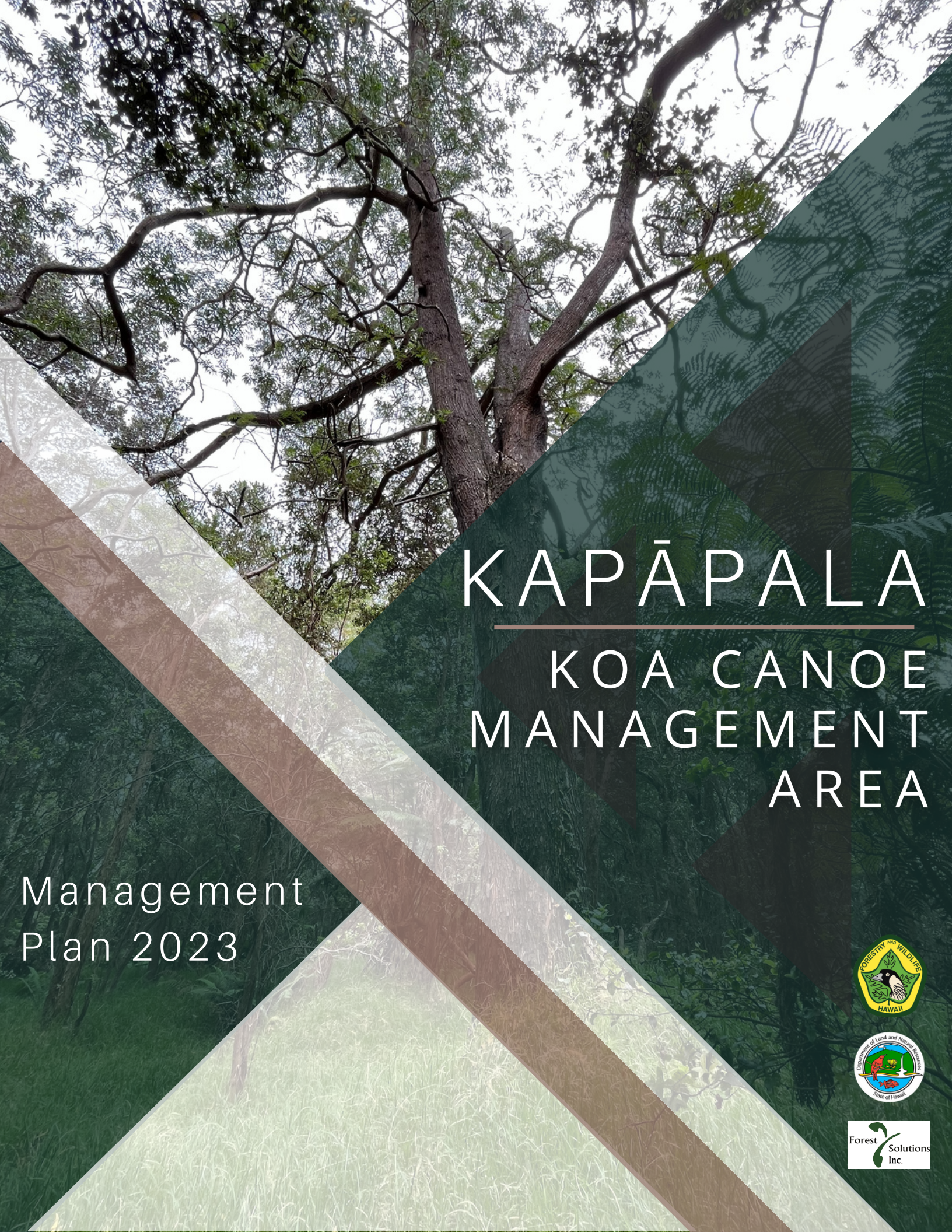

KAPĀPALA

KOA CANOE MANAGEMENT AREA

Management Plan 2023

Forestry and Wildlife Hawaii

Department of Land and Natural Resources State of Hawaii

Forest Solutions Inc.

EXECUTIVE SUMMARY

This management plan for the Kapāpala Koa Canoe Management Area (KKCMA) 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). These plans present a brief history of the specific forest reserve or section, 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.

KKCMA consists of roughly 1,257 acres on the southeastern slope of Mauna Loa in the district of Kaʻū and the ahupuaʻa of Kapāpala. The area is covered almost entirely by a native montane koa (*Acacia koa*) and ʻōhiʻa (*Metrosideros polymorpha*) forest at about 3,000-5,000ft in elevation. The primary management objective for the area is to provide a sustainable, long-term supply of koa for the traditional and cultural use of constructing koa canoes, while minimizing impacts on the natural and cultural resources in the area. This parcel is the only state land in Hawaiʻi specifically zoned for the purpose of producing koa canoe resources. Other management objectives include native forest protection, protection of watershed resources, protection of forest bird habitat, increased regeneration and restoration of koa trees and forest habitat, collaboration with educational groups and community groups, access for recreational activities, and integration of traditional Hawaiian stewardship models with western conservation practices.

A harvest plan has been developed to allow for the harvest and extraction of canoe-quality trees while regenerating koa resources on a 100-year timeframe. Current plans call for organizations who have been selected to independently implement the harvest of canoe logs with the guidance of DOFAW. DOFAW will also implement stand improvement actions, such as pre-commercial and commercial thinning, that will enhance the ability of the forest to produce large, straight koa trees capable of being made into canoes. Some of these timber resources may be sold to help fund the management of KKCMA. KKCMA has been split into management units and areas have been prioritized for restoration, habitat protection, and forest product gathering, while allowing for adaptive management as necessary. A recent timber survey of the area indicates available koa resources will likely be able to meet expected demand and maintain sustainable harvest levels. Organizations in the state of Hawaiʻi may apply for a permit to harvest a canoe log, which will be reviewed by a group of experts consisting of cultural practitioners; voyaging and racing members; kālaiwaʻa (canoe builders); forestry experts; conservationists; and community members, who will advise DOFAW/DLNR on the final allocation of canoe log permits.

Multiple protection measures will be implemented to ensure that the resources in the area are not degraded due to threats such as non-native animals, invasive weeds, human impacts, climate change, and/ or erosion. There are currently no known populations of cattle or mouflon sheep in the area, and there will continue to be zero tolerance for these animals as they severely impact koa trees and native forest ecosystems. Pigs are known in the area, a mixture of public hunting

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and staff control will be used to decrease pig populations and the damage the cause to koa and other resources in the area.. Invasive weeds are not widespread and are mostly contained to roadways in KKCMA. Weed presence has the possibility to increase with increased traffic, and monitoring and control measures will be implemented to ensure new species and populations do not become established. Erosion is another concern, and roadways within the area will be maintained with recontouring of steep, commonly degraded roadways as a high priority objective.

In order to minimize impacts on threatened and endangered (T&E) species and archeological and historical sites, mitigation measures will be implemented. Botanical surveys and archeological surveys will be implemented in all areas prior to any silviculture actions taking place in that unit. No T&E plant species are currently known within the area. Surveys for forest birds will also be implemented, and areas of higher value native forest and bird habitat will be lower priority harvest areas.

Staff have created the following categories for management priorities within KKCMA and ranked them for the area as follows:

1. Watershed Values – protect watershed values of the area.
2. Cultural Use Timber Harvesting – implement small-scale koa timber harvest for canoe construction.
3. Resource Protection – reduce damages from threats such as invasive plants and animals, wildfire, or insects and diseases on resources.
4. Native Ecosystems – protect and enhance native ecosystems in the area.
5. Threatened and Endangered (T&E) Species Management – protect and enhance T&E species in the area.
6. Access, Trails, Hunting & Other Public Uses– provide public use opportunities such as hiking, hunting, and bird watching.
7. Commercial Activity – implement small-scale sales of non-canoe quality trees.

A history of the area and Hawaiian canoe construction is found in Section 2. A full description of the site and the resources within it can be found in Section 3. Threats to the area are detailed in Section 4. Details of the above-mentioned management actions can be found in Section 5. A full list of management priority actions can be found in Table 14.

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Table of Contents

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KAPĀPALA KOA CANOE MANAGEMENT AREA MANAGEMENT PLAN SIGNATURE PAGE

Hawai‘i District certification: This plan was prepared by a team of Division of Forestry and Wildlife (DOFAW) staff to provide a management framework for Kapāpala Koa Canoe Management Area.

_____ _____

Steven T. Bergfeld – DOFAW Hawai‘i District Manager Date

Division of Forestry and Wildlife 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 Kapāpala Koa Canoe Management Area.

_____ _____

David G. Smith – DOFAW Administrator 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

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DEVELOPMENT PROCESS TIMELINE

Kapāpala Koa Canoe Management Area, Hawai‘i

Stage of Development	Date Achieved	Comments
District review	11/30/2022	Comments incorporated
DOFAW review	01/31/2023	Comments incorporated
Partner agency consultation	04/21/2023	Comments incorporated
Public consultation		
DOFAW approval		
BLNR approval		

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1. INTRODUCTION & METHODS

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

Management plans will be developed for each individual forest reserve, which will in part reflect the Division’s management guidelines specific to that area. This document represents the management plan for Kapāpala Koa Canoe Management Area (KKCMA), a section of the Ka‘ū Forest Reserve, and addresses concerns and strategies only related to this section of the forest reserve.

This management plan for KKCMA was developed using a variety of methods. Initial development consisted of reviewing the 2016 draft Forest Management Plan for the area, and reviewing and analyzing DOFAW historic and current files (found at the Administrative and Hawai‘i District office). Documents were also obtained from other state agencies including the Department of Land and Natural Resources Land Division and Bureau of Conveyances, and the Department of Accounting and General Services (DAGS) Survey Division. Hawai‘i Statewide Geographic Information System (GIS) data relating to biological, historical, and environmental resources were referenced extensively to develop this plan.

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

Once finalized by DOFAW, the KKCMA management plan will be submitted for review and approval by the Board of Land and Natural Resources (Board). If approved by the Board, the following actions may be triggered:

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

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2. HISTORY

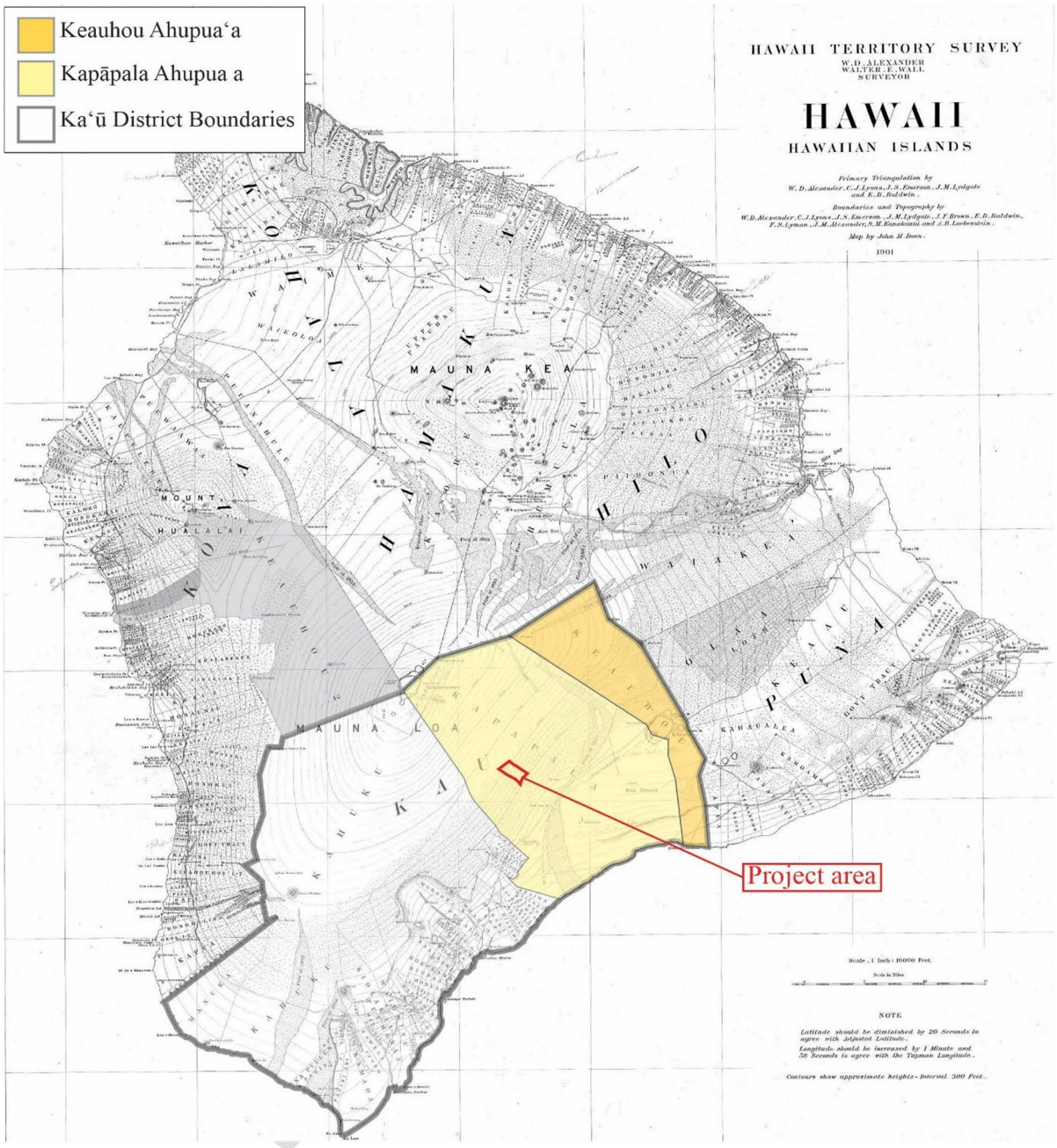

Figure 1 Hawai'i Registered Map 2060 from J.M. Donn (1901) showing KKCMA project area in Kapāpala, Ka'ū. Taken from KKCMA Cultural Impact Assessment (Appendix A)

2.1 Site History

The Kapāpala Koa Canoe Management Area (KKCMA) lies within the ahupua'a of Kapāpala in the moku of Ka'ū (Figure 1). Prior to European contact, the mauka regions of the ahupua'a of Kapāpala, where KKCMA is located, were likely not very heavily populated. Handy et. al (1991 p. 613) describe Hawaiian communities in the moku of Ka'ū, and known evidence of cultivation and inhabitance. They state that "there was never any cultivation, as far as we could learn . . . in

the forests above the pali from Kapāpala to Ohaikea the bird snarers or feather hunters had their huts, but no taro was grown." They further mention that the closest community was Hilea, a small grouping of homesteads southwest of Kapāpala.

Early European arrivals, including Captain James Cook, observed the moku of Kaʻū from the sea and accessed some of the coastal areas, but few ventured far into the inland areas where KKCMA is located. A handful of accounts from foreign travelers of the upland areas in Kaʻū include William Ellis in 1823, and Chester H. Lyman in 1846. Lyman, when describing the ahupuaʻa of Kapāpala, notes that he encountered some dwellings and canoe making sheds, and was impressed by the green hills and moist soil (Lyman 1846, p.9-10). Lyman's documentation of "canoe making sheds" is one account of Hawaiians utilizing trees from the Kapāpala area for the construction of waʻa, or canoes.

Following the Great Mahele in 1848, the entire ahupuaʻa of Kapāpala was designated as crown lands under the control of King Kamehameha III. Around 1860, Frederick Lyman established a small ranch at ʻAinapō, and in 1860 Charles Richardson and William H. Reed acquired Lyman's ranch and greatly increased its size by leasing the entire ahupuaʻa of Kapāpala from King Kamehameha IV. This expansion started their joint venture of Kapāpala Ranch.

Kapāpala Ranch became the largest working cattle ranch in Kaʻū, producing meat, dairy, hides, and other commodoties. Other uses such as hunting and traditional maile gathering also occured in the area. Throughout its history the ranch has hosted many famous guests, such as travel writer Isabella Bird, naturalist Archibald Menzies, and it was also a favorite spot of Queen Liliʻuokalani.

Over time the ranch switched owners and its boundaries changed, but it remained on public land either under a lease or permit. The lands managed by the ranch has decreased from the original 1860 lease of the entire ahupuaʻa, but the area that would become KKCMA was continuosly under ranch management from 1860 until 1989. Evidence that KKCMA was used for grazing still remains on the property including the old barbed wire cattle fence just mauka of the crossroad. There were also likely timber harvests that occured in KKCMA prior to 1989, but documentation of such events has not been found. The current forest structure of the lower elevations of KKCMA are indicative of its past exposure to cattle grazing and/or timber harvesting (see section 3.4).

Starting in the late 1980s, DLNR began searching for native forests on state land for the purpose of designating areas for koa management, in efforts to exapnd silviculture operations in the state. The ample koa resources on KKCMA made it an ideal location, and on October 27, 1989, the Board of Land and Natural Resources approved the set-aside of approximately 1,257 acres "for commercial koa timber production, with consideration for recreation, forest bird habitat, and watershed values." In the 1990s, following struggles by organizations to find koa trees suitable for the construction of voyaging canoes, the purpose of the area was further refined from broad koa management to focus on the management and cultivation of koa canoe logs.

In 2004, the 1,257 acre koa management area was officially sub-divided by the County of Hawaiʻi, removing it from the rest of the parcel that is still under lease by Kapāpala Ranch.

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Subsequently, in 2004 the Board of Land and Natural Resources approved redesignating the area as the Kapapāla Koa Canoe Management Area, and on June 27, 2005 Executive Order 4109 was issued, officially setting the area aside for the growth and production of koa trees for use in the making of traditional Hawaiian canoes. Seven additional management goals that were defined for the area include:

1) Preserve Hawai‘i’s unique natural and cultural inheritance for future generations, by fostering knowledge and respect for Hawai‘i’s native forests, in a way that inpires better care of its natural environment.
2) Protect threatened tropical forest habitat and promote environmental policies and practices, that address biological sustainability and human well-being, by identifying and integrating relevant traditional Hawaiian natural resource stewardship models with current Western management strategies.
3) Develop natural resource stewardship models that involve a wide range of constituent groups.
4) Involve youth through cooperative programs with the Department of Education, University of Hawaii, and other school and education institutions.
5) Provide wood workers with portions of harvested trees that are not processed as canoe logs.
6) Involve other constituency groups (e.g. canoe clubs, forest management entities, and cultural organizations).
7) Provide compatible opportunities for public uses such as hunting and recreation.

The set-aside as a “Koa Canoe Management Area” designation had the potential to jeopardize effective management due to the lack of applicable statues and rules to inact and enforce for the area. Therefore in 2004, the BLNR approved the cancellation of EO4109, and the issuance of a new EO incorporating the area as the Kapāpala section of the Ka‘ū State Forest Reserve, therefore rules governing forest reserves could be applied to KKCMA. These actions were formalized by the issuance of EO4427 which cancelled EO4109, and EO4428 which formalized KKCMA‘s inclusion into Ka‘ū FR on February 27, 2013.

Table 1. Summary of Executive Orders Relating to KKCMA

Action	Date	A/W	Description	Acres	Copy of Survey Furnished (CSF)	Tax Map Key
Executive Order 4109	May 23, 2005	A	Land Set Aside for the Establishment of Kapāpala Koa Mgmt Area	1257.73	23859	(3) 9-8-001:014
Executive Order 4427	February 27, 2013	-	Cancellation of EO 4109, preparation for addition to FRS	1257.73	23859	(3) 9-8-001:014
Executive Order 4428	February 28, 2013	-	Addition of parcel to FRS as Kapāpala section, K‘aū FR	1257.73	25,042	(3) 9-8-001:014

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Table 2. Historical Land Use Agreements in Kapāpala Koa Canoe Management Area.

Type of Action	Action Number	Duration	Description	Acres	Copy of Survey Furnished (CSF)	Tax Map Key parcels included (current TMKs)
Lease		March 1, 1860-1887	Lease to W.H. Reed & C. Richardson	Ahupuaʻa of Kapāpala excepting Kuleanas		
Lease	106	07/01/1887-06/30/1907	Pasture Lease to Hawaiian Agricultural Co.	172,780		
Lease	603	07/01/1908 - 06/30/1929	Pasture Lease to Hawaiian Agricultural Co.	72, 850	1853	
Lease	1920	04/16/1928-07/01/1950	Pasture Lease to Hawaiian Agricultural Co.	50,535	4980	(3) 9-8-001:003
Lease	3376	02/14/1951-12/31/1973	Pasture Lease to Hawaiian Agricultural Co.	37,466	11033	(3) 9-8-001:003, 010, 013, 014
Revocable Permit	5254	November 21, 1975 (BLNR approval) – 10/31/1977	Permit to Kaʻū Sugar Co and Richard Smart dba. Parker Ranch for sugar cane cultivation and pasture purposes	37,266		(3) 9-5-19:1, 2, 12, 16, 17, por 27, 28 ; 9-6-2:5, 10, 11, 13 ; 9-6-12:4; 9-6-13:2; 9-8-1:3, por 2
Revocable Permit	S – 5491	October 28, 1977 (blnr approval) – September 9, 1988 (blnr approved cancellation)	Permit to Kaʻū Sugar, Richard Smart dba: Parker Ranch and Gordon Cran dba: Kapāpala Ranch	38,689		(3) 9-5-19:1, 2, 12, 16, 17, por 27, 28 ; 9-6-2:5, 10, 11, 13 ; 9-6-12:4; 9-6-13:2; 9-8-1:3, por 2
Revocable Permit	S – 6582	September 9, 1988 (blnr approval) – 10/31/1989	Permit to Gordon Cran for pasture and residential purposes.	24,573		(3) 9-8-001: por 003
Revocable Permit	S – 6695	10/27/1989 (blnr approval) -	Permit to Kapāpala Ranch	23,473		(3) 9-8-001: por 003
Lease	S - 5374	12/1/1994-present	Lease for pasture w. Amendment for ecotourism. Lease S-5374 is still active, however ***KKCMA was officially withdrawn from the lease in 2005.***	23,408	22110, HSS Plat 127-A	(3) 9-8-001:014
Right of Entry		10/27/1989	Right of Entry to DOFAW to begin management actions	1257.33	NA	(3) 9-8-001:014

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2.2 History of Kālaiwa‘a, Hawaiian Canoe Construction

The significance of the wa‘a, or canoe, in Polynesian and Hawaiian culture is deeply rooted and cannot be overstated. Wa‘a were the main transporter of people from one island to the next across Polynesia, and were utilized in many other aspects of life such as fishing, warfare, and sport (Chun and Burningham 1995; Fornander 1878). When early Polynesian voyagers first landed on Hawai‘i, they continued to construct and utilize canoes and adapted their craft to the new environment of Hawai‘i. Koa (*Acacia koa*), the second most common tree in the islands and a fast growing hardwood species, became the preferred tree used in canoe construction (Holmes 1981).

Canoe construction in Hawai‘i has traditionally been guided by the kahuna kālaiwa‘a, or master canoe carver. The role of kahuna kālaiwa‘a was considered the foremost of all traditional occupational trades, as they had to possess a wide range of technical skills from building to forestry to guiding ceremonies and protocols (Holmes 1981). The kālaiwa‘a was responsible for the entire process of building the wa‘a, from deciding when and how to undertake the process until the completed wa‘a was launched into the ocean.

According to the account of David Malo, an early native Hawaiian historian, “the building of the canoe was an affair of religion” (Malo 1903). Due to the danger, high degree of difficulty, and cultural importance of canoe construction, many rituals and traditions guided the process. The exact process likely varied by location and across the islands, however the CIA drafted for this project (Appendix A) identified the accounts recorded by multiple individuals, including David Malo, Abraham Fornander, Tommy Holmes, Edgar Henriques, and Kalakuokamaile, that outlined the process likely common in the south Kona and Ka‘ū areas, and the steps during canoe construction are listed below. Detailed information can be found in the CIA which has been include as Appendix A of this plan.

1) Beginning rituals of the kahuna kālaiwa‘a
2) The ascent to the forest
3) Selecting the tree
4) Cutting and felling rituals
5) Rough hewing the canoe on site
6) Hauling the rough canoe to the coast
7) Final hewing and initial voyage rituals

Canoe Log Selection and Terminology The process of finding the right tree to create a canoe varies among historians. Many different terminologies and methods have been used to describe and qualify the growth form and suitability of koa trees for use in canoe construction. Table 3 lists a variety of Hawaiian terms gathered by Holmes (1981) describing koa trees, many of which relate to the suitability for canoe construction:

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Table 3 Hawaiian Koa Terminology (Holmes 1981)

Hawaiian Term	Definition
koa ʻawapuhi	Low density, similar to koa lāʻau maiʻa, but considered female.
koa hiʻu waʻa	growing straight up before branching; also koa hiʻu awa.
koa huhui	growing straight up, with a cluster of branches at the top.
koa huli pū	having wood of such good quality throughout that it was thought best to avoid cracking the log by exposing and drying out the roots, letting the tree fall over, rather than cutting it down.
koa iho ʻole	crooked but nicely bent in an arc; could be easily shaped to give the hull a "banana" curve; considered the most desirable type.
koa ʻiʻo ʻōhiʻa	ʻōhiʻa grain koa, high density (60-80 lbs/ft^3)
koa kamahele	having one branch larger and more serviceable than the trunk itself; also koa lālā kamahele.
koa kolo	leaning or sprawling, but still fit for use.
koa kolopū	growing straight up with no significant branching; of uniform diameter nearly the whole length of the trunk; waves will wash into a canoe made from this type.
koa kū keʻele waʻa	straight but somewhat flattened on both sides.
koa kūpalaha	having a broad, straight trunk, but rather flat on one side.
koa kūpalina	generally usable but imperfect; bent, flattened, short, not well-proportioned.
koa kupulāʻiki	same as koa kūpalaha.
koa lālā kamahele	same as koa kamahele.
koa lāʻau maiʻa	banana colored koa, low density (30-40 lbs/ft^3)
koa lau kane	(no data)
koa lau kani	strong; considered male; possibly same as koa lau kane.
koa lau nui	a large-leafed variety.
koa noʻu	straight, thick, unblemished, not very tall; suitable for a wide, short canoe such as an ʻōpelu (heavy duty fishing canoe).
koa poepoe	of good size but short and thick.

Outside of growth form, the color, density, and grain of the wood is also of importance to the kahuna kālaiwaʻa. Holmes (1981) presented different densities of wood. Low-density koa (roughly 30-40 lbs/ft^3), which was most suitable for paddles but sometimes used for canoes, was known as koa lāʻau maiʻa (banana-colored koa) and was characterized by its soft, lightweight, and yellow color. This type of koa was also known as koa ʻawapuhi (ginger koa) but was considered female. The favored wood grain for canoes was the mid-range density koa (40-60 lbs/ft^3), which was valued for both its durability and strength. High-density koa (60-80 lbs/ft^{3}f) known as koa ʻiʻo ʻōhiʻa (ʻōhiʻa grain koa) was less ideal for canoe building as the wood was exceptionally dense which made carving very difficult.

Another important factor often documented is the consultation of the ʻelepaio (*Chasiempis* sp.). ʻElepaio are native birds that eat small insects, and are considered bold and curious and often follow humans in the forest. Kahuna kālaiwaʻa formed a close connection with ʻelepaio, and

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would notice the behavior of these birds and use it to determine if trees were suitable for canoe construction. Holmes (1981) mentions that on islands where ʻelepaio were not present, kahuna kālaiwaʻa may have consulted other birds. Below is one description from Fornander of the process (Fornander 1919-1920):

> "If the bird darted down and perched on the trunk of the tree and then ran along the trunk to the other end, the canoe-hewing priest would remark: "The canoe is perfect." The conduct of the bird in running direct from the base to the end was the sign which enabled the priest to pronounce it perfect. Where the bird traversed was the top opening of the canoe. Supposing that the opening of the canoe which the bird apparently intended was underneath, the bird would fly to a certain height, then circle over the tree, the priest would understand that it was urging the turning of the tree. But if the opening that the elepaio intended to be was on the side, it would fly in that direction. On the other hand, if the bird came and stood on the trunk of the tree intended for a canoe, if it continued to remain there for some time, the canoe-hewing priest knew that a defect was at that point. If the bird again ran from the trunk and stood in another place, then another defect was at that locality, and thus the bird would indicate all the defects in the canoe, whether it be rottenness, hollow-cored, or knotted. In this way the canoe- hewing priest was made aware of the defects of the [tree for a] canoe." (Fornander 1919-1920)

Canoe Size Requirements: Different size trees are typically needed for the construction of different canoes. The dimensions for three major canoe types are shown in Table 4. These dimensions are not restrictive, as different carvers may make larger or smaller versions intended for different uses.

When making a canoe, builders often prefer to utilize a single ideal tree, however some will piece together 2-3 shorter lengths that can come from multiple trees. For the latter style, the most important requirement is tree diameter. Trees can be used even if upper sections of those trees split or do not have the most ideal growth form. Further, some builders may build canoes by combining planks instead of hollowing out entire logs, which allows for more flexibility in tree size and growth requirements. Koa trees that are too small and/or have less optimal growth form (lots of forking, a twisting main stem etc.), are not ideal for being carved into koa canoes.

Table 4 Different Types of Koa Canoes

Canoe Type*	Minimum Width**	General Length**
Fishing (ʻōpelu)- Present-day term for a short, thick hulled, wide bodied and heavy fishing canoe.	24"	10-20'
Racing - The Hawaiian Canoe Racing Association (HCRA) has strict regulations regarding racing canoes. There are separate races for koa canoes, non-koa canoes, and others.	36"	30-45'
Voyaging - The largest type of koa canoes, first designed by the Polynesian people that arrived at the islands of Hawai'i.	40"	40-60'

*Descriptions from Holmes 1981.

