AUWAHI WIND FARM
HABITAT CONSERVATION PLAN

Final Amendment

Prepared for

Auwahi Wind

Auwahi Wind Energy LLC

Prepared by

TETRA TECH

July 2019

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

AIC	Akaike information criterion
asl	above sea level
Auwahi Wind	Auwahi Wind Energy LLC
BCI	Bat Conservation International
CUA	core use area
DLNR	Hawai'i Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
EoA	Evidence of Absence
ESA	Endangered Species Act
ESRC	Endangered Species Recovery Committee
ESRC Bat Guidance	ESRC Hawaiian Hoary Bat Guidance Document 2015
GIRAS	State of Hawaii Geographic Information Retrieval and Analysis System
GIS	geographic information system
HCP	Habitat Conservation Plan
HECO	Hawaiian Electric Company
HILT	Hawaiian Islands Land Trust
HRS	Hawai'i Revised Statute
ITL	incidental take license
ITP	incidental take permit
km	kilometer
kV	kilovolt
LOC	letter of credit
LWSC	low wind speed curtailment
m	meter(s)
m/s	meters/second
MECO	Maui Electric Company
Mitigation Area	Auwahi Wind's Hawaiian hoary bat Tier 4 Mitigation Area, located on 1,752 acres of Leeward Haleakalā, on Ranch land
MW	megawatt
NAR	Natural Area Reserve
PCMP	post-construction monitoring plan
PPA	power purchase agreement

Project	Auwahi Wind Farm
Ranch	Ulupalakua Ranch
RPM	rotation per minute
SSMIP	Site-Specific Mitigation Implementation Plan
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WTG	wind turbine generator

1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 INTRODUCTION

Auwahi Wind Energy LLC (Auwahi Wind) was issued an incidental take permit (ITP) from the U.S. Fish and Wildlife Service (USFWS), and an incidental take license (ITL) from the Hawai'i Department of Land and Natural Resources (DLNR) Division of Forestry and Wildlife (DOFAW), for the Auwahi Wind Farm (Project) on February 24 and February 9, 2012, respectively. The ITP/ITL and associated Habitat Conservation Plan (HCP; Auwahi Wind 2012) provide coverage for incidental take of four species listed under the federal Endangered Species Act (ESA) and State of Hawai'i endangered species statutes that have the potential to be impacted by the Project, including ʻōpeʻapeʻa or Hawaiian hoary bat (*Lasiurus cinereus semotus*), the ʻuaʻu or Hawaiian petrel (*Pterodroma sandwichensis*), nēnē or Hawaiian goose (*Branta sandvicensis*), and the Blackburn's sphinx moth (*Manduca blackburni*). The ITP and ITL each have a term of 25 years and are effective through 2037.

The Project, which began commercial operation on December 28, 2012, is located on eastern Maui, Hawai'i, on Ulupalakua Ranch (Ranch). The Project consists of eight Siemens 3-megawatt (MW) wind turbines, augmented with an 11-MW battery storage system. Ancillary facilities include an underground electrical collection system, an operations and maintenance facility, an approximately 9-mile 34.5-kilovolt (kV) above-ground generator-tie line, and an interconnection substation (Figures 1-1 and 1-2). The planned operational period of the Project is from 2012-2032, 20 years of the 25-year permit term. In 2032, Auwahi Wind may consider extending the operational life of the Project for the remaining 5 years of the permit term through a new or revised power purchase agreement (PPA).

Auwahi Wind has prepared this HCP Amendment to support a request for an increase in the amount of take of the Hawaiian hoary bat that is authorized under the ITP/ITL. The current amount of authorized take for the Hawaiian hoary bat is 21 bats, an estimate that was based on the best available information at the time the ITP/ITL was issued (see Section 2.0). However, during the first 5 years of Project operation, Hawaiian hoary bat take has been higher than anticipated, and modeled estimations of take indicate that the Project has exceeded the currently authorized take limit, even with the implementation of additional, voluntary avoidance and minimization measures.

In 2015, Auwahi Wind initiated consultation with USFWS and DOFAW with the goal of preparing and receiving approval of an HCP Amendment (see Section 2.0) before the Project approached the currently authorized take limit. While not required under the approved HCP, Auwahi Wind concurrently initiated voluntary low wind speed curtailment (LWSC) with a 5.0 meter per second (m/s) cut-in speed, year-round, at the Project in 2015 to reduce the risk to bats. In 2018, the Project further increased the cut-in speed to 6.9 m/s from August through October as an additional minimization measure. The requested total bat take authorization for this amendment is 140 bats (119 in addition to the 21 authorized in the approved HCP). The amendment separates the requested take into three cumulative tiers of take (Tiers 4, 5, and 6) of 81, 115, and 140 bats, respectively. Discussion of tiers (including the biological justification) can be found in Section 5.1. Auwahi Wind has identified additional minimization measures to be implemented as well as compensatory mitigation, as appropriate. Mitigation and associated adaptive management for these tiers is outlined in Section 6.2. Adaptive management of minimization measures associated with take can be found in Section 7.4.

