Kahuku Wind Project
Hawaiian Hoary Bat Tier 2 Mitigation Plan

Prepared for
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Prepared by

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1.0 Introduction

Kahuku Wind Power, LLC (KAH) received an Incidental Take Statement (ITS; BO 2010-F-0190) from the U.S. Fish and Wildlife Service (USFWS) and a state Incidental Take License (ITL; ITL-10) from Hawai‘i Division of Forestry and Wildlife (DOFAW) for the Kahuku Wind Project (Project) in May and June of 2010, respectively. The ITS and ITL cover the incidental take of eight listed species including the Hawaiian hoary bat, or ‘ōpe‘ape‘a (*Lasiurus semotus*). The Kahuku Wind Power Habitat Conservation Plan (HCP; SWCA 2010) identifies two tiers of bat take and discusses compensatory mitigation for each tier. Following an observed bat take in August 2021, the Project's estimated take at the 80 percent upper credible limit crossed the upper threshold for the Baseline Rate of Take (Tier 1). Bat take estimated at the 80 percent upper credible limit falls within the Higher Rate of Take (Tier 2) of authorized incidental take of the Hawaiian hoary bat and requires the implementation of a corresponding mitigation program.

This Mitigation Plan represents KAH's plan to mitigate for Project bat take at the Tier 2 level. Specific mitigation actions are identified that are intended to offset the take of the eight bats in Tier 2. The Baseline level of take, as specified in the HCP, includes 12 adults and nine juveniles (three adult equivalents using the formula of 9*0.3 [the probability of juvenile bat survival to adulthood, based on agency guidance; USFWS 2016]), for a total of 15 bats. Higher level of take, as specified in the HCP, includes 18 adults and 14 juveniles (five adult equivalents) for a total of 23 bats. The difference between Higher and Baseline levels of take would be the offset needed for Tier 2; this difference calculates to eight bats. KAH initiated consultation with USFWS and DOFAW regarding options for a Tier 2 mitigation plan in 2020 and received and acted on preliminary suggestions from the USFWS and DOFAW HCP teams to explore funding needed for management actions supporting bat habitat improvements in the recently acquired Helemano Section of the ‘Ewa Forest Reserve or the Waimea Native Forest (Lasha-Lynn Salbosa, USFWS, pers. comm., from the October 18, 2021 Annual HCP meeting notes; see also Figure 1). In preparation of the Mitigation Plan submittal to USFWS and DOFAW HCP staff, KAH consulted with DOFAW O‘ahu for input on potential mitigation actions beneficial to the Hawaiian hoary bat within the agency HCP teams' suggested potential Tier 2 mitigation sites. DOFAW O‘ahu suggested the Helemano Section would be a more suitable alternative as an appropriate site for KAH to consider for bat mitigation because there are more opportunities to perform the types of habitat modification that are likely to achieve required benefits on the accelerated timeline required by the Project (Marigold Zoll, DOFAW O‘ahu, pers. comm., June 6, 2021). The Helemano Mitigation Area (HMA) is depicted in Figure 2.

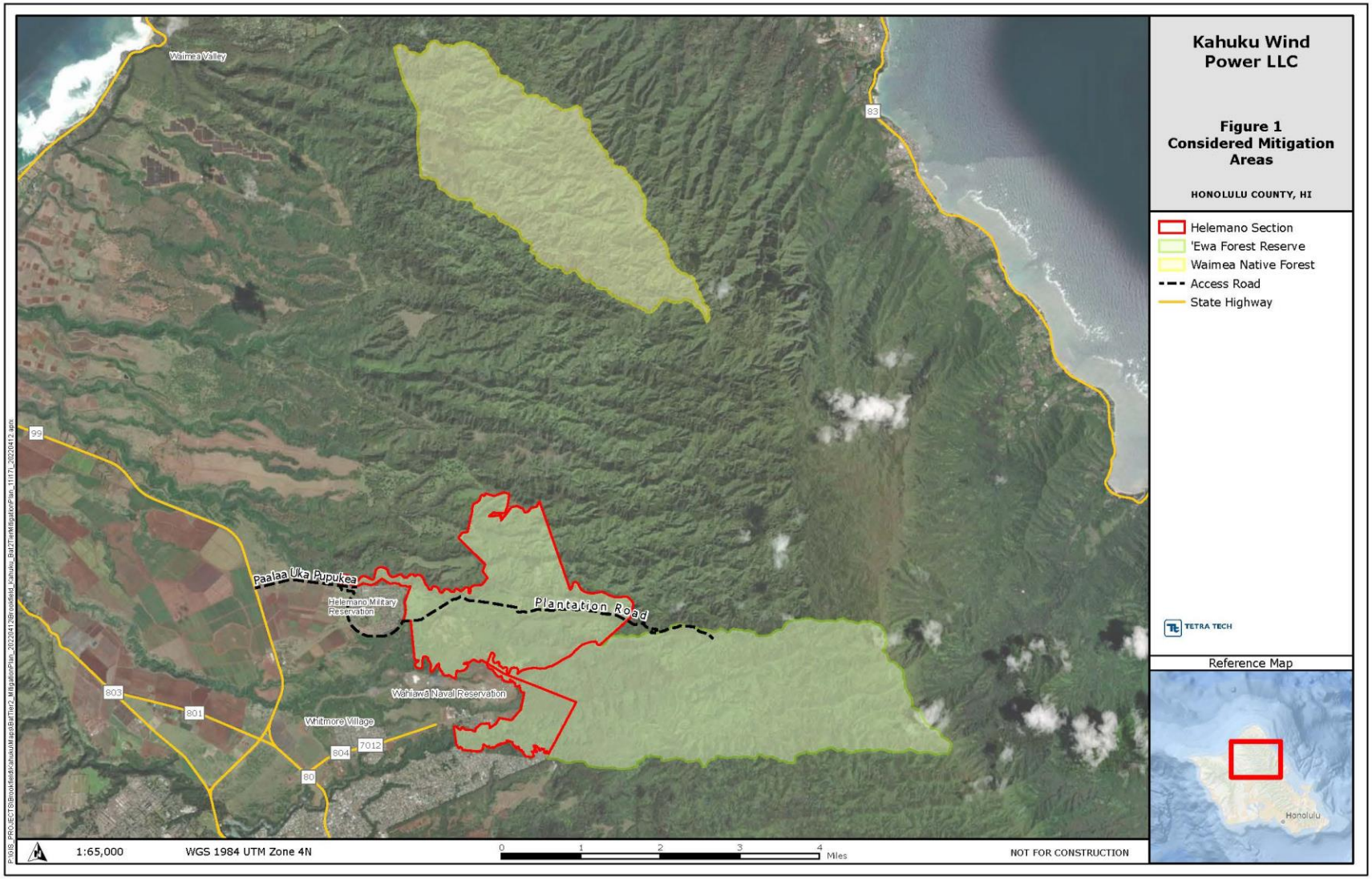

Figure 1. Considered Mitigation Areas

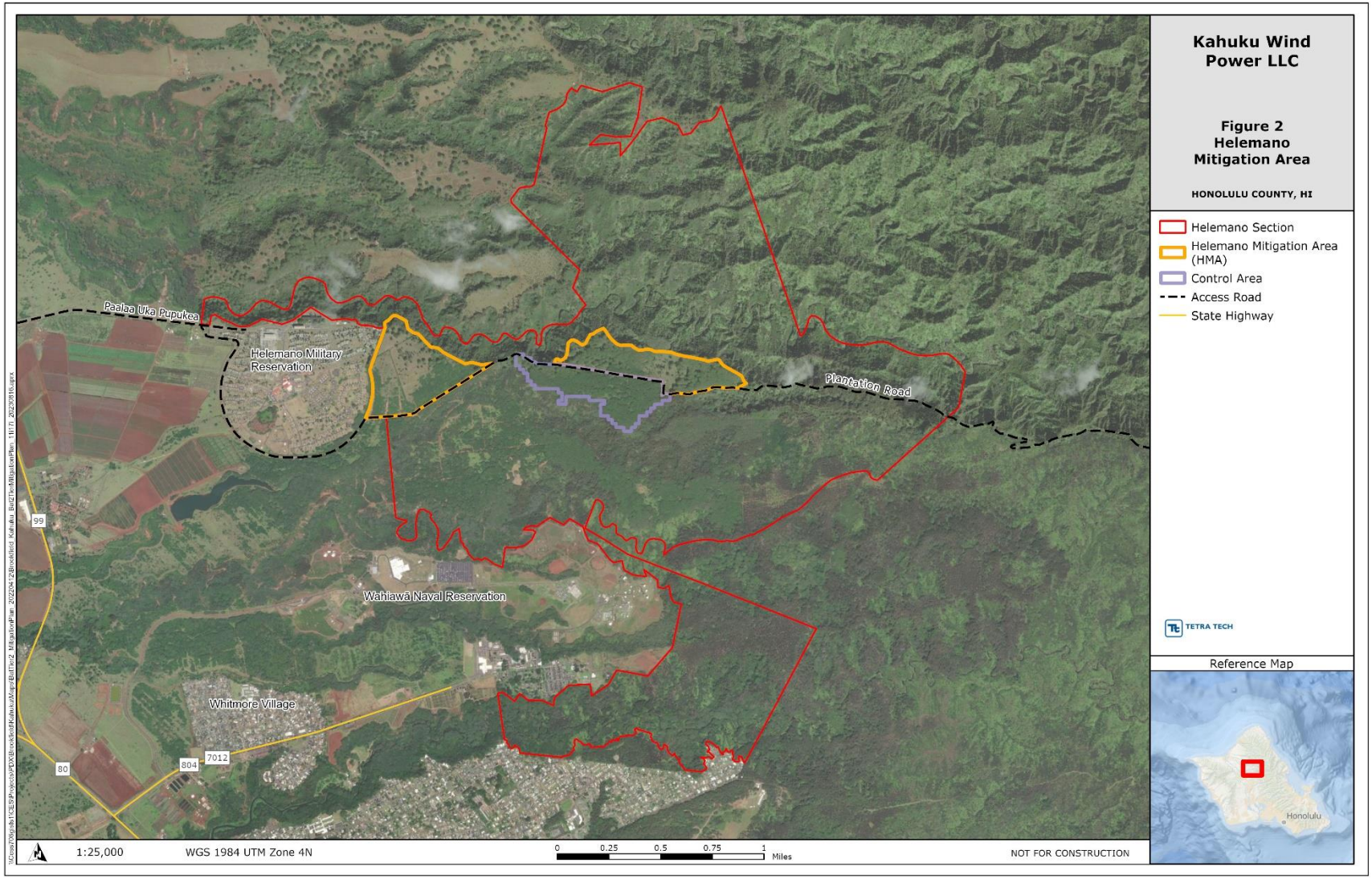

Figure 2. Helemano Mitigation Area

This Mitigation Plan describes KAH's mitigation actions for Tier 2, all of which are additive and complementary to the broad management goals and suitable forest management activities identified and previously executed by DOFAW O'ahu for the Helemano Section of the 'Ewa Forest Reserve. Thus, baseline conditions for mitigation actions in the HMA incorporate any actions already executed by DOFAW at the time this Mitigation Plan was developed. A Memorandum of Understanding (MOU) will be mutually developed by KAH and DOFAW O'ahu that defines the respective responsibilities and actions to be taken by each party relative to the HMA (see Section 4.2.2).

1.1 Triggering

As identified in the Kahuku Wind Power HCP, the implementation of additional appropriate actions to benefit the Hawaiian hoary bat is necessary (Tier 2) to mitigate for the associated take should Tier 1 be exceeded during the permit term (SWCA 2010). As outlined in guidance from the USFWS (USFWS 2016), mitigation planning for the next higher tier is triggered by reaching 75 percent of allowed take in the current tier (direct and indirect). Based on the Project's cumulative take estimate in the 2020 annual report (11 bats; Tetra Tech 2020b), planning for Tier 2 mitigation was initiated. The potential need for planning was documented in the FY 2018 annual report, although this preceded the triggering of planning recommended in the USFWS (2016) guidance. KAH began formulating Tier 2 mitigation plans in 2020 and first discussed potential mitigation actions with the USFWS and DOFAW HCP teams at the FY 2020 annual meeting on October 20, 2020. Tier 2 mitigation planning was again addressed at the FY 2021 semi-annual meeting on May 4, 2021, when refined options for a mitigation program were vetted.

Estimated take at the 80 percent upper credible limit exceeded Tier 1 when a Hawaiian hoary bat fatality was detected on August 26, 2021, during the Tier 2 mitigation planning process. KAH has developed this Mitigation Plan in consultation with USFWS and DOFAW to address the mitigation required for Tier 2.

1.2 Biological Goals and Objectives

The purpose of identifying biological goals and objectives is to establish a framework (USFWS and NMFS 2016) for developing the mitigation actions and success criteria for this Mitigation Plan. Biological goals are intended to be broad, guiding principles that clarify purpose and direction. Biological objectives are derived from the goals and provide the basis for determining strategies, monitoring effectiveness, and evaluating the success of actions (USFWS and NMFS 2016). The Project's success criteria are then derived from these objectives, which identify interim time-based metrics, that if met, will also result in the Project meeting the biological goals and objectives (see Section 4.5). The biological goals and objectives for this Mitigation Plan are shown in Table 1.

Table 1. Kahuku Hoary Bat Tier 2 Mitigation Plan Biological Goals and Objectives

Biological Goal: Fully offset the incidental take of eight Hawaiian hoary bats required for Tier 2 mitigation and provide a net benefit to the species.	
Biological Objective	Enhance, manage, and protect 176 acres of Hawaiian hoary bat foraging and roosting habitat at the Helemano Mitigation Area.
Biological Objective	Demonstrate an increase in bat activity indicative of resource improvement and availability for bats. (See Success Criteria 1; Section 4.5)
Biological Objective	Demonstrate that habitat enhancement is linked to an increase in bat prey availability. (See Success Criteria 2; Section 4.5)

The biological objectives in Table 1 track increases in bat acoustic activity and insect prey as surrogates for the direct number of bats identified in the biological goal. The Hawaiian hoary bat, like many species of bats, is a nocturnal cryptic mammal that is difficult to study. 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 of activity rather than abundance are frequently used as a proxy for population trends (Sugai et al. 2019). Acoustic monitoring can be used to infer threats and stressors and determine the level of response necessary to sustain healthy populations (Hein et al. 2021). Further assessment of the behavioral states from vocalizations identified within recorded acoustic activity can provide additional context on habitat use and insight into a populations' response to conservation actions (Teixeira et al. 2019). Surrogates are supported by both USFWS and DOFAW when it is not practical to survey and count affected wildlife directly (USFWS and NMFS 2016, DOFAW 2015).

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).

As such, this Mitigation Plan assumes that if there are statistically significant increases in bat acoustic activity and prey availability following habitat management actions for five years, this Mitigation Plan has met the biological goal. This is consistent with the Hawaiian Hoary Bat guidance document (DOFAW 2021), which states that core use area "habitat restoration that enhances or increases forested and foraging areas for bats is an optimum mitigation approach" (see Section 4.4).

The Tier 2 mitigation actions will enhance existing bat habitat through modification of habitat features that currently limit foraging and roosting opportunities within the HMA, and rapidly add resource features to increase bat foraging and roosting. To identify specific mitigation actions, KAH has leveraged results of the research, restoration, and management efforts from applicable studies (e.g., Jacobs 1999, Jantzen 2012, Gorresen et al. 2013, Ancillotto et al. 2017, Gorresen et al. 2018, Davidson 2020, Montoya-Aiona 2020), approved Hawaiian hoary bat mitigation guidance (DOFAW 2015), updates in the Endangered Species Recovery Committee (ESRC) and DOFAW revised draft guidance (2021), and USFWS and DOFAW input to identify appropriate Tier 2 mitigation actions that meet the biological goal of this Mitigation Plan.