**Size requirements are based on discussions with a variety of traditional koa canoe builders. There are no established sizing standards, and these numbers are subject to change depending on the builder.

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At this point DOFAW has done timber surveys indicating the size and general growth from of many trees in the area, details of which can be seen in section 3.5 and Appendix B. Surveys have not determined the density or grain types of trees found in KKCMA, but opportunities in monitoring and collaboration with organizations during harvest may shed light on these details in the future.

Figure 2 Men preparing to haul an unfinished canoe to Hōnaunau, South Kona. Photo courtesy of K. P. Emory, Bishop Museum Archives.

Ongoing Cultural Practices. The practice of kālaiwa‘a has historical roots but is an evolving art still practiced by many today. The techniques and methods for canoe building are constantly growing, as methods for felling, extraction, and carving are changing as new technologies emerge. One early example can be seen in Figure 2. During the precontact and early historic periods, hauling the koa out from the forest was done entirely by hand. However, as new technologies emerged including carts and wagons, kālaiwa‘a adapted their traditions to utilize these new tools to ease the workload.

Today, modern tools include heavy machinery such as bulldozers and logging trucks for felling and transporting logs, as well as hand tools such as chainsaws to assist in felling and carving are often used in canoe construction. While canoes were traditionally hewn from hollowing out a single log entirely with adzes and hand tools, some builders today utilize chainsaws to rough hew the shape before finishing with adzes. Other builders utilize planks instead of hollowing out a single tree, connecting planks together to create the hull of the canoe. This has the advantage of utilizing more wood from a tree and being able to use smaller sections of a tree in canoe construction.

Given the wide array of traditional and modern ways for selecting, felling and building a koa canoe, DOFAW understands that different organizations will want to implement different techniques. DOFAW supports organizations implementing their own traditional and cultural practices related to canoe tree selection, harvesting and construction at KKCMA, as long as the methods are safe and follow DOFAWs guidelines for timber harvest, as outlined in Section 5.3.

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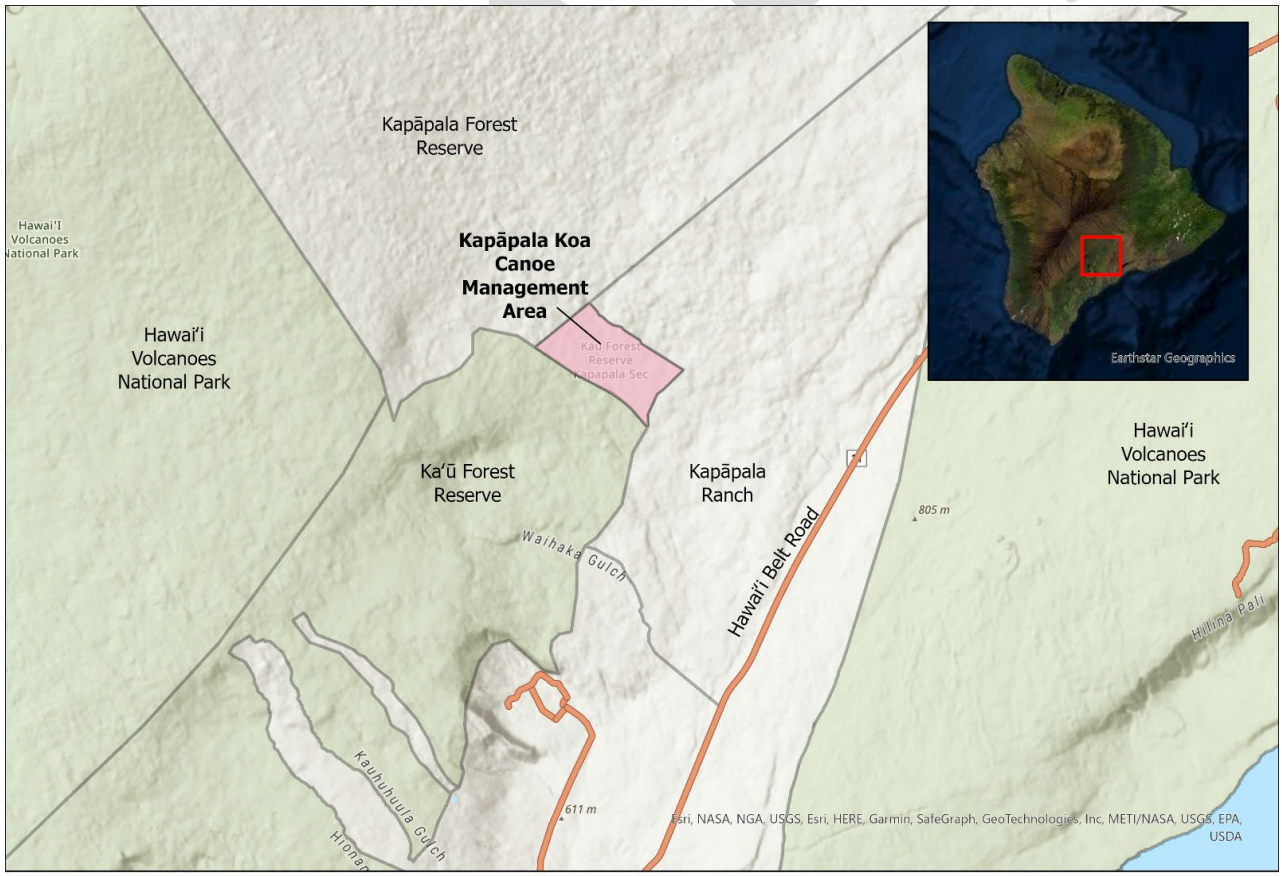
3. SITE DESCRIPTION

3.1 Location

The Kapāpala Koa Canoe Management Area (KKCMA) is comprised of 1,257 acres of public land in the moku of Kaʻū on the island of Hawaiʻi. It is in the ahupuaʻa of Kapāpala on the southeastern slopes of Mauna Loa between 3,640ft-5,100ft in elevation, with an average slope between 6-20%. The land cover is completely forested, dominated by mesic montane native koa-ʻōhiʻa forest.

KKCMA is part of the Kaʻū Forest Reserve and is surrounded by other state lands, including other sections of the Kaʻū Forest Reserve to the southwest, the Kapāpala Forest Reserve to the northwest, and public lands under general lease and revocable permits to Kapāpala Ranch to the northeast and southeast (Figure 3). Portions of Kapāpala Ranch are also a cooperative game management area (GMA). The small town of Pahala is about 10 miles south of KKCMA, and the town of Volcano is approximately 15 miles to the northeast. Kīlauea caldera is about 12 miles to the northeast as well. KKCMA is composed of Tax Map Key (TMK) (3) 9-8-001:014 and is zoned by the county of Hawaiʻi as A-20 agricultural land.

Figure 3 KKCMA Location



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0 0.5 1 2 3 4 Miles

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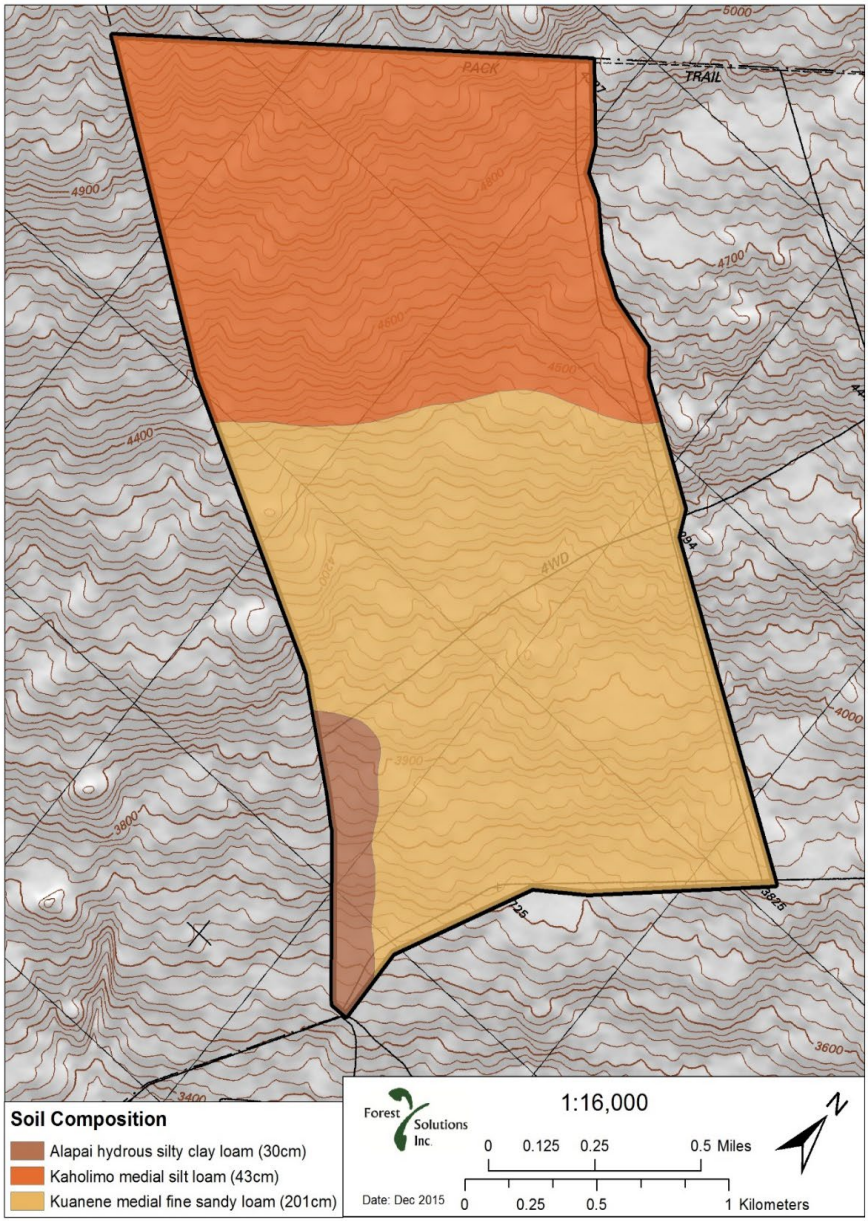
3.2 Soils

Figure 4 Soils in KKCMA



The underlying geology in the area is comprised of basic igneous rocks (basalt) beneath weathered volcanic ash and cinders. There are three soil series within KKCMA: Kaholimo, Kuanene, and Alapai (Figure 4). Kaholimo soil developed over basalt bedrock and is prevalent at higher elevations, comprising approximately 45% of KKCMA. The Kaholimo soils in the reserve generally has a rooting depth ranging from 13-17" which is shallow for a forest soil. Kuanene soil developed over pāhoehoe lava flows and comprises approximately 50% of the area, dominating lower elevations. These are the deepest soils within the parcel. Alapai soils cover a small section of the southeast corner of the reserve, and are the most shallow in the parcel.

All of these soils are andisols, meaning they were derived from volcanic ash, and are thus relatively fertile and acidic, with 0-60% organic material at the surface. These soils are highly erodible, which must be considered during forestry operations, especially harvesting. Because of the thin soils and high infiltration rates in the parent material, there is limited water holding capacity in the soil profile. This means the area is susceptible to drought, which is a common occurrence in Kaʻū.

3.3 Climate

KKCMA has an average annual temperature of 60°F (49-72 °F) and an average annual rainfall of 80 inches. Rainfall is consistent throughout the year with wetter months during the winter, similar to the rest of Hawaiʻi (Figure 5). Winter is also when temperatures are slightly cooler as daylight

hours are shorter and sun angles lower. The area commonly has dense cloud and fog, further impairing the incident sunlight and providing additional moisture via fog drip. Vog is also quite common given its proximity to Kīlauea caldera, however native forests in Kaʻū do not appear to suffer from vog exposure.

A climatological study of KKCMA was conducted by James Juvik and Paul Fishbein from 1993-1994. They summarized that there was a "distinctive diurnal wind regime (daytime upslope, nighttime downslope)" complementing the prevailing trade wind (cross slope) flow. Also discussed was the heavy rainfall recorded during a few winter storms. Rain totals were larger during these winter storms than all other rain events during the year combined. Winter storms can cause mass erosion and should be considered when planning timber activities.

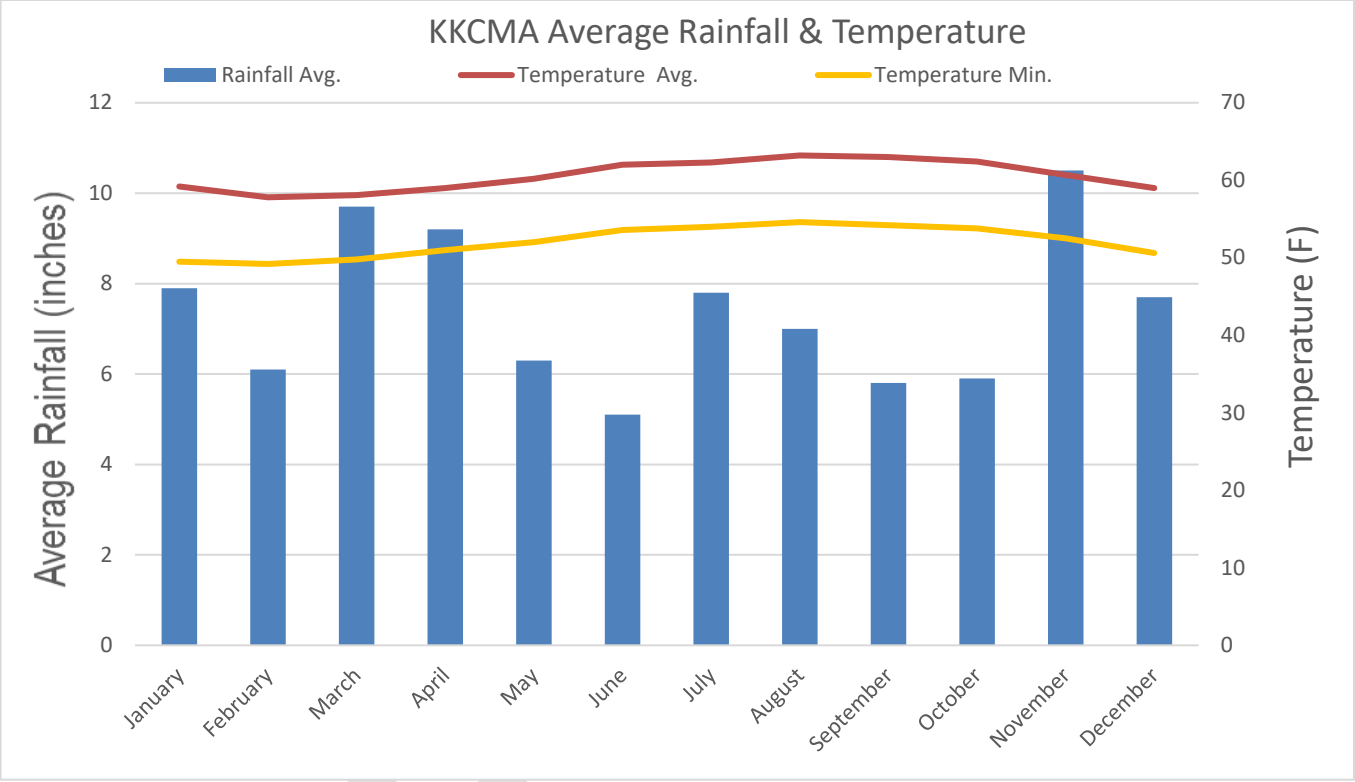


Figure 5 Average monthly rainfall and temperature in KKCMA (Giambelluca et al 2013).
Note: this graph obscures powerful winter rainstorms

3.4 Vegetation

The vegetation at KKCMA is classified as Montane Wet Forest (Wagner 1999). Based on field observations and data collected during forest inventories, the parcel was further split into four strata, largely based on vegetation cover:

- KO1: Open ʻŌhiʻa Forest (324 acres)
- KO2: Open Koa-ʻŌhiʻa Forest (386 acres)
- KO3: Closed Koa-ʻŌhiʻa Forest (323 acres)
- KO4: Mature Koa Forest (207 acres)

The forest canopy in K01 is characterized as an even-aged stand of ʻōhiʻa (*Metrosideros polymorpha*). Koa are present but generally as a subcanopy species. The forest canopy of KO2, KO3 & KO4 is mixed with both koa and ʻōhiʻa. Trees are generally larger and the canopy is more closed the higher you go in elevation. K04 has the largest, most mature koa trees and is overall the most intact native forest in KKCMA. Common subcanopy species in all strata include pilo (*Coprosma rhynchocarpa*), kōlea (*Myrsine lessertiana*), kawaʻu (*Ilex anomala*), kōpiko (*Psychotria hawaiiensis*), naio (*Myoporum sandwicense*), and ōlapa (*Cheirodendron trigynum)*.

The ground cover in the lower elevation strata, including all of KO1 and the lower parts of KO2, is less intact. It is dominated by non-native grass species such as kikuyu (*Cenchrus clandestinus*), meadow-rice grass (*Ehrharta stipoides*), and various fern species. This extends into K02, a few hundred yards mauka of the crossroad. Above this, in upper K02, K03, and K04 the percent cover of non-native grass in the understory decreases, and species like Hawaiʻi sedge (*Carex alligata*), iʻo nui (*Dryopteris wallichiana*), maʻohiʻohi (*Stenogyne microphylla*), hairgrass (*Deschampsia nubigena*) and ʻalaʻala wai nui (*Peperomia* sp.) can be found. Common shrubs and ground cover in all strata include ʻōhelo (*Vaccinium sp*.), uluhe (*Dicranopteris linearis*), and abundant maile (*Alyxia stellata*). Native shrub and fern species that are found primarily in K03 and K04, include kanawao (*Hydrangea arguta*), pāpala (*Charpentiera obovata*), ʻākala (*Rubus hawaiensis*), and hapu'u (*Cibotium* sp.). For a current, working plant list of KKCMA, see Appendix C.

The thick sward of alien grasses, lack of native understory and remains of old cattle fencelines in K01 and lower K02 all suggest that the lower forests have been heavily impacted in the past, either by grazing, logging, fire, or a combination of the three. Further, in the 2020 inventory surveys K02, K03, and K04 had around double the species richness of K01. Overall, the parcel is considered to contain relatively intact native ecosystems with minimal pressure from invasive plant species, with the exception of non-native grasses present at lower elevations.

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Figure 7 Higher elevations areas have more intact native understories, especially native fern species

Figure 6 Lower elevations areas, especially below the cross-road, are more likely to have non-native grass in the understory

Figure 8 Forest Strata in Kapāpala Koa Canoe Management Area (KKCMA)

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0 0.25 0.5 0.75 1 Miles

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Table 5 Basal Area (ft^2/acre) of Native Tree Species by Strata

Strata	koa (*Acacia koa*)	ʻōhiʻa (*Metrosideros polymorpha*)	ōlapa (*Cheirodendron trigynum*)	kōlea (*Myrsine lessertiana*)	kawaʻu (*Ilex anomala*)	pilo (*Coprosma rhynchocarpa*)	naio (*Myoporum sandwicensis*)	kōpiko (*Psychotria hawaiensis*)	Total
K01	22.9	127.4	0.0	0.0	11.4	1.6	0.0	0.0	162
K02	20.8	121.1	1.2	0.00	12.7	2.3	0.0	0.0	156
K03	46.8	74.6	2.5	1.3	6.3	15.2	2.5	1.3	132
K04	25.4	115.3	6.9	4.6	0.00	2.3	4.6	0.0	152
Overall	**28.9**	**109.6**	**2.7**	**1.5**	**7.6**	**5.4**	**1.8**	**0.3**	**150.3**

Table 6 Native Tree Seedlings and Shrubs in KKCMA (Stems Per Acre by Strata)

Tree Seedlings							
Strata	koa (*Acacia koa*)	ʻōhiʻa (*Metrosideros polymorpha*)	ōlapa (*Cheirodendron trigynum*)	kōlea (*Myrsine lessertiana*)	kawaʻu (*Ilex anomala*)	pilo (*Coprosma rhynchocarpa*)	kōpiko (*Psychotria hawaiensis*)
K01	0	13	134	0	13	13	0
K02	0	123	38	0	19	85	57
K03	0	197	94	10	31	62	0
K04	265	379	701	19	0	303	0
Shrubs							
Strata	ʻākala (*Rubus hawaiensis*)	hapu'u (*Cibotium* sp.)	kanawao (*Brussaisia arguta*)	ʻōhelo (*Vaccinium* sp.)	pāpala (*Charpenteria obovata*)		
K01	0	161	0	0	13		
K02	0	208	0	0	0		
K03	10	239	31	83	0		
K04	19	133	0	114	0		

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3.4.1 Rare, Threatened and Endangered Plants: Threatened and endangered (T&E) plant species in Hawai‘i are listed under and protected by the Federal Endangered Species Act (ESA) and the State Endangered Species Law, Chapter 195D, HRS. Other species not listed as T&E by either the state or federal listings can still be considered rare or species of concern by land managers.

Currently no rare or T&E plant species are known to occur within KKCMA. A comprehensive vegetation roadside survey of the parcel was completed in 2020 and found no T&E plant species. One individual of *Rubus macraei*, which is not a protected species but is considered rare, was found growing in an old rare plant enclosure just outside of KKCMA in Ka‘ū FR. *R. macraei* is know from approximately 3000-5000 individuals and is relatively common in the supalpine slopes of Mauna Loa. A wild population of *Phyllostegia velutina*, an endangered native hawaiian mint with roughly 30 individuals left in the wild, is known to exist about 3.5 km away from KKCMA. Surveys for rare and T&E plant species should be done in any areas where timber harvest or other management activities are planned that may cause a disturbance to avoid any potential impacts.

3.5 Koa Timber Resources

In line with the specific designation of this area, the primary timber resources of concern are koa trees capable of being carved into canoes. There is a rich history and language around the various types of koa canoes traditionally built by native Hawaiians, and on the type and size of koa trees required (see Section 2.2.).

2020 Timber inventory: In 2020 a timber inventory was done of KKCMA. The inventory consisted of two parts: 1) plot data collected throughout the entire parcel to get an overall estimate of the quantity, volume, and spatial distribution of timber 2) a more in-depth 100% tree count of roadside areas to use for planning and implementing harvest operations in the near future (see Appendix B for the entire timber inventory).

Results of the plot data show that there is approximately 5.5 million board feet (bf) of koa in KKCMA. Of this, an estimated 1 million bf, or around 18% of the koa volume, is in “canoe log trees”, or trees ideal for use canoe log construction. Another 1.5 million bf, or 27% of the koa volume, is in younger trees that will likely be capable of canoe log construction in 10-20 years. The remaining ~3.5 million bf of koa is either too small, or in trees that have the wrong growth form. Spatially, it appears

Figure 9 Big, unbranched trees are ideal for canoe construction

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that strata K02 and K03 have higher numbers of canoe log trees. The trees in K01 are smaller and a more often a subcanopy species to ʻōhiʻa (see section 3.4), and many of the trees in strata K04 are large, but over mature and far from the desired tree form. However, canoes trees can be found in both K01 and K04, just in smaller quantities. Another important finding from the plot data is that koa regeneration is alarmingly low throughout most of KKCMA. Although seedling recruitment for ʻōhiʻa, kawaʻu, and ōlapa seems to be occurring in all strata, koa seedlings were only present in K04 plots (see Table 6). This could be due to a lack of disturbance, or due to grazing pressures from ungulates. The low levels of koa regeneration is concerning in regards to maintaining a sustainable supply of koa trees for canoe logs.

The 100% tree count measured and evaluated all koa trees within 200 feet of all roads. Based on their form, trees were put into 4 classes as seen in Figure 10, with class 1 being the most ideal growth form for a canoe log and class 4 being the least ideal. For the purposes of this plan trees in class 1 and class 2 were considered useable for canoe logs; class 3 and class 4 were considered unsuitable or less suitable for constructing canoes. Taking both tree form (Figure 10) and diameter requirements (Table 4) into consideration, criteria for what trees could be used in canoe construction were developed and they are shown in Table 7. Results of the 100% roadside tree count show that most of the desirable trees are along the middle cross road (K02) and along the upper nothern boundary (K03, K04) (Figure 11).

Table 7 Canoe Log Classification of Koa Trees in KKCMA

Canoe Class	Koa Tree Diameter	Form Classification*	Description**
Ideal canoe log	≥30"	1	Koa tree likely capable of making an entire canoe
Potential/partial canoe log	≥30"	2	Koa tree with potential to make an entire canoe, or parts can be used in canoe construction
Young ideal canoe log	20-30"	1	In about 10-20+ years could become a koa tree capable of making an entire canoe
Young potential/partial canoe log	20-30"	2	In about 10-20 years could become a koa tree capable of making an entire canoe, or parts of a canoe
N/A	<20"	Any	Not capable of being used in canoe construction in near future (10-20 years)
N/A	>20"	3, 4	Not ideal for use in canoe construction

*See Figure 10 for form classification description

**These rough broad categories help provide an idea of ideal canoe trees. Canoe builders may have other methods for quantifying tree shape, such as those in Table 3

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Figure 10. Koa Tree Form Classifications Used During 2020 KKCMA Forest Inventory.

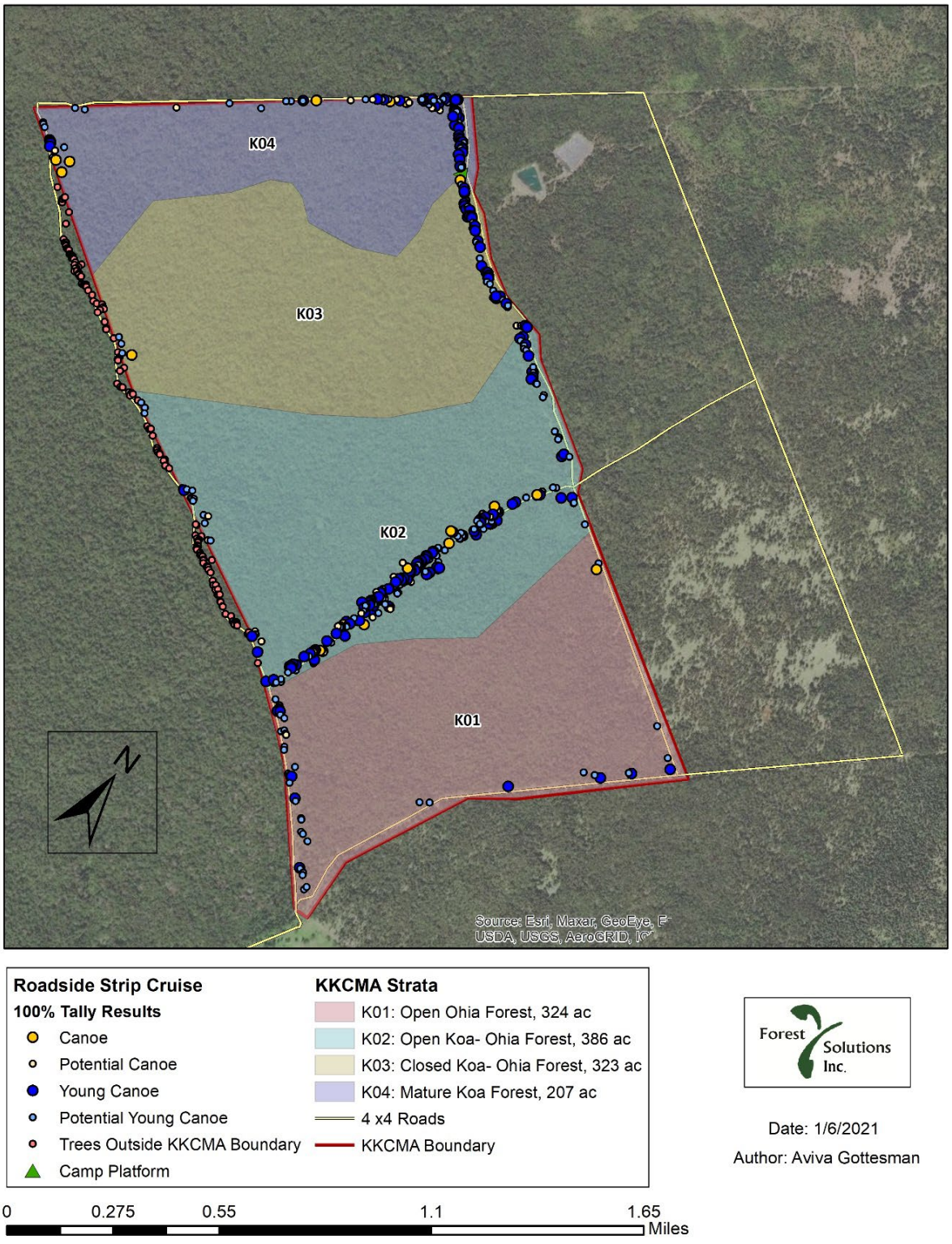
Tree Form Class 1: Straight and tall trunk, does not split until canopy (~40 ft), canoe log

Tree Form Class 2: Straight and tall, but splits or forks lower on trunk, potential canoe log

Tree Form Class 3: Big branches fork off from a lower part of the tree, sprawling form

Tree Form Class 4: Many forks, curved trunk, no canoe logs possible

Figure 11 Results of KKCMA Roadside 100% Tree Survey



3.5.1 Koa research plot: Within KKCMA there is a small, fenced area managed by the Hawai‘i Agricultural Research Center (HARC) in collaboration with DOFAW and other partners. This originally was a koa seed orchard and part of a project to develop a tree improvement program that will provide koa seeds that have been screened to be resistant to koa wilt disease. Koa wilt is a vascular wilt disease caused by the fungal pathogen *Fusarium oxysporum* f. sp. *koae* that causes high rates of mortality in many koa trees across the state, especially at lower elevations and in field plantings (Dudley et. al 2017). See section 4.3 for more information on koa wilt. Koa wilt disease is not widespread in KKCMA.

