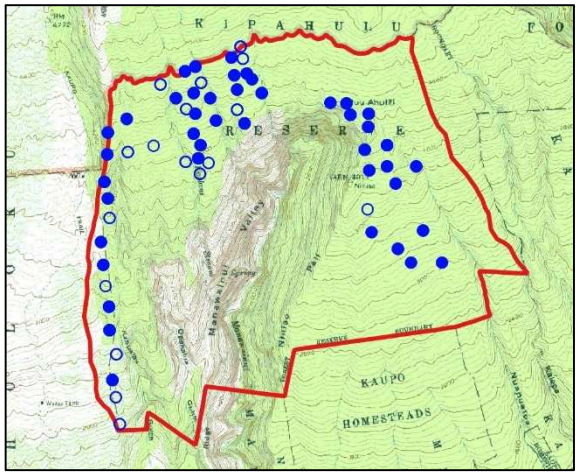


White-tailed Tropicbird

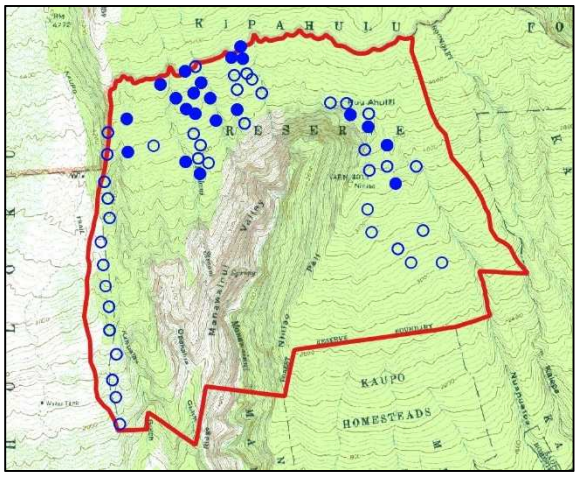
Apapane calling in ohia canopy, Kahikinui Forest Reserve.



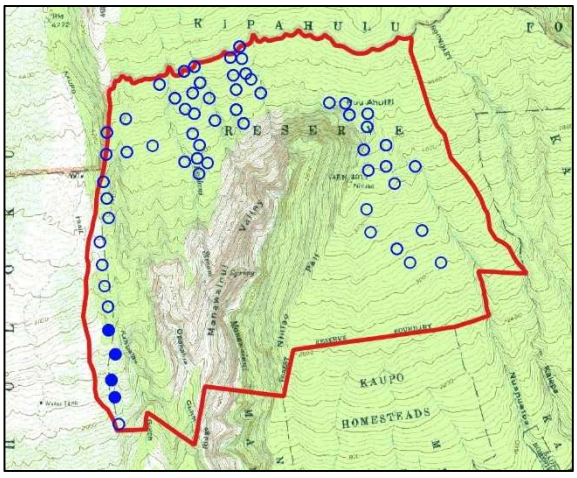
Japanese White-eye



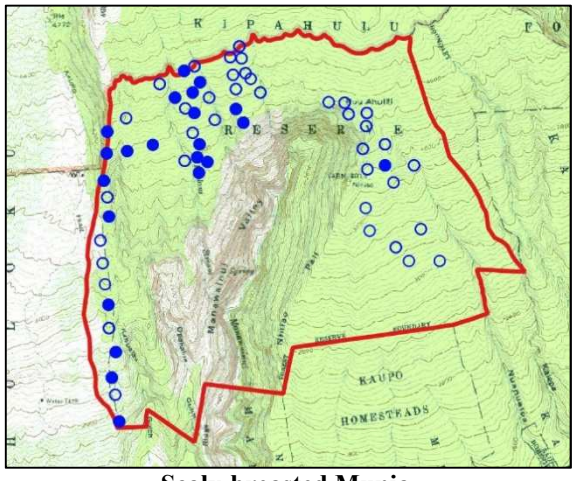
Red-billed Leiothrix



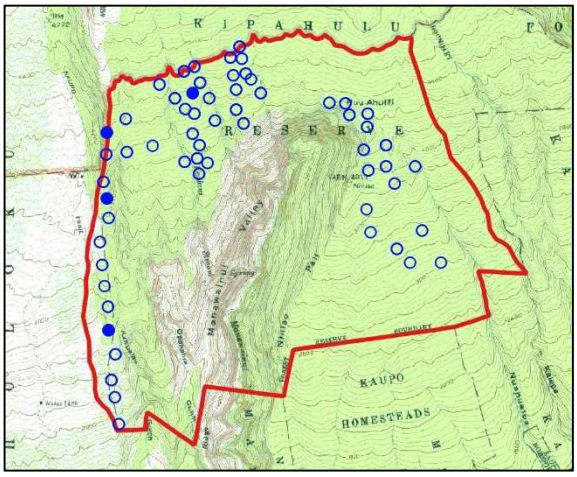
Japanese Bush-Warbler



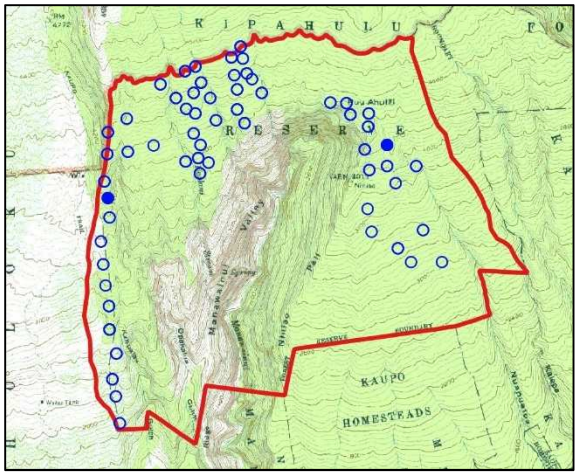
Chinese Hwamei



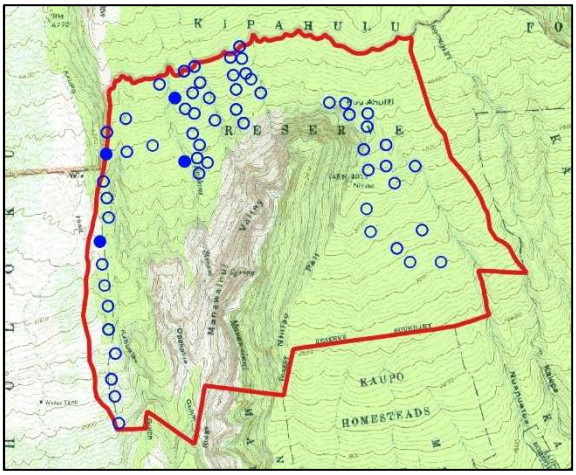
Scaly-breasted Munia



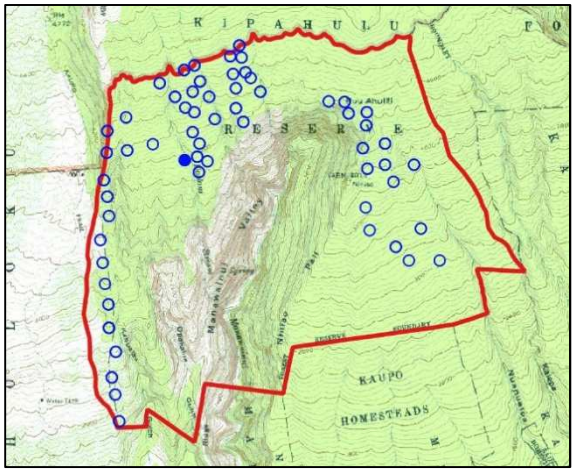
House Finch



Northern Cardinal



Northern Mockingbird



Ring-necked Pheasant

Ring-necked Pheasant, Ulupalakua.

BIRD POINT COUNT SUMMARY

Bird point count summary, sorted by elevation and abundance.

Elevation (ft.)	Japanese White-eye	Red-billed Leiothrix	Scaly Breasted Munia	Japanese Bush Warbler	Apapane	Maui Amakihi	House Finch	Iiwi	White-tailed Tropicbird	Northern Mockingbird	Chinese Hwamei	Northern Cardinal	Ring-necked Pheasant
5000	1			2	2	1		1					
5000	2	1		1		1							
5000	2	1			2	2							
5000	3	1	2	1	1	2		2					
4900	6			2	2			1					
4900				2	1	1							
4800	4	1	4	2						1			
4800	3	2				1							
4800	1	1				1							
4800	1		5	2	2	2							
4800	4	2	4	1			2						
4700		1			1								
4600		1		1									
4600	4			1	2								
4600	3	1			2	1							
4600	3	1			1	1							
4600	2	2		2									
4600		1	3	1		1							
4600	3	1		1					1				
4600	1	2			2								
4600	3	1	3				2						
4500	1		3	2	1	2							
4500	2	2		1	2								
4500	1	1											
4400			40										
4400	5		20	2									
4400	2	2			2								
4400	3	1	8		2	1							
4400		2		1		1							

Elevation (ft.)	Japanese White-eye	Red-billed Leiothrix	Scaly Breasted Munia	Japanese Bush Warbler	Apapane	Maui Amakihi	House Finch	Iiwi	White-tailed Tropicbird	Northern Mockingbird	Chinese Hwamei	Northern Cardinal	Ring-necked Pheasant
4400	1	1			1	1		1					
4400	3	1	14							1			
4300	2	1	5										
4200	4			1						1			1
4200	4	1	12		1				2				
4200	3	3			1	1							
4200	3	3		2	2	1						1	
4200	3	2	4										
4000	3		7	2									
4000	4		6										
4000	1	1	6			1							
4000		2			1	1							
4000	3	1					2					1	
3900	1	1				1							
3800		1		1									
3800	3		3										
3700					1								
3600		1								1			
3500		1											
3400	1	1											
3400	2	1											
3300	1	1			1								
3200	1												
3150		1											
3000		1											
3000	3	1	2										
2800	3								1		1		
2600	2		2								1		
2400	1	1	2						1		1		
2200	4										1		
2000	2		2										

BIRD SPECIES LIST

Following is a checklist of the bird species inventoried during the field work. For each species the following information is provided:

- Common & Scientific name

- Bio-geographical status / nativity:
  - Endemic = Native to Hawaii; not naturally occurring anywhere else in the world.
  - Indigenous = Native to Hawaii and also to one or more other geographic area(s).
  - Non-native = Brought to Hawaii intentionally or accidentally by humans.

- Abundance of each species within the project area:
  - Abundant = Many flocks or individuals seen throughout area at all times of day.
  - Common = A few flocks or well scattered individuals throughout the area.
  - Uncommon = Only one flock or several individuals seen within the project area.
  - Rare = only one or two seen within the project area.

Common name	**Scientific name**	**Nativity**	**Abundance**
Apapane	*Himatione sanguinea*	Endemic	Common
Chinese Hwamei	*Garrulax canorus*	Non-native	Occasional
House Finch	*Haemorhous mexicanus*	Non-native	Rare
Iiwi	*Vestiaria coccinea*	Endemic	Rare
Japanese Bush-warbler	*Cettia diphone*	Non-native	Common
Japanese White-eye	*Zosterops japonicus*	Non-native	Abundant
Maui Amakihi	*Chlorodrepanis virens wilsoni*	Endemic	Common
Northern Cardinal	*Cardinalis cardinalis*	Non-native	Rare
Northern Mockingbird	*Mimus polyglottos*	Non-native	Rare
Red-billed Leiothrix	*Leiothrix lutea*	Non-native	Common
Ring-necked Pheasant	*Phasianus colchicus*	Non-native	Rare
Scaly-breasted Munia	*Lonchura punctulata*	Non-native	Common
White-tailed Tropicbird	*Phaeton lepturus*	Indigenous	Occasional

Scaly-breasted Munia (*Lonchura punctulata*) in koa parkland.

INSECTS

A complete inventory of the insects was beyond the scope of this survey. Conspicuous insects were noted and special effort was made to look for insects of conservation concern. In general, there are more native insects in the areas dominated by native plants. Despite incursion by ungulates, weeds, and non-native insects, there is still an amazing diversity of native insects in the Kipahulu Forest Reserve, many undescribed. Some of the more conspicuous and noteworthy insects we came across are noted below.

Sweeping for insects in the Kipahulu Forest Reserve.

KOA BUTTERFLY

Native koa butterflies (*Udara blackburni*) (Lepidoptera: Lycaenidae) were locally abundant in the koa parkland. The larvae of this species feed on koa and aalii. As koa and aalii become more common, so too should this native butterfly.

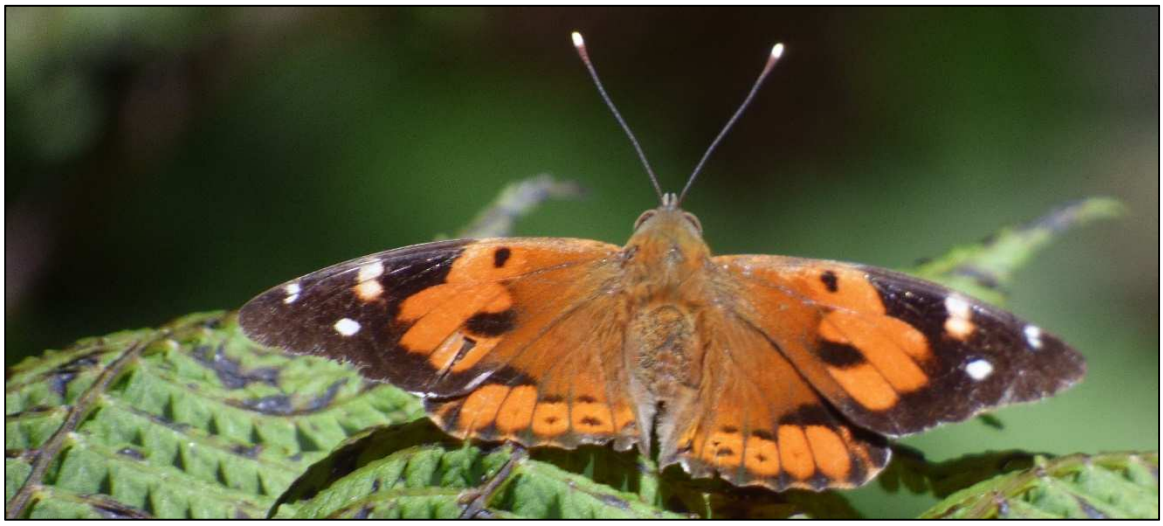
Koa butterfly (*Udara blackburni*) resting on pukiawe, Kipahulu Forest Reserve.

KAMEHAMEHA BUTTERFLY

A congregation of over a dozen Kamehameha Butterflies (*Vanessa tameamea*) was observed in a gully in the transition zone between koa parkland and wet forest. Some of the butterflies were sipping sap flux from a koa tree. Others were sunning themselves on nearby ferns. The larvae of Kamehameha Butterflies live on native Urticaceae, including mamaki (*Pipturus albidus*), which is locally common in this part of the reserve.

There are very few records of this species from this part of East Maui. In recent years this species has become less abundant over most of its range. Fencing and restoration of native habitat in the reserve should benefit this butterfly.

Will Haines, who is working on the conservation of this butterfly species suggests that given the presumably healthy population of Kamehameha Butterflies in the Kipahulu Forest Reserve, there is the potential to use it as a source population for reintroduction of this species to nearby areas that have recently been restored.



Kamehameha Butterfly sunning on fern, Kipahulu Forest Reserve.

Kamehameha Butterfly on bottom of koa branch, Kipahulu Forest Reserve.

HYPOSMOCOMA MOTHS

Native fancy-cased moths (*Hyposmocoma* spp.) (Lepidoptera: Cosmopterigidae) are abundant over much of the Kipahulu Forest Reserve. Most prevalent to our eyes were the "burrito" shaped larvae/pupae common in sheltered areas on large stones and cliff faces, especially in the koa parkland and dry forest sections. Also abundant were larvae of "cigar/carnivorous" case types, again found mostly on stones. Under the bark of dead koa were "smooth purse" case types. A few "candy wrapper" cases were also encountered.

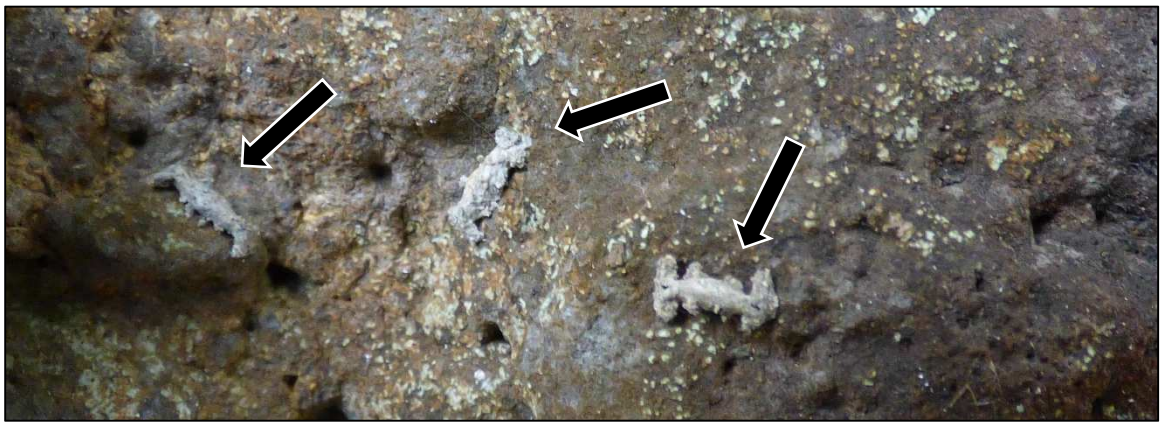
The larvae of these moths create a sleeping bag like structure they often stick bits of soil and lichen to while they crawl around and graze on lichen, fungi, and other things. Larvae pupate in the cases they make. Adults emerge as small moths. Some of these are likely new undescribed native species. Specimens have been deposited with Dan Rubinoff at University of Hawaii for further investigation and description of the new species.