2.0 Relevant Bat Biology

The Hawaiian hoary bat is a habitat generalist that uses a variety of native and non-native habitat vegetation types, ranging from open pasturelands to more heavily forested environments (Jacobs 1999, Gorresen et al. 2013, Bonaccorso et al. 2015), conferred by its flexibility and maneuverability in flight behavior (Jacobs 1996). The Hawaiian hoary bat is an insectivorous species that preys primarily on moths (Lepidoptera) and beetles (Coleoptera), but also members of other taxonomic groups, such as flies (Diptera; Jacobs 1999, Todd 2012, Pinzari et al. 2019), and typically forages in open areas, at forest edges or within gaps, and over open bodies of water including streams, ponds, and ocean along the coast (Jacobs 1994, Jacobs 1999, Bonaccorso et al. 2015, Pinzari et al. 2019). Radio-telemetry studies on Hawai'i Island have documented the hoary bat flying greater than 17 kilometers from its roost tree to a foraging site and shown it is capable of traversing multiple habitats across a wide elevation gradient within a single night to access resource-rich foraging opportunities (Todd 2012, Bonaccorso et al. 2015). Hawaiian hoary bats use both native and non-native tree species for roosting. The diversity in roost trees used by Hawaiian hoary bats has been confirmed only among non-native species, as the only native tree species confirmed as a roost tree by hoary bats is 'ōhi'a lehua (*Metrosideros polymorpha*). Habitat use studies indicate that Hawaiian hoary bats select roost trees with a mean height of 21 meters (range = 9 to 56 meters), a mean diameter at breast height of 75 centimeters, a mean canopy cover of 43 percent, and are a mean distance of 29 meters from the forest edge (Montoya-Aiona 2020). These results suggest that structure, not species, may be the deciding factor of roost selection by Hawaiian hoary bats. USFWS and DOFAW recognize all woody vegetation greater than 15 feet tall as potential bat roosting habitat (DOFAW 2015, USFWS 2022).

Use of habitats by bats can be influenced by a variety of factors, including land use, prey availability, and habitat structure. The concept of prey availability and land use coincide in two relevant studies. A study of bat feeding buzzes associated with cattle (*Bos taurus*) grazing in Italy found that several bat species were recorded foraging at cattle herds, with a positive correlation between herd size and bat activity (Ancillotto et al. 2017). Bat activity increases up to fivefold when the herd size increases from approximately 10 to 55 (Ancillotto et al. 2017). Studies in Hawai‘i of cattle manure-related insects observed several species of beetle and fly (Toyama and Ikeda 1976, Harris et al. 1982, Markin and Yoshioka 1998, Montgomery 2016), one of which is a dung beetle (*Digitonthophagus gazella* [*Onthophagus gazella*]) recorded in a Maui study as prevalent in the Hawaiian hoary bat diet (Pinzari et al. 2019). This dung beetle species has been noted as very common on O‘ahu in most areas surveyed (Harris et al. 1982, Markin and Yoshioka 1998). While one U.S. Geological Survey study did not find a significant response in bat foraging activity between areas grazed and ungrazed by ungulates on Hawai‘i Island (Montoya-Aiona et al. 2020), their study involved relatively small herds of goats and sheep. Montoya-Aiona et al. (2020) hypothesized that the larger biomass of cattle and their dung, and the quality of cattle dung in attracting more insects could have been the cause of the positive correlation to cattle observed by Ancillotto et al. (2017). A third study on the Hawaiian hoary bat reinforces the correlation between bat acoustic activity and bat prey presence. Gorresen et al. (2018) found elevated acoustic activity levels of the Hawaiian hoary bat were primarily related to beetle biomass in a study conducted on the North Shore of O‘ahu.

Habitat structure is likely an important factor in identifying high-quality Hawaiian hoary bat habitat. Bat activity has been shown to increase among edge, gulch, and riparian habitats (Grindal et al. 1999, Law and Chidel 2002, Lloyd et al. 2006, Jantzen 2012) and decrease in structurally cluttered habitats such as dense forest (Jantzen 2012). Impenetrable forest habitats have been shown to deter foraging by bats (Ober and Hayes 2008). Hawaiian hoary bats have been shown to have higher activity rates in open habitats (Jacobs 1999, Gorresen et al. 2013, H.T. Harvey 2019). Additionally, Harvey et al. (2006) found that dung beetles and bats at study sites in Nicaragua were more abundant at hedgerows than in pasturelands with low tree cover. Lewis (1969) documents that hedgerows serve as both habitat for insects and shelter for insects, noting that insect abundance is typically greater in the lee of hedgerows. Hawaiian hoary bats have been documented using forest gaps and clearings and other open spaces including pastures, windrows, roadway corridors, and along hedgerows for foraging (Bonaccorso et al. 2015). Based on this research, the creation of edge habitat in a closed forest environment would be expected to improve foraging habitat suitability for the Hawaiian hoary bat.

Water bodies are an important resource for a number of insectivorous bat species. In Hawai‘i, hoary bats have been observed foraging over a variety of water bodies, including ponds, gulches, or streams, and along the coast (Jacobs 1999, Reynolds et al. 1997, Pinzari et al. 2019, Tetra Tech 2021). However, the importance of water bodies for water acquisition and foraging is not fully understood. In areas with ample precipitation where bats can acquire water directly from the foliage of trees, open bodies of water may not be essential. On the wet windward side of Hawai‘i Island, detections over bodies of water only represented 1 percent of all detections (Reynolds et al.

1997). Among drier habitats or during drier periods of the year, water bodies may be more important.

Many species of bats have been documented roosting in or at the edge of gaps in early successional habitats (Blake and Hoppes 1986), indicating that modification of habitat features that results in multiple small gaps within a forest stand may offer bats increased opportunities for roosting. In addition, the presence of suitable roost trees in proximity to foraging sites may be a factor in roost site selection, possibly conferring benefits of reducing overall commute time and energy expenditure (Loeb and O'keefe 2011).

3.0 Mitigation Area

3.1 Site Description

The HMA is located within the Helemano Section of the ʻEwa Forest Reserve in the leeward foothills of the Koʻolau Mountains in Central Oʻahu (Figure 2). To provide the broader ecological and management context for the environment surrounding the HMA, a general description of both the Helemano Section and the HMA follows.

The State of Hawaiʻi acquired the Helemano property consisting of four parcels in 2018. DOFAW Oʻahu added the acquired Helemano parcels to the Forest Reserve System in 2021 and is in the process of creating a management plan for the area. Private land owned by Dole Food Company, Inc. is adjacent to the HMA to the north, the Helemano Military Reservation and Wahiawā Naval Reservation are adjacent to the west, the community of Whitmore Village is adjacent to the south, and the Poamoho Section of the ʻEwa Forest Reserve is adjacent to the east. Access to the site is via the Paʻalaʻa Uka Pūpūkea Road, which provides access to a gated entry to a dirt 4 x 4 road, Plantation Road, that provides access to the HMA.

The entire Helemano Section encompasses approximately 2,770 acres assessed as 69 percent alien/native mix land cover (Table 2, Figure 3; Jacobi et al. 2017). The remaining land cover is 23 percent 'heavily disturbed' from historic pineapple plantation operations and timber plantations, and 8 percent is 'native dominated' (Table 2, Figure 3; Jacobi et al. 2017). Land cover types within the wider Helemano Section reflect historical land uses, specifically watershed management for agricultural uses as well as pineapple cultivation on portions of the land (DOFAW 2021). The parcels designated as agriculture district fall within the 'heavily disturbed' land cover classification and are composed of naturalized introduced species, with invasive species predominant in the lower elevations and former agricultural lands. Dominant invasive plant species include Moluccan albizia (*Falcataria moluccana*), satin leaf (*Chrysophyllum oliviforme*), strawberry guava (*Psidium cattleianum*), and Guinea grass (*Megathyrsus maximus*).

Table 2. Habitat Classification in the Helemano Section

Land Cover	Helemano Section		HMA	
	Acres	Percentage	Acres – Western Parcel	Acres – Eastern Parcel
Alien/Native Mix	1,912	69	--	--
Heavily Disturbed	635	23	81	95
Native Dominated	224	8	--	--
TOTAL	2,770	100	176	

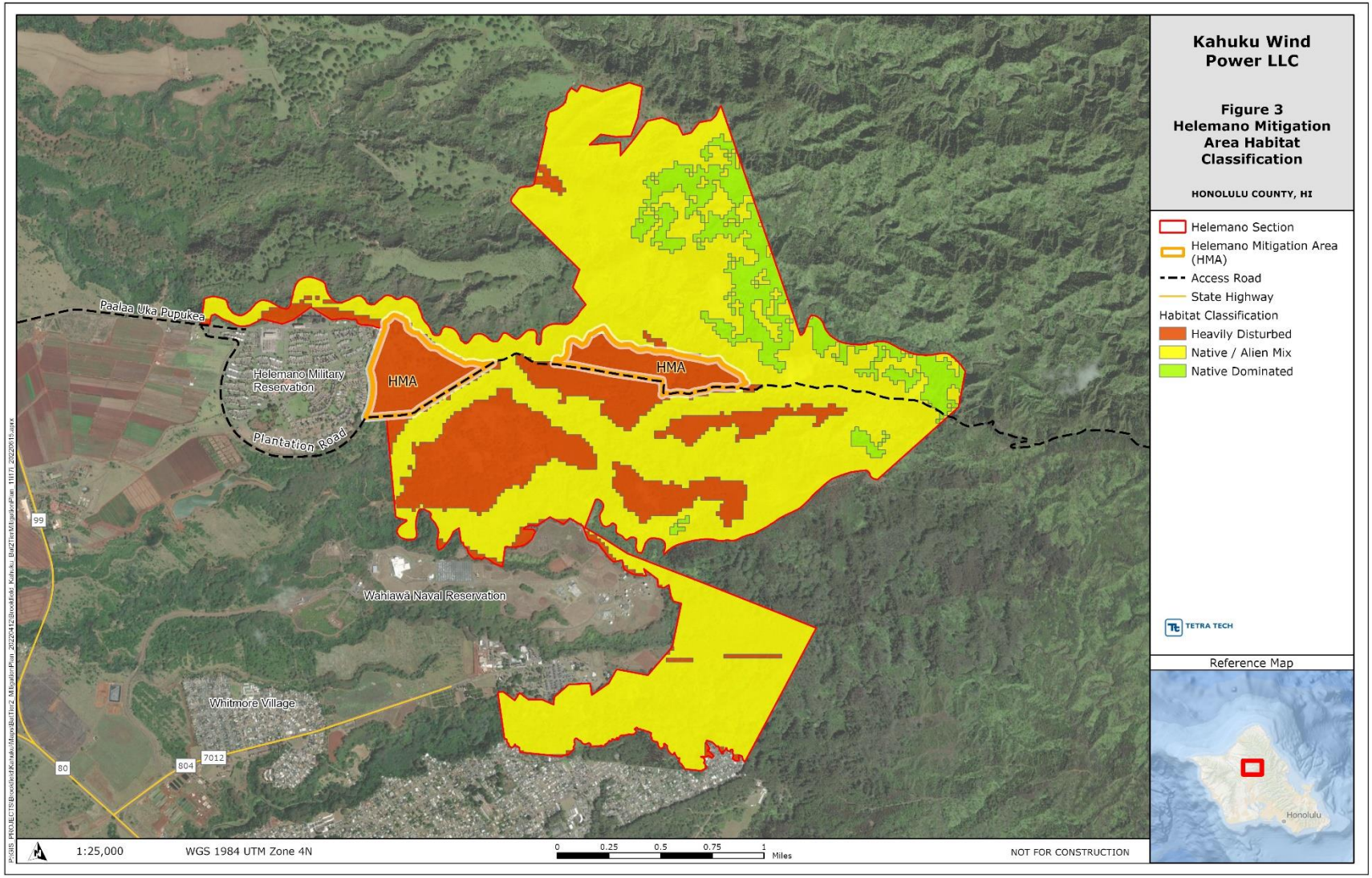

Figure 3. Helemano Mitigation Area Habitat Classification

The HMA consists of 176 acres of heavily disturbed lands zoned agricultural and comprises 27.8 percent of the 635 acres of heavily disturbed habitat within the Helemano Section (Table 2). The HMA contains habitat suitable for Hawaiian hoary bat habitat management, including enhancement of key resource features which are present but unlikely to be fully utilized by bats without modification.

The HMA is relatively flat (< 20 percent slope) land located immediately east of the Helemano Military Reservation boundary and immediately north of the main access road to the ʻEwa Forest Reserve (Plantation Road) (Figure 2; DOFAW 2021). The HMA consists of two parcels (western and eastern; Table 2 and Figure 3) of ranch land currently managed for cattle grazing under a land license agreement (DOFAW 2021) and is a combination of grazed pasture and forested ranch land. This area has been under a land license for 20 years; the current land license agreement is due to expire on December 31, 2026. KAH understands that DOFAW Oʻahu intends to renew and maintain the land license for cattle grazing within the HMA lands into the future (Ryan Peralta, DOFAW Oʻahu pers. comm., February 8, 2022). The HMA consists of areas with two primary habitats: 1) grazed grass understory with a mostly open canopy and scattered individuals of non-native trees throughout, and 2) moderate to densely forested zones with variable understory and midstory densities, and an upper canopy of non-native trees (see Section 3.4). Moisture zones within and immediately adjacent to the HMA are characterized as seasonal mesic to moist mesic, with moderately wet to wet moisture zones present further east of the HMA with increasingly higher elevations (Price et al. 2012). The HMA is situated adjacent to an area assessed as high-risk for wildfires (HWMO 2019, DOFAW 2021), particularly due to the presence of fire-prone invasive grasses (e.g., Guinea grass) that dominate neighboring fallow agricultural areas to the west and to the south within the Helemano Section, and patches of historic timber plantation stands to the south and southeast comprised of non-native, fire hazardous species (DOFAW 2021).

No surface water features are present in the HMA, but open water resources are likely available for bats from existing water bodies in the vicinity. Two perennial streams are located immediately to the north and south of the HMA (Helemano and Poamoho streams, respectively; Figure 4). The Upper Helemano ditch system originating from the upper reaches of Helemano Stream traverses between the western and eastern parcels, and feeds into the Upper Helemano (Tanada) Reservoir located one mile to the west of the HMA (Figure 4; DOFAW 2021). The only existing water feature within the HMA is a small, open cattle trough that is likely too small to be targeted by bats as a water resource (Taylor and Tuttle 2012; depicted in Figure 4). However, the mesic and wet environments in the forested land surrounding the HMA likely provide opportunities for bats to glean water from vegetation and are another potential water resource for bats in the area.