Figure 12 Koa trees within the research plot in KKCMA testing resistance to koa wilt

3.6 Wildlife

Native Birds: The native tree canopy and fruit bearing understory plant species in KKCMA provides excellent habitat for native birds. Bird surveys have been done annually since 2018 by the Three Mountain Alliance (TMA) and DOFAW. Fifteen bird species have been detected, the majority of which are native (Table 8). Apapane, followed by Hawai‘i amakihi and ‘ōma‘o, were the most abundant native birds in KKCMA. Native birds are present throughout the entire area, with decreasing abundance at lower elevations. The Japanese white eye was the most abundant non-native bird. (Table 8).

In total, eight species of native birds have been detected, including one threatened species, i‘iwi (*Drepanis coccinea),* and three endangered species, ‘akiapola‘au (*Hemiganthus wilsoni)*, Hawai‘i creeper/‘alawī (*Loxops mana)*, and the ‘io/hawaiian hawk (*Drepanis coccinea*) (Table 8). Threatened and endangered species in Hawai‘i are listed under and protected by the Federal Endangered Species Act (ESA) and the State Endangered Species Law, Chapter 195D, HRS. Note that the ‘io is no longer a federally listed species but is still considered an endangered species by the State of Hawai‘i.

I‘iwi were consistently detected and heavily correlated with higher elevation areas (Figure 16). This is not surprising given that they are highly sensitive to avian malaria, a disease spread by mosquitoes at lower elevations.

The three endangered bird species were all detected in very low numbers (Figure 17). The ‘akiapola‘au was only detected once, in the highest elevational transect of the parcel. The ‘alawī was detected four total times, all in northwest section in strata K03 & K04. ‘Io were observed most frequently in K02, potentially because of the opening in the canopy created by the road. ‘Io are known to use a variety of habitats and the mix of forested areas and small gaps in KKCMA are ideal for feeding and roosting.

Hawaiian Hoary Bat: The endangered ‘ope‘ape‘a (*Lasiurus cinereus cemotus,* Hawaiian hoary bat) has not been detected in KKCMA but it is highly probable that they are present in or around the area. With thick ‘ōhi‘a canopy interspersed with open grassy areas and nearby pasture, the forest structure of Kapāpala is ideal habitat for this species.

More research is needed on bat populations across the Hawaiian Islands. Monitoring prey items and availability through invertebrate studies can provide indicators for the health and success of bat populations. Additionally, vegetation cover should be regularly monitored to supplement the other Hawaiian hoary bat monitoring efforts.

The Hawaiian hoary bat can use a variety of land cover types; therefore, promoting a mosaic of diverse habitat types across the landscape may contribute positively to bat populations. Management activities should not seek to create a uniform, homogenous cover of native forest. Hoary bats have been found to utilize corridors and edges of corridors, such as along hiking trails and roads, for hunting and flying through dense forest (Bonaccorso et al. 2015). Since the Hawaiian hoary bat is a solitary, foliage roosting bat that roosts in both native and non-native tree species with a broad height range, care should be taken if any trees are removed from KKCMA (Gorresen et al. 2013). This is especially true if multiple trees are harvested at once, as this increases the likelihood of removing one that potentially has a day roosting bat.

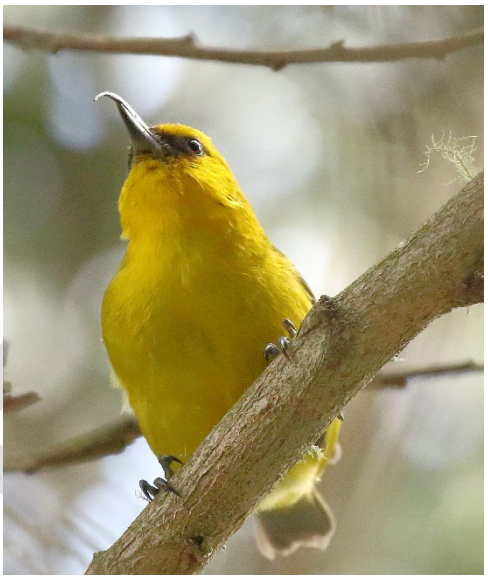


Figure 13. ‘Akiapola‘au (*Drepanis coccinea*), an endangered forest bird detected in very small quantities in the highest elevations of KKCMA

Figure 14. Hawai‘i creeper (*Loxops mana*), another endangered forest bird found in very small quantities in the highest elevations of KKCMA

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Figure 15 Total Native Bird Observations in KKCMA 2018-2021

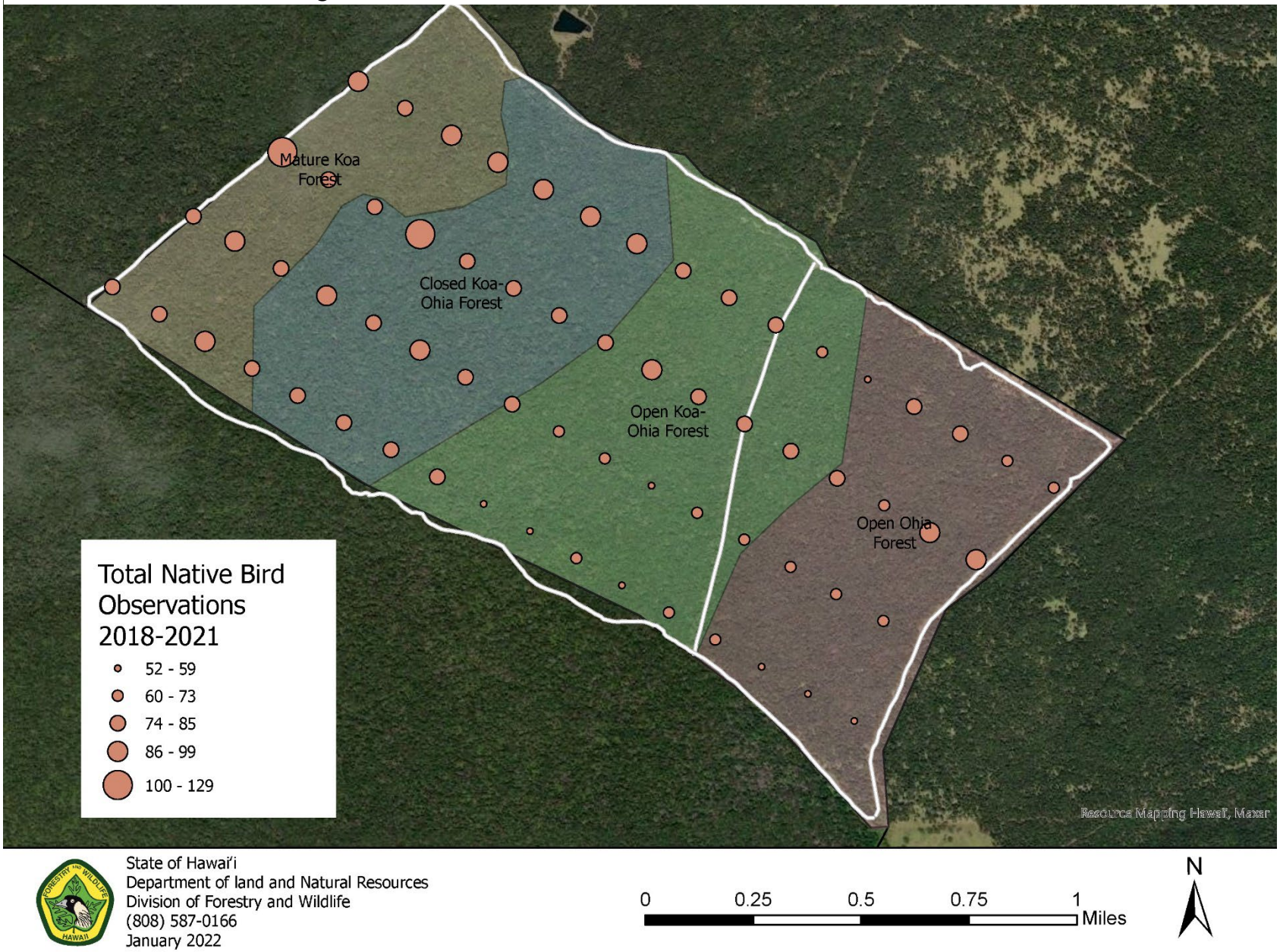

Figure 16 ‘I‘iwi (Threatened) Observations in KKCMA 2018-2021

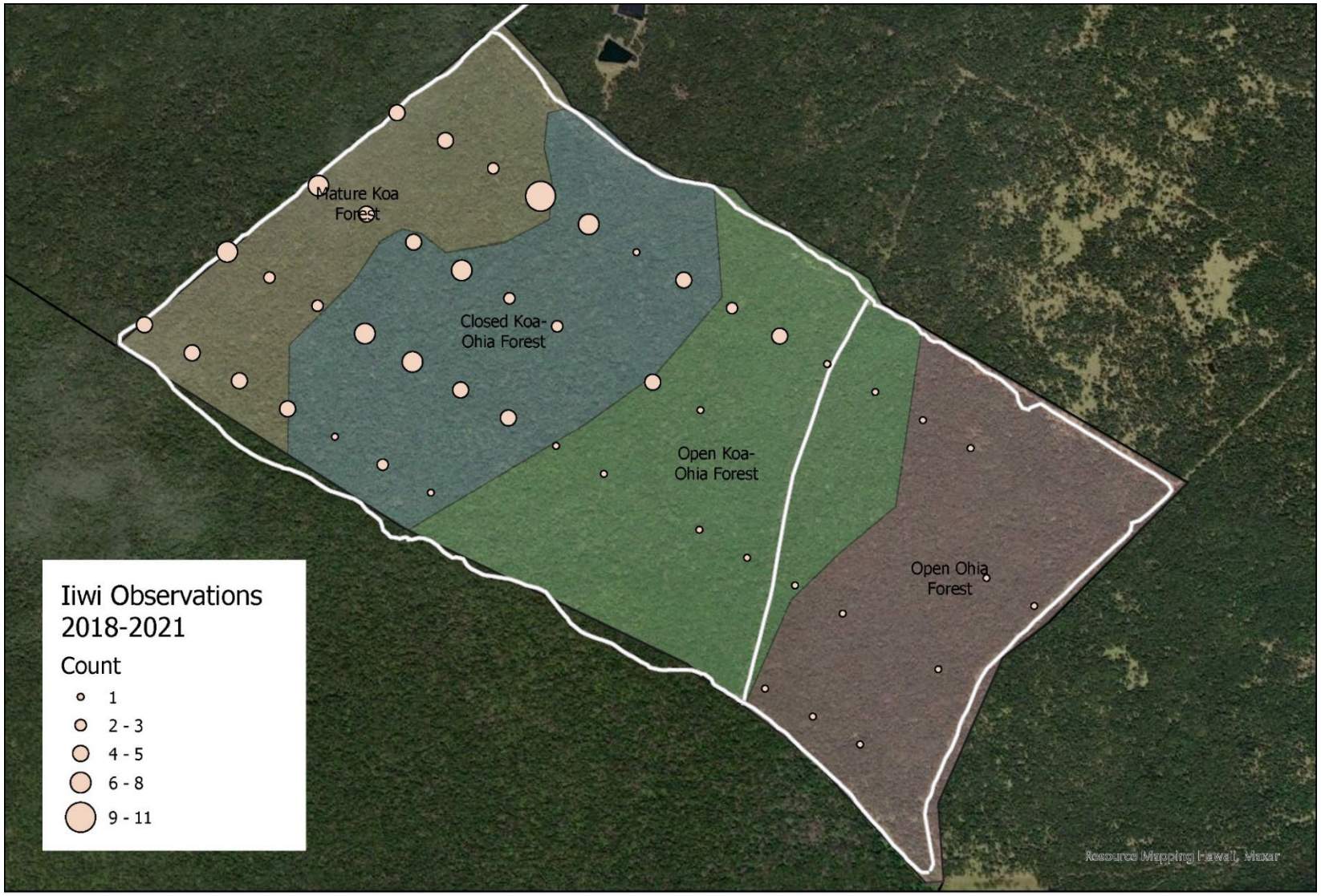

Figure 17 Endangered Bird Species Observations in KKCMA 2018-2021

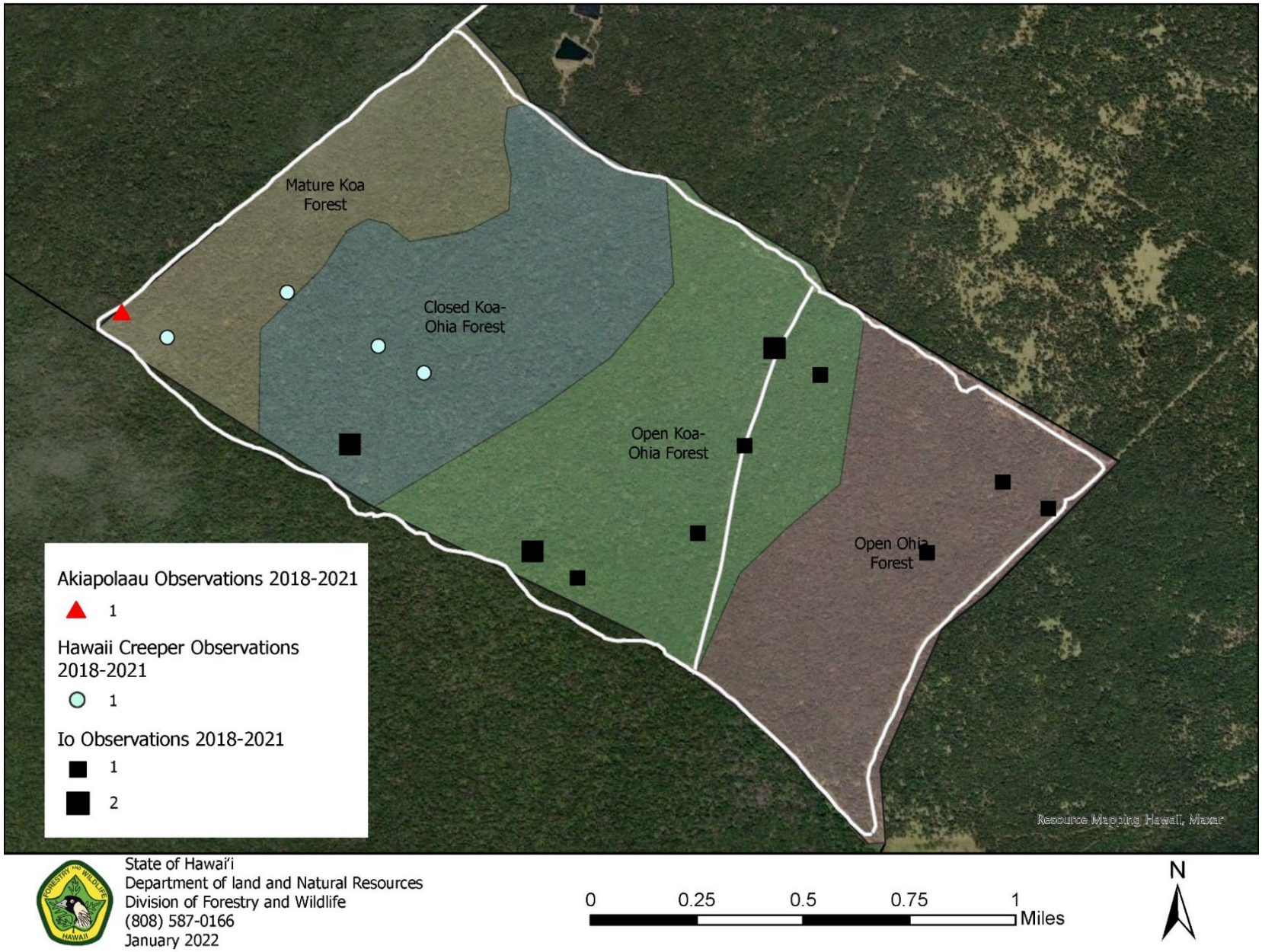

Table 8 Species Detections during 2021 KKCMA Bird Surveys (with comparison of birds per station for 2018-2020)

Alpha Code	Common Name	Scientific Name	Origin†	Status* Fed/State	2021 # Stations Occupied	2021 # Detected	2021 Percent Occurrence	2021 Birds per Station	2020 Birds per Station	2019 Birds per Station	2018 Birds per Station
AKIP	ʻAkiapolaʻau	*Hemiganthus wilsoni*	End	E/E	0	0	-	-	-	0.02	-
APAP	ʻApapane	*Himatione sanguinea*	End		65	827	100%	12.72	13.49	10.05	11.66
HAAM	Hawaiʻi ʻAmakihi	*Chlorodepanis virens*	End		64	295	95.4%	4.54	4.60	4.20	3.91
HAEL	Hawaiʻi ʻElepaio	*Chasiempis sandwichensis*	End		17	23	26.15%	0.35	0.38	0.85	0.48
HCRE	Hawaiʻi Creeper/ʻAlawī	*Loxops mana*	End	E/E	0	0	-	-	-	0.02	0.05
HOFI	House Finch	*Carpodacus mexicanus*	Int		1	1	1.54%	0.02	-	-	-
HWAH	ʻIo, Hawaiian Hawk	*Buteo solitarius*	End	-/E	1	1	1.54%	0.02	0.08	0.08	0.03
IIWI	ʻIʻiwi	*Drepanis coccinea*	End	T/-^	16	19	24.62%	0.29	0.65	0.93	0.58
JABW	Japanese Bush-Warbler	*Cettia diphone*	Int		9	10	13.85%	0.15	0.23	0.41	0.35
JAWE	Japanese White-eye	*Zosterops japonicus*	Int		60	131	92.31%	2.02	1.78	2.34	2.18
KAPH	Kalij Pheasant	*Lophura leucomelanos*	Int		2	2	3.08%	0.03	0.02	-	0.03
NOCA	Northern Cardinal	*Cardinalis cardinalis*	Int		5	8	7.69%	0.12	0.08	0.10	0.09
OMAO	ʻŌmaʻo	*Myadestes obscurus*	End		61	180	93.85%	2.77	1.34	2.08	2.65
RBLE	Red-billed Leiothrix	*Leiothrix lutea*	Int		25	40	38.46%	0.62	0.09	0.41	0.40
YFCA	Yellow-fronted Canary	*Serinus mozambicus*	Int		5	6	7.69%	0.09	0.06	0.07	0.06

†End = endemic, Int = introduced, Ind = Indigenous; * E = endangered; T = threatened; ^State status here refers to Hawaiʻi Island only

Native Insects: DOFAW entomologists implemented insect surveys in KKCMA in April 2023. Preliminary information shows that there aren't likely to be any T&E species present. There is some possibility that the rare picture wing species, *Drosophila silvestris* and *D. silvarentis* may be present, given their host plant species ʻolapa (*Cheirodendron trigynum*) and naio *(Myoporum sandwicense*),)) are present but none were found in surveys. Full details on the findings of the 2023 entomological surveys will be completed later in 2023.

3.7 Archaeological & Historical Sites

Based on research done by DOFAW staff and through the Cultural Impact Assessment (Appendix A), the area within KKCMA was likely not heavily inhabited during pre-European contact. Trails, small forest shrines, burial caves and lava tube shelters are the types of historical features that may be present, as the greater area was used historically by Hawaiians for activities such as bird hunting, harvesting timber for canoe-making, and gathering forest plants for medicinal uses. Post-European contact the lower sections of the project area were likely used for grazing, ranching, and/or timber harvest. The remnants of an old ranching era structure, now collapsed, may still be present near the east end of the cross road. DOFAW plan to implement archeological surveys in all areas that may be impacted by silviculture actions prior to any potentially disturbing actions occur, such as timber harvest, skid road construction, or stand improvement actions. Archeological features are protected by state law in Hawaiʻi. If any evidence of archeological features are found all management activities will stop until appropriate efforts to preserve or mitigate damages to the area can be put in place.

3.8 Infrastructure

Roads: Within KKCMA there are roads that roughly follow the entire perimeter of the parcel, the perimeter roads occassionally dip into the adjacent sections of the Kaʻū FR. There is also one crossroad that cuts across the parcel (Figure 18). Some of these roadways may be impassable or hard to access and may be more suitable to ATV access during or following storms, especially in winter months.

Designated Helicopter Landing Zones: There is one designated landing zone within KKCMA, however it is not actively used and needs maintenance.

Fencelines: The entire boundary of KKCMA is fenced to prevent cattle from entering the parcel. All current fencing was constructed to restrict cattle, and does not control the movement of other ungulates such as pigs or sheep. The northwest and southwest sides of the parcel have been fenced with thicker, bull-wire fencing, constructed between 2019-2021. The northeast and southeast sections of the fence are made of a lighter gauge hog wire, and was constructed within the last 10 years.

Gates & Pedestration Crossovers: There is one the main access gate, known as "domingo corner gate" located on the southwest corner. All other gates are for management use only. There are pedestration crossovers located on the fenceline between Kaʻū FR and Kapāpala FR.

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Gathering platform: A platform/gathering place was constructed in the northeast corner of KKCMA.The platform is used by staff, partner organizations, and educational groups for operations.

Koa seed orchard: A koa seed orchard, mainted by the Hawaii Agricultural Research Center (HARC), can be found in the lower section of the reserve. See section 3.5.1 for more information.

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Figure 18 Infrastructure at KKCMA

Figure 19. The public can access KKCMA via a rough 4x4 access road, but prior approval must be secured with the adjacent Kapāpala Ranch

3.9 Public Use Opportunities

Vehicle Access & Roadways: While there are multiple access roads to adjacent forest reserve lands in Kaʻū, there is one road for public access to KKCMA. The entrance is at the Honanui gate, near the 44 mile marker on Mamalahoa Hwy. This access road passes through Kapāpala Ranch, which is under lease, and requires registration and prior approval from ranch staff before the public can pass through this gate. You will not be able to get through the locked gate at the entrance without going through this process. More information about registration and access through Kapāpala Ranch can be found at: http://kapāpalaranch.weebly.com/public-access.html

This road is a very rough, 4x4 vehicle only road. During heavy storms, which can be common in the area during winter months, roadways are often not passable. The road first enters Kaʻū Forest Reserve through Kapāpala Ranch, then provides access to KKCMA at the "domingo gate" in the southwest corner of the parcel (see Figure 18).

Hiking: There are no designated hiking trails withing KKCMA, but interior roadways (Figure 18) can be used to hike around the area.

Mountain Biking: mountain biking is allowed unless otherwise posted, but only on established roadways. Due to the remote access and condition of roadways, mountain biking is not a common activity in KKCMA.

Horseback Riding: Horseback riding is not recommended within KKCMA due to the difficult access, lack of trail infrastructure, and generaly steep slopes and unstable footing for horses in the area.

Dirt Bikes and All Terrain Vehicles: OHVs are allowed unless otherwise posted, but only on established roadways.

Camping: There are no designated camping areas within KKCMA.

Fishing: No fishing opportunities are available in KKCMA.

Hunting: Hunting in state forest reserves is regulated by the Hawai‘i Administrative Rules (HAR) Chapter 13-121 Hunting General Regulations, Chapter 13-122 Game Bird Hunting, and Chapter 13-123 Game Mammal Hunting. The entirety of KKCMA is within Hunting Unit B. For copies of the administrative rules, additional information on hunter education, hunting licenses and more, visit https://dlnr.hawaii.gov/recreation/hunting/.

Forest Product Collection: Koa timber resources from KKCMA will be managed via a separate permit system, see section 5.3.4. Gathering of other non-timber 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, Hawaii Administrative Rules (HAR). Gathering of non-listed species or common materials requested in quantities that are determined by DLNR as representing personal use, is regulated through issuance of a Collection Permit free of charge. If quantities are determined to represent commercial use, a Commercial Harvest Permit may be issued at a fee. Consult the Forest Product Price List on the DOFAW website for information on personal versus commercial use quantities, as well as current commercial use pricing:
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 is 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 Hawai‘i Island office. Both addresses follow:

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

Hawai‘i Forestry Manager
Division of Forestry and Wildlife
19 E. Kawili Street
Hilo, HI 96720
Phone (808) 974-4221

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

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For more information for how to apply for permits for the state Forest Reserve System visit our permitting page:

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

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

4. THREATS

4.1 Invasive Plants

Invasive plants are non-native species with the ability to invade natural areas, grow and reproduce rapidly, and reduce biodiversity. They are harmful to the environment, economy, and/or human health and can alter ecosystem functions such as freshwater collection, soil erosion, and flood control.

Currently there are limited numbers of invasive plants in KKCMA, but there are large populations of invasive plants below the property. Within KKCMA invasive plants are more common in the lower strata and along roadways. Increased activity or timber harvest can be a vector to introduce new invasive plant species and it creates disturbance where invasive species can flourish. Table 8 lists the invasive plants known to occur in KKCMA or the surrounding Ka‘u area. The Hawai‘i Invasive Species Council has invasive species profiles for many of these species, which can be found online at: https://dlnr.hawaii.gov/hisc/info/invasive-species-profiles/. Based on potential impacts, distribution, and available control methods DOFAW has set a management objective for each species:

Invasive plant management objectives:

- Control – Reduce populations and/or the vigor of individuals
- Contain – Stop or minimize population growth and geographic spread
- Remove – Elimination of populations within KKCMA
- EDRR (Early detection rapid response) – Species that are not established within KKCMA 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.
- Monitor – Monitor spread over time

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Table 9 Invasive plant species threatening KKCMA

Species	Common Name	DOFAW Objective (in KKCMA)	Noxious Weed List Status
Abutilon pictum	painted abutilon	EDRR*	None
Andropogon virginicus	broomsedge	Contain	Hawai‘i Noxious Weed List
Bocconia frutescens	plume poppy	EDRR	Hawai‘i Noxious Weed List
Caesalpinia decapetala	cat’s claw	EDRR	None
Cestrum nocturnum	night-blooming jasmine	EDRR	None
Clidemia hirta	koster’s curse	EDRR	Hawai‘i Noxious Weed List
Crotalaria pallida	rattlepod	Contain	None
Desmodium intortum	greenleaf desmodium	Contain	None
Derris elliptica	tuba root	EDRR	None
Ehrharta stipoides	meadow rice grass	Contain	None
Grevillea robusta	silk oak	Contain	None
Fucshia x hybridus	fucshia	EDRR	None
Morella faya	firetree	Remove	Hawai‘i Noxious Weed List
Hedychium gardnerianum	Himalayan ginger	EDRR	None
Heterocentron subtriplinervium	pearlflower	EDRR	None
Passiflora laurifolia	orange lilikoi	EDRR	None
Passiflora tarminiana	banana poka	EDRR	Hawai‘i Noxious Weed List
Psidium cattleianum	strawberry guava	Contain	None
Psidium guajava	common guava	Contain	None
Rubus argutus	blackberry	Contain	Hawai‘i Noxious Weed List
Rubus ellipticus	Himalayan raspberry	Contain	Hawai‘i Noxious Weed List
Rubus niveus	mysore raspberry	Contain	Hawai‘i Noxious Weed List
Setaria palmifolia	palm grass	Remove	None
Schinus terebinthifolia	Christmas berry	EDRR	None
Senecio madagascariensis	fireweed	Contain	Hawai‘i Noxious Weed List
Tibouchina spp.	glorybush, cane tibouchina	Contain	Hawai‘i Noxious Weed List

* EDRR – Early Detection, Rapid Response; target species not currently known to occur in KKCMA, but are known in the surrounding areas.

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

4.2 Invasive Animals

Invasive animal species, especially ungulates, are a significant stressor on all native terrestrial ecosystems in Hawai‘i. They have been shown to alter ecosystem processes, contribute to native species mortality, and undermine the integrity and persistence of native ecosystems (Gregg, 2018).

Cattle appear to be the primary animal threat to the native ecosystems in KKCMA. They cause damage by trampling and browsing native vegetation. In KKCMA damage to koa seedlings and

inhibition of koa recruitment is especially concerning. Although cattle fencing surrounds the parcel there is still cattle ingress to the area, either from damage to fencing, and gates being left open either intentionally or accidentally. Cattle have been observed in KKCMA and there are signs of activity including excrement and browse damage on vegetation throughout the parcel, especially in the lower strata.

Figure 20. damage to koa seedlings, likely from grazing from cattle

Other ungulates reported from the Kapāpala area include mouflon and pigs. Mouflon cause similar browsing damage as cattle. Pigs root and disturb soil, which disturbs native ecosystems and creates habitat that invasive plant species can then colonize. Other non-native animal species include rats, cats, and mongoose, all of which are widespread in the hawaiian islands and negatively effect native plants and animals.
Invasive animals known to occur in KKCMA and their potential impacts are listed in Table 10. Based on potential impacts, distribution, and available control methods, DOFAW has set a management objective for each non-native animal species.