***Hyposmocoma* spp. adults, likely undescribed species, Kipahulu Forest Reserve.**

Typical rock habitat for *Hyposmocoma* spp. This rock had many dozens of "burrito" larvae/pupae nestled in crevices. Adults were also in the area, resting quietly nearby.

Hyposmocoma **sp. "burrito" shaped larvae/pupae adorned with bits of lichen. These are locally abundant on large stones and rock faces.**

Under the bark of dead koa trees, "smooth purse" case types were occasionally found.



Hyposmocoma **sp. "cigar/carnivorous" larvae on rock face.**

OMIODES MOTHS

Native Hawaiian leaf roller moths (*Omiodes continuatalis*) (Lepidoptera: Crambidae) were observed multiple times in the koa parkland. This native moth was once widespread across the state, but has since declined in distribution, and in 1980 was listed as extinct. Subsequent surveys "rediscovered" the species on Hawaii island and Maui-Nui, where, this species is locally abundant in a few select places, including mid-elevation East Maui. The larvae are able to utilize both native and non-native grasses as host plants, allowing it to survive in a wide range of areas, such as Kipahulu Forest Reserve.

Hawaiian leaf roller moth (*Omiodes continuatalis*) in sweep net, Kipahulu Forest Reserve.

BLACKBURN'S SPHINX MOTH

The Blackburn's sphinx moth (*Manduca blackburni*) (Lepidoptera: Sphingidae) is an endangered native moth that feeds on the non-native tree tobacco (*Nicotiana glauca*), as well as the native aiea (*Nothocestrum*). No Blackburn's sphinx moths, tree tobacco, or aiea were encountered. That said, it is probable Blackburn sphinx moths are in the reserve at times, especially in the lower elevation, drier sections.

Blackburn's sphinx moth larva on tree tobacco (*Nicotiana glauca*) at Puu o Kali, Maui.

OHIA PSYLLIDS

Many ohia trees in the Kipahulu Forest Reserve have galls on their leaves created by native psyllids or jumping plant lice (*Pariaconus* spp.) (Hemiptera: Psyllidae). There are at least two types of galls created by different native ohia psyllid species in the reserve. The "closed gall" psyllids create galls that look like little bumps on the leaves of ohia. "Stem/flower bud gallers" make galls in the stems and flower buds of ohia.

"Closed galls" on ohia leaves created by native psyllids (*Pariaconus* sp. nr. *montgomeri*).

"Stem/flower bud gall" created on ohia by native psyllids (*Pariaconus* spp.).

***Pariaconus* sp. native ohia stem/flower bud galler adult.**

PLANTHOPPERS

Native *Oliarus* planthoppers (Hemiptera: Cixiidae) are locally abundant in the koa parkland and wet forest areas of the reserve. Nymphs feed on roots of plants and in rotting stems of ferns.

Native planthoppers (*Oliarus* spp.) are plentiful in the Kipahulu Forest Reserve.

PLANT BUGS

Many native plants bugs (Hemiptera: Miridae), some undescribed, were swept from vegetation in the Kipahulu Forest Reserve. Dan Polhemus placed them in the genera *Koanoa*, *Opuna*, *Orthotylus*, and *Sarona*. These feed on a variety of native plants.

Native Miridae from Kipahulu Forest Reserve, including some new undescribed species.

DAMSELFLIES

Numerous native damselflies or pinao ula (*Megalagrion* spp.) (Odonata: Coenagrionidae) were observed in the reserve, especially near areas with streams and seeps. Three species were encountered (*M. blackburni, M. calliphya,* and *M. hawaiiense*). These native damselflies are predators on insects. The larvae live in streams or ponds, feeding on a variety of aquatic insects. The adults are strong flyers and patrol for insects along stream corridors, wetland areas, ridges, and gulches.

Pinao ula (*Megalagrion blackburni*) female, Kipahulu Forest Reserve.

Pinao ula (*Megalagrion hawaiiense*), Kipahulu Forest Reserve.

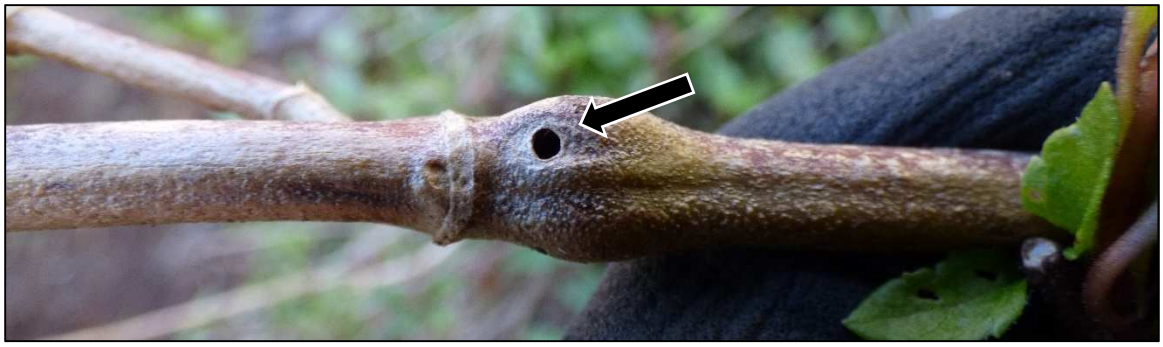
NON-NATIVE TEPHRITID FLIES

A number of non-native tephritid flies (Diptera: Tephritidae) have been introduced to Hawaii for biocontrol of weeds. Below are a few present within the reserve.

When pamakani became a serious pest in agriculture and forestry in Hawaii, the gall forming tephritid flies, *Procecidochares utilis* and *P. alani* were imported. Within a few years of introduction, they dramatically reduced populations of pamakani.

Eutreta xanthochaeta was introduced in 1902 for biocontrol of lantana, also by creating galls. However, it is generally not considered significant for control of lantana.

Gall from stem galler (*Procecidochares utilis*) in Maui pamakani (*Ageratina adenophora*).



Gall and exit hole of stem galler (*Procecidochares alani*) in Hamakua pamakani (*Ageratina riparia*).

Lantana stem-galler (*Eutreta xanthochaeta*) in gall formed in lantana.

YELLOW-FACED BEES

Once common, native yellow-faced bees (*Hylaeus* spp.) (Hymenoptera: Colletidae) are now mostly restricted to pockets of remnant native vegetation. These small black bees with yellow face markings are important pollinators of native plants.

In the Kipahulu Forest Reserve, a large grouping of *Hylaeus difficilis* were encountered in a bare patch in the koa parkland, where they were possibly looking for or provisioning nesting sites in crevices under rocks or burrows in the soil. *H. difficilis* gathers nectar and pollen from a broad range of native plants including koa, ohia, aalii, and naio. Karl Magnacca assisted with identification of this sometimes tricky to identify species.

Native yellow-faced bee (*Hylaeus difficilis*), Kipahulu Forest Reserve.

Dozens of native yellow-faced bees (*Hylaeus difficilis*) were buzzing about this dirt area, perhaps looking for or provisioning nesting sites in crevices under rocks or burrows in the soil.

ANTS

Hawaii has no native ants (Hymenoptera: Formicidae). The big-headed ant (*Pheidole megacephala*), long-legged ant (*Anoplolepis gracilipes*), glaber ant (*Ochetellus glaber*), and *Cardiocondyla* nr. *kagetsuchi*, were encountered within the reserve. Detailed ant surveys including baiting were not done for this project and more ant species likely exist within the reserve. Argentine ants (*Linepethima humile*), a highly invasive species which would be more likely to be found above 4,000 ft., were not encountered. This bodes well for native insects, which can be heavily impacted by ants.

***Cardiocondyla* nr. *kagetsuchi* in koa parkland of Kipahulu Forest Reserve.**

SPIDERS

Spiders are present in small numbers over the entire reserve. Of note are the native *Tetragnatha* spiders (Araneae: Theriidae). Other native spiders observed include predatory crab spiders (*Mecaphesa* sp.) (Araneae: Thomisidae) camouflaged in ohia flowers, waiting to ambush their prey.

Native *Tetragnatha acuta* spider, resident of the koa parkland. Identified by Rosie Gillespie.

INSECT SPECIES LIST

Following is a checklist of the insect species inventoried during the field work. For each species the following information is provided:

- Oder, Family, Scientific & Common name

- Bio-geographical status / nativity:

    - Endemic = Native to Hawaii; not naturally occurring anywhere else in the world.
    - Indigenous = Native to Hawaii and also to one or more other geographic area(s).
    - Non-native = Brought to Hawaii intentionally or accidentally by humans.

Order	Family	Scientific Name	Common Name	Nativity
Araneae	Araneidae	*Gasteracantha mammosa*	Asian spiny backed spider	Non-Native
Araneae	Theriidae	*Tetragnatha acuta*	Hawaiian long-jawed spider	Endemic
Araneae	Thomisidae	*Misumenops* sp.	Hawaiian crab spider	Endemic
Coleoptera	Coccinellidae	*Cryptolaemus montrouzieri*	Mealybug destroyer	Non-Native
Coleoptera	Coccinellidae	*Halmus chalybeus*	Steel blue ladybird beetle	Non-Native
Coleoptera	Crambidae	*Omiodes continuatalis*	Hawaiian grass leafroller	Endemic
Coleoptera	Curculionidae	*Naupactus godmani*	Fuller rose weevil	Non-Native
Coleoptera	Elateridae	?	Click beetle	?
Coleoptera	Scarabaeidae	*Adoretus sinicus*	Chinese rose beetle	Non-Native
Diptera	Ceratopogonidae	?	Midge	?
Diptera	Culicidae	*Aedes albopictus*	Mosquito	Non-Native
Diptera	Culicidae	*Aedes japonicus*	Mosquito	Non-Native
Diptera	Drosophilidae	*Drosophila* sp.	Fruit fly	Non-Native
Diptera	Sarcophagidae	?	Flesh fly	Non-Native
Diptera	Syrphidae	*Toxomerus marginatus*	Syrphid fly	Non-Native
Diptera	Tephritidae	*Eutreta xanthochaeta?*	Lantana gall fly	Non-Native
Diptera	Tephritidae	*Procecidochares utilis*	Gall fly	Non-Native
Diptera	Tipulidae	?	Crane flies	Endemic
Hemiptera	Aphididae	?	Aphid	Non-Native
Hemiptera	Cixiidae	*Oliarus* sp.	Plant hopper	Endemic
Hemiptera	Lygaeidae	*Nysius caledoniae*	Seed bug	Non-Native
Hemiptera	Nabidae	*Nabis capsifomis*	Damsel bug	Non-Native
Hemiptera	Psyllidae	*Pariaconus* sp.	Ohia flower bud psyllid	Endemic

Order	Family	Scientific Name	Common Name	Nativity
Hemiptera	Psyllidae	*Pariaconus* sp. nr. *montgomeri*	Ohia closed gall psyllid	Endemic
Hemiptera	Tingidae	*Teleonemia scrupulosa*	Lantana lace bug	Non-Native
Heteroptera	Miridae	*Koanoa* sp.	Koanoa	Endemic
Heteroptera	Miridae	*Opuna* sp.	Opuna	Endemic
Heteroptera	Miridae	*Orthotylus kassandropsis*	Orthotylus	Endemic
Heteroptera	Miridae	*Sarona* sp.	Sarona	Endemic
Hymenoptera	Apidae	*Apis mellifera*	Honey bee	Non-Native
Hymenoptera	Chalcidoidea	?	Parasitic wasp	Non-Native
Hymenoptera	Colletidae	*Hylaeus difficilis*	Yellow faced bee	Endemic
Hymenoptera	Formicidae	*Anoplolepis gracilipes*	Long legged ant	Non-Native
Hymenoptera	Formicidae	*Cardiocondyla* nr. *kagutsuchi*	Ant	Non-Native
Hymenoptera	Formicidae	*Ochetellus glaber*	Black household ant	Non-Native
Hymenoptera	Formicidae	*Pheidole megacephala*	Big headed ant	Non-Native
Hymenoptera	Ichneumonidae	?	Parasitic wasp	Non-Native
Isoptera	?	?	Termite	Non-Native
Lepidoptera	Cosmopterigidae	*Carposina sp.*	Carposina moth	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* sp.	Fancy cased moths - "candy wrapper"	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* sp.	Fancy cased moths - "cigar/carnivorous"	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* sp.	Fancy cased moths - "flat purse"	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* spp.	Fancy cased moths - "burrito"	Endemic
Lepidoptera	Crambidae	*Herpetogramma licarsisalis*	Grass webworm	Non-native
Lepidoptera	Crambidae	*Mestolobes* sp.	Mestolobes	Endemic
Lepidoptera	Crambidae	*Omiodes continuatalis*	Leafroller moth	Endemic
Lepidoptera	Crambidae	*Spoladea recurvalis*	Beet webworm	Non-Native
Lepidoptera	Geometridae	*Scotorythra paludicola*	Koa moth	Endemic
Lepidoptera	Hesperiidae	*Hylephila phyleus*	Fiery skipper	Non-Native
Lepidoptera	Lycaenidae	*Udara blackburni*	Koa butterfly	Endemic
Lepidoptera	Lycaenidae	*Zizina otis*	Lesser grass blue butterfly	Non-Native
Lepidoptera	Nymphalidae	*Agraulis vanillae*	Passion vine butterfly	Non-Native
Lepidoptera	Nymphalidae	*Danaus plexippus*	Monarch butterfly	Non-Native
Lepidoptera	Nymphalidae	*Vanessa tameamea*	Kamehameha butterfly	Endemic
Lepidoptera	Nymphalidae	*Vanessa virginiensis*	American lady butterfly	Non-Native
Lepidoptera	Schreckensteiniidae	*Schreckensteinia festaliella*	Rubus biocontrol	Non-Native
Neuroptera	Hemerobiidae	?	Brown Lacewing	?

Order	Family	Scientific Name	Common Name	Nativity
Odonata	Aeschnidae	*Anax* sp.	Darner	Native
Odonata	Coenagrionidae	*Megalagrion blackburni*	Blackburn's damselfly	Endemic
Odonata	Coenagrionidae	*Megalagrion calliphya*	Beautiful Hawaiian damselfly	Endemic
Odonata	Coenagrionidae	*Megalagrion hawaiiense*	Hawaiian upland damselfly	Endemic
Odonata	Libellulidae	*Pantala flavescens*	Globe skimmer	Indigenous
Orthoptera	Acrididae	*Schistocerca nitens*	Vagrant grasshopper	Non-Native
Orthoptera	Gryllidae	*Trigonidium* sp.	Cricket	Endemic
Siphonaptera	Pulicidae	*Ctenocephalides felis*	Cat flea	Non-Native

Surveying for insects in the Kipahulu Forest Reserve. In this distance are Kaupo Gap, Haleakala Peak, and the south slope of East Maui. Insects are mostly unstudied across this vast landscape.

Additional Native Insects Collected in 1976 Survey

Rick Villegus was the entomologist on the 1976 Manawainui Research Project. He spent two months surveying the area, including parts of the Kahikinui Forest Reserve. One of the main overall findings in 1976 was that native insects were much more abundant in areas dominated by native plants than in areas dominated by non-native plants. He identified Manawainui Valley as having the least native insects, the koa parkland having more, and the wet forest area dominated by native plants having the most native insects. We found a similar pattern of insect nativity in 2018.

Below are native insects collected in the reserve in 1976 that were not observed in 2018. Though not observed in 2018, most of these species are cryptic, very small, and were probably just overlooked. Interestingly, in 1976 they did not encounter the koa butterfly or Kamehameha Butterfly, which were relatively conspicuous in 2018. Also of note, most specimens were not identified to species level, attesting to the diversity of native insects present, and the difficulty of trying to inventory nature's wondrous splendor.

