Hawaiian Hoary Bat Tier 5
Site-Specific Mitigation Implementation Plan

Prepared for

AUWAHI WIND

Prepared by

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February 2025

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Table of Contents

List of Tables

List of Photos

List of Figures

List of Attachments

Acronyms and Abbreviations

C-CAP	NOAA Coastal Change Analysis Program
DOFAW	Division of Forestry and Wildlife
HCP	Habitat Conservation Plan
HRS	Hawai‘i Revised Statutes
KMFR	Kamehamenui Forest Reserve
Mitigation Area	Tier 5 Mitigation Area
SSMIP	Site-Specific Mitigation Implementation Plan
USFS	U. S. Forest Service
USFWS	U. S. Fish and Wildlife Service

1.0 Introduction

This Tier 5 Site-Specific Mitigation Implementation Plan (SSMIP) follows the mitigation planning for the Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus semotus*), as outlined in the Auwahi Wind Farm (Project) Habitat Conservation Plan (HCP) and as amended in 2019 (HCP Amendment; Auwahi Wind 2012, Tetra Tech 2019). The SSMIP identifies specific mitigation actions for review and approval by the U.S. Fish and Wildlife Service (USFWS) and Hawaiʻi Division of Forestry and Wildlife (DOFAW) at the time mitigation is triggered. Tier 5 mitigation must offset the take of 34 bats. The Auwahi Wind Energy LLC (Auwahi Wind) proposed Tier 5 bat mitigation site is located within the Kamehamenui Parcel (public land) on Maui and on the adjacent Haleakalā Ranch (private landowner) lands. The State of Hawaiʻi Department of Land and Natural Resources acquired 3,433 acres in Kamehamenui in 2020 (Kamehamenui Parcel), and DOFAW has received approval from the Board of Land and Natural Resources (BLNR) to add the Kamehamenui Parcel to the Forest Reserve System to create the Kamehamenui Forest Reserve (KMFR). DOFAW is in the process of creating a management plan for the KMFR. As part of the preparation of this SSMIP, Auwahi Wind has consulted with USFWS and DOFAW HCP staff and staff at the DOFAW Maui Branch (DOFAW Maui) for input and approval of mitigation actions that would be beneficial to the Hawaiian hoary bat within the proposed mitigation site. Auwahi Wind has also consulted with Haleakalā Ranch on the proposed installation of a water source on their land (Attachment 1). This SSMIP describes Auwahi Wind's mitigation actions, all of which are additive and complementary to the management actions planned by DOFAW Maui for the KMFR.

1.1 Goals and Objectives

The HCP Amendment identifies broad biological goals and objectives that describe the guiding principles and specific strategies required to define and implement a successful land-based mitigation plan (Tetra Tech 2019). Here these goals and objectives are refined to address the specifics of mitigation offset requirements and mitigation site conditions. The overall goal of the Tier 5 SSMIP is mitigation to offset the incidental take of 34 bats at the Project by protecting, enhancing, and managing Hawaiian hoary bat foraging and roosting habitat and prey availability. The objectives of the SSMIP define specific protections, enhancements, and management actions connected to the natural landscape features used by the Hawaiian hoary bat at the KMFR. These objectives provide the basis for the specific mitigation actions (Section 4.0), effectiveness monitoring approaches (Section 6.0), and success criteria (Section 8.0). Auwahi Wind has leveraged results of the research, bat habitat restoration, and management efforts conducted in Tiers 1 – 4 (Figure 1), data from other applicable studies, and USFWS and DOFAW mitigation guidance, to identify appropriate Tier 5 mitigation actions that will offset the incidental take of 34 bats for Tier 5 (Tetra Tech 2019).

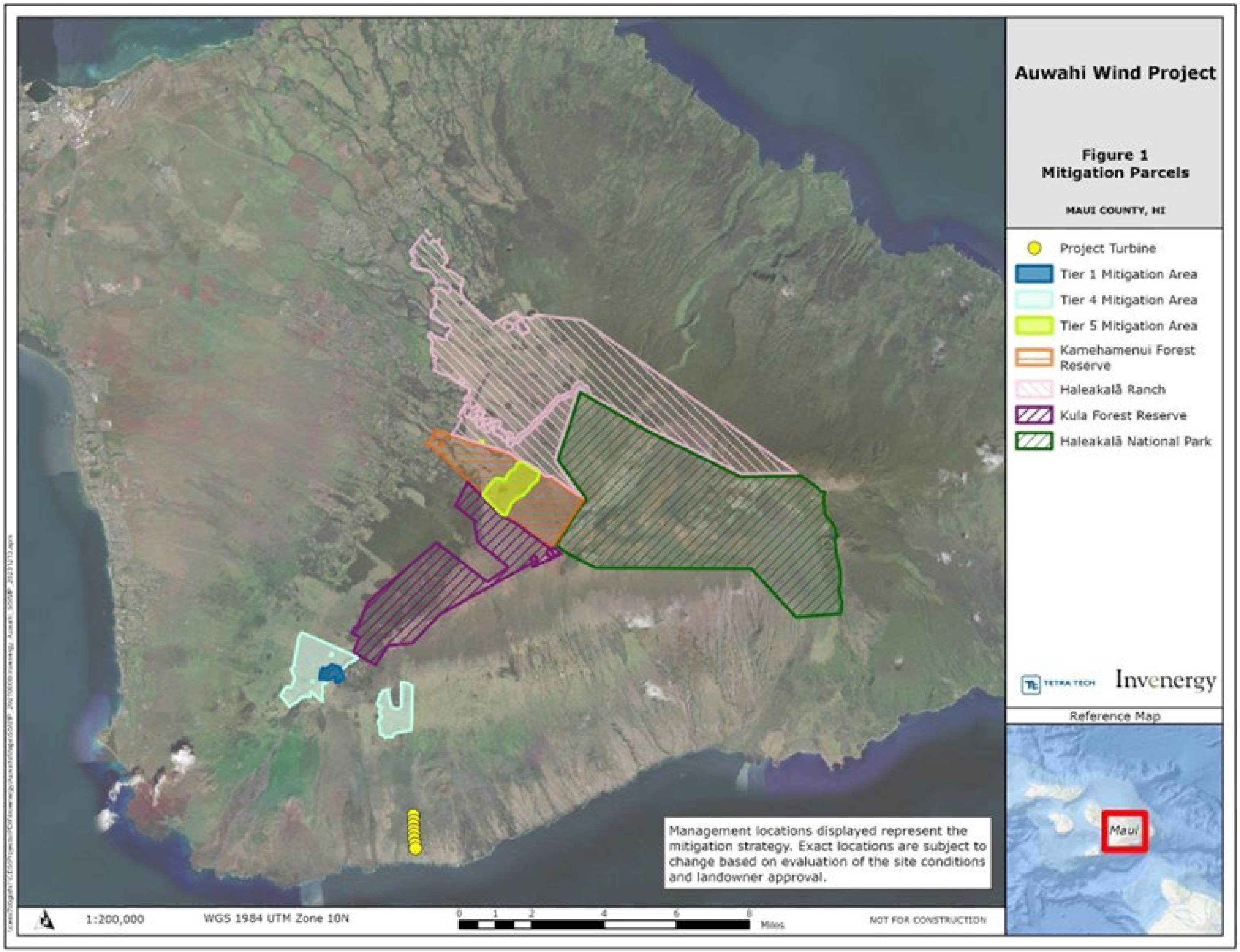

Figure 1. Mitigation Parcels

To provide the framework for the SSMIP the goal, objective, and associated mitigation actions are outlined below.

Goal: To offset the incidental take of 34 bats at the Auwahi wind facility, increase Hawaiian hoary bat roosting and foraging habitat, and prey availability within a 690-acre portion of the KMFR (Kamehamenui Parcel) and on adjacent Haleakalā Ranch (private landowner) lands (collectively "Mitigation Area") through long-term legal protection and management, habitat creation and enhancement, and ungulate removal.

Objective 1: Secure long-term legal protection for the Mitigation Area.

- *Action 1 – Legal Protection:* Execute legal instruments with DOFAW Maui to ensure protection of the lands for conservation purposes and to guarantee no other activities could occur that would harm bats or reduce conservation benefits.

  Ensure the bat-safe above-ground water basin(s) located on Haleakalā Ranch property is legally protected by management agreement for the life of the mitigation plan. The terms of the management plan established under the agreement will be reviewed and verified as adequately capturing the necessary criteria for this SSMIP by DOFAW prior to final execution.

Objective 2: Increase in Hawaiian hoary bat roosting and foraging habitat, and prey availability within the Mitigation Area.

- *Mitigation Action 1 – Ungulate exclusion Fence:* Upon approval of this SSMIP and accompanying legally binding agreement, reimburse DOFAW Maui for the equivalent cost of construction and quarterly inspection, maintenance and repair of a deer-proof fence enclosing the Mitigation Area, as shown in Figure 1. The fence installation reimbursement will be made in two annual payments.
- *Mitigation Action 2 – Outplantings:* Complete outplanting of 138 acres of koa within one year following the removal of ungulates from the fenced Mitigation Area.
- *Mitigation Action 3 – Vegetation Control:* Enhance growth and survival of native vegetation through quarterly invasive plant management throughout the Mitigation Area to help decrease the competition on native species reforestation from invasive, non-native woody vegetation.
- *Mitigation Action 4 – Ungulate Removal:* Upon approval of this SSMIP and accompanying legally binding agreement, reimburse DOFAW Maui for the cost of initial removal and quarterly monitoring/maintenance control of feral ungulates from the Mitigation Area, as shown in Figure 1, to protect areas to be revegetated through outplanting from browsing by feral ungulates.
- *Mitigation Action 5 – Water Source:* Within one year of SSMIP approval, install a new bat-safe above-ground water basin(s) to increase and diversify foraging habitat/substrate for bats and bat prey (i.e., insects).

The Action in Objective 1 is necessary to ensure long-term management and protection of the Mitigation Area. The success of the SSMIP is contingent upon completion of the Mitigation Actions and Success Criteria in Section 8.0.

Like many bat species the Hawaiian hoary bat is difficult to study and therefore measuring how the species responds to mitigation actions is also difficult. In particular, monitoring population trends is challenging as standard methods for estimating population size or densities across the landscape are not yet feasible (Frick 2013, Gorresen et al., 2018, Cornman et al. 2021, Kotila et al. 2023). Instead, changes in the magnitude and type of activity, rather than abundance, are frequently used as a proxy for population trends (Sugai et al. 2019). Acoustic monitoring can be used to determine if bats are present. Further assessment of the behavioral states from vocalizations identified within recorded acoustic activity can provide insights into habitat use and behaviors that allow for a more complete understanding of how bats are responding to mitigation actions (Teixeira et al. 2019). Evaluating behavior from acoustic recordings will provide additional insight that will further aid in understanding the effects of the mitigations actions on habitat use by bats.

1.2 Hawaiian Hoary Bat Biology

The Hawaiian hoary bat is a tree roosting and insectivorous bat species. The bat feeds on a variety of native and non-native night-flying insects including moths, beetles, crickets, mosquitoes, and termites (Whitaker and Tomich 1983). Fecal pellet analysis and insect sampling have shown that 99 percent of the Hawaiian hoary bat diet consists of moth and beetle prey (Todd 2012). Above 2,000 feet, Hawaiian hoary bats selectively ate beetles (43 percent of diet) relative to their abundance at study sites (less than 4 percent of insects sampled), although species such as moths and beetles may be overestimated in fecal pellet analysis due to sampling bias. Additionally, bat activity is correlated with insect activity, meaning as insect abundance increased so did bat activity (Todd 2012, Gorresen et al. 2018). Bats are documented to travel up to 7 miles per night on the island of Hawaiʻi to reach foraging grounds (Bonaccorso et al. 2015).

The Hawaiian hoary bat feeds primarily in edge, open habitats, and open bodies of water (USFWS 1998) which is supported by call structure, wing shape, and behavioral observations. Hawaiian hoary bats weigh about 45 percent less than mainland hoary bats, which are open area foragers (Fenton 1990), and this smaller body mass leads to lower wing loading and an increased aptitude for flying in both open and more cluttered environments (Jacobs 1996), such as edge habitats.

Hawaiian hoary bats use high-intensity echolocation calls with a mix of narrow and broadband components, which is consistent with forest edge habitat foraging behavior.

Hawaiian hoary bats forage across a wide array of habitat types and plant communities from sea level to at least 12,000 feet above sea level. Bats occupy and actively forage among a variety of high elevation habitats both seasonally and nightly and are even suggested to travel relatively long distances on the island of Hawaiʻi (greater than 1 mile) to access some high elevation habitats for the purpose of foraging (Bonaccorso et al. 2016). The importance of high elevation habitat, although not completely understood, is well established, as the use of high elevation habitats has been observed on the islands of Hawai`i (Menard 2001, Todd 2012, Gorresen et al. 2013, Bonaccorso et

al. 2016) and Maui (Todd et al. 2016). On Maui, vast portions of high elevation native forest, particularly on the west and southwest slopes of Haleakalā, have been lost due to fire, introduced ungulates, and landscape-level invasion of non-native grasses. (Perkins et al. 2014). The loss of this high elevation native forest habitat may be a limiting factor for Hawaiian hoary bats, particularly during the non-breeding season when bats are most likely to occupy these areas.

Bats are documented to use water for drinking and as a foraging substrate (Brooks and Ford 2005, Heim et al. 2017, Jackrel and Matlack 2010, Tuttle et al. 2006, Vindigni et al. 2009). The Hawaiian hoary bat is no exception. The species has been documented utilizing ponds installed as part of Auwahi Wind's Tier 4 Mitigation Area (Thompson and Hammond 2021, Thompson and Hammond 2022).

1.3 Mitigation Overview

Auwahi Wind will implement Hawaiian hoary bat Tier 5 mitigation within the KMFR and on Haleakalā Ranch located on Leeward Haleakalā, Maui (Mitigation Area; Figure 2). An amendment to the Auwahi Wind Habitat Conservation Plan approved by USFWS and DLNR in 2019 (Amendment) identifies the Kamehamenui Parcel as an anticipated mitigation site for Tier 5 bat mitigation. This Amendment explains that the focus of the management actions at the Kamehamenui Parcel will be to increase bat roosting, foraging habitat, and prey availability through management that is consistent with DOFAW's native ecosystem restoration work in KMFR, and that the mitigation program implemented will provide a net benefit to the species (Amendment pg 6-42 to 43). The size of the Mitigation Area is based on the core use area of 20.3 acres per bat (Amendment pg 6-43).[1] Mitigation actions are anticipated to offset the take of 34 bats.

[1] In the HCP Amendment (Tetra Tech 2019), Auwahi Wind commits to 690 acres of mitigation for Tier 5. Auwahi Wind may exceed this value by a nominal amount to ensure that the required mitigation obligations have been fulfilled.

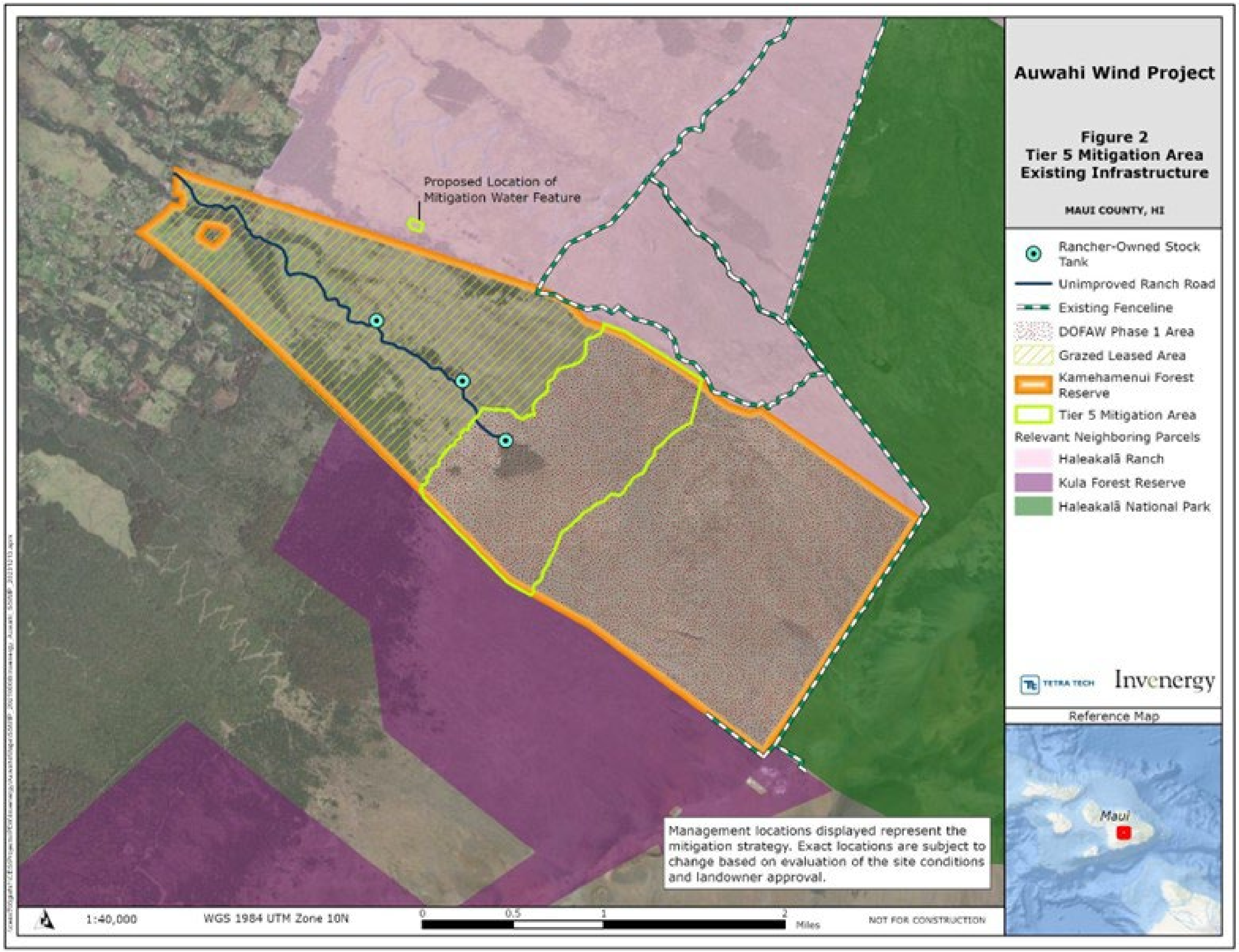

Figure 2. Tier 5 Mitigation Area Existing Infrastructure

The overall goal of the SSMIP is to protect, enhance, and increase bat roosting and foraging habitat and bat prey availability in the Mitigation Area. A combination of open foraging areas, edge habitat, and closed canopy is expected to best meet the species' foraging habitat requirements (Johnston 2020, Section 3.8.1.1 in Tetra Tech. 2019). The SSMIP will be accomplished by increasing native forest cover at Mitigation Site through the Mitigation Actions described in Section 4 including fence installation and maintenance, ungulate removal, outplantings of native species, and invasive vegetation management within the KMFR Mitigation Area. These mitigation actions will provide additional roost structure and host plants for insect prey and wind breaks for foraging habitat, protected by invasive plant and ungulate control.

In addition to outplanting for native vegetation communities within KMFR, Auwahi Wind will install an above-ground water basin(s) on neighboring Haleakalā Ranch land. Hawaiian hoary bat experts' discussion of Core Use Area suggests that the addition of key resource features, such as water sources and foraging habitat, enhances bat habitat. Open water features are scarce on leeward Haleakalā and research from Tier 2-3 mitigation and monitoring from Tier 4 mitigation has demonstrated the use of water features by bats on Maui (Pinzari et al 2019). Further, it has been shown that bats use koa (Acacia koa) trees for foraging (Banko et al 2016, Montoya-Aiona et al 2023). The construction of a water feature(s) and the outplanting of native koa will provide a variety of habitat attributes for bats to forage at in this location. The Tier 5 mitigation actions will also augment the connectivity between nearby State Forest Reserves and other conservation areas that currently provide bat habitat (Figure 2).

The success of the SSMIP is contingent upon completion of the Mitigation Actions in Section 4.0 and Success Criteria in Section 8.0.

The Mitigation Area will be protected from grazing pressure, through the installation and maintenance of fencing, to promote natural (passive) regeneration of native vegetation other than koa. Outplanting of koa will be completed to further the development of native vegetation communities and create edge habitat throughout the currently grazed pasture; thus, enhancing the habitat for bat foraging. Auwahi Wind will also reimburse DOFAW for the equivalent costs of monitoring, maintaining, and repairing a fence to enclose the mitigation area shown in Figure 1. Additionally, quarterly invasive plant management will be implemented throughout the Mitigation Area, primarily in the outplanting areas, to help support natural regeneration of native vegetation and establishment of native outplantings. Invasive plant management shall be sufficient that no new target species become established in the mitigation area and there is no documented increase in the distribution of those already present.

To promote outplanted and regenerating native tree establishment, DOFAW Maui Forest Reserve Program will be responsible for the initial ungulate removal in the overall approximately 2,300-acre fenced area which encompasses the 690-acre Mitigation Area, ongoing ungulate removal as needed to maintain it as ungulate free (see Section 4.4). Auwahi Wind will provide reimbursement funds to DOFAW Maui Forest Preserve Program to complete the initial ungulate eradication and quarterly maintenance. Should DOFAW Maui Forest Preserve Program be unable to complete this work,

Auwahi Wind will contract with a third-party entity to do so within the Mitigation Area in time to continue on-schedule implementation.

Based on the natural history characteristics of the Hawaiian hoary bat and monitoring results from the Auwahi Wind Tier 1 bat mitigation actions, Auwahi Wind expects to provide high value foraging resources for Hawaiian hoary bats in the Mitigation Area through the increase in three-dimensional foraging habitat, increase in bat prey (i.e., insects), and bat foraging activity in the Mitigation Area. Additionally, the Tier 5 mitigation actions will augment the connectivity between nearby State Forest Reserves and other conservation areas that currently provide bat habitat.

2.0 Mitigation Area

2.1 Overall Site Description

The Mitigation Area includes 690-acres of mitigation land within the KMFR to be improved to meet the requirement to mitigate for 34 bats under Tier 5 (Auwahi Wind 2012). Additionally, an above-ground water basin(s) will be installed on the neighboring private Haleakalā Ranch. Both locations are within the mesic to subalpine zones (between 4,900– 7,600 feet elevation) on the north slopes of Haleakalā (Figure 2). Haleakalā National Park is near the Mitigation Area to the east, the Kula Forest Reserve is adjacent to the south, and Haleakalā Ranch borders it to the north (Figure 2). The makai fence line of DOFAW's Phase 1 area serves as the lower boundary of the Mitigation Area in the KMFR, with the upper boundary generally following the 7,600-foot contour (Figure 2, Figure 3); the fence line for the Phase 1 area extends eastward to the Haleakalā National Park boundary and fully encompasses approximately 2,300 acres up to approximately the 9,500-foot contour. The current habitat within the Mitigation Area is subject to grazing pressure from cattle as well as feral pigs, goats, deer, and sheep. This ungulate pressure has denuded the vegetation leaving many areas bare or vegetated by sparse short stature non-native pasture grasses; however, the Mitigation Area also includes one, approximately 20-acre forested area and a second roughly 1-acre forested area, both of which have endured the grazing pressure.

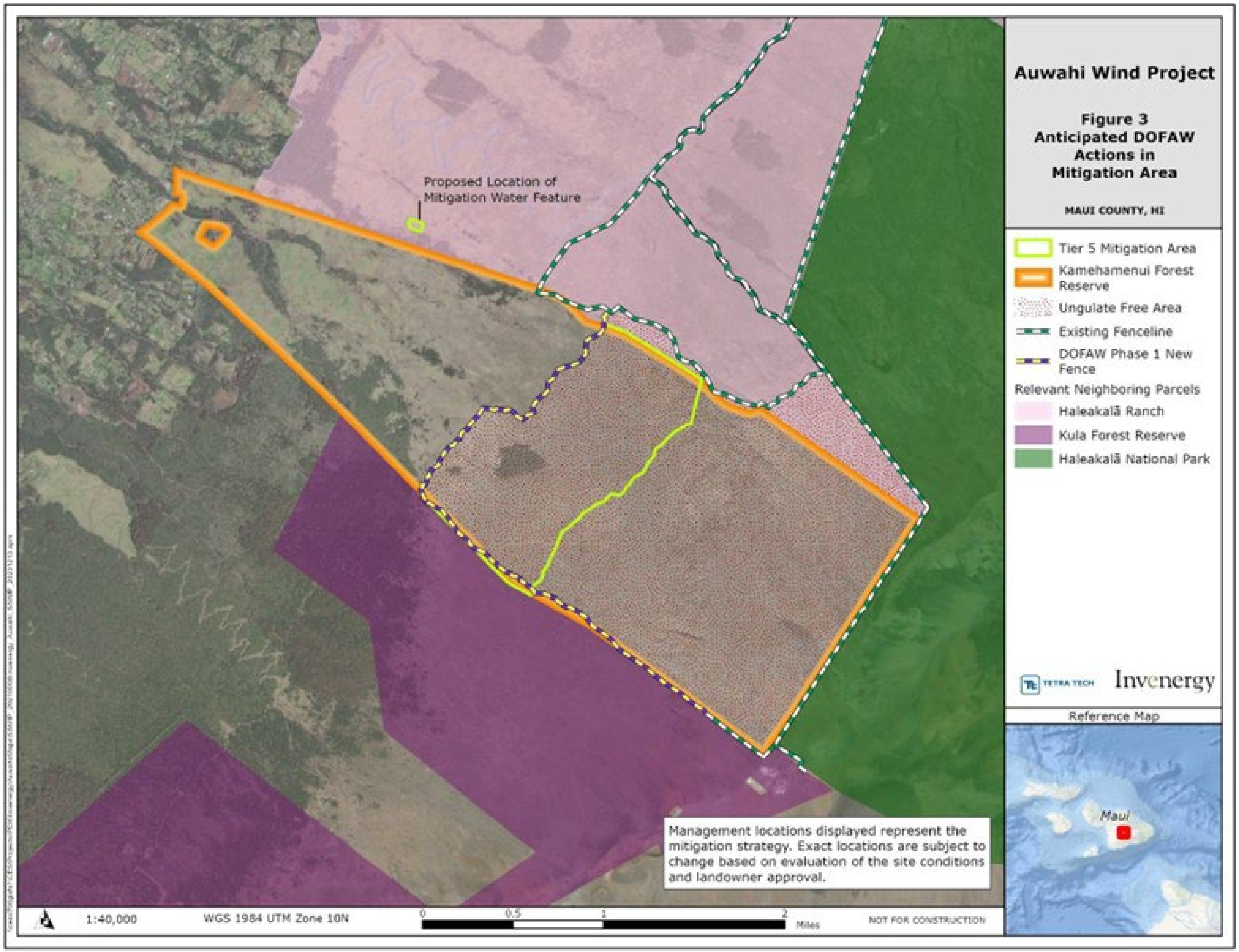

Figure 3. Anticipated DOFAW Actions in Mitigation Area

2.2 KMFR

2.2.1 Kamehamenui Site Description

DOFAW Maui contracted Starr Environmental to perform biological surveys throughout the parcel. Starr Environmental characterizes the parcel as follows (see Attachment 2):

> *The land is steep, and there are many small gullies. Much of the area is pasture, with short statured shrubland up high, and scattered forest areas in the pastures, gulches, and along the property margins. The elevation ranges from 3,700 to 9,800 feet above sea level. Annual rainfall averages 27-40 inches. Annual air temperature averages 44-61 degrees Fahrenheit.*

Little infrastructure exists within the newly acquired KMFR. The Kamehamenui Parcel has three lessee owned water tanks, one of which occurs within the Mitigation Area (Figure 2). The State acquired a well with the purchase, located near the makai boundary of the KMFR. The well is used to pump water to the water tanks. Water resources are generally limited in Leeward Haleakalā (USGS 2013); however, one livestock water tank (approximately 50,000 gallons in size) owned by a rancher (the current lessee) is present within the Mitigation Area (see Section 3.1).

There are currently no established trails within the Mitigation Area, and the only road is a 300-foot segment of the unimproved ranch road (Figure 2). The site has no permanent fencing but does border parcels which have existing fencing.

2.2.2 KMFR Existing Legal Protections

The Board of Land and Natural Resources approved the Kamehamenui Parcel (Tax Map Key (2) 2-3-005-002) to become part of Kamehamenui Forest Reserve. DOFAW is working on a forest management plan for Kamehamenui Forest Reserves.

2.3 Haleakalā Ranch

2.3.1 Haleakalā Ranch Site Description

Auwahi Wind will install an above-ground water basin(s) for bat use on the adjacent Haleakalā Ranch lands north of the KMFR. Due to concerns by DOFAW Maui regarding safety and vandalism, a similar water feature would not be suitable for installation on public land in the KMFR. Auwahi Wind and Haleakalā Ranch have coordinated and expect to site the feature on a parcel (TMK (2)2-3005-003) within the existing Haleakalā Ranch lands at 4,900 feet in elevation (Figure 2). More details on the basin(s) can be found in Section 4.4.

The Haleakalā Ranch parcel is near the main access road for Haleakalā National Park; the road traverses the northern edge of the parcel adjacent to the KMFR. Haleakalā Ranch also has additional lands north of the Haleakalā Highway. In addition to this main road, the ranch has several ranch roads and some cabins on the pasturelands surrounding the parcel which are used to support ranch operations. Haleakalā Ranch maintains cattle fencing along the perimeter of this pasture.

2.3.2 Haleakalā Ranch Existing Legal Protections

Prior to this management plan, the lands owned by Haleakalā Ranch have no existing legal protections that provides benefits specifically for the Hawaiian hoary bat.

3.0 Baseline Habitat Conditions

The state of the Mitigation Area prior to acquisition of the KMFR by DOFAW reflects the baseline habitat conditions. Baseline habitat conditions described below provide the starting point from which mitigation benefits will be measured.

3.1 KMFR Baseline Habitat Conditions

The Starr Environmental survey report from 2021 describes the baseline habitat conditions within the KMFR (Attachment 2). In summary, the habitat across the entire KMFR parcel is comprised of three main vegetation types: Grassland/Pasture, Mesic Forest, and Subalpine Shrubland. These vegetation communities are associated with elevation levels within KMFR. The majority of the area below 6,500 feet is dominated by pasture with vast areas of open grassland and non-native species. Mesic forest is scattered within the grassland, especially near gullies (Figure 4). Most of the tree species within these pockets of forest are non-native but native trees still persist, generally in areas above 5,500 feet. Subalpine shrubland exists above 6,500 feet and is dominated by native shrubs with sparse grasses and ferns. At the highest elevations of the subalpine shrubland, vegetation is very sparse and, in some areas, does not exist.

The current and past use of KMFR is ranching, and the vegetative communities were largely unmanaged and subject to grazing by feral ungulates that affected the plant communities throughout the Mitigation Area. Included in the purchase of the parcel in 2020 was an existing ranching lease. In 2022, portions of the lease were withdrawn, including the Mitigation Area.