Invasive animal management objectives:

- Control – Reduce populations and/or the vigor of individuals.
- Contain – Stop or minimize population growth and geographic spread.
- Remove – Full removal of populations within KKCMA.
- EDRR (Early detection rapid response) – Species that are not established within KKCMA 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.
- Public hunting – provide hunting opportunities.

Table 10 Invasive Animals with the Potential to Disrupt Ecosystems in KKCMA

Species	Common Name	Status/Threat	DOFAW Objective
Bos taurus	cattle	Trample plants, strip bark from trees, causing vegetation damage/erosion (currently believed to not be present)	EDRR*
Canis lupus familiaris	dog	Predate on native birds, game mammals and game birds; threat to public safety	Control
Ovis gmelini musimon	mouflon	Eat and trample vegetation; cause erosion (currently believed to not be present).	EDRR

Culex spp.	mosquito	Vectors for diseases that are a threat to public safety and native wildlife (especially *Culex quinquefasciatus*).	Control
Felis catus	cat	Predate on native and game birds; vectors of toxoplasmosis, a zoonotic disease	Control
Herpestes auropunctatus	mongoose	Predate on native and game birds	Control
Rattus spp.	rat	Predate on native plant fruits/seeds and native and game birds	Control
Sus scrofa	feral pig	Vegetation damage; trail damage & erosion; decrease infiltration/water quality and increase runoff; spread of invasive species and pathogens such as ROD; creating breeding ground for mosquitos carrying avian malaria	Public Hunting, Control

*EDRR – Early Detection, Rapid Response; target species not currently believe to be in KKCMA, but known from surrounding areas

4.3 Insects & Disease

New and sudden increases of insects and diseases can be a serious threat to KKCMA. With globalization and an increased dependence on imports, approximately 20 insect species become established in Hawai‘i every year (State of Hawai‘i 2010). Of particular concern in KKCMA are those that have the potential to cause widespread dieback of predominant forest canopy species such as koa and ‘ōhi‘a. Below are some of the known insects and diseases that threaten KKCMA. Many of these insects or diseases are very hard to control or have limited control options, and a sudden outbreak may drastically alter the forest composition. If an outbreak of one of these diseases does occur, it may drastically alter the management goals for the area.

Based on potential impacts, distribution, and available control methods, DOFAW has set a management objective for each insect or disease.

- Control – Reduce populations and/or the vigor of individuals
- Contain – Stop or minimize population growth and geographic spread
- Early Detection Rapid Response (EDRR) –These species are not established in the area but pose a threat. Actions will be taken to try and control the population early if detected.
- Remove – Elimination of populations within KKCMA
- Monitor – Species is widespread and containment is not feasible. Monitor changes in population over time and evaluate if new control options become available.

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Table 11 Insects and Diseases with Potential to Cause Damages in KKCMA

Species	Common Name	Threat	DOFAW Objective (in KKCMA)
Fusarium oxysporum f.sp *koae*	koa wilt	Dieback and/or decline of koa, especially in low elevations/warmer areas	EDRR
Scotoryhta paludicola	koa moth	Endemic insect that occasionally experiences large population increases that can cause severe defoliation of koa trees.	Monitor
Tetraleurodes acaciae	acacia whitefly	Decreased plant vigor, leaf yellowing/defoliation of varying hosts	EDRR
Accizia uncatoides	acacia psyllid	Decline or poor growth form of koa.	Monitor
Xylosandrus compactus	black twig borer	Stunted growth and death of over 100 tree and shrub species	Monitor
Ceratocystis lukuʻōhiʻa, C. huliʻōhiʻa	rapid ʻōhiʻa death	Widespread and rapid death and/or stress of ʻōhiʻa lehua	Monitor
Klambothrips myopori	naio thrips	Defoliation and potential death of naio	Monitor
Plasmodium relictum	avian malaria	Deadly to many species of birds, especially native hawaiian species	Monitor

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

The virulence of *Fusarium oxysporum* in relationship to soil temperature is well studied in many host species and it has been determined that there is increased virulence at higher temperatures (Scott et al. 2001, Landa et al. 2006). The effects of koa wilt appear minimal at KKCMA and it is hypothesized that the high elevation and cool ambient soil temperatures of the area are not optimal for the survival of *F. oxysporum* f. sp. *koae*. Nonetheless, with climate change and the potential for increasing soil temperatures, koa in KKCMA should be monitored for signs of koa wilt.

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DOFAW has worked in collaboration with the Hawaii Agricultural Research Center (HARC) to create seed orchards of koa trees that ha ve been screened and found resistant to koa wilt and installed across the state. This statewide network of koa orchards are located on state and private lands across the state, providing wilt resistant, localized koa seeds for outplanting and reforestation projects. One of these seed orchards was planted in KKCMA in roughly 2014 and is still functioning today.

Figure 21 A koa trunk infected with koa wilt. Note the staining in the sapwood. Photo by J.B. Friday

Acacia whitefly: The acacia whitefly (*Tetraleurodes acaciae*) is a new pest that was first identified in Hawai‘i in 2021 from populations in Waikiki on O‘ahu. Infestations can lead to decreased plant vigor, including leaf yellowing, wilting, and defoliation. Their preferred hosts are within the Fabaceae plant family but other species can be affected as well. Known hosts include common landscape trees such as shower trees (*Cassia* spp.), orchid trees (*Bauhinia* spp.), and endemic plants such as wiliwili (*Erythrina sandwicensis*) and koa (*Acacia koa)*. At this point the acacia whitefly has only been detected on O‘ahu, but more monitoring is likely needed on other islands. For more information see: https://hdoa.hawaii.gov/pi/files/2021/12/NPA-21-02-Tetraleurodes-acaciae2.pdf

Black twig borer: The black twig borer (*Xylosandrus compactus*) is a small ambrosia beetle that is a major forestry, ornamental, and agricultural pest. They damage and stunt the growth of over 100 different shrub and tree species in Hawai‘i (Hara & Beardsley 1979). Female black twig borers tunnel into woody twigs, leaving pin-sized entry holes. Once inside they excavate galleries and lay eggs. This excavation, along with the introduction of pathogens, is the cause of damage to the host. Black twig borers damage koa and field plantings of other host species, hindering restoration and reforestation efforts. It is not known if black twig borer is a problem within KKCMA. Further surveys are needed to determine the extent and damages to trees in the area.

Acacia psyllid: The acacia psyllid *(Accizia uncatoides)* was first detected in Hawai‘i in 1966. This insect feeds on new growth of koa, which usually does not kill trees but can potentially lead to forking or multiple stems. This is a concern for KKCMA since growth form is important for koa canoe logs. Both biocontrol and chemical agents have been used to control acacia psyllids, the latter with success in forest plantings (Baribault 2014). Insect surveys in April 2023 did not find anyInsect surveys in April 2023 did not find any acacia psyllids present, which is uncommon for forests in Hawai‘i (K. Magnacca, pers. comm). The presence or extent of acacia psyllids present, which is uncommon for forests in Hawai‘i (K. Magnacca, pers. comm). Forest

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health monitoring surveys should continue to look for this pest species and potential impacts to koa regeneration should be examined.

Koa moth: The koa moth (*Scotoryhta paludicola*) is an endemic insect on the islands of Hawai‘i, Maui and O‘ahu. The caterpillars feed on koa leaves and are capable of defoliating large swaths of koa forests. The insect is normally present in low levels in the koa forests. In January 2013 DLNR staff reported sever defoliation of koa forests above Hilo, and surveys concluded the cause was likely due to damages from large populations of the *S. paludicola* caterpillars. The outbreak soon spread all over Hawai‘i island causing wide spread defoliation. The outbreak seemed to subside within a few months in most places and trees began to refoliate. It is not known what caused the large population spike and eventual decline, but this is another insect that should be monitored for in KKCMA.

Rapid ‘ōhi‘a death (ROD): ROD is a disease that has killed over a million ‘ōhi‘a trees on Hawai‘i Island and has been found on Kaua‘i and O‘ahu. The fungi that cause the disease are wound fungi that enter the tree through wounds to the bark and then spreads in the sapwood. There are two pathogens associated with ROD: *Ceratocystis luku‘ōhi‘a* which causes an aggressive wilt disease and is responsible for most of the stand-level die-off; and *Ceratocystis huli‘ōhi‘a* which is a slower-acting, canker pathogen which is thought to have been present in Hawai‘i for a longer period of time.

Through various efforts, managers have recognized a few patterns of disease occurrence and spread. Climate does not seem to limit presence of the disease, but ROD appears most aggressive in wet areas and lower elevations, likely from higher temperatures. Storm and wind events that wound ‘ōhi‘a trees can lead to infection by the fungus. Typically, these storm events occur in an “episode” with a spike of tree mortality, followed by a decreased continuing mortality.

Another pattern that has been more recently observed in surveys is the higher incidence of *C. luku‘ōhi‘a* detections in areas where hoofed animals are present, compared to adjacent areas where animals have been removed. The mechanisms are not fully understood, but it is thought

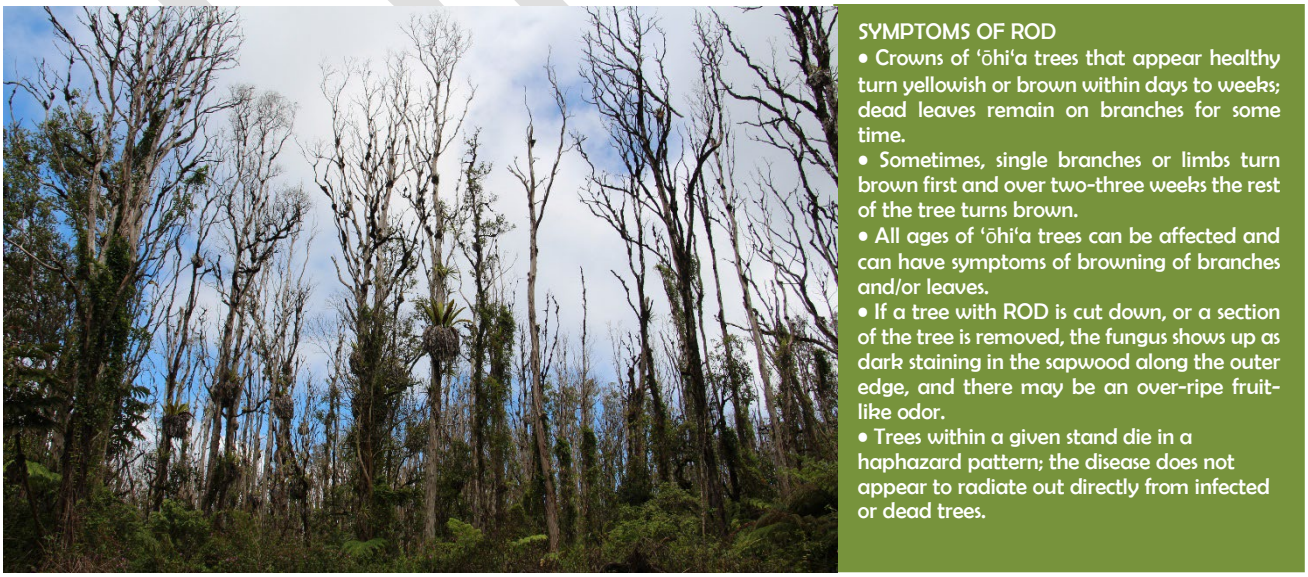

Figure 22. ‘Ōhi‘a killed by ROD in lower Puna on the island of Hawai‘i Photo Credit: J.B. Friday

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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.

Ambrosia beetles which bore into ʻōhiʻa trees are responsible for releasing frass which contains fungal spores into the environment. Entomologists have conducted controlled studies demonstrating that beetles can actually carry the fungus on their bodies and directly infect living ʻōhiʻa seedlings. However, beetles normally attack dead and dying trees, and scientists do not think that beetles serve as the main disease vector. Humans can also spread ROD through moving soil either on their clothing, boots, or vehicles. Anyone entering or exiting KKCMA should brush and sanitize all footwear and vehicles to minimize the risk of spreading ROD pathogens.

ROD is now found throughout Hawaiʻi Island forests and will need to be managed in the long-term similar to invasive plants or effects of climate change. It is believed that spores of both *Ceratocystis* species are circulating widely on the island, and management actions can only help reduce wounding and entry points for the disease to enter trees. The relationship to feral animals offers potential management tools for preventing wounding and possibly 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 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 ROD outbreaks caused by storm damage. Areas in which ungulates have already been excluded are still likely to have ROD show up, but the rate of infection over time is likely to be reduced.

ROD has been detected in KKCMA and the surrounding areas. A few ʻōhiʻa trees that were sampled confirm the presence within KKCMA, and a large number of positive samples have been documented in the adjacent Kaʻū Forest Reserve to the west. Almost all samples taken in and around KKCMA show the presence of *C. lukuʻōhiʻa*, the more damaging of the two pathogens.

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Myoporum thrips: Myoporum, or naio thrips (*Klambothrips myopori*) feed on and infest native naio trees (*Myoporum sandwicense*). Myoporum thrips are likely native to Australia or New Zealand and were detected in Southern California in 2005. In 2008, it was found on the island of Hawai‘i and then found in several locations on O‘ahu in 2018. They cause leaf distortion, gall-like symptoms and in severe cases, death. It appears that naio trees located in drier habitats are more vulnerable, and widescale dieback, potentially combined with drought stress, has been seen at Pu‘u Wa‘awa‘a on Hawai‘i island. Mortality rates could increase with climate change if rainfall decreases. Thrips and thrips damage have been observed throughout KKCMA, but widespread dieback has not been documented. Insect surveys in April 2023 did not detect any *K. myopori* present, although some plants showed slight damage associated with the insect. It may be that they move into the area seasonally and with warmer, drier weather, but the exact reasoning for their absence in surveys is undetermined.

Figure 23. Close up of curled leaf damage due to naio thrips, *Klambothrips myopori*

Avian malaria: This disease is carried by mosquitos and is deadly to many native birds species. It is considered one of the key factors limiting the distribution and abundance of native forest birds in Hawai‘i. Even when avian malaria isn’t fatal, it can decrease lifespans, and female birds infected with malaria can pass down a genetic predisposition for shorter life spans (Asghar et al. 2015). The range of suitable habitat for mosquitos is expanding as temperatures rise due to climate change, placing Hawaii’s forest birds at higher risk of avian malaria and further decreasing their available habitat. Bird surveys of KKCMA show that threatened and endangered bird species are mostly found at higher elevations which may be partly due to the presence of avian malaria (see section 3.6).

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4.4 Fire

Native ecosystems in Hawai‘i are not well adapted to wildfire and the majority of native plant species are not able to regenerate after a fire. Wildfires tend to lead to increased cover of non-native species and can convert forested areas to shrublands or grasslands (Trauernicht 2014). There have been no documented fires within KKCMA and wildfire risk in the parcel is considered low. However, wildfires are still possible, especially with human activitiy in the area. The principal human caused ignition threats are from vehicles or heavy equipment interactions with vegetation on roadways, arson, or illegal campfires. Fires have been documented in the adjacent Ka‘ū Forest Reserve and at lower elevations nearby. In 2005, a roughly 100 acre burn occured on state land in the Kapapāla Ranch area about 3 miles directly south of KKCMA. In 2002/2003, the Pahuamimi fire burned 1000+ acres in Kapāpala FR, about 5 miles east of KKCMA.

4.5 Flooding & Erosion

Flood risk is considered low in KKCMA due to the lack of nearby streams. Erosion is a concern, as topsoil in portions of the reserve is shallow and highly erodible (see section 3.2). Erosion is most likely to occur along roadways, especially during heavy winter storms which can be common in the Ka‘ū area. The use of heavy machinery during timber harvest or other management activities could also increase soil erosion and appropriate mitigation strategies should be implemented.

Figure 24. Roadways in KKCMA can get washed out and hard to pass due to erosion

4.6 Climate Change

Forest ecosystems in Hawai‘i will face new environmental conditions and a variety of increased threats associated with climate change. According to the 2012 Pacific Islands Regional Climate Assessment (PIRCA), documented indicators of climate change in the region include increasing air temperature (more significant at higher elevation), decrease in rainfall across much of the region, decrease in ground water discharge to streams, changes to frequency and intensity of climatic extremes, mean sea level rise (Western Pacific), and changes in species distributions. Potential impacts to our communities and natural environments include shifts in rainfall patterns, a decrease in freshwater supplies, increase in extreme weather events, flooding and erosion, increase in non-native biological invasions, increase in frequency and size of wildfires, and an increased risk of species extinction (Keener et al. 2012).

In 2018, the Pacific Island Climate Change Cooperative (PICCC) and EcoAdapt completed the Hawaiian Islands Climate Vulnerability and Adaptation Synthesis. Through literature reviews, expert elicitation, vulnerability mapping, and workshops with resource managers and conservation planners, the synthesis provides information to improve understanding of climate

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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 habitats types and ecosystem services.

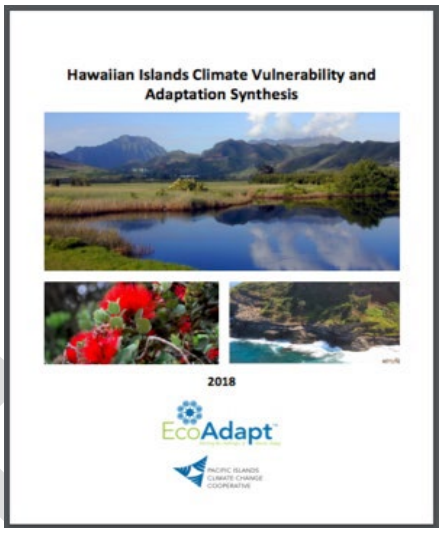

Figure 25 The Hawaiian Islands and Climate Vulnerability and Adaptation Synthesis

The habitat classification from the 2018 Climate Synthesis that applies to KKCMA is Mesic and Wet Forests, which according to the report are moderately vulnerable to climate change. Some of the recommendations suggested for mitigating damage from climate change in these habitats are to expand fencing and ungulate removal, prioritize the planting of native species that thrive in a wide variety of conditions, and to determine agency roles in biosecurity plans for the area. The full summary of climate change adaptation for mesic & wet forests on Hawai‘i island can be found here:

http://www.cakex.org/sites/default/files/documents/EcoAdapt_Hawaii_Mesic%20%26%20Wet%20Forest_Adaptation%20Summary_January2018.pdf

4.7 Volcanism

Although KKCMA is only about 12 miles southwest of Kīlauea crater, the parcel is at low risk of having direct lava flow or an eruption event. Figure 26 shows the lava hazard zones for the island of Hawai‘i; Zone 1 is the area of greatest hazard and Zone 9 is the least hazardous. KKCMA falls within lava hazard Zone 6 on the southeast slope of Mauna Loa (Juvik & Juvik 1998).

A secondary effect of volcanic activity, volcanic smog or “vog,” is of concern at KKCMA. Vog refers to the hazy air pollution caused by volcanic emissions. The main particles of concern are sulfur gases, especially sulfur dioxide (SO_2), and small particulate matter (PM). In high quantities vog can cause serious deterioration of metal fencing and other infrastructure. Vog can also damage vegetation, especially non-native crops and agricultural species. Some native plants, such as ‘ōhi‘a lehua, appear to have adapted to periodic exposure to vog (Elias & Sutton 2017). Humans vary in their sensitivity to vog, but symptoms can include respiratory irritation or a general lack of energy.

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4.8 Vandalism & Human Activities

It is believed human activities are one of the main reasons for cattle ingress into KKCMA. Gates to the area have been left open, either purposefully or accidentally, allowing cattle to enter the area. Vandalism of infrastructure in the area, particularly to the fencing surrounding KKCMA is another potential source of cattle ingress. Cattle damage native forest ecosystems and are likely severely limiting koa regeneration. This threatens the continued supply of koa resources for cultural uses for generations to come.

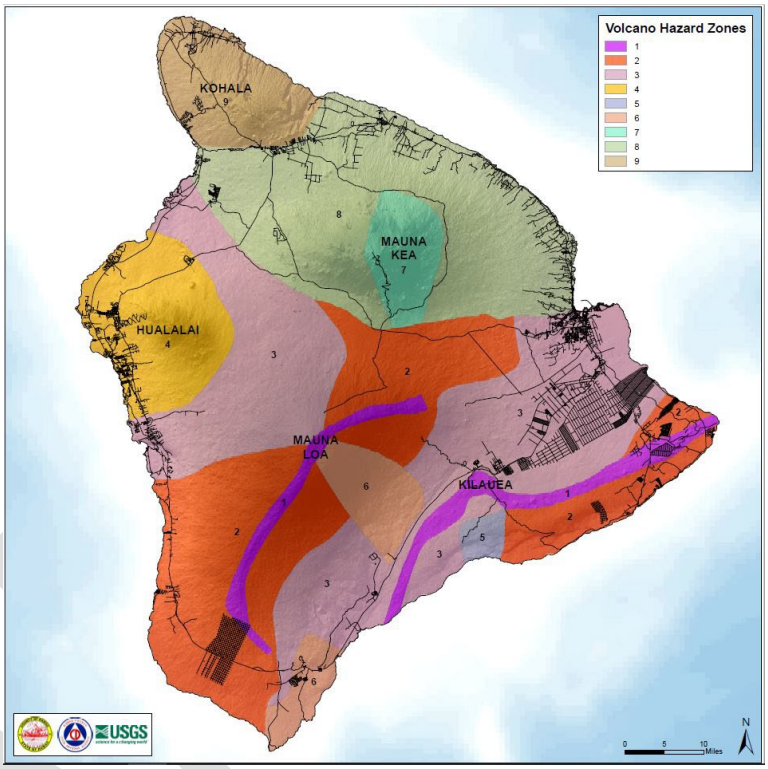

Figure 26 Volcano Hazard Zones on Hawai‘i Island. KKCMA lies within Hazard Zone 6.

Illegal, unpermitted harvesting of non-timber forest products has also been documented in the area. DOFAW staff have also seen evidence of maile propagation activities, including fertilizer and and other cultivation paraphernalia within KKCMA and other parts of Ka‘ū FR. Bringing soil, compost, or fertilizer into the forest is unsafe as it can lead to the spread of insects and diseases, such as rapid ‘ōhi‘a death and little fire ants. The unpermitted collection of forest products leads to the decline of resources for the rest of the public and for those collecting pono, with permits and in non-commercial quantities.

Other human activities of concern that have been noted is evidence of drug use in the area, and unsanctioned camping. Unsanctioned camping and campfires can be a fire threat, and drug use can create an unsafe environment for educational groups or the public.

5. MANAGEMENT

5.1 Summary of Past Management Activities

DOFAW began managing KKCMA in 1989. For information on the area before 1989, see Section 2.1. Between 1990-1994, state funding was secured and a cattle proof fenceline was constructed around the parcel in two phases. During the construction of this fence, some trees

were cut and harvested that were either obstructing the fence or threatening the integrity of the fenceline. Cattle from nearby ranchlands still ingressed into the area during and after fence construction, which was mainly managed by notifying the nearby ranches to retrieve and remove cattle. Cattle have been periodically removed over time, but they often encroach back into the area. Fence maintenance has improved, but cattle ingress either through fence failures or gates being left open is an ongoing issue.

A variety of timber, flora and fauna surveys have been completed in KKCMA. Multiple timber surveys have occured, including a 2000 inventory of koa and ʻōhiʻa, partial timber surveys in 2006 and 2007, and a full timber inventory in 2020, the 2020 Kapāpala Koa Canoe Forest Inventory (Appendix B). The 2020 inventory focused on koa timber resources, but also describes other vegetation in the area, and has heavily influenced the understanding of forest composition and koa timber resources for this plan. A roadside plant species list of KKCMA was completed in 2021, noting the presence of every plant species found in view from the roadside areas. This has been adapted to the Kapāpala Working Plant List (Appendix C). The Three Mountain Alliance (TMA) and DOFAW have collaborated on annual bird surveys in KKCMA from 2018-2022, of which the 2018-2021 data can be seen summarized (Section 3.6) and in its entirety (Appendix D).

The Three Mountain Alliance spearheaded a Youth Education Plan in the early 2010's, which included the construction of a gathering platform in the northeast corner of KKCMA (see Figure 18). TMA led educational trips to the area, but a few problems led the organization to determine it was not an ideal site. The parcel is open to the public, and some evidence of drug use and illegal camping had been noted. Also, the remoteness of the location, in combination with the very rough 4x4 access road that was often impassable during winter storms, made it hard to reliably access the area for educational groups.

In the southwest corner of the parcel, the Hawaiʻi Agricultural Research Center (HARC) in collaboration with DOFAW, created a koa seed orchard to provide koa seeds from trees screened to be resistant to koa wilt, a disease that often kills or heavily impacts koa trees, mainly at lower elevations (see section 3.5.1 and 4.3). This orchard is still present and active.

KKCMA Working Group: In an effort to advance the sustainable management of KKCMA, TMA and DOFAW partnered in late 2014 to bring together roughly 20 key stakeholders including cultural practitioners; voyaging and racing associations, clubs, and members; waʻa (canoe) builders; forestry experts; conservationists; land managers; and residents of Kaʻū. This working group was asked to provide insight and guidance on the long-term stewardship of the forest and appropriate use and perpetuation of wa'a and other forest resources in KKCMA. The first several meetings of the working group began by sharing knowledge that ultimately led to the development of a 2016 Preliminary Forest Management Plan. In 2017 and 2018, the working group supported DOFAW in drafting an application and allocation protocol for canoe logs from KKCMA. Based on feedback from the working group and the preliminary plan and allocation protocol, it was determined a forest inventory was needed, which was implemented in 2019 and early 2020 (Appendix B). The forest inventory provided DOFAW with the needed information to revise and finalize the forest management plan for KKCMA, which the working group was once again asked to provide guidance on. The KKCMA working group has met approximately one to

three times per year since its inception, for a total of ten meetings. Over the last seven years, the working group has been a source of diverse expertise and varied perspectives that are critical to the development of this Management Plan and the overall advancement of KKCMA.

5.1.1 Past & Related Plans

Plans that contain relevant information on the resources and management strategies pertinent to the management of KKCMA are listed below.

- Hawai‘i’s State Wildlife Action Plan
- DOFAW Forest Action Plan
- DOFAW Draft Management Guidelines (Appendix E)
- USFWS Endangered Species Recovery Plans
- KCF Preliminary Draft Management Plan (2016)
- Kapāpala Koa Canoe Forest Youth Education Plan
- Ka‘ū Forest Reserve Management Plan (2012)
- Forest Management Plan for the Waiākea Timber Management Area

5.2 Management Guidelines

DOFAW has developed a set of draft management guidelines and associated maps to assist in evaluating and balancing human activities and resource management goals and objectives. 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 five principal classifications: Conservation Resources, Forest Products Management, Recreation Management, Vegetation Management, and Hunting Management (Figure 27). Detailed definitions of these classifications and their associated management strategies can be found in Appendix E.

Forest Products Management Guidelines: There are four categories for Forest Products Management: Large Scale Commercial (F-1), Small Scale Commercial (F-2), Personal Use (F-3), and Restricted (F-4). **KKCMA is listed as F-2.** While the main purpose of KKCMA is koa timber harvest for koa construction, this is considered at a small, non-commercial scale and not large scale commercial. Some small scale commercial harvests will occur due to thinning operations in the area.

Conservation Resource Guidelines: There are four categories for Conservation Resources: C-1 (High Conservation Resources), C-2 (Medium Conservation Resources), C-3 (Low Conservation Resources), and C-4 (Little to No Conservations Resources). **KKCMA is listed as C-2.** KKCMA consists of predominantly intact native forest, something that is increasingly rare in Hawai‘i. However, there are minimal rare or endangered species, and unique resources in the area, which is why it is not considered C-1. However, it is still a very important area of conservation value.

Vegetation Management Guidelines: There are four categories for Vegetation Management: V-1 (Highest Quality Native Vegetation), V-2 (Predominantly Native Areas), V-3 (Considerable

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Degraded Vegetation Areas) and V-4 (Heavily Degraded Areas). **KKCMA is listed as V-2.** Similar to the conservation guideline, the vegetation in KKCMA is predominantly native, althought there are some non-native grasses in lower areas and some invasive species along roadways (see section 4.1).

Hunting Management Guidelines: There are four categories for Hunting Management: Active Hunting Management (H-1), Moderate Hunting Management (H-2), Low Intensity Hunting Management (H-3), and No Hunting Management (H-4). **KKCMA is listed as H-2.** Public hunting is encouraged and common activity in KKCMA. However, the main objective of providing a long term sustainable supply of koa timber is a higher management objective than providing continuous hunting opportunities, which are a secondary management objective.

Recreation Management Guidelines: There are four categories for Recreation Management: R-1 (High Recreation Management), R-2 (Medium Recreation Management), R-3 (Low Recreation Management), and R-4 (Restricted Access). **KKCMA is listed as R-3.** Due to its remote location and difficult accessibility, KKCMA is not a common recreation area for many visitors. However, there is current public access that allows for hiking, bird watching, hunting and forest product gathering, provided you secure access through the nearby ranchlands (see section 3.9).