The biological goals from the approved HCP are still applicable for the HCP Amendment. Biological goals are intended to be broad, guiding principles that clarify the purpose and direction of the HCP (USFWS and NMFS 2016). The goals of the approved HCP are to:

- Avoid, minimize, and mitigate the potential effects on the Covered Species associated with the construction and operation of the Project;
- Increase the knowledge and understanding of the occurrence and behavior of the Covered Species in the Project vicinity;
- Adhere to the goals of the recovery plans for each of the Covered Species; and
- Provide a net conservation benefit to each of the Covered Species.

Additionally, the biological goals of this HCP Amendment are to:

- Minimize impacts to the Hawaiian hoary bat to the maximum extent practicable in the Project area; and
- Mitigate remaining impacts to fully offset impacts and provide a net benefit to the Hawaiian hoary bat by protecting, enhancing and/or managing Hawaiian hoary bat foraging and/or roosting habitat.

Avoidance, minimization, and mitigation measures that will be used to achieve these goals and associated objectives are described in the subsequent sections of this HCP Amendment (Sections 4.1, 6.2, and 7.4).

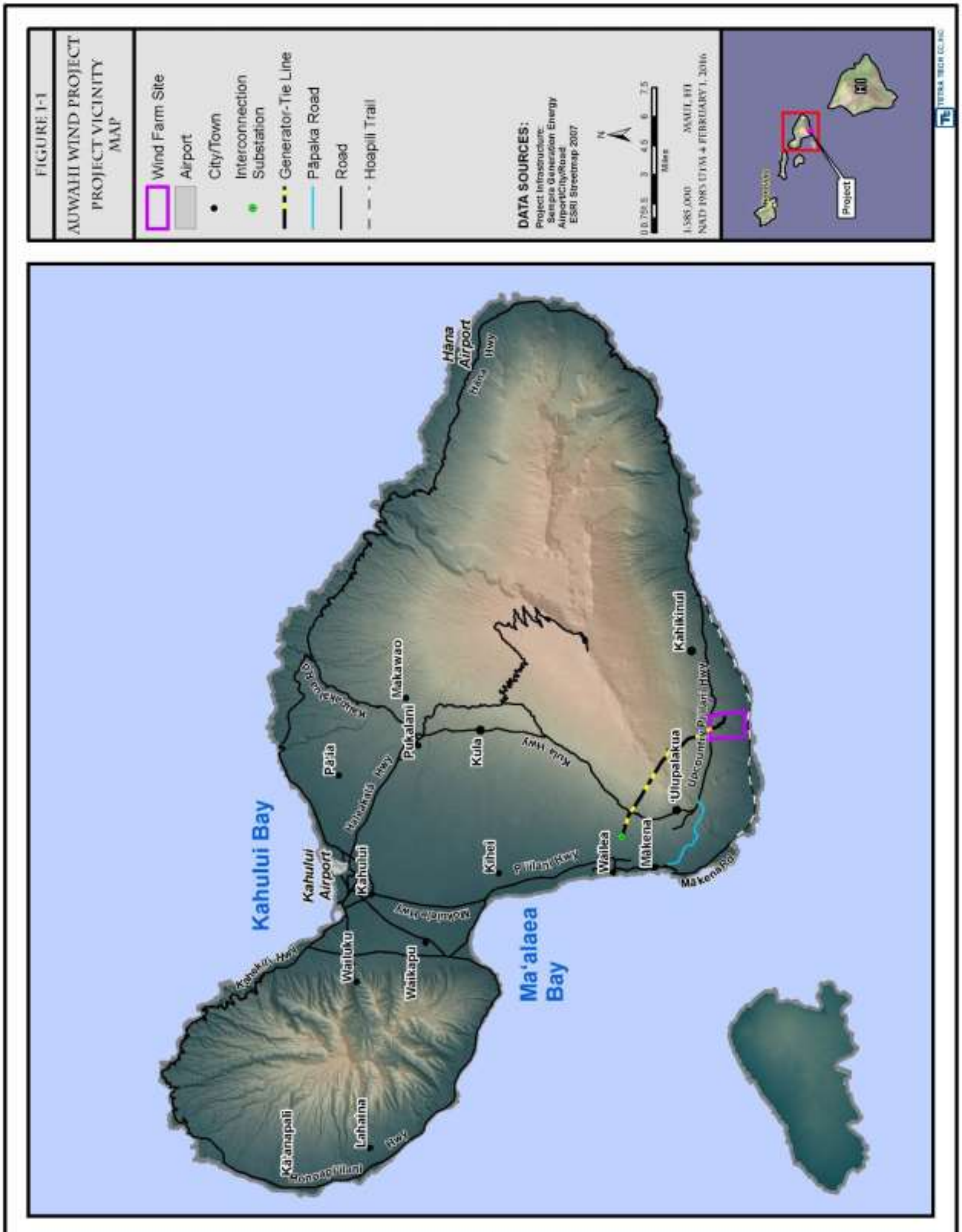


Figure 1-1. Project Vicinity Map

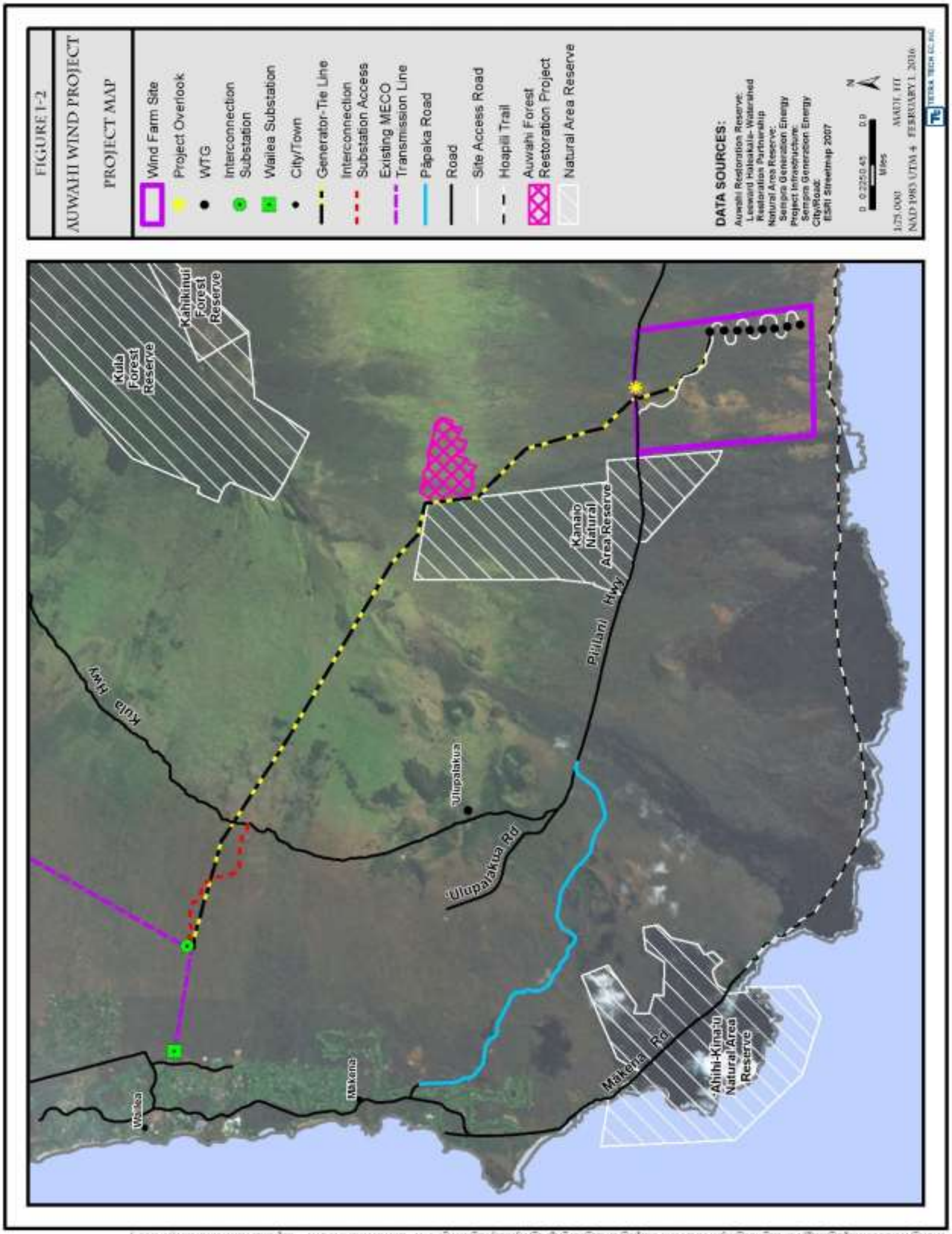


Figure 1-2. Project Map

This Amendment:

1. Describes biological goals and objectives for the Hawaiian hoary bat (Section 4.1);
2. Describes additional measures to avoid and minimize Hawaiian hoary bat take (Section 4.2);
3. Provides an updated estimate of total Project-related Hawaiian hoary bat take, projected over the remainder of the permit term based on results of Project-specific post-construction mortality monitoring (Section 5.1);
4. Presents the request for additional authorized take of Hawaiian hoary bats (Section 5.1);
5. Identifies associated additional compensatory mitigation (Section 6.2); and
6. Presents a long-term post-construction monitoring plan (PCMP; Section 7.1 and Appendix E).