Following the withdrawal of a portion of the lease above approximately 6,000 feet elevation to conservation from grazing, DOFAW began habitat restoration through fencing and eradication of feral ungulates (L. De Silva, pers. comm., March 30, 2021). The fence completed by DOFAW extends beyond the Tier 5 mitigation area shown in Figure 1 to cover a larger, approximately 2,300-acre area as part of DOFAW native ecosystem restoration work to the summit in Phase 1 of the KMFR management plan. Auwahi Wind will reimburse DOFAW Maui for the fence in an amount equivalent to the cost of fencing the mitigation area. Accordingly, during the mitigation term, Auwahi Wind will be responsible for reimbursing DOFAW the cost equivalent of the quarterly inspections, maintenance, and repair of that portion of the fence to ensure it continues to function as an exclusion fence for ungulates.

As noted in Section 2.1.1, one livestock water tank (50,000 gallons in size) owned by the current lessee is present within the Mitigation Area (Figure 5). No ponds exist within the KMFR. The exact surface area of the water tank is unknown but is approximately 650 ft^2. The rancher is expected to remove the water tank when the current lease expires, which is in approximately 6.5 years.

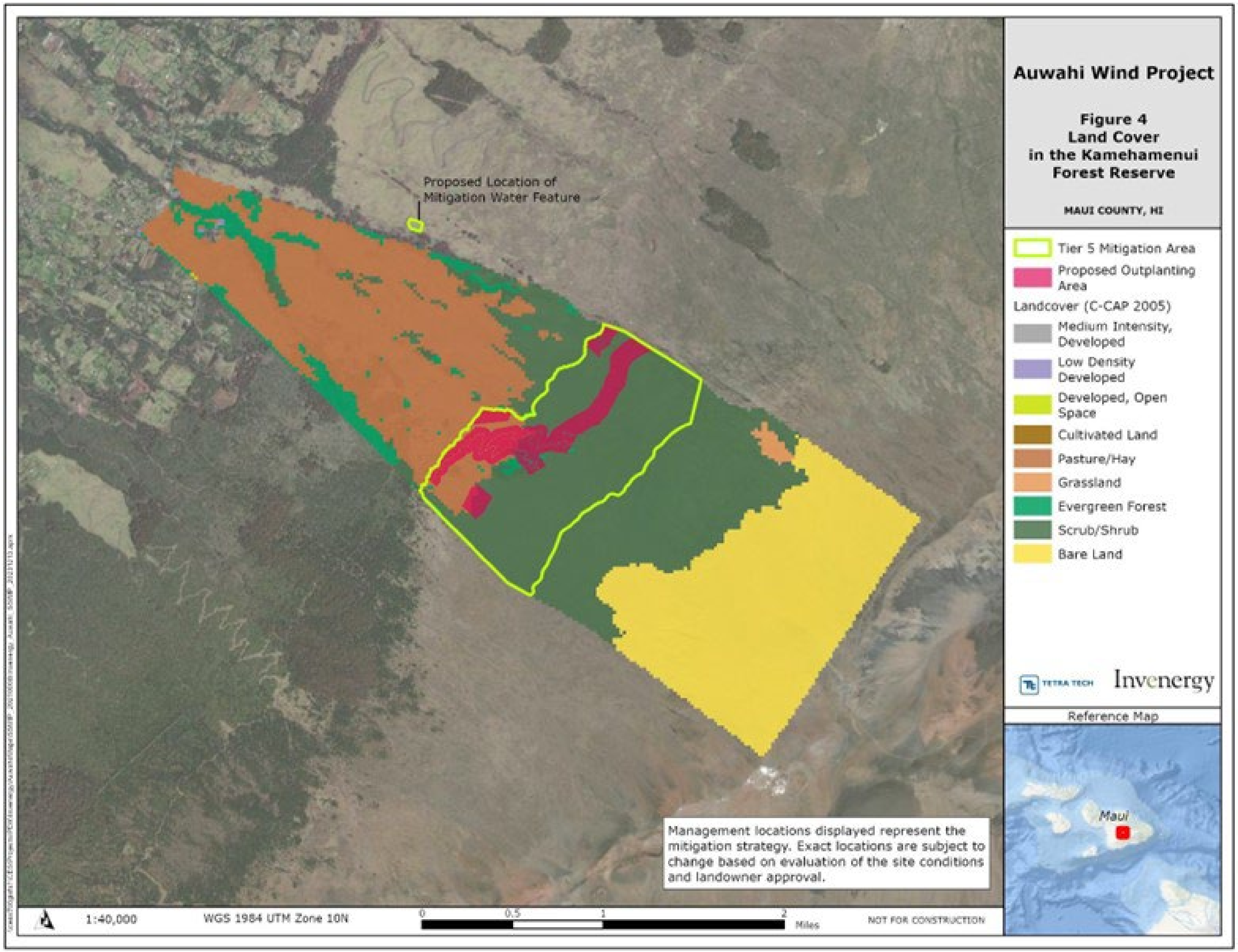

Figure 4. Land Cover in the Kamehamenui Forest Reserve

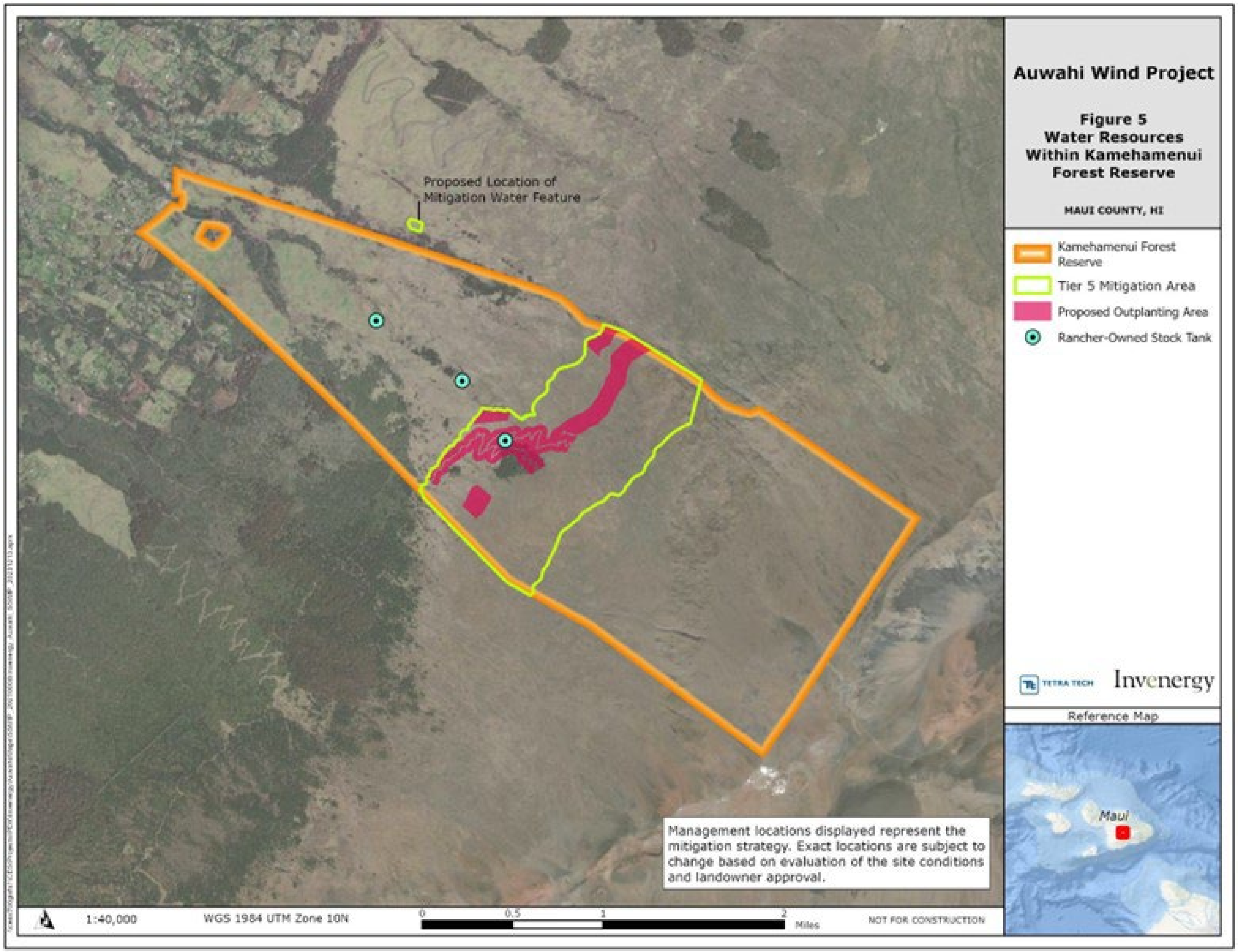

Figure 5. Water Resources within Kamehamenui Forest Reserve

The subalpine portion of the KMFR includes some portions of intact native subalpine ecosystem that is designated federal critical habitat for 10 rare plant and bird species, though no critical habitat occurs within the Mitigation Area. These areas are expected to be important for species' adaptation to climate change as habitats shift under changing conditions.

Little forest cover exists within the Mitigation Area. Table 1 shows land cover estimates from the NOAA Coastal Change Analysis Program (C-CAP) (Figure 4). Although characterized as scrub/shrub habitat by C-CAP much of the vegetation in the Mitigation Area is low stature and sparse as illustrated by field surveys (Attachment 2).

Table 1. Baseline Land Cover in the Proposed Mitigation Area

Land Cover	Tier 5 Mitigation Area[1]	
	Acres	Percentage
Scrub-Shrub	563	82
Pasture/Hay	105	15
Evergreen	22	3
Total	690	100

1. The final Mitigation Area will total 690 acres and will include lands from both the KMFR and an approximately 2-acre parcel on Haleakalā Ranch, within which an above-ground water basin(s) will be constructed. This area will be located within the larger area summarized here.

Hawaiian hoary bats have been noted to use gulches (Todd et al. 2016, H.T. Harvey 2020), and several prominent gulches pass through the Mitigation Area that could also provide priority habitat for the Hawaiian hoary bat (Photo 1).

Photo 1. Aerial Photo of the Current Conditions of the Kamehamenui Forest Reserve

(Photo credit: DLNR n.d.)

Hawaiian hoary bats occur adjacent to the Mitigation Area based on documented occurrences from the Hawaiian Heritage Database, the U.S. Geological Survey's Bison database, and results from the Endangered Species Recovery Committee (ESRC)-approved research (Figure 6; H.T. Harvey 2019). Furthermore, telemetry work by H.T. Harvey (2020) demonstrated overlap of several individual bat Core Use Areas and foraging areas within the Mitigation Area. Auwahi Wind has implemented one year of Pre-Trigger, Baseline Monitoring at KMFR (see Section 6.0). Monitoring to date shows moderate bat activity, and Auwahi Wind will document use rates in a summary report following the completion of Pre-trigger, Baseline Monitoring (Attachment 3).

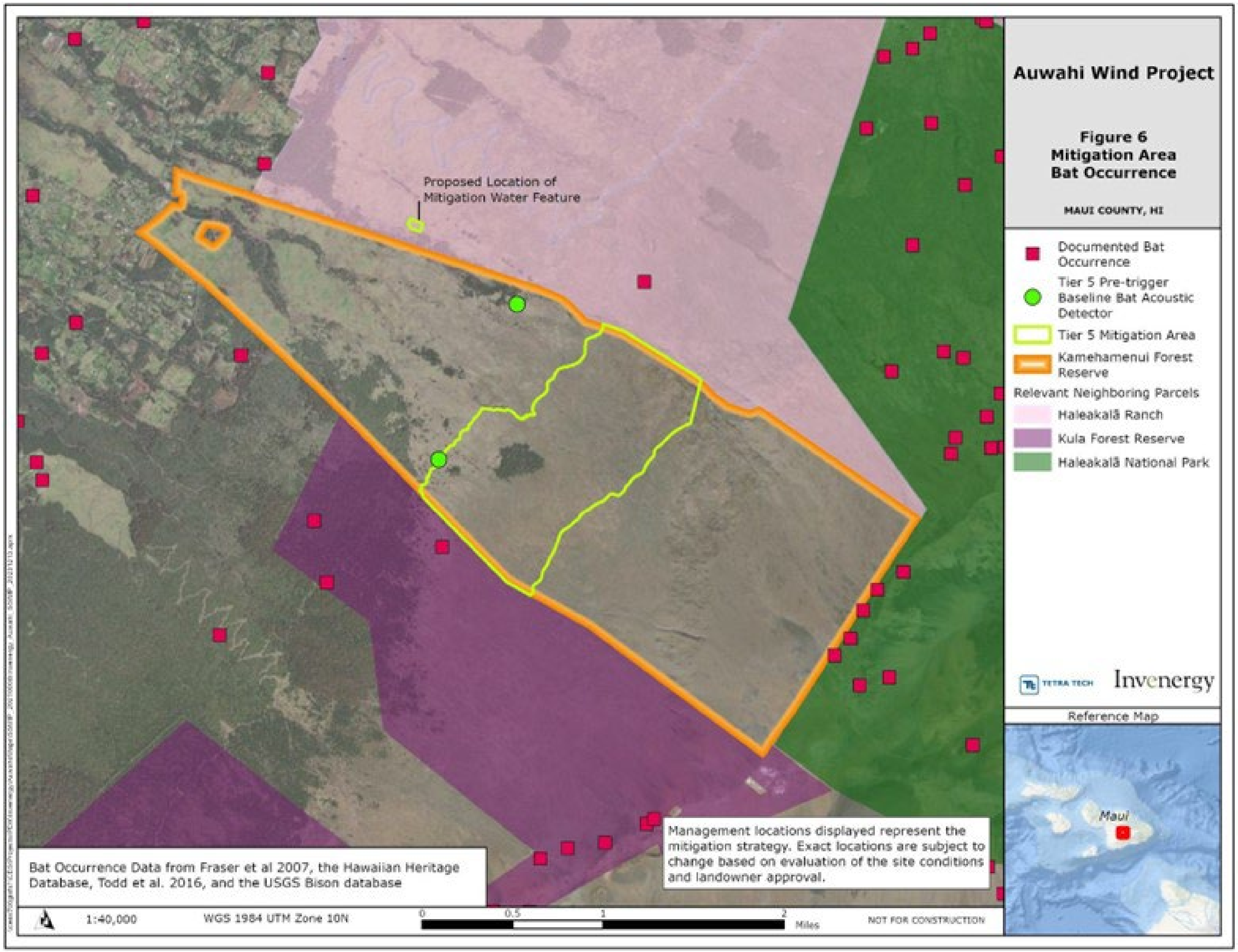

Figure 6. Mitigation Area Bat Occurrence

3.2 Haleakalā Ranch Existing Habitat Conditions

The baseline habitat conditions within the adjacent Haleakalā Ranch lands to the north are similar to the existing habitat conditions at the KMFR. This parcel includes thousands of acres, currently grazed by cattle and also used by feral goats, pigs, and deer. The vegetation is predominantly a mix of kikuyu grass (*Pennisetum clandestinum*) and short stature shrubs of pūkiawe (*Leptecophylla tameiameiae*), aʻaliʻi (*Dodonaea viscosa*), and some hedgerows of eucalyptus (*Eucalyptus* sp.) are near the proposed location of the Haleakalā Ranch water feature(s). The ranch is also working to plant koa for forestry practices at densities ranging from 6 to 100 trees per acre in pastures along the Haleakalā Highway. No existing ponds are present on the parcel directly north of KMFR. The parcel where the new water feature(s) will be located is within the larger Haleakalā Ranch described here and is currently grazed grassland.

Given the proximity to KMFR and bats capability for movement, Auwahi presumes bat activity in the Haleakalā Ranch lands are similar to the bat activity rates documented within the KMFR, through Pre-Trigger, Baseline Monitoring.

4.0 Mitigation Actions

The goal of the SSMIP is mitigation to offset the incidental take of 34 bats at the Auwahi Wind Facility by protecting, enhancing, and managing Hawaiian hoary bat foraging and roosting habitat, and prey availability within the Mitigation Area. This goal will be accomplished through the achievement of two primary mitigation objectives (Section 1.1). Objective 1 is accomplished through an action necessary to ensure long-term management and protection of the Mitigation Area. Objective 2 is accomplished through Mitigation Actions. The success of the Mitigation Actions are necessary to fulfill the goal of the SSMIP. These actions have been reviewed by DOFAW as part of a collaborative process with Auwahi Wind to develop and implement mitigation actions which are both beneficial to the Hawaiian hoary bat and complementary to DOFAW's long term management goals for the KMFR property.

As previously identified, the primary land cover type in the Mitigation Area is scrub shrub with small areas of pasture/hay, evergreen, and grassland habitats (Table 1), and provides limited bat foraging habitat. A portion of the Mitigation Area contains one, approximately 20-acre forested area and another roughly 1-acre forested area that may serve as foraging habitat and provide edge habitat important for foraging, but generally the Mitigation Area is devoid of forested area. Removal of ungulates will stop grazing pressure on those two forest stands. If DOFAW determines that any existing alien forest stands need to be removed for any reason that reduce the forest cover below the 20 percent forest threshold, Auwahi Wind will plant native trees to continue to meet the mitigation requirements described in this SSMIP (See 4.3 below). The creation of habitat in this area is expected to enhance bat foraging efficiency by decreasing the distance bats are required to transit to reach high density foraging resources (see discussion in the HCP Amendment, Sections 3.8.1.1

[biology] and 6.2.4.2 [mitigation actions]; Tetra Tech 2019). Thus, the location of the Mitigation Area within the subalpine zone increases its conservation value for bats (and other species).

Outplantings in a 138-acre section of the Mitigation Area will provide additional foraging habitat (Table 1, Figure 4).

The acquisition of the KMFR by the State provides an opportunity for improving the habitat to increase its suitability for the Hawaiian hoary bat. Had the parcel not been acquired, the presence of cattle, sheep, deer, and goats throughout the Mitigation Area may have continued. One water tank is currently located within the Mitigation Area; it does not have wildlife egress structures, nor is it currently used by the State for fire management purposes, and it is slated for potential removal by the lessee at the termination of their lease before the end of the Tier 5 mitigation term (see Section 3.1).

As discussed in the Amendment (Tetra Tech 2019), the Hawaiian hoary bat uses a variety of habitats for a variety of purposes; thus, a combination of open foraging areas, edge habitat, and closed canopy is expected to best meet the species' needs. As a result, Auwahi Wind will achieve its Tier 5 mitigation objectives by implementing the following Mitigation Actions in the Mitigation Area (Figure 7):

- *Mitigation Action 1 – Ungulate Exclusion Fence:* Upon approval of this SSMIP and execution of accompanying legally binding agreement, reimburse DOFAW Maui for the cost of construction and quarterly inspection, maintenance, and repair of a deer-proof fence enclosing the Mitigation Area, as shown in Figure 1.
- *Mitigation Action 2 – Outplantings:* Complete outplanting of 138 acres of koa within one year following the removal of ungulates from the fenced Mitigation Area.
- *Mitigation Action 3 – Vegetation Control:* Enhance growth and survival of native vegetation through quarterly invasive plant management throughout the Mitigation Area to help decrease the competition from invasive, non-native woody vegetation.
- *Mitigation Action 4 – Ungulate Removal:* Upon approval of this SSMIP and accompanying legally binding agreement reimburse DOFAW Maui for the cost of initial removal and quarterly monitoring/maintenance control of feral ungulates from the Mitigation Area, as shown in Figure 1, to protect areas to be revegetated through outplanting.
- *Mitigation Action 5 – Water Source:* Within one year of SSMIP approval, install a new above-ground water basin(s) to increase and diversify foraging habitat/substrate for bats and bat prey (i.e., insects).

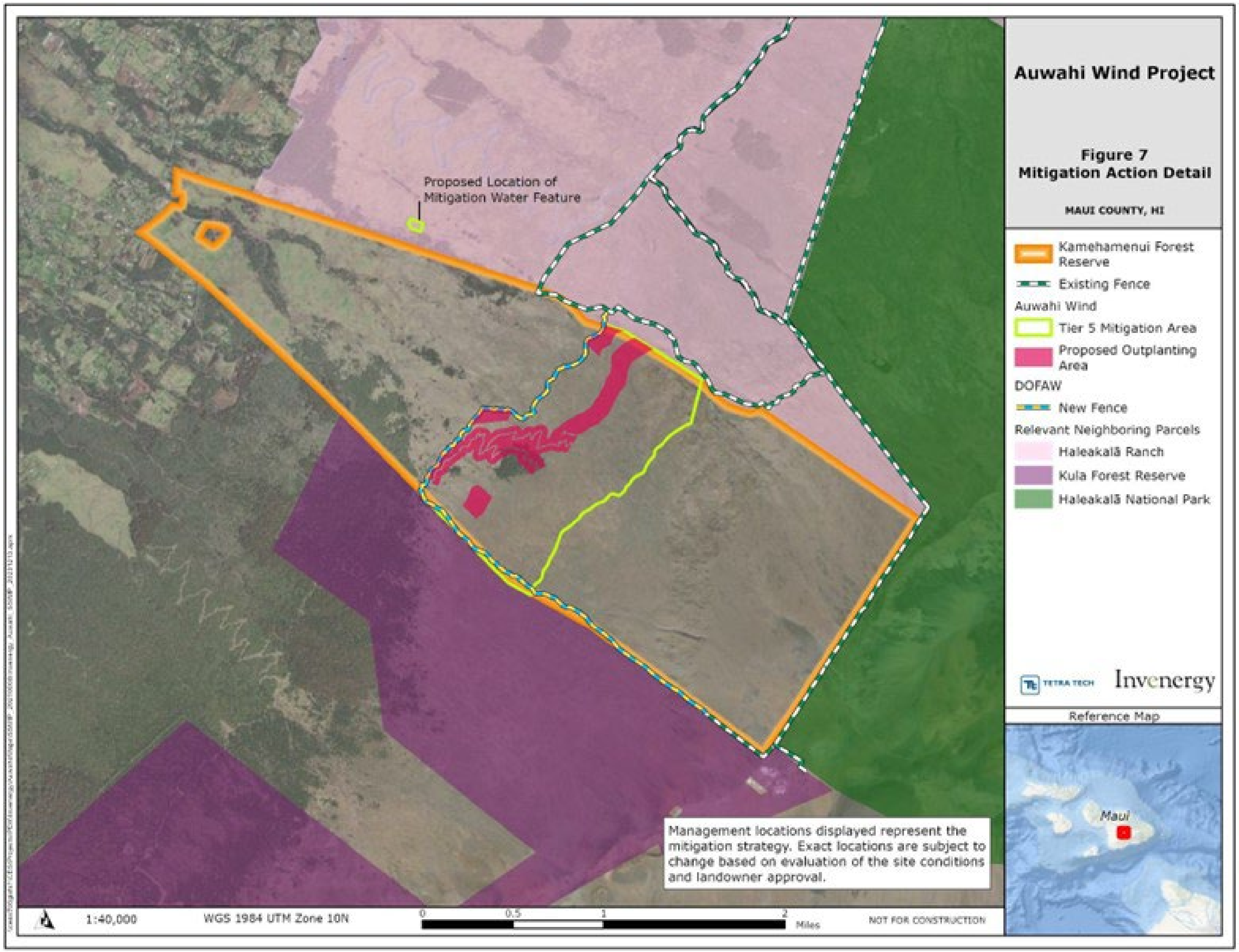

Figure 7. Mitigation Action Detail

These habitat enhancements and features will increase the amount of available foraging resources for Hawaiian hoary bats on Maui. The combination of these specific mitigation actions will provide immediate, near-term, and long-term benefits to bats. Auwahi Wind will coordinate with DOFAW to ensure that Auwahi Wind's proposed mitigation actions are compatible with DOFAW's management. Lessons learned from similar Hawaiian hoary bat mitigation actions performed by Auwahi Wind for Tiers 1 – 4 will be applied. The success of creating edge habitats has been demonstrated at Auwahi's Tier 1 Mitigation Area where forest cover has increased rapidly because of outplanted koa (Photo 2, Photo 3).

Additionally, in their Auwahi Tier 2/3 bat mitigation study, the U.S. Geological Survey noted a degree of co-occurrence of adult bats adjacent to the Tier 1 mitigation site and suggests that either prey was not limiting, or resources facilitated tolerance of intraspecific competition, or high spatial-temporal turn over in a high resource area (Pinzari et al. 2019). Additional acoustic and thermal monitoring conducted at the Tier 4 Mitigation Area shows higher relative activity rates adjacent to the Puʻu Makua mitigation site likely due to increased forest cover edge habitat (Photo 4; Tetra Tech 2021).

Photo 2. Pu'u Makua Forest Cover June 2018

Photo 3. Pu'u Makua Forest Cover October 2021

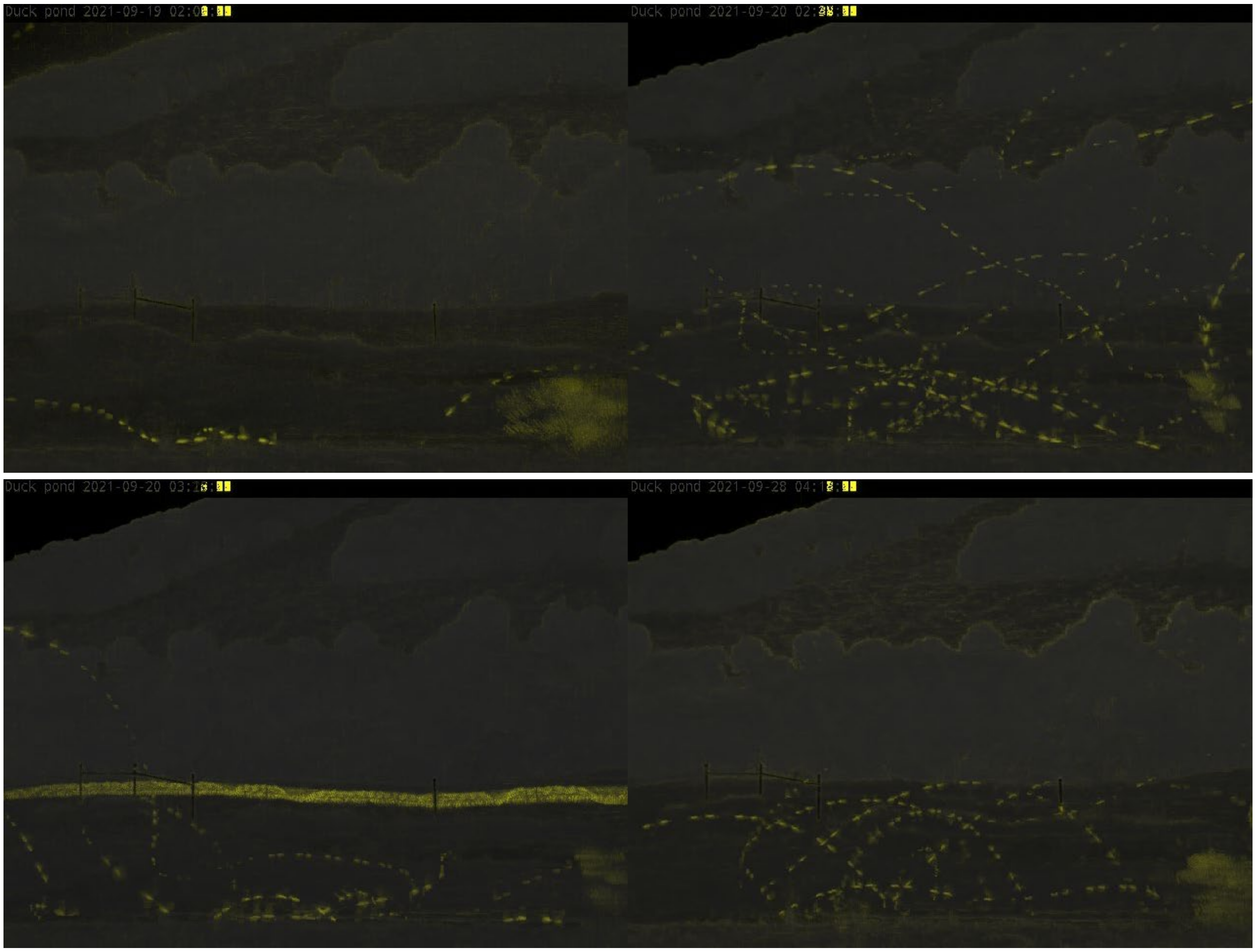

Photo 4. Example Photos Illustrating Hawaiian Hoary Bat Activity Varying over Several Nights from the Newly Installed Tier 4 Ponds in September 2021

The actions implemented by Auwahi Wind will be distinct from those implemented by DOFAW Maui, except in instances where Auwahi Wind will reimburse DOFAW Maui for management activities (i.e., fence installation and maintenance and ungulate removal). Auwahi Wind will fund DOFAW Maui through reimbursement for work completed that implements actions necessary to achieve the bat habitat enhancement and protection measures described in this document. The process by which Auwahi Wind will fund DOFAW Maui for management activities will be outlined in the roles and responsibilities section of the legally binding agreement between Auwahi and DOFAW associated with this SSMIP.

Auwahi Wind is responsible for implementing these measures and meeting the associated success criteria. In the event that DOFAW Maui is unable to complete fence and/or ungulate removal work, Auwahi Wind will seek third-party contractors to complete the specific tasks. This will be coordinated in advance following the terms of the legally binding agreement between the parties. For more specific timing of when these activities will occur refer to Section 11.

4.1 Action 1: Legal Protections to Benefit Hawaiian Hoary Bats

4.1.1 KMFR – Legal Protections

The Board of Land and Natural Resources approved the Kamehamenui Parcel (Tax Map Key (2) 2-3-005-002) to become part of Kamehamenui Forest Reserve. DOFAW is working on a forest management plan for Kamehamenui Forest Reserves.

To conduct management actions within the Kamehamenui Parcel, Auwahi Wind will secure a special use permit pursuant to chapter 13-104, Hawaii Administrative Rules, or enter into a legally binding agreement with DOFAW to identify roles and responsibilities for coordination of management activities, including best management practices for the prevention of fire, invasive species, and operational safety.

4.1.2 Haleakalā Ranch – Legal Protections

Auwahi Wind will prepare a 10-year management agreement (i.e. legal agreement) to allow for the installation, maintenance, and management of the above-ground water basin(s) on Haleakalā Ranch for the primary benefit of creating a water source for bats. The basin(s), described in Section 4.5, will likely outlast the agreement assuming Haleakalā Ranch plans to continue to use it for long-term fire suppression and livestock water once the agreement and mitigation term has expired.

The terms of the agreement will include the identified location of the basin(s), prescription of allowable uses, requirements to maintain water levels in the basin(s) and wildlife egress structure(s), documentation/reporting responsibilities, and ensuring the design precludes direct use of the water in the basin(s) by feral ungulates. The agreement will allow Haleakalā Ranch to draw water for watering cattle, fire suppression, or outplanting independent of the Auwahi Wind mitigation, so long as the draw down does not deplete the utility of the water levels for bats (Section 4.5). Operational controls, such as an elevated outlet, will limit how much water can be drawn for these other purposes, except for emergency use in fire suppression. The terms of the agreement will be reviewed and verified as adequately capturing the necessary criteria for this SSMIP by DOFAW prior to final execution.