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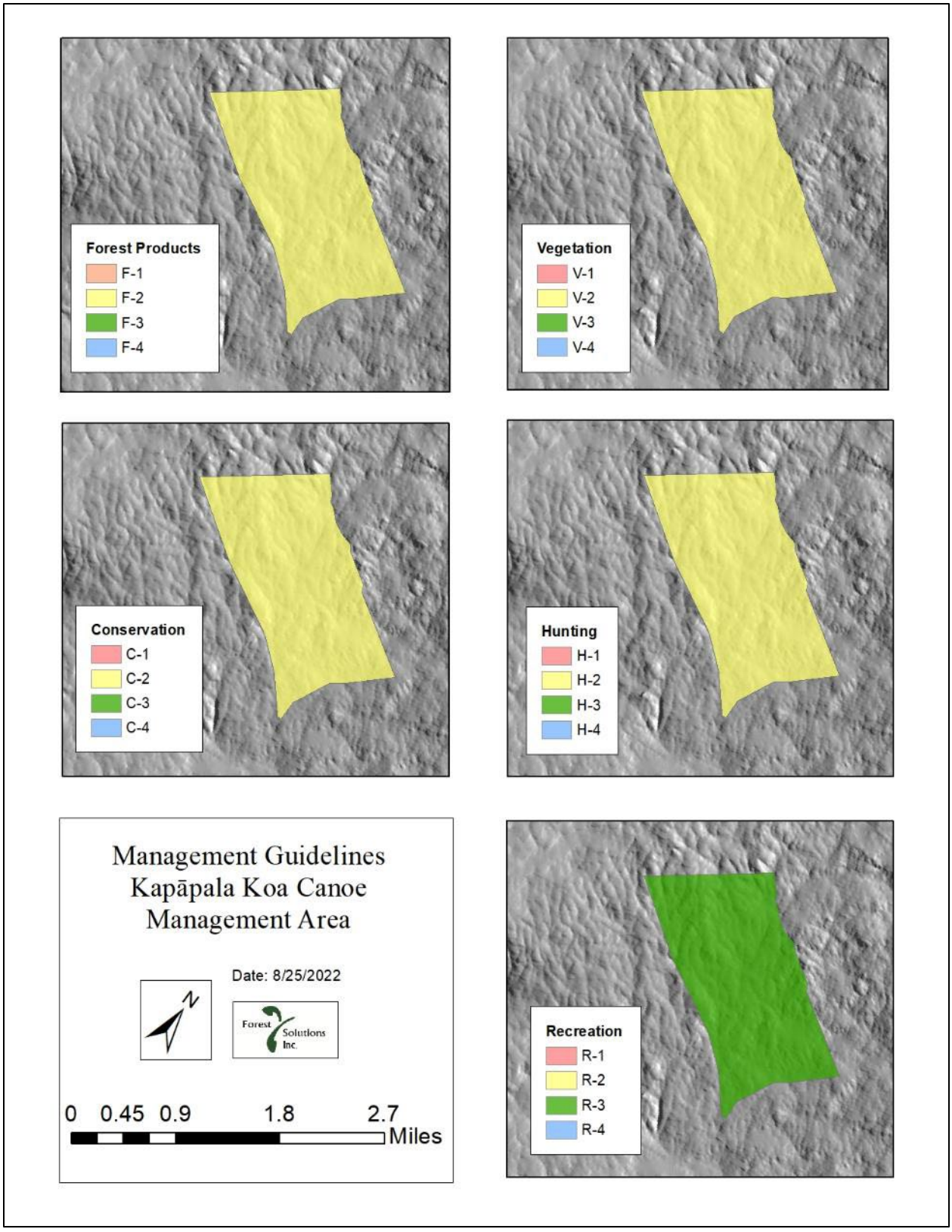
Figure 27 Management Guidelines for KKCMA



5.3 Timber Harvest

5.3.1 Harvest Plan Overview

The primary goal for this area is to sustainably produce koa logs suitable for building canoes now and for future generations. However, other goals, such as the protection of watershed benefits, native ecosystems, threatened and endangered species, and providing recreational opportunities, are also priorities. Therefore, this timber harvest plan is designed so that KKCMA can fulfill the need for koa canoe logs while also ensuring these other resources will be protected in perpetuity. This will be done by using sustainable silviculture and forestry practices developed for a 100-year horizon, and will be revisited at least every 10-years to integrate adaptive management strategies as needed.

The harvesting and forestry management proposed at KKCMA will follow the practice of disturbance-based or structural retention silviculture. This involves retaining various structures at the time of harvest, longer harvest rotations, and active creation of heterogeneity in the managed stand (Gustafsson et al. 2012). By attempting to emulate natural disturbance processes, management actions can give rise to a complex, structurally diverse forest while still utilizing and cultivating timber resources. In Hawai‘i, the most common disturbances in forests are flooding and landslides caused by extreme rainfall events, wind damage from tropical cyclones, and wildfire (Barton et al. 2021). In general, the spatial extent and intensity of the disturbance are inversely correlated with frequency, meaning small storms occur more frequently than large hurricanes or floods (Barton et al. 2021). At KKCMA, there are often windstorms that cause one or more koa trees to fall, increasing light availability to the forest ground and allowing a new generation of seedlings to grow. Forest management prescriptions can simulate this process through the harvest of single trees and groups of trees across the landscape at varying frequencies.

Figure 28 The disturbance-based harvest plan is meant to minimize impacts on the forest and promote regeneration of koa resources

The main resource targeted during harvest operations will be large koa trees capable of being made into canoes (see Section 3.5). However, harvesting only large trees from the forest will, in the long term, result in a forest composed of smaller trees with poor form. The practice of removing only large trees, with hope that smaller ones will fill in, is referred to as high-grading or diameter-limit harvesting. This is an unsustainable practice with deleterious outcomes well documented in forests world-wide (Power et al. 2019, Oliver & Larson 1996). Through harvesting a variety of sizes and qualities of koa trees, forest

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management can positively influence the development of future koa stands, as opposed to selectively harvesting all the large koa trees in an area.

Therefore, harvest activities at KKCMA will be two-fold, and implemented in the same location:

1. Selective harvest of canoe trees
2. Thinning or other stand improvements actions, including selective harvests of non-canoe trees.

Canoe log harvests will be geographically paired with thinning and stand improvement operations to create openings for seedling recruitment and to prevent high grading through the removal of non-canoe quality trees. All timber management prescriptions will be guided by Hawai‘i’s Best Management Practices (BMP) policies (Appendix F) to mitigate any potential negative impacts from forestry activities. BMPs have a central focus on protection of water quality, and as such they commonly address maintenance of forest roads, timber harvesting, skid trails, reforestation, site preparation, and the protection and management of watersheds (Cristan et al. 2016).

Forest Management Units:

To assist in the organization of management practices, the forest has been divided into ten forest management units (FMU’s). These FMU‘s are large enough to allow for efficient forest management operations yet small enough to be managed in a designated time frame. Each FMU has a unique identification number (UID), so that operations within it can be tracked and planned (Figure 30).

Forest Management Classes:

Each FMU is also assigned a management class as either 1) Restoration 2) Forest Product Management, or 3) Resource Protection (Figure 30). These classes represent the overall management goal for that unit and the potential management activities in that area. However, this does not mean management activity must be applied across the entire area, or that activities will not overlap across classes.

Restoration (271 acres): The lower elevation forests in the restoration management class contain an open ‘ōhi‘a forest with koa mostly in the sub-canopy (Figure 8). This area has a prior history of grazing and potentially past harvesting (see section 3.4), and is the most in need of restoration of forest structure. Suitable management activities may include pre-commercial thinning, commercial thinning, weed control, and enrichment planting of koa and/or other seedlings as needed.

Forest Product Management (684 acres): The mid-elevation in the forest product management class (Figure 30) contain both open ‘ōhi‘a-koa forest and closed koa-‘ōhi‘a forest and has koa trees of all diameter classes. These units include strata K02 and K03 (Figure 8), therefore, containing the transitionary zone from the low elevation forest to the thick, diverse, mature koa

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forest. This seems to be the best area for promoting the growth of canoe logs, as there is a higher concentration of canoe trees in this area (Figure 32). Management activities may include pre-commercial thinning, commercial thinning, and forest stand improvements.

Resource Protection (285 acres)**:** The upper elevation forest of KKCMA contains remnant native, intact forest with mature koa trees represented by strata K04 (Figure 8). This area is critical to native bird populations, potential T&E species habitat, and overall watershed functions. The majority of koa trees are large, mature, sprawling trees that would not be suitable for canoes, though they contain a large volume of wood. There are three FMU's in this class, totaling 285 acres (Figure 30). This area has high conservation value and management will mostly include forest protection and forest stand improvements, with limited harvesting to target specific resources. However, canoe tree harvest of desired resources will occur as needed in the area.

Figure 29 Upper areas shown as "resource protection" in Figure 31 have more intact native ecosystems and large koa trees, but many are not ideal for canoe construction. Harvesting may still occur in these areas, but will be a lower priority.

Harvest Priority Zones:

In addition to FMU's and management classes, the forest has been divided into Priority Zones according to proximity to roadways. The goal of defining Priority Zones is to concentrate the harvest impact to specific areas at different times. Priority 1 is located within 200-feet from the roads and canoe tree resources have already been identified to help facilitate initial harvest activities. Priority 2 is 400-yards from the road and Priority 3 is the interior units that are more than 400-yards from the road (Figure 31). Both canoe tree harvests and stand improvement activities are planned to begin in the Priority 1 Zone in the first 10 years of the plan, then move into Priority 2 management units, followed by Priority 3 management units. However, Priority Zones are not restrictive and harvest activities can occur outside of the given Priority Zone as needed to allow for adaptive management.

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Figure 30 Forest Management Units (FMUs) categorized by Forest Management

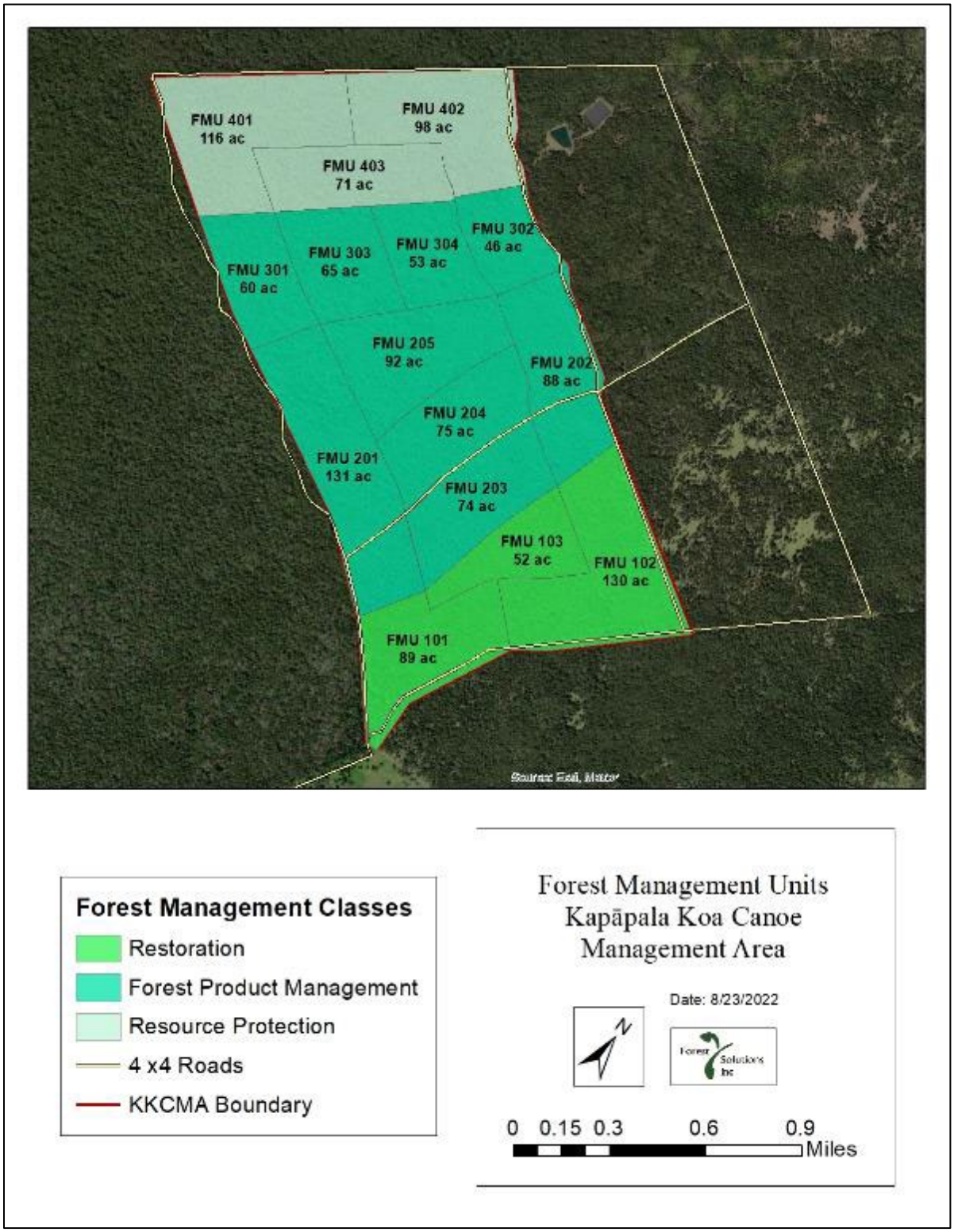


Figure 31 Priority Areas for Silviculture Activities

Note: Priority areas are broad designations showing where timber harvest, thinning operations, and general stand improvement actions are most likely to occur in the next 10-20 years. Actual operations may vary based on adapative management needs

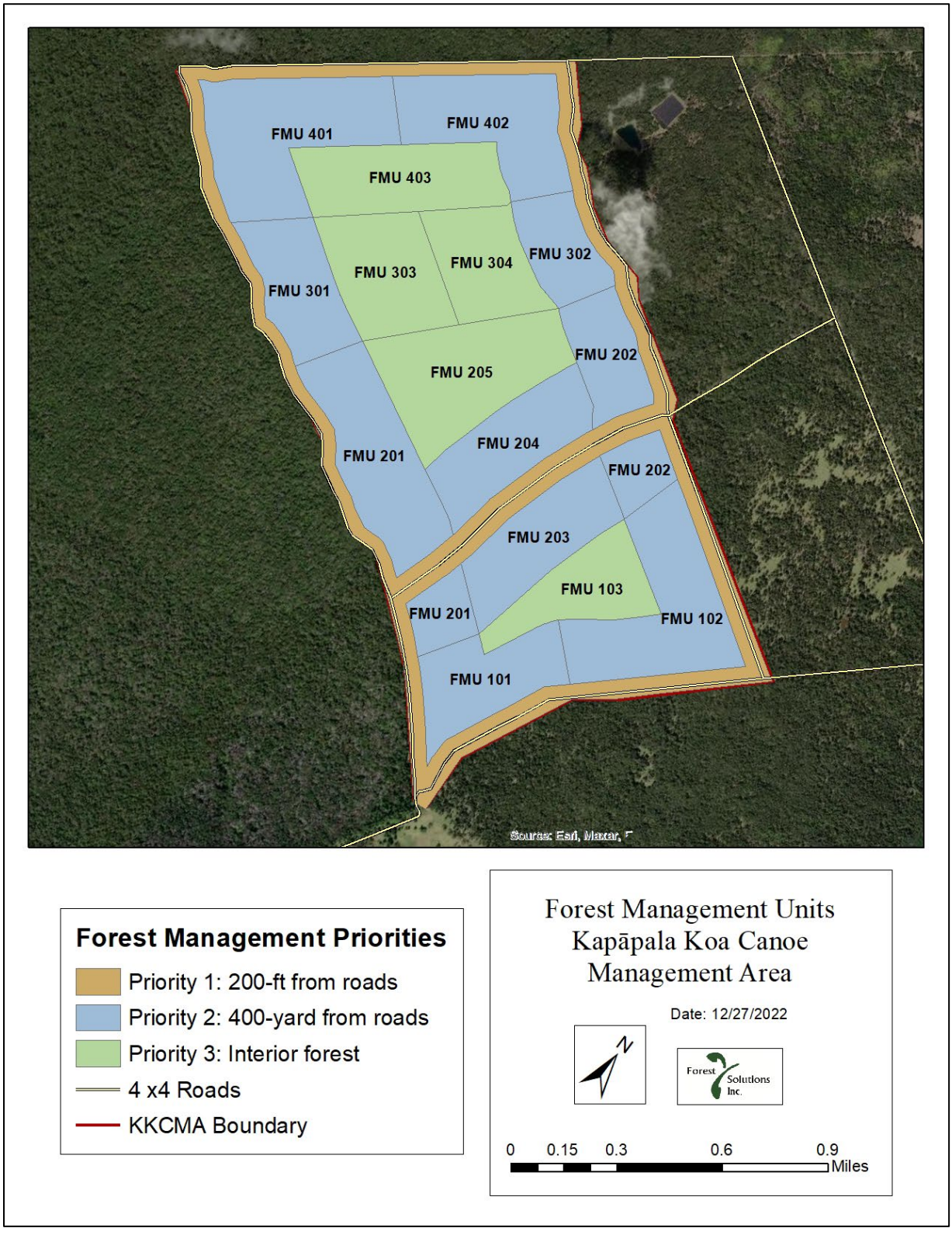


Table 12 Description of Forest Management Units (FMUs)

Management Class	Forest Type*	FMU	Acres	Estimated volume (bf)**	Koa canoe tree frequency***	Location	Potential Silviculture Actions
K01: Restoration	Open ʻŌhiʻa Forest	101	89	192,000	Low	400-yard	pre-commercial & commercial thinning, enrichment planting, weed control, harvesting
		102	130	280,800	Low	400-yard	
		103	52	113,000	Low	Interior	
K02: Forest Product Management	Open Koa-ʻŌhiʻa Forest	201	131	460,500	Medium	400-yard	pre-commercial & commercial thinning, forest stand improvements, weed control, harvesting
		202	88	361,600	Medium	400-yard	
		203	74	248,500	Medium	400-yard	
		204	75	290,300	Medium	400-yard	
		205	92	475,000	Medium	Interior	
K03: Forest Product Management	Closed Koa-ʻŌhiʻa Forest	301	60	475,300	High	400-yard	
		302	46	393,200	High	400-yard	
		303	65	566,900	High	Interior	
		304	53	463,000	High	Interior	
K04: Resource Protection	Mature Koa Forest	401	116	383,000	Medium	400-yard	forest protection, stand improvements, limited harvesting
		402	98	325,300	Medium	400-yard	
		403	71	476,200	Medium	Interior	

*see section 3.4 for in-depth description of forest composition

**volume is rounded to nearest 100 board feet (bf)

***see section 3.5 for in-depth description of koa resources

Roadside Inventory and Known Canoe Quality Trees:

During the 2020 timber inventory, all living koa trees over 20 inches and within 200-feet of the roadsides were tallied and spatially logged with GPS. The roadsides were targeted as a good starting point for canoe tree selection, as these trees are easier to access, thus they will require fewer initial resources to harvest and leave minimal impact on the forest. A total of 822 koa trees

DRAFT

were tallied (Table 13). There was a total of 64 canoe trees and 123 potential/partial canoe trees. Additionally, 193 young canoe trees and 230 young potential/partial canoe trees will likely reach canoe size in 10- 20 years. There were 212 koa trees over 20 inches that were identified as unsuitable for canoe logs (see section 3.5 for more information on canoe log descriptions). Only living trees were catalogued, although canoe builders have indicated that dead and downed trees can also be utilized.

During the 2020 timber inventory, sample plots were also taken at regular intervals in the interior of KKCMA. While not a full survey, some notes were made of canoe quality trees in the interior of KKCMA. Figure 32 shows the location of known living canoe quality trees in KKCMA. While not complete, this help identify what areas of the forest are most likely to have canoe quality trees. Note Figure 32 only shows living trees.

Table 13. Results of Canoe Trees* from 2020 100% Roadside Tally

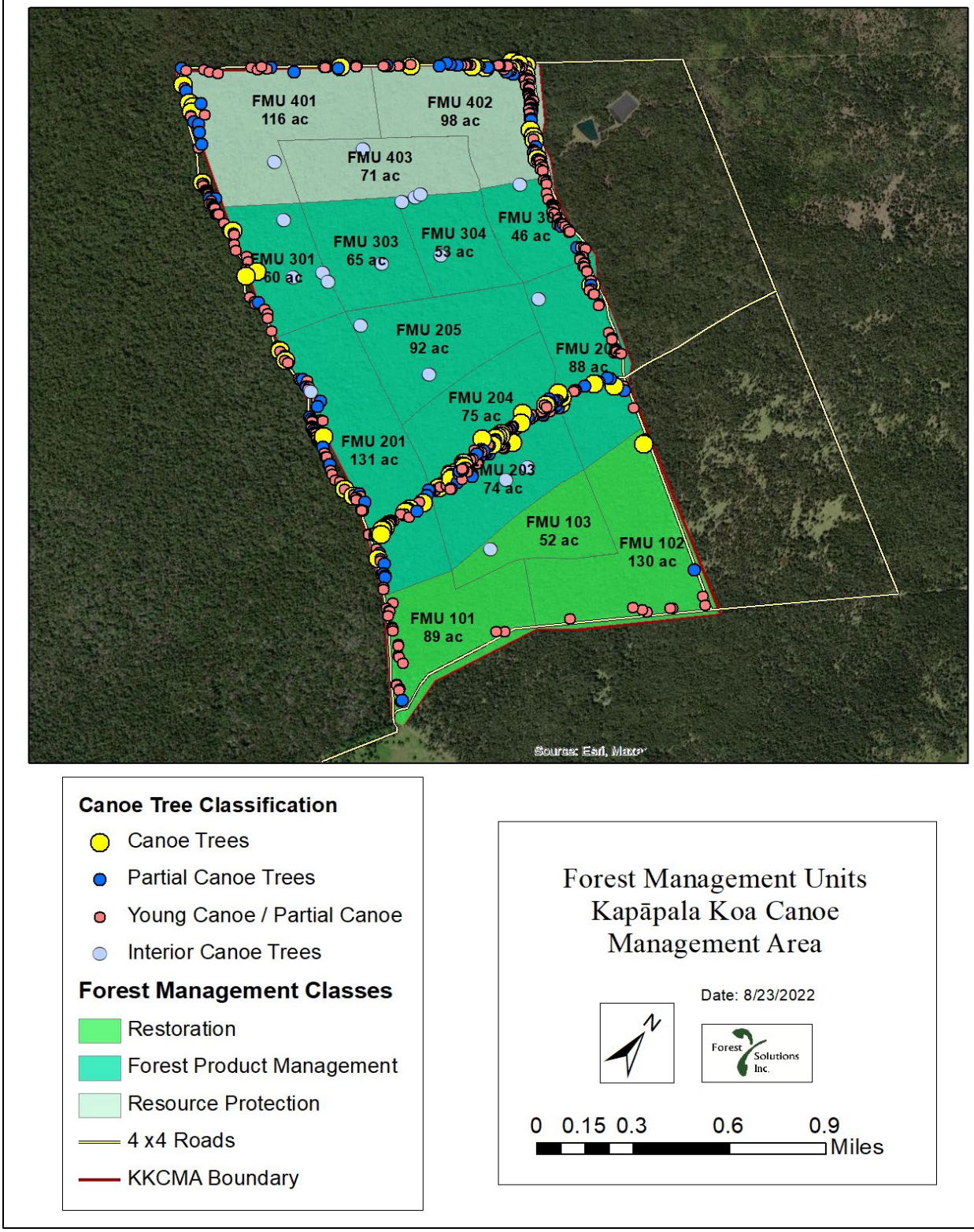
200-ft boundary by FMU	**Canoe**	**Partial Canoe**	**Young Canoe**	**Young Partial Canoe**	**Additional Koa > 20 in (non-canoe form)**
101	0	1	4	17	28
102	1	1	4	5	11
201	14	32	39	45	54
202	6	10	13	17	36
203	6	20	17	30	4
204	13	17	34	16	0
301	3	3	4	18	20
302	0	2	17	15	12
401	6	18	12	25	37
402	15	19	49	42	10
Total**	**64**	**123**	**193**	**230**	**212**

* See section 3.5 for more information on canoe tree classification. These totals do no include dead and downed trees, which can be utilized.

DRAFT

Figure 32 Location of Known Koa Canoe Quality Trees in KKCMA

Note: While not complete, this map identifies areas with the highest potential for canoe quality trees (see section 3.5 for details on canoe tree classification). All living trees within 200ft of roadways were assessed in the 2020 timber survey (Appendix E). Interior areas have not been fully surveyed, but some canoe trees were noted during plot sampling. This map only shows living trees, but dead and downed trees may also be utilized in canoe construction.



Skid Trails and Interior Access

Skid trails, also known as skid roads, are roads installed for access to conduct management activities, such as the harvest of forest products. At KKCMA, skid trails will be used to extract logs from the forest and bring them to the main access roads. The objective of these trails is to allow suitable access while minimizing damage to the forest ecosystem, and not creating a large network of permanent public access roads.

Skid trail installation will follow Best Management Practices by planning the design and location with the objective of minimizing the disruption of natural drainage and preventing excessive soil displacement. Skid trails should have a slope of three to five percent and not exceed a slope of ten percent. Skid trails on a steep slope will require occasional water bars or drainage features. The width of the trail should be one meter (3.28 ft) wider than the width of the equipment employed for log extraction (Gumus and Turk 2016). Typically at KKCMA, this results in a trail width between 12 - 16 feet.

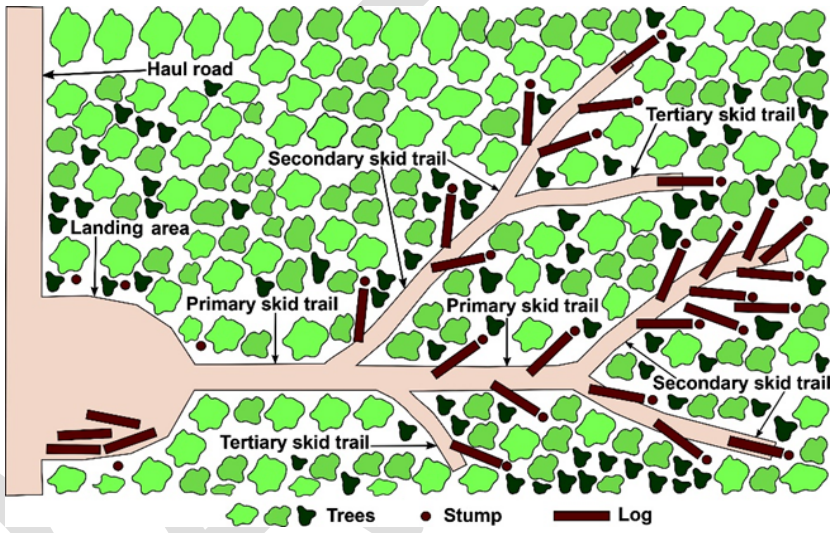


Figure 33 Example of a skid trail and timber hauling road system (DeArmond et al 2021)

It is difficult to predict the scope of land impacted by skid trails without knowing the number of trees and their locations for each harvest entry. Research on harvest access systems found skid trails impact between 1.6% to 10% of the harvest area in temperate and tropical forests (Sawyers et al. 2012, Medjibe et al. 2013, DeArmond et al. 2021). KKCMA is a small-scale, selective harvest system, therefore the skid trails will not be extensive, and the subsequent impact will be minimal. Additionally, the scarification created by skid trails will likely increase koa germination.

Post-harvest clean-up may include the retirement of skid trails that will no longer be needed. Retired skid trails are covered with slash piles (treetops, small branches) from the harvest to mulch erosion-prone areas and to discourage continued use of the trail. Lightly used skid trails can fully recover within a decade or less (DeArmond et al. 2021). If a skid trail is in an area that will require ongoing management activities (e.g. weed control, enrichment planting, thinning), the trail may be maintained and used again. It is always better to re-use existing skid trails, instead of removing mature trees to clear a new skid trail. Therefore, skid trails will always be GPS marked to maintain a record of their locations.

Figure 34 Examples of Skid Roads in Hawai‘i.
Top Row l to r: 1) newly constructed skid road 2) skid road about 5-10 years after construction 3) skid road 10+ years after construction.
Bottom row l to r: 1) a newly constructed skid road 2) a similar skid road 4 years after construction

5.3.2 Pre-Harvest Actions and Mitigation Measures

All efforts will be taken so that silviculture activities, such as skid road construction, timber harvest, and stand improvement operations, occur in such a way that the least amount of ecological damage occurs. Mitigation and avoidance of impacts to resources may include spatially and temporally avoiding sensitive and/or listed species, pre-harvest surveys of the areas, and ensuring staff are knowledge of sensitive natural and cultural resources. Further descriptions are provided below:

Native Birds: In consideration of the native bird populations, mitigation measures will be taken to minimize impacts to t&e bird species. Recent surveys (see section 3.4) indicate that most of the T&E species have been deteced at higher elevations in KKCMA. Harvest activities will be generally be lower in these areas, especially in the northwest corner where ʻakiapolaʻau and ʻalawī have been detected. Additionally, extra caution will be taken between March 1 to June 1 during the nesting and fledging season of native bird species, including ʻiʻiwi. Prior to harvest, the immediate area will be checked by DOFAW staff to survey for bird nests in or nearby trees being felled. If ʻio are found nesting, harvesting within 330 feet of that area will not proceed until the juvenile hawk has fully fledged.

Hawaiian Hoary Bat: To reduce the chances of injurying ʻopeʻapeʻa, the Hawaiian hoary bat, no tree harvest will occur between June 1 and September 15. Harvest and related forest disturbance activities will therefore be done in the period from September 16 to June 1, when it is least likely to affect native listed fauna reproduction. Prior to harvest, the immediate area will be checked for visual observations of bats that may be nesting or foraging nearby. Additionally, information on bat identification will be included in the worker training event for field personnel prior to starting harvest operations.