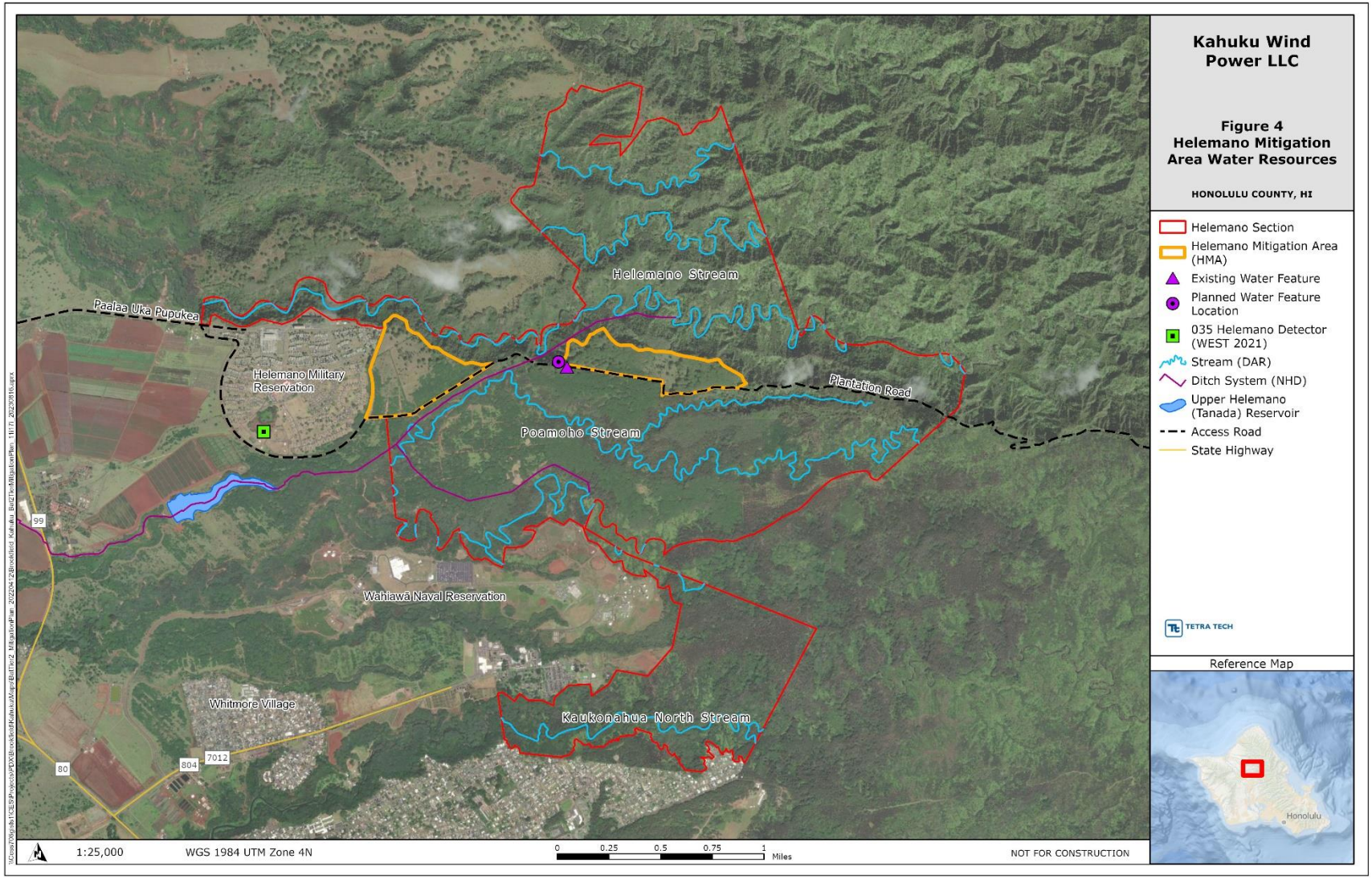

Figure 4. Helemano Mitigation Area Water Resources

DOFAW O‘ahu identified the grazed, open canopy lands in the HMA as providing important habitat for the Hawaiian hoary bat which are known to utilize this type of open space when foraging (DOFAW 2021). However, significant portions of the HMA have been overtaken by populations of invasive Moluccan albizia, shoebutton ardisia (*Ardisia elliptica*), and Christmas berry (*Schinus terebinthifolia*). The invasion of Christmas berry and shoebutton ardisia in substantial portions of the land license area has resulted in a dense monotypic mid-canopy and understory that is unusable by bats as well as by cattle for grazing. Because DOFAW’s broad management goals for the land within the HMA include land management to benefit the Hawaiian hoary bat, and monitoring and managing invasive species (specifically Christmas berry and shoebutton ardisia) to prevent an increase of or to reduce current population sizes (DOFAW 2021), the installation of bat foraging corridors was deemed an appropriate management action for the area.

As of June 2022, DOFAW O‘ahu has completed a one-time management action in the HMA to improve habitat for bats, conducted based on funding opportunities available in 2022. This action included mechanically cutting rows in two areas with densely forested invasive trees to create bat foraging corridors (Ryan Peralta, DOFAW O‘ahu, pers. comm., February 8, 2022, March 29, 2022, and June 9, 2022; see Section 3.4). DOFAW O‘ahu also proposed that additional KAH-driven management activity for the lands within the HMA would consist of further installation of more bat foraging corridors in areas adjacent to DOFAW’s actions, and the installation of a water feature which could provide a water source for fire suppression activities in the Helemano Section (Ryan Peralta, DOFAW O‘ahu, pers. comm., February 8, 2022).

3.2 Bat Activity and Prey Resources

Bat use has been documented in the HMA and the larger Helemano Section. Two studies have documented low levels of bat activity (Davidson 2020, WEST 2021). The Davidson study defined and sampled four distinct habitats within 1,600 acres spanning an elevation of 300 to 500 meters of the Helemano Section (grazed grassland, ungrazed grassland, grazed evergreen forest, and ungrazed evergreen forest) between the months of December 2019 and March 2020. Grazed grassland and grazed evergreen forest study sites were situated in portions of the HMA. Although the study primarily occurred during the pre-pregnancy reproductive period, when bat occurrence is known to be generally low (Todd 2012, Todd et al. 2016, WEST 2021), bats were detected on 39 nights out of 672 detector nights (5.8 percent) (Davidson 2020). Bats were recorded at 28 of the 80 sites sampled (35 percent) and detections were broadly distributed across all habitats throughout the Helemano Section (Davidson 2020). Additionally, the WEST study maintained a bat detector in the Helemano Military Reservation located approximately 0.5 miles to the west of the HMA and situated in undeveloped green space between a row of trees and an open field (Figure 4). From June 2017 to August 2020, Hawaiian hoary bats were documented on 80 nights out of 1,422 detector nights, resulting in 5.6 percent of detector nights with detections (WEST 2021).

Further, invertebrates, especially beetles and moths, provide a vital source of prey for the Hawaiian hoary bat (Jacobs 1999, Todd 2012). A 2021 survey in the Helemano Section identified six distinct species of moths, two-thirds of the total moth species that were observed, and three distinct species of beetles (DOFAW 2021), suggesting foraging resources exist in the area.

3.3 Existing Legal Protection

In 2018, the Department of Land and Natural Resources purchased four parcels of land consisting of both conservation district and agricultural lands in the Helemano area in central Oʻahu (Warranty Deed Doc No (s) A – 68640629) with the support of federal, state, and private partners (DOFAW 2021). The acquisition includes an important access route to the Poamoho Section of the ʻEwa Forest Reserve and the Poamoho Trail, which leads to the summit of the Koʻolau Mountains. On March 12, 2021, Governor David Ige issued an executive order to designate the area as part of the State of Hawaiʻi's Forest Reserve System. The acquired area is now the Helemano Section of the ʻEwa Forest Reserve and managed by DOFAW Oʻahu (DOFAW 2021).

DOFAW Oʻahu acquired the parcels to be managed for multiple uses and resource management purposes, including to benefit the Hawaiian hoary bat by protecting existing bat roosting and foraging habitat and developing a long-term management strategy to restore and improve degraded habitat (Tetra Tech 2019a, DOFAW 2021).

DOFAW Oʻahu is currently in Phase 2 of a three-phase planning process to develop a comprehensive multi-use management plan based on public input and funding partner requirements (DOFAW 2021). Phase 2 involves developing a preliminary management plan that includes identifying both broad management goals and suitable forest management activities for the Helemano Section with its diverse land use history. Phase 3 will involve the completion of a final management plan and environmental review (DOFAW 2021).

DOFAW Oʻahu's principal management goals for the Helemano Section include the following:

- To protect and manage central Oʻahu's forested watersheds for production of fresh water supply for public uses now and into the future.
- To improve and protect valuable habitat for native species of plants and animals, many of which are endangered.
- To provide outdoor recreational opportunities for the public and to increase public access to the Poamoho Section of the ʻEwa Forest Reserve and the historic Poamoho Trail.
- To manage threatened and endangered species, with a focus on protecting the Hawaiian hoary bat habitat and population.
- To restore native forest in previously degraded land dominated by non-native species and to protect existing intact native forest.
- To monitor emerging weed populations and to control established weed populations.
- To promote forests as economic assets by managing land for forest products.
- To increase public hunting opportunities.

The following land protections are expected to be incorporated into DOFAW Oʻahu's final comprehensive multi-use management plan. KAH will include these measures in an MOU mutually

developed by KAH and DOFAW O'ahu that defines the respective responsibilities of each party relative to the HMA.

- No trees over 15 feet tall may be removed during bat pupping season (June 1 through September 15 of each year).
- Any insect pest control work (i.e., application of herbicides) within the Helemano Section must follow an integrated pest control approach that minimizes impacts to insects used as prey by bats.
- Prohibition on the use of barbed wire when installing fencing or other such structures. DOFAW O'ahu may use barbed wire fencing, if necessary, to protect critical infrastructure.

3.4 Baseline Habitat Conditions

The HMA's baseline habitat conditions for bats prior to KAH's mitigation actions includes the condition of the HMA as a result of DOFAW O'ahu's one-time management actions within the HMA as of June 2022 (see Section 3.4.1). DOFAW O'ahu subdivided the western and eastern parcels of the HMA into four management units (referred to here as Parcel 1, 2, 3, and 4; see Figure 6). The overall baseline habitat conditions include two conditions as a starting point for KAH's mitigation actions: 1) DOFAW-created bat foraging corridors in Parcel 2 and Parcel 4 that would revert to the overgrown invasive forest conditions present prior to DOFAW's clearing actions unless maintained by KAH, and 2) overgrown invasive forest in Parcel 1 and Parcel 3.

As described previously, the HMA consists of areas comprised of a mix of grazed grass understory with primarily open canopy, and moderate to densely forested areas of invasive vegetation characterized by a moderately open to impenetrable understory with a moderate to dense mid- and upper canopy comprised of invasive tree species, including Moluccan albizia, Christmas berry, and shoebutton ardisia. Documented non-native Hawaiian hoary bat roost tree species that occur in the HMA include eucalyptus (*Eucalyptus* sp.), paperbark (*Melaleuca quinquenervia*), lychee (*Litchi chinensis*), African tulip (*Spathodea campanulata*), and kukui (*Aleurites moluccana*) (Bryan 1955, Montoya-Aiona 2020). Other non-native roost tree species that were recorded in the Helemano Section during surveys by DOFAW O'ahu (2021) and likely to occur within the vicinity of the HMA are ironwood (*Casuarina equisetifolia*), mango (*Mangifera indica*), and Chinese banyan (*Ficus macrocarpa*).

The HMA's western and eastern parcels are fenced with 4-string barbed wire fence along the perimeter of both parcels, within which the land licensee's cattle are allowed to range freely. An assessment of the entire fence line was conducted in March 2023 to determine how much of the barbed wire fencing is currently encased in vegetation (e.g., Guinea grass and shoebutton ardisia) (Appendix A). Six risk-level categories—ranging from no risk (0), where the fence does not contain barbed wire or is completely enclosed in vegetation, to highest risk (5), where all rows of barbed wire fence are exposed for five feet or more and the surrounding habitat is open on both side of the fence—were used to determine the risk to Hawaiian hoary bat by fence line span. The assessment determined that 86.5 percent of the fence is at the lowest risk level (0 or 1), with the majority of

this low risk (65.1 percent) assessed as having no risk to bats, limiting the direct risk of exposed barbs to bats (Figure 5, Appendix A). Barbed wire exposure throughout the Management Plan's 5-year timeframe will be addressed through adaptive management, as described in Section 8.0 and Appendix A.

Additional ranch infrastructure includes the existing water feature (a small, open water trough; Figure 4) and a series of gates, which control access to the grazed areas.

Figure 5. Perimeter Barbed Wire Fence Encased in Vegetation in Parcel 2 of the HMA

3.4.1 Bat Foraging Corridors

Based on funding opportunities in 2022, DOFAW carried out a one-time management action in the HMA with the creation of bat foraging corridors. As mentioned above, DOFAW O'ahu subdivided the western and eastern parcels of the HMA into four management units (Figure 6) and targeted two of them, Parcel 2 and Parcel 4, for their action. The DOFAW-created corridors were completed in June 2022 (Figure 6). Individual parcel acreage includes approximately 34 acres in Parcel 1, 47 acres in Parcel 2, 63 acres in Parcel 3, and 32 acres in Parcel 4.

Vegetation cover in Parcel 2 and Parcel 4 includes a combination of grazed grassland and forested ranch land. Moluccan albizia and shoebutton ardisia comprise the dominant forest species in Parcel 2, where shoebutton ardisia forms a dense mid-story layer approximately 12 to 15 feet tall with Moluccan albizia trees in the overstory reaching heights up to 100 feet. Scattered paperbark trees approximately 25 feet tall are found among the Moluccan albizia and shoebutton ardisia stands, and within the narrow band of mostly open pastureland at the eastern boundary of Parcel 2 where it borders Parcel 1. The western and southern boundaries of Parcel 4 are ringed with moderately open to very dense vegetation around a central, primarily open pastureland dotted with individual non-native trees. Christmas berry is the dominant tree species in Parcel 4 and is primarily concentrated in the southern half of the parcel where it forms dense stands up to 20 feet tall. Open to moderately dense patches of kukui trees up to 20 feet tall also occur in scattered patches among the stands of Christmas berry.

DOFAW O'ahu created the bat foraging corridors by mechanically removing swaths of trees from within the existing dense stands of shoebutton ardisia and Moluccan albizia in Parcel 2 and Christmas berry in Parcel 4 to form primarily open lanes approximately 60 feet in width (R. Peralta, pers. comm., June 20, 2022) alternating with parallel rows of uncut vegetation. In Parcel 2, only scattered individuals of Moluccan albizia too large in diameter and height to remove mechanically remain standing in place within the open lanes, which are otherwise cleared of vegetation (Figure 7). The bands of uncut vegetation are of sufficient width to act as a wind break for the corridors of open vegetation, promoting the aggregation of bat prey within and access to the corridors by bats.

DOFAW O'ahu will not take any further management actions in the corridors they created in Parcels 2 and 4, nor do they have planned any additional vegetation removal of this kind within the HMA (R. Peralta, pers. comm., June 9, 2022). Baseline conditions within the HMA will be measured to include the one-time management action already undertaken by DOFAW (Figure 7; see Section 5.0). Because corridors have not been maintained and are currently experiencing regrowth, corridor maintenance is an important action within this Mitigation Plan (Section 4.2.2). Thus, the created edge habitat was at its maximum benefit just after the initial cutting, with declining benefit as the vegetation regrows. Without maintenance, the ability of the foraging corridors to improve the habitat into the future diminishes with time.