New information regarding Hawaiian hoary bat ecology, distribution, and mortality that has become available since the preparation of the approved HCP has also been incorporated to support the HCP Amendment.

This document is intended as a supplement to the approved HCP. For ease of use, this document uses the same general section organization as the approved HCP, and where appropriate, individual sections from the approved HCP are updated in this document. Sections not requiring updates for this HCP Amendment are identified by the following text after the section heading: "This section requires no edits for the HCP Amendment." The approved HCP should be referenced in these cases. The original, approved HCP can be viewed and downloaded online at: http://dlnr.hawaii.gov/wildlife/files/2013/10/Auwahi-Wind-Farm-FINAL-HCP-1-24-12-R1.pdf.

1.2 Applicant Information

The applicant for this HCP Amendment is Auwahi Wind Energy LLC, a joint venture between AEP Renewables, LLC (AEP) and BP Wind Energy North America Inc. The Project is operated by AEP.

1.3 Project Description

The Project is as described in Section 1.3 of the approved HCP[1]. No physical changes to the Project facilities, or additional development is proposed under the HCP Amendment. Changes in operations of the Project associated with avoidance and minimization measures are outlined in Section 4.2.4.

[1] Section 1.1 of the approved HCP stated that the Project wind turbine generators (WTG) would have a net generating capacity of 21 MW and were expected to be curtailed at night on a regular basis based on expected Maui Electric Company (MECO) demands. Subsequently, MECO implemented a dispatch process that optimizes use of renewable energy generators, such that the Project is routinely operated at night. Each of the eight wind turbine generators is capable of generating up to 3 MW. However, even if the Project generated the full 24 MW, there is no increased risk to wildlife because the rotations per minute (RPMs) of the turbine blades are the same at 3 MW as at 2.6 MW.

The Tax Map Key (property lot identification in Hawai'i) for the HCP Amendment is (2) 1-9-001:006.

1.4 Regulatory Framework and Relationship to Other Plans, Policies, and Laws

This section requires no edits for the HCP Amendment.

2.0 DESCRIPTION OF THE HABITAT CONSERVATION PLAN

2.1 PURPOSE AND NEED FOR THE HCP

The purpose and need for the HCP Amendment is to address impacts to the Hawaiian hoary bat beyond those authorized under the existing ITP/ITL, and to request the authorization of additional incidental take for the Hawaiian hoary bat. The HCP Amendment identifies appropriate minimization measures, mitigation actions, adaptive management strategies, and monitoring requirements associated with the requested additional take. The approved HCP and the HCP Amendment both respond to the need for authorization of incidental take of listed species associated with the Project, pursuant to the ESA and Hawai'i Revised Statutes (HRS) Chapter 195D, and the need for measures to minimize and mitigate these impacts to the maximum extent practicable. The ITP/ITL application requires development of an HCP that ensures the continued existence of, and aids in the recovery of the Hawaiian hoary bat while allowing for incidental take of the species during Project operation.

Take of Hawaiian hoary bats at the Project has been higher than anticipated under the approved HCP, in part because risk to bats associated with wind energy development in Hawai'i was largely unknown and underestimated at the time the HCP was approved. Additionally, a significant amount of data has been collected that is now available to support statistical projections of future fatality rates. When the approved HCP was prepared, post-construction mortality monitoring data from Hawai'i wind farms were limited. Estimates of take were based on the best available surrogate information, such as preliminary monitoring data from one operating wind farm in Hawai'i and general comparisons of bat acoustic activity among sites, which now are shown to have underestimated collision risk for bats. Advancements in acoustic monitoring and thermography have shown that prior population estimates under-reported the abundance of the Hawaiian hoary bat (Gorresen et al. 2017). Since the development of the approved HCP, USFWS and DOFAW have adopted a more conservative standard for estimating bat take (e.g., Evidence of Absence [EoA] statistical software; see Section 5.0), which is also now used to evaluate HCP compliance. This software enables the incorporation of fatality data from previous years, or informed assumptions in the absence of such data, to model fatality rates over time, accounting for both observed and unobserved take. The model is conservative in that it does not produce a point estimate of a number of fatalities, but enables the identification of a range of fatality estimates with an upper limit defined by a user-selected confidence threshold (see Section 5.0, Appendix H).