Coleoptera: Aglycyderidae - *Proterhinus* sp. (Weevil)
Coleoptera: Carabidae - *Mecyclothorax* sp. (Ground beetle)
Coleoptera: Curculionidae - *Nesotocus* sp. (Snout weevil)
Coleoptera: Nitidulidae - *Orthostolus* sp. (Sap beetle)
Diptera: Dolichipodidae - *Campsicnemus* spp. (Long-legged fly)
Diptera: Dolichipodidae - *Eurynogaster* spp. (Long-legged fly)
Diptera: Drosophilidae - *Drosophila* spp. (Fruit fly)
Diptera: Drosophilidae - *Scaptomyza* spp. (Fruit fly)
Diptera: Drosophilidae - *Titanochaeta chauliodon* (Fruit fly)
Diptera: Empididae - *Chersodromia* sp. (Dagger fly)
Diptera: Muscidae - *Lispocephala* sp. (House fly)
Hemiptera: Cicadellidae - *Nesophrosyne* spp. (Leafhopper)
Hemiptera: Cixiidae - *Iolania mauiensis* (Planthopper)
Hemiptera: Lygaeidae - *Metrarga* sp. (Seed bug)
Hemiptera: Nabidae - *Nabis* spp. (Damsel bug)
Hemiptera: Pentatomidae - *Oechelia* sp. (Stink bug)
Hemiptera: Saldidae - *Saldula* sp. (Shore bug)
Lepidoptera: Geometridae - *Eupithecia* spp. (Pug moth)
Lepidoptera: Geometridae - *Fletcherana* spp. (Geometer moth)
Lepidoptera: Noctuidae - *Agrotis* spp. (Owlet moth)
Lepidoptera: Noctuidae - *Haliophyle* spp. (Owlet moth)
Neuroptera: Chrysopidae - *Anomalochrysa* spp. (Green lacewing)
Neuroptera: Hemerobiidae - *Micromus* [*Nesomicromus*] spp. (Brown lacewing)
Orthoptera: Gryllidae - *Paratrigonidium* sp. (Cricket)
Psocoptera: Elipsocidae - *Kilauella* spp. (Barklice)
Psocoptera: Elipsocidae - *Palistreptus* sp. (Barklice)
Psocoptera: Psocidae - *Ptycta* [*Psocus*] sp. (Barklice)

MOLLUSKS

Snails were not actively searched for during this survey. But in 1976, dedicated surveys for snails were done during the Manawainui Research Project by Paul Meyer, who collected specimens and submitted them to malacologist Yoshio Kondo at Bishop Museum for identification.

Below are the snails collected during the 1976 Manawainui Research Project. They were found mostly on foliage, especially on the native plants kolea (*Myrsine*), kanawao (*Broussaisia*), and oha wai (*Clermontia*).

Native
Auriculella crassula
Elasmias sp.
Lamellidia oblonga
Nesopupa spp.
Philonesia sp.
Pronesopupa sp.
Succinea spp.
Tornatellides spp.

Non-native
Bradybaena similaris (Asian trampsnail)
Euglandina rosea (Rosy wolfsnail)
Oxychilus spp. (Garlic snail)

Native *Succinea* sp. snail on rock in dry forest section of Kipahulu Forest Reserve near Kaupo Gap.

REFERENCES

Giambelluca, T. W., X. Shuai, M. L. Barnes, R. J. Alliss, R. J. Longman, T. Miura, Q. Chen, A. G. Frazier, R. G. Mudd, L. Cuo, and A. D. Businger. 2014. Evapotranspiration of Hawaii. Final report submitted to the U.S. Army Corps of Engineers - Honolulu District, and the Commission on Water Resource Management, State of Hawaii.

Nishida, G. M. 2002. Hawaii Arthropod Checklist Fourth Edition. Bishop Museum Technical Report 22: iv+313 pp.

Palmer, D. D. 2003. Hawaii's Ferns and Fern Allies. University of Hawaii Press, Honolulu, HI.

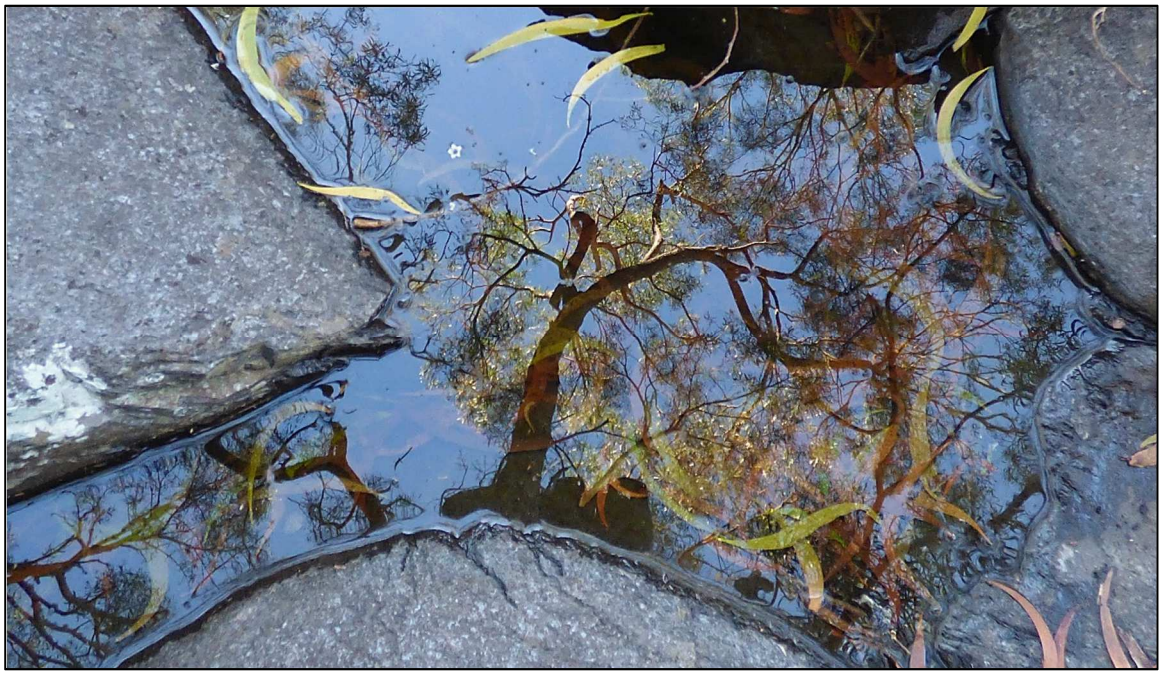
Peterson, D. 1976. The Scientific Report of the Manawainui Research Project, East Maui, Hawaii. Report for National Science Foundation, Student-Originated Studies Program.

Pyle, R.L., and P. Pyle. 2009. The Birds of the Hawaiian Islands: Occurrence, History, Distribution, and Status. B.P. Bishop Museum, Honolulu, HI, U.S.A. Version 1.

Severns, M. 2011. Shells of the Hawaiian Islands: The Land Shells. Conch Books.

Tomich, P. Q. 1986. Mammals in Hawaii. Bishop Museum Press, Honolulu, HI.

Wagner, W. L., D. R. Herbst, and S. H. Sohmer. 1999. Manual of the Flowering Plants of Hawaii. Univ. of Hawaii Press and Bishop Museum Press, Honolulu, HI.



Ephemeral pool of water under a canopy of koa trees in Kipahulu Forest Reserve.
"Hahai nō ka ua i ka ululāʻau" - The rain follows the forest.

Appendix C: State of Hawai‘i Wildlife Action Plan Species Profiles

Photo: USFWS

Terrestrial Mammal

ʻŌpeʻapeʻa or Hawaiian hoary bat

Lasiurus cinereus semotus

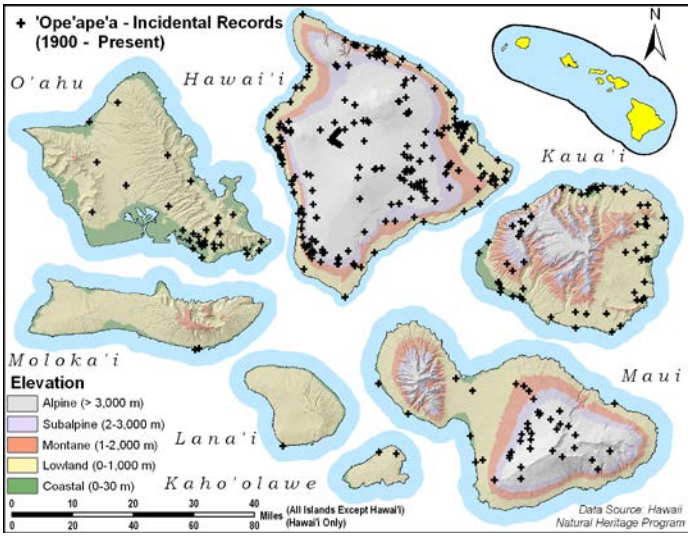
SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Indigenous (at the Species Level and Endemic at the Subspecies Level)
NatureServe Heritage Rank G5/T2 – Species Secure/Subspecies Imperiled
Recovery Plan for the Hawaiian Hoary Bat – USFWS 1998

SPECIES INFORMATION: The ʻōpeʻapeʻa, or Hawaiian hoary bat (Family: Vespertilionidae), is Hawaiʻi's only native terrestrial mammal, although sub-fossil evidence indicates that at least one other bat species was native to the islands. Additionally, the hoary bat has dispersed to the Hawaiian Islands from the mainland at least twice, forming two different populations of Hawaiian hoary bats (Russell et al. 2015). The first emigrant arrived approximately ten thousand years ago, and the more recent emigrant arrived an estimated 600 years ago (Russell et al. 2015). Both sexes have a coat of brown and gray fur. Individual hairs of the coat are tipped or frosted with white; hence the name "hoary" which means frosted. The older population of hoary bats on the Hawaiian Islands is typically chestnut brown in color with less white "frosting" of the fur tips—it has largely lost the "frosted" appearance. The more recent population comprises individuals that are more hoary ("frosted"), similar to mainland hoary bats. Males and females have a wingspan of approximately one-third of a meter (1 foot), and females are typically larger than males. The Hawaiian name refers to a half taro leaf or canoe sail shape; these being somewhat similar to the shape of the bat.

Little research has been done on the ʻōpeʻapeʻa, and little is known about its habitat requirements or population status. Fewer than 30 accounts of roosting are known statewide, but these indicate that ʻōpeʻapeʻa roost in native and non-native vegetation from 1 to 9 meters (3 – 29 feet) above ground level; the species is rarely observed using lava tubes, cracks in rocks, or human-made structures for roosting. While roosting during the day, ʻōpeʻapeʻa are solitary, although mothers and pups roost together. They begin foraging either just before or after sunset depending on the time of year; altitude also may affect activity patterns. ʻŌpeʻapeʻa feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites; and similar to other insectivorous bats, prey is located using echolocation. Water courses and edges (e.g., coastlines and forest/pasture boundaries) appear to be important foraging areas; the species also is attracted to insects that congregate near lights. Breeding bats (e.g., lactating females) have been documented only on the islands of Hawaiʻi, Kauaʻi, and Oʻahu (Dave Johnston pers. obs.). Mating most likely occurs between September and December, and females usually give birth to twins during June. Mother bats likely stay

with their pups until they are six to seven weeks old. Little is known regarding dispersal or movements, but inter-island dispersal is possible.

DISTRIBUTION: The hoary bat is the most widely distributed bat in North America. In Hawai'i, 'ōpe'ape'a have been reported from all the Main Hawaiian Islands except for Ni'ihau, although specimen records exist only for Kaua'i, O'ahu, Maui, Moloka'i, and the island of Hawai'i. 'Ōpe'ape'a occur in a wide range of habitats across a wide elevation gradient. On the island of Hawai'i, bats are found primarily from sea level to 2,288 meters (7,500 feet) elevation, although they have been observed near the island's summits (above 3,963 meters or 13,000 feet). See "Location and Condition of Key Habitat," below, for distribution by seasons.



ABUNDANCE: Mostly unknown, although Pinzari et al. 2014 suggested that the population on the island of Hawai'i has been stable or is slightly increasing based on occupancy models from acoustic monitoring. Survey methods to count or estimate populations of solitary roosting bats have not been established. Although based on incomplete data, Kaua'i and the island of Hawai'i may support the largest populations.

LOCATION AND CONDITION OF KEY HABITAT: 'Ōpe'ape'a have been found roosting in 'ōhi'a (*Metrosideros polymorpha*), pu hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Proscopis pallida*), avocado (*Persea americana*), shower trees (*Cassie javanica*), pūkiawe (*Styphelia tameiameiae*), fern clumps, eucalyptus (*Eucalyptus* spp.), cook pine (*Araucaria columnaris*), and Norfolk Island pine (*Araucaria heterophylla*) stands. Recent work on the island of Hawai'i found that bat activity varied with season and altitude, and the greatest level of activity occurred at low elevations (below 1,280 meters or 4,200 feet) from April to December (Bonaccorso et al. 2015). Because warm temperatures are strongly associated with reproductive success in this and other bat species, it has been suggested that key breeding habitat is likely to occur at sites where the average July minimum temperature is above 11°C (52°F). If true, key breeding habitat on the island of Hawai'i would occur below 1,280 meters (4,200 feet) elevation (Bonaccorso et al. 2015). Because bats use both native and non-native habitat for foraging and roosting, the importance of non-native timber stands, particularly those at low elevations, should be determined. Breeding sites are known for Mānuka Natural Area Reserve and scattered areas along the Hāmākua Coast.

THREATS: Bats are affected by habitat loss, pesticides, collisions with structures, and roost disturbance. A reduction in tree cover (e.g., roost sites) might be the primary reason for the species' decline in Hawai'i. Pesticides also may have reduced populations. Bats are known to interact and sometimes collide with wind turbines. Lastly, bats of many species are affected by predation, so this may also be a problem for 'ōpe'ape'a.

CONSERVATION ACTIONS: The goals of conservation actions are to not only protect current populations and key breeding habitats, but also to establish additional populations thereby reducing the risk of extinction (U.S. Fish and Wildlife Service 1998). In addition to common statewide and island conservation actions, specific management directed toward ʻōpeʻapeʻa should include the following:

- Conserve known occupied habitat.
- Develop and implement conservation plans and strategies that guide the management and use of forests to reduce negative effects on known bat populations.
- Support Hawaiian hoary bat research.

MONITORING: Continue surveys of population and distribution in known and likely habitats and identify key limiting factors affecting the recovery of the species.

RESEARCH PRIORITIES: Given that little is known about ʻōpeʻapeʻa any research would contribute to the understanding of and ability to conserve this species. Research priorities for the ʻōpeʻapeʻa include the following:

- Develop standard survey and monitoring methods and procedures that will allow the accurate estimation of populations and changes in activity and/or occupancy.
- Conduct occupancy surveys of all the Main Hawaiian Islands to examine distribution and population trends.
- Identify key breeding and wintering sites.
- Better describe roost site characteristics and preferences.
- Increase efforts to track and monitor movements and behaviors.
- Determine the extent to which Hawaiian hoary bats use torpor.
- Better describe threats and important factors limiting recovery such as whether depredation by introduced animals or availability of prey represent constraints for populations.
- Continue to support the development of avoidance and minimization measures that can be effectively implemented to reduce collisions with wind turbines.
- Direct research findings toward the development of conservation and management actions that address the needs and deficiencies of the species and refine these approaches using an adaptive management approach.

References:

Frank J. Bonaccorso, FJ, CM Todd, AC Miles, and PM Gorresen. 2015. Foraging range movements of the endangered Hawaiian hoary bat, *Lasiurus cinereus semotus* (Chiroptera: Vespertilionidae). Journal of Mammalogy 96(1):64-71. 2015

Hawaiian Hoary Bat Research Cooperative. Available at: http://www.dofaw.net/fbrp/projects.php?id=39.Hawai'i Natural Heritage Program [Hawai'i Biodiversity and Mapping Program]. 2004. Natural diversity database. University of Hawai'i, Center for Conservation Research and Training. Honolulu, HI.Pinzari, C. A., F. J. Bonaccorso, and K. Montoya-Aiona. 2014 Hawaiian Hoary bat occupancy at kaloko-honokohau National Historical Park Hawaii Cooperative Studies Unit, University of Hawaii at Hilo, Technical Report 51:1-19Russell AL, CA Pinzari, MJ Vonhof, KJ Olival, FJ Bonaccorso. 2015. Two Tickets to Paradise: Multiple Dispersal Events in the Founding of Hoary Bat Populations in Hawai'i. PLoS ONE 10(6): e0127912.

doi:10.1371/journal.pone.0127912U.S. Fish and Wildlife Service. 1998. Recovery plan for the Hawaiian hoary bat. Portland, (OR): U.S. Fish and Wildlife Service. 50 pp.


Photo: NRCS

Pueo or Hawaiian Short-eared Owl

Asio flammeus sandwichensis

SPECIES STATUS:
State listed as Endangered on O'ahu
State recognized as Endemic at the subspecies level
NatureServe Heritage Rank G5/T2 –
Species secure/Subspecies imperiled

SPECIES INFORMATION: The pueo, or Hawaiian short-eared owl, is an endemic subspecies of the nearly pandemic short-eared owl (*Asio flammeus*; Family: Strigidae). The species is thought to have colonized the Hawaiian Islands sometime after the arrival of Polynesians. Unlike most owls, pueo are active during the day (i.e., diurnal), and are commonly seen hovering or soaring over open areas. Like short-eared owls in continental environments, those in Hawai'i primarily consume small mammals. Their relatively recent establishment on Hawai'i may have been tied to the rats (*Rattus exulans*) that Polynesians brought to the islands. Little is known about the breeding biology of pueo, but nests have been found throughout the year. Males perform aerial displays known as a sky dancing display to prospective females. Nests are constructed by females and are comprised of simple scrapes in the ground lined with grasses and feather down. Females also perform all incubating and brooding. Males feed females and defend nests. Chicks hatch asynchronously and are fed by female with food delivered by male. Young may fledge from nest on foot before they are able to fly and depend on their parents for approximately two months.

DISTRIBUTION: Found on all the Main Hawaiian Islands from sea level to 2,450 meters (8,000 feet).

ABUNDANCE: Unknown. Because of relatively few detections, the Hawaiian Forest Bird Survey did not estimate the population size of the pueo. Pueo were widespread at the end of the 19th century, but are thought to be declining.