4.2 Mitigation Action 1: Ungulate Exclusion Fence

The Mitigation Area will be protected from grazing pressure, through the installation and maintenance of fencing, to promote natural (passive) regeneration of vegetation. Outplanting of native species will be completed to develop native vegetation communities and create edge habitat throughout the currently grazed pasture; thus, enhancing the habitat for bat foraging. DOFAW Maui, independent of Auwahi Wind's mitigation, has acquired fencing material and procured a fencing contractor to install ungulate fencing to protect their Phase 1 area4. Auwahi Wind will reimburse DOFAW Maui for the cost of installing the approximately 4 miles of the Phase 1 perimeter fence around the ~2,300-acre Phase 1 area (see Figure 3), which is of approximately equivalent length to the perimeter of the 690-acre Mitigation Site. This new fencing will provide connectivity to the

Haleakalā Ranch fence, the Kula Forest Reserve, and mauka to the Haleakalā National Park, protecting the Mitigation Area within the larger DOFAW Maui Phase 1 area (Figure 3).

Auwahi Wind will reimburse DOFAW Maui for the cost of quarterly monitoring, maintenance, and repair along the length of the fence. DOFAW Maui will coordinate and report to Auwahi the progress of these activities in accordance with the legally binding agreement associated with this SSMIP.

4.3 Mitigation Action 2: Outplantings to Increase Bat Foraging Habitat

The Hawaiian hoary bat forages in open areas, at forest edges or within gaps, and over open bodies of water including streams, ponds, and ocean along the coast (Whitaker and Tomich 1983, Bonaccorso et al. 2015, Pinzari et al. 2019). The creation of edge habitat has been proposed to facilitate bats transiting the Mitigation Area and to serve as a foraging substrate (Entwistle et al. 2001, Jantzen 2012). Edge habitats in general provide efficient foraging habitat that minimizes commuting energy costs and maximizes foraging opportunities (Grindal and Brigham 1999). Edge habitats also provide benefits to some insect species (Langhans and Tockner 2014), as well as providing shelter where insects congregate and where bat foraging activity increases (Grindal and Brigham 1999). Based on acoustic data, Hawaiian hoary bats selectively foraged in gulches, low-density developed, and grassland habitats among nine habitat types in a study on Maui focused in the Kula area (H.T. Harvey 2020).

Auwahi Wind will outplant and maintain areas within the Outplanting Area to achieve a total of 138 outplanted acres in Tier 5, or 20 percent of the 690-acre Mitigation Area (Figure 7). Twenty percent forest cover corresponds to the first statistically significant peak in mainland hoary bat utilization (Jantzen 2012). Woodlands appear particularly important for the Hawaiian hoary bat, with call minutes and feeding buzzes twice as high in woodlands than in grasslands (Moseley et al. 2022) Auwahi Wind will maintain the outplantings as a matrix of open, edge, and canopied areas. A buffer of 8 feet or greater will be implemented along the loop trails proposed by DOFAW. Outplanting will be focused primarily within a 50-meter buffer around the DOFAW interpretive trail which will provide edge habitat both along the trail and along the exterior of the buffer.

DOFAW will also be planting trees in the Mitigation Area. DOFAW Maui has a long-term goal of native ecosystem restoration and at least 75 percent forest cover in the Phase 1 KMFR area. Auwahi Wind will plant fast growing species (koa) to achieve forest cover more quickly (approximately 5 feet/year under ideal conditions; Elevitch et al. 2006), while DOFAW intends to restore native ecosystems with plant communities representative of the natural biomes in Kamehamenui, including species (e.g., ʻiliahi or sandalwood [Santalum sp.]) which grow more slowly (typically 1 –2 feet/year; Merlin et al. 2006). This temporal difference in planting and the difference in species, will maintain edge habitat for Hawaiian hoary bat over a long period of time.

Within the Outplanting Area, trees will be planted and maintained to a density of approximately 100 trees per acre, or 20-foot spacing between the trees. The specific species of trees used for foraging does not appear important to Hawaiian hoary bats (Gorresen et al. 2013, Bonaccorso et al. 2015). Koa was selected as the only native tree which could grow fast enough to reasonably attain the necessary height to be suitable to increasing edge habitat and foraging opportunities by the end of

the planned operational period of the Project (December 2032). Koa is also identified as providing food for Hawaiian hoary bat insect prey on Maui (Banko et al. 2016, Pinzari et al. 2019). Similar to the parameters of Auwahi Tier 4 mitigation in the Amendment, Auwahi Wind will plant the Outplanting Area with koa at 100 trees per acre and in a manner designed to create interspersed gaps and 3-dimensional structure, unless other species or arrangements are mutually agreed on by the DOFAW and Auwahi Wind.

If the amount of koa trees is not available to sufficiently complete outplantings as described in this document, alternate plants will be included in the planting mix to ensure the acreage requirements are met. Any changes in seed mix will be coordinated with and approved by both USFWS and DOFAW. To facilitate species diversity, Auwahi Wind will also plant an additional tree per acre of ʻōhiʻa (Metrosideros polymorpha), ʻiliahi, or māmane (Sophora chrysophylla). Because ʻōhiʻa, māmane, and ʻiliahi are slow growing, these supplemental trees will not be included in the assessment of canopy height, connectivity, or forest cover as they will likely not be of suitable size for bat use until well beyond the end of the planned operational period of the Project (December 2032). The metric used to assess forest coverage initially, will be the number of acres outplanted by Auwahi Wind with trees, but over time the expansion of canopy cover will be quantified using aerial imagery.

4.4 Mitigation Action 3: Vegetation Control

Auwahi Wind will conduct invasive vegetation control throughout the KMFR Mitigation Area to enable the Koa trees to thrive and to aid in regeneration of the native seed bank and establishment of native outplantings by decreasing the competition from invasive, non-native woody plants. Vegetation control will include initial and ongoing monitoring to identify the establishment of any new invasive woody plant species in the Mitigation Area, which will be subsequently removed; it is expected mechanical removal of specific species to be the primary method of control and management. Based on species lists from the management plan for the nearby Kula Forest Reserve (DOFAW 2017), species such as gorse (Ulex europaeus), Australian tree fern (Sphaeopteris cooperi), mysore raspberry (Rubus niveus), Florida blackberry (Rubus argutus), banana poka (Passiflora tarminiana), cotoneaster (Cotoneaster pannosus), or plume poppy (Bocconia frutescens) can be expected. For invasive woody plant species already present, such as the existing pine stands, vegetation management will be implemented to prevent any further spread of those species. Over time, the target species and management plan will be coordinated with DOFAW so these actions are compatible with DOFAW's larger KMFR management program, focused toward managing the species of highest concern for spread, as practicable.

4.5 Mitigation Action 4: Ungulate Removal

Auwahi Wind is committed to ensuring the outplantings reach maturity to provide benefits to bats. To protect the outplanted trees from non-native ungulates, DOFAW estimates the Mitigation Area will be ungulate free within 1 year of fence completion (Figure 3; Lance De Silva, pers. comm., 2021). Auwahi will reimburse DOFAW for the Mitigation Area-equivalent cost of ungulate eradication within the KMFR Phase 1 area.

Maintaining the Mitigation Area free of ungulates will facilitate passive forest restoration. The Mitigation Area has remnant subalpine shrubland and is expected to have a significant native seed bank which will facilitate passive restoration once ungulates are removed. Similar ungulate removal efforts have yielded passive restoration results at Haleakalā National Park and in the Kahikinui Forest Reserve/Nakula Natural Area Reserve. Restoration specialists Forest and Kim Starr similarly expect passive restoration resulting from ungulate removal to result in native regeneration throughout the Phase 1 area (Starr, pers. comm., June 2022; Lance De Silva, pers. comm., June 2022). Given expected lags in establishment of trees from the native seed bank, over timeframes longer than the mitigation project, this would be expected to contribute a more diverse patchwork of forest suitable for bat foraging. Upon signing of the legally-binding agreement, Auwahi will reimburse DOFAW for the Mitigation Area-equivalent cost of the initial ungulate control activities, and each year the subsequent quarterly ungulate monitoring and control.

4.6 Mitigation Action 5: Water Source

Open water features are scarce on leeward Haleakalā and monitoring from Tier 2-3 research and Tier 4 mitigation monitoring has demonstrated the value of water features for bats on Maui. In the Tier 4 Mitigation Area, bats were documented at notably higher densities at the existing duck ponds. The capture of eight adult males over two sampling periods spanning eight months and within the limited area suitable for netting bats, indicated a degree of co-occurrence as-yet not observed elsewhere. Bats have also been documented utilizing the new ponds installed as part of Auwahi Wind's Tier 4 mitigation within 6 months of being filled. In March 2021 the ponds were filled, and by September 2021 when thermal monitoring occurred at the newly installed ponds, the thermal monitoring documented bats using the pond throughout the night, suggesting multiple bats are benefiting from the pond installation with minimal lag time from pond completion.

Auwahi Wind will add an above-ground water basin(s) ideally within the previously identified approximately 2-acre parcel on Haleakalā Ranch, pending site suitability for an above-ground feature (Figure 5, Figure 7) to increase the availability of water sources for the Hawaiian hoary bat. If this location is not ideal, an alternative site in the portion of Haleakalā Ranch adjacent KMFR will be used. A secondary benefit of installing this basin(s) is creating local availability of water for fire suppression, necessitating the basin(s) be of sufficient volume to support this emergency need should it arise.

According to Taylor and Tuttle (2012), the minimum size of a water feature used by bats for drinking varies according to species, but a basin with a minimum diameter of 20 feet will accommodate most mainland bat species, and a minimum height of 4 feet will preclude use by non-bird/bat animals. Further, Taylor and Tuttle (2012) recommends including wildlife egress capacity; Auwahi will include wildlife egress in the final tank design. Because tank dimensions are affected by location and logistics, the exact size and shape of the water feature(s) will depend on the site conditions and availability of suitable tanks, but to allow for bat drinking and fire suppression, minimum dimensions will be 20-foot diameter, 4-foot depth/height, and 20,000 gallon-or-larger capacity per feature. An additional above-ground water basin(s) will be installed if 50,000 gallons of capacity cannot be accommodated by one feature. Installation of such a water feature(s) is expected

to increase bat foraging and drinking resources given the relatively dry environment in the local area.

A third anticipated use of the water source includes draw-down capabilities for cattle watering by Haleakala. Water levels in the basin(s) will be manually or electronically confirmed on a minimum monthly basis, during other routine maintenance or monitoring activities. Except for emergency fire situations, the water levels in the basin(s) will be maintained so it represents an available drinking water source; if used for emergency purposes, water levels will be restored as soon as possible. The final non-emergency draw-down and emergency fire suppression parameters will be agreed upon between Auwahi and Haleakala Ranch in the associated legal agreement.

5.0 Complementary DOFAW Management Actions for KMFR

In addition to the actions planned by Auwahi Wind (outlined above), DOFAW's management plan for KMFR includes native ecosystem restoration, which is complementary to the mitigation proposed in this SSMIP. DOFAW has completed 22,000 feet of fence necessary to connect from the existing Haleakalā Ranch fence, along the makai boundary of the Phase 1 area to the Kula Forest Reserve, and mauka to the Haleakalā National Park (Figure 3). DOFAW plans to enhance the Outplanting Area with ʻiliahi, ʻōhiʻa, and native understory species that comprise natural plant communities in Kamehamenui. The Outplanting Area will provide a seed source. Plans to place ʻiliahi plantings between the koa trees are being planned with Hawaiʻi Agricultural Research Center.

These additional species plantings will not be required to meet Auwahi Wind's forest cover goals but the diversity of native species will provide additional net benefits. The Mitigation Area may support additional compatible uses, including public access, outdoor recreation, seed orchards, and related forestry operations that are compatible with native ecosystems, endangered species, and bat mitigation. The timeline for growth of other species besides koa varies based on species and environmental conditions, for example, ʻiliahi requires 7 years or more before flowering and 10 years before heartwood develops. Because of the distinct growth timelines for each species, the benefits of Auwahi Wind's koa outplanting can easily be distinguished from other species outplanted when assessed as outlined below in Section 6.3.

6.0 Monitoring

Auwahi Wind will conduct monitoring to track the response of the Hawaiian hoary bat to the mitigation actions in the Mitigation Area. Monitoring efforts will include bat activity (acoustic and thermal) as described in Section 6.2. Auwahi Wind will also monitor insect biomass and diversity, and forest cover. These variables will be used in regression modeling, as described in Section 7.0, to determine whether changes that result from mitigation actions are correlated to changes in bat foraging activity.

Bat behaviors identified in acoustic monitoring files are the primary means that Auwahi Wind will use to characterize foraging activity. Generally an increase in bat foraging activity is expected following the implementation of mitigation actions. However, interpreting bat behavior can be nuanced. So while the monitoring program described below is intended to determine whether or not bat foraging activity has increase as a result of the mitigation actions, it is also intended to characterize how bats are using the site, what portions of the site are being used for what purpose, and the availability of prey species.

6.1 Monitoring Periods

Monitoring in the Mitigation Area will be conducted over three periods:

- Pre-Trigger, Baseline Monitoring.
- Baseline Monitoring, and
- Post-Mitigation Implementation Monitoring.

Pre-Trigger, Baseline Monitoring has been underway since 2022 and consists of an initial deployment of two acoustic detectors to document site-specific Hawaiian hoary bat activity (Attachment 3) for up to 5 years. This information will be used to determine the level of acoustic monitoring required to measure pre-mitigation baseline activity levels and post-mitigation implementation activity levels. Pre-trigger, Baseline Monitoring will conclude and a report submitted to the agencies when mitigation implementation begins.

Baseline Monitoring and Post-Mitigation Implementation Monitoring will include measures of acoustic bat activity (Section 6.2), percent forest cover (Section 6.3), thermal monitoring (Section 6.4), and insect monitoring (Section 6.5). Baseline Monitoring will occur before mitigation actions have had an opportunity to affect the local bat population. Post-Mitigation Implementation Monitoring will occur periodically thereafter in order to measure the effect of the mitigation actions on bat foraging activity.

Baseline Monitoring will occur as soon as practicable and no later than 6 months from the start of Mitigation Actions outlined in Section 4. The acoustic Baseline Monitoring will be used to assess increases in bat activity in the Mitigation Area and will consist of up to 5 years of acoustic monitoring after approval of this SSMIP by USFWS and DOFAW HCP staff. Baseline monitoring periods are shorter for other variables, due to the expectation that responses to mitigation actions (i.e., increase in forest cover) measured by the monitoring are likely to occur more quickly, or due to a recognition that completion of the mitigation action sooner, rather than later, would have a more immediate benefit for bats (i.e., installation of the water source). These monitoring periods are described in the individual sections below and the associated information will be primarily used to inform adaptive management actions, if required.

Post-Mitigation Implementation Monitoring will consist of acoustic monitoring for the remainder of the planned operational period of the Project (through December 2032) after the Baseline Monitoring period (or until the success criteria is met).

Table 2. Summary of Tier 5 SSMIP Goal, Objective 2, Mitigation Actions, and Monitoring Actions

Goal	Increase Hawaiian hoary bat roosting and foraging habitat, and prey availability within a 690-acre portion of the KMFR (Kamehamenui Parcel) and create a water source on the adjacent Haleakalā Ranch (private landowner) lands (collectively "Mitigation Area") through long-term legal protection and management, habitat creation and enhancement, and ungulate removal.
Objective 2	Increase in Hawaiian hoary bat roosting and foraging habitat, and prey availability within the Mitigation Area.

<table>
<tr><th>Mitigation Actions</th><th>Monitoring Actions</th></tr>
<tr><td>Mitigation Action 1 – Ungulate exclusion Fence: Upon approval of this SSMIP and associated legally binding agreement, reimburse DOFAW Maui for the cost of construction and quarterly inspection, maintenance and repair of a deer-proof fence enclosing the Mitigation Area, as shown in Figure 1.</td><td rowspan="5">Acoustic monitoring in Mitigation Area.
Annual tracking of forest cover.
Thermal camera monitoring at water source and outplantings.
Insect monitoring.</td></tr>
<tr><td>Mitigation Action 2 – Outplantings: Complete outplanting of 138 acres of koa within one year following the removal of ungulates from the fenced Mitigation Area.</td></tr>
<tr><td>Mitigation Action 3 – Vegetation Control: Enhance growth and survival of native vegetation through quarterly invasive plant management within the Mitigation Area to help decrease the competition from invasive, non-native plants.</td></tr>
<tr><td>Mitigation Action 4 – Ungulate Removal: Upon approval of this SSMIP and associated legally binding agreement, reimburse DOFAW Maui for the area-equivalent cost of removal and ongoing monitoring/control of feral ungulates from the Mitigation Area, as shown in Figure 1, to protect areas to be revegetated through outplanting from browsing by feral ungulates.</td></tr>
<tr><td>Mitigation Action 5 – Water Source: Within one year of SSMIP approval, install a new above-ground water basin(s) to provide a local drinking water source for bats, and for emergency fire suppression in the vicinity.</td></tr>
</table>

6.2 Acoustic Monitoring

For many cryptic species, especially echolocating bats, acoustic monitoring is a well-established method for monitoring bat activity patterns, changes in habitat use, and activity of bats across habitats (Hayes 1997, Hayes 2000, Broders et al. 2003, Gehrt and Chelsvig 2003, Gehrt and Chelsvig 2004, Gorresen et al. 2008, Hayes et al. 2009, Parsons and Szewczak 2009, Frick 2013, Sugai et al.

2019, Peterson et al. 2021, Ross et al. 2023). Currently, it is not yet possible to use acoustic data to make any inferences about population abundance or densities as individuals cannot be reliably identified from acoustic data alone (Poe 2007, Hayes et al. 2009, Frick 2013, Fill et al. 2023). For example, it is not possible to know if 10 bat passes represent 10 bats or one bat passing 10 times (Frick 2013). However, there is a vast amount of conservation-relevant information that can be derived from acoustic signatures associated with particular behaviors (Teixeira et al. 2019). In bats, acoustic signatures can be used to identify various states of foraging behavior (i.e., active or passive) or feeding rates, socializing, and grouping behavior (i.e., multiple individuals). When combined with knowledge on the timing of key life-history stages, vocal behaviors from acoustic data can be used to identify important habitats for reproductive success. Examining the spatial and temporal trends in vocal behaviors through acoustic monitoring can provide a means to assess habitat quality, evaluate the effectiveness of conservation actions, and identify factors in the environment that could be adaptively managed (Teixeira et al. 2019).

Auwahi Wind implemented acoustic monitoring at KMFR, following the commitments in the HCP Amendment (Section 6.2.5.1 in Tetra Tech 2019). In May 2021, following consultation with DOFAW, Auwahi Wind deployed two acoustic detectors for Pre-Trigger, Baseline Monitoring to document site-specific Hawaiian hoary bat activity. Acoustic monitoring locations were selected based on accessibility and proximity to the anticipated location of the Mitigation Area. Due to the relative homogeneity of the habitat and land use, the monitors could have been located virtually anywhere within the mesic to subalpine zones at Kamehamenui to get a representative sample of bat activity. The Pre-Trigger, Baseline Monitoring will provide preliminary insight on bat activity at the Mitigation Area and inform planning of acoustic monitoring methods. Pre-Trigger, Baseline Monitoring will be suspended at the start of Baseline Monitoring (Attachment 3).

Baseline Acoustic Monitoring for the Hawaiian hoary bat will be conducted in the Mitigation Area year-round for the first 5 years of SSMIP implementation. Auwahi Wind will conduct acoustic monitoring (Post-Mitigation Implementation Monitoring) year-round after the Baseline Monitoring period, every other year, for the remainder of the planned operational period of the Project (December 2032) or until success criteria have been satisfied; acoustic monitoring will begin no later than six months after mitigation actions have started.

Baseline Acoustic monitoring will be established at 14 or more locations within the Mitigation Area. to provide a high level of granularity in bat use and response to management within the Mitigation Area. Due to the level of bat activity documented during Pre-Trigger, Baseline Monitoring (Attachment 3) this number of detectors will provide enough data to discern bat behaviors at the mitigation site, such that changes in behavior from baseline can be distinguished. At least 4 of these

detectors will be placed within the Outplanting Area. The remaining detectors will be distributed throughout the Mitigation Area, stratified by habitat type (e.g., scrub shrub, grassland) and land use (i.e., recreational use and forestry areas). One detector will be installed at the new above-ground water basin, or one at each basin if more than one basin is installed, at the Haleakala Ranch parcel. Detector checks are planned monthly during year-round deployments but will occur no less than twice per year in monitoring years, with data collection, metrics, and analyses following that described for Tier 4 (Tetra Tech 2019). Methods and results will be included in the annual report for the years when acoustic monitoring occurs.

One of the goals of monitoring is to provide a quantifiable measure of bat foraging activity. Therefore, any modification of the acoustic monitoring must be done systematically to account for any previous monitoring. Additionally, efforts will be made to ensure that all monitoring is comparable; minimizing changes in location, technology (such as microphones), or software/firmware to maximize the ability to compare pre- and post-mitigation actions.

Changes in bat foraging activity will be assessed using several metrics obtained from acoustic data recorded throughout the mitigation area. The use of animal vocalizations accompanied with an applied knowledge of associated behaviors can be a useful tool for monitoring a populations response to conservation actions (Teixeria et al 2019). Together these metrics will be used as a proxy for bat activity to provide a better understanding of the response of bat use at the mitigation area following the implementation of mitigation actions.

Changes in bat acoustic activity will be assessed using detection rate (the number of sampling nights with detections/the number of sampling nights). In addition, based on Teixeira et al. (2019) the following activity metrics will be used to evaluate changes in bat activity within the Mitigation area over time. Teixeria et al. (2019) suggests that vocalizations can serve as indicators of behavioral states and contexts that provide insight into populations as it relates to their conservation.

- Number of nightly call files;
- Number of echolocation pulses;
- Type of call (i.e., passive or active search call, and feeding);
- Foraging duration; and
- Timing of nightly activity.

See Section 7.0 for more discussion on modeling that will be used to determine whether there are correlations between the results of mitigation actions and changes in bat activity.

6.3 Percent Forest Cover

Optimal forest cover as documented by Jantzen (2012) is 20 to 25 percent cover of the Mitigation Area to optimize hoary bat utilization of the site. The percent forest cover of the Mitigation Area will be assessed through GIS analysis using aerial imagery; either imagery taken by satellite if less than 1 year old or taken by drone. Percent forest cover will be assessed during the Baseline Monitoring

period, and the baseline forest cover will be established following the final year of Baseline Monitoring. Percent forest cover will then be resampled during subsequent monitoring years.

It is assumed that the percent forest cover will increase each year and that the goal of at least 20 percent (138 acres) forest cover will be reached by Year 5 after outplanting is completed (likely 2030 – 2031). As long as forest cover is increasing, no additional actions are necessary. If, in Year 5 forest cover has not reach the goal of 20 percent, then Auwahi Wind will replant native plants necessary to bring the native plant cover up to 20 percent. Prior to additional required planting, Auwahi Wind may first error check or resample the Outplanting Area to ensure that any measurement that does not meet success criteria was not the result of seasonal variation or inconsistencies in the data collection method.

6.4 Thermal Camera Monitoring

Thermal monitoring is a valuable tool for characterizing bat behavior. The goal of thermal monitoring is to provide additional insight into bat behavior to improve management decisions for improving bat habitat.

6.4.1 Bat Use of Water Features

Although Hawaiian hoary bats are theorized to use water tanks and other man-made features, the level of use, use patterns, intensity, and frequency have not been well documented. If bats are documented to use water tanks for foraging, drinking, or both, using thermal cameras to record these behaviors would add to the body of knowledge used in bat management.

Accordingly, Auwahi Wind will document bat use in response to installation of the one or more installed above-ground water basins, as described in Section 4.6. Thermal Monitoring will be limited to one season (between August 1 through October 31 time period), in one year of the first three bat reproductive seasons at each basin, after installation. If no bat activity is documented, a second season of monitoring will be performed in one of the subsequent three bat reproductive seasons.

6.4.2 Bat Use of Outplanted Trees Over Time

Thermal monitoring of bat use of foraging habitats relative to habitat features may improve our understanding of bat foraging strategies. Bats use of forest habitat has been well documented as described in the HCP Amendment, and this management plan. However, no study has looked at how bats use vegetation of different stature, or age. Additionally, bat experts have theorized that bats may use the top of forest canopy similar to edge habitats, which would vastly increase the current assessment of available foraging resources for bats. This mitigation provides a unique opportunity to investigate these bat/habitat interactions over time, as forest vegetation develops and vertical structure changes.

Auwahi Wind will use two thermal cameras during the high activity months of August through October to monitor forest canopy and forest edge during the first year following approval of the

SSMIP, and at 2-year intervals, thereafter. Monitoring will not occur for the entire three months, but will occur for whatever amount of time necessary to adequately characterize bat occurrence and behavior at the monitoring locations. That will include monitoring in years 1, 3, and 5 during the Baseline Monitoring period. For the remainder of the planned operational period of the Project (December 2032), at the 2-year intervals (years 6 and 8), Auwahi will re-deploy these cameras to measure activity rates in the Outplanting Area. After year 8, Auwahi Wind, the USFWS, and DOFAW will discuss whether continued monitoring is warranted. Any additional monitoring would examine changes in bat activity over time, as the forest structure changes, and would be separate from Implementation Monitoring, once success criteria are achieved.

Auwahi Wind will use the relative activity rates at 10-minute intervals from sunset to sunrise to characterize bat activity rates and compare activity rates between monitoring years. This is a new method of monitoring and will therefore not be tied to success criteria but will provide both a quantitative and qualitative assessment of bat use rates over time and bat behavioral changes observed as a result of outplanted koa age and forest cover.

6.5 Insect Monitoring

Arthropod monitoring will be conducted to determine the response of bat prey communities, specifically diversity and overall biomass, to the implementation of management actions. Biomass was chosen as a response variable as it has shown to be a strong response variable when investigating trophic interactions and can provide a more accurate picture of the processes driving changes in community structure (Saint-Germain et al. 2007). Arthropods will be sampled in the Mitigation Area during each monitoring year using two methods:

- Six malaise traps with two collection reservoirs each, deployed at evenly distributed locations within the Outplanting Areas and at the water feature(s). Monitoring locations will remain consistent throughout all sampling years.
- One UV Light trap deployed within each malaise trap (6 traps total) for a duration of three hours per night-time sampling period over the course of three consecutive sampling nights.

Auwahi will quantify insect abundance in the Mitigation Area using at least 3 insect traps during Years 1 – 2 to establish a baseline level of arthropod diversity and biomass. In Years 3, 5, and 7, Auwahi will conduct quarterly insect monitoring (Table 3). Insect monitoring is a tool to assess the impact of mitigation actions and identify appropriate changes to management, if necessary, through adaptive management. Auwahi Wind will conduct quarterly insect monitoring for the Baseline Monitoring period (up to 2 years) for both managed edge habitat and water features. If at any point insects in the coleoptera order are not being detected in expected numbers, pitfall traps may be used during focused sampling for those species. Following the sampling, the lepidopteran and coleopterans will be identified and insect biomass and diversity of each order (for insects over 10 millimeters) will be reported in the annual report.

6.6 Other Monitoring

Other monitoring may be added or substituted to the monitoring protocol if Auwahi Wind determines that there are more effective ways of determining whether success criteria are being met. Changes in monitoring protocols will be coordinated with USFWS and DOFAW and any changes to the monitoring program will be agreed to by all parties. Additional tools or monitoring methods may be developed or adopted as industry standards which are not available today or are currently considered experimental. Auwahi Wind will continue to evaluate the state of science and assess the applicability of tools to meet the success criteria for the mitigation. Table 3 provides a summary of expected mitigation and monitoring actions by year.

Table 3. Summary of Expected Mitigation and Monitoring Actions by Monitoring Year

Action	Monitoring Year									
	Post-Trigger	Post-Trigger	1	2	3	4	5	6	7	8
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Complete ungulate exclusion	X	X								
Complete feral ungulate removal		X	X							
Install water basin(s)			X	X						
Complete plantings in Outplanting Area			X							
Acoustic monitoring in Mitigation Area (Section 6.2)			B	B	B	B	B	I		
Thermal monitoring in Outplanting Area (Section 6.4)			B		B		B	I		I
Acoustic monitoring at new water basin(s)			B	I		I		I		I
Thermal monitoring at new water feature(s)				I						
Quarterly insect monitoring			B	B	I		I		I	
Assess percent forest cover of Mitigation Area (Section 6.3)		B			B	I	I	I	I	I

X = Action will be completed; B = Baseline monitoring; I – Implementation monitoring

1. The timeline for the associated actions described are Auwahi Wind's best estimate based on current information; however, timing of approvals, logistical challenges, or other factors may affect the precise scheduling of actions (e.g., the installation of the basin(s)). Changes in the timing of a mitigation action are also likely to affect the associated monitoring. The commitments to the timing of mitigation actions and associated monitoring are described in sections 4.0, 6.0, and their respective subsections.

2. Ten-year timeline presented aligns with the remaining planned operational life of the Project, through 2032 (Section 1.1 in Tetra Tech 2019).

7.0 Modeling

Linear mixed model regression analysis will be conducted to test for correlations between bat acoustic activity and environmental variables that will be influenced by the mitigation actions among years. This model framework treats monitoring locations as spatially independent. Acoustic monitors will be distributed widely to minimize the spatial autocorrelation among adjacent monitors. If large spatial correlation is suspected, analysis methods to take this into account can be considered (Dormann et al. 2007).

The primary variables that will be used to indicate bat activity are the number of nightly call files and number of echolocation/feeding buzzes, though number of detection nights and detection probability may also be used. The assumption is that following implementation of mitigation actions, namely forest outplantings and removal of ungulates, bat activity will increase by the end of the permit term.

The regression analysis will illustrate the strength of the relationships between changes in bat foraging activity and other measured variables, such as percent forest cover and changes in insect diversity or biomass. Fixed parameters in the models may include but are not limited to year, proximity to outplanting area or water feature, elevation, temperature, and rainfall. Sampling location will be included as a random parameter.

Among highly correlated bat activity metrics the use of Principal Component Analysis (PCA) will be explored to reduce the number of inputs for the linear mixed model analysis, while maintaining interpretability of changes in bat acoustic activity. For example, the number of nightly call files may be highly correlated with number of echolocation pulses. In that case, PCA results would indicate that combining those variables into a single input is statistically justified and would improve the linear mixed model regression. Using PCA prior to regression analysis, especially in the presence of multiple environmental variables, is common because it enhances the regression model's interpretability.

Information gained by the number of nightly call files and number of echolocation pulses will be supplemented by the type of call (i.e., passive or active search call, or feeding call), foraging duration, and time of nightly activity. These variables will be tracked to provide greater context for what bats are doing at the mitigation site while they are there, how long they stay, and when they arrive; these variables may be used in the linear mixed model regression analysis as well.