Native Invertebrates: Implement staff surveys for rare or T&E native insects and spiders and seek to avoid habitat and obligate host plants as part of adaptive management**.**

Rare and Endangered Plants: Prior to harvest, botanical surveys will be performed to check harvest areas and proposed skid road pathways to ensure activities will not harm sensitive or T&E resources. Currently, no T&E plant species are known in the area (see section 3.4).

Should any T&E flora species be found, they will be buffered to at least 50 ft. of their location or larger if warranted to keep the population safe and the area will be flagged. The buffer includes not felling trees into this area or creating skid roads in that area. The proper agencies will be advised of and consulted for further mitigation steps.

Historical Sites & Archeology: DOFAW will implement archeological surveys in all areas of KKCMA prior to the implementation of any timber harvest, skid road construction, or thinning operations. This may either be through one large survey of the entire parcel, or through incremental surveys. Regardless, potentially disruptive management actions such timber harvest,

DRAFT

skid road construction, and stand improvement actions will not occur in an area prior to archeological surveys of that place.

In the event any surface and/or subsurface evidence of historic properties, including cultural deposits or features, human remains, lava tubes, structural remnants or concentrations of artifacts are uncovered during any management activities, DOFAW will immediately cease activity in the area, protect the discovery from further disturbance, and contact the State Historic Preservation Division (SHPD) for further advisement. If significant historical sites are present and require mitigation, a mitigation or preservation plan will need to be developed and submitted to SHPD for review and acceptance prior to initiation of project work.

Rapid ʻŌhiʻa Death (ROD): ROD is known to occur within and near KKCMA, and mitigation measure are meant to decrease the potential spread or increase of ROD in the area. Damages to ʻōhiʻa trees can increase pathways for ROD to enter uninfected trees (see section 4.3), and silviculture actions may require the impacting some ʻōhiʻa trees during skid road construction or timber harvest. However, damages can be mitigated by implementing the following actions (CTAHR, accessed June 2022):

- Inspect and clean all vehicles, machinery, equipment, and material (including fill) prior to entering the forest. Vehicles and machinery must be sanitized using hoses to clean wheel wells, bumpers, grill, fenders, and side panels behind wheel. A pressurized hose is recommended, though a hose with spray nozzle attachment can be used.
- Sanitize boots, backpacks and equipment with 70% isopropyl or ethanol. Vehicles should be washed before and after entry into the area.
- Avoid damaging ʻōhiʻa trees by hand clearing a path for the machinery ahead of time. Place the path where valuable trees are less dense and make the path only as wide as needed to fit the machine.
- When possible, give small ʻōhiʻa a 10-ft buffer and large ʻōhiʻa a 20-ft buffer to minimize damage to roots and trunks.
- If damage occurs, fresh injuries to ʻōhiʻa can be sprayed with a pruning sealant to prevent ROD-causing fungi from landing on the wounds and causing infection. Be aware that the use of pruning sealant will not guarantee that the tree will be safe from infection.

Improved Road Access & Erosion Management: To improve access for harvest operations, road improvements and road contouring along some roadways within KKCMA (see Figure 18) are high management priorities. Also, some sections of the access road will likely need improvements to facilitate the movement of heavy machinery and forest products.

Due to the steep nature of the mauka-makai roads within KKCMA, road re-contouring will be necessary to reduce the constant need for road maintenance and to help facilitate management activities. Road contouring is a grading technique that decreases the slope of the road in areas that are severely impacted by erosion. The road is re-routed along a contour, making a small turn in the road, reducing the slope of the road. Road contouring increases the longevity of the road by mitigating erosion and improves overall water quality in the area. Road contouring will be limited to within the 200-ft road buffer and will not extend into the interior of the forest.

DRAFT

Temporary skid trails will be created as necessary to access interior forest areas during harvest operations. After harvest operations, skid trails can be closed with slash piles to prevent continued use of roads. This wil be done to decrease chances for invasive species entry and spread, decrease chances for erosion, and decrease habitat fragmentation, among other concerns.

To reduce erosion and for safety concerns, all operations will be halted during heavy rain and storm events, and may be postponed until staff deem roadways safe. Storms in KKCMA are most common during the winter and early spring.

5.3.3 Harvest Volume Restrictions & Harvest Rotations

In order to ensure sustainable harvest levels, and to maintain other goals such as watershed protection and native ecosystem protections, restrictions on the amount that will be harvested within KKCMA will be put in place. No more than 500,000 board feet, or approximately 10% of the 5.5 million board feet of koa estimated within KKCMA, will be removed from the forest within a 10-year period. The volume restriction includes all harvest and thinning operations, including harvesting of canoe trees and additional silvicultural activities.

Like many tree species, diameter growth for koa varies throughout tree and stand development. Koa growth studies have found an annual growth rate ranging between 0.24 inches/year in low quality shady sites, to 0.59 inches/year in direct sunlight (Baker et al. 2009). This is an average of 0.41 inches of growth per year, indicating that the average diameter in a 100-year-old stand of koa trees would be 41 inches. Therefore, we estimate that a typical racing canoe size log (see section 3.5), with a healthy thinning regime, is attainable at or before a koa tree becomes 100 years of age.

The harvest rotation is the planned number of years between the time a stand regenerates and its final cutting at a specific stage of maturity (Nyland 2007). The harvest rotation for a canoe tree is 100 years, meaning after a canoe tree is removed and an opening is created for a seedling to grow, that seedling will be a canoe quality tree in 100 years. If 1% of the forest area is harvested each year, then the first 1% will be ready to harvest again after 100 years. This concept is scaled up to 10% of the forest area every 10 years, to account for variability in management intensity from year to year.

Although there is variety in koa volume densities across the property, if 10% of the total volume is removed in an area, then that volume will return over the course of the lengthy 100-year rotational period. In fact, it is likely that more than the original volume will come back due to stand improvement activities and forest health management.

Expected demand and available koa timber: The protocol and guidelines required for an organization to be allocated a canoe are extensive. Further, the number of suitable organizations and canoe carvers is finite. Once all the organizations needing a canoe tree are satisfied, they will not need another one for many years. By implementing a harvest limit of 10% of the total volume over a 10-year period, the annual harvest volumes may vary depending on the needs of the organizations. It is likely that koa canoe trees will be in high demand initially, and then decrease significantly with each subsequent year. On average, a canoe tree is estimated to be

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between 3,000 bf and 5,000 bf, therefore the harvest limit is more than enough to meet the needs of all the eligible organizations and sustain harvest activities to support the management of the forest.

According to recent inventories and surveys, stand development theory, and anticipated stand improvement actions, a maximum volume of 500,000 board feet every 10 years is predicted to be a sustainable number that will not negatively impact the koa canoe resource and associated forest ecosystems. After each 10-year period, the plan shall be reviewed to ensure the harvest limit restrictions remain sustainable.

5.3.4 Canoe Tree Application Process

Organizations within the state of Hawai‘i may submit an application for the opportunity to harvest a koa tree or tree(s) from KKCMA for the purpose of creating a koa canoe for cultural and traditional uses. This includes for the purpose of creating racing canoes, voyaging canoes, or fishing canoes, among others. Details on the application, scoring and ranking system for applicants and the allocation process will be outlined in a separate submittal that will be brought before the Board of Land and Natural Resources (BLNR) for approval. However, the general application process and award of a canoe log from KKCMA will be as follows:

1) Organizations will submit an application for a canoe log from KKCMA.
    a) Organizations must be able to demonstrate their financial capacity and means of processing the log into a canoe, demonstrate they have an experienced builder available with the capacity to utilize the log, and have a harvest plan approved by DOFAW.
    b) Organizations must have a Stewardship Plan outlining forest conservation or land stewardship activities.
    c) This is a separate application than any other requests for timber from DOFAW, such as the salvage timber waiting list.
2) Applications will be reviewed by a selected group of experts that will provide recommendations to DLNR/DOFAW to make final decisions and issue a special use collection permit to allow for harvest.
    a) Applicant reviewers will consist of cultural practitioners; voyaging and racing associations, clubs, and members; wa'a (canoe) builders; forestry experts; conservationists; land managers; and community members of Ka‘ū and Hawai‘i island.
3) DOFAW will identify specific trees that are available for harvest according to the plan. The number of trees and volume of koa harvested annually will depend on the number of qualified applicants, in accordance with the 10-year harvest volume restriction of 10% of the total volume of the area.
4) The organizations that are selected will be able to select the appropriate tree for harvest, and be provided a timeline of when they are allowed to perform the harvest. The

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organizations are encouraged to collaborate with one another or in conjunction with DOFAW's other management activities to decrease costs, or independently to determine a date for the harvest.

5) All harvest operations will be conducted according to the State's Best Management Practices (Appendix F).

5.3.5 Canoe Tree Extraction Operations

The harvest operations, and costs associated with extracting canoe trees, will be the responsibility of the organization who is awarded a special use permit for canoe tree harvest. All thinning or stand improvement silviculture actions will be the responsibility of DOFAW. This allows organizations the flexibility of what protocols and methods are appropriate for their traditional and cultural use of harvesting canoe logs, and to allow for different organizations to have different processes for harvest.

Harvesting whole logs destined to become canoes requires different operational activities than harvesting short saw logs for parts or sale. The method recommended for extraction is ground-based, however alternative extraction methods may feasible (i.e. helicopters). Ground based methods use chainsaws or bulldozers to fell trees and heavy machinery to extract them. Some trees may be felled by a bulldozer pushing over the tree and slowing its descent to the earth to protect the wood. Once a tree is felled, it is extracted to a main access road where it can be loaded onto a highway truck. The extraction can potentially be damaging to the tree and should be supervised by an experienced forest manager to help preserve the condition of the log. Specialized heavy machinery may be needed to safely move these large logs without damaging them. Trees will be extracted from the forest to the road using skid trails, which are temporary routes for the machinery to remove the log. Skid trails will be surveyed and marked ahead of time, to avoid sensitive habitat, such as mature ʻōhiʻa trees. Typically, scarification of the soil by machinery on skid trails can activate koa seeds and stimulate regeneration of koa seedlings.

The labor costs associated with harvesting include hiring an experienced cutter, a ground man, and a machine operator, are the responsibility of the applicant for the canoe log. DOFAW is not responsible for harvesting and delivering the logs to the applicant. Machine rentals may include an excavator, a forwarder, and/or a bulldozer. These machines need to be transported to and from the forest, which adds additional costs to the operation. Finally, the log is transported on the highway in an oversized load transportation vehicle and may ultimately be shipped off the island to another location. The budget is estimated between $6,000 and $20,000, though it is highly variable and subject to change according to harvest operations and the destination of the log. As many organizations are not experienced foresters and timber harvesters, an existing advisory group, consisting partly of experienced foresters, as well as DOFAW staff, may be able to provide guidance and connections to capable extraction operators and best practices.

If and when possible, it will be cost-efficient and reduce impacts on infrastructure and on the forest if operations between organizations or with DOFAW can be combined or done in quick sucession with each other. All harvest and thinning operations must follow Hawaii Timber Best

Management Practices (Appendix F) and any other guidelines included in the special-use permit for canoe log extraction, and will be done to minimize impacts on the forest.

5.3.6 Thinning & Stand Improvement Operations

Thinning is a stand improvement action designed to preserve a balance of tree sizes and genetic diversity in the forest by removing smaller and less well-formed trees. By removing sub-standard quality trees, thinning promotes a superior growing stock for future growth. The result is a balanced stand containing both large and small trees, which prevents the negative impacts of high grading (only harvesting the biggest and best trees). Thinning in KKCMA will target koa trees, as they are the most common and fastest growing native tree in the area. ʻŌhiʻa and other natives will usually not be targets for thinning operations unless considered hazard trees. Thinning will favor a selection of dominant koa trees to grow into canoe quality trees quicker and at a higher frequency.

As harvesting operations occur at KKCMA, dense stands of young trees are expected to grow in the openings created by tree removal. Young koa growing in this environment experience high rates of mortality and grow very slowly. Research on koa stands ranging from 9 to 25 years found that thinning leads to substantially increased tree growth rates and tree vigor (Baker et al. 2009). Therefore, the two thinning practices that will be implemented at KKCMA are pre-commercial thinning and commercial thinning. Both practices are employed to reduce stand densities, prevent stagnation, improve tree form, and increase the growth of the remaining trees. **The goal of all thinning operations is stand improvement, not resource extraction.**

Pre-commercial thinning. This thinning method is performed prior to trees reaching merchantable size. During pre-commercial thinning, small trees are cut and typically left in the forest, allowing the remaining trees to grow quicker due to less competition (NRCS 2012). This type of thinning can be done in-house by DOFAW with mechanical or chemical methods, depending on the size of the trees being thinned. The smaller the trees, the less costly it is to perform the thinning operation. Wood from precommercial thinning may be collected and made available to woodworkers and community members through collection permits.

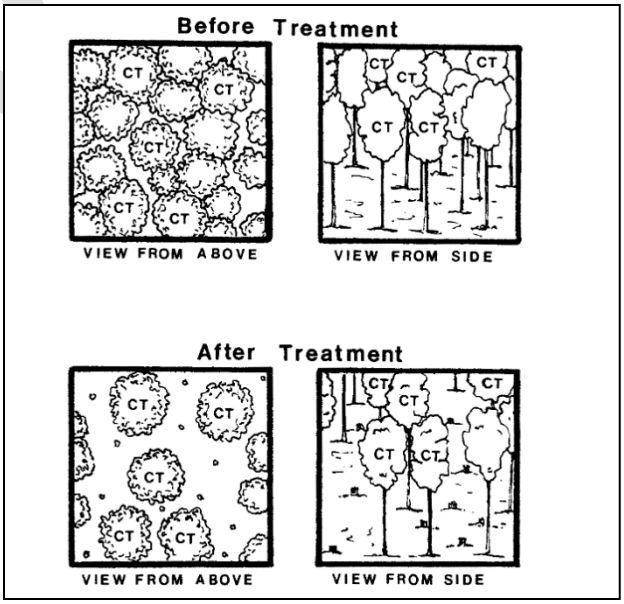

Figure 35 Aerial and side views of stand before and after releasing crop trees by crown tree release/thinning operations. (Lamson et al. 1990)

Commercial thinning. This involves removing damaged or poor form trees that are of merchantable size. Commercial thinning operations will target koa trees that are damaged or have abundant rot, to provide growing space for future koa canoe trees. Staff will also remove trees that are less dominant or of poor form. Commercially thinned trees may be sold for revenue to be used in the continued management of the forest, i.e.:

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ecosystem protection, weed management, thinning operations, inventory, and data collection. Additionally, both types of thinning could potentially provide material for canoe parts or other woodworking opportunities.

In forest management, land managers utilize species-specific stocking guides to develop a sound precommercial and commercial thinning regime. Unfortunately, a koa growth model does not exist and conclusive stocking data is not available. However, studies have examined the response of koa to thinning and found that stands thinned to lower densities of trees (80-120 trees per acre) result in much faster growth of the remaining trees, compared to stands thinned more lightly (Baker et al. 2009). Managers at KKCMA will continue to draw on the latest koa forestry research, combined with on the ground stand assessments, to develop and adapt a suitable thinning regime.

5.4 Non-Harvest Management Objectives

5.4.1 Ungulate control

The control of ungulate populations is a high priority for KKCMA. The primary threat to the recovery of forests within KKCMA is from grazing cattle (see section 4.2). The entirety of KKCMA is fenced, and currently staff believe the area is cattle free. Recently there has been evidence of a small feral herd (<5 cattle) present in the reserve, and that ingress from nearby ranching land has occurred either when gates are left open, or potentially through openings in the fence due to vandalism. Scheduled fence checks and monitoring of the area through checking game cameras are currently ongoing to ensure cattle do not return, and if any cattle are found they will quickly be removed. Another goal is to secure funding to be able to install cattle guards at access gates to prevent intrusion. For this project to succeed, the threat of cattle must be removed and actively monitored to ensure they do not come back in.

Sheep, mouflon sheep, and goats are not currently found in KKCMA, but monitoring will be done to ensure they do not enter the area. These ungulates detrimentally browse native vegetation, including koa, therefore there will be zero tolerance for sheep, mouflon, goats and cattle in the area. Damage to koa seedlings and regeneration is too costly economically, biologically, and culturally.

Pig populations are present at KKCMA, and they have the potential to grow and severely damage natural and cultural resources, especially koa trees in the area (see section 4.2). Currently, KKCMA is open to public hunting as part of hunting unit B (see section 3.9). DOFAW plans to include additional staff control of pigs to reduce populations levels within KKCMA. This may include trapping, staff hunting, and adding skirting to fence lines to protect forest resources, with the possibility of making the area 100% ungulate free depending on forest health needs and the needs to protect koa resources for canoe construction.

5.4.2 Increased koa regeneration

The 2020 timber inventory showed that natural recruitment of koa seedlings is low or non-existent throughout much of the area (see section 3.5 and Appendix B). This is likely due to recent browsing by cattle, and more intensive cattle control will likely increase seedling

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recruitment. However, other management actions that can be done to increase koa recruitment include:

Scarification: Koa seeds have a hard, protective seed coat that protect it for a few decades or more in the soil. Most of KKCMA contains mature, fruiting koa trees and therefore likely has a healthy seedbank of koa seeds in the soil. Scarification of the seed coat is needed to break dormancy for germination. Ground disturbance due to silviculture operations (see section 5.3) will scarify seeds and stimulate germination. This operation is inexpensive, effective and will be an important component of stand replacement, provided that cattle are excluded.

Enrichment planting: Insufficient koa regeneration can occur due to a limited seed bank, uneven diameter class distribution, disease or invasive species, and inadvertent cattle predation. Should regeneration fail, planting of seedlings from good seed stock will be needed. The seed source should come from within KKCMA and should be propagated using well-developed nursery techniques.

If large areas are found without regeneration, then proper forestry techniques including site preparation and competition control should be considered to ensure survival of planted seedlings. This is an unlikely outcome, such as in the recovery of a severe fire or when reforesting open grass patches.

5.4.3 Invasive plant control

At this time, invasive weed populations are minimal throughout the forest (see section 4.1). Current weed management actions, including the eradication of palm grass (*Setaria palmifolia*) and monitoring for the presence of Early Detection and Rapid Response (EDRR) target species will continue (see section 4.1 for a list of target weed species and goals). However, with increased management activities and traffic in the forest, it is likely that there may be an increase in weed populations. To mitigate the spread and introduction of invasive plants due to increased public access, informational signage and boot brushes will be installed at the forest entrance to encourage public cleaning of gear. Additionally, the ROD prevention protocol (section 5.3.2), including pressure washing vehicles, will also provide protection against weed seedlings and propagules from entering the area.

Monitoring of areas post harvest or after stand improvement actions is necessary to detect and quickly control new weed populations. A diverse monitoring regime (outlined in section 5.4.6) promotes early detection of incipient weeds, as well as long-term information on changes in understory species composition.

When needed, additional invasive weed management will be conducted to achieve the desired control of the target weed species. Manual and chemical control of habitat-modifying weed species will target incipient weeds that may be altering the native forest composition. Biological control will also be used to manage invasive species when they are available.

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5.4.4 Wildfire Management

Management for the prevention of wildfire requires that both the perimeter road and the interior crossroad are maintained as fuelbreaks. Maintenance includes clearing the road of vegetation or fallen trees. Fire activity in surrounding areas should be monitored to determine the level of risk at KKCMA. If fire risk is high, the area will be closed to the public. The existing helicopter LZ (Figure 18) will also be improved and maintained to prepare for wildfire response. Finally, water access must be identified and secured to prepare for the control of a wildfire.

5.4.5 Access and Public Use

Ongoing road maintenance and road improvements (see section 5.3.2) will facilitate safe public access of the forest. Road contouring for harvest operations will help improve access and prevent erosion in the area. Road re-grading is another common maintenance that will be implemented to remove ruts and washouts created by erosion.

Roadways can be utilized for hiking and bird watching opportunities, as well as access for hunting and forest collection. Hunting will be monitored and managed according to HAR Chapter 122 & 123. Signs and a boot cleaning station will be installed and maintained at the entrance to increase public awareness on pests and disease (i.e. ROD, invasive plants, invasive animals). DOFAW requests all hunter takes be reported to contribute to monitoring efforts. Various non-timber products can be collected in the forest with the proper collection permit (see section 3.9), and when possible non-commercial timber resources from silvicultural activities in the area will be made available to the public for wood working, focused on traditional and cultural uses. Further, DOFAW will look to collaborate with cultural and educational groups, as well as organizations harvesting canoe logs, to integrate traditional and cultural practices and collaborate on management of KKCMA when possible.

5.4.6 Forest Monitoring and Research

Forest monitoring is critical to determine the success of management activities and to facilitate adaptive management at KKCMA. DOFAW staff will conduct regular fence checks and informal monitoring during site visits to observe ungulate transgress, as well as invasive weed species. In addition to informal forest checks, regeneration plots and/or photo points near or in harvest areas, and permanent sample plots will track the long-term growth and recovery of trees in the area. Further, a full forest inventory, similar to what was conducted in 2020 (Appendix B), will be conducted roughly every 10-20 years. All monitoring activities will include forest health assessments of priority insects and diseases (Table 11).

Regeneration plots and photo points

Prior to each harvest, between one and three regeneration plots should be installed to measure baseline forest conditions. The plots will measure the abundance (count) of koa seedlings and saplings, as well as other regenerating tree species. Observations of ungulate browse within the plot will be recorded. Each plot will have a photo point associated with it, to provide photo documentation of the forest conditions. Plot re-measurements and photo point documentation should occur approximately 6 months post-harvest and then every 2-3 years after that. The regeneration plots and photo points will provide both quantitative and qualitative data tracking forest development over time.

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Permananet Sample Plots and other research opportunities

DOFAW, either internally or through collaborations with outside groups, will establish monitoring to track growth and health of timber resources, likely through permanent sample plots. Permanent Sample Plots (PSPs) are fixed plots designed to measure koa growth and yield. All trees in the plots are marked and measured repeatedly to track growth. Data generated from this type of monitoring can help contribute to the general understanding of koa stand dynamics, aiding in management decisions regarding diameter class thinning or other silviculture prescriptions. This forest provides an excellent opportunity for the research community to collect continuous data to create various predictive biometric equations for use in koa forest management.

Additionally, DOFAW will continue to collaborate with Hawai‘i Agriculture Research Center (HARC) on koa research by maintaining the existing seed orchard and research plot within KKCMA (see section 3.5).

Inventory of koa resources

A complete inventory of the forest, documenting all trees that meet the criteria for a canoe log currently and trees that will meet the criteria in the near future, is vital to determine how many canoe logs are in the forest. This inventory will focus on koa resources, to understand how management activities have impacted the forest. Data gathered from this management inventory will provide information on stocking, basal area, diameter, heights, form, and health. This inventory is the most infrequent of all monitoring work, estimated to be conducted every 10-20 years, and will be similar to the inventory conducted in 2020 (Appendix B).

Biodiversity and forest health monitoring

Regular monitoring supports the early detection of pests and disease. DOFAW will collaborate with partners to secure essential technical information and understanding of new threats. Forest health monitoring will include checking for evidence of ROD within KKCMA to determine if the distribution is increasing over time. For the protection of T&E bird species, DOFAW will continue to collaborate with the Three Mountain Alliance in annual forest bird monitoring.

Bird Surveys

DOFAW will continue to collaborate with TMA to implement annual bird surveys at KKCMA. This data has been crucial to develop spatial representation of native birds and T&E species in the reserve and track the impacts of climate change on increasing distribution of avian malaria.

Insect Surveys

DOFAW plans to implement invertebrate surveys at KKCMA in the near future. These surveys will be done by DOFAW staff, mainly focusing on insects and spiders and not cover all invertebrates. Surveys will focus on T&E and rare insect species such as the endangered picture wing fly *Drosophila heteroneura* and other rare species like endemic species of pinapinao (*Megalagrion* sp.).

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5.5 Management Actions & Costs

Table 14 Management Goals for KKCMA

Priority #1: Watershed Values

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Reduce impacts of ungulates on watershed resources	Cattle control & removal	Maintain fences surrounding KKCMA through regular fence checks and repairs	$15k/year, staff & mgmt. costs
		Replace fence with bull wire as needed (10+ years)	$1M
		Continued monitoring of cattle populations & removal as needed	Staff & mgmt. costs only
		Implement Cattle guards at 3 gates entering property ($20K per cattle guard)	$60K
		Check game cameras to ensure cattle remain absent from the area	Staff & mgmt. costs only
	Mouflon sheep monitoring	Continue to monitor (game cameras, staff observations) for presence of mouflon within the area (currently none are believed to be present)	Staff & mgmt. costs only
	Monitor & manage pig populations	Promote & track public hunting of pigs within the area	Staff & mgmt. costs only
		Increase staff control of pigs in the area through trapping and/or staff hunts	Staff & mgmt. costs only
		Install fence skirting along existing fencelines	~$800K

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Minimize Erosion	Monitor and manage access road conditions	Implement road contouring in steep areas of mauka/makai roads prone to erosion	$20K
		Conduct road maintenance (gravel fill potholes) as needed	$TBD/year + staff costs
	Minimize erosional impacts from harvest operations	Ensure all harvest operations follow harvest best management practices (Appendix F)	Staff & mgmt. costs only
		Suspend all harvest operations during storms or heavy rain events	Staff & mgmt. costs only
Collaboration	Maintain DOFAW's partner role in the Three Mountain Alliance (TMA) Watershed Partnership	Establish regular communications, schedules, and protocols with WP	Staff & mgmt. costs only
		Participate in WP meetings.	Staff & mgmt. costs only
Climate change adaptation	Monitor latest information on climate change, vulnerability, modelling, and adaptation.	Participate in climate change seminars, meetings, and workshops	Staff & mgmt. costs only
	Track changes to forest composition over time	Utilize monitoring to determine if forest plant composition changes over time. Adapt management actions as needed to account for new environment as needed	Staff & mgmt. costs only

Priority #2: Cultural Use Timber Harvesting

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Increase DOFAW capacity to manage KKCMA	Increase funding and resources for KKCMA	Request funding for a dedicated forester position to guide the management, community collaboration, planning, and implementation of projects at KKCMA	~$74-90K/year
		Pursue state and federal funding sources to implement short and near term management goals	Staff & mgmt costs
Oversee & guide koa canoe tree harvest	Facilitate canoe tree distribution	DLNR will manage and award koa canoe tree allocation, in collaboration with recommendations from community, cultural, user group, and natural resource experts	Staff & mgmt. costs only
		Provide oversight prior to and during the applicant koa tree harvest	Staff & mgmt. costs only
		Work with canoe log recipients to ensure they implement work plans aimed at conserving and/or giving back to KKCMA or other forest areas within the state	Staff & mgmt costs only
		Encourage and collaborate with applicants on culturally appropriate harvest operations and protocols	Staff & mgmt costs only
		Ensure all permits require compliance with DOT regulations of transporting oversize or overweight vehicles.	Staff & mgmt costs only

General Management Actions	Tactical Goals	Action Items	Estimated Cost
		Ensure transportation crews coordinate with DOT through oversize load permit process to determine scheduling	Staff & mgmt costs only
Manage koa resources for sustainable long term supply of canoe logs	Ensure sustainable harvest levels for long term use	Track harvest levels annually and evaluate harvest goals and operations every 10 years	TBD, Staff & mgmt costs
		Implement forest monitoring as described in Resource Protection below	TBD
	Promote koa regeneration	Conduct mechanical scarification in select areas to increase koa seedling recruitment	Staff & mgmt. costs only
		Implement enrichment planting as needed	TBD, based on acreage
	Conduct silvicultural activities to improve koa canoe log availability	Develop thinning plan with desired stocking densities prior to implementation	Staff & mgmt. costs only
		Conduct thinning in specified management units according to a designated timeline	TBD Staff & mgmt. costs only
	Integrate traditional Hawaiian knowledge in silviculture operations	Implement traditional Hawaiian practices in the monitoring, selection of canoe trees, and management of KKCMA	Staff & mgmt. costs only

Priority #3: Resource Protection

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Manage incipient and established invasive species	Invasive species monitoring and control	Prevent the establishment of new invasive weed species within KKCMA, especially those outlined in Table 8 of this plan	TBD
		Use photo point monitoring (as well as regeneration and timber inventory data) to track invasive species levels over time	Staff & mgmt. costs only
		Implement manual, chemical, mechanical, and/or biological control as needed	Manual - $625/ac, chemical- $350/ac, and mechanical- $180/ac
		Require cleaning of harvest machinery per Best Management Practices (Appendix F)	Staff & mgmt. Costs only
		Encourage public cleaning of gear via informational signage and boot brushes at forest entrance	Staff & mgmt. costs only
Manage ungulate populations	Control all ungulate populations at levels consistent with forest protection needs	Regular checks for animal ingress	Staff & mgmt. costs only
		Install motion sensor game cameras at known locations of cattle ingress	$2,000
		Staff control of ungulates according to observations by staff, hunting data, and regeneration data	Staff & mgmt. costs only