LOCATION AND CONDITION OF KEY HABITAT: Pueo occupy a variety of habitats, including wet and dry forests, but are most common in open habitats such as grasslands, shrublands, and montane parklands, including urban areas and those actively managed for conservation. Because of a lack of historical population data and the species' current, broad habitat use, key habitat variables are difficult to determine. Pueo occur in many areas that are managed by the Sate of Hawai'i or Federal agencies.

THREATS: Pueo are likely susceptible to the same factors that threaten other native Hawaiian birds, including: loss and degradation of habitat, predation by introduced mammals, and disease. However, their persistence in lowland, non-native and rangeland habitats suggests

that they may be less vulnerable to extinction than other native birds, especially because they may be resistant to avian malaria (*Plasmodium relictum*) and avian pox (*Poxvirus avium*). Despite this, for pueo populations, the following are of particular concern:

- "Sick owl syndrome". Mortality on Kaua'i has been attributed to this syndrome, which may be related to pesticide poisoning or food shortages.
- Predation. Because pueo nest on the ground, their eggs and young are vulnerable to predation by rats (*Rattus* spp.), cats (*Felis silvestris*), and the small Indian mongoose (*Herpestes auropunctatus*).
- Habitat loss. May be particularly important to O'ahu pueo populations.
- Contaminants or toxins. Because pueo are top predators, fat-soluble contaminants may accumulate in prey species; may be related to "sick owl syndrome" (see above).
- Human interaction. Hunting behavior and habitat use predispose pueo to vehicular collisions, which have been documented on Lāna'i and the island of Hawai'i.

CONSERVATION ACTIONS: Pueo likely have benefited from management activities designed to conserve other endangered birds. They also may benefit from game bird management; high densities of pueo occur on lands where game birds also are common. In addition to these efforts, future management specific to the pueo may include the following:

- Determine population trends, especially on islands where "sick owl syndrome" has been documented.
- Public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Regular island-wide population surveys are necessary to determine population trends for this species. This information is needed to assess the efficacy of habitat management efforts.

RESEARCH PRIORITIES: Research priorities specific to pueo include the following:

- Analysis of population trends and changes in habitat occupancy, especially on O'ahu.
- Determine the cause of "sick owl syndrome" and its potential effect on populations.
- Quantify the number of vehicular collisions and determine the level of threat to populations.

References:

Berger AJ. 1981. Hawaiian birdlife. Honolulu: University of Hawai'i Press. 260 pp.

Holt DW, Leasure SM. 1993. Short-eared owl (*Asio flammeus*). *In* The Birds of North America, No. 62 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Mostello CS, Conant S. In prep. Diets of native and alien apex predators in Hawai'i.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (August 10, 2005).

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

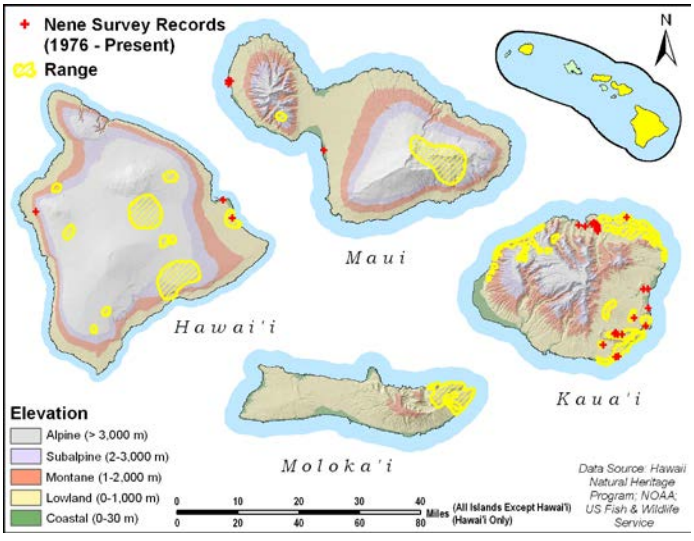
Photo: Jack Jeffery

Nēnē
or Hawaiian goose

Branta sandvicensis

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1 - Critically Imperiled
IUCN Red List Ranking - Vulnerable
Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*) – USFWS 2004

SPECIES INFORMATION: Historically, at least five species of geese (family: Anatidae) occurred in Hawai'i; today, only the nēnē, or Hawaiian goose, survives. Adults are mostly dark brown or sepia with a black face and crown, cream-colored cheeks, and a buff neck with black streaks. Females are smaller than males. Compared to other geese, nēnē are more terrestrial and have longer legs and less webbing between their toes, which likely facilitates walking on lava flows. Nēnē graze and browse on the leaves, seeds, flowers, and fruits of at least 50 native and nonnative grasses, sedges, composites, and shrubs. Diet varies by location and habitat, and they may require a diverse suite of food plants. Currently, several species of nonnative grass are important in mid- and high-elevation habitats. Nēnē facilitate seed dispersal and play an important role in influencing the species composition of early successional plant communities. Historically, flocks moved between high-elevation feeding habitats and lowland nesting areas. Pairs mate for life and engage in relatively simple courtship displays in which the male attacks or threatens potential competitors, runs back to his mate, and calls loudly. Nēnē have an extended breeding season, and nesting may occur in all months except May, June, and July, although the majority of birds nest between October and March, and most clutches are laid between October and December. Nests consist of a shallow scrape lined with plant material and down. Breeding pairs usually return to the previous year's nest site, typically in dense vegetation; when available, kīpuka may be preferred. Females lay two to five eggs, which hatch after 30 days. Young are precocial and not fed by their parents; however, they remain with their parents for up to a year.



DISTRIBUTION: Between sea level and 2,400 meters (7,800 feet) elevation on the island of Hawai'i, Maui, Kaua'i, and Moloka'i, and a single pair was reported on O'ahu in 2014. Historically, the

species was found on all Main Hawaiian Islands and was likely widespread.

ABUNDANCE: In 1951, the wild nēnē population was estimated at 30 individuals and information on historical abundance is limited. The current population is estimated at 2,450–2,550 birds, with 550 on the island of Hawai'i, 400 on Maui, 1,500 on Kaua'i, 80 on Moloka'i, and a single nesting pair reported on O'ahu in 2014. During 2005-2010, about 224 nēnē were removed from near the Kaua'i Airport and released at remote relocation sites on that island to reduce the risk of bird-aircraft strikes. Since 2011, the continued growth of the Kaua'i nēnē population prompted the removal of an additional 600 nēnē from the vicinity of the Kaua'i Airport and which were released into the wild on Hawai'i and Maui.

LOCATION AND CONDITION OF KEY HABITAT: Nēnē historically occurred in lowland dry forest, shrubland, grassland, and montane dry forest, and shrubland. Current habitat preferences are likely biased by the location of release sites of captive-bred birds. They currently use a wide variety of habitats including coastal dune vegetation and nonnative grasslands (e.g., golf courses, pastures, rural areas), sparsely vegetated low- and high-elevation lava flows, mid-elevation native and nonnative shrubland, early successional cinderfall, cinder deserts, native alpine grasslands and shrublands, and open native and nonnative alpine shrubland-woodland community interfaces. Nesting occurs in a variety of habitats, including beach strand, shrubland, grassland, and lava rock, and at a range of elevations. On the islands of Hawai'i and Maui, most nests are built under native vegetation, such as pūkiawe (*Styphelia tameiameiae*), 'a'ali'i (*Dondonaea viscose*), and 'ōhi'a (*Metrosideros polymorpha*). On Kaua'i, however, most nesting areas are dominated by nonnative species, and nēnē often nest under Christmas berry (*Schinus terebinthifolius*), shrub verbena (*Lantana camara*), and ironwood (*Casuarina* spp.). The condition of habitats occupied by nēnē varies considerably. Many of the areas used by the species are managed for conservation by the State of Hawai'i and the U.S. Fish and Wildlife Service (USFWS).

THREATS: Historical threats included habitat loss and degradation, hunting, and predation by rats (*Rattus* spp.), cats (*Felis silvestris*), dogs (*Canis familiaris*), and the small Indian mongoose (*Herpestes auropunctatus*). Current threats include predation by nonnative mammals; exposure to diseases that can be transmitted by introduced nonnative animals such as feral and domestic cats (e.g. toxoplasmosis); nutritional deficiencies due to paucity of quality habitat, exposure stress at high-elevation habitats; a lack of contiguous lowland habitat; human-caused disturbance and mortality (e.g., road mortality, disturbance by hikers, aircraft strikes, collisions with wind turbines); behavioral problems related to captive propagation; and inbreeding depression.

CONSERVATION ACTIONS: Past and current actions include captive propagation and release of captive-bred individuals into the wild, predator control, habitat enhancement, research and monitoring, private conservation efforts, formation of the Nēnē Recovery Action Group, and public education. Other actions specific to conservation of nēnē should include the following:

- Enhance and protect habitats used by nēnē, including foraging habitat, breeding grounds, and summer flocking areas.
- Increase predator control effort and effectiveness, including use of predator-proof fences. Increase efforts to detect and remove mongooses from Kaua'i.

- Significantly increase efforts to minimize negative human-nēnē interactions through public education and outreach focused on communities or areas where the number of nēnē are known to be increasing; continue to promote avoidance and minimization measures that will reduce the risk of collisions with vehicles , aircraft, and wind turbines.
- Develop a statewide long-range management plan for nēnē that includes all of the distinct populations and anticipates changes resulting from management actions and human interaction.
- Continue the nēnē population reintroduction efforts and establish additional populations only where risks can be minimized and habitat quality can support recovery.

MONITORING: Continue surveys to monitor abundance and distribution and annual productivity.

RESEARCH PRIORITIES:

- Standardize survey and monitoring protocols and develop a platform for data sharing.
- Conduct studies on diet and nutrition, particularly as it relates to forage quality of nonnative versus native vegetation, focusing on the needs of goslings and breeding females.
- Refine predator control and exclusion methods.
- Evaluate movement patterns and habitat use by nēnē.
- Evaluate and refine translocation and release methods that incorporates monitoring subsequent dispersal and movement patterns, survival, and reproduction.
- Investigate population genetics as a management tool to monitor the potential for inbreeding.

References

Banko PC, Black JM, Banko WE. 1999. Hawaiian goose (*Branta sandvicensis*). *In* The Birds of North America, No. 434 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

State of Hawai'i, Department of Land and Natural Resources, Division of Forestry and Wildlife. 2014. Kaua'i Nēnē Relocation Project: December 2014 Project Update.

U.S. Fish and Wildlife Service. 2004. Draft revised recovery plan for the Nene or Hawaiian Goose (*Branta sandvicensis*). U.S. Fish and Wildlife Service, Portland, OR. 148 + xi pp.

U.S. Fish and Wildlife Service. 2011. Nene or Hawaiian goose (*Branta sandvicensis*) 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, HI.

VanderWerf, EA. 2012. Hawaiian Bird Conservation Action Plan. Pacific Rim Conservation, Honolulu, HI.

Work, T., J. Dagenais, R. Rameyer, and R. Breeden. 2015. Mortality patters in endangered Hawaiian Geese (Nēnē, *Branta sandvicensis*). Journal of Wildlife Diseases. Vol. 51, Issue 3, pg(s) 688-695 doi: 10.7589/2014-11-256


Photo: Chris Eckart

Forest Birds

Hawai‘i ‘amakihi

Hemignathus virens

SPECIES STATUS:
State Listed Endangered on Lāna‘i
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable

SPECIES INFORMATION: The Hawai‘i ‘amakihi is a small, generalist Hawaiian honeycreeper (Family: Fringillidae). Until 1995, the Hawai‘i ‘amakihi, and the O‘ahu (*H. flavus*) and Kaua‘i ‘amakihi (*H. kauaiensis*) were considered a single species: the common ‘amakihi (*H. virens*). Plumage of all species is similar; males are yellow-green to olive with black lores. Females are generally similar, but duller. All have decurved bills. Plumage of males is bright yellow-green above, and there is some inter-island variation, especially among females. The Hawai‘i ‘amakihi is brighter and smaller than the Kaua‘i ‘amakihi. Hawai‘i ‘amakihi are generalized foragers that glean arthropods from the leaves, blossoms, twigs, branches, and less frequently from tree trunks, ferns, and shrubs. Feeds on nectar predominately from the flowers of ‘ōhi‘a (*Metrosideros polymorpha*), māmane (*Sophora chrysophylla*), and native lobelias (Campanulaceae), but also forages on flowers of a number of other native and non-native plants. They also eat fruit from native and non-native plants, but predominately from pilo (*Coprosma* spp.). Forages alone, in pairs, in family groups, or in mixed flocks. Courtship behavior is somewhat complex and includes courtship chases, advertising displays, and courtship feeding. Pairs remain together for successive breeding seasons. Pair selects nest site; female builds an open-cup nest and lays two or three eggs. Only females incubate eggs and brood nestlings. Males deliver food to females who then feed nestlings. Fledglings are dependent on parents for up to three months. The Hawai‘i ‘amakihi usually raise two broods in a season.

DISTRIBUTION: Occurs between 300 and 2,900 meters (1,000 – 9,500 feet) on Hawai‘i, Maui and Moloka‘i; not common below 500 meters (1,625 feet). Widely distributed on Hawai‘i and Maui. Original range likely included all forested regions of the above islands as well as those on Lāna‘i, where it was last seen in 1976.

ABUNDANCE: The Hawaiian Forest Bird Survey (1976-1983) estimated the population at 870,000 ± 5,612 (95% confidence interval) birds on the island of Hawai‘i, 44,000 ± 1,786 birds on east Maui, 3,000 ± 408 on west Maui, and 1,800 ± 357 birds on Moloka‘i. Populations on Hawai‘i and Maui are probably stable; the Moloka‘i population is probably declining.

LOCATION AND CONDITION OF KEY HABITAT: A range of habitats including native shrubland and dry, mesic, and wet forests in montane and subalpine communities. Densities are highest on the island of Hawai‘i in subalpine ‘ōhi‘a scrub in Ka‘ū, and in māmane/naio (*Sophora chrysophylla* and *Myoporum sandiwicense*) forests on Mauna Kea. ‘Amakihi also are common in koa (*Acacia koa*) reforestation areas at higher elevations. On Maui, they are common in subalpine dry communities dominated by ‘ōhi‘a, māmane, pūkiawe (*Styphelia tamieameiae*)

and ʻaʻaliʻi (*Dodonea viscosa*). They also occupy some non-native tree plantations on Maui, near areas where native vegetation persists. Habitat on Molokaʻi is restricted to the ʻōhiʻa forests of the eastern half of the island. The condition of this habitat varies considerably. Much of the species' current range is under State or federal jurisdiction.

THREATS: Although populations appear stable they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including loss and degradation of habitat, predation by introduced mammals, and disease.

CONSERVATION ACTIONS: Hawaiʻi ʻamakihi likely have benefited from management actions to conserve other endangered forest birds in the Hakalau Forest National Wildlife Refuge, Hawaiʻi Volcanoes National Park, and the ʻŌlaʻa/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future management specific to the Hawaiʻi ʻamakihi may include the following:

- Translocate captive-bred individuals to Lānaʻi and Kahoʻolawe.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Currently, the U.S. Geological Survey's Biological Resources Division is conducting genetic analyses to determine the species' phylogenetic status and examining the relationship between genetic diversity and disease resistance. Additional research priorities include the following:

- Quantify population structure, dispersal patterns, survivorship, nesting phenology and success, especially for Maui and Molokaʻi populations.
- Determine if competition with Japanese white-eyes (*Zosterops japonicus*) occurs, and if so, its effect on Hawaiʻi ʻamakihi populations.
- Conduct translocation experiments using Hawaiʻi ʻamakihi to help reestablish this and other Hawaiian honeycreeper populations.

References:

Lindsey GD, VanderWerf EA, Baker H, Baker PE. 1998. Hawaiʻi (*Hemignathus virens*), Kauaʻi (*Hemignathus kauaiensis*), Oʻahu (*Hemignathus chloris*) and greater ʻamakihi (*Hemignathus sagittirostris*). *In* The Birds of North America, No. 360 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Photo: Eric Nishibayashi

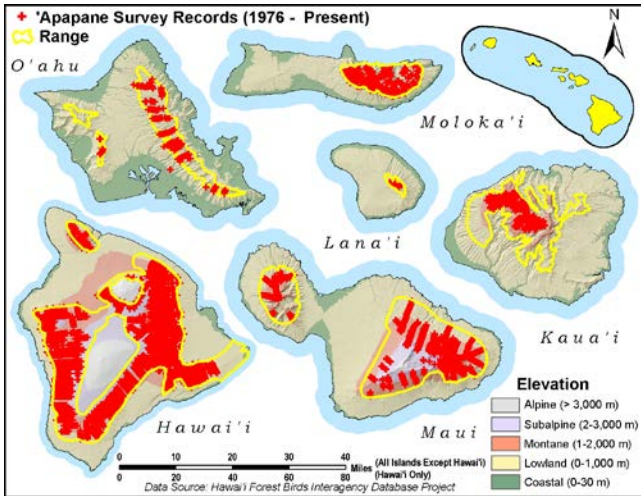
Forest Birds

ʻApapane

Himatione sanguinea

SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G3—Vulnerable
IUCN Red List Ranking— Least Concern

SPECIES INFORMATION: The ʻapapane is a small, crimson, primarily nectarivorous Hawaiian honeycreeper (Family: Fringillidae) and is an important ʻōhiʻa (*Metrosideros polymorpha*) pollinator. It is the most abundant and widely distributed Hawaiian honeycreeper, and is often seen flying above the canopy in search of patches of flowering ʻōhiʻa. Wide-ranging movements may facilitate disease transmission among native forest birds. ʻApapane often forage in conspecific flocks, likely to overwhelm ʻiʻiwi (*Vestiaria coccinea*) and ʻākohekohe (*Palmeria dolei*), which often defend flower-rich trees. Outside the breeding season, ʻapapane also join mixed-species flocks. They feed on insects, which they glean from outer foliage and twigs in the upper- and mid-canopy. Sexual chasing and courtship feeding often precede nest building, a task shared by both male and female. Pairs defend small territories around nests. Females incubate three eggs and brood young; males feed females away from the nest. Both parents feed nestlings, and fledglings may remain with their parents for up to four months.