8.0 Success Criteria

Because the Hawaiian hoary bat is a solitary tree-roosting species, monitoring can be difficult. Industry standard methods of monitoring have included using acoustic monitoring of bat activity, particularly the quantification of feeding buzzes to assess changes in foraging activity as a result of mitigation actions. Todd (2012) and Gorresen et al. (2018) used similar acoustic monitoring

approaches to assess foraging activity in different habitats. Supplementing acoustic monitoring with thermal camera videography can provide a qualitative assessment of behavior. The following success criteria will be used for each objective:

Objective 1: Secure long-term legal protection for the Mitigation Area.

Success Criteria for Action 1:

Action 1 – Legal Protection: Execute legal instruments with DOFAW Maui and Haleakalā Ranch to ensure protection of the lands for conservation purposes and to guarantee no other activities could occur that would harm bats or reduce conservation benefits. Ensure the installation, maintenance, and management of bat-safe above-ground water basin(s) located on Haleakalā Ranch property is under legal agreement for 10 years. The terms of the management plan established under the agreement will be reviewed and verified as adequately capturing the necessary criteria for this SSMIP by DOFAW prior to final execution.

- Verify agreement terms with DOFAW and confirm execution of legal agreement for above-ground water basin(s) on Haleakalā Ranch property within 6 months of SSMIP approval.
- Confirm execution of necessary permits and agreements with DOFAW for access and management action within the Kamehamenui Parcel.

Objective 2: Increase in Hawaiian hoary bat roosting and foraging habitat, and prey availability within the Mitigation Area.

Success Criteria for Mitigation Actions:

Broadly, the success of the SSMIP is contingent upon completion of the Mitigation Actions and Success Criteria in this section. Cumulatively across these Mitigation Actions, the SSMIP assumes that if there is a statistically significant increase in bat acoustic activity (as demonstrated through monitoring several metrics, see Section 6.2) following 5 years of implementation, then the bat activity within the Mitigation Area has successfully increased.

Mitigation Action 1: Phase 1 Exclusion Fence: DOFAW completed the fence in March 2024.

- Upon approval of this SSMIP and associated legally binding agreement, reimburse DOFAW for the cost of Phase 1 fence installation.
- Annually reimburse DOFAW for the costs of monitoring, maintaining, and repairing the equivalent length of fence enclosing the Mitigation Area.
- Document annually inspection and repairs using information provided by DOFAW from monitoring, maintenance, and repairs.

Mitigation Action 2 – Outplantings and Passive Restoration: Complete outplanting of 138 acres of koa within one year following the removal of ungulates from the fenced Mitigation Area at a rate of 100 stems/acre, designed to include interspersed gaps to provide three-dimensional structure and edge habitat.

- Plant 138 acres of Koa at 100 trees per acre within one year following the initial removal of ungulates from the fenced Mitigation Area, or approval of this Plan and execution of the legally binding agreement, whichever occurs later.
- Document 20 percent canopy cover by year 5 and maintain coverage through 2032 within the 690-acre Mitigation Area.

Mitigation Action 3 – Vegetation Control: Enhance growth and survival of native vegetation through quarterly invasive plant management in the Mitigation Area to help decrease the competition from invasive, non-native plants.

- Document no new woody invasive plant species have become established in the Mitigation Area
- Document annually invasive woody plant species present at baseline have not expanded in distribution within the Mitigation Area.

Mitigation Action 4 – Ungulate Removal:

- Upon approval of this SSMIP and associated legally binding agreement, reimburse DOFAW Maui for the removal of feral ungulates to protect areas to be revegetated through outplanting.
- Annually, reimburse DOFAW for quarterly ungulate monitoring and removal.
- Document annually monitoring and removal of ungulates from the Mitigation Area using information provided by DOFAW.
- Document annually ingress into Mitigation Area not to exceed two ungulates per mission on average per year based on information provided by DOFAW.

Mitigation Action 5 – Water Source:

- Within one year of SSMIP approval, install a new above-ground water feature(s) to increase and diversify foraging habitat/substrate for bats and bat prey (i.e., insects).

8.1 Take Offset/Net Benefit

For Tier 5 Mitigation, the SSMIP will increase Hawaiian hoary bat roosting and foraging habitat, and prey availability within the Mitigation Area. The size of the Mitigation Area is based on the core use area of 20.3 acres per bat (Amendment pg 6-43). Mitigation actions are anticipated to offset the take of 34 bats. Auwahi Wind will include a bat monitoring program to document a statistically significant increase in bat activity at the site as a result of mitigation actions. If success criteria outlined in Section 8.0 are reached, then the mitigation actions will be considered to offset bat take.

8.2 Additional Ecological Benefits

In addition to benefits to the Hawaiian hoary bat, management and enhancement of habitat within the Mitigation Area is expected to protect native ecosystems and other native species. Fencing, ungulate removal and native flora and fauna recovery are expected to enhance recovery efforts for

other endangered wildlife including the ʻuaʻu, forest birds, and nēnē. ʻUaʻu have been documented in the Mauka portion of the KMFR and will likely experience a decrease in burrow trampling after ungulates are removed resulting in more ʻuaʻu surviving to adulthood. Forest birds such as iʻiwi are documented in the adjacent Kula Forest Reserve and will benefit from the increase in native tree habitat. Nēnē are known to suffer from predation from feral pigs and will likely experience increased survival as a result of fencing and ungulate removal. These additional benefits support the HRS 195(D)(4)(g)(8) requirement ʻto provide net environmental benefits.'

9.0 Reporting

Quantitative measures identified for each monitoring variable described in Section 6.0, along with the success criteria summarized in Section 8.0 will be the primary metrics for analysis. Auwahi Wind will include in the annual report a summary of the data by year, including the Baseline Monitoring Years. Specifically, Auwahi Wind will include in the annual report:

- A report on the results of pre-trigger baseline monitoring and baseline monitoring in Section 6.0;
- Affirmation the legally binding agreement or permit with DOFAW is fully executed;
- Photos of new and existing above-ground water basins;
- In the year(s) in which the acoustic monitoring is conducted, Auwahi Wind will report the results and changes from the baseline, including the statistical power with which any change is documented for each parameter;
- Auwahi Wind will report annually in the Auwahi HCP annual report on the mitigation actions implemented and associated results of changes that occur during the restoration process. These parameters will include:
    - Metrics and status of success criteria identified in Section 8.0 above;
    - Number of trees planted, acreage planted, and percent of forest cover above baseline;
    - Length of edge habitat created;
    - Size in gallons, and surface area of new basin(s);
    - Characterization of bat foraging behavior;
    - Relationship between changes in bat foraging behavior and changes in quality and quantity of bat foraging habitat;
    - A summary of insect biomass and diversity by quarter and year, and a comparison to acoustic monitoring results in years of monitoring;
    - A summary of the thermal monitoring results for both:

  - Bat use of water features; and,
  - Bat use of outplanted trees over time;
- Any adaptive mitigation actions taken; and
- Any additional pertinent summary information needed to provide a full picture of mitigation actions.

10.0 Adaptive Management

Adaptive management may be necessary if the planned mitigation actions do not result in stated success criteria. The outcomes of mitigation actions will be evaluated against the success criteria outlined in Section 8.0 through monitoring, outlined in Section 6.0. Should success criteria not be met in the time period stated, adaptive management will be triggered. This may result in either modified monitoring activities, modified or additional management activities, or a combination of both. Due to the short time remaining in the permit term adaptive management opportunities that could yield a response during the permit term are limited. Installation of an additional water feature would be the primary adaptive management action, if a sufficient increase in bat foraging activity is not observed, although additional vegetation management activities and supplemental plantings inside the KMFR Tier 5 area could also be used if forest canopy cover is not achieved. Triggers and corresponding responses developed for Tier 4 mitigation as prescribed in Section 6.4.2.7 of the Amendment will also be used for Tier 5.

Any adaptive management actions or additional monitoring that is required through the adaptive management process, beyond what is outlined in this document and the Amendment, will be discussed with and approved by USFWS and DOFAW prior to the implementation of new management or monitoring activity. Any changes to management activities will be consistent with the terms and conditions of the legally binding agreement between Auwahi Wind and DOFAW. Triggers and corresponding responses developed for Tier 4 mitigation (Tetra Tech 2019) will also be used for Tier 5.

Beyond understanding that benefits to specific implemented mitigation actions may vary and require adaptive management, Auwahi Wind recognizes that all or part of the implementation of Tier 5 mitigation actions in the Mitigation Area may not be feasible within the estimated timeline (Section 11.0). Should this occur, Auwahi Wind will work with DOFAW and USFWS to identify an alternate or supplemental area and/or action to replace all or component parts of the identified mitigation actions in coordination with USFWS and DOFAW. Auwahi Wind has had preliminary discussions with Haleakalā Ranch, bordering the Mitigation Area (Figure 2, Figure 7), and has determined that it may be a suitable location for implementation of a supplemental component of the mitigation plan (See Attachment 1), should the need arise. Table 4 describes the adaptive management workflow to be used for triggering and responding to conditions at the Mitigation Area. Broadly, this approach uses information from the implementation and monitoring program to identify and respond effectively to root causes for failure to meet mitigation objectives.

Table 4. Summary of Monitoring and Adaptive Management Program

Objectives	Success Criteria	Adaptive Management Trigger	Considerations for Adaptive Management Response	Example Adaptive Management Reponses
Objective 1: Secure long-term legal protection for the Mitigation Area.	Execution of agreement	N/A	N/A	N/A
Objective 2: Increase in Hawaiian hoary bat roosting and foraging habitat, and prey availability within the Mitigation Area.	A statistically significant increase in bat activity across the Mitigation Area and an increase in bat foraging activity in the Outplanting Area, by the end of the permit term.	Hawaiian hoary bat activity that is not increasing (i.e., neutral or decreasing) across the Mitigation Area at the end of Year 6 after completion of outplantings.	If bat activity is not increasing across the Mitigation Area at Year 6 after completion of outplantings, but bat foraging activity is trending in the positive direction at the Outplanting Area, then the adaptive management response shown in the last column will be employed. If bat activity in trending neutral or in the negative direction at Year 6 following the completion of outplantings, then the adaptive management response shown in the last column will be employed.	Conduct acoustic monitoring during the following year (Year 7 following completion of outplantings) and rerun analysis. Additional data collection strengthens regression models by enhancing its ability to detect significant effects. Investigate trends in forest cover and in insect biomass and diversity and their correlation with bat activity in general and foraging activity specifically, and determine if any adaptive management actions shown in the row below, could be employed to increase the chance of meeting success criteria by the end of the permit term. Deploy actions as needed. Auwahi Wind will install an additional water feature near the Mitigation Area. If forest cover is not at least 20 percent (138 acres) above baseline condition Auwahi Wind will complete supplemental plantings in order to get forest cover to at least 20 percent by the end of an agreed upon timeframe with USFWS and DOFAW.

10.1 Alternative Mitigation Actions

If the modification of mitigation actions described in Section 10.0 is not feasible as an appropriate adaptive mitigation action, Auwahi Wind will work with USFWS and DOFAW to identify appropriate alternative actions based on the monitoring data.

10.2 Monitoring

If new management actions are necessary, through adaptive management, to meet the success criteria, the monitoring program will similarly be modified to determine if the new management actions are effective. Any change to monitoring will be provided to the USFWS and DOFAW for review and modifications will be coordinated with both agencies and noted in the annual report. Any changes to the monitoring program will be agreed to by all parties.

11.0 Timeline

As mentioned above, in August 2021, the mitigation planning trigger was reached for Tier 5. Permit conditions require that a draft SSMIP be prepared within 5 months of reaching the Tier 5 planning trigger. A draft was submitted to the agencies in November 2021 and, since that time, several rounds of revisions and discussions have been completed. Based on initial agency input supportive of the proposed Mitigation Area, Auwahi Wind began Pre-Trigger, Baseline Monitoring using two acoustic monitors to aid in establishing a Baseline Monitoring program of the Mitigation Area prior to implementing any mitigation actions. Such monitoring is important to enable documenting changes to the landscape and demonstrating that success criteria are met. Anticipated critical path timelines and expected time for completion are shown in Table 5.

Table 5. Approximate Timeline for Actions to Be Implemented by Auwahi Wind

Timeline [1, 2]	Monitoring Period	Mitigation	Description of Actions [3]
2022-2023	Pre-Baseline Monitoring Year 1		• Auwahi Wind deployed two acoustic detectors at KMFR. These detectors will be deployed for up to five years.
2024	Pre-Baseline Monitoring Year 1 +		• Auwahi Wind deployed two acoustic detectors at KMFR. These detectors will be deployed for up to five years. • Auwahi Wind, DOFAW, and USFWS will finalize the SSMIP and Auwahi and DOFAW will prepare and submit legally binding agreement(s) defining roles and responsibilities • DOFAW completes its comprehensive multi-use management plan for the Forest Reserve. • DOFAW completes fence installation and feral ungulate removal from Phase 1 area (Auwahi Wind supports removal in Mitigation Area).

Timeline [1, 2]	Monitoring Period	Mitigation	Description of Actions [3]
2025	Baseline Monitoring Year 1	Year 1	• Land protections and roles and responsibilities outlined in legally binding agreements are signed by applicable parties. • Auwahi Wind conducts baseline acoustic monitoring in the Mitigation Area (Section 6.2). • Auwahi Wind conducts baseline thermal monitoring in Outplanting Area (Section 6.4). • Auwahi Wind completes outplanting in Outplanting Area. • Auwahi Wind conducts focused acoustic and thermal monitoring at new basin(s), following install.[4] • Auwahi Wind conducts quarterly baseline insect monitoring. • Auwahi Wind installs water feature(s). • DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports).
2026	Baseline Monitoring Year 2	Year 2	• Auwahi Wind conducts baseline acoustic monitoring in the Mitigation Area (Section 6.2). • Auwahi Wind conducts quarterly baseline insect monitoring. • Auwahi Wind assesses percent forest cover of Mitigation Area (Section 6.3).
2027	Baseline Monitoring Year 3	Year 3	• Auwahi Wind conducts baseline acoustic monitoring in the Mitigation Area (Section 6.2). • Auwahi Wind conducts baseline thermal monitoring in Outplanting Area (Section 6.4). • Auwahi Wind conducts focused acoustic monitoring at new basin(s). • Auwahi Wind conducts quarterly insect implementation monitoring (Section 6.5). • DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports)
2028	Baseline Monitoring Year 4	Year 4	• Auwahi Wind conducts baseline acoustic monitoring in the Mitigation Area (Section 6.2). • DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports)
2029	Baseline Monitoring Year 5	Year 5	• Auwahi Wind conducts baseline acoustic monitoring in the Mitigation Area (Section 6.2). • Auwahi Wind conducts baseline thermal monitoring in Outplanting Area (Section 6.4). • Auwahi Wind conducts focused acoustic monitoring at new water basin(s). • Auwahi Wind conducts quarterly insect implementation monitoring (Section 6.5). • Auwahi Wind measures percent forest cover (Section 6.3).

Timeline [1, 2]	Monitoring Period	Mitigation	Description of Actions [3]
			• DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports)
2030	Post-Mitigation Implementation Monitoring Year 1	Year 6	• Auwahi Wind conducts acoustic implementation monitoring in Mitigation Area (Sections 6.2). • Auwahi Wind conducts thermal implementation monitoring in Outplanting Area (Sections 6.4). • Auwahi Wind measures percent forest cover (Section 6.3). • DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports)
2031	Post-Mitigation Implementation Monitoring Year 2	Year 7	• Auwahi Wind conducts focused acoustic monitoring at new basin(s). • Auwahi Wind conducts quarterly insect implementation monitoring (Section 6.5). • Auwahi Wind measures percent forest cover (Section 6.3). • DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports)
2032	Post-Mitigation Implementation Monitoring Year 3	Year 8	• Auwahi Wind conducts acoustic implementation monitoring in Mitigation Area (Sections 6.2). • Auwahi Wind conducts thermal implementation monitoring in Outplanting Area (Sections 6.4). • Auwahi Wind measures percent forest cover (Section 6.3). • DOFAW conducts quarterly fence inspections/maintenance and ungulate inspections/control (Auwahi Supports)

1. The timeline for the associated actions described are Auwahi Wind's best estimate based on current information; however, timing of approvals, logistical challenges, or other factors may affect the precise scheduling of actions (e.g., the installation of the new basin[s]). Changes in the timing of a mitigation action are also likely to affect the associated monitoring. The commitments to the timing of mitigation actions and associated monitoring are described in Sections 4.0, 6.0, and their respective subsections.
2. Timeline presented aligns with the remaining planned operational life of the Project, through 2032 (Section 1.1 in Tetra Tech 2019).
3. Several actions performed by DOFAW relate to Auwahi Wind's ability to implement mitigation actions according to this timeline. For this reason, several actions refer to DOFAW as the actor.
4. Thermal monitoring can occur in one of any of the three years following installation of the new basin(s) (Section 6.4.1).

12.0 Cost Estimate

Approximate costs to implement the mitigation plan are identified in Table 6. Figures are estimates only, actual costs to achieve success metrics may vary.

Table 6. Cost Estimate

Mitigation Action	Total
Native plants	$92,000
Outplanting	$340,000
Reimbursement to DOFAW for exclusion fence installation	$1,057,695
Estimated annual reimbursement to DOFAW for fence monitoring and maintenance (on average $15,000 annually for 9 years)	$135,000
Estimated annual reimbursement to DOFAW for initial and ongoing ungulate removal (on average 2.5 hours per year for 9 years)	$75,000
Above-ground water basin(s) installation and maintenance	$100,000
Invasive vegetation control	$330,000
Maintenance and monitoring	$313,000
Acoustic monitoring	$200,000
Insect monitoring	$67,000
Transportation	$146,000
Thermal videography	$40,000
Total	**$2,895,695**

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Attachment 1. Haleakalā Ranch Company Letter of Support for Performing Tier 5 Mitigation Work on Haleakalā Ranch

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HALEAKALA RANCH
• EST. MAUI 1888 •

March 8, 2022

To: USFWS/DOFAW HCP staff:

Subject: Landowner support for Auwahi Wind Energy LLC's proposed Tier 5 mitigation work on Haleakala Ranch

Haleakala Ranch is very interested in partnering with Auwahi Wind Energy, LLC in its development and implementation of the Site-Specific Mitigation Implementation Plan to support the Auwahi Wind Habitat Conservation Plan.

It is our understanding that the Tier 5 Mitigation process would fund the protection of 690 acres, the construction of new water features, invasive species control, and reforestation of pastures (especially with Koa), all which would provide significant net benefit and mitigate project impacts on the Hawaiian hoary bat. Haleakala Ranch fully supports this work on our land, provided it can be done in a manner that meets all of the Parties' operational, administrative and compliance goals. We think it could be a really good fit and provide multiple long-lasting ecological services and community benefits far beyond the scope of the HCP.

Haleakala Ranch has a long and demonstrated history of proactive, responsible land stewardship and conservation. We have partnered successfully with DOFAW and USFWS on numerous important conservation/recovery efforts on our own lands and continue to develop and support ecological restoration in our pastures, licensed areas, lands held under Conservation Easement, and regional lands managed via Watershed Partnerships and other Partners. This new potential partnership with Auwahi Wind is consistent with that history and vision.

We welcome any opportunity to show you our work so you can gain a better understanding of our commitment to conservation and our innovative approaches to land stewardship.

Please feel free to contact me at your convenience to discuss this further. I am more than happy to answer any questions, comments or concerns you may have.

Respectfully,

Jordan Jokiel
Vice President/Land Management

Cc: J. Scott Meidell, President and CEO
Luke Estes, Senior Vice President/Real Estate
Greg Friel, Vice President/Livestock Managent

HALEAKALA RANCH COMPANY • 529 KEALALOA AVENUE • MAKAWAO, HI 96768 • PH: 808.572.1500 FAX 808.572.7288

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Attachment 2. Flora and Fauna Survey Kamehamenui Forest Reserve, Maui

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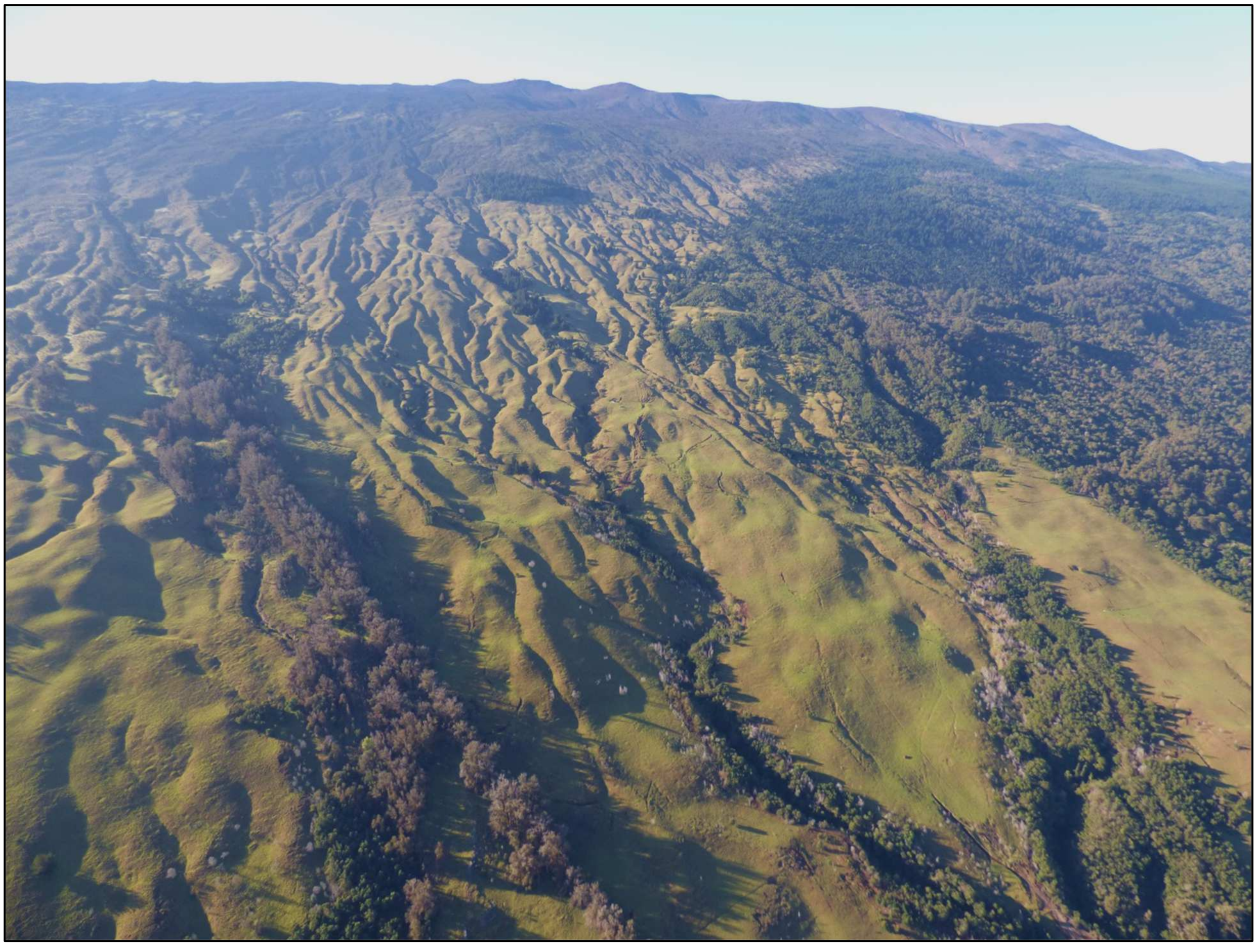
FLORA AND FAUNA SURVEY
KAMEHAMENUI FOREST RESERVE, MAUI



Prepared By:
FOREST & KIM STARR

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

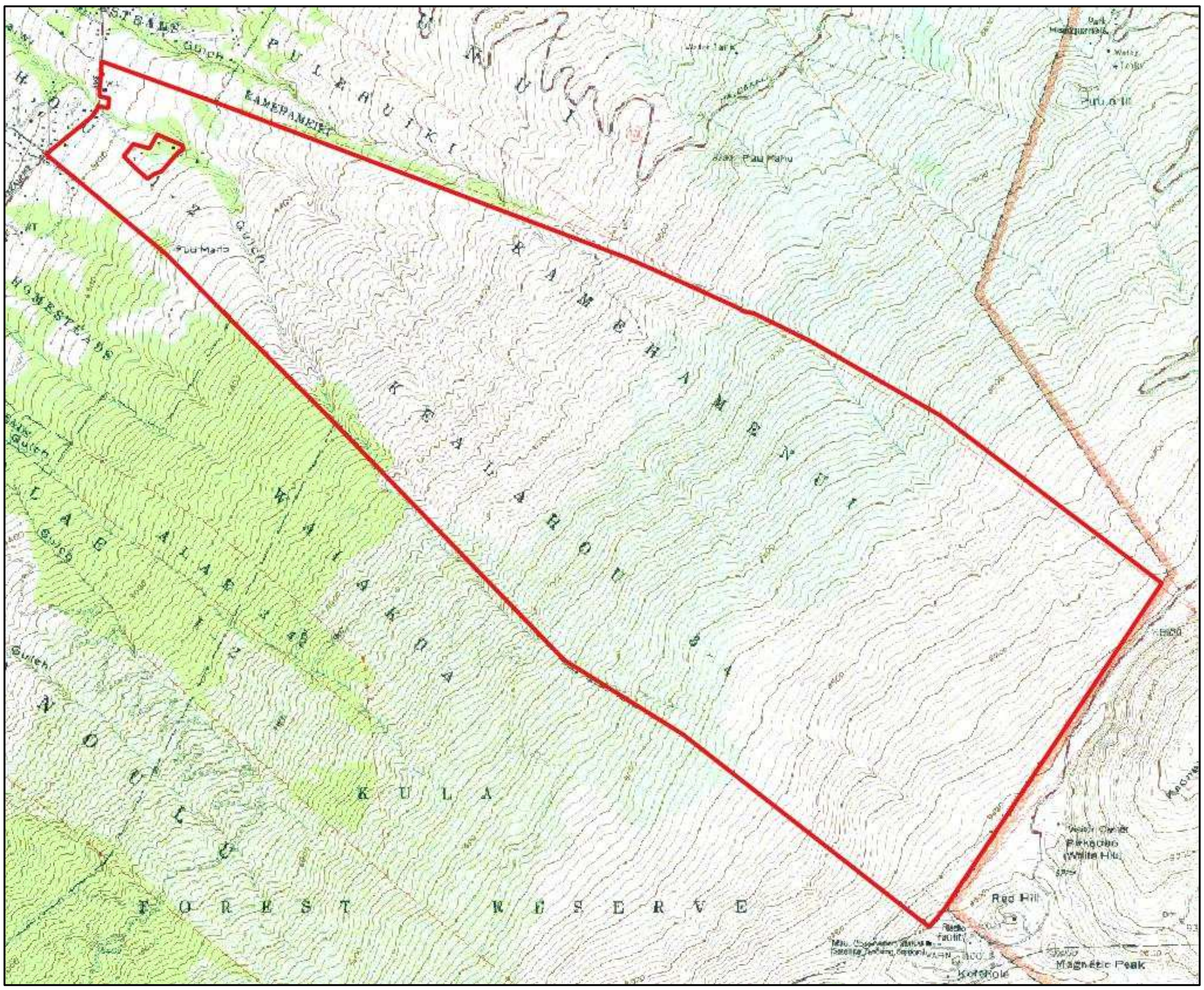
2021

INTRODUCTION

The Kamehamenui Forest Reserve encompasses about 3,434 acres (TMK 230050020000) on the west slope of East Maui. The goal of this survey was to inventory the flora and fauna in the area, to provide current information to be included in a management plan for the reserve.

SITE DESCRIPTION

The land is steep, and there are many small gullies. Much of the area is pasture, with short-statured shrubland up high, and scattered forest areas in the pastures, gulches, and along the property margins. The elevation ranges from 3,700 to 9,800 feet above sea level. Annual rainfall averages 27-40 inches. Annual air temperature averages 44-61 degrees Fahrenheit.



Project area, Kamehamenui Forest Reserve, Maui.

SURVEY OBJECTIVES

The main objectives of the survey were to:

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

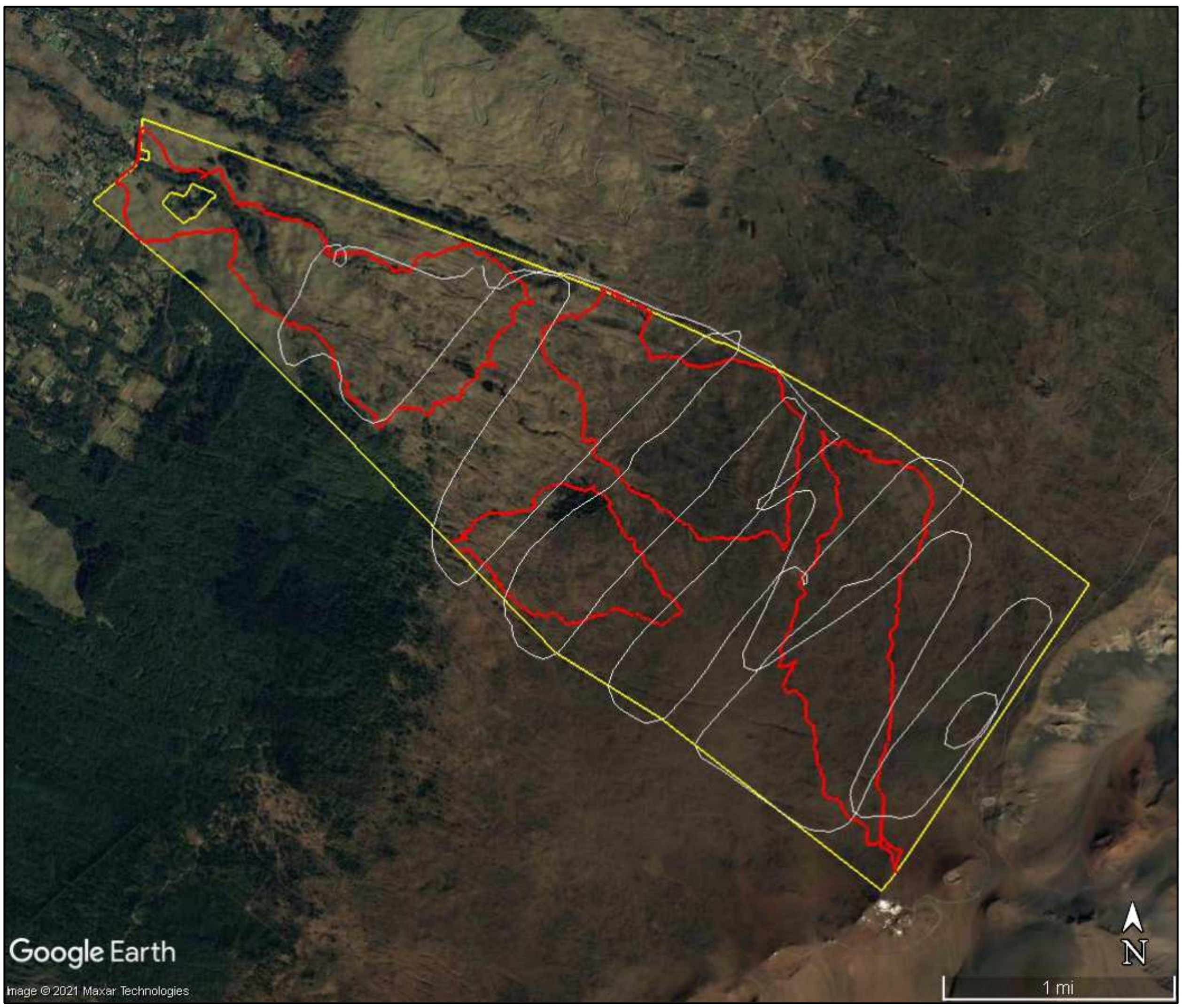
- Write up findings in a report that includes checklists of species, along with images and discussion of some of the more conspicuous and noteworthy elements of the flora and fauna.