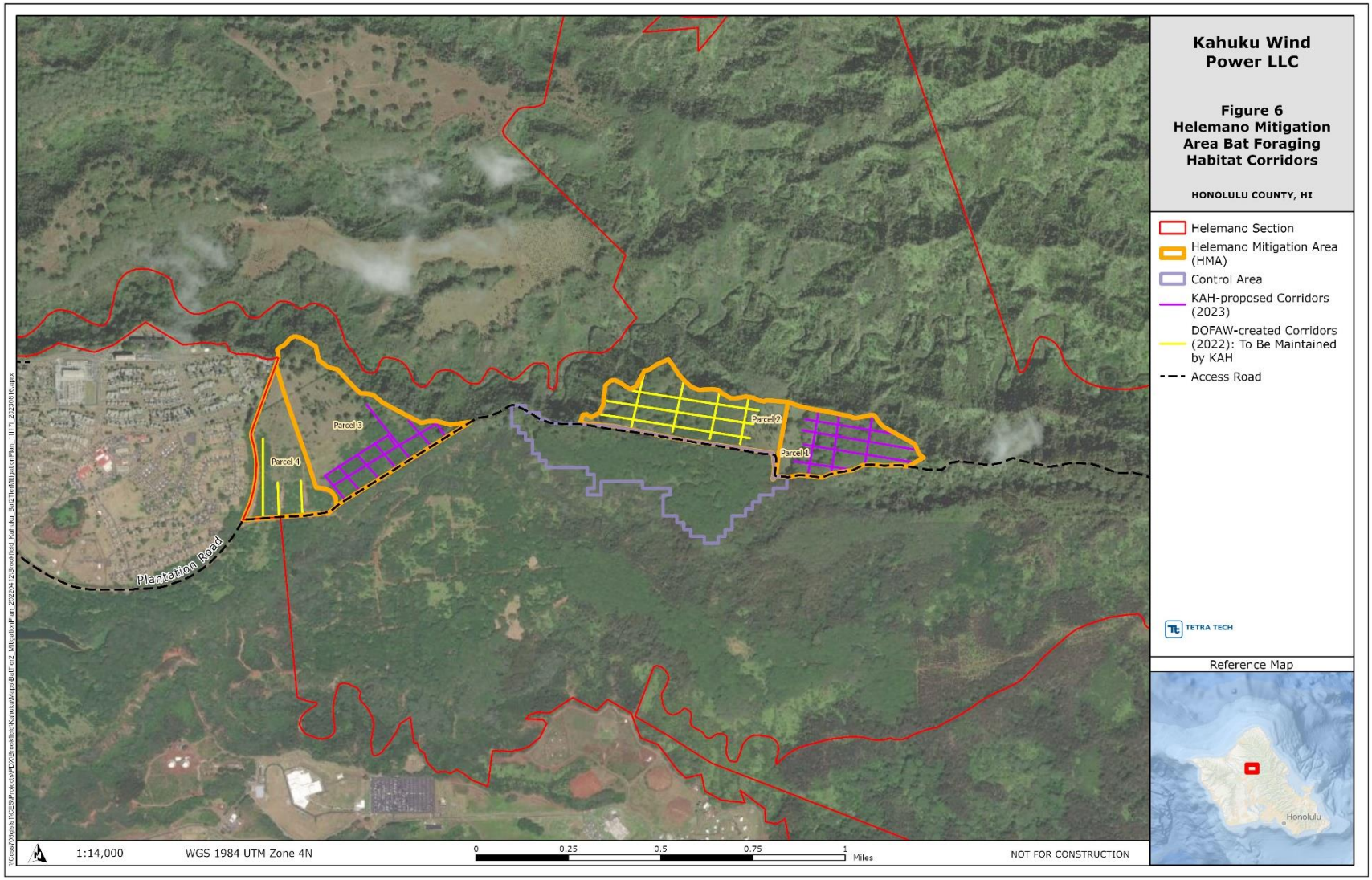

Figure 6. Helemano Mitigation Area Bat Foraging Corridors

Figure 7. DOFAW-created Bat Foraging Corridors in the HMA, Parcel 2

3.4.2 Invasive Forest

Vegetation cover in Parcel 1 and Parcel 3 is also composed of a combination of grazed grassland and forested ranch land. The majority of Parcel 1 is covered in invasive forest dominated by Moluccan albizia and shoebutton ardisia, where shoebutton ardisia forms a dense mid-story layer approximately 15 feet tall, with Moluccan albizia trees in the overstory reaching heights up to 100 feet. Scattered paperbark trees that are approximately 25 feet tall are also found among other trees of the forest. In addition, patches of eucalyptus trees exceeding 25 feet in height occur in the eastern portion of Parcel 1 among the dense stands of vegetation. The western boundary of Parcel 1 consists of a narrow band of mostly open pastureland with scattered paperbark trees approximately 25 feet tall.

Parcel 3's boundary is ringed with moderately open to very dense vegetation around a central, primarily open pastureland dotted with individual non-native trees. Christmas berry is the dominant tree species in Parcel 3 and is primarily concentrated in the southern half of the parcel, where it forms dense stands up to 20 feet tall. Moderate to dense patches of kukui trees up to 20 feet tall are scattered among the Christmas berry and also concentrated along the southern boundary of Parcel 3 near the DOFAW Oʻahu access road (Plantation Road). Within Parcel 3, several lychee trees reaching approximately 15 feet in height are planted along the entry road leading into the central pasture area. Single trees of invasive silver oak (*Grevillea robusta*) reaching heights of 25 to 30 feet are scattered in the central pasture, along with the invasive shrub pua nānā honua (*Solanum mauritianum*). No creation of managed bat foraging corridors within Parcels 1 and 3 has yet occurred (Figure 6); baseline conditions will be measured prior to KAH's mitigation actions.

3.4.3 Control Site

A control site will be established adjacent to and south of the HMA (Figures 4 and 6; see Section 5.1). The control site is 73.34 acres in size with forested ranch land habitat similar to Mitigation Parcels 1 and 2 (see Sections 3.1 and 3.4.2). The control site is not fenced and is not grazed, although cattle have been documented moving in and out of the area through breaches in the HMA fencing. No management actions will occur at the control site to isolate the effects of management actions in comparison to the Mitigation Parcels. Monitoring of bat activity and insect composition, like the monitoring methods at Mitigation Parcels 1 and 2, will occur within the control site (see Section 5.0).

4.0 Mitigation Actions

The mitigation actions at HMA are designed to restore, enhance and manage habitat features for bats, thereby increasing the concentration of resources beneficial to bats. Mitigation actions have the potential to show benefits within a relatively short term of 5 to7 years (ʻUkoʻa Wetland Mitigation Site; Tetra Tech 2020a). Changes in response variables (see Section 5.0) are expected to

be documented relatively quickly, and if adjustments are required, the program can still be adaptively managed to meet obligations within the permit term.

Mitigation actions will occur within the 176 acres of heavily disturbed, former agricultural land areas of the HMA, including within the bat foraging corridors created by DOFAW O‘ahu and maintained by KAH in Parcel 2 and Parcel 4. These actions will leverage agricultural practices to benefit bats and will include using activities such as grazing to mitigation advantage (e.g., maintaining edge habitat and promoting additional bat prey resource availability through cattle presence). KAH’s mitigation actions are designed to be additive and complementary to the broad management goals and suitable forest management activities identified by DOFAW O‘ahu for the Helemano Section of the ‘Ewa Forest Reserve and any actions already executed by DOFAW. KAH will establish baseline measures that account for the immediate, short-term benefits to bats achieved by the extant DOFAW-created foraging corridors in Parcel 2 and Parcel 4 as separate from KAH’s mitigation actions (see Section 5.0).

As discussed in Section 2.0, the Hawaiian hoary bat uses a variety of habitats for a range of purposes. Cattle presence provides opportunities to augment prey resources within a variety of habitats, thus supporting development of a strong and distributed prey base accessible to bats. The creation and management of a combination of open foraging areas, edge, and closed canopy habitats is therefore expected to best meet the species’ needs. As a result, KAH will achieve its mitigation objective by implementing the following mitigation actions by the end of the permit term:

1. Creating additional bat foraging corridors which will also serve to improve access to existing adjacent roosting habitat.
2. Maintaining the DOFAW-created bat foraging corridors.
3. Promoting additional bat prey resource through cattle grazing and management activities within corridors (supplemented by mechanical clearing, as necessary). These maintenance actions are applicable to both extant DOFAW-created foraging corridors and planned KAH-created foraging corridors (see Section 4.2.2).
4. Adding a water resource to protect bat habitat in the HMA by supporting wildfire suppression activities, with a potential secondary benefit to bats as a water resource.

These habitat enhancements will increase the amount of available, high-quality foraging and roosting resources for Hawaiian hoary bats on O‘ahu by 176 acres and support the protection of those resources from disturbance by wildfire. The combination of these specific mitigation actions, both in terms of acres of protected habitat and habitat quality, will provide benefits to bats beginning in the near term and extending beyond the conclusion of the Project, resulting in a net benefit to this species.

Such a prompt response is anticipated based on results at another O‘ahu bat mitigation project. A change in bat acoustic activity suggesting increases in foraging behavior was documented following the installation of bat foraging corridors through dense forest at ‘Uko‘a Wetland. At that site, bat

acoustic monitoring data showed a statistically significant increase in bat acoustic detection rates and foraging (feeding buzzes) in reproductive periods within 2 years after mitigation measures were implemented at the site (Tetra Tech 2020a). The various resources within the HMA, their baseline conditions, and the mitigation actions to be taken by KAH are summarized in Table 3.

KAH will coordinate with DOFAW O‘ahu throughout the development of the Forest Reserve’s management plan to ensure that KAH’s mitigation actions are compatible with suitable management actions identified by DOFAW O‘ahu for the Helemano Section. The framework for this coordination will be documented in the MOU.

Table 3. Summary of Management Actions in the Mitigation Area

Resource	Baseline Condition	Mitigation Actions	Mitigation Outcome
Ranch Land	Grazed by cattle	Manage existing or increase livestock grazing numbers. Support current land license agreement for permit term.	Increase bat prey in diversity and/or biomass. Maintain DOFAW-created bat foraging habitat (edge and corridors).
Foraging Habitat – Edge	Bat Corridors (Parcels 2 and 4): Developed by initial, one-time DOFAW O'ahu action through mechanical clearing of Moluccan albizia and dense shoebutton ardisia or Christmas berry forest in portions of grazed ranch lands.	Edge habitat maintained through managed grazing and mechanical clearing, as necessary.	Increase foraging opportunities for bats.
	Invasive Forest (Parcels 1 and 3): Moluccan albizia and dense shoebutton ardisia or Christmas berry forest in portions of grazed ranch lands.	Strategic mechanical removal of vegetation to open cluttered forest and increase size and quality of bat foraging habitat within grazed ranch lands. Edge habitat maintained through managed grazing and mechanical clearing, as necessary.	
Foraging Habitat and Movement- Corridors	Bat Corridors (Parcels 2 and 4): Developed by initial, one-time DOFAW O'ahu action through mechanical clearing of Moluccan albizia and dense shoebutton ardisia or Christmas berry forest in portions of grazed ranch lands.	Foraging corridors maintained through managed grazing and mechanical clearing, as necessary.	Increase area and improve quality of foraging habitat for bats by opening cluttered forest habitat and improving ranch lands for grazing. Promote additional prey resource availability to bats through the presence of cattle (i.e., cattle dung).
	Invasive Forest (Parcels 1 and 3): Moluccan albizia and dense shoebutton ardisia or Christmas berry forest in portions of grazed ranch lands.	Forest corridors will be cleared within stands of invasive tree species to increase foraging opportunities and access to known adjacent tree species recognized to support bat roosting. Foraging corridors maintained through managed grazing and mechanical clearing, as necessary. Tree species not beneficial to bat roosting will be strategically removed as safety conditions allow in the foraging corridors.	

Resource	Baseline Condition	Mitigation Actions	Mitigation Outcome
Water Feature	Cattle trough (small, not beneficial to bats)	Install and maintain an above-ground water tank to support DOFAW wildfire suppression activities.	Protection of bat habitat from destructive wildfire disturbance. Potential secondary benefit to bats as a water resource.

4.1 Ranch Land Management

Current grazing management practices for cattle will be modified and designed to increase bat prey in numbers and/or diversity, as well as to maintain invasive vegetation as open and at low stature within bat foraging corridors (see Section 4.2.3). The presence of cattle provides opportunity for additional and increased diversity of prey resources for Hawaiian hoary bats (Todd 2012, Pinzari et al. 2019, ESRC and DOFAW 2021) and, furthermore, cattle presence and herd size can be leveraged to facilitate vegetation maintenance through grazing the opened foraging corridors, control weed species, and reduce fuel loads which lowers the risk of wildfire (see Section 2.0).

KAH understands that DOFAW O'ahu has long-term plans to continue offering a land license for grazing within the western and eastern parcels that comprise the HMA after the current 20-year Land License Agreement expires on December 31, 2026 (R. Peralta, pers. comm., February 8, 2022). Thus, it is KAH's understanding that the grazing land license agreement is to be maintained for the term of KAH's Tier 2 mitigation actions and beyond (see Section 9.0). KAH will initiate adaptive managment (see Section 8.0) should the land license agreement not be renewed.

4.2 Management of Habitat

4.2.1 Invasive Forest

Management opportunities to benefit bat foraging in the HMA include creating corridors within the existing dense stands of invasive tree species in the forested ranch land. KAH will create bat foraging corridors in Mitigation Parcel 1 and Parcel 3 (Figure 6). To create the corridors, KAH will follow the same methods used by DOFAW O'ahu in Parcel 2 and Parcel 4. Methods include mechanically removing swaths of dense Moluccan albizia (as size allows), shoebutton ardisia, and Christmas berry populations, tree species that have not been documented as species that support bat roosting nor provide a direct benefit to cattle. Based on the current density of the invasive vegetation and to maximize the edge habitat offering foraging opportunity, bat foraging corridors in Parcel 1 and Parcel 3 are being developed in a grid pattern (Figure 6) to match the pattern employed by DOFAW O'ahu in Parcel 2 and Parcel 4 (see Section 4.2.3). Hawaiian hoary bats have been documented foraging in forest gaps and open spaces, including orchard settings (Bonaccorso et al. 2015), the physiognomy of which the proposed grid pattern mimics. Removal of these swaths of invasive tree species in a grid configuration provides opportunity for less restricted movement by bats through otherwise densely vegetated areas and opens cluttered forest habitat to create more foraging surface area in an otherwise closed forest environment. This management action also creates better quality ranch lands for grazing, which in turn is expected to result in more better-quality foraging habitat for bats. Trees taller than 15 feet will not be removed during the months of June 1 through September 15 (the Hawaiian hoary bat pupping season; USFWS 2022). Removal of documented Hawaiian hoary bat roost tree species will be avoided.

4.2.2 Bat Foraging Corridors

KAH will inherit the bat foraging corridors created by DOFAW O'ahu in their one-time action in Parcel 2 and Parcel 4 (Figure 6) and will create bat foraging corridors in Parcel 1 and Parcel 3 (see Section 4.2.3). Benefits to bats immediately incurred by these corridors would diminish over time without active maintenance. KAH will maintain all bat foraging corridors in Parcels 1–4 by incentivizing the cattle to graze. The presence of grazing cattle is also expected to provide beneficial resource inputs (i.e., cattle dung) that promote additional prey resources for bats within the grazed corridors. Due to potential seasonal variation and dependent on stock numbers held by the land licensee within the HMA, the timing, duration, and intensity of targeted grazing will be informed by monitoring. Because the height of the bat foraging corridors range from approximately 15 to 20 feet tall based on the maximum mid-story canopy height of shoebutton ardisia and Christmas berry, respectively, vegetation within the corridors will be monitored and maintained at a maximum of 36 inches in height so that approximately 75 percent of the upper, vertical portion of the corridor is maintained as open for foraging by bats (Chris Todd, pers. comm, August 23, 2023).

Target grazing is anticipated to be the best solution to maintain corridors for Hawaiian hoary bat (Susan Ching, DOFAW O'ahu, pers. comm., August 25, 2023). Targeted grazing will include, but not be limited to:

- Focusing the distribution of cattle in the HMA through temporary fencing or herding;
- Maintaining an appropriate stocking density to manage vegetation within corridors; and
- Rotational grazing within and between parcels.

If necessary, KAH will seed shade-tolerant grasses suitable for cattle forage to encourage grazing within the corridors. KAH will utilize seed stock of non-native grass species based on the availability of stock, and establishment status in the HMA, and favorable as cattle forage. Seed selection will be agreed upon in consultation with DOFAW O'ahu (Ryan Peralta, DOFAW O'ahu, pers. comm., August 15, 2023). While KAH recognizes that native grass species are important to overall habitat, they are not adapted to and would succumb under grazing pressure, resulting in exposed soil vulnerable to erosion, decreased grazing area available to the land licensee, and reduced capacity to maintain and provide beneficial inputs to the bat foraging corridors through cattle grazing. KAH's seeding plan will consider the following four factors:

- Expected selection by cattle of palatable plants in the HMA corridors;
- Expected grazing intensity (based on aforementioned selectivity);
- Season; and
- Required frequency of repeated grazing based on monitoring of vegetation regrowth within corridors (Thorne et al. 2007).

Monitoring will support adaptive management decisions to adjust the frequency, duration, and locations of targeted grazing, as well as any necessary intervention by mechanical control, to achieve the desired condition of maintaining vegetation at low stature within the bat foraging

corridors throughout the permit term (see Section 5.3). In addition, cattle dung input will create opportunities for additional prey resource availability to bats in the foraging corridors. Therefore, KAH's management of the cattle and supplemental mechanical maintenance of all bat foraging corridors in Parcels 1–4 will be important factors in achieving longer term benefits to bats.

Memorandum of Understanding

KAH will include the following measures in an MOU mutually developed by KAH and DOFAW O'ahu for the Mitigation Plan term. While the MOU will be comprehensive for all mitigation activity, the following measures that define the respective responsibilities of each party relative to the bat foraging corridors created by DOFAW will include:

- DOFAW O'ahu performed a one-time management action in the HMA of creating the bat foraging corridors in Parcel 2 and Parcel 4;
- KAH will assume the role of maintaining the DOFAW-created bat foraging corridors in Parcel 2 and Parcel 4;
- KAH will create and maintain bat foraging corridors in Parcel 1 and Parcel 3;
- KAH will work with the licensee to incentivize targeted cattle grazing in the bat foraging corridors to maintain the suitability of the corridors for bats and promote additional opportunities for bat prey resource conferred by cattle presence;
- KAH will take additional actions as needed to maintain the suitability of the corridors for bat foraging, e.g., through seeding of shade tolerant grasses to encourage grazing, temporary cattle control fencing to manage grazing within corridors, additional mechanical clearing, etc.;
- KAH will install and maintain a dip-tank with wildlife egress and pump system to maintain water levels within the tank; and
- KAH, while not the holder of the land license, will assume responsibility for ensuring that specific mitigation actions occur and benefits identified are achieved.