DISTRIBUTION: Occurs in native forests above 1,250 meters (4,100 feet) on the islands of Hawaiʻi, Maui, and Kauaʻi. On Oʻahu, occurs in the Koʻolau Range from 300 meters (975 feet) to summit at 946 meters (3,075 feet), and are less common in the Waiʻanae Range above 600 meters (1,950 feet). Rare on Molokaʻi and Lānaʻi. Historically were common at low elevations on all islands with appropriate habitat.

ABUNDANCE: Based on Hawaiian Forest Bird Surveys (1976-1981): 1,080,000 ± 25,000 (95% confidence interval) birds on island of Hawaiʻi, 110,000 ± 9,000 on Maui (86% on Haleakalā), 39,000 ± 5,000 on Molokaʻi, 540 ± 213 on Lānaʻi, and 30,000 ± 1,500 on Kauaʻi (Oʻahu was not included in surveys). On Kauaʻi, populations declined after the 1992 hurricane but have significantly increased since, estimated at 64,972 ± 2,014 (SE) birds in 2000. Rare on Molokaʻi and Lānaʻi.

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet forests dominated by ʻōhiʻa and koa (*Acacia koa*), primarily at elevations greater than 1,250 meters (4,100 feet). The

primary reason for this limitation is the high density of cold-intolerant *Culex* mosquitoes, an important disease vector, below this elevation. Occupied habitats also contain kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and hapu'u tree ferns (*Cibotium* spp.). Māmane (*Sophora chrysophylla*) is common in high-elevation foraging habitat. Although much of the species' current range is under State or Federal jurisdiction, habitat protection and restoration efforts vary considerably.

THREATS: Although populations appear stable on the islands of Hawai'i, Maui, and Kaua'i, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds including habitat loss and degradation, predation by introduced mammals, and disease. For 'apapane the following is of particular concern:

- Disease. Of Hawaii's native forest birds, 'apapane have the highest prevalence of avian malaria. Individuals infected with avian pox also are more likely to be infected with malaria. Foraging movements may increase their exposure to disease. 'Apapane breed in mid-elevation forests, which suggests some disease resistance.

CONSERVATION ACTIONS: 'Apapane likely benefited from actions to conserve other endangered forest birds on northeastern Haleakalā, Hakalau Forest National Wildlife Refuge, Hawai'i Volcanoes National Park, the 'Ōla'a/Kīlauea Watershed Partnership, and Alaka'i Wilderness Preserve and surrounding areas. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future actions specific to the protection of 'apapane may include the following:

- Control mosquitos in degraded habitats.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to 'apapane include the following:

- Determine if disease-resistant individuals exist and if so, if resistance is passed to offspring. Disease-resistant birds could be used to found of new populations.
- Determine the role of 'apapane in disease transmission between high- and low-elevation habitats.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology, and success of this poorly known species.

References:

Fancy SG, Ralph CJ. 1997. 'Apapane (*Himatione sanguinea*). *In* The Birds of North America, No. 296 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alaka'i swamp, Kaua'i. Conservation Biology 18:716-725.

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.


Photo: DOFAW

Forest Birds

ʻĀkohekohe or Crested honeycreeper

Palmeria dolei

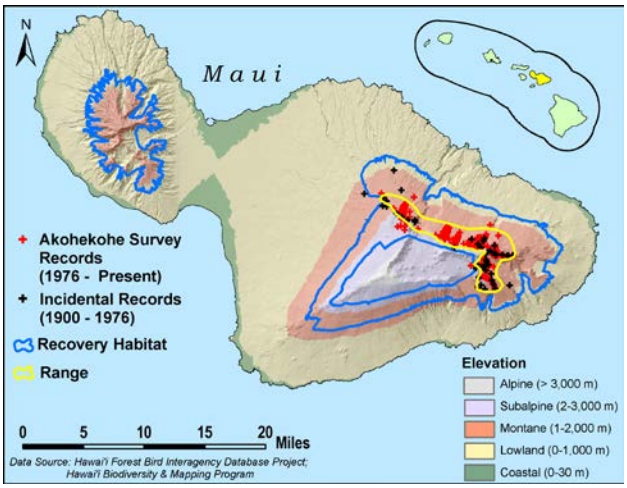
SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking—Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The ʻākohekohe, or crested honeycreeper (Family: Fringillidae), is the largest extant honeycreeper on Maui Nui (Lānaʻi, Molokaʻi, Maui, and Kahoʻolawe). Although primarily black, the plumage of the ʻākohekohe is striking. Depending on their location, feathers are tipped with orange-yellow, gray, silver, or white. Orange feathers surround the eyes and extend over the nape, orange or yellow-white feathers cover the thighs, the epaulettes are white with orange tips, and there is a distinctive plume of white feathers that curl forward over the bill. They do not sing, but produce a random series of buzzes, croaks, and whistles. They are primarily nectarivorous, feeding mainly on ʻōhiʻa (*Metrosideros polymorpha*), but also from the flowers of other trees and shrubs. Like ʻapapane (*Himatione sanguinea*) and iʻiwi (*Vestiaria coccinea*), ʻākohekohe are strong fliers and will move from low to high elevations in search of blooming ʻōhiʻa. Arthropods, mainly gleaned from ʻōhiʻa, are also part of the species' diet. They spend up to 70 percent of the day foraging. They aggressively defend feeding and nesting territories year-round. Females build open-cup nests primarily in ʻōhiʻa, incubate the clutch of one or two eggs, and brood nestlings; male feeds female on nest. Fledglings can forage independently 10 to 14 days after leaving the nest. Pairs successfully fledge two to three broods per season.

DISTRIBUTION: Restricted to a 58 square kilometer (22 square mile) area on the northeastern slope of Haleakalā at 1,100 to 2,300 meters (3,600 – 7,550 feet). Subfossil evidence indicates they once occurred in Maui's lowland dry forests, and they also once occurred eastern Molokaʻi. They currently occupy 5 percent of the historical range.

ABUNDANCE: The Hawaiian Forest Bird Survey (1980) estimated the population at 3,800 ± 700 (95% confidence interval) individuals. Surveys in 1992 and 1995-97 indicated similar densities across the same range.

LOCATION AND CONDITION OF KEY HABITAT: Wet and mesic montane forests dominated by ʻōhiʻa and ʻōlapa (*Cheirodendron trigynum*); koa (*Acacia koa*) and kāwaʻu (*Ilex anomala*) occur at lower densities. Nearly all birds occur in forest between 1,500 and 2,100 meters (5,000 – 6,000 feet) elevation in rugged, steep terrain with a dense understory. The entire known range of the species occurs within State (e.g., Forest Reserve and Natural Area Reserve) or Federally (e.g., National Park) managed lands.



THREATS: ʻĀkohekohe are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For ʻākohekohe, the following are of particular concern:

- Disease. Similar to ʻapapane and ʻiʻiwi, movements between low- and high-elevation foraging sites may increase these birds' exposure to mosquito-borne diseases.
- Habitat degradation. Feral pig (*Sus scrofa*) damage to understory vegetation may reduce the availability of nectar-producing plants important to ʻākohekohe, especially those flowering when ʻōhiʻa nectar is less available.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: Captive propagation of ʻākohekohe has been attempted, but to date has been unsuccessful. ʻĀkohekohe likely benefited from actions to conserve endangered forest bird species on the northeastern slope of Haleakalā, including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. In addition to these efforts, future actions specific to ʻākohekohe may include the following:

- Establish a second population to reduce the chances that a catastrophe could result in the species' extinction. Potential re-introduction sites (e.g., west Maui and Molokaʻi) are limited because of the presence of mosquitoes.
- Continue attempts at establishing a captive population, especially if a second wild population cannot be establish.
- Implement additional fencing and feral pig control to improve understory conditions in occupied habitat and potentially facilitate expansion of ʻākohekohe populations.
- Conduct public outreach and education.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats and feral cats in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to ʻākohekohe include the following:

- Determine if disease-resistant individuals exist, and if so, if resistance is passed to offspring. Disease-resistant individuals could be used to establish new populations.
- Determine the role of ʻākohekohe in transmitting disease between high- and low-elevation habitats.

References:

Berlin KE, VanGelder EM. 1999. ʻAkohekohe (*Palmeria dolei*). *In* The Birds of North America, No. 400 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org. (Accessed May 2015).

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

U.S. Fish and Wildlife Service. 2006. Revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: Jack Jeffrey

Maui ʻalauahio or Maui creeper

Paroreomyza montana

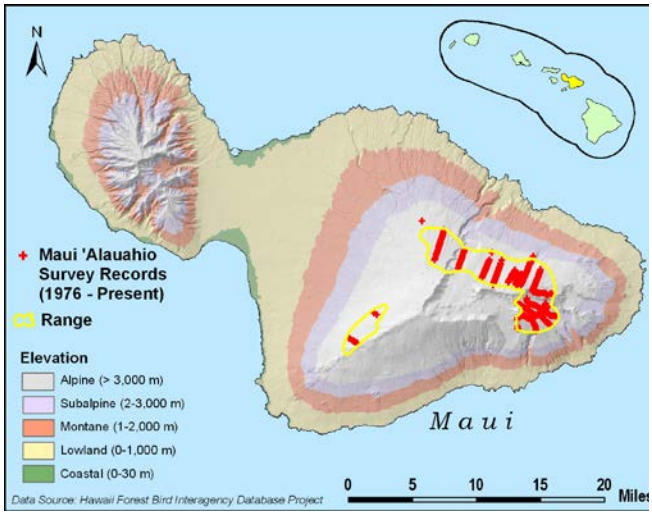
SPECIES STATUS:
State Recognized as Endemic
NatureServe Heritage Rank G4—Apparently Secure
IUCN Red List Ranking—Endangered

SPECIES INFORMATION: The Maui ʻalauahio, or Maui creeper, is a small insectivorous Hawaiian honeycreeper (Family: Fringillidae) endemic to Maui. The species also occurred on Lānaʻi but was last seen in 1937 and is presumed extinct. Adult males are predominantly olive-green above and have a bright yellow face, throat, and belly; the amount and intensity of yellow varies among individuals. Adult females are similar, but generally not as bright; both have short, fine straight bills. Adult plumage is not attained for several years. The Maui ʻalauahio gleans invertebrates from woody and leafy parts of a variety of plants. Adults defend 1 to 2 hectare (2.5 – 5 acre) home ranges against conspecifics year round and will chase ʻapapane (*Himantione sanguinea*) and Japanese white-eyes (*Zosterops japnicus*) from the vicinity of their nests. They are socially monogamous and pair for life, although extra-pair copulations have been confirmed through genetic analysis. Females choose the nest site and build open-cup nests. Clutch size is two, and birds will renest after a failure, although double brooding has not been documented. Only females incubate eggs and brood nestlings. They do not breed until their third year, and young birds (i.e., helpers) associate with breeding pairs. Helpers are usually offspring from the previous year and feed the female, nestlings, and fledglings. Fledglings are fed for two to three months, and young remain with their parents in family groups for 18 - 20 months.

DISTRIBUTION: Above 900 meters (3,000 feet) on the slopes of Haleakalā. Historically common in west Maui and on Lānaʻi; these populations are now extirpated. Fossil evidence suggests they were common across the south side of the island and in lowland forests.

ABUNDANCE: The Hawaiian Forest Bird Survey (1980) estimated the population at 35,000 ± 5,000 (95% confidence interval) birds. Surveys conducted in 1995-1997 found similar numbers, but densities decreased below 1,600 meters (5,250 feet) and the range appears to have contracted.

LOCATION AND CONDITION OF KEY HABITAT: Primarily wet and mesic montane forests dominated by ʻōhiʻa (*Metrosideros polymorpha*), although they also occur in subalpine māmane scrub (*Sophora chrysophylla*), and in dry and mesic forests dominated by pine (*Pinus* spp.) and eucalyptus (*Eucalyptus* spp.; e.g., Polipoli State Park and Hosmer Grove); all populations occur above 900 meters (2,925 feet) elevation. Habitat conditions vary greatly across the species' range. The northeastern part of the species' range is actively managed by the State of Hawaiʻi, (i.e., Forest Reserve and Natural Area Reserve), the National Park Service, and private landowners including the Nature Conservancy. All entities are current members of the East Maui Watershed Partnership. The remainder of the species' range occurs on State and Federally owned lands, where management efforts vary considerably.



THREATS:

- Predation. Rats (*Rattus* spp.) have been observed depredating nests and females. Female behavior of begging near nests may make them particularly susceptible to rats.
- Disease. Susceptibility to avian malaria has been documented, and likely prevents the establishment of populations in lowland areas. In Kahikinui, few individuals show signs of avian pox, although it is prevalent in ʻamakihi (*Hemignathus virens*) and ʻapapane (*Himatione sanguinea*). These data are equivocal, indicating low transmission rates, possible resistance, or very high mortality for this species.
- Habitat degradation. Current fencing around protected areas is not effective in excluding axis deer (*Axis axis*). Currently, deer populations on Maui are growing and threaten to further degrade forests occupied by the ʻalauahio.

CONSERVATION ACTIONS: Maui ʻalauahio likely have benefited from actions to conserve endangered forest birds on northeastern Haleakalā including fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies on disease and disease vectors. In addition, ongoing fencing and ungulate control on Department of Hawaiian Home Lands at Kahikinui will likely benefit the small population there. In general, actions should include continued protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for Hawaiian forest birds include improving methods for controlling rats and feral cats (*Felis silvestris*) in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquitoes. Research priorities specific to Maui ʻalauahio include development of a translocation protocol to facilitate reintroduction into restored high-elevation forests.

References:

Baker H, Baker PE. 2000. Maui ʻalauahio (*Paroreomyza montana*). *In* The Birds of North America, No. 504 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org. (Accessed May 2015).

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Photo: Eric VanderWerf

Koa'e kea or White-tailed Tropicbird

Phaethon lepturus

SPECIES STATUS:
State recognized as Indigenous
NatureServe Heritage Ranking G5 - Secure
North American Waterbird Conservation Plan – High concern
Regional Seabird Conservation Plan - USFWS 2005

SPECIES INFORMATION: The koa'e kea or white-tailed tropicbird is a showy, white seabird (Family: Phaethontidae), related to boobies and frigatebirds. Six koa'e kea (white-tailed tropicbird) subspecies are recognized; only one (*P. l. dorothea*) breeds in Hawai'i. Adult male and females are mostly white, although sometimes with pale pinkish wash, except for a narrow black eye patch, black streak on upper wings, and black on the leading edge of the outer primaries; both sexes have long, narrow, white central tail feathers. Large yellow-green bill; legs and feet are very small. Flight is characterized by rapid wing beats, interspersed with brief periods of gliding. Koa'e kea (white-tailed tropicbird) usually forage alone, but occasional with conspecifics, most often far from land; often will follow ships. Koa'e kea (white-tailed tropicbird) captures prey by plunge diving from 15 to 20 meters (50 – 65 feet) above the water. Diet is poorly known, but includes flyingfish and is likely similar to koa'e ula or red-tailed tropicbird (*P. rubricauda*). Koa'e kea (white-tailed tropicbird) breed in colonies and pairs remain together for years. At the beginning of the breeding season, pairs engage in complex aerial displays. Nests are placed in hard to reach locations on cliffs as well as in caves and tree hollows; nests have little if any material. In Hawai'i, breeding occurs March through October and a single egg is laid per season. Both parents incubate the egg, and brood and fed the chick. No post-fledging care is provided. Based on few data, age at first breeding is likely after fourth year; no data on longevity.

DISTRIBUTION: Koa'e kea (white-tailed tropicbird) breed on Midway Atoll and in the MHI at the following locations: Waimea Canyon, Kīlauea Point National Wildlife Refuge, and the Nā Pali Coast on Kaua'i; Pelekunu Valley, Waikolu, and windward sea cliffs on Moloka'i; Kaholo Pali, Maunalei Gulch, Hauola Gulch on Lāna'i ; Kīlauea Crater and windward coast on the island of Hawai'i, and the offshore islet Mokoli'i. A few pairs nest on southeastern O'ahu. Outside of Hawai'i, koa'e kea (white-tailed tropicbird) breed on oceanic islands throughout the Atlantic, Indian, and Pacific oceans as well as the Caribbean. Outside the breeding season, adults are solitary and pelagic, and their range is poorly known.

ABUNDANCE: In Hawai'i, population estimated at 1,800 breeding pairs with most occurring in the MHI. The worldwide population is estimated at less than 200,000 breeding pairs.