The HCP Amendment employs the EoA statistical software and Project-specific post-construction mortality monitoring data (see Section 5.0, Appendix H), which improves the understanding of inter-annual variability in fatality rates and other Project-specific uncertainties. Thus, this HCP Amendment is anticipated to more accurately estimate the range of Hawaiian hoary bat take over the remaining years of Project operation, and better matches the current approach taken by USFWS and

DOFAW to assess ITP/ITL compliance, as compared to the approved HCP. See Appendix E for details associated with long-term post-construction mortality monitoring and compliance.

2.2 Scope and Term

The HCP Amendment does not propose any changes to the scope of the approved HCP (all areas where construction and operation of the Project and associated facilities have the potential to affect the Covered Species), or to the original permit term of 25 years (2012 – 2037).

2.3 Survey and Resources

The following resources were used during the preparation of the HCP Amendment:

- Data from Project operations (2012 – 2017);
- Results from post-construction mortality monitoring surveys (2013 – 2017);
- Acoustic bat monitoring surveys using Wildlife Acoustics monitors (July 2013 – December 2015);
- EoA fatality modeling software (version 2.0, Dalthorp et al. 2017); and
- The Endangered Species Recovery Committee (ESRC) Hawaiian Hoary Bat Guidance Document (ESRC Bat Guidance; DOFAW 2015) and subsequent verbal and written guidance and recommendations provided by USFWS and DOFAW.

3.0 ENVIRONMENTAL SETTING

3.1 REGIONAL LOCATION

This section requires no edits for the HCP Amendment.

3.2 LAND USE

This section requires no edits for the HCP Amendment.

3.3 TOPOGRAPHY AND GEOLOGY

This section requires no edits for the HCP Amendment.

3.4 SOILS

This section requires no edits for the HCP Amendment.

3.5 HYDROLOGY AND WATER RESOURCES

This section requires no edits for the HCP Amendment.

3.6 TERRESTRIAL FLORA

This section requires no edits for the HCP Amendment.

3.7 NON-LISTED WILDLIFE

This section requires no edits for the HCP Amendment.

3.8 LISTED WILDLIFE

This section requires no edits for the HCP Amendment except as provided in the subsections below.

3.8.1 Hawaiian Hoary Bat

3.8.1.1 Distribution, Population Estimates, and Ecology

The Hawaiian hoary bat is the only fully terrestrial, native mammal in the Hawaiian Islands. Recent studies and ongoing research have shown that bats have an extensive distribution across the islands (Bonaccorso et al. 2015, Gorresen et al. 2013, H.T. Harvey and Associates 2019, Starcevich et al. 2019) and breeding populations are known to occur on all of the main Hawaiian Islands except Ni’ihau and Kaho’olawe (Bonaccorso et al. 2015). Numerous research studies have been conducted on the Hawaiian hoary bat in the last decade. The bat has been detected broadly across the State and on Maui specifically. The most current studies of the Hawaiian hoary bat population come from occupancy modeling on Hawai’i Island from 2007 – 2011, which show the population of the Hawaiian hoary bat is “stable to increasing” (Gorresen et al. 2013). Documented occurrences of the

Hawaiian hoary bat from monitoring at wind farms, associated mitigation sites, and research show that the bat is more widespread and abundant than the estimate provided in the 1998 USFWS Hawaiian hoary bat recovery plan (Auwahi Wind 2017, Kaheawa Wind Power 2017, Kaheawa Wind Power II 2017, Gorresen et al. 2013, Bonaccorso et al. 2015, HT Harvey 2019).

The Hawaiian hoary bat has been observed in a variety of habitats, including open pastures and more heavily forested areas, and in both native and non-native habitats (DLNR 2015, Gorresen et al. 2013). In addition to utilizing undeveloped areas, foraging and roosting has been documented in a variety of developed areas (golf courses, urban, suburban, rural, military and industrial) on O'ahu, Maui, Kaua'i, and Hawai'i Island (Kawailoa Wind Power 2014, Jacobs 1994, USFWS 1998). Typically, this species feeds over streams, bays, along the coast, over lava flows, or at forest edges. Hawaiian hoary bats have also been documented using forest gaps and clearings, forest edges, along roads, and along hedgerows for foraging (Bonaccorso et al. 2015).

Gorresen et al. (2013) found that Hawaiian hoary bats concentrated in the lowlands during the breeding season on Hawai'i Island, and migrated to interior highlands during the non-breeding season. Limited data suggest breeding may primarily occur at lower elevations, at 3,300 feet (1,000 meters [m]) above sea level (asl) or lower; however, a pregnant female was captured in June 2017 above 5,000 feet asl (DOFAW 2015; Corinna Pinzari, USGS, personal communication).