4.2.3 Invasive Species Management

KAH's management and monitoring of invasive Moluccan albizia, shoebutton ardisia, and Christmas berry tree populations in the HMA as part of creating and maintaining bat foraging corridors (see Sections 4.3.1 and 4.3.2) aligns with a principal management activity identified by DOFAW O'ahu for the lands within the HMA (DOFAW 2021). Additionally, KAH will conduct early detection and mechanical removal of specific invasive species within the HMA to prevent expansion of existing populations (e.g. Moluccan albizia, shoebutton ardisia, and Christmas berry) into currently open pastureland, or prior to firm establishment (i.e., incipient invasive species). Invasive species detection and removal will occur after the bat foraging corridors have been created and for the duration of the project as part of spot monitoring and mechanical management of the corridors in the HMA as needed. Incipient weed species identified as of highest concern to DOFAW O'ahu

include devil weed (*Chromolaena odorata*), mānuka (*Leptospermum scoparium*), and *Arthrostemma ciliatum* (DOFAW 2021). If identified within the HMA, KAH will manage these invasive species of highest concern to minimize the risk of spread, as practicable, and in coordination with the Oʻahu Invasive Species Committee (devil weed) and DOFAW Oʻahu (mānuka and *Arthrostemma ciliatum*).

4.3 Water Resource

Within the HMA, KAH will add and maintain a water feature for the primary purpose of protecting bat habitat by providing a water resource available to DOFAW Oʻahu for wildfire suppression activities in the Helemano Section. While not directly quantifiable, fire suppression support is an important action for protecting bat foraging and roosting habitat, and preventing the loss of adult bats with dependent young unable to take flight from a wildland fire (USFWS 2021). Given the presence of natural water features in the vicinity (Figure 4) and opportunities for bats to glean water from vegetation in the surrounding mesic and wet forests, it is not clear that water is a limiting factor for bats in the HMA. However, the addition of a water feature in the HMA for fire suppression support may provide a secondary benefit to bats as a potential water resource. A water feature of a volume and dimension suitable for use by DOFAW Oʻahu firefighters, and also amenable to potential use by bats, would be added and targeted to a location accessible by both wildfire helicopters and bats, as well as practical for installation, filling, and maintenance. The potential location in the HMA has been identified by DOFAW for siting the water feature near the existing water feature (small trough) (Figure 4; Ryan Peralta, DOFAW Oʻahu, pers. comm., March 22, 2023)—which would allow unobstructed access for potential use by bats. The source of the water used to supply the water feature and the exact location of installation will be determined in conjunction with DOFAW Oʻahu and will depend on permitting, possible access limitations and road conditions. Potential sources of water include drawing from a nearby stream (dependent upon permitting) or flume, delivery by water truck, supplementary catchment, as well as other possible sources which may become apparent as work commences and would be agreed to with DOFAW.

Research from the continental U.S. has shown the minimum size of water sources utilized by bats varies depending on the flight characteristics of each species, with an inverse relationship between the dimensions of an open water source and degree of species' maneuverability (Taylor and Tuttle 2012). Water features such as troughs or stock tanks must be large enough for bats to use (minimum 10 to 12-foot length/diameter), circular or oriented parallel to the prevailing wind, unobstructed by surrounding structures or vegetation to allow for a clear swoop zone, kept full year-round, and include an egress structure (Taylor and Tuttle 2012). KAH has reached agreement with DOFAW Oʻahu and the land licensee to install an above-ground, circular, galvanized steel water tank with a height and diameter of 7-feet 3-inches by 21-feet 7-inches, respectively, and an approximately 20,000-gallon capacity. The above-ground water tank will feature an open top for use in wildfire suppression, a wildlife egress, and draw-down capabilities for use by the land licensee for cattle watering. KAH will also work with USFWS and DOFAW HCP staff to ensure the above-ground water tank has the potential to provide a secondary benefit and minimize risk to bats. While studies in the continental U.S. suggest the use of water tanks by bats in the arid southwest (Taylor and Tuttle 2012), there is no empirical evidence of the same in Hawaiʻi. As a

result, KAH will acoustically monitor the water feature as a separate component of the monitoring plan to improve our understanding of whether bats would use such a feature in this environment (see Section 5.1).

4.4 Offset/Net Benefit

The management actions will create modifications to the existing closed habitat structure and promote additional bat prey resources which are anticipated to increase foraging access and prey resources for bats and facilitate increased access to roosting habitat (Whitaker et al. 2000, Gruner 2007). In addition, a permanent water feature will be installed, which will serve as a stock tank, a potential water source and prey attractant for Hawaiian hoary bat, and wildfire suppression. KAH will implement monitoring programs to document changes in bat activity and insect abundance at the HMA in response to the mitigation actions. If 176 acres of habitat is improved for the benefit of bats, as determined through monitoring, the mitigation actions will be considered to offset the take of eight bats. The benefits to Hawaiian hoary bat from the creation of foraging corridors and installation of the water features will extend beyond the life of this Mitigation Plan, resulting in a net benefit to the species.

Core use area has been used as a metric to identify appropriate scales of mitigation for the Hawaiian hoary bat (DOFAW 2015, Tetra Tech 2019b, Tetra Tech 2019c). However, draft revised guidance (ESRC and DOFAW 2021) recognizes potential challenges in the use of this metric, citing variation in results from different studies and a lack of certainty that habitat is a limiting factor. In addition, some studies have shown that core use area size may depend on bat age, habitat suitability, and foraging efficiency (Pinzari 2014, Bonaccorso et al. 2015). Data from Bonaccorso et al. (2015) suggest that although there is variability in the size of core use areas, subadults tend to use larger core use areas than adults. Research on the Hawaiian hoary bat has also generally indicated smaller foraging areas are associated with smaller core use areas (Bonaccorso et al. 2015, H.T. Harvey 2019).

We suggest it is the differences in core use area size associated with habitat suitability that habitat management mitigation projects should seek to exploit. It is the development of areas rich in bat resources (e.g., foraging habitat with an adequate prey base, proximate to suitable roosting habitat) that represent the most strongly supported action to benefit bats. Based on the 176 acres managed under this Mitigation Plan, KAH estimates the improvement of 22 acres per bat—which exceeds the median bat core use area of 20.3 acres for males used in the approved bat mitigation guidance to calculate required mitigation acreage (DOFAW 2015)—will not only offset the incidental take of eight bats (8 x 22= 176), but also provide a net benefit to the species (i.e., greater amount of habitat protected and enhanced than required under the current bat guidance).

Finally, we suggest that a net benefit to the species will be realized resulting from the estimation of take at the Kahuku Wind Project. Take is estimated at the 80 percent Upper Credible Limit (UCL), indicating 80 percent certainty that the estimated take is equal to or less than the estimated number of fatalities incurred at the Project over a given time period. Because this conservative analysis likely overestimates impacts at the Project level, the offset of eight bats estimated at the 80

percent UCL would provide a net benefit when the overestimate is taken into account (PNWWRM XIV 2023).

4.5 Success Criteria

The completion of all mitigation actions and a statistically significant increase in bat activity and insect prey at the HMA will indicate that mitigation actions have been successful. A statistically significant increase (i.e., p-value < 0.05) indicates that the observed change or difference in bat activity pre- and post-mitigation is unlikely to have occurred due to random chance. It provides confidence that the observed increase is a real and meaningful effect.

KAH has developed success criteria to ensure that the objectives of protecting and enhancing bat foraging and roosting habitat are being met. The monitoring program (see Section 5.0) is designed to determine the overall trends in bat acoustic activity and bat prey presence in the HMA compared to baseline conditions, which are key elements of the success criteria. These measurable and time-based success criteria identify interim targets related to bat acoustic activity and bat prey presence, that if not met will trigger the adaptive management program (Section 8.0).

Success Criteria:

1. Bat acoustic activity
    - Year 1: Demonstrate that bat acoustic activity (see Section 5.1) is either equal to or increasing from the baseline monitoring year to Year 1.
    - Year 3: Demonstrate that bat acoustic activity (see Section 5.1) in Year 3 has a statistically significant increase relative to the baseline monitoring year (see Section 6.0). Reported changes in bat activity will include 95 percent confidence intervals and significance at an alpha value of 0.05.
    - Year 5: Demonstrate that bat acoustic activity (see Section 5.1) in Year 5 has a statistically significant increase relative to the baseline monitoring year (see Section 6.0). Reported changes in bat activity will include 95 percent confidence intervals and significance at an alpha value of 0.05.
2. Biomass and/or diversity of bat prey (i.e., insects)
    - Year 1: Demonstrate that biomass and/or diversity of bat prey (i.e., insects) (see Section 5.1) is either equal to or increasing from the baseline monitoring year to Year 1.
    - Year 3: Demonstrate a statistically significant increase in biomass and/or diversity of bat prey (i.e., insects) in Year 3 compared to the baseline monitoring year as measured from insect sampling (see Sections 5.2 and 6.0). Reported changes in bat prey items will include 95 percent confidence intervals and significance at an alpha value of 0.05.
    - Year 5: Demonstrate a statistically significant increase in biomass and/or diversity of bat prey (i.e., insects) in Year 5 over the baseline monitoring year as measured

from insect sampling (see Sections 5.2 and 6.0). Reported changes in bat prey items will include 95 percent confidence intervals and significance at an alpha value of 0.05.

3. Ensure that the barbed wire fence around the parcels does not reach or exceed 20 percent high risk and highest risk vegetation exposure levels (Appendix A) in Years 1, 3, and 5.
4. Install a water feature in Year 1 suitable for wildfire suppression support in the HMA and complete independent acoustic monitoring of bat activity at the water feature to provide insight on the effects of the installation of an above-ground water feature on bat activity and behavior (see Section 5.1).
5. Summarize and report the results of monitoring in annual HCP Implementation reports as an appendix in years when monitoring occurs (Years 1, 3, and 5) and as an actions-taken update in years when monitoring does not occur (Years 2 and 4).

The control site is not considered for a success criterion because the parcel is not fenced, and therefore is not intentionally grazeable. This condition precludes management actions involving cattle. Therefore, it is included in this Mitigation Plan for the sole purpose of informing monitoring results.

5.0 Monitoring

KAH will monitor the response of the Hawaiian hoary bat to the mitigation actions implemented by KAH in the HMA (including accounting for the separate and initial one-time management action of the DOFAW-created bat foraging corridors in Parcel 2 and Parcel 4). This includes acoustic monitoring of bat activity, insect diversity and biomass, and vegetation relative to mitigation actions.

The status and location of Moluccan albizia, shoebutton ardisia, and Christmas berry populations targeted for strategic management of vegetation will be monitored within the HMA.

5.1 Acoustic Monitoring

Acoustic monitoring will be employed to determine whether an increase in bat activity has occurred following the implementation of mitigation actions performed by KAH. Acoustic monitoring will be conducted within each Mitigation Parcel for one year to establish a baseline of bat activity. These areas will then be resampled in Years 1, 3, and 5. Bat activity will be compared across the four Mitigation Parcels over the 5-year period to determine if a statistically significant increase has occurred.

A secondary purpose is to try to discern changes in bat activity in response to specific mitigation actions taken (i.e., the creation of foraging corridors). Given the similarity of habitat, bat activity in Mitigation Parcels 1 and 2 will be compared to bat activity at the control site to help better understand the effects from the implementation of mitigations actions on bat activity (Section 3.4.3). Mitigation Parcels 3 and 4 have been excluded from the comparison portion of this analysis

to eliminate potential confounding effects associated with immediate and surrounding habitat (i.e., large open fields and proximity to light pollution). Similar to the mitigation area, acoustic monitoring will be conducted at the control site for one year to establish a baseline of bat activity, with resampling occurring in Years 1, 3, and 5, to allow for comparison with Mitigation Parcels 1 and 2.

Acoustic monitoring will be conducted at 36 sites within each of the four Mitigation Parcels and the control site (180 total sites). Nightly monitoring, beginning 1-hour prior to sunset and ending 1-hour after sunrise, will be conducted for a 12-month period during the baseline monitoring year, and in monitoring Years 1, 3 and 5. Acoustic monitoring will be conducted using Song Meter SM4BAT-FS (SM4) ultrasonic recorders equipped with high frequency microphones (SMM-U2; Wildlife Acoustics, Inc., Maynard, MA, Wildlife Acoustics 2022). SM4 units will be deployed at three randomly selected sites 100 meters apart within each Mitigation Parcel and the control site for the duration of one month, at which time each of the three SM4 units within each parcel and the control site will be redeployed at a new randomly selected site for the first year of monitoring (Figure 8). Monitoring locations established during the baseline monitoring year will remain consistent throughout subsequent sampling years.

Separate from the primary acoustic monitoring effort, one acoustic monitor will be deployed at the water feature location. This monitor will be placed prior to installation in conjunction with baseline monitoring to capture baseline activity for the area and will remain after the feature is installed. Monitoring of the water feature may provide insight on the use of non-natural water features by bats in the HMA.

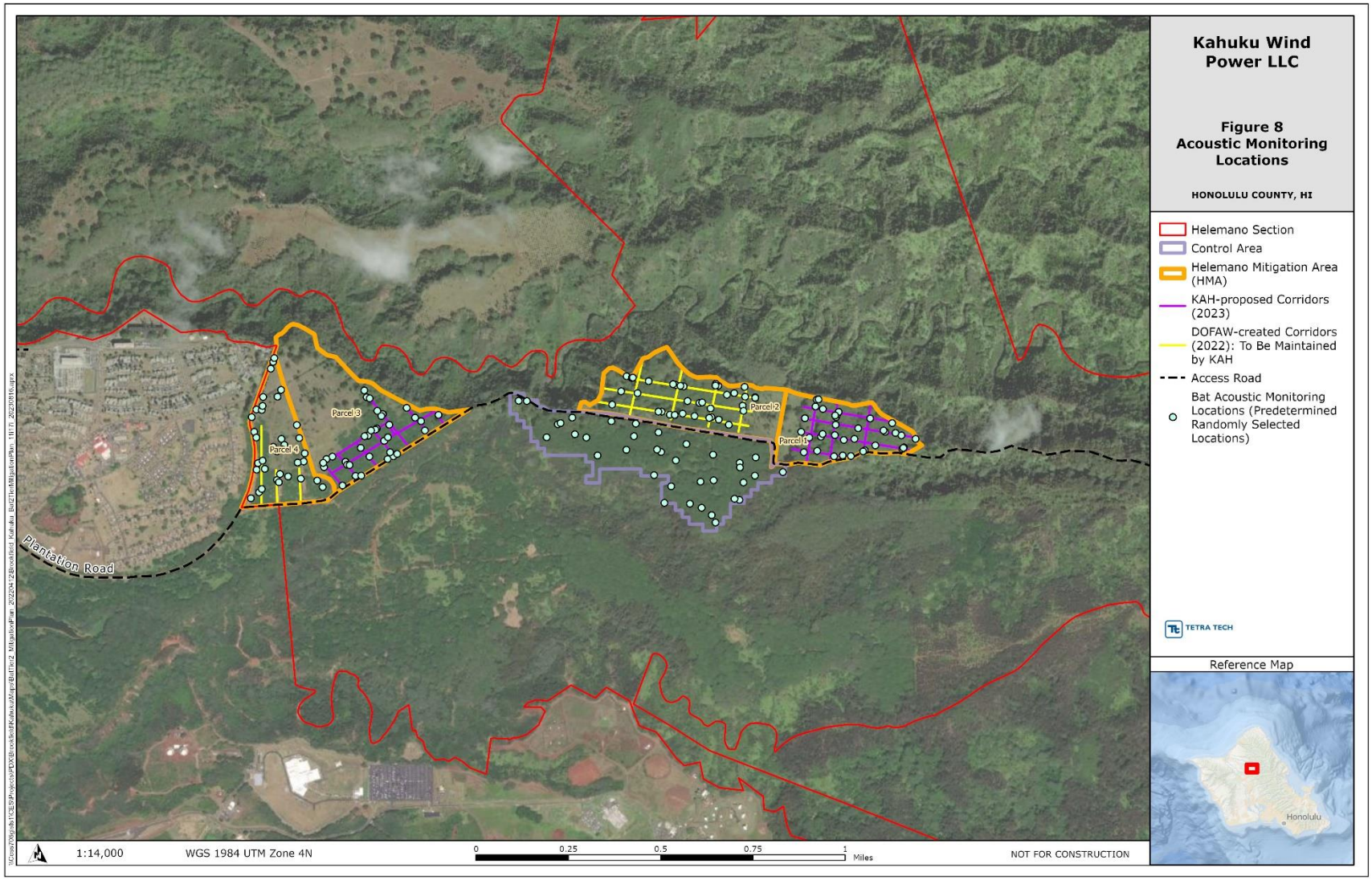

Figure 8. Acoustic Monitoring Locations

5.2 Insect Monitoring

Arthropod monitoring will be conducted to determine the response of bat prey communities, specifically diversity and/or 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 each parcel and at the control site (Section 3.4.3) during each monitoring year using three methods:

- Three malaise traps with two collection reservoirs each, deployed within each parcel and the control site at randomly selected locations at least 400 meters apart (15 traps total). Monitoring locations will remain consistent throughout all sampling years.
- One UV Light trap deployed within each parcel (5 traps total) for a duration of three hours per night-time sampling period over the course of three consecutive sampling nights.
- Random sampling of cattle dung in each Mitigation Parcel will be conducted to identify dung beetles and other insects.