LOCATION AND CONDITION OF KEY HABITAT: Terrestrial: Koa'e kea (white-tailed tropicbird) breeds mainly on oceanic islands. Frequently nests in inaccessible crevices or ledges on cliff walls, outside of Hawai'i the species is known to nest in a variety of sites including caves, tree hollows, and in closed-canopy rain forests. **Marine:** Pelagic and nearshore.

THREATS:

- Introduced predators. Like all seabirds, adults and nests susceptible to predation by rats (*Rattus* spp.) and feral cats (*Felis silvestris*).

CONSERVATION ACTIONS: The following management goals are important to Pacific seabird conservation: maintain, protect, and enhance habitat; eradicate or control non-natives; minimize bycatch and other negative effects of fishing; improve the effectiveness of oil spill response efforts; identify contaminates and hazardous substances; and minimize the effects of powerlines, towers, wind turbines and lights (USFWS 2005). The goal of these management actions is not only to protect seabird populations and their breeding colonies, but also to re-establish former breeding colonies thereby reducing the risk of extinction. In addition to these efforts, future management specific to Hawaiian populations of koa'e kea (white-tailed tropicbird) should include the following:

- Eradication and control of introduced predators at current and potential breeding colonies.
- Continued protection and management of existing wildlife sanctuaries and refuges.

MONITORING: Continue surveys of population and distribution in known and likely habitats.

RESEARCH PRIORITIES: Most research priorities for seabirds are related to determining the most appropriate methods for achieving the above goals**.** Research priorities specific to koa'e kea (white-tailed tropicbird) include the following:

- Conduct long-term demographic studies to determine population trends, philopatry to nest colonies and nest sites, survival rates, and reproductive success.
- Develop survey protocol to assess population status and monitor trends.

References:

Kushlan JA, et al. 2002. Waterbird Conservation for the Americas: The North American waterbird conservation plan, Version 1 Waterbird Conservation for the Americas, Washington, DC. 78pp. Available at: www.waterbirdconservation.org.

Lee DS, Walsh-McGehee M. 1998. White-tailed tropicbird (*Phaeton lepturus*). *In* The Birds of North America, No. 353 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, (OR): U.S. Fish and Wildlife Service.

Photo: Robby Kohley

Forest Birds

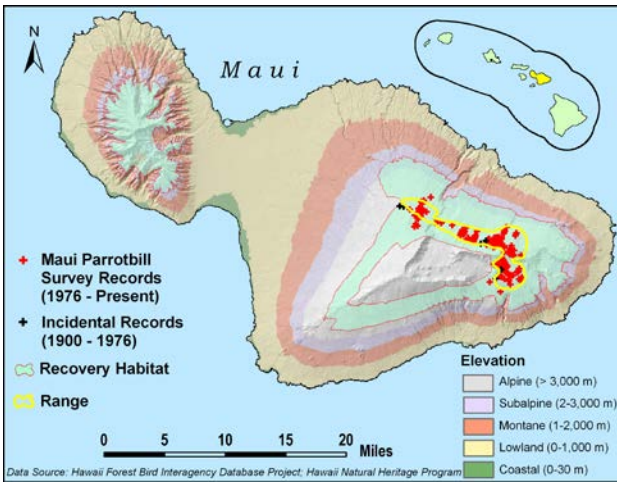
Kiwikiu or Maui parrotbill

Pseudonestor xanthophrys

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Endemic
NatureServe Heritage Rank G1—Critically Imperiled
IUCN Red List Ranking— Critically Endangered
Revised Recovery Plan for Hawaiian Forest Birds—USFWS 2006

SPECIES INFORMATION: The kiwikiu or Maui parrotbill is stocky, bull-headed Hawaiian honeycreeper endemic to Maui, with a short tail and a relatively large, parrot-like bill. Adults are mostly olive-green above with a yellow breast, belly and cheeks, and a bright yellow line above their eyes (i.e., supercilium). Males are typically brighter than females, although individuals are variable. Males are larger than females with a larger bill. They feed on a variety of shrubs and small trees, especially ʻakala (*Rubus hawaiensis*), kanawao (*Broussaisia arguta*), ʻōhiʻa (*Metrosideros polymorpha*), and koa (*Acacia koa*) where it gleans prey from moss-covered branches or uses its bill to chisel, crack, crush, dig, and tear bark and softer wood in search of beetle and Lepidoptera larvae and pupae. Also opens fruit in search of insects. Pairs defend relatively large (6-8 hectare), year-round home ranges. Females build nests, incubate eggs, and brood young. Clutch size is usually one, and females feed nestlings with food delivered by males. Males feed fledglings. They will renest after a nest failure, but are not known to attempt another nest if the first is successful. Development of bill and acquisition of foraging techniques is prolonged and young remain with parents for 5 to 18 months. Because of this long period of dependency, kiwikiu are often seen in small groups and males can be seen provisioning juveniles from current and previous years.

DISTRIBUTION: Restricted to a ~50 square kilometer (19 square mile) on the northeastern slopes of Haleakalā between 1,230 and 2,370 meters (4,000 – 7,700 feet). Subfossils indicate they once occurred island-wide including at low elevations and leeward (southeastern) forests and on the island of Moloka'i.



ABUNDANCE: The Hawaiian Forest Bird Survey (1980) estimated the population at 502 ± 116 (95% confidence interval) birds. More recent surveys reported densities similar to those from the 1980 survey.

LOCATION AND CONDITION OF KEY HABITAT: Mid-to-upper-elevation montane wet forests dominated by 'ōhi'a, and in a few mesic areas dominated by 'ōhi'a and koa (*Acacia koa*), with a dense, diverse native understory and subcanopy of ferns, sedges, epiphytes, shrubs, and small to medium trees. Most of the range is managed by the National Park Service, State of Hawai'i, The Nature Conservancy (TNC), and the East Maui Watershed Partnership.

THREATS:

- Low reproduction. Unlike many Hawaiian honeycreepers, kiwikiu have low annual fledgling production. This results from a low reproductive potential (one fledgling per year) coupled with low reproductive success due to habitat limitations and weather. This life history characteristic may be related to their very specialized foraging strategy. Regardless, the species is susceptible to factors that reduce population size.
- Disease. Despite the availability of seemingly suitable habitat below 1,350 meters (4,500 feet), kiwikiu are not found in these areas, suggesting that disease may be restricting populations to higher elevations.
- Predation. Predation on adults and nests by rats (*Rattus* spp.), cats (*Felis silvestris*), the small Indian mongoose (*Herpestes auropunctatus*), and owls (*Asio flammeus sandwichensis, Tyto alba*) may limit the species. High rat densities have been reported in the Hanawī area, which also supports a large proportion of the kiw

The rare Maui Parrotbill— Photo by Eric Nishibayasl

- Habitat loss. Historical accounts suggest that kiwikiu f and ranching has resulted in the loss of large areas of mesic koa forest, and their current range is restricted to wet forests where koa density is relatively low. Thus like many endangered Hawaiian forest birds, kiwikiu may be restricted to suboptimal habitat.
- Habitat degradation. Damage to understory vegetation by feral pigs (*Sus scrofa*) likely reduces habitat suitability and may contribute to reduced food availability and low reproductive success. Habitat degradation also may increase exposure of nests to inclement weather.
- Population size. Small populations are plagued by a variety of potentially irreversible problems that fall into three categories: demographic, stochastic, and genetic; the former are usually most problematic. Demographic factors include skewed sex ratios and stochastic factors include natural disasters. Habitat fragmentation exacerbates demographic and genetic problems.

CONSERVATION ACTIONS: In 1997, a captive breeding program was initiated. As of 2015, 14 kiwikiu are in captivity at the Maui Bird Conservation Center. The kiwikiu also benefits from management efforts to conserve other endangered forest birds on northeastern Haleakalā, such as the establishment of the 3,000 hectare (7,500 acre) Hanawī Natural Area Reserve in 1986, the formation of East Maui Watershed Partnership and Maui Forest Bird Recovery Project, fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future actions specific to the recovery of the kiwikiu may include the following:

- Protect and restore habitat in high-elevation disease-free areas.
- Implement fencing and ungulate control in low-elevation habitat from the Hanawī Natural Area Reserve to TNC's Waikamoi Preserve, to facilitate the recovery of the understory and subcanopy vegetation and eventually result in high-quality kiwikiu habitat.
- Establish a continuous corridor of suitable habitat around Haleakalā by connecting conservation lands on the southern and western parts of the mountain. Restoration of koa forests to this area would be a key element to this effort.
- Restore, fence, and eradicate ungulates from the remnant mesic koa forests on the State Forest Reserve and Department of Hawaiian Home Lands in the Kahikinui region of southern Haleakalā. Restoration of this area would be a cost-effective starting point to providing the kiwikiu with high-quality habitat.
- Conduct public outreach and education about the importance of invasive species control and forest restoration.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats, mongooses, and feral cats in native forests, determining ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquitoes. Research priorities specific to the kiwikiu include the following:

- Evaluate the effect of predator control on reproduction and survival of kiwikiu.
- Further refine captive breeding techniques and evaluate experimental reintroduction sites. Evaluation should include mosquito surveys and determination of disease prevalence in lower elevation sites.
- Investigate habitat use in forests that kiwikiu do not currently inhabit to design and implement large-scale restoration.

References:

Brinck KW, Camp RJ, Gorresen PM, Leonard DL, Mounce HL, Iknayan KJ, Paxton EH. 2012. 2011 Kiwikiu (Maui Parrotbill) and Maui Alauahio abundance estimates and the effect of sampling effort on power to detect a trend. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo. Technical Report HCSU-035.

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org. (Accessed May 2015).

Mounce HL, Leonard DL, Swinnerton KJ, Becker CD, Berthold LK, Iknayan KJ, Groombridge JJ.

2013. Determining productivity of Maui Parrotbills, an endangered Hawaiian honeycreeper. Journal of Field Ornithology 84(1):32-39.

Mounce, HL, Iknayan, KJ, Leonard, DL, Swinnerton, KJ, and Groombridge, JJ. 2014. Management implications derived from long term re-sight data: annual survival of the Maui Parrotbill *Pseudonestor xanthophrys*. Bird Conservation International 24:316-326

Mounce HL, Raisin C, Leonard DL, Wickenden H, Swinnerton KJ, Groombridge JJ. 2015. Spatial genetic architecture of the critically-endangered Maui Parrotbill (*Psuedonestor xanthophrys*): management considerations for reintroduction strategies. Conservation Genetics Volume 16, Issue 1: Page 71-84.

Scott JM, Mountainspring S, Ramsey FL, Kepler CB. 1986. Forest bird communities of the Hawaiian islands: their dynamics, ecology and conservation. Lawrence, (KS): Cooper Ornithological Society.

Simon JC, Baker PE, Baker H. 1997. Maui parrotbill (*Pseudonestor xanthophrys*). *In* The Birds of North America, No. 311 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Warren CW, Mounce HL. 2014. Home-range patterns of two Hawaiian honeycreepers, Kiwikiu (*Pseudonestor xanthophrys*) and Maui Alauahio (*Paroeomyza montana*). Presentation. Island Biology Conference, Honolulu, HI.

U.S. Fish and Wildlife Service. 2006. Revised Recovery plan for Hawaiian forest birds. Portland, (OR): U.S. Fish and Wildlife Service.


Photo: C. S. N. Bailey, NPS

ʻUaʻu or Hawaiian petrel

Pterodroma sandwichensis

SPECIES STATUS:
Federally Listed as Endangered
State Listed as Endangered
State Recognized as Indigenous
NatureServe Heritage Rank G2/T2 –
Species Globally Imperiled/Subspecies Locally Imperiled
IUCN Red List Ranking – Vulnerable
Regional Seabird Conservation Plan – USFWS 2005

SPECIES INFORMATION: The ʻuaʻu or Hawaiian petrel is a medium-sized, nocturnal gadfly petrel (Family: Procellariidae) endemic to Hawaiʻi. The name is derived from a commonly uttered call, heard at colonies. Adults are uniformly dark grayish black above forming a partial collar which contrasts with white throat, forehead, and cheeks; entirely white below except for black tail and leading and trailing edges of underwings. Owing to darkness of back color, the 'W-pattern' across back and upper surface of wings is not visible except in worm plumage. Bill black, and legs and feet mostly pink. Even during the breeding season, ʻuaʻu often feed thousands of kilometers from their breeding colonies, usually foraging within mixed-species feeding flocks over schools of predatory fishes. They feed by seizing prey while sitting on the water or by dipping prey while flapping just above the ocean surface. In Hawaiʻi, they feed primarily on squid, but also on fish, especially goatfish and lantern fish, and crustaceans. ʻUaʻu nest in colonies, form long-term pair bonds, and return to the same nest site year after year. Colonies are now typically in high-elevation, xeric habitats or wet, dense forests, although before the arrival of the Polynesians and their associated animals these birds nested in the lowlands, too. They nest in burrows, crevices, or cracks in lava tubes; nest chambers can be from 1 to 9 meters (3-30 feet) deep. Most eggs are laid in May and June and most birds fledge by December, although there are significant inter-island differences in breeding phenology; for example, the nesters that are earliest by more than a month reside at the summit of Haleakala Volcano. Both parents incubate the single egg, and brood and feed the chick. Birds first breed at five to six years of age.

DISTRIBUTION: Nests among the Main Hawaiian Islands (MHI) including Maui, Hawaiʻi, Kauaʻi, Lānaʻi, and possibly on Molokaʻi. Subfossil evidence indicates that prior to the arrival of Polynesians, ʻuaʻu was common throughout the MHI. At sea, they occur throughout the central tropical and subtropical Pacific Ocean.

ABUNDANCE: In the early 1990s the population was estimated at 19,000 individuals with a breeding population of 4,500 to 5,000 pairs, although inaccessible nesting locations make accurate counts difficult. Analysis of at-sea counts indicate broad consistency with the island-based estimates. More recently (1998-2011) the global population was estimated at 52,000 birds,

although due to differences in sampling methods it is unknown whether these higher numbers reflect a population increase or a difference in the proportion of the total population sampled. More than 1,800 individuals occur at Haleakalā National Park on Maui (a few hundred more nest in West Maui), around 150 pairs occur on Mauna Kea, Hawai'i; around 1,600 pairs occur on Kaua'i; several thousand birds occur on Lāna'i; and potentially around 50 pairs nest on Moloka'i.

LOCATION AND CONDITION OF KEY HABITAT: Nests in a variety of remote, inland habitats. On the islands of Hawai'i and Maui, colonies are located above 2,500 meters (8,200 feet) in xeric habitats with very sparse vegetation, with most nests in existing crevices in the lava. On Kaua'i and Lāna'i, and West Maui colonies occur in lower-elevation forests dominated by 'ōhi'a (*Metrosideros polymorpha*) often with a dense understory of uluhe fern (*Dicranopteris linearis*). At sea, they are pelagic and occur over the open ocean.

THREATS:

- Historical hunting. Nestlings were considered a delicacy by Polynesians, and were harvested from nest burrows, including artificial ones constructed by the Polynesians. Adults were netted as they returned to colonies, and smoky fires were sometimes lit along flight corridors to disorient and ground birds.
- Introduced predators. Adults and chicks are susceptible to depredation by dogs, pigs, rats, barn owls, feral cats, and the small Indian mongoose. The presence of these destructive introduced animals, the main force behind population decline, has relegated the species now to nest only in remote interior areas, at very high altitude, or on islands that are predator-free.
- Feral ungulates. Feral goats (*Capra hircus*), mouflon sheep (*Ovis musimon*), and potentially axis deer (*Axis axis*) trample burrows and degrade nesting habitat.
- Artificial lighting. Street and resort lights, especially in coastal areas, disorient fledglings, causing them to eventually fall to the ground exhausted or increasing their chance of colliding with artificial structures (i.e., fallout) such as powerlines. Once on the ground, fledglings are killed by cars, cats, and dogs, or die of starvation or dehydration.
- Collisions. Adults and fledglings are susceptible to mortality from collisions with obstacles such as communication towers, utility lines, fences, and wind farm structures while commuting between inland nest sites and the ocean at night.
- Colony locations. The remoteness of colonies, as well as the habitat in which they occur (e.g., steep terrain or dense forest), complicates predator and ungulate eradication or control.

CONSERVATION ACTIONS: Past actions directed at 'a'o (Newell's shearwater [*Puffinus auricularis*]) have often benefited 'ua'u populations. These actions include the rescue and rehabilitation of downed fledglings by the Save Our Shearwaters (SOS) program and efforts to shade and curtail resort and event lighting and streetlights. Current and future conservation efforts on Kaua'i to benefit should include efforts to reduce and shield lighting, control predators and invasive species at breeding colonies, conduct surveys to locate and characterize additional colonies, evaluate updated population estimates, and implement management actions appropriately. Actions being carried out in association with several Habitat Conservation Plans, along with State and federal recovery efforts are resulting in conservation benefits to 'ua'u on Maui, Lāna'i and Kaua'i; these include efforts to protect existing breeding populations and establish new colonies using predator-proof fencing, predator control,

ungulate control, social attraction, and translocation work plans. In addition to these efforts, future management actions specific to ʻuaʻu populations should include the following:

- Continue predator and ungulate control at colonies on Hawaiʻi, Maui, Lānaʻi, and Kauaʻi, and potentially at offshore islets that contain suitable nesting habitat.
- Locate additional breeding colonies on Lānaʻi, Hawaiʻi, Maui, and Kauaʻi and perform surveys on Molokaʻi, Lānaʻi, and Kahoʻolawe to assess ʻuaʻu presence on these islands.
- Continue to identify fallout areas and minimize effects of powerlines and artificial lights.
- Continue to support the SOS program, particularly public outreach about light attraction and fallout, the rescue and rehabilitation program, and the establishment of similar programs on other islands where appropriate.
- Re-establish/expand breeding colonies by identifying suitable candidate locations for social attraction and/or translocation, and continue to refine translocation protocols.