SURVEY METHODS

A walk-through survey method was used over representative areas of the reserve in April-June, 2021. Extra emphasis was placed on areas with potential for high diversity, such as gullies and remnant native plants. Notes were made on plant and animals species encountered. In addition, a sweep net was used to get closer looks at insects. A helicopter overflight was also done to get a big picture overview, look at areas we didn't get to on foot, and get images for this report.

Taking notes on flora and fauna.

Sweeping for insects in subalpine vegetation.



Area surveyed. Red lines are ground survey, white lines are aerial survey.

RESULTS

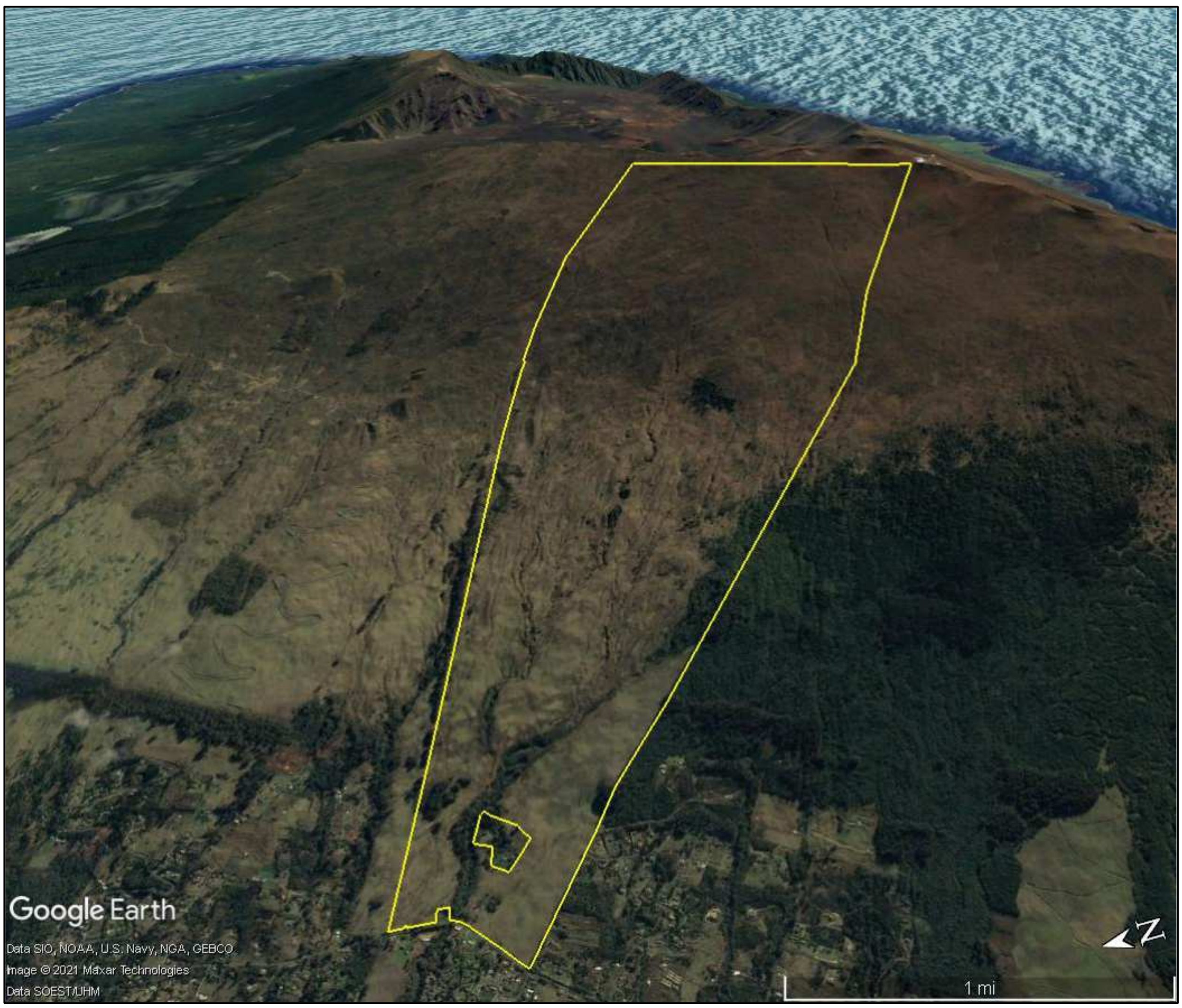
VEGETATION

There are three main vegetation types in Kamehamenui:

Grassland/Pasture: The bulk of the area below 6,500 ft. is dominated by pasture. This section is characterized by vast areas of open grassland and non-native species.

Mesic Forest: Scattered about the grassland are groves of mostly non-native trees, especially in and near gullies. Pockets of native trees persist, especially above 5,500 ft.

Subalpine Shrubland: Above 6,500 ft. native shrubs dominate, along with sparse grasses and ferns. At the top of the reserve, the vegetation is very sparse with large areas of no vegetation.



Kamehamenui Forest Reserve.

SUBALPINE SHRUBLAND

Upper subalpine shrubland, Kamehamenui Forest Reserve.

The highest elevations of the Kamehamenui Forest Reserve, 6,500-9,800 ft. are comprised of mostly the shrub kupaoa (*Dubautia menziesii*). Just below the summit area, the dominant vegetation quickly becomes pūkiawe (*Leptecophylla tameiameiae*) shrubs. Most of the vegetation in this zone is native.

The upper reaches of the reserve have sparse and short vegetation. As one descends in elevation, the vegetation becomes taller, thicker, and more diverse. The vegetation is heavily browsed.

Pūkiawe is by far the most common plant in this zone. Other native shrubs in this area include kūpaoa (*Dubautia menziesii*), ʻōhelo (*Vaccinium reticulatum*), and kukaenēnē (*Coprosma ernodeoides*).

ʻAʻaliʻi (*Dodonaea viscosa*) is the most common tree in this zone, often found in small groves. Other trees in this zone include māmane (*Sophora chrysophylla*), Haleakalā sandalwood (*Santalum haleakalae*), and hōʻawa (*Pittosporum confertiflorum*). All of these are in poor health due to intense ungulate pressure.

Haleakalā silverswords or ʻāhinahina (*Argyroxiphium sandwicense* subsp. *macrocephalum*) are found in the upper most reaches of the subalpine zone, as is the native pamakani or Haleakalā tetramolopium (*Tetramolopium humile* subsp. *haleakalae*).

Non-native herbs and low growing plants in the subalpine shrubland include evening primrose (*Oenothera stricta* subsp. *stricta*), sheep sorrel (*Rumex acetosella*), hairy horseweed (*Conyza bonariensis*), fireweed (*Senecio madagascariensis*), and hairy cat's ear (*Hypochoeris radicata*).

Native grasses are predominantly hairgrass (*Deschampsia nubigena*) and pili uka (*Trisetum glomeratum*).

Non-native grasses include Sweet vernal grass (*Anthoxanthum odoratum*), Yorkshire fog (*Holcus lanatus*), rattail (*Vulpia* sp.), and cheatgrass (*Bromus tectorum*).

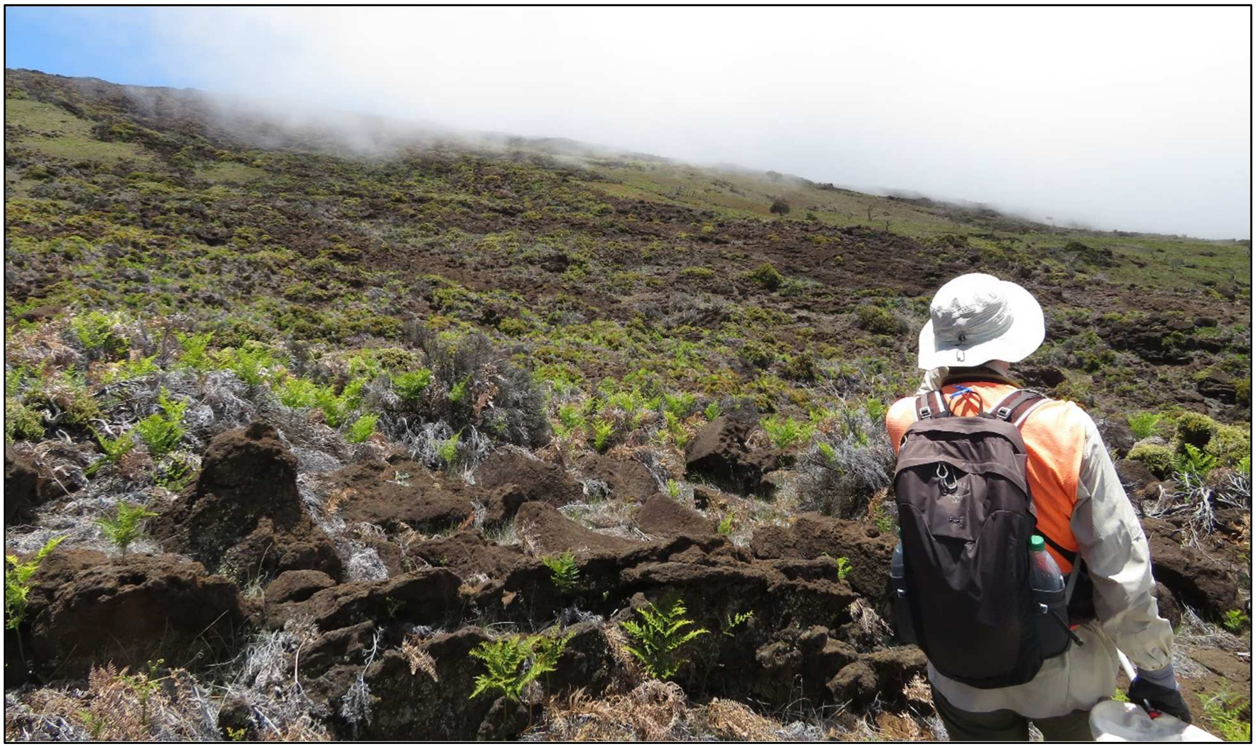
By far the most common native fern in this zone is kīlau or bracken fern (*Pteridium aquilinum* subsp. *decompositum*). This hardy fern is one of the only plants growing over vast sections of the reserve with the heaviest ungulate pressure.

Other native ferns in this zone include kalamoho (*Pellaea ternifolia*), ʻiwaʻiwa (*Asplenium adiantum-nigrum*), and maidenhair spleenwort (*Asplenium trichomanes* subsp. *densum*). The most common non-native fern in this zone is the golden fern (*Pityrogramma austroamericana*).

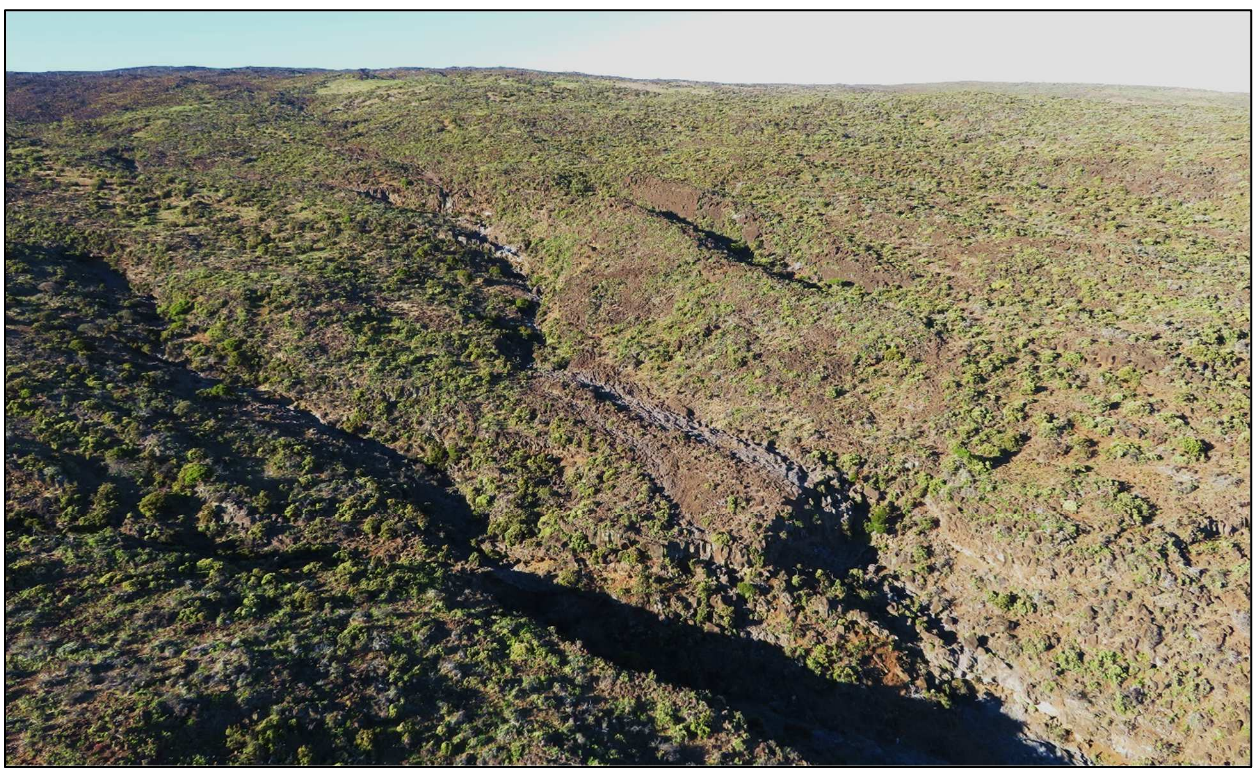
There are many areas of the subalpine shrubland at Kamehamenui where all other vegetation has been destroyed by ungulates, and only kīlau or bracken fern is able to survive.

Vegetation is naturally sparse in the highest elevations of the reserve due to the cold, dry, windy environment.

Virtually all the plants in the highest elevations of the reserve are native. Pūkiawe (*Leptecophylla tameiameiae*) is by far the most common plant, able to survive ungulates and the harsh environment.



Lower down the mountain, there is much more subalpine vegetation. It remains native dominated, though the diversity is low given the heavy ungulate pressure in the area.



The northern portion of the reserve near Hāpapa Gulch has the most remnant subalpine vegetation diversity. The bulk of the sandalwood (*Santalum*) we came across were in this area, as was the hōʻawa (*Pittosporum*).


Pūkiawe shrubs remain the dominant plant in the subalpine zone, along with occasional ʻaʻaliʻi trees.


In areas where ungulate pressure is greatest, most of the vegetation has been taken down to dirt.

In some areas there are "māmane graveyards", with scores of dead tree skeletons and a handful of remnant trees on the cusp of death. Bracken fern often dominates in these areas.

A remnant sandalwood tree, the largest of about a dozen we came across. This tree was in decline, it's trunk and foliage heavily browsed, and the roots undermined. On the horizon is a similarly browsed ‘a‘ali‘i.

Pūkiawe is the dominant plant within the subalpine shrubland.

***Tetramolopium humile* is locally abundant in the highest elevations of the reserve, often tucked next to stones.**

A few Haleakalā silverswords or ʻāhinahina (*Argyroxiphium sandwicense* subsp. *macrocephalum*) reside in the highest elevations of the subalpine zone.

Vast areas of bracken fern occur in the subalpine shrubland, making it almost more of a fernland in places.

Hairgrass (*Deschampsia nubigena*) is present in the subalpine shrubland. As with many other species, this clumping native grass will likely become more prevalent if ungulates are removed.

Haleakalā sandalwoods or ʻiliahi occur as scattered individuals and small groves in the reserve. Most are in decline or near death, due to the heavy ungulate pressure.

MESIC FOREST

Native ‘ōhi‘a trees in the mesic forest portion of Kamehamenui Forest Reserve.

Below 6,500 ft. trees become more prevalent. The dominant native tree in this zone is ‘ōhi‘a (*Metrosideros polymorpha*), which persists on steep gulch walls as small groves, mostly between 5,500-7,500 ft. Perhaps it would be a stretch to call it a forest today, but not long ago, that's what it was. Two "varieties" of ‘ōhi‘a are present (*incana* and *glaberrima*), occasionally on the same tree, though the glabrous form (*glaberrima*) is most common.

We only came across a handful of koa (*Acacia koa*) trees, perhaps a half dozen, clinging to gulch walls near the 4,500 ft. level. The ranchers have been controlling black wattle (*Acacia mearnsii*) near the koa trees to help protect them from being overrun.

Black wattle is the most common non-native tree in the reserve. It is especially abundant below 6,000 ft. on the southern boundary of the reserve and in gulches. Not long ago, much of the area this wattle forest occupies was open pasture.

There are a few conifer plantings in the reserve. The largest and most mauka (6,700 ft.) is predominantly Monterey pine (*Pinus radiata*) with some redwood (*Sequoia sempervirens*). Other conifers encountered include Maritime pine (*Pinus pinaster*).

A long line of blue gum eucalyptus (*Eucalyptus globulus*) marks the northern boundary of the reserve. These trees are in decline due to multiple new insects and pathogens. Eucalyptus is also spreading from these plantings into nearby areas.

Fire tree (*Morella faya*) is present on both boundaries between 5,000-7,000 ft. as incipient groves and scattered trees. This tree seems to prefer areas where ʻōhiʻa also likes to grow.

Pūkiawe (*Leptecophylla tameiameiae*) is the most common shrub in this zone. Other native shrubs present in much lower numbers include ʻakala berry (*Rubus hawaiensis*), hinahina (*Artemisia mauiensis*), pilo (*Coprosma montana*), and ʻaʻaliʻi (*Dodonaea viscosa*).

Non-native shrubs include Canary Island St. John's wort (*Hypericum canariense*), pamakani (*Ageratina adenophora* and *A. riparia*), and Mysore raspberry (*Rubus niveus*).

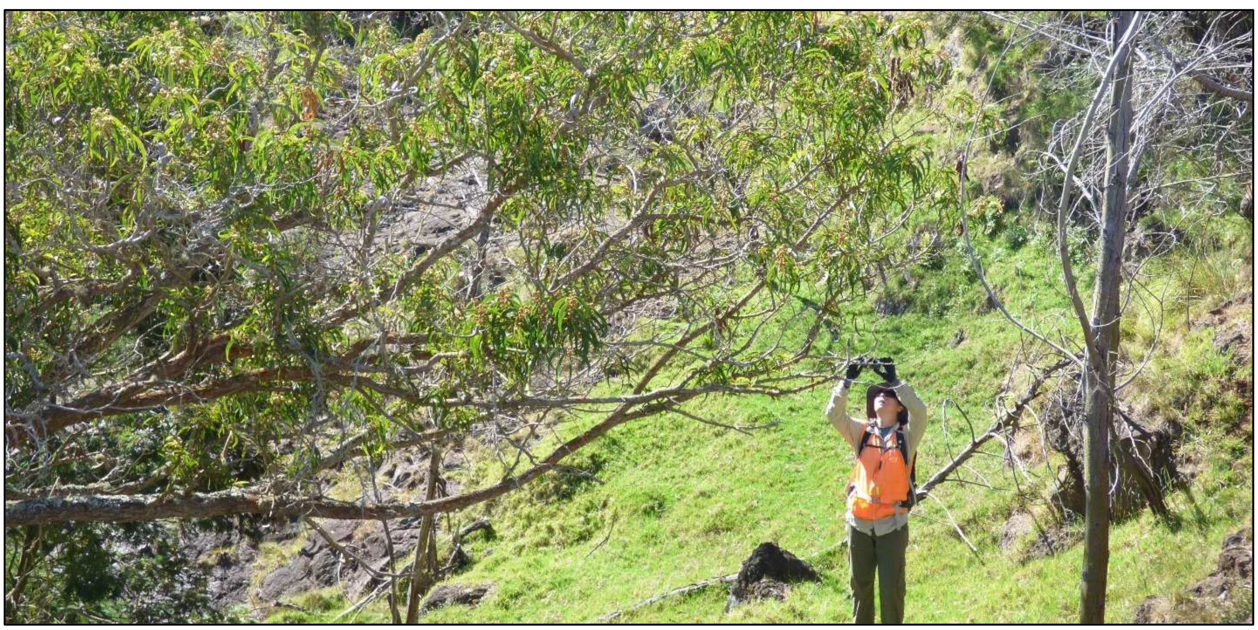
The dominant grass in this zone is Kikuyu (*Cenchrus clandestinus*), though the understory beneath all these non-native trees is mostly barren.

Native sedges include *Carex macloviana* subsp. *subfusca* and *Carex wahuensis* and wood rush (*Luzula hawaiiensis*).

Non-native herbs include daisy fleabane (*Erigeron karvinskianus*), fireweed (*Senecio madagascariensis*), and bull thistle (*Cirsium vulgare*). Banana poka (*Passiflora tarminiana*) is the most prevalent non-native vine.

In steep sites protected from ungulates with some sun, ferns and shrubs are able to eke out a living. Native ferns encountered include ʻamaʻu (*Sadleria cyatheoides*), polystichum (*Polystichum haleakalense*), mākuʻe (*Elaphoglossum paleaceum*), laukahi (*Dryopteris wallichiana*), palapalai (*Microlepia strigosa*), and pohole (*Diplazium sandwichianum*).

Non-native ferns include blechnum (*Blechnum appendiculatum*), Australian brake (*Pteris tremula*), and downy wood fern (*Cyclosorus dentatus*).



One of a handful of remnant native koa trees in Kamehamenui.

Small patches of remnant ‘ōhi‘a forest can still be found in steep, rocky gulches, such as Hāpapa Gulch.

The remnant ‘ōhi‘a able to survive ungulate pressure are growing mostly on cliff walls.

The largest patch of koa we came across in the reserve was just a handful of trees growing on cliff walls. Ranchers have been controlling black wattle nearby to help keep the koa from being overtaken.

The handful of koa trees left in the reserve survived the ungulate pressure by growing on cliffs. These were the largest koa trees we came across in the reserve.

Black wattle forest dominates much of the southern portion of reserve. This forest is relatively young, having recently over taken what used to be mostly pasture, especially in and near Keahuaiwi Gulch.

The wattle forest understory is mostly barren.

There are multiple pine/conifer groves planted in the reserve. Pines are also spreading from the plantings into nearby shrubland and creating new groves.

The conifers can get quite large, with an understory of virtually no other plants.

A long line of blue gum eucalyptus in poor health marks the northern boundary of the reserve. The bright green trees are fire tree, which is beginning to dominate in areas with remnant ʻōhiʻa.

Many of the eucalyptus trees are massive.

Small local sites in the mesic zone gulches where ungulates have a hard time reaching are able to support lush vegetation, both native and non-native, such as this fern grotto.

In similar areas where the non-native trees have started to fill in to the point of a closed canopy, fern grottos still exist, but the vegetation is less lush.

‘Ōhi‘a is the most common native forest tree in Kamehamenui.

This hinahina (*Artemisia mauiensis*) growing out of a crack on a cliff wall was the only one we came across.

Native parasitic mistletoe or hulumoa (*Korthalsella complanata*) growing on a pūkiawe shrub.

Pohole fern (*Diplazium sandwichianum*) found in grottos where ungulates can't easily reach.

***Polystichum haleakalense*, a locally common fern in the area.**

Cliff brake fern (*Pteris cretica*) growing out of a cliff.

PASTURE / GRASSLAND

Pasture/grasslands in the Kamehamenui Forest Reserve.

Much of the reserve below 7,000 ft. is dominated by non-native grasses. The most common grass is Kikuyu (*Cenchrus clandestinus*). Other grasses encountered include Natal red top (*Melinis repens*), sweet vernal (*Anthoxanthum odoratum*), weeping lovegrass (*Eragrostis curvula*), and Yorkshire fog (*Holcus lanatus*).

Pūkiawe shrubs are scattered about the pastures in the highest elevations, but are mostly absent below 5,500 ft. In the lowest elevations, incipient non-native shrubs are taking hold, including Canary Island St. John's wort (*Hypericum canariense*), cotoneaster (*Cotoneaster pannosus*), and firethorn (*Pyracantha* spp.).

Non-native herbs in this zone include red clover (*Trifolium pratense* var. *sativum*), fireweed (*Senecio madagascariensis*), black medic (*Medicago lupulina*), scarlet pimpernel (*Anagalis arvensis*), common dandelion (*Taraxacum officinale*), and bitter herb (*Centaurium erythraea subsp. erythraea*).

Moa (*Psilotum nudum*) and a few other native ferns are tucked into rocks including kalamoho (*Pellaea ternifolia*) and ʻiwaʻiwa (*Asplenium adiantum-nigrum*).

Mauka portion of the grasslands.

The pastures are heavily grazed, resulting in low-growing non-native grass over vast areas.

Makai portion of the grasslands.

Corral, fences, and water tank in makai pastures.

Kikuyu is the dominant grass over much of the area. Other than grass, only small weedy herbs such as fireweed are able to survive ungulate browsing in the most open areas.

Low numbers of ferns and other more delicate vegetation is present in small pockets of the open pastures, but is restricted to areas protected by steep terrain.

Natal Red Top (*Melinis repens*).

Sweet Vernal Grass (*Anthoxanthum odoratum*)

Moa (*Psilotum nudum*).

Pānini (*Opuntia ficus-indica*).

Weeping lovegrass (*Eragrostis curvula*).

Red Clover (*Trifolium pratense* var. *sativum*).

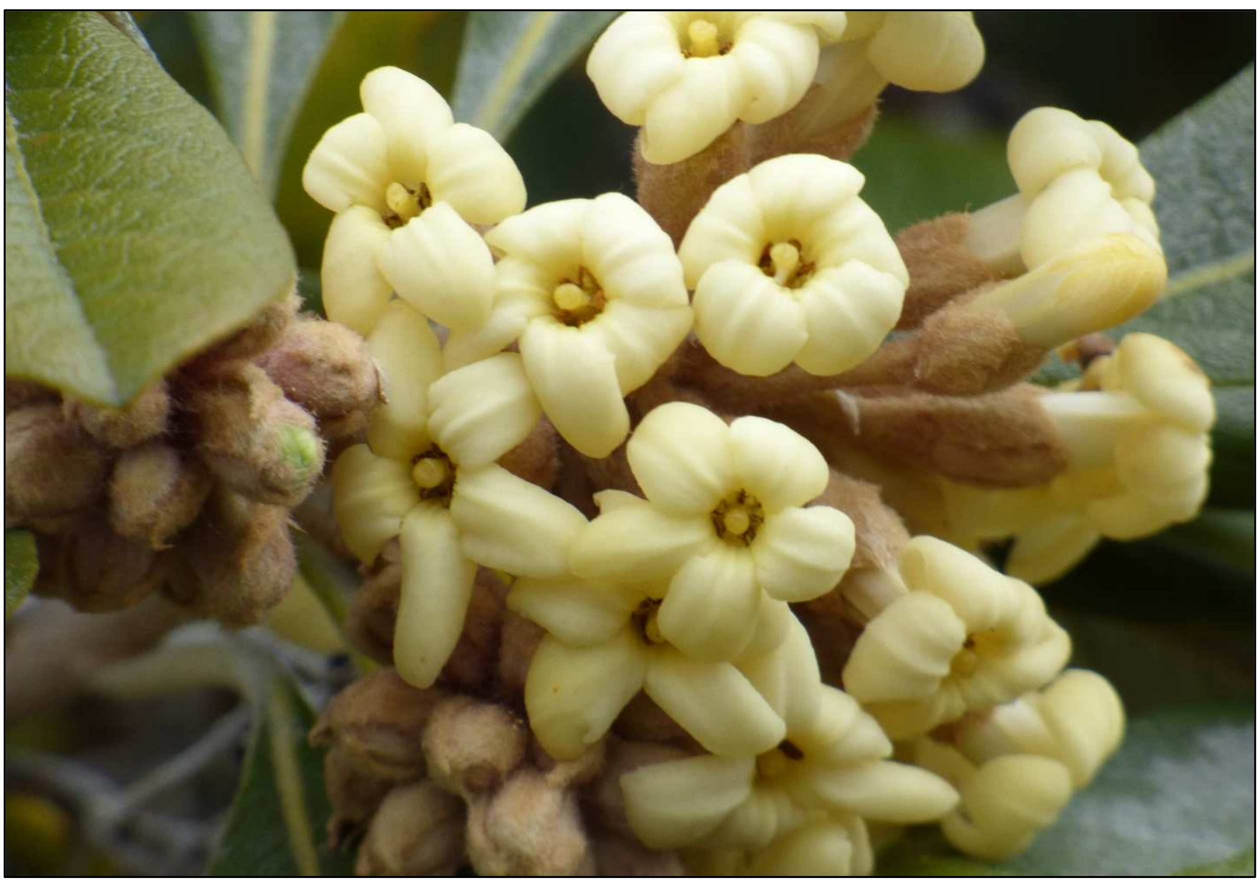
RARE PLANTS

Many plants considered common in other areas are "rare" in the reserve given the heavy ungulate pressure, such as koa (*Acacia koa*), mamane (*Sophora chrysophylla*) and kūpaoa (*Dubautia menziesii*). If ungulates are removed, these species will likely once again become common, especially with additional plantings.

Another subset of species currently in the reserve are rare even in the best areas of East Maui and will likely require additional care to thrive in the reserve, such as Haleakalā sandalwood or ʻiliahi (*Santalum haleakalae*) and hōʻawa (*Pittosporum confertiflorum*).

Rare plants not encountered in the reserve that could be a focus of future restoration activities include nohoanu (*Geranium arboreum*), a native mint *Stenogyne microphylla*, a rare fern *Diplazium molokaiense*, and many more.

Nearby Haleakalā National Park has a greenhouse with many of the rare plants found within the subalpine region of East Maui, and would be a good propagule source for restoration plantings of rare plants at Kamehamenui, including Haleakalā silverswords.



Hōʻawa (*Pittosporum confertiflorum*) flowers on the lone tree we came across in the reserve. Hōʻawa would be a good species to include in restoration plantings, along with sandalwood and other increasingly rare plants.

INCIPIENT PLANTS

Though many non-native plants are already well established in the reserve. There are other invasive plants that are just starting get a foothold in the reserve. Below are some of them. Most are located in the lowest reaches of the reserve, especially in and near gulches.