All arthropod samples collected from the traps within each parcel and the control site and during each monitoring period will be combined. Data will include arthropods collected during each sampling period with a body length ≥ 5 millimeters identified to family or the most specific taxonomic level possible, measured, and oven-dried for 48 hours at 65°C (Gorresen et al. 2018). These will be size classified into the categories of ≥ 5 to 10 millimeters, >10 to 20 millimeters, and > 20 millimeters.

- All flying insects with a body length 3 mm or greater will be identified to family or the most specific taxonomic level possible[1], counted, and measured to the nearest millimeter. A focused effort will be made to identify to genus or species those insects that are abundant and considered most important to the Hawaiian hoary bat as prey.
- For species that are abundant, body length measurements may be estimates based on pooling all individuals in a sample, or among samples.
- Lepidoptera from SLAM traps (i.e., aerial Malaise trap) may be difficult to identify because the fluid preservative used in the traps (propylene glycol) removes scales that are important identifying characters. These moths will still be measured and identified to the level that is most practicable.
- Each insect will be photographed. Each photo will be labeled to indicate taxonomy.
- A reference collection (physical specimen or photograph) will be maintained for each insect to allow for standardized processing of samples between sampling periods.

Biomass of collected bat prey insects will be calculated using the weight-length relationship determined by Gruner (2003):

$$y = a(x)^b$$

[1] Lepidoptera and Diptera are difficult to identify without genetic barcoding or sending to taxonomic experts.

Where $y =$ dry biomass, $x =$ size measurement, either length or length * width; a and b are coefficients individually chosen for each taxon.

Sampling of arthropods will be conducted quarterly over the course of a single month during the first year, prior to any KAH mitigation actions, to establish a baseline level of arthropod diversity and biomass, and subsequently in Years 1, 3, and 5. Timing of quarterly sampling will be consistent across all sampling years and align with bat reproductive periods as defined by Gorresen et al. (2013): lactation (mid-June to August), post-lactation (September to mid-December), pre-pregnancy (mid-December to March), and pregnancy (April to mid-June).

5.3 Vegetation Monitoring

Vegetation monitoring will be conducted to ensure that the habitat management actions (Section 4.2) within the bat foraging corridors are at or below the desired maximum vegetation height (36 inches). Vegetation height in each bat foraging corridor will be measured monthly throughout all five years of this Mitigation Plan (see Section 9.0) to determine if any portion of the corridor is in exceedance of 36 inches. The monitoring data will be used by KAH to rotate cattle grazing and/or mechanically remove vegetation to maintain vegetation at the low stature within the corridors. In addition, invasive species monitoring will also occur monthly to document any spread of Moluccan albizia, shoebutton ardisia, and Christmas berry within the bat foraging corridors. KAH will pay particular attention to the corridor edges where spread is most likely to begin. KAH will record any incidental observation of devil weed, mānuka (*Leptospermum scoparium*), and *Arthrostemma ciliatum* in the bat foraging corridors.

The amount of the barbed wire perimeter fence encased in vegetation will also be monitored to document changes over time, concurrently with monthly vegetation monitoring (see Section 5.1). As stated in Section 8.0 and Appendix A, adaptive management will be triggered if the total amount of fence line spans in the two highest risk categories (Levels 4 and 5) doubles (from the current assessed amount of 10 percent) (see Section 8.0).

6.0 Analysis

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 and across Mitigation Parcels 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. These data parameters will further aid in understanding the effects of the mitigations actions on habitat use by bats:

- 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.

6.1 Modeling

Linear mixed models will be constructed to test for differences in bat acoustic activity and insect biomass and diversity among years. Fixed parameters in the models may include but are not limited to year, parcel, temperature, and rainfall. Sampling location will be included as a random parameter. Insect biomass and diversity will be included as fixed parameters in models testing changes in bat acoustic activity. Among highly correlated bat activity metrics the use of Principal Component Analysis (PCA) will be explored to reduce the number of inputs, while maintaining interpretability of changes in bat acoustic activity.

Additionally, a second set of models will be constructed to evaluate changes in habitat use following the implementation of mitigation actions at Mitigation Parcels 1 and 2 and will be compared to the adjacent control site. Predictive variables will include current mitigation state (i.e., no action or foraging corridors) and arthropod biomass and/or diversity. Results of these analyses will be summarized in the annual report following the completion of each year of acoustic monitoring. As previously mentioned, Mitigation Parcels 3 and 4 have been excluded from the success criteria to eliminate potential confounding effects associated with immediate and surrounding habitat (i.e., large open fields and proximity to light pollution).

A statistical comparison of pre- and post-baseline activity levels at the water feature will be conducted using bat activity metrics. This will not only aid in understanding how the addition of a non-natural water feature may affect bat use and behavior at the Project, but this data can also be applied to other mitigation projects in Hawai'i. Statistical models will test for changes in bat activity metrics only and will not include any predictive variables other than the presence or absence of a water feature.

7.0 Reporting

Annual reports will be drafted to provide an overview of all mitigation actions completed for that year. Annual reports will include:

- A description and the status of incipient weed populations in HMA;
- Number and mapped locations of corridors created in alien forests;
- Summary of acoustic monitoring data and a comparison of the sampling year's monitoring data (in Years 1, 3, and 5) to the baseline monitoring data, including the statistical power with which any change is documented to determine if there is a statistically significant increase in Years 3 and 5 (see Sections 4.5 and 6.0);
- Summary of insect monitoring data and comparison of the sampling year's monitoring data (in Years 1, 3, and 5) to the baseline monitoring for each year sampled to determine if there is a statistically significant increase in Years 3 and 5 (see Sections 4.5 and 6.0);

- Summary of barbed wire fence risk level assessment (see Appendix A for example);
- Any adaptive management actions taken; and
- Any additional pertinent summary information needed to provide a full picture of mitigation actions.

8.0 Adaptive Management

Adaptive management will occur following Years 1 and 3 when bat acoustic activity and insect prey are not increasing by a statistically significant level as compared to baseline. In Year 5 if the success criteria are not met, additional adaptive management actions will be identified and implemented in consultation with USFWS and DOFAW and monitoring will continue until the Year 5 success criteria are met.

Adaptive management actions will be responsive to the needs observed through monitoring and compatible with the intent of DOFAW Oʻahu to maintain and renew the grazing license for the agriculture-zoned HMA lands into the future. If the success criteria are not met, KAH will work with DOFAW Oʻahu to get approval to modify the mitigation actions in conjunction with seeking approval from DOFAW HCP staff. KAH has the following potential adaptive management responses available for modifying the mitigation actions. Table 4 crosswalks these potential adaptive management responses with the biological goals and objectives, success criteria, and adaptive management triggers to illustrate the decision-making process that will result in the implementation of these adaptive management responses:

1. Install fence to enclose currently unfenced, highly disturbed habitat adjacent to the HMA to allow for cattle grazing;
2. Increase the amount of area cleared for bat foraging corridors within the HMA;
3. Create more bat foraging corridors in additional targeted areas within the Helemano Section to benefit bats, such as in the highly disturbed habitat adjacent to the HMA (See Item 1 above), or strategically opening up areas of dense non-native canopy above existing access roads to promote bat ingress and foraging;
4. Increase the longevity of the created structure of bat foraging corridors by over-seeding them with diverse, non-native, non-woody vegetation to promote insect diversity and facilitate maintenance of openings by cattle;
5. Remove and replace the top one to two strands of barbed wire from the perimeter fence in newly exposed areas identified during monitoring with a high risk or higher risk level as compared to the baseline assessment (Appendix A). Barbed wire will be replaced with smooth high-tensile wire; and
6. Other to-be-identified options likely to increase bat use of the area and/or further enhance bat resources.

Table 4. Adaptive Management Strategy

Biological Goal	Biological Objective	Expected Output and Outcomes	Types of Monitoring	Success Criteria	Adaptive Management Triggers	Example Adaptive Management Responses
Fully offset the incidental take of eight Hawaiian hoary bats required for Tier 2 mitigation and provide a net benefit to the species.	Protect, manage, and enhance 176 acres of Hawaiian hoary bat foraging and roosting habitat at the Helemano Mitigation Area (HMA).	• Improved habitat quality in the HMA • Reduced level of invasive species • Barbed wire fence remaining a low risk to Hawaiian hoary bat	Vegetation monitoring	Ensure that the barbed wire fence around the parcels does not reach or exceed 20% high risk and highest risk vegetation exposure levels in Years 1, 3, and 5 (Appendix A).	Barbed wire fence reaches or exceeds 20% high risk or highest risk vegetation exposure levels in Years 1, 3, and 5 (Appendix A).	Remove and replace the top one to two strands of barbed wire from the perimeter fence in newly exposed areas identified during monitoring with a high risk or higher risk level as compared to the baseline assessment.
	Demonstrate an increase in bat activity indicative of resource improvement and availability for bats.	Increased bat acoustic activity	Acoustic monitoring	**Year 1**: Demonstrate that bat acoustic activity (see Section 5.1) has not decreased between the baseline year and Year 1. **Years 3 and 5**: Demonstrate that bat acoustic activity (see Section 5.1) in Year 3 and Year 5 has a statistically significant increase relative to the baseline monitoring year (see Section 6.0). Reported changes in bat activity will include 95% confidence intervals and significance at an alpha value of 0.05.	**Year 1**: Bat acoustic activity decreases between the baseline year and Year 1. **Years 3 and 5**: Bat acoustic activity does not show a statistically significant increase between Year 3 or Year 5 and the baseline year.	• Install fence to enclose currently unfenced, highly disturbed habitat adjacent to the HMA to allow for cattle grazing; • Increase the amount of area cleared for bat foraging corridors within the HMA; • Create more bat foraging corridors in additional targeted areas within the Helemano Section to benefit bats, such as in the highly disturbed habitat adjacent to the HMA (See first item above), or strategically opening up areas of dense non-native canopy above existing access roads to promote bat ingress and foraging.

Biological Goal	Biological Objective	Expected Output and Outcomes	Types of Monitoring	Success Criteria	Adaptive Management Triggers	Example Adaptive Management Responses
	Demonstrate that habitat enhancement is linked to an increase in bat prey availability.	Increased prey availability	Insect monitoring	**Year 1**: Demonstrate that biomass and/or diversity of bat prey items (i.e., insects) (see Section 5.1) have not decreased between the baseline year and Year 1. **Years 3 and 5**: Demonstrate a statistically significant increase of bat prey items (i.e., insects) in Year 3 and Year 5 over the baseline monitoring year as measured from insect sampling (see Sections 5.2 and 6.0). Reported changes in bat prey items will include 95% confidence intervals and significance at an alpha value of 0.05.	**Year 1**: Biomass and diversity of prey items decreases between the baseline year and Year 1. **Years 3 and 5**: Biomass and diversity of prey items does not show a statistically significant increase between Year 3 or Year 5 and the baseline year.	Increase the number of cattle to the extent practicable in order to further distribute dung throughout the Mitigation Parcels.

9.0 Timeline

In August 2021, the mitigation planning trigger for Tier 2 was reached. As such, KAH has begun mitigation planning in consultation with DOFAW and USFWS. Anticipated critical path timelines and expected time for completion are shown in Table 5.

Table 5. Timeline for Actions to be Implemented

Time Frame	Mitigation Year	Description of Actions
June 2022 - October 2023	Pre-Mitigation	• Preparation and submittal of Hawaiian Hoary Bat Tier 2 Mitigation Plan to DOFAW and USFWS • Review, revision, and approval of Tier 2 Mitigation Plan by DOFAW and USFWS
March 2023 – March 2024	Baseline Monitoring	• Acoustic monitoring (baseline) • Insect monitoring (baseline) • Assessment of exposed barbed wire fence line • Completion of MOU
2024 – 2026[1]	Year 1	• Create bat foraging corridors in Parcel 1 and Parcel 3 • Cattle management practices that allow for grazing in the bat foraging corridors in Parcels 1-4 to maintain vegetation within corridors at a low stature • Install water feature • Acoustic monitoring • Insect monitoring • Barbed wire fence monitoring • Data analysis • Assess success criteria • Adaptive management, as needed
2026 – 2027	Year 2	• Cattle management practices that allow for grazing in the bat foraging corridors in Parcels 1-4 to maintain vegetation within corridors at a low stature
2027 – 2028	Year 3	• Cattle management practices that allow for grazing in the bat foraging corridors in Parcels 1-4 to maintain vegetation within corridors at a low stature • Acoustic monitoring • Insect monitoring • Barbed wire fence monitoring • Data analysis • Assess success criteria • Adaptive management, as needed

Time Frame	Mitigation Year	Description of Actions
2029 – 2030	Year 4	• Cattle management practices that allow for grazing in the bat foraging corridors in Parcels 1-4 to maintain vegetation within corridors at a low stature
2031 – 2032	Year 5	• Acoustic monitoring • Insect monitoring • Barbed wire fence monitoring • Data analysis • Adaptive management, as needed • Assess success criteria
[1]The duration of Year 1 will be longer than 12 months to account for the time needed for management actions to occur ahead of the yearlong acoustic monitoring effort.		

10.0 Literature Cited

Ancillotto, L. A. Ariano, V. Nardone, I. Budinski, J. Rydell, and D. Russo. 2017. Effects of free-ranging cattle and landscape complexity on bat foraging: Implications for bat conservation and livestock management. *Agriculture, Ecosystems and Environment.* 241, 54-61.

Blake, J. G. and W. G. Hoppes. 1986. Influence of resource abundance on use of tree-fall gaps by birds in an isolated woodlot. *Auk.* 103:328–340

Bonaccorso, F. J., C. M. Todd, A. C. Miles, and P. M. Gorresen. 2015. Foraging range movements of the endangered Hawaiian hoary bat, *Lasiurus cinereus semotus* (Chiroptera: Vespertilionidae). *Journal of Mammalogy.* 96:64–71.

Broders, H. G., G. M. Quinn, and G. J. Forbes. 2003. Species status, and the spatial and temporal patterns of activity of bats in southwest Nova Scotia, Canada. *Northeastern Naturalist*. *10*(4): 383-398.

Bryan, E. H., Jr. 1955. The Hawaiian bat. *'Elepaio, Journal of the Hawai'i Audubon Society.* 15(11):1-2.