MONITORING: Continue at-sea and terrestrial surveys in known and likely habitats to evaluate the population size and status, and to locate unidentified breeding colonies. Monitor breeding incidence, breeding density, reproductive success, causes of mortality, population trends, return rates and effectiveness of management at breeding colonies. Assess the efficacy of predator control efforts.

RESEARCH PRIORITIES:

- Develop and implement standardized survey and monitoring protocols that can be used throughout Hawaiʻi to better estimate population parameters and changes.
- Expand and refine radar studies to monitor population trends, locate colonies, investigate behavior, determine geographic variability in threats, and evaluate the effectiveness of conservation measures.
- Conduct long-term demographic studies to evaluate reproductive success, breeding incidence, breeding density, colony boundaries, population trends, and survival rates.
- Develop, refine, and monitor the outcome of conservation actions and measures that are employed to avoid and minimize impacts from flight collision and other causes, and broaden adaptive management approaches.

References:

Hawai'i Natural Heritage Program [Hawai'i Biodiversity and Mapping Program]. 2004. Natural diversity database. University of Hawai'i, Center for Conservation Research and Training. Honolulu, Hawai'i.

Holmes N, Friefeld H, Duvall F, Penniman J, Laut M, Creps N. 2011. Newell's Shearwater and Hawaiian Petrel Recovery: A Five-Year Action Plan. Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu, HI; Pacific Cooperative Studies Unit, Honolulu, HI; and U.S. Fish and Wildlife Service, Honolulu, HI.

Hu, D. G.E. Ackerman, C.S.N. Bailey, D.C. Duffy, and D.C. Schneider. 2015. Hawaiian petrel monitoring protocol – Pacific Island Network. Natural Resources Report NPS/PACN/NRR–2015/993. National Park Service, Fort Collins, Colorado.

IUCN Red List of Threatened Species. Version 2014.3. www.iucnredlist.org. (Accessed May 2015).

Joyce, TW. 2013. Personal communication. Scripps Institute of Oceanography, La Jolla, California.

NatureServe. 2003. Downloadable animal data sets. NatureServe Central Databases. Available at: http://www.natureserve.org/getData/vertinvertdata.jsp (March 10, 2005).

Simons TR, Hodges CN. 1998. Dark-rumped petrel (*Pterodroma phaeopygia*). *In* The Birds of North America, No. 345 (Poole A, Gill F, editors). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

U.S. Fish and Wildlife Service. 2005. Regional seabird conservation plan, Pacific Region. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region. Portland, Oregon.

U.S. Fish and Wildlife Service. 2011. Hawaiian dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*) 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawai'i.


Photo: Eric VanderWerf

Forest Birds

ʻIʻiwi

Vestiaria coccinea

SPECIES STATUS:
State Listed as Endangered on Oʻahu, Molokaʻi, Lānaʻi
State Recognized as Endemic
NatureServe Heritage Rank G4/T1/TH—Apparently Secure/
Critically Imperiled Globally on Oʻahu and Molokaʻi/Possibly Extinct on Lānaʻi
IUCN Red List Ranking—Vulnerable

SPECIES INFORMATION: The ʻiʻiwi is one of the most beautiful of the extant Hawaiian honeycreepers (Family: Fringillidae). Both males and females are vermillion red, with a black tail and wings, and a long, decurved pink bill. Native Hawaiians created feather capes using hundreds of thousands of ʻiʻiwi feathers; such capes signified power and prestige. Like ʻapapane (*Himatione sanguinea*), ʻiʻiwi often fly long distances in search of flowering ʻōhiʻa (*Metrosideros polymorpha*) trees and are important ʻōhiʻa pollinators. Their diet consists primarily of nectar from a variety of native and non-native flowers and the presence of non-native flowers may have contributed to increases in some populations. In addition to nectar, ʻiʻiwi also eat small arthropods. Both sexes defend small nesting territories and may defend important nectar resources. Courtship chases and feeding may precede breeding. Nest sites are in terminal branches of ʻōhiʻa trees and both sexes build the open-cup nest. Only females incubate eggs (typically two) and brood young. Young are mostly provisioned by female; males feed females off the nest. Despite their widespread distribution, little is known about their life history.

DISTRIBUTION: Occurs above 1,250 meters (4,100 feet) elevation on the islands of Hawaiʻi, Maui, and Kauaʻi; and may occur at reduced densities below. Relict populations occur on Oʻahu and Molokaʻi. Historically, ʻiʻiwi were common down to low elevations on all the Main Hawaiian Islands.

ABUNDANCE: The following island population estimates are based on Paxton et al. (2013): 543,009 ± 26,697 (95% confidence interval) birds on island of Hawaiʻi, 59,859 ± 5,290 on east Maui, 176 on west Maui, 80 on Molokaʻi, and 2,551 ± 617 on Kauaʻi. Oʻahu supports a population of less than 50 birds. The population is probably declining, but the species' wide-ranging foraging complicates population estimates and the determination of long-term trends.

LOCATION AND CONDITION OF KEY HABITAT: Mesic and wet forest dominated by ʻōhiʻa and koa (*Acacia koa*). Loss and degradation of habitat and high densities of cold-intolerant *Culex* mosquitoes, an important disease vector, in lowland areas restrict most birds to elevations above 1,250 meters (4,100 feet). Habitats with the highest ʻiʻiwi densities also support kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*), and hapuʻu tree ferns (*Cibotium* spp.). Māmane (*Sophora chrysophylla*) is common in high-elevation foraging habitat. Although much of the species' current range is under State or Federal jurisdiction, habitat quality and habitat protection and restoration varies considerably.

THREATS: Although populations appear stable on the islands of Hawai'i and Maui, they are likely susceptible to the same factors that threaten other native Hawaiian forest birds, including habitat loss and degradation, predation by introduced mammals, and disease. For 'i'iwi, the following is of particular concern:

- Disease. 'I'iwi are very susceptible to avian malaria and avian pox. Nine of ten individuals died within 37 days after receiving a single bite from mosquitoes infected with *Plasmodium*. Individuals infected with pox also are more likely to be infected with malaria. Because the highest points on Moloka'i and O'ahu are below 1,250 meters (4,100 feet), this susceptibility likely explains the severe population declines noted on these islands. Foraging movements may increase their exposure to disease.

CONSERVATION ACTIONS: 'I'iwi likely have benefited from actions to conserve other endangered forest birds on northeastern Haleakalā, Hakalau Forest National Wildlife Refuge, Alaka'i Wilderness Preserve and surrounding areas, Hawai'i Volcanoes National Park, and the 'Ōla'a/Kīlauea Watershed Partnership. These efforts include fencing, ungulate and small mammal control, forest restoration, habitat monitoring, and studies of disease and disease vectors. Future actions specific to the protection of 'i'iwi may include the following:

- Control mosquitos in degraded habitats.
- Conduct public education and outreach.
- Continue protection and management of wildlife sanctuaries and refuges.

MONITORING: Continue forest bird surveys and habitat monitoring on all islands.

RESEARCH PRIORITIES: Research priorities for most Hawaiian forest birds include improving methods for controlling rats (*Rattus* spp.) and feral cats (*Felis silvestris*) in native forests, determining the ecological requirements of *Culex* mosquitoes at mid- and high-elevation forests, and developing methods to control mosquito populations. Research priorities specific to 'i'iwi include the following:

- Determine if disease-resistant birds exist, and if so, determine if resistance is passed to offspring. Disease-resistant birds could be used to establish new populations.
- Determine the role of 'i'iwi in transmitting disease between low and high elevations.
- Conduct life history studies to quantify the population structure, dispersal patterns, survivorship, nesting phenology and success of this poorly known species.

References:

Fancy S G, Ralph CJ. 1998. 'I'iwi (*Vestiaria coccinea*). *In* The Birds of North America, No. 327 (Poole A, Gill F, editors.). Philadelphia, (PA): The Academy of Natural Sciences; and Washington DC: The American Ornithologists' Union.

Foster JT, Tweed EJ, Camp RJ, Woodworth BL, Adler CD, Telfer T. 2004. Long-term population changes of native and introduced birds in the Alaka'i swamp, Kaua'i. Conservation Biology 18:716-725.

IUCN Red List of Threatened Species. 2015. Version 2014.3. Available at: www.iucnredlist.org. (Accessed May 2015).

Paxton, EH, Gorresen, PM, Camp RJ. 2013. Abundance, distribution, and population trends of the iconic Hawaiian Honeycreeper, the 'I'iwi (*Vestiaria coccinea*) throughout the Hawaiian Islands: U.S. Geological Survey Open-File Report 2013-1150.

VanderWerf EA, Rohrer JL. 1996. Discovery of an ʻIʻiwi population in the Koʻolau Mountains of Oʻahu. ʻElepaio 56:25–28.

Appendix D: Invasive Plant Species Profiles

PLUME POPPY (*Bocconia frutescens*)

Hawai‘i Pacific Weed Risk Assessment: None
Regulatory Status: Hawai‘i Noxious Weed List (HAR 68)
Prevention and Control Category: None

REPORT INVASIVE SPECIES
643-PEST
643pest.org
CALL OR CLICK TO PROTECT HAWAII

Description

- Shrub to small (20 ft) tall tree.
- Native to Central and South America, introduced to Hawai‘i 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

- Kaua‘i: Not present. Please contact KISC if you see this plant on Kaua‘i.
- O‘ahu: 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.
- Molokaʻi: None known.
- Lānaʻi: None known.
- Kahoʻolawe: None known.
- Big Island: Infestations in Wood Valley, Kaʻu Forest Reserve, Honomalino and Manukā 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.

KOSTER'S CURSE (*Clidemia hirta*)

Hawai'i Pacific Weed Risk Assessment: 28 High risk
Regulatory Status: Hawai'i Noxious Weed List (HAR 4-68)
Prevention and Control Category: None

Description

- Densely branched shrub that grows to 0.5-3 m tall.
- 5 veined leaves that are ovate to oblong-ovate, 5-16 cm long, 3-8 cm wide.
- Stems are covered with red bristles.
- It has small whitish flowers and fruits that are dark blue when ripe.

Impacts

- *Clidemia* is a shade tolerant shrub that rapidly spreads in understories and newly exposed gaps in wet and mesic forest, as well as pasturelands across the state.
- Can forms dense and almost impenetrable thickets that shade out native vegetation.
- Fruits are abundantly produced, and seeds (roughly 500 per fruit) are dispersed mainly by birds but also may be carried by animals moving through the thickets.

Distribution

- Native to southern Mexico to northern Argentina and east to the islands of the West Indies.
- First observed on O'ahu in 1941 and has subsequently spread to Hawai'i Island (1972), Moloka'i (1973), Maui (1977), Kaua'i (1982), and Lāna'i (1988).

SILKY OAK (*Grevillea robusta*)

Hawai‘i Pacific Weed Risk Assessment: 8, High Risk
Regulatory Status: None
Prevention and Control Category: None

Description

- Common names: Silky oak, silk oak, silver oak
- Tall tree that grows up to 70 ft. in height.
- Young branches are hairy and rusty.
- Leaves simple, alternate, smooth, deeply and narrowly lobed, grows up to 1 ft. long. Lower surface of leaves rusty turning to whitish with margins curling under.
- Flower in clusters up to 7 inches long, orange to golden brown in color. Peak blooming occurs from May to June.
- Fruits are dry, dark capsules (follicles) with a long hair-like appendage at the end.

Silky oak flower and fruit

Impacts

- Silky oak was widely planted and is a prolific seeder.
- It is a pest in mesic pastures and forests.
- Pollen may trigger allergies.

Distribution

- Native to Australia.
- It was introduced to Hawai‘i around 1880 with over two million trees have been planted throughout Hawai‘i.
- Occurs on all major islands.
- Drought resistant but also does well in moist areas (60-80 in. rainfall).

Flowering silky oak

HIMALAYAN (KĀHILI) GINGER (*Hedychium gardnerianum*)

Photo Credit: Forest & Kim Starr

Impacts

While there are a wide variety of ginger species naturalized in Hawai‘i, a few pose serious threats to our native forests. None are as problematic as Himalayan ginger or *Hedychium gardnerianum*, considered one of the world’s 100 worst invasive species by the IUCN. *H. gardnerianum* stalks grow 1.5-2m tall from dense mats of rhizomes (underground stems of the plant) that quickly smother the forest floor. These large thickets easily grow in shade and dominate the understory of many Hawaiian forests where they outcompete native understory species and prevent native tree seedlings like ‘ōhi‘a lehua from establishing. This can permanently alter and diminish native ecosystems.

Distribution

This horticultural introduction of *H. gardnerianum* is found on all major Hawaiian islands. The weed, originating from the Himalayas, thrives in moist, forested lands and is a pest of areas worldwide, including New Zealand, the Federated States of Micronesia, South Africa, and Jamaica, among others.

H. gardnerianum has also been called kāhili ginger due to its similarity to the kāhili feather staffs symbolic of Hawaiian ali‘i. However, many have taken to calling the plant Himalayan ginger given that the species is native to the Himalayas. A Hawaiian name can potentially mislead people to believe it is a native species.

LANTANA (*Lantana camara*)

Hawai'i Pacific Weed Risk Assessment: 21 High risk
Regulatory Status: None
Prevention and Control Category: None

Description

- A woody shrub that grows 2-3 m tall.
- Leaves are 2-12 cm long and 2-4.5 cm wide.
- Stems are prickly and plants emit a strong odor.
- Flower heads are comprised of numerous brightly colored (pink, orange, yellow, violet) flowers.
- Fruits are purple or black and are 3 mm in diameter.

Impacts

- Seeds are consumed and dispersed by non-native birds.
- Forms dense impenetrable strands in dry and mesic grasslands and forests crowding out native species.
- Lantana contains a toxin lantadene that induces photosensitivity in animals that graze on it.

Distribution

- Likely native to the West Indies and is now widely distributed in the tropic and subtropic.
- Naturalized on all major Hawaiian Islands and Midway.

MOLASSES GRASS (*Melinis minutiflora*)

Hawai‘i Pacific Weed Risk Assessment: 18 High risk
Regulatory Status: None
Prevention and Control Category: None

Description

- A sprawling perennial grass that grows to 3.5 feet tall.
- Blades are dull green with sticky hairs and are 10-25 cm long, 3-11 mm wide.
- Plants have a noticeable sweet odor.
- Inflorescences are often purple-tinged and are 10-30 cm long.

Impacts

- Once it gets established, it can form monotypic mats that smother the vegetation around it.
- A fire-adapted species that can be a fire hazard during the dry season.

Distribution

- Native to Africa it has been introduced throughout the tropics as livestock feed.
- It is found in dry to moist areas on all of the main Hawaiian Islands except for Ni‘ihau.

MICONIA (*Miconia calvescens*)

Hawai‘i Pacific Weed Risk Assessment: 14 High risk
Regulatory Status: Hawai‘i Noxious Weed List (HAR 68)
Prevention and Control Category: KISC Target Species. OISC Target Species. MISC Target Species.

Report this species if seen on Kaua‘i, O‘ahu, Moloka‘i, Lāna‘i, or West Maui

REPORT INVASIVE SPECIES
643-PEST
643pest.org
CALL OR CLICK TO PROTECT HAWAII

Description
Miconia is a fast growing weedy tree that reaches 13-50′ in height. It has large leaves that average 3′ long and 1′ wide, and are dark green and felty above, with a distinctive “leaf within a leaf” vein pattern. The underside of the leaves are purple. It produces dark purple fruits that are 1/3″ in diameter and contain hundreds of seeds.

Impacts
Miconia trees grow quickly and close together, shading out nearly all other forest plants with their large oval leaves. It also has a shallow root system and can cause increased erosion and landslides. Miconia quickly matures, producing fruit after three to four years and flowers and fruits several times a year. Plants produce ten to twenty million seeds a year, which can remain viable for twelve years and possibly longer. Birds and animals (such as rats) spread miconia seed long distances. Seeds, about the size of a sand grain, are unintentionally spread by humans and hitchhike on clothes, boots, gear, pets, and contaminated vehicles, equipment, and soil.

Distribution
- Kaua‘i: There are three known populations, in Wailua River State Park, Wailua Homesteads, and the Wailua Game Management Area.

- O‘ahu: Originally introduced and traded amongst botanical gardens in the early 1960’s, miconia has since spread into several locations in the Ko‘olau range. The potential population boundary extends to 9,500 acres (including areas considered “seed banks”).
- Moloka‘i: No known to be present.
- Maui: Introduced to Maui in the early 1970s at a private nursery and botanical gardens near Hana. Infestations now occur in the forests near Hāna, Nāhiku, Ke‘anae and Huelo. Today, approximately 37,000 acres throughout East Maui, could potentially contain miconia. Not known from West Maui.
- Lāna‘i: Not known to be present.
- Kaho‘olawe: Not known to be present.
- Big Island: Large infestations on the windward side, with a smaller population on the leeward side. BIISC works to control populations on the windward side; community groups and private landowners also assist in some locations.