General Management Actions	Tactical Goals	Action Items	Estimated Cost
		Install cattle guards at gates	$60K
Forest health protection from insects and diseases	Protection of koa trees from insects and diseases	Include monitoring for koa insects and diseases, especially those outlined in Table 10 of this plan, in all monitoring activities, including timber inventory	Staff & mgmt. costs only
	Early detection of pests and disease	Assist and collaborate with partners to secure essential technical information and understanding of new threats	Staff & mgmt. costs only
	Rapid ʻŌhiʻa Death	Include ROD sanitation and prevention procedures for all collection permits issued for KKCMA	Staff & mgmt. costs only
		Minimize impacts and wounds to ʻōhiʻa trees during harvest operations	Staff & mgmt. costs only
		Look for signs of increased ROD distribution within KKCMA	Staff & mgmt. costs only
	Monitor avian malaria	Utilize forest bird surveys to monitor distribution of avian malaria in the area	Staff & mgmt. costs only
	Increase public information and awareness on pests and disease	Sign installation and replacement as needed	$2K/year + staff costs
Wildfire management and prevention	Wildfire prevention	Maintain roadways to act as fuelbreaks	Staff & mgmt. costs only

General Management Actions	Tactical Goals	Action Items	Estimated Cost
		Monitor fire activity in surrounding areas to determine activity increases in elevation or in surrounding areas	Staff & mgmt. costs only
	Wildfire response	Improve and maintain helicopter lz for access to the area	Staff & mgmt. costs only
		Ensure access to water in case of fire response in the area	Staff & mgmt. costs only
Forest monitoring and research	Forest monitoring	Conduct regular fences checks, and informal staff monitoring of presence of invasive species through regular operations	Staff & mgmt. costs only
		Conduct photo point plots to measure regeneration and identify evidence of ungulates	Staff & mgmt. costs only
		Implement growth monitoring, likely through permanent sample plots (PSPs)	TBD
		Conduct full timber inventory (roughly every 10-20 years)	$30K
	Collaborate with Hawaii Agriculture Research Center (HARC) on koa research	Utilize seed orchard/research plot for timber or growth experiments	TBD
		Management and maintenance of fenceline around research plot	TBD
		Collect wilt resistant seeds from current orchard trees	TBD
		Collaborate with HARC on establishing alternative koa orchard seedlings on Hawai‘i island	Staff & mgmt costs only

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Cultural resource protection	Protect Historic Sites found within KKCMA	At a minimum, an archaeological survey will be undertaken once a potential harvest area is defined and before any harvesting activities are carried out.	TBD
	Include native Hawaiian knowledge within management plans and actions	Seek as a part of management to utilize names of traditional places, Hawaiian environmental zones (wao) and associated individuals such as former konohiki	Staff & mgmt costs only
	Formalize and utilize existing working group	Continue to utilize the existing working group to guide appropriate cultural protocols and advise on planned activities.	Staff & mgmt costs only
		Utilize working group to advise on the canoe log allocation process	Staff & mgmt costs only
		Continue to maintain the working group consisting of kālaiwa‘a, kūpuna and kama‘āina of Kapāpala and Ka‘ū, canoe clubs, forestry experts, and other stakeholders	Staff & mgmt costs only
	Develop culturally integrated educational and stewardship opportunities	Require hālau (organizations) requesting a canoe log to implement stewardship, educational, and/or outreach efforts as a form of reciprocation as part of receiving permits to harvest a canoe log	Staff & mgmt costs only
		Collaborate with Ka‘ū and Hawai‘i island community groups and organizations on educational and stewardship opportunities at KKCMA	Staff & mgmt costs only

Priority #4: Native Ecosystems

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Maintain intact native forest habitats	Protection of upper elevation and interior forests	Interior and upper elevation areas prioritized as resource protection areas where silviculture operations will not occur	Staff & mgmt costs only
	Ensure regeneration of koa and other native trees post harvest operations	Based on monitoring data, utilize scarification or enrichment planting to ensure native seedlings regenerate in harvest areas	TBD
	Utilize monitoring to track native ecosystems over time	Photo point data, regneration, and timber inventories will use to track status of native ecosystems overtime, and guide protection measures or adjustments to harvest operations	Staff & mgmt costs only
Climate change adaptation	Anticipate and facilitate habitat migration	Monitor abundance of native and invasive species as temperature rises and precipitation changes	Staff & mgmt costs only
	Prepare for increased possibility of insects and diseases	Integrate monitoring for insects and diseases (esp. those in Table 10) in monitoring and surveys	Staff & mgmt costs only
Minimize invasive species impacts on native ecosystems	Ungulate control	see Resource Protection goals for invasive plants, cattle, mouflon, and pigs	Staff & mgmt. costs only
	Invasive weed control		

Priority #5: Threatened & Endangered Species

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Protection and recovery of listed rare plants and animals	Protection of T&E bird species	DOFAW to implement pre-harvest surveys for T&E birds in any areas prior to harvest	Staff & mgmt. costs only
		Prioritize mid-elevation areas for majority of harvest operations	Staff & mgmt. costs only
		Continue annual forest bird monitoring in collaboration with Three Mountain Alliance	TBD
		If hawks are found nesting, no harvest operations will occur within 330 feet until the juvenile hawk has fully fledged	Staff & mgmt costs only
	Protection of the Hawaiian hoary bat	Maintain diversity in forest cover to protect bat habitat and food sources	Staff & mgmt. costs only
		Temporal avoidance of harvest operations to avoid bat pupping season (June 1-Sept 15)	Staff & mgmt. costs only
	Protection of rare plant species (none currently known within parcel)	Implement DOFAW staff monitoring for T&E plant species in all areas planned for timber harvest prior to any timber operations	Staff & mgmt. costs only
	Protection of T&E insect species	Implement DOFAW staff surveys of insects in the area. Utilize surveys to avoid damages to listed T&E species	Staff & mgmt. Costs only

Priority #6: Access, Trails, Hunting, & Other Public Uses

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Promote public hunting through Chapter 122 & 123	Regulate hunting as per HAR Chapter 122 & 123	Monitor and manage hunting activities	Staff & mgmt. costs only
		Ask hunters to report their daily take to contribute to monitoring efforts	Staff & mgmt. costs only
Maintain a variety of public uses	Encourage sustainable collecting of plants by the public	Require the use of collection permits for maile collection	Staff & mgmt. costs only
		Issue collection permits for other non-timber forest products	Staff & mgmt. costs only
		Collaborate with DOCARE to enforce over-harvesting or illegal collections within KKCMA	Staff & mgmt. costs only
	Facilitate public use of the forest for cultural, educational, and stewardship activities	Collaborate with organizations harvesting canoe logs to implement conservation and restoration efforts	Staff & mgmt. costs only
		Collaborate with cultural and educational groups	Staff & mgmt. costs only
	Utilize non-commercial timber resources from stand improving silviculture activities	Supply pre-commercial thinning timber to small wood workers and cultural practitioners through collection or harvest permits	Staff & mgmt. costs only
	Maintain hiking and bird watching opportunities	Utilize roadways as hiking and bird watching opportunities	Staff & mgmt. costs only
Maintain public access	Maintain roadways within parcel	Road maintenance and improvements as needed	Staff & mgmt. costs only

General Management Actions	Tactical Goals	Action Items	Estimated Cost
	Secure access agreement to the reserve	Solidify public access agreement through Honanui road	Staff & mgmt. costs only

Priority #7: Commercial Activity

General Management Actions	Tactical Goals	Action Items	Estimated Cost
Commercial thinning operations	Utilize commercially viable timber from thinning operations	Generate revenue from small scale commercial thinning operations through the sale of harvested koa. Revenue would be used to fund management at KKCMA	TBD

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5.6 Measures of Success

Measures of success for individual reserve management plans can be derived from the State of Hawai‘i annual variance reports. Initial measures of success that may be applicable to KKCMA include:

- Number of koa canoe tree permits allocated
- Number of non-timber forest product collection permits allocated
- Percent increase of koa population rates
- Percent reduction of ungulates present in the forest
- Number of invasive animals removed
- Acres of invasive plants controlled
- Miles of fence maintained
- Number of T&E plants/animals protected
- Acres of forests without new invasive species established
- Acres of native ecosystem that remain intact
- Number of stewardship projects implemented
- Number of cultural and educational group visits/ events
- Number of regeneration plots and photo points installed and remeasured
- Number of biological surveys and/or research studies conducted

5.7 Future Recommendations

Additional suggestions for management activities include:

- Conduct further surveys of other biological resources
- Continue to monitor harvest levels to ensure they remain sustainable for long term use
- Utilize regeneration plot results to help inform adaptive silvicultural management
- Collect seeds for establishing seed orchards
- Continued collaboration with Working Group
- Plan for harvests of more interior areas where appropriate.
- Collaborate with educational, cultural, and conservation groups at KKCMA when possible.

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7. APPENDICES

Appendix A: Cultural Impact Assessment for the Kapāpala Koa Canoe Management Area

Appendix B: 2020 Kapāpala Koa Canoe Forest Inventory

Appendix C: Kapāpala Koa Canoe Management Area Working Plant List

Appendix D: Kapāpala Koa Canoe Management Area Forest Bird Surveys 2021

Appendix E: DOFAW Management Guideline Classification Definitions

Appendix F: Best Management Practices for Maintaining Water Quality in Hawaii

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Appendix A: Cultural Impact Assessment (CIA) for the Kapāpala Koa Canoe Management Area

Due to the length of the Cultural Impact Assessment, the entire document has been made available online at the address below:

https://dlnr.hawaii.gov/forestry/files/2023/03/CIA_Kapapala-Canoe-Forest-3.14.2023_final.pdf

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Appendix B: Kapāpala Koa Canoe Management Area Forest Inventory 2020

Due to the length of this appendix, the entire document has been made available online at the address below:

https://dlnr.hawaii.gov/forestry/files/2023/01/Kapapala-Koa-Canoe-Management-Area-Inventory-2020.pdf

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Appendix C: Kapāpala Koa Canoe Management Area Working Plant List

Kapapala Koa Canoe Area Roadside Survey
March 10, 2021
Conducted by L. Perry and J. VanDeMark
This was a roadside survey to compile a plant species list. All roads (approximately seven miles) in the Kapapala Koa Canoe Area were traversed and plant species recorded within 200 feet of the roadways. No endangered species were observed along these roadways but there was a rare species (*Rubus macraei*) observed adjacent to the western boundary of the Koa Canoe Area within an old Vicia enclosure. It will be important to look for this species during future surveys when any koa felling is to occur. DOFAW recommends that prior to any tree felling a comprehensive floristic and entomological survey be conducted in the immediate vicinity of each tree that is extracted from this area and along any pathways that are utilized to extract such trees to minimize damage to native species. Another recommendation is to prioritize the lowest areas in terms of elevation for tree extraction first as these areas are more degraded by introduced species and less damage will be done to native species and the habitat by concentrating extraction activities in the lower half of the Koa Canoe Area. The forest steadily improves in terms of quality the higher in elevation one travels.

Native species observed:
Tree and Shrub species:
Acacia koa (koa)
Metrosideros polymorpha (ohi'a)
Cheirodendron trigynum ('olapa)
Ilex anomala (kawa'u)
Melicope volcanica (alani)
Myoporum sandwicensis (naio)
Myrsine lessertiana (kolea)
Psychotria hawaiiensis (kopiko)
Brousaissia arguta (kanawao)
Coprosma ernodeiodes (kukaenene)
Coprosma rhynchocarpa (pilo)
Vaccinium reticulatum (ohelo)
Vaccinium calycinum (ohelo)
Dodonaea viscosa (a'ali'i)
Lythrum maritimum (pukamole)
Pipturus albidus (mamaki)
Rubus hawaiiensis (`akala)
Rubus macraei (rare species of Rubus that was observed in old Vicia enclosure just outside of Koa Canoe area)
Styphelia tamieamieae (pukiawe)
Vines, Herbaceous and Grass Species:
Astelia menziesiana (pa'iniu)

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Alyxia stellata (maile)
Carex alligata
Deschampsia nubigena
Stenogyne calaminthoides
Smilax melastomifolia (hoi kuahiwi)
Fern Species:
Amauropelta globulifera (palapalai a Kamapua`a)
Asplenium lobulatum (pi`ipi`I lau manamana)
Asplenium contiguum
Athyrium microphyllum (`akolea)
Cibotium glaucum (hapu'u pulu)
Cibotium menziesii (hapu'u 'I'i)
Cyclosorus interruptus (neke)
Dicranopteris linearis (uluhe)
Diplazium sandwichianum (ho`i`o)
Dryopteris hawaiiensis
Dryopteris wallichiana (`i`o nui)
Marattia douglasii (pala)
Microlepia strigosa (palapalai)
Nephrolepis cordifolia (sword fern)
Pneumatopteris sandwicensis (ho`i`o kula)
Pseudophegopteris keraudriana (waimakanui)
Pteris cretica (`oali)
Pteris excelsa (`iwa)
Sadleria souleytiana (`ama`u)
Sadleria cyatheoides (`ama`u)
Sphenomeris chinensis (pala`a)

Non-native species observed:
Grass Species:
Andropogon virginicus (broomsedge)
Anthoxanthum odoratum (sweet vernalgrass)
Ehrharta stipoides (meadow rice grass)
Holcus lanatus (Yorkshire fog, velvet grass)
Paspalum vaginatum (seashore paspalum)
Pennisetum clandestinum (kikuyu grass)
Schizachryium condensatum (bushy beard grass)
Tree, Shrub and Herb Species:
Anemone huphensis (Japanese anemone)
Arundina grandifolia (bamboo orchid)
Crocosmia x *crocosmiiflora*
Desmodium intortum
Erechtites valerianifolia
Fragaria vesca (European strawberry)
Grevillea robusta (silk oak)
Ipomoea sp.

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Juncus effusus (Japanese mat rush)
Morella faya (faya tree)
Musa sp. (banana)
Physalis peruviana (poha)
Plantago major (plantain)
Pluchea symphitifolia (sourbush)
Psidium cattleianum (waiwi)
Pyracantha angustifolia (firethorn)
Rubus argutus (blackberry)
Senna pendula
Tibouchina herbacea (glorybush)

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Appendix D: Kapāpala Koa Canoe Management Area Forest Bird Surveys 2021

Three Mountain Alliance Forest Bird Surveys at the Kapāpala Koa Canoe Forest Summary of Detections in 2021

March 2021

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The TMA forest bird surveys at Kapāpala Koa Canoe Forest took place February 8 & 20, 2021. Survey efforts were led by Colleen Cole, TMA Coordinator; assistance was provided DOFAW staff.

Table 1. Participants, 2021 Kapāpala Koa Canoe Forest Bird Surveys

Name	**Affiliation**	**Counter type**
Colleen Cole	TMA	Primary
Ian Cole	DOFAW East Hawai‘i Wildlife	Primary
Bret Mossman	DOFAW NARS	Primary
Alex Wang	DOFAW NARS	Primary
Naomi Himley	KUPU/DOFAW NARS	Secondary

Observers used the variable circular plot method (VCP). At each station species, distance and detection method (audible and/or visual) were recorded for each individual bird detected during an 8-minute interval. For rare birds, detection before or after the count period and detections between stations were also recorded. Data were entered into a MS Access database using the Avian Monitoring Entry Form. Entered and proofed data were passed on to USGS for inclusion in Hawai‘i Forest Bird Database and possible future analysis of population trends. This report provides a short summary of the detections.

A total of 65 stations along four transects were surveyed in the Kapāpapla Koa Canoe Forest (Figure1). The counters detected seven introduced species, and six endemic species including one threatened species (‘I‘iwi). All species detections are presented in Table 2 and illustrated in Figures 2-10.

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Table 2. Species detected during the 2021 Kapāpala Koa Canoe Forest bird surveys, with comparison of bps values for three prior years.

Alpha Code	Common Name	Scientific Name	Origin†	Status* Fed/State	2021 # Stations Occupied**	2021 # Detected	2021 Percent Occurrence	2021 Birds per Station	2020 Birds per Station	2019 Birds per Station	2018 Birds per Station
AKIP	ʻAkiapolaʻau	*Hemiganthus wilsoni*	End	E/E	0	0	-	-	-	0.02	-
APAP	ʻApapane	*Himatione sanguinea*	End		65	827	100%	12.72	13.49	10.05	11.66
HAAM	Hawaiʻi ʻAmakihi	*Chlorodepanis virens*	End		64	295	95.4%	4.54	4.60	4.20	3.91
HAEL	Hawaiʻi ʻElepaio	*Chasiempis sandwichensis*	End		17	23	26.15%	0.35	0.38	0.85	0.48
HCRE	Hawaiʻi Creeper/ʻAlawī	*Loxops mana*	End	E/E	0	0	-	-	-	0.02	0.05
HOFI	House Finch	*Carpodacus mexicanus*	Int		1	1	1.54%	0.02	-	-	-
HWAH	ʻIo, Hawaiian Hawk	*Buteo solitarius*	End	-/E	1	1	1.54%	0.02	0.08	0.08	0.03
IIWI	ʻIʻiwi	*Drepanis coccinea*	End	T/-^	16	19	24.62%	0.29	0.65	0.93	0.58
JABW	Japanese Bush-Warbler	*Cettia diphone*	Int		9	10	13.85%	0.15	0.23	0.41	0.35
JAWE	Japanese White-eye	*Zosterops japonicus*	Int		60	131	92.31%	2.02	1.78	2.34	2.18
KAPH	Kalij Pheasant	*Lophura leucomelanos*	Int		2	2	3.08%	0.03	0.02	-	0.03
NOCA	Northern Cardinal	*Cardinalis cardinalis*	Int		5	8	7.69%	0.12	0.08	0.10	0.09
OMAO	ʻŌmaʻo	*Myadestes obscurus*	End		61	180	93.85%	2.77	1.34	2.08	2.65
RBLE	Red-billed Leiothrix	*Leiothrix lutea*	Int		25	40	38.46%	0.62	0.09	0.41	0.40
YFCA	Yellow-fronted Canary	*Serinus mozambicus*	Int		5	6	7.69%	0.09	0.06	0.07	0.06

†End = endemic, Int = introduced, Ind = Indigenous; * E = endangered; T = threatened; ^State status here refers to Hawaiʻi Island only.

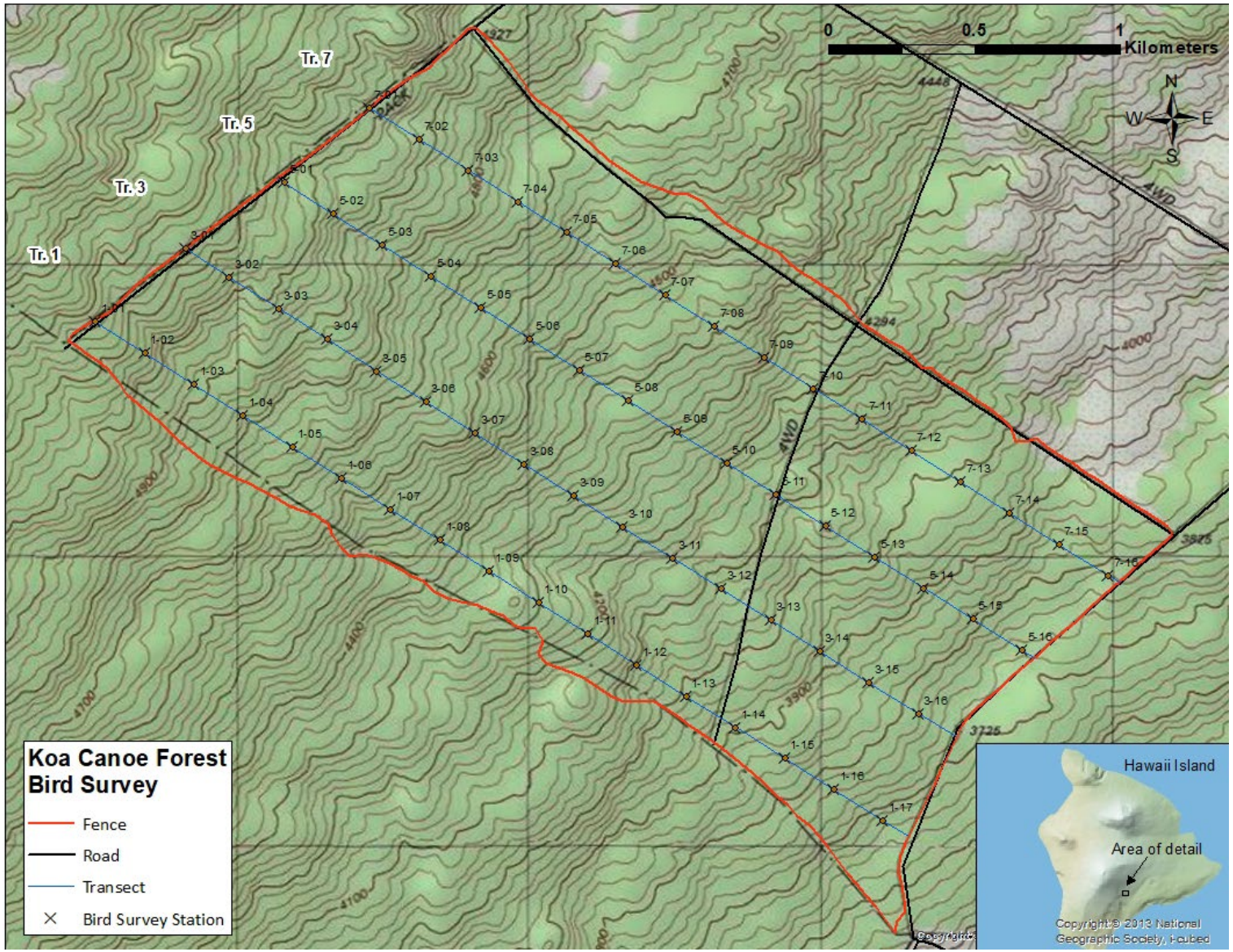

Figure 1. Transects and stations surveyed during the 2021 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

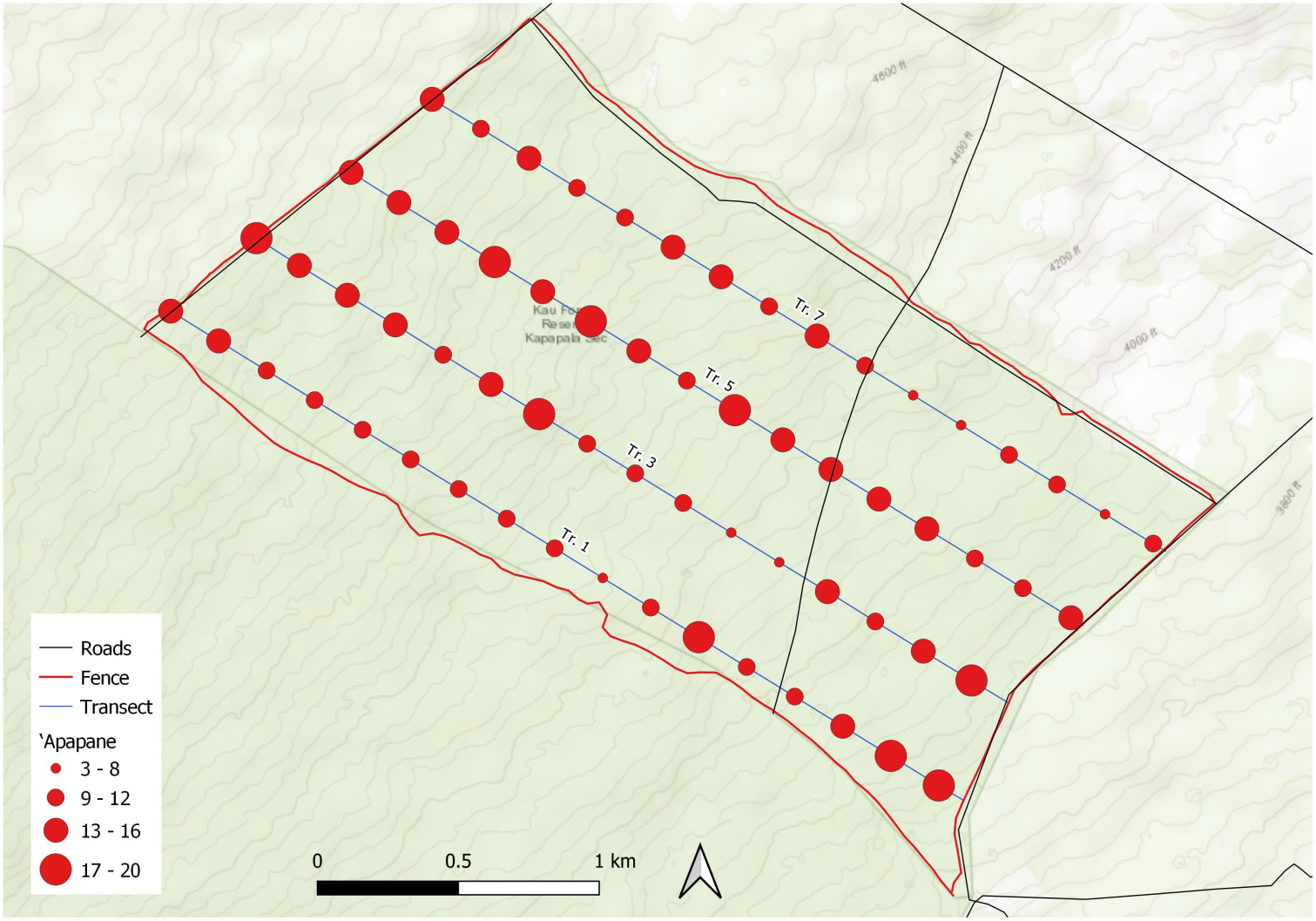

Figure 2. Detections of ʻApapane (*Himatione sanguinea*) during the 2021 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

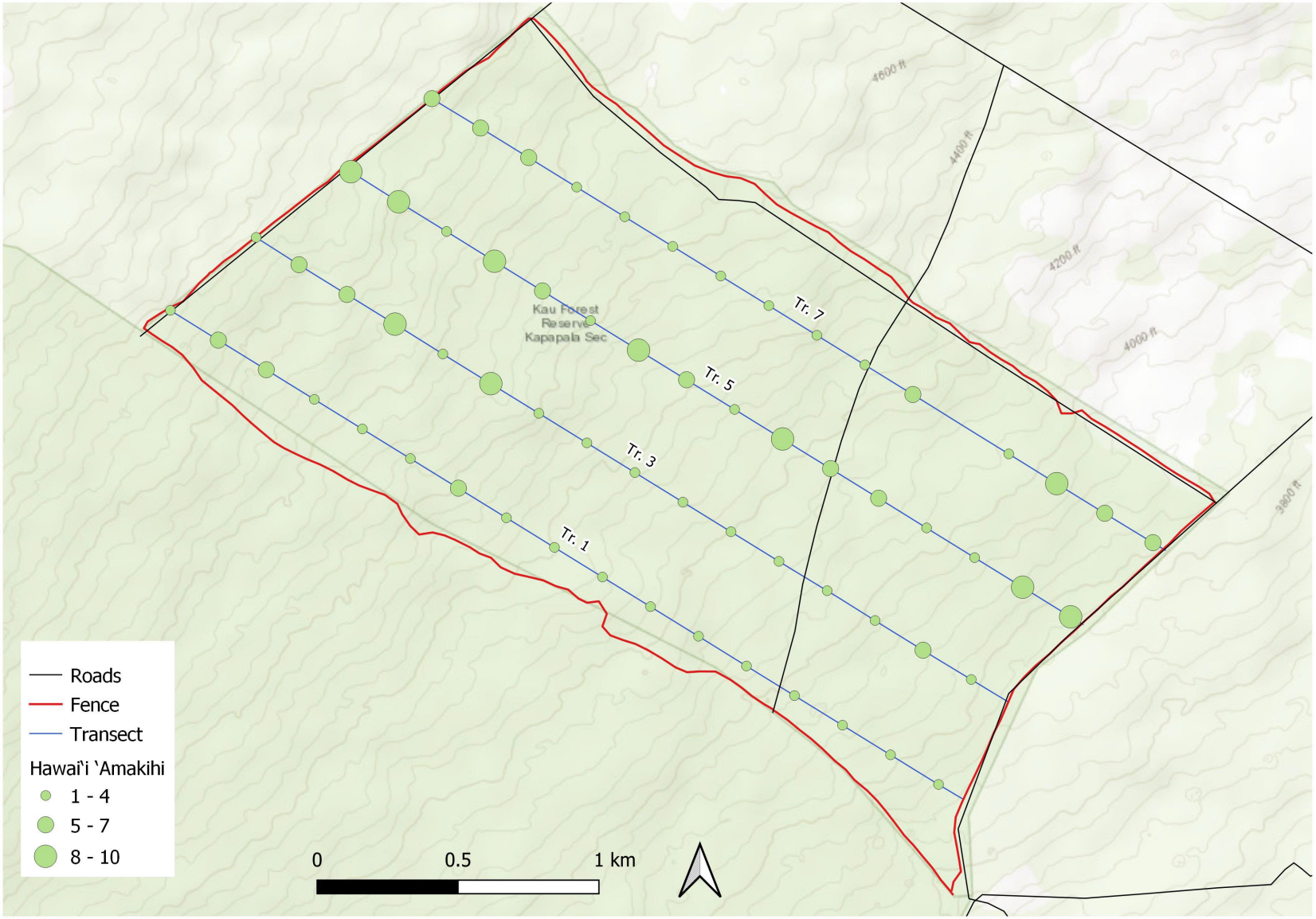

Figure 3. Detections of Hawai'i 'Amakihi (*Chlorodepanis virens*) during the 2021 TMA forest bird surveys