Early detection and rapid response efforts to address these invasive species while they are still in low numbers will be most successful. Efforts will also be much more effective if undertaken while ungulates are still present, as the ungulates are doing just as much to damage to the non-native species as they are to the native plants. And once ungulates are removed, these plants will be released from that pressure and will shift to a much faster rate of expansion through the area.

- Banana poka (*Passiflora tarminiana*)
- Canary Island St. John's Wort (*Hypericum canariense*)
- Coast banksia (*Banksia integrifolia*)
- Cotoneaster (*Cotoneaster pannosus*)
- Firethorn (*Pyracantha* spp.)
- Japanese honeysuckle (*Lonicera japonica*)
- Mock orange (*Pittosporum undulatum*)
- Pampas grass (*Cortaderia* spp.)
- Night blooming jasmine (*Cestrum nocturnum*)
- Smoke bush (*Buddleia* spp.)
- Tree poppy (*Bocconia frutescens*)

Canary Island St. John's Wort (*Hypericum canariense*) is establishing in the lower gulches of the reserve.

PLANT SPECIES LIST

Following is a checklist of all vascular plant species inventoried during field studies. Abundance of each species within the project area:

- Dominant = Forming a major part of the vegetation within the project area.
- Common = Widely scattered throughout the area or locally abundant within a portion.
- Occasional = Scattered sparsely throughout the area or occurring in a few small patches.
- Rare = Only a few isolated individuals within the project area.

Family	**Scientific Name**	**Common Name**	**Nativity**	**Abundance**
Fabaceae	*Acacia koa*	Koa	Endemic	Rare
Fabaceae	*Acacia mearnsii*	Wattle	Non-native	Common
Pteridaceae	*Adiantum hispidulum*	Rough maidenhair fern	Non-native	Occasional
Asparagaceae	*Agave attenuata*	Swan's neck agave	Non-native	Rare
Asteraceae	*Ageratina adenophora*	Maui pamakani	Non-native	Occasional
Asteraceae	*Ageratina riparia*	Hamakua pamakani	Non-native	Occasional
Primulaceae	*Anagalis arvensis*	Scarlet pimpernel	Non-native	Occasional
Poaceae	*Anthoxanthum odoratum*	Sweet vernal grass	Non-native	Common
Asclepiadaceae	*Asclepias physocarpa*	Balloon plant	Non-native	Occasional
Asteraceae	*Argyroxiphium sandwicense* subsp. *macrocephalum*	Haleakalā silversword, ʻāhinahina	Endemic	Rare
Asparagaceae	*Asparagus asparagoides*	Bridal creeper	Non-native	Rare
Aspleniaceae	*Asplenium adiantum-nigrum*	ʻIwaʻiwa	Indigenous	Occasional
Aspleniaceae	*Asplenium trichomanes* subsp. *densum*	Maidenhair spleenwort	Endemic	Occasional
Asteraceae	*Artemisia mauiensis*	Hinahina	Endemic	Rare
Poaceae	*Axonopus fissifolius*	Narrow-leaved carpetgrass	Non-native	Occasional
Proteaceae	*Banksia integrifolia*	Coast banksia	Non-native	Rare
Blechnaceae	*Blechnum appendiculatum*	Blechnum	Non-native	Rare
Papaveraceae	*Bocconia frutescens*	Tree poppy	Non-native	Occasional
Poaceae	*Bromus catharticus*	Rescue grass	Non-native	Rare
Poaceae	*Bromus diandrus*	Ripgut	Non-native	Rare
Poaceae	*Bromus tectorum*	Cheat grass	Non-native	Occasional
Scrophulariaceae	*Buddleja davidii*	Butterfly bush	Non-native	Rare
Scrophulariaceae	*Buddleja madagascariensis*	Smoke bush	Non-native	Rare
Cyperaceae	*Carex macloviana subsp. subfusca*	Carex	Indigenous	Rare
Cyperaceae	*Carex wahuensis*	Carex	Endemic	Rare
Poaceae	*Cenchrus clandestinus*	Kikuyu grass	Non-native	Common
Asteraceae	*Centaurium erythraea* subsp. *erythraea*	Bitter herb	Non-native	Rare
Valerianaceae	*Centranthus ruber*	Valerian	Non-native	Rare

Family	Scientific Name	Common Name	Nativity	Abundance
Caryophyllaceae	*Cerastium fontanum* subsp. *vulgare*	Mouse-ear chickweed	Non-native	Rare
Solanaceae	*Cestrum nocturnum*	Night blooming cestrum	Non-native	Occasional
Pteridaceae	*Cheilanthes viridis*	Green cliff brake	Non-native	Rare
Poaceae	*Chloris gayana*	Rhodes grass	Non-native	Rare
Asteraceae	*Cirsium vulgare*	Bull thistle	Non-native	Rare
Commeliniaceae	*Commelina diffusa*	Honohono	Non-native	Rare
Asteraceae	*Conyza bonariensis*	Hairy horseweed	Non-native	Rare
Rubiaceae	*Coprosma ernodeoides*	Kukaenene	Endemic	Rare
Rubiaceae	*Coprosma montana*	Pilo	Endemic	Rare
Poaceae	*Cortaderia jubata*	Pampas grass	Non-native	Rare
Rosaceae	*Cotoneaster pannosus*	Cotoneaster	Non-native	Occasional
Thelypteridaceae	*Cyclosorus dentatus*	Downy wood fern	Non-native	Occasional
Poaceae	*Cynodon dactylon*	Bermuda grass	Non-native	Rare
Cyperaceae	*Cyperus stoloniferus*	Cyperus	Non-native	Rare
Dryopteridaceae	*Cyrtomium caryotideum*	Kaapeape	Indigenous	Rare
Poaceae	*Dactylis glomerata*	Cocksfoot	Non-native	Occasional
Asteraceae	*Delairea odorata*	Cape ivy	Non-native	Occasional
Poaceae	*Deschampsia nubigena*	Hairgrass	Endemic	Occasional
Convolvulaceae	*Dichondra micrantha*	Dichondra	Non-native	Rare
Athyriaceae	*Diplazium sandwichianum*	Pohole	Endemic	Rare
Sapindaceae	*Dodonaea viscosa*	ʻAʻali'i	Indigenous	Occasional
Dryopteridaceae	*Dryopteris wallichiana*	Laukahi	Indigenous	Occasional
Asteraceae	*Dubautia menziesii*	Kūpaoa	Endemic	Common
Dryopteridaceae	*Elaphoglossum paleaceum*	Mākuʻe	Indigenous	Rare
Geraniaceae	*Erodium cicutarium*	Pin clover	Non-native	Occasional
Myrtaceae	*Eucalyptus globulus*	Blue gum	Non-native	Common
Myrtaceae	*Eucalyptus robusta*	Swamp mahogany	Non-native	Rare
Poaceae	*Eragrostis curvula*	Weeping love grass	Non-native	Occasional
Asteraceae	*Erigeron karvinskianus*	Daisy fleabane	Non-native	Occasional
Poaceae	*Festuca rubra*	Red fescue	Non-native	Common
Apiaceae	*Foeniculum vulgare*	Fennel	Non-native	Occasional
Asteraceae	*Gamochaeta* sp.	Gamochaeta	Non-native	Occasional
Geraniaceae	*Geranium homeanum*	Cranesbill	Non-native	Occasional
Proteaceae	*Grevillea robusta*	Silky oak	Non-native	Rare
Asteraceae	*Heterotheca grandiflora*	Telegraph weed	Non-native	Rare
Poaceae	*Holcus lanatus*	Yorkshire fog	Non-native	Common
Hypericaceae	*Hypericum canariense*	Canary Islands St. John's wort	Non-native	Occasional

Family	Scientific Name	Common Name	Nativity	Abundance
Asteraceae	*Hypochoeris radicata*	Hairy cat's ear	Non-native	Occasional
Convolvulaceae	*Ipomoea indica*	Koali ʻawa	Indigenous	Rare
Bignoniaceae	*Jacaranda mimosifolia*	Jacaranda	Non-native	Rare
Juncaceae	*Juncus* sp.	Juncus rush	Non-native	Rare
Santalaceae	*Korthalsella complanata*	Hulumoa	Indigenous	Rare
Poaceae	*Lachnagrostis filiformis*	Heʻupueo	Indigenous	Rare
Asteraceae	*Lapsana communis*	Nipplewort	Non-native	Rare
Ericaceae	*Leptecophylla tameiameiae*	Pūkiawe	Indigenous	Common
Caprifoliaceae	*Lonicera japonica*	Japanese honeysuckle	Non-native	Rare
Juncaceae	*Luzula hawaiiensis*	Wood rush	Endemic	Rare
Lythraceae	*Lythrum maritimum*	Lythrum	Non-native	Rare
Fabaceae	*Medicago lupulina*	Black medic	Non-native	Occasional
Poaceae	*Melinis minutiflora*	Molasses grass	Non-native	Occasional
Poaceae	*Melinis repens*	Natal red top	Non-native	Occasional
Myrtaceae	*Metrosideros polymorpha* var. *glaberrima*	ʻŌhiʻa	Endemic	Rare
Myrtaceae	*Metrosideros polymorpha* var. *incana*	ʻŌhiʻa	Endemic	Rare
Dennstaedtiaceae	*Microlepia strigosa*	Palapalai	Indigenous	Rare
Myricaceae	*Morella faya*	Firetree	Non-native	Common
Solanaceae	*Nicandra physalodes*	Apple of Peru	Non-native	Occasional
Onagraceae	*Oenothera laciniata*	Cut-leaved evening primrose	Non-native	Rare
Onagraceae	*Oenothera stricta subsp. stricta*	Evening primrose	Non-native	Rare
Oleaceae	*Olea europaea subsp. cuspidata*	African olive	Non-native	Occasional
Cactaceae	*Opuntia ficus-indica*	Pānini	Non-native	Rare
Oxalidaceae	*Oxalis corniculata*	Yellow wood sorrel	Non-native	Rare
Passifloraceae	*Passiflora tarminiana*	Banana poka	Non-native	Occasional
Pteridaceae	*Pellaea ternifolia*	Kalamoho	Indigenous	Occasional
Polygonaceae	*Persicaria capitata*	Pink knotweed	Non-native	Rare
Solanaceae	*Physalis peruviana*	Poha	Non-native	Occasional
Phytolaccaceae	*Phytolacca octandra*	Pokeweed	Non-native	Occasional
Pinaceae	*Pinus pinaster*	Maritime pine	Non-native	Rare
Pinaceae	*Pinus radiata*	Monterey Pine	Non-native	Common
Pittosporaceae	*Pittosporum confertiflorum*	Hōʻawa	Endemic	Rare
Pittosporaceae	*Pittosporum undulatum*	Victorian box	Non-native	Rare
Pteridaceae	*Pityrogramma austroamericana*	Golden fern	Non-native	Rare
Plantaginaceae	*Plantago lanceolata*	Narrow-leaved plantain	Non-native	Occasional
Dryopteridaceae	*Polystichum haleakalense*	Polystichum	Endemic	Rare
Rosaceae	*Prunus campanulata*	Taiwan cherry	Non-native	Occasional

Family	**Scientific Name**	**Common Name**	**Nativity**	**Abundance**
Asteraceae	*Pseudognaphalium sandwicensium var. sandwicensium*	ʻEnaʻena	Endemic	Rare
Psilotaceae	*Psilotum nudum*	Moa	Indigenous	Rare
Hypolepidaceae	*Pteridium aquilinum* subsp. *decompositum*	Kīlau, bracken fern	Indigenous	Common
Pteridaceae	*Pteris cretica*	Cretan brake	Indigenous	Occasional
Pteridaceae	*Pteris tremula*	Australian brake	Non-native	Rare
Rosaceae	*Pyracantha angustifolia*	Firethorn	Non-native	Occasional
Rosaceae	*Pyracantha koidzumii*	Formosa firethorn	Non-native	Occasional
Rosaceae	*Rubus argutus*	Black berry	Non-native	Rare
Rosaceae	*Rubus hawaiensis*	ʻAkala	Endemic	Rare
Rosaceae	*Rubus niveus*	Mysore raspberry	Non-native	Common
Rosaceae	*Rubus rosifolius*	Thimbleberry	Non-native	Occasional
Polygonaceae	*Rumex acetosella*	Sheep sorrel	Non-native	Occasional
Blechnaceae	*Sadleria cyatheoides*	ʻAmaʻu	Endemic	Rare
Santalaceae	*Santalum haleakalae var. haleakalae*	ʻIliahi, Haleakalā sandalwood	Endemic	Rare
Asteraceae	*Senecio madagascariensis*	Fireweed	Non-native	Common
Taxodiaceae	*Sequoia sempervirens*	Redwood	Non-native	Rare
Rubiaceae	*Sherardia arvensis*	Blue fieldmadder	Non-native	Rare
Solanaceae	*Solanum americanum*	Pōpolo	Indigenous	Rare
Solanaceae	*Solanum linnaeanum*	Apple of Sodom	Non-native	Occasional
Fabaceae	*Sophora chrysophylla*	Māmane	Endemic	Rare
Poaceae	*Sporobolus indicus*	Smut grass	Non-native	Occasional
Caryophyllaceae	*Stellaria media*	Common chickweed	Non-native	Rare
Asteraceae	*Taraxacum officinale*	Common dandelion	Non-native	Occasional
Asteraceae	*Tetramolopium humile subsp. haleakalae*	Haleakalā tetramolopium	Endemic	Occasional
Bignoniaceae	*Thunbergia alata*	Black-eyed Susan vine	Non-native	Rare
Fabaceae	*Trifolium pratense var. sativum*	Red clover	Non-native	Occasional
Fabaceae	*Trifolium repens*	White clover	Non-native	Occasional
Poaceae	*Trisetum glomeratum*	Pili uka	Endemic	Occasional
Ericaceae	*Vaccinium reticulatum*	ʻŌhelo	Endemic	Rare
Verbenaceae	*Verbena litoralis*	Vervain	Non-native	Rare
Plantaginaceae	*Veronica arvensis*	Corn speedwell	Non-native	Rare
Fabaceae	*Vicia sp.*	Vetch	Non-native	Occasional
Apocynaceae	*Vinca sp.*	Vinca	Non-native	Rare
Poaceae	*Vulpia sp.*	Fescue	Non-native	Rare
Iridaceae	*Watsonia borbonica*	Watsonia	Non-native	Rare
Asteraceae	*Youngia japonica*	Oriental hawksbeard	Non-native	Occasional

BATS

We did not survey for Hawaiian Hoary Bats or ‘Ōpe‘ape‘a (*Lasiurus cinereus semotus*), as a year-long monitoring program with an array of ultrasonic bat detectors is being done by others.

Anecdotally, bats are present over all of East Maui, and some of their highest numbers occur in forested sections of the mid-elevations.

Our guess is there will be low levels of transiting bats anywhere within the reserve, with the most down by Kekaulike Ave., and the least up high near the summit where there is no vegetation.

The bats will likely follow gulches and forage in and near there. And any groves of trees will also likely be utilized, even non-native, especially the leeward sides out of the weather where insects would seek refuge, those sorts of locations attract foraging bats.

Hawaiian Hoary Bats tend to roost in large trees in sheltered locations. We anticipate most of the bat roosting sites will be in the lowest elevations of the reserve.

Very little is known about this nocturnal native, but many bats likely call Kamehamenui home.

Hawaiian Hoary Bat or ‘Ōpe‘ape‘a (*Lasiurus cinereus semotus*), Olinda, Maui.

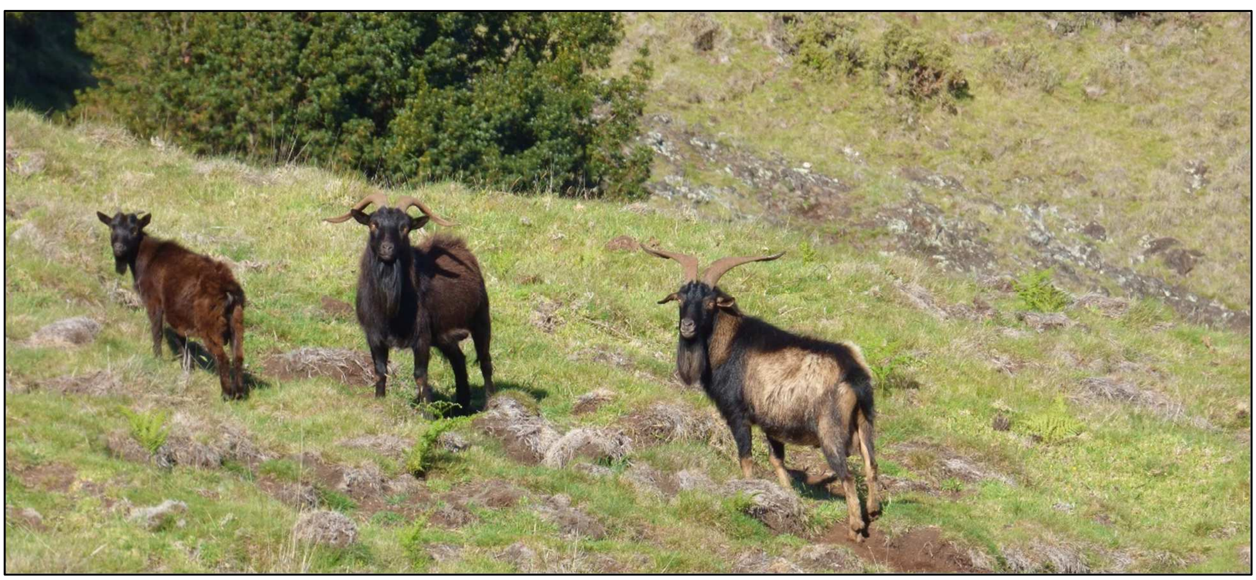
NON-NATIVE MAMMALS

The Kamehamenui Forest Reserve is currently an active ranch with numerous cows (*Bos taurus*), goats (*Capra hircus*), pigs (*Sus scrofa*), axis deer (*Axis axis*), and sheep (*Ovis aries*). Ungulate signs are evident over the entire reserve, though are markedly less in the highest elevations.

There are some nice looking pastures down low. However, damage to the native plants from the ungulates is severe, with vast areas completely denuded and taken down to dirt and stone.

Other mammals likely to utilize this property, but which were not observed or heard include rats (*Rattus* spp.), mice (*Mus domesticus*), cats (*Felis domesticus*), dogs (*Canis lupus familiaris*), and mongooses (*Herpestes javanicus*).

Cattle (*Bos taurus*).



Goats (*Capra hircus*).

Pig (*Sus scrofa*).

Axis Deer (*Axis axis*).

Sheep (*Ovis aries*).

Many previously vegetated areas of the reserve have been grazed and grubbed down to dirt by ungulates.

Bleached skeletons are all that remain of the native subalpine shrubland that once called this area home. Vast areas of the reserve are currently like this.

Pig damage is severe over much of the reserve.

Pigs are even able to uproot pūkiawe bushes.


Wool caught on barbed wire as sheep duck under the fence. ʻŌhiʻa trees in the background.


Sheep wool at the base of an ʻōhiʻa tree being used as a rubbing post.


Sandalwood tree heavily damaged by ungulates. All the sandalwood trees we encountered in the reserve are near death as a result of ungulate damage.


The base of another sandalwood tree. It's amazing the tree is still alive given the damage.

Newly installed fence adjacent to the reserve. Mostly ungulate free on the left, outside the reserve.

Same fence on the ground. Less vegetation and more pig digging on the right, inside the reserve.

BIRDS

There are a variety of habitats and elevational range in the reserve, resulting in a variety of birds. Of the native birds, the Maui ‘Amakihi (*Chlorodrepanis virens* var. *wilsoni*) is the most common, found in forested or densely vegetated shrubland from 4,000-7,500 ft.

‘Apapane (*Himatione sanguinea*) are also locally prevalent, but appeared less widespread, they were encountered in heavily forested areas from 5,500-7,500 ft. As with ‘Amakihi, they were present in both native and non-native forest.

Though not encountered in the reserve, ‘I‘iwi (*Vestiaria coccinea*) and Maui Creeper or ‘Alauahio (*Paroreomyza montana newtoni*) occur in nearby Kula Forest Reserve.

A Hawaiian Owl or Pueo (*Asio flammeus sandwichensis*) was observed gliding over open areas around 6,000 ft. They could occur over the entire range of the reserve. Though not encountered, Hawaiian Geese or Nēnē (*Branta sandvicensis*) likely also occur in the reserve at times.

Pacific Golden-Plovers or Kōlea (*Pluvialis fulva*) were regularly encountered on our first field day in late April. However, by the next week in early May, they had all left for Alaska. As a result, our bird distribution map does not convey the actual distribution, which is that Kōlea likely seasonally occur in all open areas from the bottom of the reserve to 8,500 ft.

Hawaiian Petrels or ‘Ua‘u (*Pterodroma sandwichensis*) nest in burrows dug in the ground in the higher elevations of the reserve. Though no live petrels were observed or heard, one dead petrel was found below powerlines near the summit, and we came across many recently active burrows.

Though seemingly barren and empty during the day, once darkness arrives, the night sky at the summit fills with seabirds and their raucous calls. With protection, the highest elevations of the reserve have the potential to support a huge number of seabirds.

Along with the Hawaiian Petrel, the Band-rumped Storm-Petrel (*Oceanodroma castro*) and Newell's Shearwaters (*Puffinus newelli*) may be able to utilize the habitat, especially as the area is further protected and restored.

Looking and listening for birds.

Eurasian Skylarks (*Alauda arvensis*) were omni-present over much of the reserve, given the vast open areas. There was almost constant singing by one to a few skylarks in many areas.

Non-native passerines found in forested areas in the reserve include Red-billed Leiothrix (*Leiothrix lutea*), Japanese Bush-warbler (*Cettia diphone*), Warbling White-eye (*Zosterops japonicus*), House Finch (*Haemorhous mexicanus*), Common Myna (*Acridotheres tristis*), Northern Mockingbird (*Mimus polyglottos*), and Northern Cardinal (*Cardinalis cardinalis*).

Game birds and doves heard or seen were Ring-necked Pheasant (*Phasianus colchicus*), Chukar (*Alectoris chukar*), Mourning Dove (*Zenaida macroura*), Zebra Dove (*Geopelia striata*), and Rock Pigeon (*Columba livia*).

A Barn Owl (*Tyto alba*) flushed from a rock cave in a cliff in the pasture zone as we approached.

Many birds are only found in the lowest parts of the reserve, including Chestnut Munia (*Lonchura atricapilla*), House Sparrow (*Passer domesticus*), and Junglefowl (*Gallus gallus*).

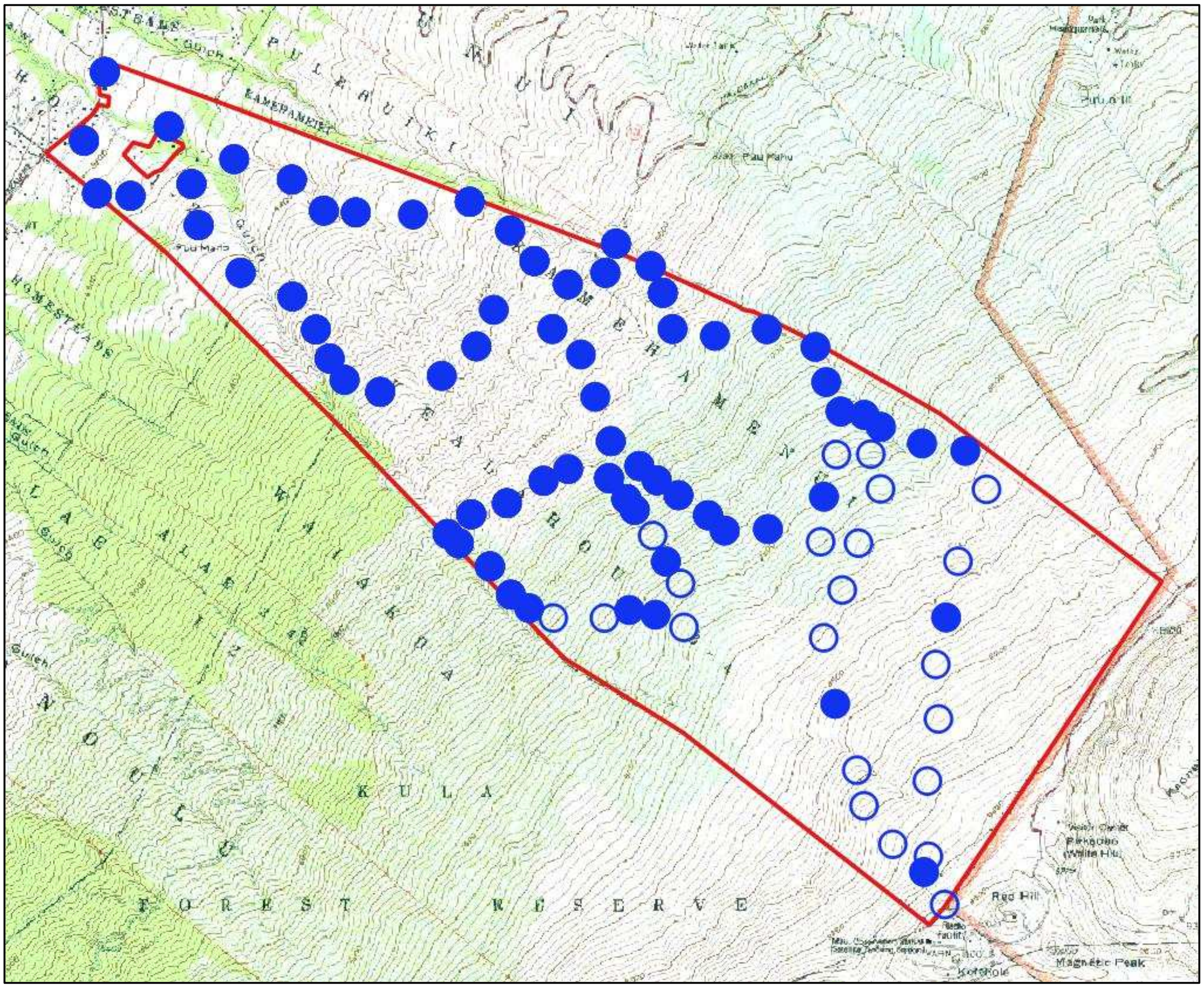
Chestnut Munia (*Lonchura atricapilla*) resting in a wattle snag on the edge of a pasture.

Hawaiian Petrel or ʻUaʻu burrow dug under a stone outcrop in the summit region, with burrow number.

Dead Hawaiian Petrel or ʻUaʻu under powerlines in the summit region. The vast and mostly barren summit region has the potential to support huge numbers of seabirds.

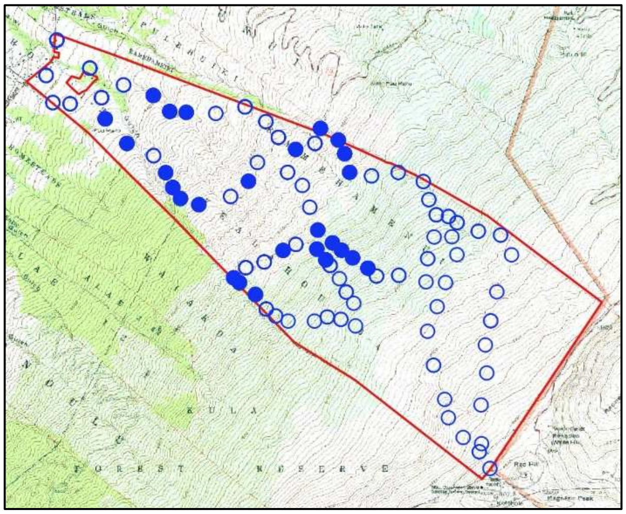
BIRD COUNTS

91 travelling counts of variable time and length were done across a range of habitat types and elevations. The average distance travelled for each count was 280 meters, and the average duration was 18 minutes. All birds observed or heard for an unlimited distance were recorded. Solid blue circles indicate detection, open blue circles indicate no detection.

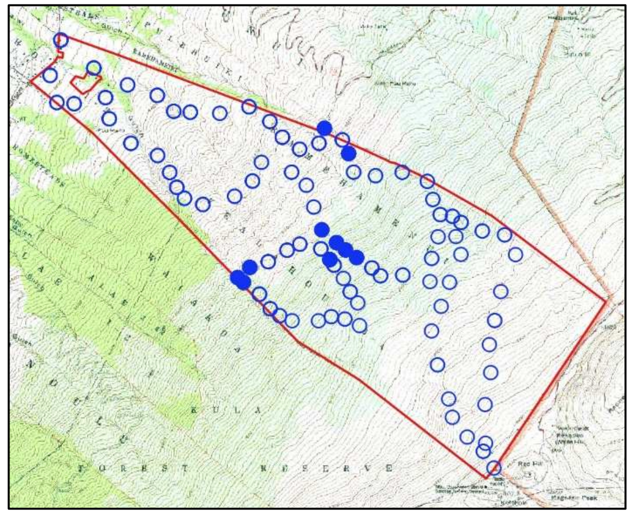


All bird count locations.

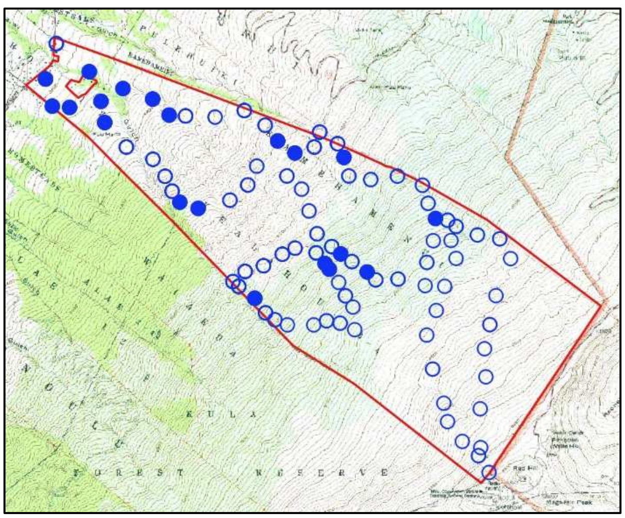
Looking and listening for birds.