Hawaiian hoary bats are found in both wet and dry areas from sea level to 13,000 feet asl, with most observations occurring below 7,500 feet. Although the Hawaiian hoary bat may occasionally disperse between islands and demonstrate seasonal movement within topographical gradients on the islands, long-distance migration like that of the mainland hoary bat is not documented (USFWS 1998). Seasonal and altitudinal differences in bat activity have been suggested (Menard 2001). Hawaiian hoary bats can range among habitats and elevations within a single night to target optimal local foraging opportunities (Gorresen et al. 2013, 2015. Bonaccorso et al. 2016).

Roosting Habitat

Hawaiian hoary bats are known to have solitary day roosts in tree foliage, and have only rarely been seen exiting lava tubes, leaving cracks in rock walls, or hanging from human-made structures. Foliage roosting has been documented in hala (*Pandanus tectorus*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), pūkiawe (*Styphelia tameiameiae*), Java plum (*Syzygium cumini*), kiawe, avocado (*Persea americana*), shower trees (*Cassie javanica*), ʻōhiʻa trees (*Meterosideros polymorpha*), fern clumps, ironwood (*Casuarina equisetifolia*), macadamia (Macadamia spp.), and mature eucalyptus (*Eucalyptus* spp.) plantations; they are also suspected to roost in Sugi pine (*Cyrptomeria japonica*) stands (USFWS 1998; DLNR 2005, Gorresen et al. 2013, Kawailoa Wind Power 2013). Hawaiian hoary bats have also been observed using night roosts to rest after foraging or seek shelter from rain (Todd 2012). Generally, bats are thought to use night roosts to serve several potential functions for bats: energy conservation, digestion, predator avoidance, information transfer, and social interactions (Kunz 1982). The selection criteria of bats in general for night roosts is not well documented, but proximity to foraging grounds is suggested to be an important criterion (Knight 2009).

Breeding

Breeding activity takes place between April and August, with pregnancy and the birth of two young (occasionally one) occurring from April to June (Bogan 1972). Based on the data available, USFWS estimates the Hawaiian hoary bat reproductive rate to be 0.54 offspring per female surviving to adulthood (USFWS 2016a). Until weaning at 3 months of age, the young are completely dependent on the female for survival. Lactating females have been documented from June to August, and post-lactating females have been documented from September to December (Menard 2001). USFWS and DOFAW have interpreted this as female Hawaiian hoary bats potentially having dependent young from April 1 – September 15 (USFWS and DOFAW 2016). The lifespan of the Hawaiian hoary bat has been estimated to be a minimum of 4 years (Bonaccorso 2016) and a maximum of 10 years (DOFAW 2015).

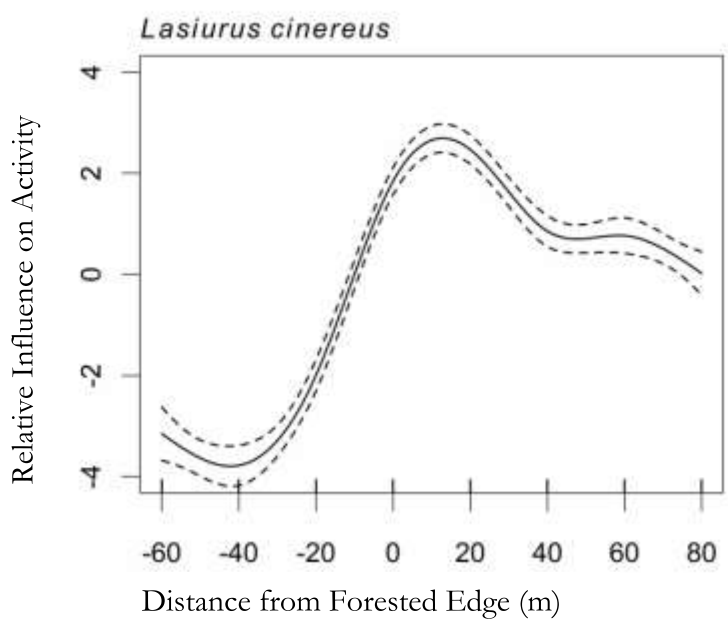
Foraging Habitat and Diet

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

Water provides an essential habitat component for foraging, reproductive, and basic physiological requirements for bat species. All bats, with the exception of a few frugivorous or nectivorous bats, drink water (van Helverson and Reyer 1984). Water sources have been shown to increase Hawaiian hoary bat activity relative to surrounding habitats (SWCA 2011). Mainland and Hawaiian hoary bats have been documented at artificial water sources such as reservoirs (Jackrel and Matlack 2010, Vindigni et al. 2009, Uyehara and Wiles 2009). Hawaiian hoary bats have been captured foraging for moths over open water (Todd 2012, USFWS 1998). Additionally, bat use of natural and artificial water sources as foraging substrates is well documented on the mainland and in Europe (Brooks and Ford 2005, Heim et al. 2018, Vindigni et al. 2009), specifically drinking from water troughs in arid regions of the mainland United States (Jackrel and Matlack 2010, Tuttle et al. 2006, Vindigni et al. 2009).