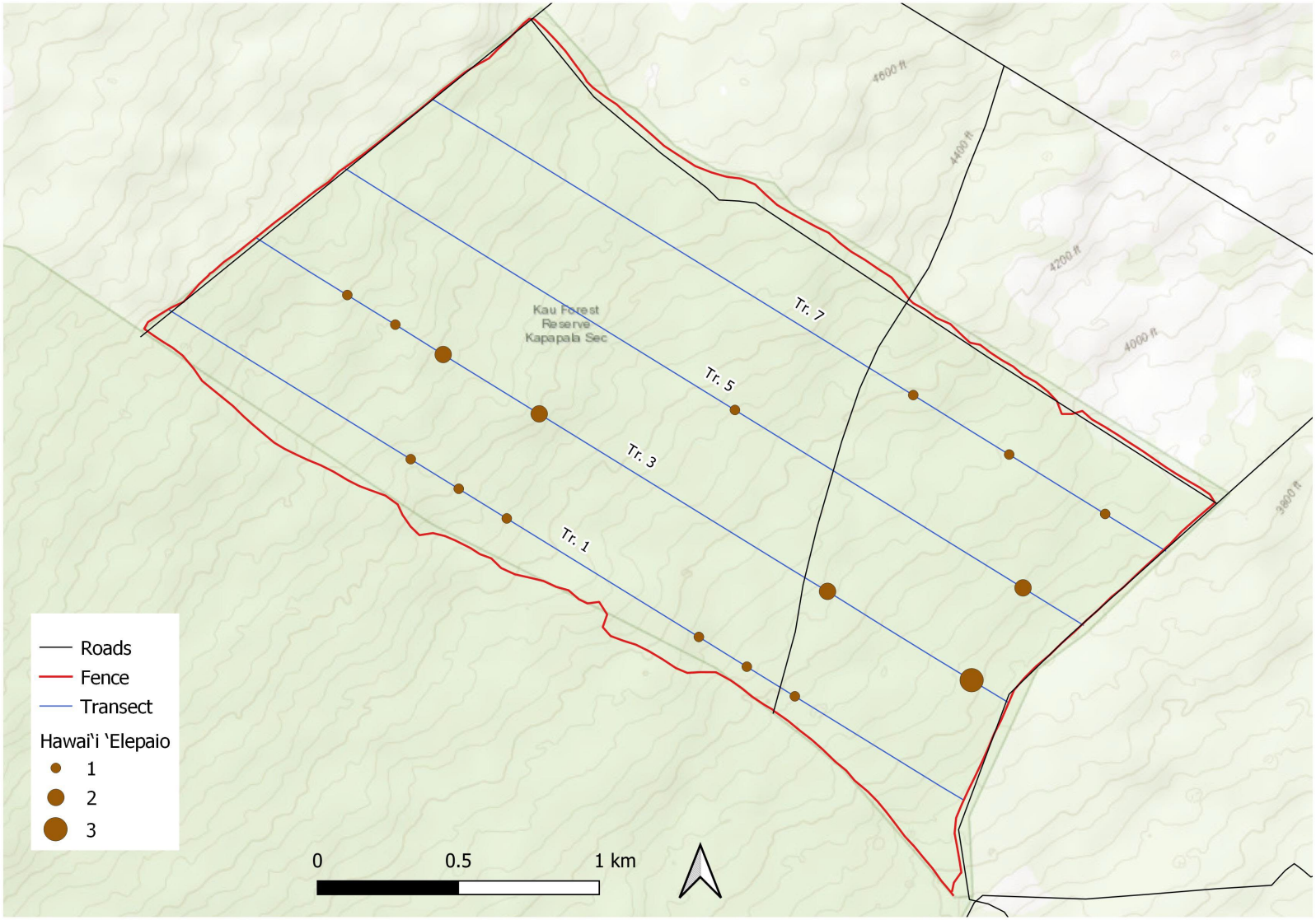

Figure 4. Detections of Hawai'i 'Elepaio (*Chasiempis sandwichensis*) during the 2021 TMA forest bird surveys

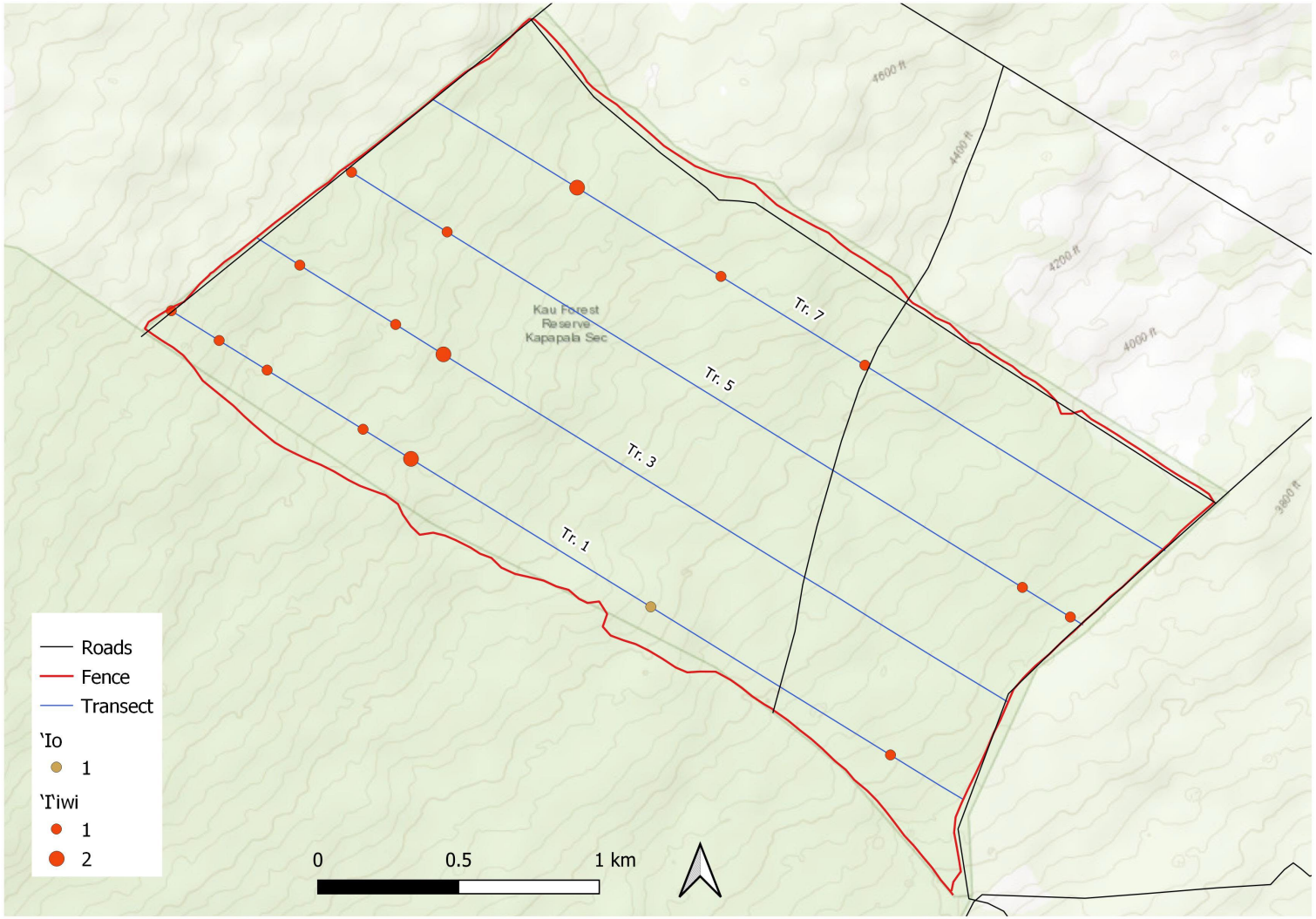

Figure 5. Detections of ʻIʻiwi (*Drepanis coccinea*) and ʻIo/Hawaiian Hawk (*Buteo solitarius*) during the 2021 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

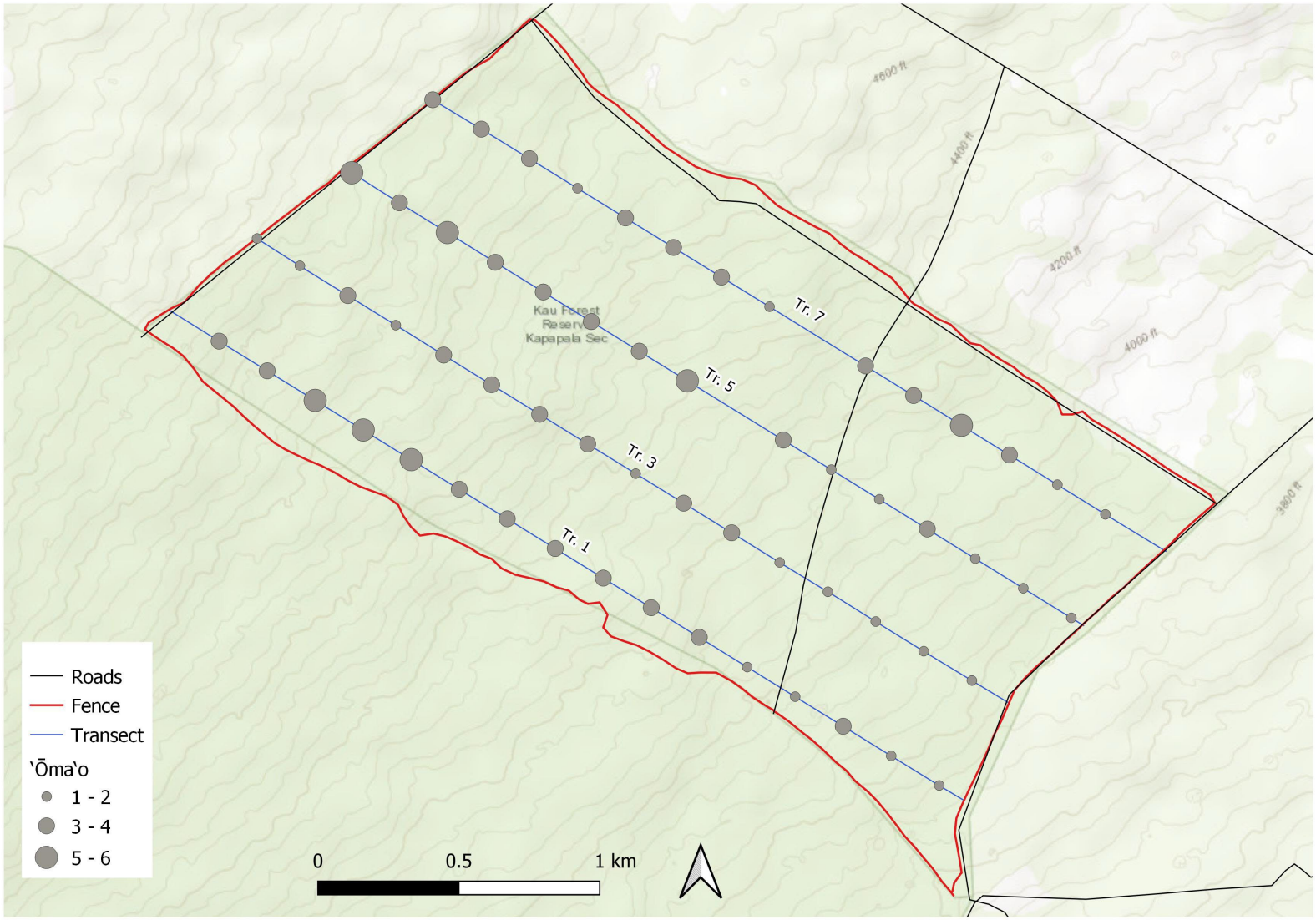

Figure 6. Detections of ʻŌmaʻo (*Myadestes obscurus*) during the 2021 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

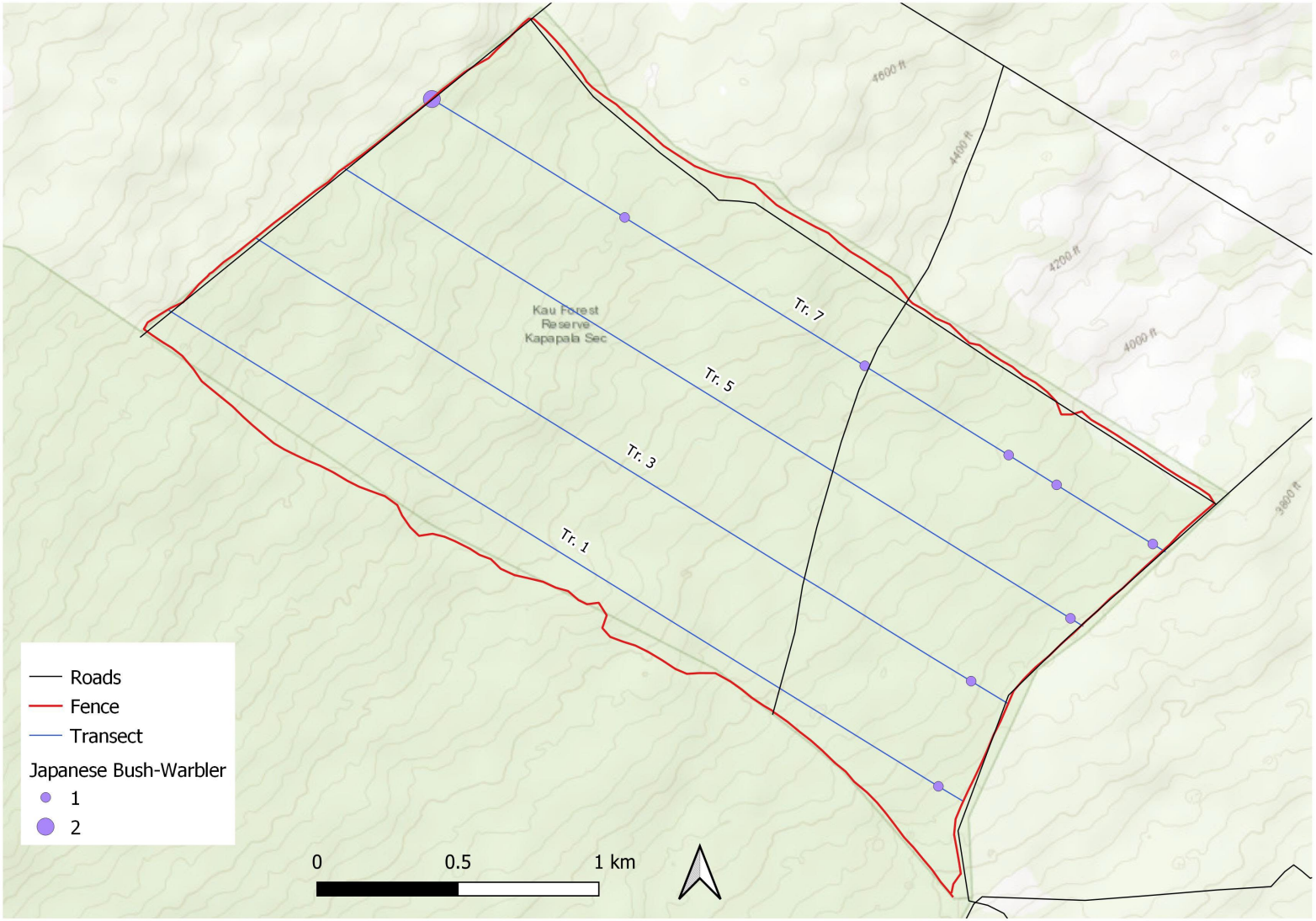

Figure 7. Detections of Japanese Bush-Warbler (*Cettia diphone*) during the 2021 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

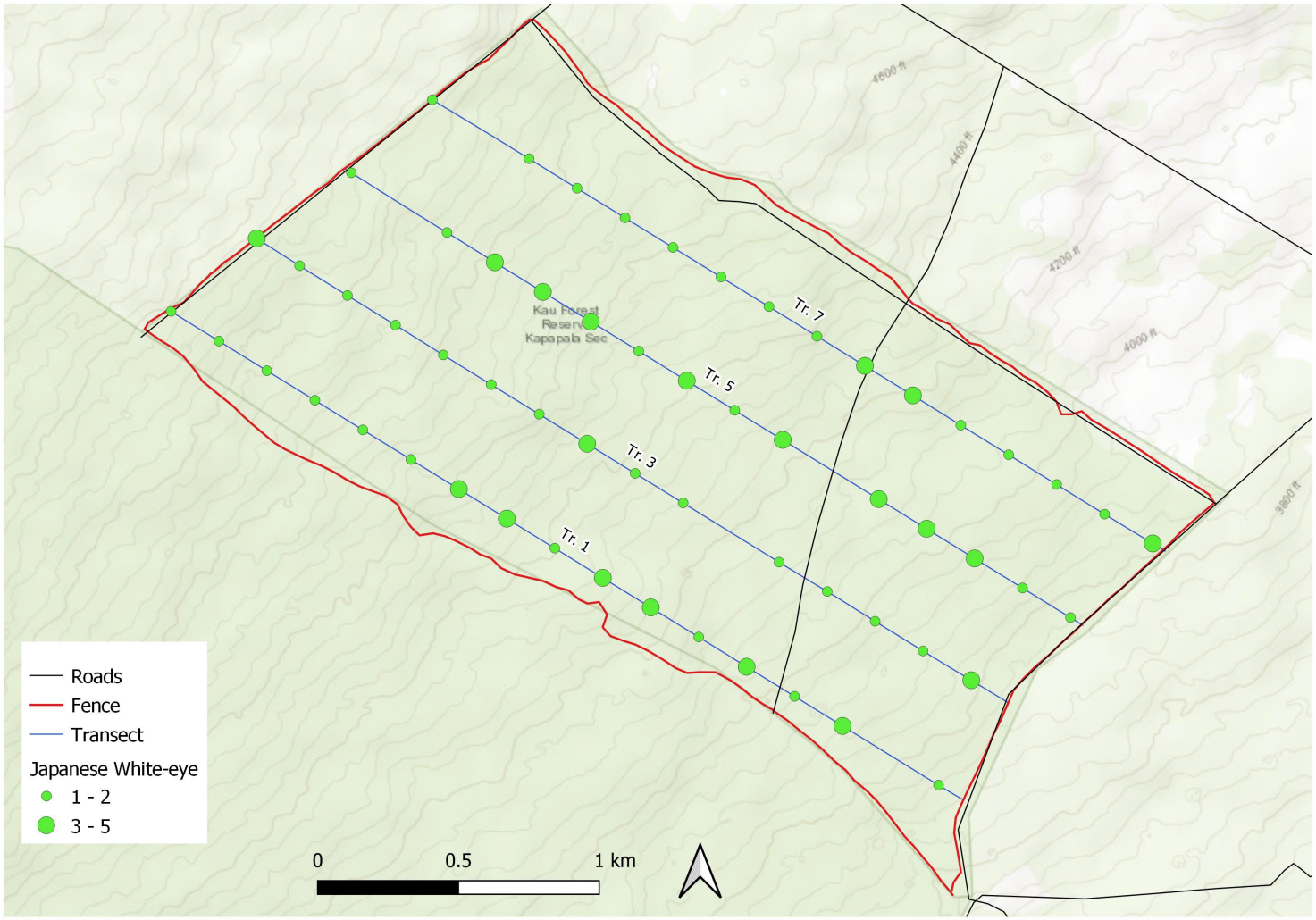

Figure 8. Detections of Japanese White-eye (*Zosterops japonicus*) during the 2021 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

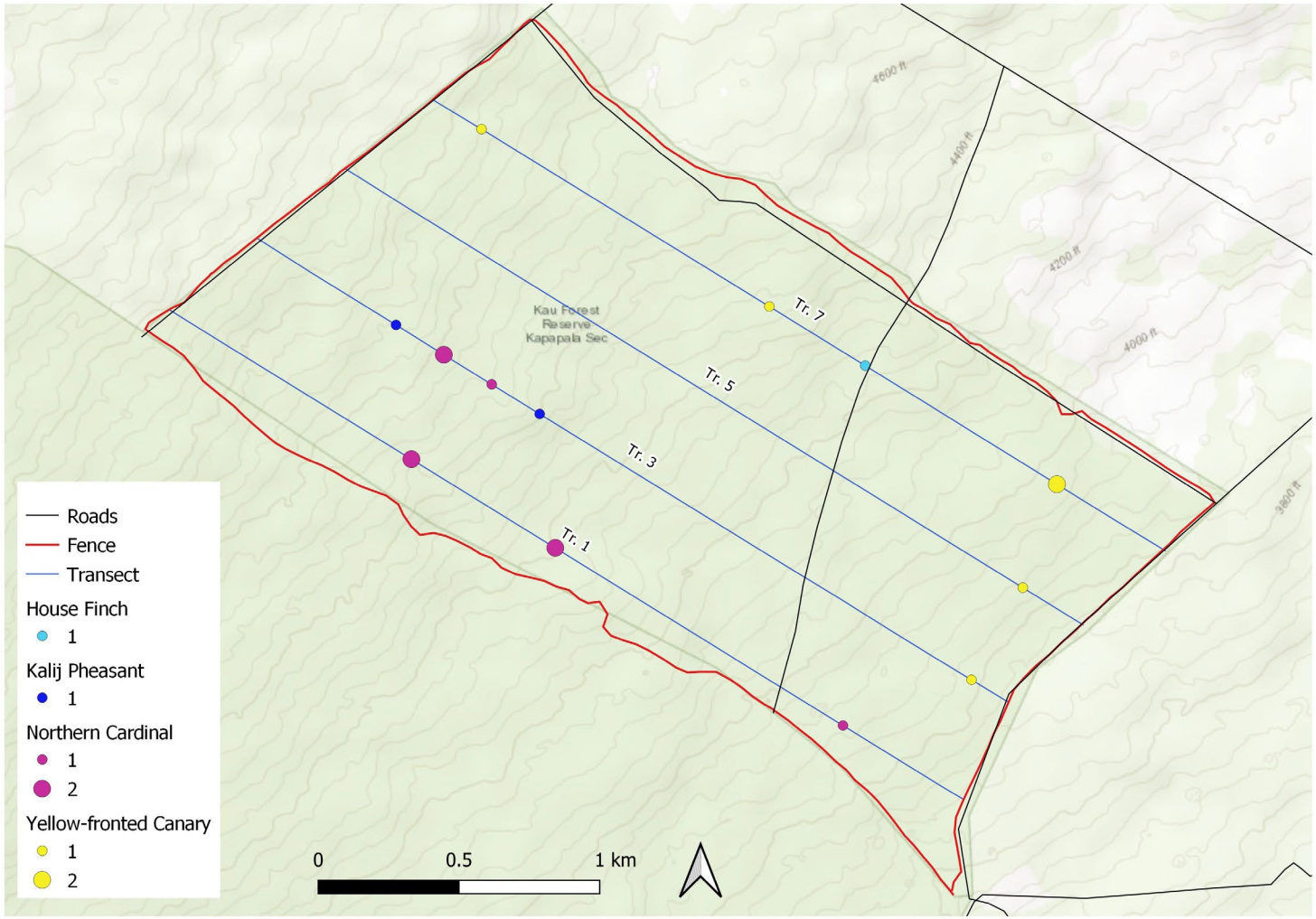

Figure 9. Detections of House Finch (*Carpodacus mexicanus*), Kalij Pheasant (*Lophura leucomelanos*), Northern Cardinal (*Cardinalis cardinalis*), Red-billed Leiothrix (*Leiothrix lutea*) and Yellow-fronted Canary (*Serinus mozambicus*) during the 2020 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

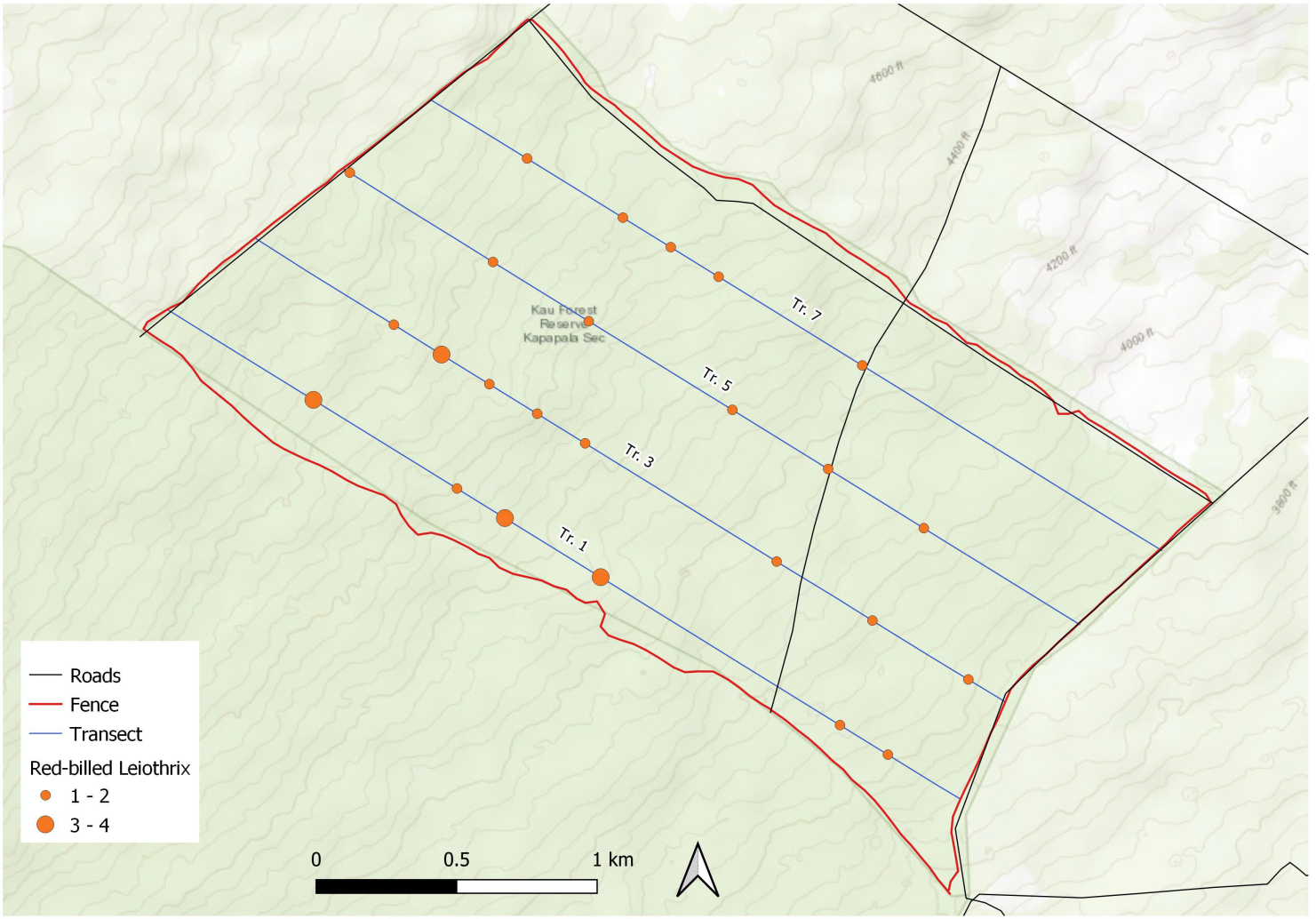

Figure 10. Detections of Red-billed Leiothrix (*Leiothrix lutea*) during the 2020 TMA forest bird surveys at the Kapāpala Koa Canoe Forest.

Appendix E: DOFAW Management Guidelines Classification

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;	• Resource protection is the top priority;

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	• 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.	• 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.

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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).

Conservation Management - Native Species Habitat, Water Resources – LNR 402/407		
Class Name	Class Definition	Management Strategy
Intensively Managed Areas	• High degree of watershed, native species and/or biodiversity conservation management is underway.	• Conservation of watersheds and/or native species and biodiversity is a higher priority than all other uses; • Management focus is on protection, restoration and maintenance of native ecosystems and species; • Employ strategies to reduce the threat of alien species or other factors to the greatest extent possible - fencing, intensive animal and/or weed control; • Maintain & improve native ecosystem processes; • Collect genetic material, reintroduce species, work to recover threatened and endangered species, protect areas from degradation, restore damaged resources as needed;

Vegetation Resources – LNR 402/407	
Class Name	Class Definition
V-1: Highest Quality Native Vegetation	These areas consist of the highest quality native ecosystems and communities. They have minimal disturbance, with low levels (less than 10%) of non-native plants in any vegetative layer (91-100% native plant cover).
V-2: Predominantly Native Areas:	Areas in which native plants predominate in communities that are relatively intact, and are minimally disturbed. They have a significant component of non-native plants (51-90% native plant cover).
V-3: Considerably Degraded Native Vegetation Cover:	Areas have a considerable amount of disturbance to native vegetation. Non-native plants may predominate, however there may be pockets of remaining native plant communities (11-50% native plant cover).

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V-4: Heavily Degraded Areas:	Areas where the native vegetation is severely degraded or highly altered from its natural state. There may be areas of severe erosion, former pasture or crop lands, forest plantations, areas of non-native grass or brush resulting from fires or intensive grazing. (0-10% native plant cover).

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.

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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.

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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.

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Appendix F: Best Management Practices for Maintaining Water Quality in Hawai‘i

Due to the length of the Cultural Impact Assessment, the entire document has been made available online at the address below:

https://dlnr.hawaii.gov/forestry/files/2023/01/DOFAW-Best-Management-Practices-for-Maintaining-Water-Quality-in-Hawaii-1996.pdf

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