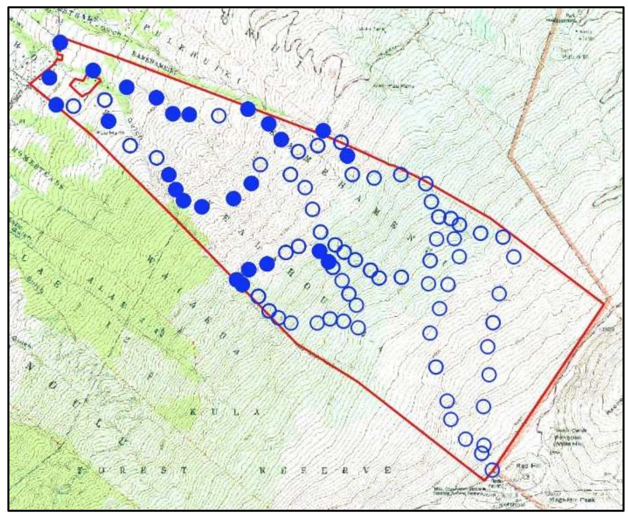
Maui ‘Amakihi



‘Apapane

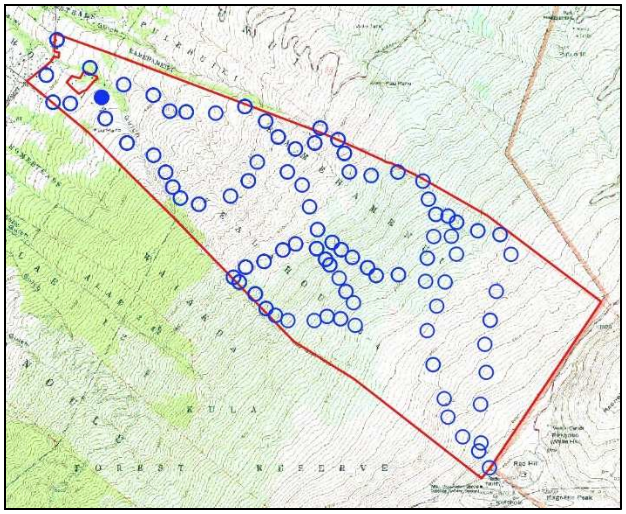


Warbling White-eye

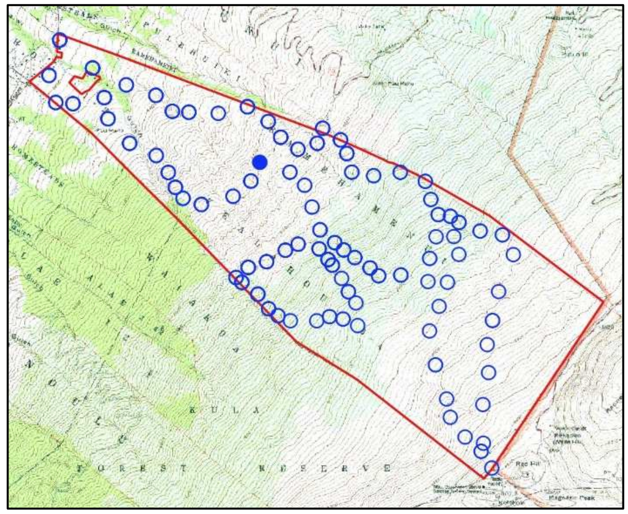


Red-billed Leiothrix

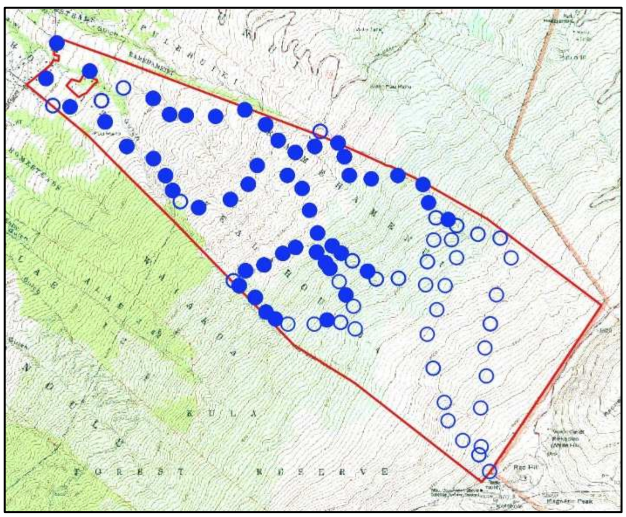
‘Apapane calling in ‘ōhi‘a canopy, Kahikinui Forest Reserve.



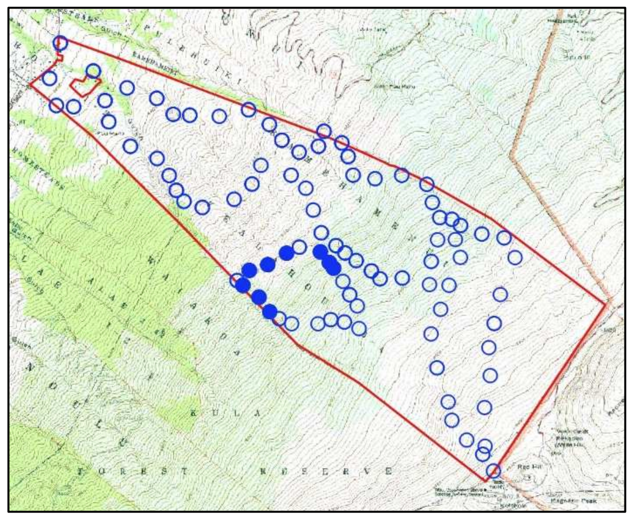
Hawaiian Owl or Pueo



Barn Owl

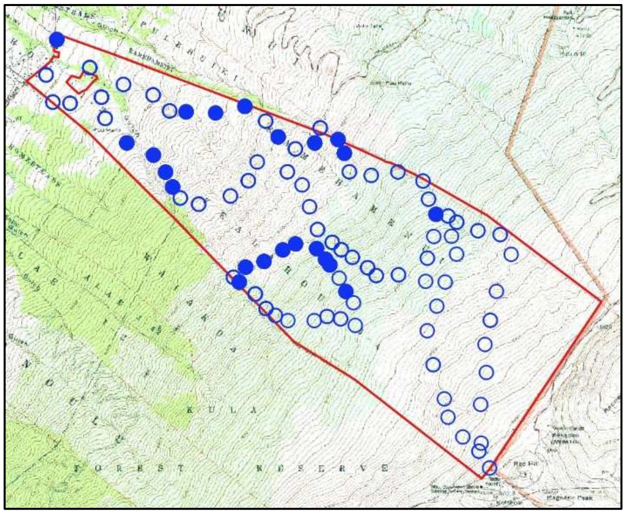


Eurasian Skylark

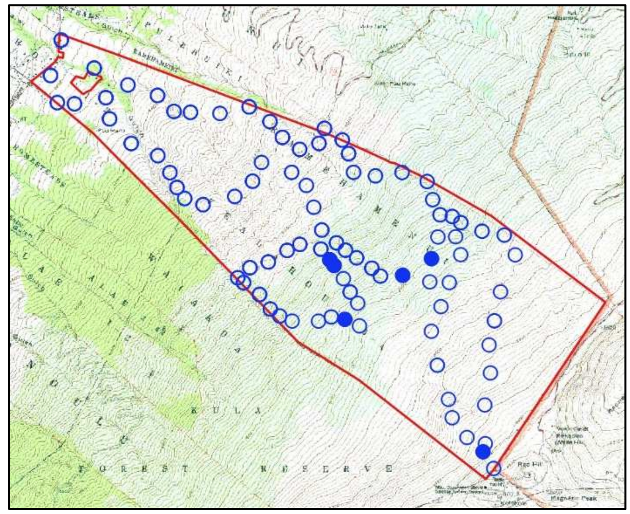


Pacific Golden-Plover or Kōlea

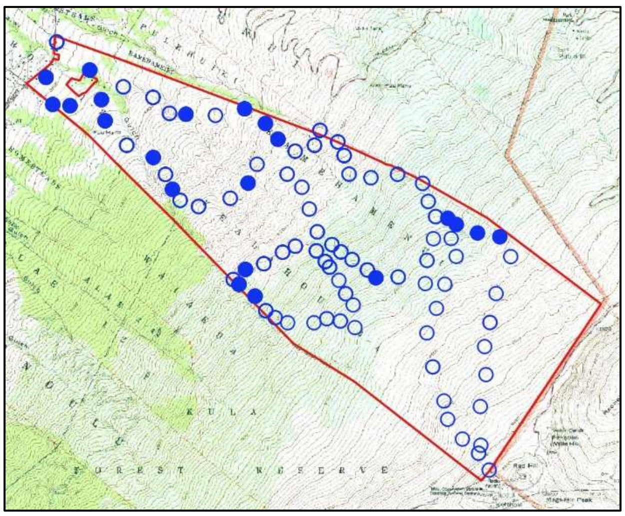
Hawaiian Owl or Pueo chick, Kula.



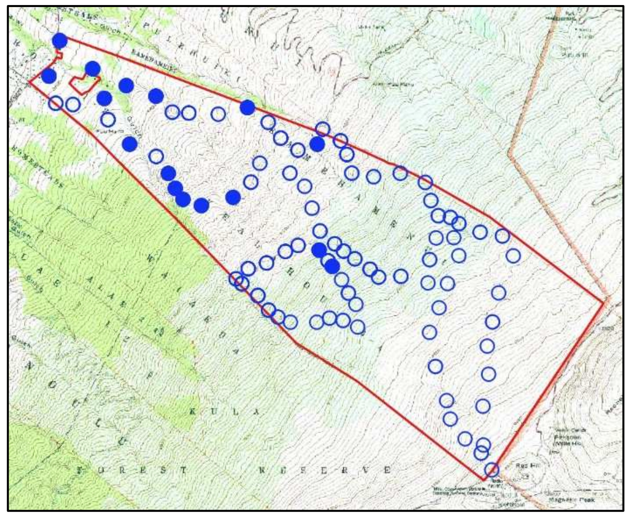
Ring-necked Pheasant



Chukar

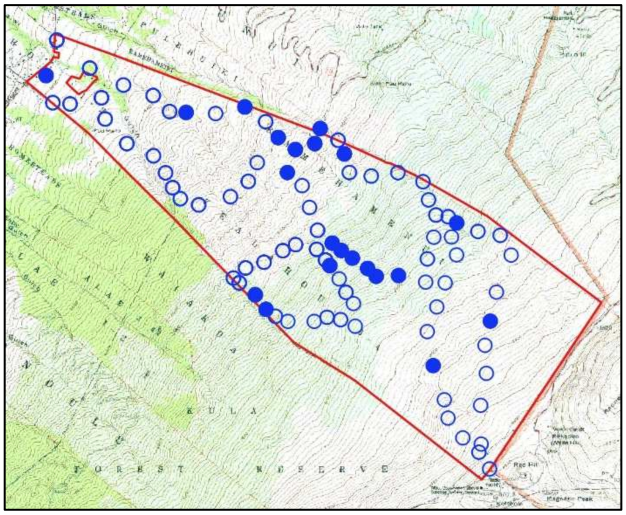


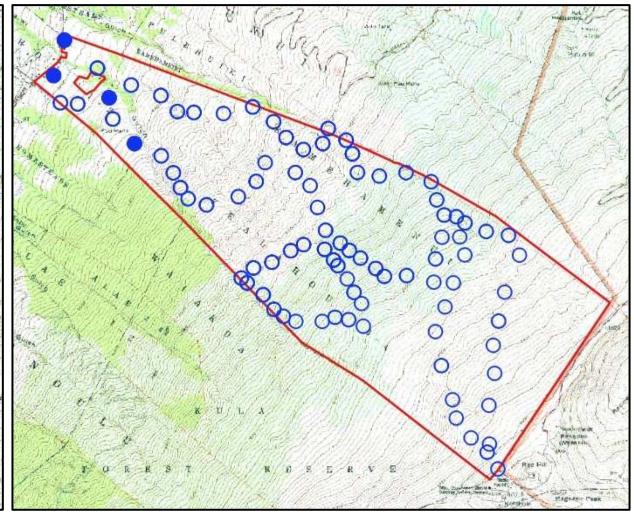
House Finch



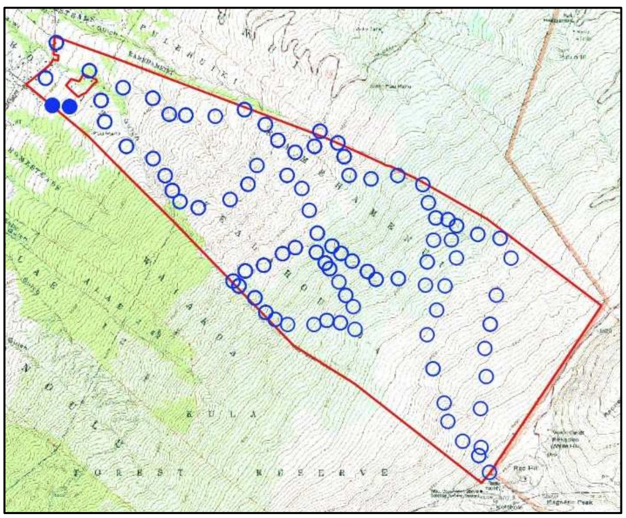
Northern Cardinal

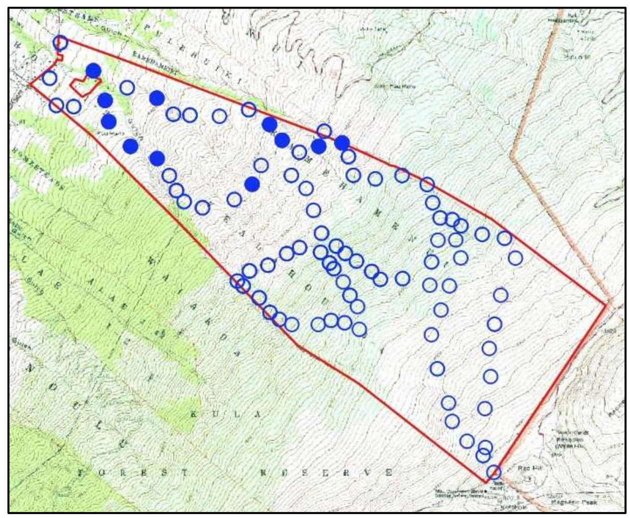
Ring-necked Pheasant, 'Ulupalakua.





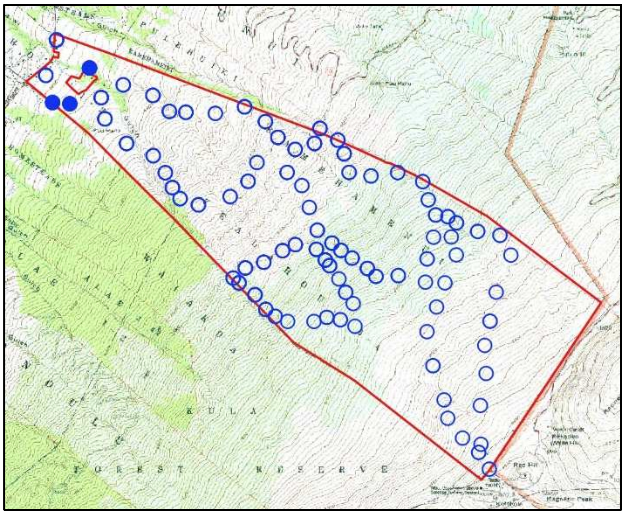
Northern Mockingbird **Red Junglefowl**



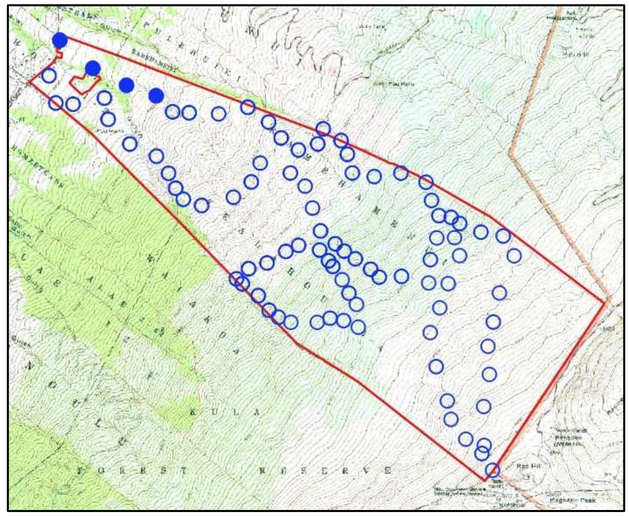


Chestnut Munia **Common Myna**

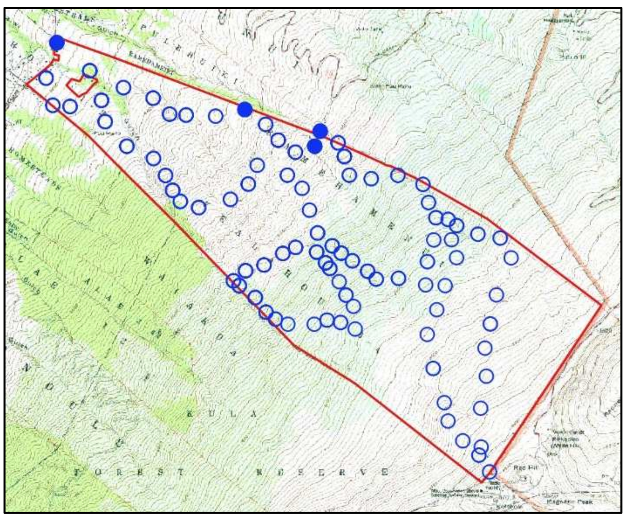
Common Myna birds, Midway Atoll.



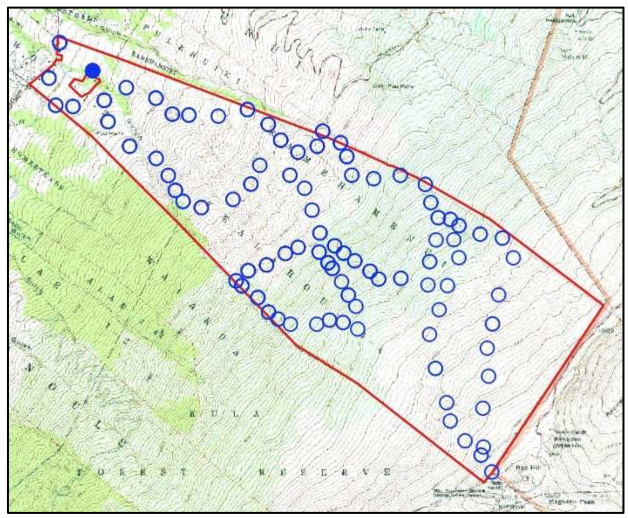
House Sparrow



Mourning Dove



Rock Pigeon



Zebra Dove

A lost Rock Pigeon at the Haleakalā summit visitor center parking lot.

BIRD SPECIES LIST

Following is a checklist of the bird species inventoried during the field work.

Abundance of each species within the project area:

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

Common name	**Scientific name**	**Nativity**	**Abundance**
‘Apapane	*Himatione sanguinea*	Endemic	Occasional
Barn Owl	*Tyto alba*	Non-native	Rare
Chestnut Munia	*Lonchura atricapilla*	Non-native	Rare
Chukar	*Alectoris chukar*	Non-native	Occasional
Common Myna	*Acridotheres tristis*	Non-native	Occasional
Eurasian Skylark	*Alauda arvensis*	Non-native	Common
Hawaiian Owl	*Asio flammeus sandwichensis*	Endemic	Rare
Hawaiian Petrel	*Pterodroma sandwichensis*	Endemic	Rare
House Finch	*Haemorhous mexicanus*	Non-native	Common
House Sparrow	*Passer domesticus*	Non-native	Occasional
Maui ‘Amakihi	*Chlorodrepanis virens wilsoni*	Endemic	Occasional
Northern Cardinal	*Cardinalis cardinalis*	Non-native	Occasional
Northern Mockingbird	*Mimus polyglottos*	Non-native	Occasional
Pacific Golden-Plover	*Pluvialis fulva*	Migratory	Occasional
Red Junglefowl	*Gallus gallus*	Non-native	Rare
Red-billed Leiothrix	*Leiothrix lutea*	Non-native	Common
Ring-necked Pheasant	*Phasianus colchicus*	Non-native	Common
Rock Pigeon	*Columba livia*	Non-native	Occasional
Warbling White-eye	*Zosterops japonicus*	Non-native	Common
Zebra Dove	*Geopelia striata*	Non-native	Occasional

Maui ‘Amakihi visiting ‘ōhi‘a flowers in Kahikinui Forest Reserve.

INSECTS

A complete inventory of the insects was beyond the scope of this survey. Conspicuous insects were noted and special effort was made to look for insects of conservation concern. Very little survey work has been done on insects in the Kamehamenui Forest Reserve, and there is still much to be discovered, including new undescribed species. Some of the more conspicuous and noteworthy insects we came across are noted below.

YELLOW-FACED BEES

Native yellow-faced bees (*Hylaeus* spp.) (Hymenoptera: Colletidae) are abundant in the subalpine shrubland of the reserve, especially on and near pūkiawe and ‘a‘ali‘i plants in bloom. These black bees with yellow and sometimes red markings are important pollinators of the Haleakalā silversword and other plants. Once common across all Hawai‘i, subalpine East Maui is now one of the only places these native bees are still abundant. The upper reaches of the reserve, 7,500-9,500 ft., have some of the highest numbers of yellow-faced bees we've encountered.

Yellow-faced bee (*Hylaeus nivicola*), an important pollinator of native plants such as silverswords. These increasingly rare native bees are abundant over much of the subalpine shrubland of Kamehamenui.

Kleptoparasitic yellow-faced bee (*Hylaeus volatilis*). Instead of visiting flowers to collect pollen and nectar, these native bees lay their eggs in the nests of other native bees while they are out foraging, like cuckoo birds.

KOA BUTTERFLY

Native native koa butterflies (*Udara blackburni*) (Lepidoptera: Lycaenidae) are locally abundant in the reserve. The larvae of this species feed on koa, ʻaʻaliʻi, and perhaps black wattle. As these plant species become more common, so too should this small but showy native butterfly.

Koa butterfly (*Udara blackburni*) in the koa/wattle forest of Kamehamenui Forest Reserve.

FLIGHTLESS MOTHS

The highest elevations of the reserve are home to the native Haleakalā flightless moth (*Thyrocopa apatela*) (Lepidoptera: Xyloryctidae). This brown moth can occasionally be seen hopping around the cinders and stones in the summit region. The moths are largely diurnal, being more active in the day. The larva is likely a generalist, feeding on plant debris. These ground bound moths benefit from no invasive ants in the highest elevations of the reserve.

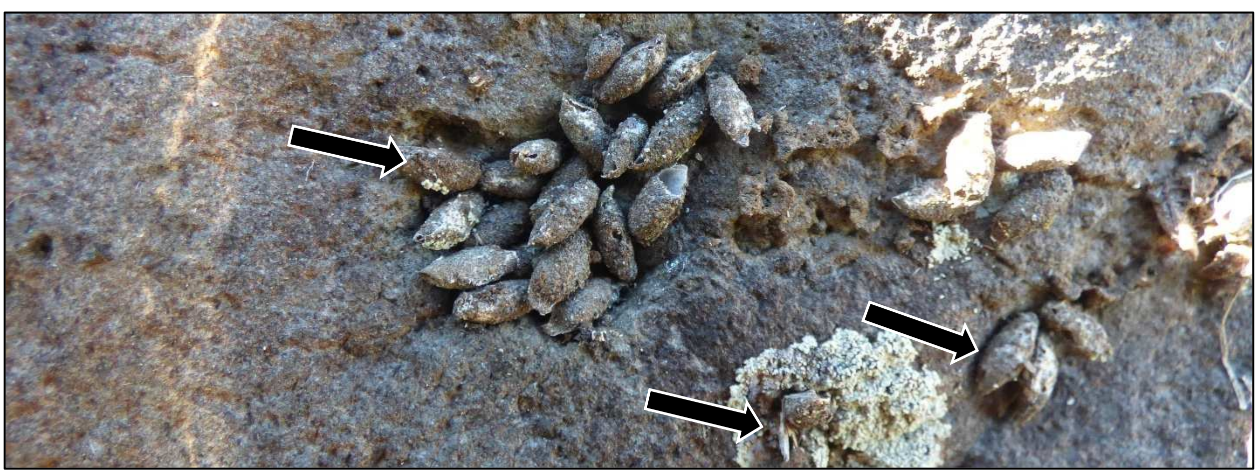
Haleakalā flightless moth (*Thyrocopa apatela*) in the summit region of Kamehamenui Forest Reserve.

FANCY-CASED MOTHS

Able to survive in some of the least hospitable areas of Hawaiʻi, native fancy-cased moths (*Hyposmocoma* spp.) (Lepidoptera: Cosmopterigidae) are abundant over much of Kamehamenui. Most prevalent to our eyes were the "burrito" shaped larvae/pupae that were common in sheltered areas on large stones and cliff faces across the entire reserve. We also came across cases of the "carnivorous/snail eater" and "candy wrapper" types. In most places in the reserve, *Hyposmocoma* were the most common moths in our sweep net.

The larvae of the "burrito" moths create a sleeping bag type structure they stick bits of mud and lichen to while they crawl around and graze on lichen and fungi. Larvae pupate in the cases. Adults emerge as small moths. The "carnivorous" larvae eat snails or possibly other *Hyposmocoma*. Many of the *Hyposmocoma* moths encountered in the reserve are new undescribed native species. Entomologists at the University of Hawaiʻi are further working up and archiving the specimens. There is still much to learn about these small native moths.

Hyposmocoma **spp. habitat in sheltered areas on stones and cliff faces.**



Hyposmocoma **sp. "burrito" shaped larvae/pupae adorned with bits of soil and lichen.**

***Hyposmocoma* sp. "carnivorous" larva / caterpillar adorned with white lichen.**

Adult *Hyposmocoma* moths showing some of the diversity found in Kamehamenui Forest Reserve.

Looking for native *Hyposmocoma* moths, which are super abundant in Kamehamenui Forest Reserve.

NATIVE TEPHRITID FLIES

Once common over much of Hawaiʻi, native tephritid or fruit flies (Diptera:Tephritidae) have now become restricted to the least disturbed habitats of Hawaiʻi. Subalpine East Maui is one of the last significant refugia for these flies. Though less diverse than it once was, the Kamehamenui Forest Reserve still contains multiple species of native tephritid flies.

Most abundant is *Trupanea cratericola*, which lays eggs on flowers of kūpaoa (*Dubautia* spp.) and Haleakalā silverswords. The larvae eat the seeds and pupate within them. *T. limpidapex* lays eggs in the shoot tips of *Dubautia*. Pupal cases and characteristic damage to *Dubautia* from both of these species was observed in the subalpine shrubland.

Though no adults or pupae were observed, *T. artemisae* is likely utilizing the flowers of hinahina (*Artemisia mauiensis*) within the reserve. Additionally, *T. crassipes*, which utilizes the flowers and seeds of the non-native Spanish needle (*Bidens pilosa*) may episodically become abundant.

Tephritid fly (*Trupanea cratericola*) swept from vegetation in subalpine region.

Tephritid fly (*Trupanea cratericola*) pupal case in seedhead of kūpaoa (*Dubautia menziesii*).

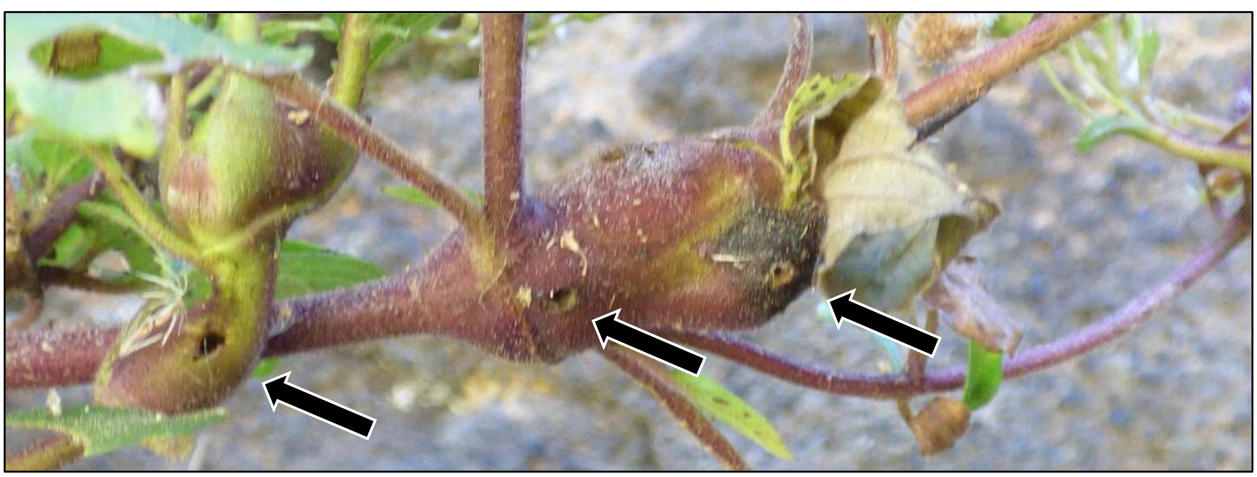
Remnants of tephritid fly (*Trupanea limpidapex*) pupa in shoot tip of kūpaoa (*Dubautia menziesii*).

NON-NATIVE TEPHRITID FLIES

A number of non-native tephritid flies (Diptera: Tephritidae) have been introduced to Hawai‘i for biocontrol of weeds.

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

P. utilis is present within the reserve virtually everywhere Maui pamakani is.

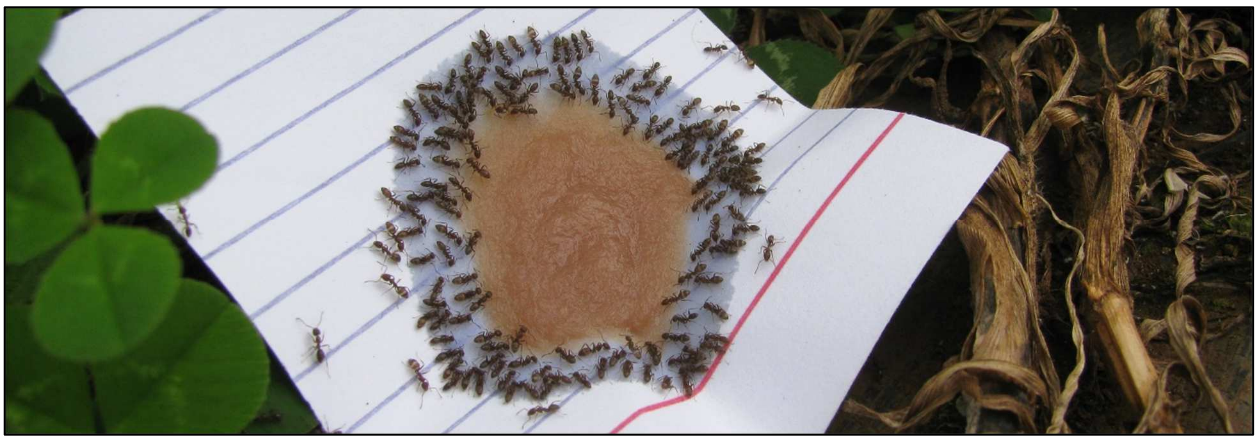


Gall and exit holes of stem galler (*Procecidochares utilis*) in Maui pamakani (*Ageratina adenophora*).

ANTS

Hawai'i has no native ants (Hymenoptera: Formicidae). Just two species were encountered in the reserve, Argentine ant (*Linepithema humile*) and glaber ant (*Ochetellus glaber*), both were in the lowest elevations. Anecdotally, the reserve appears to have vast areas mostly devoid of invasive tramp ants, which bodes well for the native insects, which can be heavily impacted by ants.