Cornman R.S, J.A. Fike, S.J. Oyler-McCance, and P.M. Cryan. 2021. Historical effective population size of North American hoary bat (*Lasiurus cinereus*) and challenges to estimating trends in contemporary effective breeding population size from archived samples. *PeerJ.* 9:e11285 https://doi.org/10.7717/peerj.11285

Davidson, L. N. 2020. Assessing ʻŌpeʻapeʻa (Hawaiian Hoary Bat, *Lasiurus semotus*) Habitat Use and Occupancy in the Helemano Wilderness Area, Central Oʻahu. Capstone Project for the degree of Master of Environmental Management. Department of Natural Resources and Environmental Management, University of Hawai'i at Mānoa. Available at: https://scholarspace.manoa.hawaii.edu/items/b10c8b9a-d26d-4504-893a-3ca70cc66ffd. Accessed June 2022.

DOFAW (State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife). 2015. Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance Document.

DOFAW. 2021. Helemano Section of the ʻEwa Forest Reserve, Oʻahu, Preliminary Draft Management Plan, June 20, 2021. Prepared by Forest Solutions, Inc.

ESRC and DOFAW (Endangered Species Recovery Committee and State of Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife). 2021. Draft Hawaiian hoary bat guidance for wind energy projects. Updated January 2021. Available at: https://dlnr.hawaii.gov/wildlife/files/2021/01/Draft-Hawaiian-Hoary-Bat-Guidance-Document_011321.pdf.

Fill C.T., C.R. Allen, J.F. Benson, and D. Twidwell. 2023. Spatial and temporal activity patterns among sympatric tree-roosting bat species in an agriculturally dominated great plains landscape. PLoS ONE. 18(6): e0286621. https://doi.org/10.1371/journal.pone.0286621

Frick, W. F. 2013. Acoustic monitoring of bats, considerations of options for long-term monitoring. *Therya.* 4(1): 69-70.

Gehrt, S. D., and J. E. Chelsvig. 2003. Bat activity in an urban landscape: patterns at the landscape and microhabitat scale. *Ecological Applications.* 13: 939-950.

Gehrt, S. D. and J. E. Chelsvig. 2004. Species-specific patterns of bat activity in an urban landscape. *Ecological Applications.* 14(2): 625-635.

Gorresen, P. M., A. C. Miles., C. M. Todd, F. J. Bonaccorso, and T. J. Weller. 2008. Assessing bat detectability and occupancy with multiple automated echolocation detectors. *Journal of Mammalogy.* 89(1): 11-17.

Gorresen, P. M., F. J. Bonaccorso, C. A. Pinzari, C. M. Todd, K. Montoya-Aiona, and K. Brinck. 2013. A five-year study of Hawaiian hoary bat (*Lasiurus cinereus semotus*) occupancy on the island of Hawaiʻi. Technical Report HCSU-041. Hawaiʻi Cooperative Studies Unit, University of Hawaiʻi at Hilo, Hilo, Hawaiʻi. July 2013.

Gorresen, P. M., K. W. Brinck, M. A. DeLisle, K. Montoya-Aiona, C. A. Pinzari, and F. J. Bonaccorso. 2018. Multi-state occupancy models of foraging habitat use by the Hawaiian hoary bat (*Lasiurus cinereus semotus*). PloS ONE. 13:e0205150.

Grindal, S. D., J. L. Morisette, and R. M. Brigham. 1999. Concentration of bat activity in riparian habitats over an elevational gradient. *Canadian Journal of Zoology.* 77: 972–977.

Gruner, D. S. 2003. Regressions of length and width to predict arthropod biomass in the Hawaiian Islands. *Pacific Science*. *57*(3), 325-336.

Gruner, D. S. 2007. Geological age, ecosystem development, and local resource constraints on arthropod community structure in the Hawaiian Islands, *Biological Journal of the Linnean Society.* 90(3): 551–570, https://doi.org/10.1111/j.1095-8312.2007.00748.x.

Harris, R.L., K. Onaga, R. R. Blume, J. P. Roth, and J. W. Summerlin. 1982. Survey of beneficial insects in undisturbed cattle droppings on O'ahu, Hawai'i. *Proceedings of the Hawai'i Entomological Society.* 24(1): 91-95.

Hayes, J. P. 1997. Temporal variation in activity of bats and the design of echolocation-monitoring studies. *Journal of Mammalogy.* 78(2): 514-524.

Hayes, J. P. 2000. Assumptions and practical considerations in the design and interpretation of echolocation-monitoring studies. *Acta Chiropterologica.* 2: 225-236.

Hayes, J. P., H. K. Ober, and R. E. Sherwin. 2009. Survey and monitoring of bats. Pp. 112-132 in *The Ecological and Behavioral Methods for the Study of Bats* (Kunz, T. H., and S. Parsons, eds.). The John Hopkins University Press. Baltimore, Marylan EE.UU.

H.T. Harvey. 2019. Hawaiian Hoary Bat Research, Maui, Final Report 2019. Project #3978-01. Prepared for Lily Henning, TerraForm Power. Prepared by H.T. Harvey and Associates. February 2020.

Hein, C., A. Hale, and B. Straw. 2021. Acoustic and Genetic Approaches for Informing Population Status and Trends of Migratory Tree Bats (Report No. NREL/TP-5000-78563). Reporting by National Renewable Energy Laboratory (NREL). Report for U.S. Department of Energy (DOE).

HWMO (Hawai'i Wildfire Management Organization). 2019. Overall Wildfire Hazard Map. Accessible online at: https://bnhm-shiny.berkeley.edu/HWMO/

Jacobi, J. D., J. P. Price, L. B. Fortini, S. M. Gon III, and P. Berkowitz. 2017. Carbon Assessment of Hawaii: U.S. Geological Survey data release. https://doi.org/10.5066/F7DB80B9.

Jacobs, D. S.. 1994. Distribution and abundance of the endangered Hawaiian hoary bat, *Lasiurus cinereus semotus*, on the island of Hawai'i. *Pacific Science.* 48(2): 193-200.

Jacobs, D. S.. 1996. Morphological divergence in an insular bat, *Lasiurus cinereus semotus*. *Functional Ecology.* 10(5): 622-630.

Jacobs, D.S. 1999. The diet of the insectivorous Hawaiian hoary bat (*Lasiurus cinereus semotus*) in an open and a cluttered habitat. *Canadian Journal of Zoology.* 77: 1603-1608. 10.1139/z99-110.

Jantzen, M. K. 2012. Bats and the landscape: the influence of edge effects and forest cover on bat activity. M.S. thesis, University of Western Ontario, London, Ontario, Canada.

Kotila, M., K.M. Suominen, V.V. Vasko, A.S. Blomberg, A. Lehikoinen, T. Andersson, J. Aspi, T. Cederberg, J. Hänninen, J. Inkinen, J. Koskinen, G. Lundberg, K. Mäkinen, M. Rontti, M. Snickars, J. Solbakken, J. Sundell, I. Syvänperä, S. Vuorenmaa, J. Ylönen, E.J. Vesterinen, and T.M. Lilley. 2023. Large-scale long-term passive-acoustic monitoring reveals spatio-temporal activity patterns of boreal bats. Ecography. 2023: e06617. https://doi.org/10.1111/ecog.06617

Jantzen, M. K. 2012. Bats and the landscape: The influence of edge effects and forest cover on bat activity. The University of Western Ontario. *Electronic Thesis and Dissertation Repository*. 439. Available at: https://ir.lib.uwo.ca/etd/439.

Law, B. and M. Chidel. 2002. Tracks and Riparian Zones Facilitate the Use of Australian Regrowth Forest by Insectivorous Bats. *Journal of Applied Ecology.* 39(4): 605-617. Accessible at: http://www.jstor.org/stable/827170.

Lewis, T. 1969. The Distribution of Flying Insects Near a Low Hedgerow. *Journal of Applied Ecology.* 6(3): 443-452. doi:10.2307/2401510.

Lloyd, A., R. Law, and B. Goldingay. 2006. Bat activity on riparian zones and upper slopes in Australian timber production forests and the effectiveness of riparian buffers. *Biological Conservation.* 129: 207-220. 10.1016/j.biocon.2005.10.035.

Loeb, S. C. and J. M. O'keefe. 2011. Bats and gaps: the role of early successional patches in the roosting and foraging ecology of bats. In *Sustaining young forest communities*. pp. 167-189. Springer, Dordrecht.

Markin, G. P., and E. R. Yoshioka. 1998. Biological Control of the Horn Fly, *Haematobia irritans* L., in Hawai'i (Diptera: Muscidae). *Proceedings of the Hawaiian Entomological Society.* 33: 43-50.

Montgomery, S. 2016. Cattle manure-related insect species and biological controls for Hawai'i Dairy Farms Māhā'ulepū, Kaua'i, Hawai'i. Prepared for Hawai'i Dairy Farms, LLC.

Montoya-Aiona, K. 2020. Roosting Ecology and Behavior of the Solitary and Foliage-Roosting Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). MSc thesis. University of Hawai'i at Hilo, Hilo, Hawai'i.

Montoya-Aiona, K., C. Pinzari, R. Peck, K. Brinck, and F. Bonaccorso. 2020. Hawaiian Hoary Bat (*Lasiurus Cinereus Semotus*) Acoustic Monitoring at Hawai'i Army National Guard (HIARNG) Installations Statewide. Technical Report HCSU-092. Hawai'i Cooperative Studies Unit, University of Hawaii at Hilo, Hilo, Hawai'i. January 2020.

Ober, H. and J. Hayes. 2008. Influence of Vegetation on Bat Use of Riparian Areas at Multiple Spatial Scales. *The Journal of Wildlife Management.* 72(2): 396-404. Available at: https://doi.org/10.2193/2007-193.

Parsons, S. and J. Szewczak. 2009. Detecting, recording and analysing the vocalisations of bats. *Ecological and behavioral methods for the study of bats. 2nd edition*, pp. 91-111.

Peterson T.S., B. Mcgill, C.D. Hein, and A. Rusk. 2021. Acoustic exposure to turbine operation quantifies risk to bats at commercial wind energy facilities. *Wildlife Society Bulletin.* 45: 552–565.

Pinzari, C. A. 2014. Hawaiian Hoary bat occupancy at Kaloko Honokōhau National Historical park. Technical Report HCSU-051. Hawai'i Cooperative Studies Unit, University of Hawaii at Hilo, Hilo, Hawai'i. April 2014.

Pinzari, C., R. Peck, T. Zinn, D. Gross, K. Montoya-Aiona, K. Brinck, M. Gorressen, and F. Bonaccorso. 2019. Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) activity, diet and prey availability at the Waihou Mitigation Area, Maui. Technical Report HCSU-090. Hawai'i Cooperative Studies Unit, University of Hawai'i at Hilo, Hilo, Hawai'i. June 2019.

PNWWRM XIV. 2023. Proceedings of the 14th Wind-Wildlife Research Meeting. November 15-17, 2022. K.E. Johnson (ed.). Prepared by the Renewable Energy Wildlife Institute, Washington, DC. 109 pp.

Poe, E. A. 2007. The Effects of Foraging Habitat on the Echolocation Calls of Lasiurus Cinereus Semotus (Hawaiian Hoary Bat). Doctoral dissertation, Faculty of Graduate Studies, University of Western Ontario, London, Ontario, Canada.

Price, J. P., J. D. Jacobi, S. M. Gon III, D. Matsuwaki, L. Mehrhoff, W. Wagner, M. Lucas, and B. Rowe. 2012. Mapping plant species ranges in the Hawaiian Islands—Developing a methodology and associated GIS layers. U.S. Geological Survey Open-File Report 2012–1192, 34 p., one appendix (species table), 1,158 maps. Available at: http://pubs.usgs.gov/of/2012/1192/.

Reynolds, M. H., B. M. B. Nielsen, and J. D. Jacobi. 1997. Surveys of the Hawaiian Hoary Bat in the District of Puna, Hawai'i Island. *'Elepaio, Journal of the Hawai'i Audubon Society* 57(9). December 1997/January 1998.

Ross, S.-J., D. P. O'Connell, J. L. Deichmann, C. Desjonquères, A. Gasc,, J. N, Phillips, S. S. Sethi, C. M. Wood, and Z. Burivalova. 2023. Passive acoustic monitoring provides a fresh perspective on fundamental ecological questions. *Functional Ecology*. 37, 959–975. https://doi.org/10.1111/1365-2435.14275

Saint-Germain, M., C. M. Buddle, M. Larrivee, A. Mercado, T. Motchula, E. Reichert, T. E. Sackett, Z. Sylvain, and A. Webb. 2007. Should biomass be considered more frequently as a currency in terrestrial arthropod community analyses? *Journal of Applied Ecology.* 44(2): 330-339.

Sugai, L.S.M., T.S.F. Silvea, J.W. Ribeiro Jr., and D. Llusia. 2019. Terrestrial Passive Acoustic Monitoring: Review and Perspectives, *BioScience*. Volume 69, Issue 1, January 2019, Pages 15–25. Oxford University Press. https://doi.org/10.1093/biosci/biy147

SWCA (SWCA Environmental Consultants). 2010. Kahuku Wind Power Habitat Conservation Plan. Prepared for Kahuku Wind Power LLC. March 2010. Available at: https://dlnr.hawaii.gov/wildlife/files/2013/10/Kahuku-Wind-Power-HCP-FINAL-TEXT.pdf.

Taylor, D.A.R. and M. D. Tuttle. 2012. Water for Wildlife: A Handbook for Ranchers and Range Managers, Revised Edition. Bat Conservation International.

Tetra Tech (Tetra Tech, Inc.). 2019a. Kawailoa Wind Project Habitat Conservation Plan, FY 2018 Annual Report. Prepared for Kawailoa Wind, LLC. February 2019.

Tetra Tech. 2019b. Kawailoa Wind Power Final Habitat Conservation Plan Amendment. Prepared for Kawailoa Wind, LLC. Available at:

https://dlnr.hawaii.gov/wildlife/files/2021/03/Kawailoa-FINAL-HCP-Amendment-09042019.pdf.

Tetra Tech. 2019c. Auwahi Wind Farm Habitat Conservation Plan Final Amendment. Prepared for Auwahi Wind Energy, LLC. Available at: https://dlnr.hawaii.gov/wildlife/files/2020/01/Auwahi-Wind-HCP-Amendment-FINAL_7-29-2019-BLNR-Amendment.pdf.

Tetra Tech. 2020a. Kawailoa Wind Project Habitat Conservation Plan, FY 2020 Annual Report. Prepared for Kawailoa Wind, LLC. August 1, 2020. Available at: https://dlnr.hawaii.gov/wildlife/files/2021/01/Kawailoa-HCP-FY-2020-Annual-Report_083120_final.pdf.

Tetra Tech. 2020b. Kahuku Wind Power Habitat Conservation Plan Annual Report: FY 2020. Prepared for TerraForm Power. September 2020. Available at: https://dlnr.hawaii.gov/wildlife/files/2021/01/Kahuku-FY20-Report_Final.pdf.

Tetra Tech. 2021. Kawailoa Wind Project Habitat Conservation Plan, FY 2021 Annual Report. Prepared for Kawailoa Wind, LLC. December 13, 2021. Available at: https://dlnr.hawaii.gov/wildlife/files/2022/03/Kawailoa-HCP-FY2021Annual-Report_Revised13Dec2021.pdf.

Teixeira, D., M. Maron, and B.J. Rensburg. 2019. Bioacoustic monitoring of animal vocal behavior for conservation. *Conserv. Sci. Pract*. 1: e72. doi:10.1111/csp2.72.

Thorne, M. S., G. K. Fukumoto, and M. H. Stevenson. 2007. Foraging behavior and grazing management planning. University of Hawai‘i at Mānoa, College of Tropical Agriculture and Human Resources, in cooperation with the U.S. Department of Agriculture.

Todd, C.M. 2012. Effects of Prey Abundance on Seasonal Movements of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). MSc Thesis, University of Hawai‘i at Hilo, Hilo, Hawai‘i.

Todd, C. M., C. A. Pinzari, and F. J. Bonaccorso. 2016. Acoustic surveys of Hawaiian hoary bats in Kahikinui Forest Reserve and Nakula Natural Area Reserve on the island of Maui. Technical Report HCSU-078. Hawai‘i Cooperative Studies Unit, University of Hawa‘i at Hilo, Hilo, Hawai‘i. July 2016.