What you can do

Decontamination is extremely important to reduce the risk of spreading miconia. Hikers, biker and any vehicle or construction equipment can easily transport miconia’s long-lived, tiny seeds that are caught in tread, dirt, clothing, and mud. Thoroughly clean all vehicles, boots, clothing, equipment, and anything else exposed to mud before moving out of the miconia infestation zone.

STRAWBERRY GUAVA (WAIAWĪ) (*Psidium cattleianum*)

Hawai‘i Pacific Weed Risk Assessment: 18 High risk
Regulatory Status: None
Prevention and Control Category: None

Description

- A tall tree that grows to 20 feet.
- Bark is smooth, reddish, and mottled.
- Leaves are leathery and shiny and are up to 5 inches long and 2.5 inches wide.
- Flowers are white and with many stamens.
- Fruits are red or yellow and are about one inch in diameter.
- Seeds have a high rate of germination but short viability.

Impacts

- One of the most ecologically damaging invasive plant species in Hawai‘i.
- A shade-tolerant invasive species and prolific seeder.
- It forms dense stands in pastures and forests aggressively replacing native forests.
- Seeds spread by birds and pigs.
- Fruits host fruit flies.

Distribution

- Native to Brazil it was introduced to Hawai‘i in 1825.
- It is widely distributed in mesic and wet forests in Hawai‘i.

FLORIDA RASPBERRY (*Rubus argutus*)

Photo Credit: Forest & Kim Starr

Hawai‘i Pacific Weed Risk Assessment: 21.5 High risk
Regulatory Status: none
Prevention and Control Category: none

REPORT INVASIVE SPECIES
643-PEST
643pest.org
CALL OR CLICK TO PROTECT HAWAII

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 Hawai‘i, Maui, Moloka‘i, O‘ahu, and Kaua‘i
- Lāna‘i: presence/absence unknown

FIREWEED (*Senecio madagascariensis*)

Hawai‘i Pacific Weed Risk Assessment: 23, High Risk.
Regulatory Status: Hawai‘i 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, O‘ahu, Lāna‘i, and Hawai‘i, but can be prevented from invading Kaua‘i. 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 ¼” 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 Lānaʻi. On Kauaʻi, known infestations from hydro-mulched areas near Halfway Bridge and in Kalihiwai were controlled by KISC and HDOA. Kauaʻi, Oʻahu, and Molokaʻi 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!**

CHRISTMAS BERRY (*Schinus terebinthifolius*)

Hawai‘i Pacific Weed Risk Assessment: 19, High Risk
Regulatory Status: None
Prevention and Control Category: None

Description

- Common names: Brazilian peppertree, Christmasberry, wilelaiki.
- A local politician Willie Rice used to wear the berries on his hat, hence the name wilelaiki.
- Small tree that grows up to 20 ft. in height, bark is dark and slightly rough.
- Leaves alternate, pinnately compound with 7 leaflets, each about 3 in. by 1.25 in. wide. Terminal leaflet is the largest.
- Flowers are in clusters, greenish white in color. Male and female trees separate.
- Fruits cluster, bright red “berries,” papery hull, single seed per fruit. Trees fruit in fall and winter hence the name “Christmasberry.”
- Seeds will not germinate while in fruit and will retain viability no more than nine months.

Impacts

- Grows densely in dry-mesic pastures and forests.
- This plant is a prolific seeder and is spread by birds.
- Pollen can cause respiratory problems and the sap can cause a rash.
- Seeds are known to kill deer and horses.

Distribution

- Native of Argentina, Brazil, and Paraguay.
- Widespread throughout Hawai‘i in mesic to dry areas.
- Also a serious problem in Florida and Australia.

AFRICAN TULIP TREE (*Spathodea campanulata*)

Hawai‘i Pacific Weed Risk Assessment:14 High risk
Regulatory Status: none
Prevention and Control Category: none

Description

- A tall tree up to 75 ft
- 3-19 leaflets (5 in long by 3 in wide) form the compound leaves
- Scarlet-orange, showy flowers grow in clusters (about 4 in high and 8 in across) year-round; fruit clusters are upright
- Canoe-shaped seed capsules up to 10 in long

Impacts

- Spreads rapidly in mesic to wet areas, invading pastures and mature forests
- Seeds germinate quickly and form understory thickets
- Crowds out native vegetation in forests and waterways
- Brittle branches are a safety hazard

Distribution

- There are major infestations tucked away in almost every rainforest valley along the northern and eastern slopes of Kaua’i, O’ahu, Hawai’i, and East Maui.

AUSTRALIAN TREE FERN (*Sphaeopteris cooperi*)

Hawai‘i 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 hāpu‘u, which has red hairs)
- Trunk doesn’t have the thick, soft fiber wrapping like the native hāpu‘u
- Native to Australia, introduced to Hawai‘i as an ornamental

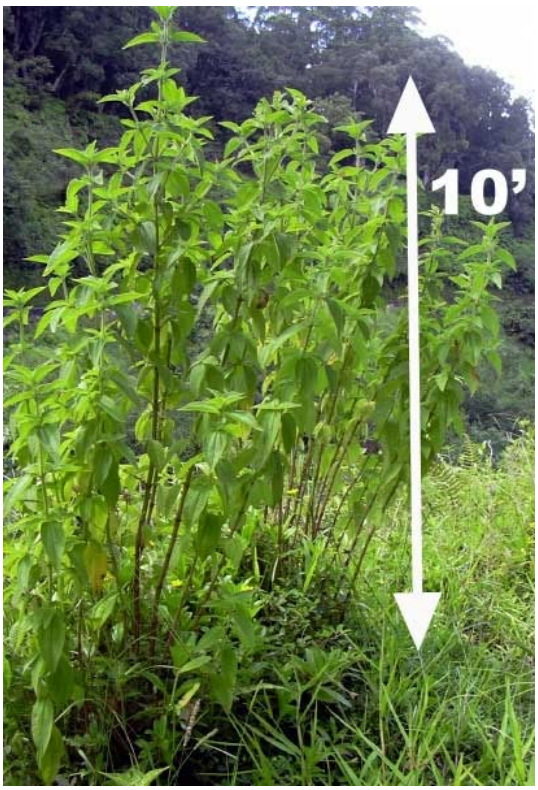
Impacts

- 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 hāpu‘u

Distribution

- Kaua‘i: Spreading in native forests including Hanalei, Kōloa, and Kōke‘e. Landowners are asked to plant non-invasive alternates instead.
- O‘ahu: Spreading in the Koolau and Waianae mountains. Landowners are asked to plant non-invasive alternates instead.
- Maui: Widely cultivated and naturalized. Infesting Kipahulu Valley, Pe‘ahi, Ha‘ikū, and areas in West Maui.
- Moloka‘i: 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.
- Lāna‘i: Presence/absence unknown
- Kaho‘olawe: None known.
- Big Island: Spreading from landscaped areas in Volcano, Laupāhoehoe, Kona and other areas. Landowners are asked to plant non-invasive alternatives instead of non-native tree ferns.

CANE TIBOUCHINA (*Tibouchina herbacea*)



Report this species if seen on O‘ahu

REPORT INVASIVE SPECIES
643-PEST
643pest.org
CALL OR CLICK TO PROTECT HAWAII

Hawai‘i Pacific Weed Risk Assessment Score: 24
Regulatory Status: Hawai‘i Noxious Weed List (HAR 68)
Prevention and Control Category: OISC Target Species

Description

- This shrub is semi-woody and can grow up to 9′ tall.
- The young stems are angled and hairy.
- The leaves are opposite, 3″ long by 1.4″ wide, hairy, and have 5-7 prominent veins.
- The flowers are pink and have 4 petals with bright yellow anthers.
- The fruit is cup-like and extremely small.
- The seeds are very small and numerous.

Impacts

- This plant is a prolific seeder and spread by birds.
- It forms dense stands in pastures and can also invade disturbed forest areas, displacing native species.

Distribution

- This shrub is native to southern Brazil, Uruguay, and Paraguay.
- Cane tibouchina has heavy infestations on Maui and Hawai‘i Island.
- It occurs in the northern Ko‘olau range on O‘ahu, as well as on Moloka‘i and Lāna‘i, and in Hilo, including lower Saddle Road on Hawai’i.
- This pest is not known to be on Kaua‘i. Please report any new sighting of this pest!

Look-alike Species

Glorybush (*Tibouchina urvilleana*): Also called princess flower, this is another Melastome species that can be very invasive. It has larger, purple flowers with five petals and can grow up to 12′ tall. The anthers of this plant are purple, unlike the yellow anthers of cane tibouchina. This plant can be seen in Kōkeʻe, naturalized along the roadside. This look-alike is also a pest.

Asian melastome (*Melastoma candidum, M. septemnervium*): This is a spreading shrub that forms tangled brush between 5′ to 15′ tall. Each flower usually contains five to six petals, averaging 1″ long. This plant is widespread across Kauaʻi. This look-alike is also a pest.

Appendix E: DOFAW Management Guideline Classification Definitions

Forest Products Management – LNR 172		
Management of sustainable forest product opportunities.		
Class Name	Class Definition	Management Strategies
F-1: Large Scale Commercial	• Forest products are a primary objective, and large scale sustainable commercial timber harvesting or salvage is allowed; • Permits, licenses and environmental compliance are required; • Harvesting of non-timber forest products is allowed.	• Produce a sustainable timber supply in balance with other resource management objectives; • Activities may include site preparation, tree-planting, thinning operations, forest stand improvement and large-scale timber harvest; • Timber management plans are required to mitigate non-timber resource impacts, and assure sustainable yield and positive impact forestry.
F-2: Small Scale Commercial	• Areas where limited commercial timber harvesting or salvage is allowed in balance with other land uses; • Required permits, licenses and environmental compliance depend on scope and scale of operations; • Harvesting of non-timber forest products may be allowed.	• To produce a sustainable supply of forest products while minimizing other resource impacts; • Activities may include site preparation, tree-planting, thinning operations, forest stand improvement and small-scale timber harvest; • Impacts of harvesting distributed over the resource area through controlled seasons and harvest; • Timber management plans are required to mitigate non-timber resource impacts, and assure sustainable yield and positive impact forestry; • Forest management activities performed in coordination with other resource management activities.
F-3: Personal Use	• Areas where selective non-commercial timber harvesting and targeted commercial timber salvage is allowed in balance with other land use objectives; • Permits for harvest of non-timber products issued on a case by case basis. •	• Limited timber harvest performed as appropriate to bring materials to local market, and produce other positive resource outcomes; • Minimize human impacts to native species and native ecosystems; • Accommodate harvest of forest products for sustainable personal use.
F-4: Restricted	• Harvesting of timber only considered if activity improves other priority resource outcomes; • Permits for harvest of non-timber forest products will be considered on a case by case basis for research and education, improving forest science and health, watershed protection, traditional and customary practices, and conservation efforts.	• Resource protection is the top priority; • Prioritize protection of native species and native ecosystems; • Permitted activities in these areas are minimally disruptive, and focused on improving forest and watershed health, native ecosystems, and other conservation efforts.

Conservation Resources - Native Species Habitat, Water Resources – LNR 402/407		
Class Name	Class Definition: May have one, all, or a combination of conservation values	Management Strategy
C-1: High Conservation Resources	• High level of native biological resources, native ecosystem intactness, and/or recovery potential; • Essential to the conservation and/or recovery of native species; • Important restoration areas, such as rare ecosystem remnants, native wildlife habitat, wetlands, and offshore islands; • High degree of conservation related regulatory encumbrances - critical habitat, restricted watershed, conservation easements and/or zoning; • High watershed conservation value per CWRM, USGS, BWS, and/or DOFAW.	• Intensive management applied, as necessary, to protect watershed values, and native species and ecosystems, as resources permit; • Management may include animal exclusion fencing, predator control, vegetation/weed control; • Work may include out-planting of native vegetation and reintroduction of native wildlife, as needed.
C-2: Medium Conservation Resources	• Moderate level of native biological diversity and/or native ecosystem intactness; • Contributes to the conservation and/or recovery of native species (i.e. T&E / native species habitat, water resources); • Medium degree of conservation related regulatory encumbrances; • Medium watershed conservation value.	• Management activities to control priority threats and improve watershed, native species or ecosystem outcomes; • Work may include out-planting of native vegetation and reintroduction of native wildlife, as needed. • Other uses may include forest products gathering, hiking, and liberal hunting.
C-3: Low Conservation Resources	• Low level of native biological diversity and/or native ecosystem intactness; • Low conservation and/or recovery of native species but may contribute to conservation (i.e. individual or small clusters of rare plants; genetic collection); • Low degree of conservation related regulatory encumbrances; • May have low watershed conservation value.	• Native species management occurs mostly in remnant patches and fenced units; • Mixed use area with forest products gathering, hunting and non-hunting recreation, as appropriate.
C-4: Little to No Conservation Resources	• Little to no native biological diversity and/or native ecosystems highly degraded or absent; • Little to no contribution to the conservation and/or recovery of native species; • Very little or no conservation related regulatory encumbrances; • May have low watershed conservation value.	• Area managed for a variety of uses not appropriate for more pristine environments, including timber harvest, regulated hunting and more intensive non-hunting recreation (hiking, equestrian and/or off-road vehicles).

Hunting Management – LNR 804		
Management for public recreation, subsistence hunting and animal damage control.		
Class Name	Class Definition	Management Strategy
H-1: Active Hunting Management:	• Public hunting is a high priority land use; • Area is suitable for a high degree of active management for public hunting; • Management of the area is designed to provide maximum sustained yield of game animals.	• Hunting regulations for the area are designed to provide maximum sustained yield while minimizing environmental impacts; • High degree of management to maintain or improve hunting program infrastructure; • Habitat is managed to maintain or increase game animal carrying capacity, while maintaining healthy vegetative cover for proper range management and erosion control.
H-2: Moderate Hunting Management:	• Area is suitable for a moderate degree of active management for animal enhancement and habitat management to increase animal productivity for public hunting; • Public hunting opportunities may be improved or maximized; • Public hunting is balanced with other objectives.	• Hunting regulations established to manage animal harvest; • Moderate degree of infrastructure for animal management; • Habitat modification for game animal production as appropriate for the area; • Balance animal impacts with other resources.
H-3: Low Intensity Hunting Management:	• Area not suitable for game enhancement and habitat management to increase animal densities - hunters play an important role in limiting animal impacts; • Minimal public hunting restrictions provide maximum public hunting opportunity; • Public hunting management includes maintaining access and monitoring hunter effort and success.	• Hunting seasons, bag limits and other hunting regulations liberalized to maximize hunting opportunity; • Hunting opportunities may include permitted hunts if needed to improve access; • No habitat modification for production and/or enhancement of game animals.
H-4: No Hunting Management:	• Area is not suitable for open public hunting due to environmental sensitivity, access, or safety; • No active management for public hunting; public hunting may be used for animal damage control on a permit basis; • Public hunting is not a primary land management objective.	• Area not open to regular public hunting seasons for either management, access or safety reasons; • Animal control to be conducted by staff, permitted and/or guided hunters, and other cooperators as appropriate.

Recreation Management – LNR 804		
Class Name	Class Definition	Management Strategy
R-1: High Recreation Management:	• Areas where outdoor recreation is a primary objective; • High level of visitor use is received and accommodated; • May include recreation, transit and/or urban elements; • Approximate average daily use: 100 - 1000+ users.	• Area can sustain heavy recreational use; recreation plays a major role in use of the area; • Trails maintained to sustain heavy use which may include hiking, mountain bike riding, equestrian and/or off-road vehicle use; • Improvements commensurate with use.
R-2: Medium Recreation Management:	• Areas where outdoor recreation is of moderate intensity, and may be integrated with other uses; • Includes a wide range of trails and roads requiring a moderate level of management and maintenance to meet user needs and balance other land use objectives; • Approximate average daily use: 0 – 500 (+/-) users.	• Area can sustain moderate recreational use; recreation integrated with other management programs; • Roads and trails maintained to sustain moderate use which may include hiking, mountain bike riding, equestrian, and/or off-road vehicle improvements; • Improvements commensurate with use.
R-3: Low Recreation Management:	• Areas where outdoor recreation is of low intensity, and is integrated with other uses; • Trails and roads that receive limited use, or whose character and terrain require little maintenance relative to the usage; • Approximate average daily use: 0 – 100 (+/-).	• Areas may be inaccessible or remote; facilities and improvements are limited, in keeping with the level of use; • Areas may be managed for multiple uses including forest protection, conservation, hunting, and hiking, or protected and managed to preserve natural conditions; activities may include hiking, biking, equestrian and/or off-road vehicles; • To protect both the trail environment and experience, improvements are typically minimal, and designed to fit the setting and need.
R-4: Recreation Management (Restricted access):	• Areas where outdoor recreation is restricted or controlled; • Areas sensitive to human disturbance due to natural, cultural or archaeological features; • Access primarily for management purposes, and/or limited or programmatic recreational or educational uses.	• Areas may be classified “restricted” due to hazardous conditions, watershed protection, sensitive wildlife, fragile ecosystems, cultural resources, limited accessibility, or management practices incompatible with recreational activities; • Managed to limit impacts from human activities; • Facilities and improvements are very limited and generally associated resource management; • Trails will not feature extensive recreational amenities and will generally incorporate only facilities necessary to protect and manage the resource; • Access may be controlled via permits, group number limitations, or other restrictions as appropriate for the area.