Detailed ant surveys including baiting were not done for this project and more ant species likely exist within the reserve. An ant survey of part of the reserve in 2008 by Paul Krushelnycky found three additional species *Cardiocondyla kagutsuchi*, big-headed ant (*Pheidole megacephala*), and *Hypoponera opaciceps*. Again the tramp ants were only found in the lowest elevations.



Argentine ants (*Linepithema humile*) at bait card at nearby Waipoli Rd.

PLANTHOPPERS

Native planthoppers (*Nesosydne* sp.) (Hemiptera: Delphacidae) are present within the reserve. The *Nesosydne* genus is an adaptive radiation of host-specialized Hawaiian planthoppers. It has been said that each species of native Hawaiian plant likely has its own species of *Nesosydne* that evolved to feed on it. The Haleakalā silversword even has its own, *N. argyroxiphii.* As the native plants within the reserve become more abundant, so too will these native planthoppers.

Native planthopper (*Nesosydne* sp.) swept from subalpine vegetation.

SPIDERS

Spiders are present in small numbers over the entire reserve. Of note are the native wolf spiders (*Lycosa hawaiiensis*) (Araneae: Lycosidae), which hunt for prey in the subalpine shrubland. These spiders live under stones, and at times carry dozens of live young baby spiders on their backs. Other native spiders observed include predatory crab spiders (*Mecaphesa* sp.) (Araneae: Thomisidae), which wait in flowers or vegetation to ambush their prey, and long-jawed spiders *Tetragnatha acuta* (Araneae: Tetragnathidae) which were swept from the subalpine vegetation.

Hawaiian wolf spider (*Lycosa hawaiiensis*) on silversword, Haleakalā National Park.

Long-jawed spider *(Tetragnatha acuta)*, swept from subalpine vegetation of Kamehamenui.

INSECT SPECIES LIST

Following is a checklist of the insect species inventoried during the field work. A more thorough arthropod inventory was done in similar shrubland in nearby Haleakalā National Park by Paul Krushelnycky (2007). Many of the insects identified in that survey likely also occur in Kamehamenui. Groups he found most diverse included Hemiptera (Bugs), Diptera (Flies), Lepidoptera (Moths and Butterflies), Coleoptera (Beetles), and Araneae (Spiders), which is similar to what we encountered in Kamehamenui.

Order	Family	Scientific Name	Common Name	Nativity
Araneae	Araneidae	*Gasteracantha mammosa*	Asian spiny back spider	Non-native
Araneae	Lycosidae	*Lycosa hawaiiensis*	Wolf spider	Endemic
Araneae	Salticidae	*?*	Jumping spider	Non-native
Araneae	Tetragnathidae	*Tetragnatha acuta*	Hawaiian long-jawed spider	Endemic
Araneae	Thomisidae	*Mecaphesa* sp.	Crab spider	Endemic
Coleoptera	Chrysomelidae	*Chrysophtharta m-fuscum*	Eucalyptus tortoise beetle	Non-native
Coleoptera	Coccinellidae	*Coccinella septempunctata*	Seven-spotted ladybird	Non-native
Coleoptera	Coccinellidae	*Cryptolaemus montrouzieri*	Mealybug destroyer	Non-native
Coleoptera	Coccinellidae	*Olla v-nigrum*	Ashy gray lady beetle	Non-native
Coleoptera	Curculionidae	*Gonipterus scutellatus*	Eucalyptus snout beetle	Non-native
Diplopoda	?	*?*	Millipede	Non-native
Diptera	Muscidae	*?*	House fly	Non-native
Diptera	Sepsidae	*?*	Dung fly	Non-native
Diptera	Syrphidae	*?*	Syrphid flies	Non-native
Diptera	Tephritidae	*Procecidochares utilis*	Pamakani stem gall	Non-native
Diptera	Tephritidae	*Trupanea cratericola*	Hawaiian fruit fly	Endemic
Diptera	Tephritidae	*Trupanea limpidapex*	Hawaiian fruit fly	Endemic
Diptera	Tipulidae	*?*	Crane fly	?
Hemiptera	Cicadellidae	*?*	Cicadellid	?
Hemiptera	Cixiidae	*Oliarus* sp.	Planthopper	Endemic
Hemiptera	Delphacidae	*Nesosydne* spp.	Planthopper	Endemic
Hemiptera	Lygaeidae	*Nysius* spp.	False chinch bugs	Endemic
Hemiptera	Miridae	*?*	Mirid bugs	?
Hemiptera	Psyllidae	*?*	Psyllids	?
Hemiptera	Tingidae	*Corythucha morrilli*	Lace bug	Non-native
Hemiptera	Tingidae	*Teleonemia scrupulosa*	Lantana lace bug	Non-native
Hymenoptera	Apidae	*Apis mellifera*	Honey bee	Non-native
Hymenoptera	Braconidae	*?*	Braconid wasp	?
Hymenoptera	Colletidae	*Hylaeus nivicola*	Yellow faced bee	Endemic
Hymenoptera	Colletidae	*Hylaeus volatilis*	Yellow faced bee	Endemic
Hymenoptera	Formicidae	*Linepithema humile*	Argentine ant	Non-native
Hymenoptera	Formicidae	*Ochetellus glaber*	Glaber ant	Non-native

Order	Family	Scientific Name	Common Name	Nativity
Hymenoptera	Vespidae	*Odynerus* sp.	Potter wasp	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* spp.	Fancy cased moths - "burrito" (at least 3 species)	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* sp.	Fancy cased moths - "small burrito"	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* spp.	Fancy cased moths - "candy wrapper" (at least 2 species)	Endemic
Lepidoptera	Cosmopterigidae	*Hyposmocoma* sp.	Fancy cased moths - "carnivore/snail eater"	Endemic
Lepidoptera	Erebidae	*Secusio [Galtara] extensa*	Fireweed biocontrol moth	Non-native
Lepidoptera	Lycaenidae	*Udara blackburni*	Koa butterfly	Endemic
Lepidoptera	Nymphalidae	*Danaus plexippus*	Monarch butterfly	Non-native
Lepidoptera	Nymphalidae	*Vanessa virginiensis*	American painted lady butterfly	Non-native
Lepidoptera	Pieridae	*Abaeis nicippe*	Sleepy orange butterfly	Non-native
Lepidoptera	Pieridae	*Pieris rapae*	Cabbage looper	Non-native
Lepidoptera	Schreckensteiniidae	*Schreckensteinia festaliella*	Rubus biocontrol moth	Non-native
Lepidoptera	Xyloryctidae	*Thyrocopa apatela*	Haleakalā flightless moth	Endemic
Neuroptera	Hemerobiidae	*?*	Brown lacewing	Non-native
Odonata	Libellulidae	*?*	Skimmer	?
Orthoptera	Gryllidae	*?*	Cricket	Non-native

Searching for native *Hyposmocoma* moths in Hāpapa Gulch. These cryptic native moths, many of which are new undescribed species, are abundant and diverse in Kamehamenui.

MOLLUSKS

Native tornatellid snails (*Tornatellides* sp.) (Gastropoda: Achatinellidae) were encountered on foliage and stones. This genus of snails is found in a variety of habitats from the Northwestern Hawaiian Islands to the main Hawaiian Islands. Tornatellid snails are known to be eaten by some species of native *Hyposmocoma* moths, which capture snails with silk and eat them alive.

Also observed were non-native garlic snails (*Oxychilus alliarius*). This invasive snail is a predator of small snails, and negatively impacts native snail communities where introduced.

We looked for, but did not find, the rare native ground snail (*Vitrina tenella*). It was previously known from Kamehamenui, where it was collected on ferns, shrubs, and the ground (6,000-8,500 ft.). However, it is currently only known from one site on Mauna Kea. It could have possibly been wiped out in Kamehamenui by the garlic snail (*Oxychilus*).

Further surveys would undoubtedly turn up more species of snails in the reserve. Native amber snails (*Succinea* spp.) are able to utilize both native and non-native dominated habitat, and are likely in parts of the reserve. And perhaps *Vitrina* is still present and just overlooked.

Non-native garlic snail (*Oxychilus alliarius*).

Native tornatellid snail (*Tornatellides* sp.).

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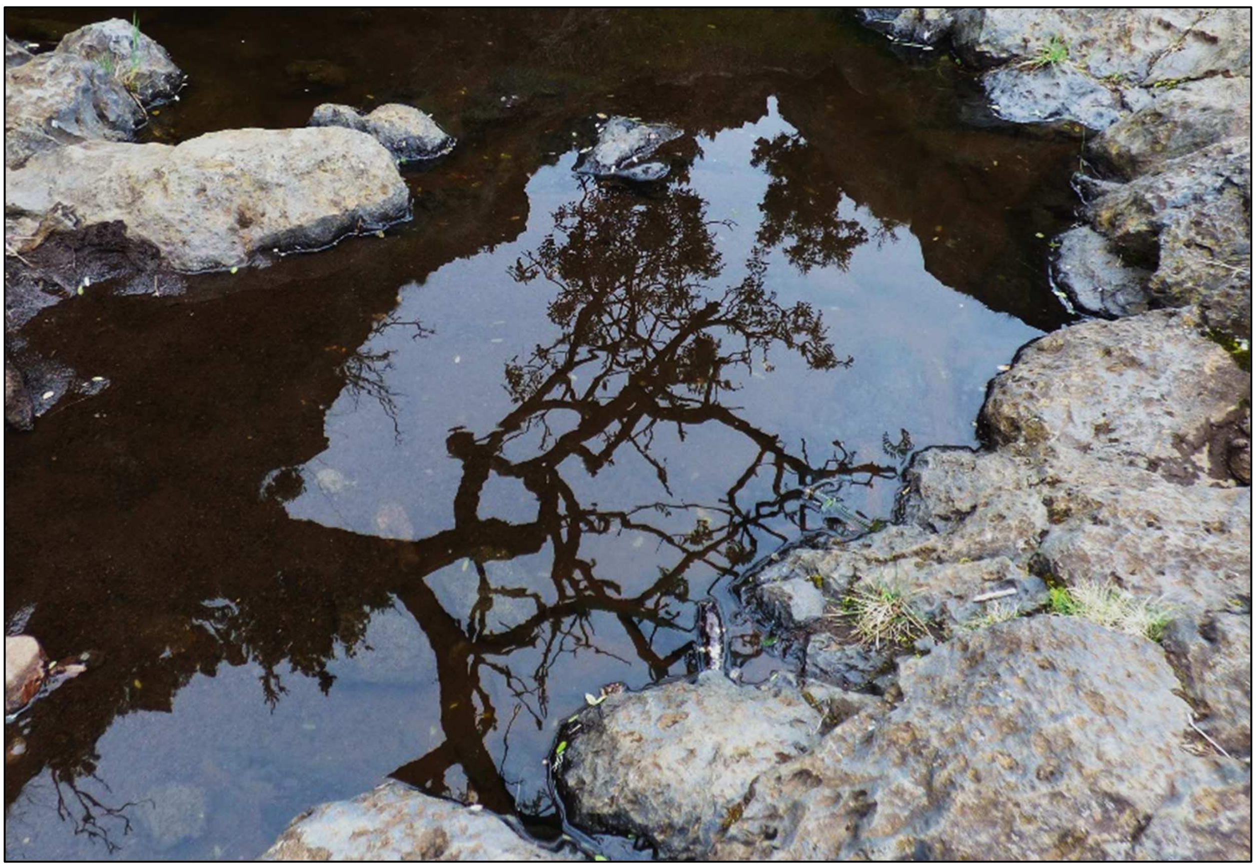

Ephemeral pool of water under a māmane tree in Kamehamenui Forest Reserve.
"Hahai nō ka ua i ka ululāʻau" **- The rain follows the forest.**

Attachment 3. Tier 5 Bat Mitigation Monitoring: Interim Monitoring Summary for May 2021 – March 2023

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Tier 5 Bat Mitigation Monitoring: Interim Monitoring Summary for May 2021 – March 2023
Revised Report

Auwahi Wind Energy LLC
Maui, Hawaii

Prepared by:
Joel Thompson
Western EcoSystems Technology, Inc.
2725 Northwest Walnut Boulevard
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Revised
December 3, 2024

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REPORT REFERENCE

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CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Auwahi Wind Energy LLC (Auwahi Wind) has established a Tier 5 Mitigation Site (Mitigation Site) within the Kamehamenui Forest Reserve to mitigate take of Hawaiian hoary bat (ʻōpeʻapeʻa*; Lasiurus semotus*) at their Auwahi Wind Energy Facility (Figure 1.1). Within the Mitigation Site, Auwahi Wind will implement management actions to improve habitat conditions for ʻōpeʻapeʻa and will monitor bat activity levels to assess the success of mitigation actions over time. Auwahi Wind's Tier 5 monitoring obligations consist of pre-trigger baseline acoustic monitoring at two detector locations, followed by baseline acoustic monitoring at a minimum of 14 detectors prior to initiating management actions (i.e., habitat enhancements) and post-management monitoring (Tetra Tech 2022). The primary objective of the acoustic monitoring is to document changes in ʻōpeʻapeʻa activity rates over time to assess the impact of management actions on bat activity within the Mitigation Site. This interim report provides a summary of the cumulative pre-trigger baseline monitoring dataset for acoustic bat data collected and analyzed for the period May 11, 2021, through March 30, 2023.

2 ENVIRONMENTAL SETTING

The Mitigation Site consists of approximately 700 acres of former ranchland at elevations ranging from approximately 6,200 – 7,600 feet on the north slopes of Haleakala, Maui, Hawaii (Figure 1.1). The Mitigation Site is centrally located in the Kamehamenui Forest Reserve and managed by the Hawaii Division of Forestry and Wildlife (DOFAW). Acquired by DOFAW in 2020, planned management for the Forest Reserve includes restoration of the pasturelands to native forest and mixed public use. The Mitigation Site consists primarily of open grasslands historically used for cattle grazing (i.e., pasture), with one approximately 25-acre stand of forest and scattered other trees (Figure 1.1). Perennial water is scarce within the Mitigation Site, with the primary water source limited to one cattle tank.

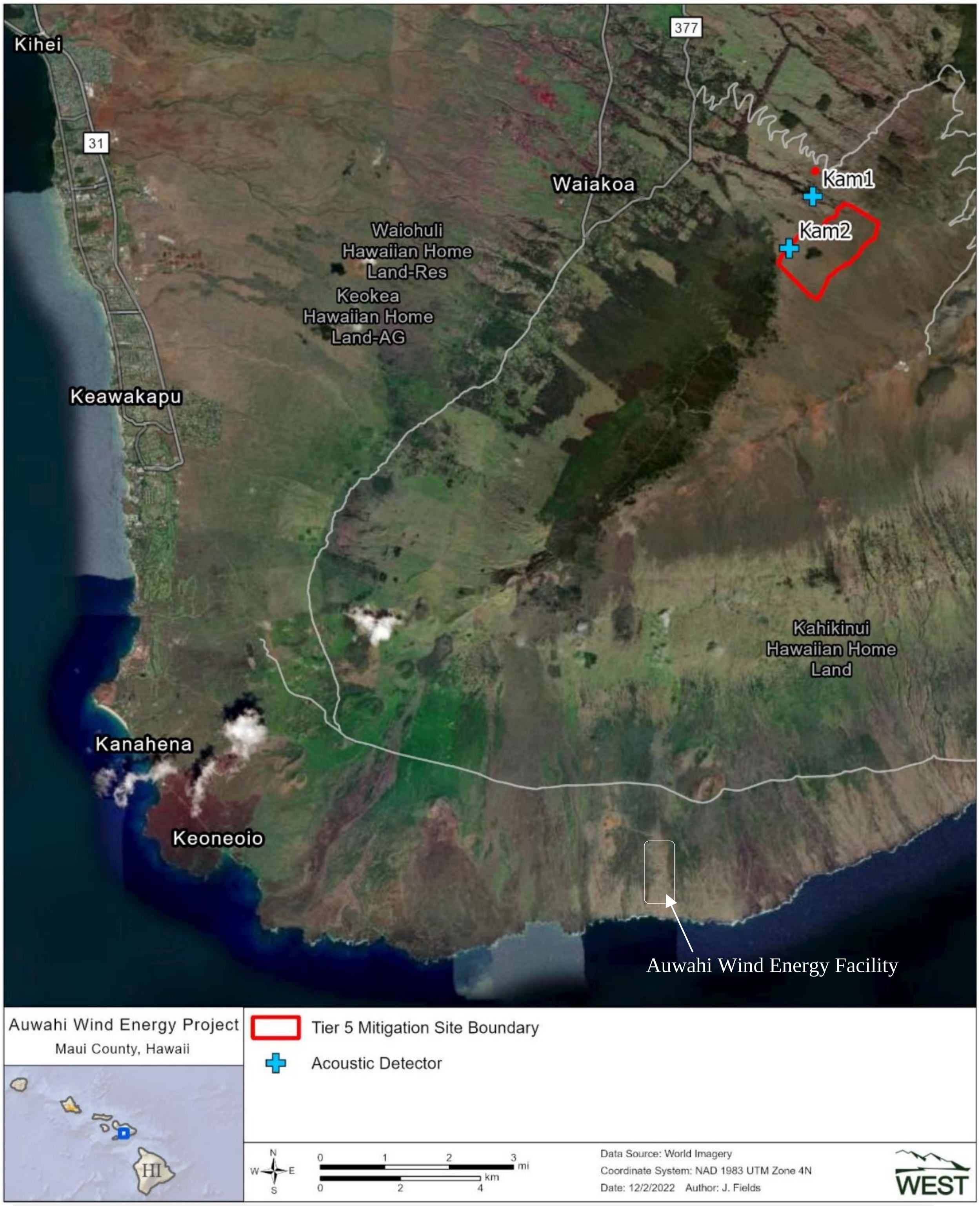

Figure 1.1. Location of Auwahi Wind's Tier 5 Hawaiian hoary bat Mitigation Site and acoustic bat detector locations, Maui, Hawaii.

3 METHODS

Two Wildlife Acoustics SM4Bat full spectrum bat detectors (Wildlife Acoustics, Maynard, Massachusetts) were deployed in May 2021 to begin pre-trigger baseline monitoring (Figure 1.1). Detector Kam1 is located within the Kamehamenui Forest Reserve, but outside the Mitigation Site. Its location outside the Mitigation Site is a result of its deployment prior to finalizing the boundaries of the Mitigation Site. Pre-trigger baseline data from Kam1 is considered representative of bat use within the area in general; however, because it is located outside the Mitigation Site, Kam1 would be considered a control site in future analyses to assess the effect of management actions within the Mitigation Site. Detector Kam 2 is located within the Mitigation Site.

Auwahi Wind provided all acoustic monitoring equipment and associated accessories (e.g., microphones, solar panels, and batteries) and managed all aspects of the field study, including the ongoing maintenance of the detectors and data retrieval. Once retrieved, data was transferred to Western EcoSystems Technology, Inc. (WEST) for analysis. Once data was received from Auwahi Wind, WEST reviewed and verified its completeness and conducted a quality check of the summary and acoustic files to ensure detectors and microphones were functioning properly. Full spectrum data were then processed and converted to zero-cross data using the software package Kaleidoscope Pro (version 5.1.0; Wildlife Acoustics), reducing the overall file sizes for storage and further analysis. During the conversion process, Kaleidoscope Pro filtered zero-cross files suspected to be noise into a folder separate from the other zero-cross files. Once converted and filtered, all zero-cross files, including suspect noise files, were reviewed as digital sonograms and labeled by a bat biologist using the program Analook (Titley Scientific). This process was used to confirm the presence of sufficient echolocation pulses (a minimum of two) to qualify as a bat call, determine consistency with the call parameters of ʻōpeʻapeʻa (both call frequency and pattern), and to classify the call type (i.e., searching/location calls or feeding buzzes). To ensure consistent organization and comparability of data across years and studies, data handling procedures were consistent with those used by WEST during review of data collected during the first 2 years of monitoring and other acoustic studies conducted by WEST in Hawaii (e.g., Leeward Haleakala and Oahu occupancy studies; Thompson and Starcevich 2021, 2022), as well as analyses of Auwahi's Tier 4 Mitigation Site data (Thompson and Hammond-Rendon 2024).

Once all call files were reviewed and bat presence verified, the call data were used to calculate the bat use metrics requested by Auwahi Wind:

1. **Call abundance** = total bat calls/total active detector-nights (a detector-night was defined as one detector operating for one night),
2. **Call nightly detection** = total nights with bat calls/total active detector-nights, and
3. **Activity minutes per night** = total number of minutes during an active detector-night with at least one bat call.

A second set of metrics was generated based on feeding buzzes only, with a feeding buzz defined as the tightly spaced series of sequential echolocation pulses used to home in on prey and indicative of active feeding:

1. **Feeding buzz abundance** = total feeding buzzes/total active detector-nights, and
2. **Feeding buzz nightly detection** = total nights with feeding buzzes/total active detector-nights.

Call abundance and nightly detection for all calls and feeding buzzes are the metrics identified in the Auwahi Wind Habitat Conservation Plan (HCP; Tetra Tech 2019) for monitoring purposes. Activity minutes per night was not included as a required monitoring metric in the HCP but has been included here based on additional discussion and a request from the Hawaii Endangered Species Recovery Committee (ESRC). Data are summarized for each of the two detectors by year for comparison purposes. Year 0 is defined as the initial year of pre-trigger baseline monitoring and included the period May 11, 2021–March 31, 2022; Year 1 included the period April 1, 2022–March 30, 2023. The information presented herein includes additional data that had been temporarily lost in transition from Auwahi to WEST and therefore not included in the in the July 2024 interim report (Thompson 2024). This data was located and analyzed after submitting the July 2024 report, and as such, data gaps were filled for some relatively high use periods of the study, which affected the annual comparisons presented in the July 2024 report. Like the July 2024 interim report, data in this revised report are only presented for Years 0 and 1, as data for Year 2 is still incomplete (i.e., the full year of data have not been provided and/or analyzed); therefore any annual activity metrics produced would not be readily comparable to those from Year 0 and Year 1. Data collection and analysis of the Tier 5 monitoring is ongoing, and Year 2 data will be included in analyses once a full year of data are collected and analyzed.

4 RESULTS

4.1.1 All Bat Calls

The number of detector nights sampled during the period May 11, 2021–March 30, 2023, totaled 1,371 and resulted in 49,670 bat calls at the two Tier 5 sampling stations (Kam1 and Kam2; Table 4.1). Kam1 accounted for 73% of all recorded bat calls compared to 27% at Kam2 (Table 4.1). Bat call abundance was greater at station Kam1 in both years (32.75 and 71.61 calls/detector night) relative to Kam2 (18.99 and 19.88; Table 4.1). Bat call abundance at Kam1 was much higher in Year 1 compared to Year 0, whereas it was only slightly higher in Year 1 at Kam2 (Table 4.1). Call nightly detection was similar and high (90–96%) at both stations in both years, indicating that bats were active at both stations on most nights (Table 4.1).

Table 4.1. Results for all bat detections during acoustic surveys conducted at two stations (Kam1 and Kam2) in and near Auwahi Wind's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–March 30, 2023.

Year	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector - Nights	Call Abundance (Bat Calls/ Detector-Nights[a])	Nightly Detection (Nights Bats Detected/Total Detector-Nights)	Average Bat Minutes/ Detector Night
				Kam1		
0	10,644	309	325	32.75±2.70	0.95	25.04
1	25,638	344	358	71.61±6.60	0.96	39.02
				Kam2		
0	6,152	304	324	18.99±1.35	0.94	15.62
1	7,236	326	364	19.88±1.18	0.90	17.67

[a] ± bootstrapped standard error.
Year 0 = May 11, 2021–March 31, 2022
Year 1 = April 1, 2022–March 30, 2023

4.1.2 Feeding Buzzes

For the period May 11, 2021–March 30, 2023, 132 feeding buzzes were recorded (Table 4.2). The Kam1 detector accounted for 70% of all recorded feeding buzzes compared to 30% at Kam2. Similar to call abundance for all calls, feeding buzz abundance was greater at station Kam1 in both years (0.05 and 0.21 feeding buzzes/detector night) relative to Kam2 (0.02 and 0.09) and feeding buzz abundance was greater in Year 1 compared to Year 0 at both stations (Table 4.2). Feeding buzz nightly detection varied more than call nightly detection for all calls and ranged from 5–16% at Kam1 and from 2–7% at Kam2 (Table 4.2).

Table 4.2. Results for feeding buzz detections during acoustic surveys conducted at two stations (Kam1 and Kam2) in and near Auwahi Wind's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–March 30, 2023.

Year	# of Feeding Buzzes	Detector-Nights with Feeding Buzzes	Total Detector-Nights	Feeding Buzz Abundance (Feeding Buzzes/ Detector-Nights[a])	Feeding Buzz Nightly Detection (Nights Bats Detected/Total Detector-Nights[b])
			Kam1		
0	16	15	325	0.05±0.01	0.05
1	76	58	358	0.21±0.03	0.16
			Kam2		
0	6	6	324	0.02±0.01	0.02
1	34	27	364	0.09±0.02	0.07

[a] ± bootstrapped standard error.
Year 0 = May 11, 2021–March 31, 2022
Year 1 = April 1, 2022–March 30, 2023

4.1.3 Minutes of Activity

The average number of minutes per night with bat activity followed the same pattern as call abundance and was greater at Kam1 than Kam2 in both years (see Table 4.1). Similarly, the minutes with activity metric was much higher in Year 1 (39.02) than Year 0 (25.04) at Kam1, but only slightly higher in Year 1 at Kam2 (17.76 compared to 15.62; Table 4.1). While annual patterns were not apparent based on the two years of data, minutes with activity showed clear seasonal patterns, with substantially more minutes containing bat calls recorded during the summer and fall months, although a slightly later peak in minutes of activity was seen in Year 1 (late August-September) compared to Year 0 (early August; Figure 4.1).

5 DISCUSSION

Data available to date provides general insight into overall activity rates at the Mitigation Site and provides pre-trigger baseline data that can be used to assess monitoring study needs and to which future bat activity metrics can be compared. Relative to the interim report provided in July 2024, additional data was recovered that filled in data gaps for some relatively high-use periods (summer through fall) at the Kam2 sampling station, providing a more complete and robust baseline dataset to which future comparisons can be made.

Seasonal estimates were not calculated for the activity metrics, but it is assumed that call abundance, at minimum, would likely follow a seasonal pattern similar to the activity minutes and consistent with the seasonal patterns of ʻōpeʻapeʻa activity reported by others (e.g., Menard 2001; Gorresen et al. 2013; Thompson and Starcevich 2021, 2022; Thompson and Hammond 2024).

While the objective of the long-term monitoring study is to measure changes in bat activity within the Mitigation Site over time in response to management activities, the current dataset presented herein represents only the pre-trigger baseline monitoring. Pre-trigger baseline monitoring was required to inform the long-term monitoring study design and provides the baseline data to which future activity rates can be compared after management activities are implemented. Additional detectors will be deployed throughout the Mitigation Site (anticipated to occur in 2024 or early 2025) for baseline monitoring and additional data will be collected over the coming years to monitor the Mitigation Site and the response of bat activity metrics to management activities following their implementation.

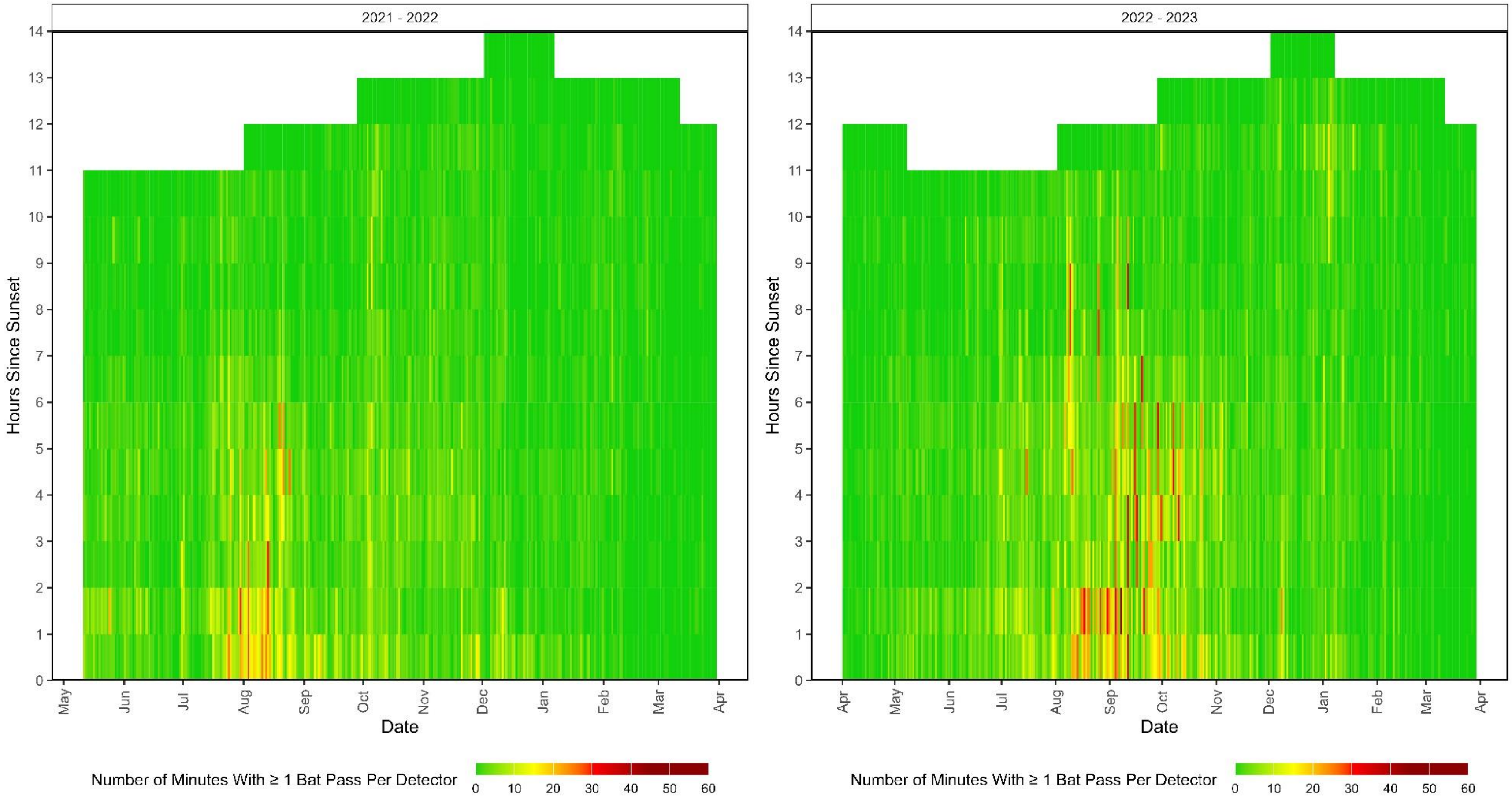

Figure 4.1. Bat activity patterns relative to sunset (hour zero) and time of year illustrated by the number of minutes with one or more bat calls averaged across the two acoustic sampling stations within Auwahi Wind's Tier 5 Mitigation Site May 11, 2021–March 30, 2023, Maui, Hawaii. Year 0 is represented in the left panel and Year 1 in the right panel.

6 REFERENCES

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