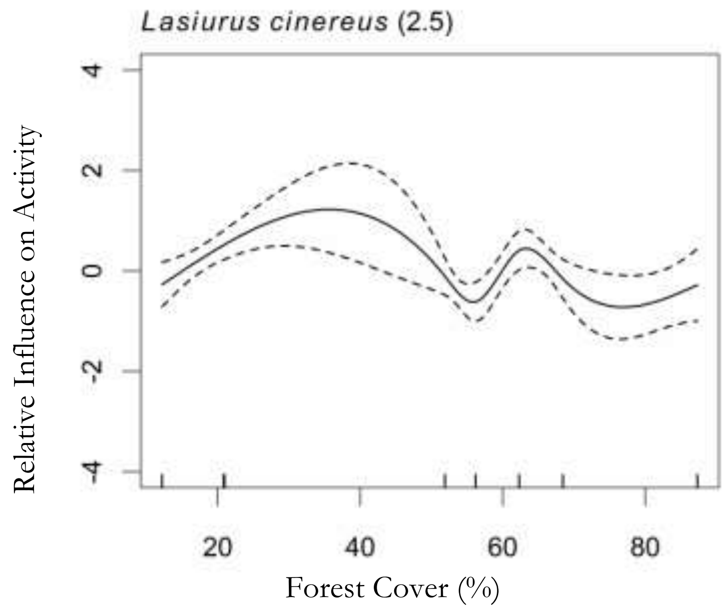
The Hawaiian hoary bat feeds primarily in edge and open habitats, which is supported by call structure, wing shape, and behavioral observations. Hawaiian hoary bats weigh about 45 percent less than mainland hoary bats, which are open area foragers (Fenton 1990), and this smaller body mass leads to lower wing loading and an increased aptitude for flying in both open and more cluttered environments (Jacobs 1996), such as edge habitats. Hawaiian hoary bats also use high-intensity echolocation calls with a mix of narrow and broadband components, which is consistent with forest edge habitat foraging behavior. Edge habitats in general provide efficient foraging habitat that minimizes commuting energy costs and maximizes foraging opportunities (Grindal and Brigham 1999). Edge habitats also provide benefits to some insect species (Langhans and Tockner 2014), as well as providing shelter where insects congregate and where bat foraging activity increases (Grindal and Brigham 1999).

Additional information on the use of edge habitat by mainland hoary bats is expected to be relevant to the Hawaiian hoary bat. Research on mainland hoary bats has evaluated the habitat density and distance from forest habitats that are correlated with higher use rates by bat species (Jantzen 2012). For mainland hoary bats, increased activity was recorded out to 262 feet from forest edges (Figure 3-1). In addition to looking at bat activity at varying distances from edge habitats, this research also included a geographic information system (GIS) analysis of the habitat at varying spatial scales to assess how the percent of forest cover influenced bat activity. At the 0.9-mile and the 1.5-mile spatial scale, a bimodal distribution with statistically significant peaks of activity were noted from 20 to 25 percent forest cover and at 70 percent forest cover. The data from the 1.5-mile spatial scale suggest increased activity up to 40 percent forest cover (Figure 3-2).