Toyama G. M. and J. K. Ikeda. 1976. An evaluation of fly breeding and fly parasites at animal farms on leeward and central O‘ahu. *Proceedings of the Hawaiian Entomological Society.* 22(2): 353-368.

USFWS (U.S. Fish and Wildlife Service). 2016. Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take. USFWS Pacific Islands Field Office. Honolulu, Hawai‘i. October 2016.

USFWS. 2021. 5-Year Status Review for ‘ōpe‘ape‘a or Hawaiian hoary bat. Interior Region 12/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i.

USFWS. 2022. Animal Avoidance and Minimization Measures. Available online at: https://www.fws.gov/media/animal-avoidance-and-minimization-measures. Accessed September 2022.

USFWS and NMFS (National Marine Fisheries Service). 2016. Habitat Conservation Planning and Incidental Take Permit Processing Handbook. December 2021. Available online at: https://www.fws.gov/media/habitat-conservation-planning-and-incidental-take-permit-processing-handbook

WEST (Western EcoSystems Technology, Inc.). 2021. Oahu Hawaiian Hoary Bat Occupancy and Distribution Study: Project Updates and Third Year Analysis. Prepared for the Hawaii Endangered Species Research Committee. May 28, 2021.

Whitaker, D., A. L. Carroll, and W. A. Montevecchi. 2000. Elevated numbers of flying insects and insectivorous birds in riparian buffer strips. *Canadian Journal of Zoology-revue Canadienne De Zoologie.* 78: 740-747.

Wildlife Acoustics. 2022. Song Meter SM4BAT FS Bioacoustic Recorder User Guide. Available online at: https://www.wildlifeacoustics.com/uploads/user-guides/SM4-BAT-FS-USER-GUIDE-EN20220923.pdf

Appendix A.

Kahuku Wind Project Fence Assessment Report

Prepared for:
Kahuku Wind Power LLC.

Prepared by:

TETRA TECH

September 2023

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1.0 Introduction

The Kahuku Wind Project (Project) Hawaiian Hoary Bat Tier 2 Mitigation Plan (Mitigation Plan) is designed to improve Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*) roosting and foraging habitat at the Helemano Mitigation Area (HMA). The HMA consists of four parcels enclosed and separated by 4.5 miles (23,740 feet) of fencing (Figure 1), most of which is barbed wire. This type of fence wire poses some risk to bats in the form of injury and mortality, including the Hawaiian hoary bat (ESRC and DOFAW 2021). The purpose of this memorandum is to describe the amount of vegetation cover at the fence line, assess the risk the fence line poses to Hawaiian hoary bat, and the process by which this risk will be addressed in the Mitigation Plan.

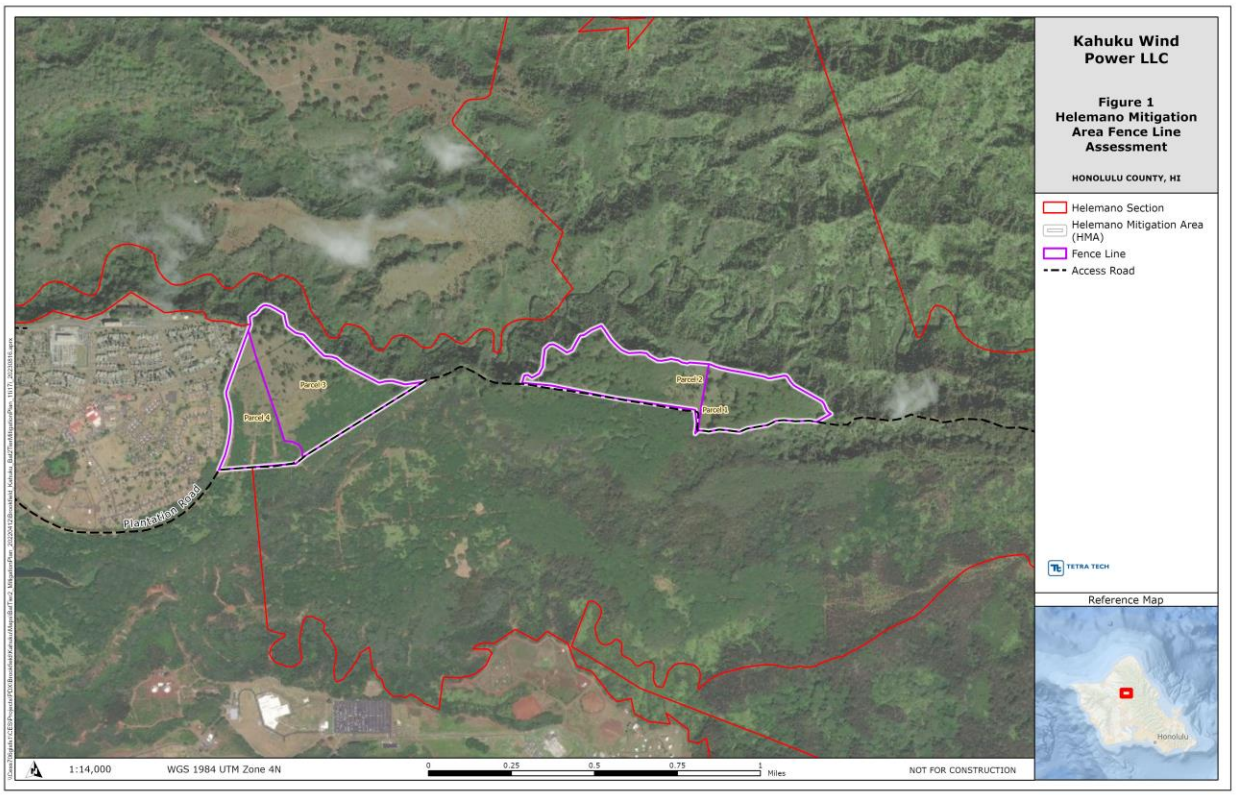

Figure 1. Helemano Mitigation Area Fence Line Assessment

2.0 Methods

To document the current condition of the HMA fence line, the entire fence line of the HMA, inclusive of the perimeter and inter-parcel fence lines, was surveyed in March 2023. Using six risk level categories developed in conjunction with Tetra Tech's Hawaiian hoary bat expert, Christop Todd, the fence was assessed for its degree of concealment by vegetation. Barbed wire fences that are covered in vegetation are unlikely to injure or kill bats due to vegetative concealment and

subsequent avoidance of the vegetated area. The risk levels range from no risk, in which all wire levels are completely enclosed by vegetation, to the highest risk level, where all wire levels are completely visible and the surrounding habitat is open (Table 1). The survey was performed on foot by Tetra Tech staff; representative photos were taken to illustrate the six risk level categories (Attachment 1).

Table 1. Risk Level Categories

Risk Level	Definition
No risk (0)	Fence does not contain barbed wire or fence is completely enclosed in vegetation
Lowest risk (1)	Partial exposure of a single row of barbed wire < 2 feet, barbed wire exposure is completely closed on one side, surrounding habitat is closed or heavily cluttered and dense
Low risk (2)	One to two rows of barbed wire exposure, lengths of exposure are ≤ 5 feet, surrounding habitat is cluttered
Medium risk (3)	Three to five rows of barbed wire exposure, length of exposure is ≥ 5 feet, vegetation barrier is present (< 2 feet from fence line) along one side of exposed fence line, surrounding habitat is partially open with moderate clutter on one side of the fence only
Higher risk (4)	One to three rows of barbed wire exposure ≥ 5 feet, vegetation may be present at fence line, surrounding habitat is mostly open on both sides of the fence with some partial clutter
Highest risk (5)	All rows of barbed wire fence are exposed for ≥ 5 feet, surrounding habitat is open and uncluttered on both sides of the fence

3.0 Results

The field survey documented that most of the fence line poses an extremely low risk to Hawaiian hoary bat. A total of 85.6% was assessed at the lowest risk level or below, with 65.1% assessed as having no risk to bats (Table 1). The remaining 14.4% of fencing has a medium to highest risk level to Hawaiian hoary bat (Table 1, Figure 2).

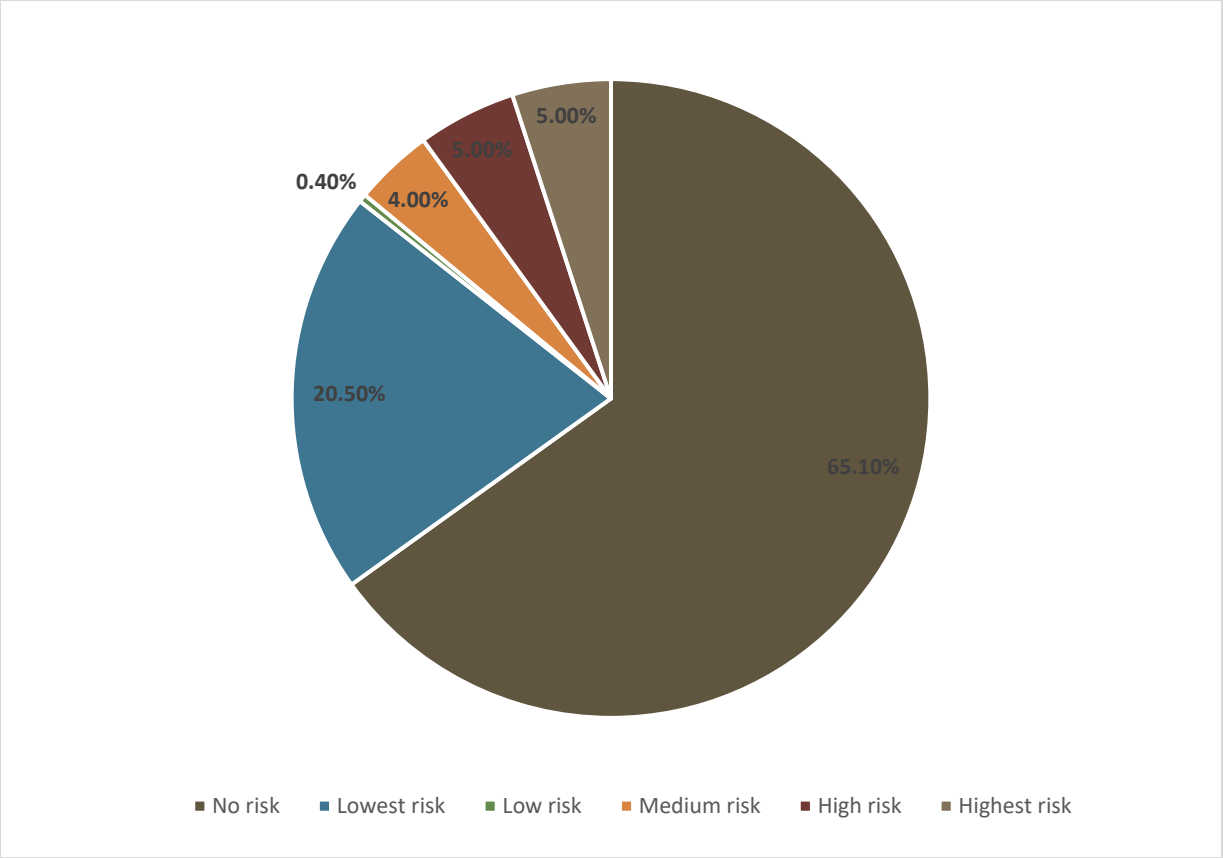

Figure 2. Total fence line risk to Hawaiian hoary bat by risk level

The parcel-specific data identifies which of the four parcels in the HMA (Figure 1) have the greatest length[1] of high-risk fence line, and which has the fewest (Table 1). Parcel 1 has the least risk to Hawaiian hoary bats with 94% of the fence line assessed as having either the lowest risk (2,347 feet, 45%) or no risk (2,155 feet, 49%). Parcel 3 also primarily consists of low (601 feet, 15%) or no risk (2,500 feet, 62.3%) fence line spans, together totaling 77.2%. Both Parcels 1 and 3 have no fence line spans in the highest risk category. Parcel 2 contains 984 feet of the highest risk fence line spans, which is the greatest amount across all four parcels, but still amounts to only 12.3% of the total fence line spans in that parcel. Parcel 4 primarily fell within the no risk (82.7%) or low risk (13.7%) categories, but 3.3% was assessed as the highest risk category (Table 1).

Table 2. Parcel Risk Level Assessment

Risk Level		**Parcel**				**Total**
		1	**2**	**3**	**4**	
No risk (0)	Distance in feet	2,347	4,634	2,500	5,970	**15,450**
	Percent	48.9%	60.1%	62.3%	82.7%	**65.1%**

[1] The total fence line length is non-contiguous.

Risk Level		Parcel				Total
		1	2	3	4	
Lowest risk (1)	Distance in feet	2,155	1,117	601	993	**4,865**
	Percent	44.9%	14.5%	15%	13.7%	**20.5**%
Low risk (2)	Distance in feet	--	43	63	--	**107**
	Percent	--	0.6%	1.6%	--	**0.4**%
Medium risk (3)	Distance in feet	156	616	156	10	**938**
	Percent	3.2%	8%	3.9%	0.1%	**4**%
Higher risk (4)	Distance in feet	141	346	695	14	**1,196**
	Percent	2.9%	4.5%	17.3%	0.2%	**5**%
Highest risk (5)	Distance in feet	--	948	--	236	**1,184**
	Percent	--	12.3%	--	3.3%	**5**%
Total (feet)		**4,799**	**7,705**	**4,015**	**7,222**	**23,740**

4.0 Discussion

This assessment demonstrates that the barbed wire fence currently presents a minimal threat to Hawaiian hoary bat in the HMA. As stated above, more than 75% of the total fence line length was assessed as the lowest risk level or no risk level (Figure 1). These baseline risk levels are not expected to change significantly during the implementation of the Mitigation Plan given the short duration (5 years) and the fact that vegetation management is not expected to affect vegetation along the fence line. The risk levels are based not only on vegetation present along the immediate fence line, but also consider the density of vegetation in the vicinity of the fence line (Table 1). That is, vegetation density along both the fence line and in the surrounding area would have to be significantly altered for the baseline risk level to increase from low to high. Additionally, consideration has been given to the potential to increase risk of exposure to the Hawaiian hoary bat due to the vegetation clearing that would be necessary to remove and replace barbed wire from the current fence line.

Given all these factors, regular management of the fence line throughout the life of the Mitigation Plan is not expected to be necessary since the overall risk to Hawaiian hoary bat is low. Instead, the barbed wire fence will be monitored monthly through visual inspection, as described in the Mitigation Plan. Vegetation increases or decreases along the fence line will be tracked and adaptive management will be triggered if the total feet of high or higher risk level (i.e., levels 4 or 5) fencing doubles during implementation of the Mitigation Plan. This means that the total feet of high to

higher risk level fence line would need to increase 20%, as compared to the baseline amount of 10%, for adaptive management to be triggered. Although 20% is arbitrary, it is a low enough limit that it will serve as a checkpoint to ensure that greater amounts of fence line do not become exposed that could potentially have a more significant effect on Hawaiian hoary bat. The adaptive management response, as described in the Mitigation Plan, is to replace the top two barbed wire levels with smooth high-tensile wire.

5.0 References

ESRC (Endangered Species Recovery Committee) and DLNR DOFAW (Department of Land and Natural Resources Division of Forestry and Wildlife). 2021. Hawaiian Hoary Bat Guidance for Wind Energy Projects. https://dlnr.hawaii.gov/wildlife/files/2021/01/Draft-Hawaiian

Appendix 1. Fence Line Risk Level Photo Documentation

Risk Level 0: No risk

Risk Level 0: No risk

Risk Level 1: Lowest risk

Risk Level 1: Lowest risk

Risk Level 1: Lowest risk

Risk Level 2: Low risk

Risk Level 2: Low risk

Risk Level 3: Medium risk

Risk Level 3: Medium risk

Risk Level 3: Medium risk

Risk Level 4: High risk

Risk Level 4: High risk

Risk Level 5: Highest risk

Risk Level 5: Highest risk

Risk Level 5: Highest risk