Source: Jantzen 2012, reproduced with permission

Figure 3-1. Relative Bat Activity Compared to the Distance from a Forest Edge

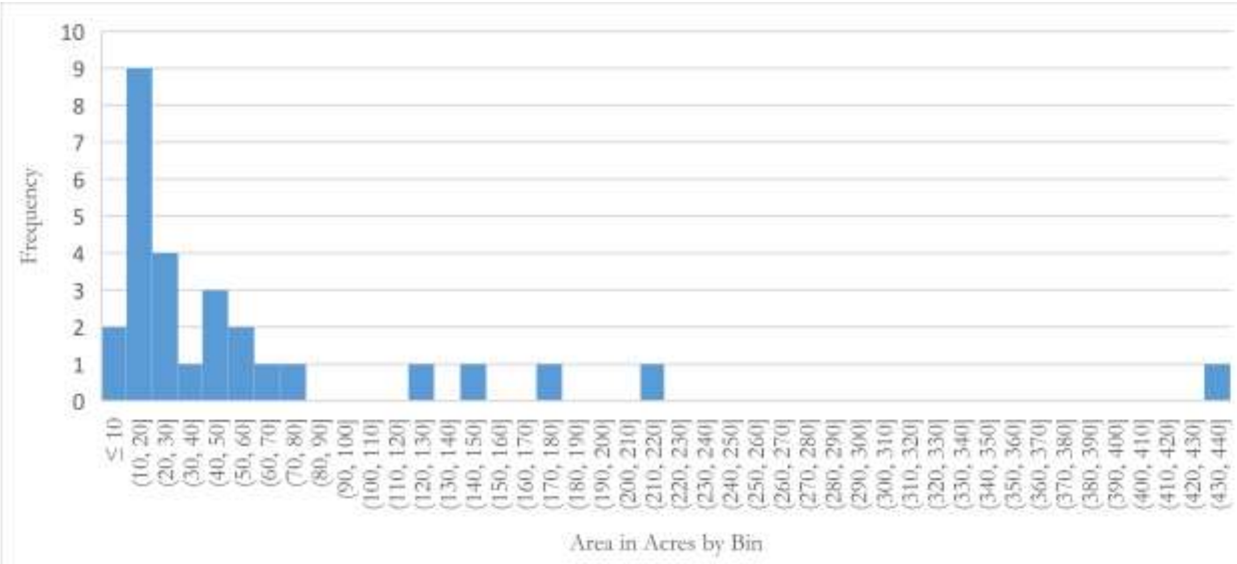


Source: Jantzen 2012, reproduced with permission

Figure 3-2. Hoary Bat Activity Relative to the Forest Density at the 1.5-mile Spatial Scale

A Hawaiian hoary bat's foraging range contains the area used by an individual bat foraging for food and movements to and from day roosts and night roosts. The Hawaiian hoary bat foraging range on Hawai'i Island in late spring, summer, and fall was moderately large (mean of 570.1 ± 178.7 acres [230.7 ± 72.3 hectares]), but foraging activity within this range was concentrated within small core use areas (CUA; 11.1 percent of mean foraging range; Bonaccorso et al. 2015). The term CUA is defined as areas within the foraging range that have very intensive use. Although this study reports no overlap in adult male CUA, overlap is documented in the CUA of sub-adults and the larger foraging ranges. Additionally, multiple bats have been observed to use the same resources, such as the 11 bats captured and tagged near the Pu'u Makua mitigation site (Auwahi Wind 2017). Thus, individual male Hawaiian hoary bats may have overlapping foraging ranges, but appear to have almost no overlap in CUA. This lack of overlap is supported by behavioral studies in which antagonistic interactions have been documented between individuals (Belwood and Fullard 1984). The median CUA of 20.3 acres is reported by DOFAW (DOFAW 2015) and the size of core use areas is illustrated in Figure 3-3. Variation in CUA size may depend on age, habitat suitability, and foraging efficiency (Bonaccorso et al. 2015, Pinzari 2014). Data from Bonnocorso et al. (2015) suggests that although there is variability in the size of CUAs[2], subadults tend to use larger core use areas than adults.

[2] In January 2019, HT Harvey presented preliminary research to the ESRC (HT Harvey 2019). The study showed bats have a broad distribution across the area surveyed. Preliminary findings from 5 bats tracked for 5 nights suggest "Bats regularly forage over a large area 2967 acres". The final report and methods for this study are not yet available.



Source: Bonaccorso et al. 2015

Figure 3-3. Histogram of Core Use Area Sizes (acres) Binned by 10 acres

Population

Literature Review

As previously identified, neither a state-wide nor an island-wide population estimate has been derived for the Hawaiian hoary bat. Current studies are working toward collecting the empirical information to be able to provide more of a statewide estimate and suggest the Hawaiian hoary bat has a relatively large population statewide and on Maui. The Hawaiian hoary bat has been detected broadly statewide and across Maui in many habitats. In most of the locations where people have made efforts to detect the Hawaiian hoary bat, they have been documented. The life history traits known for the bat suggest it is a species resilient to environmental changes. Occupancy models and genetic studies have been, and continue to be, conducted to attempt to determine population indices and effective population sizes; effective population does not necessarily equate to actual population size (Gorresen 2008, Gorresen et al. 2013). Thus, using the best available information for the bat, an estimate of an overall population range for Maui can be derived that takes into consideration land cover and occupancy in addition to use of proxy assumptions. This section describes in more detail the parameters considered for this exercise to model a population range for Maui.

The life history characteristics known for the Hawaiian hoary bat provide indicators that the population would be expected to be widespread, abundant, and resilient to change:

- The ability of the Hawaiian hoary bat to fly long distances to utilize resources;
- The utilization of a variety of tree species for roosting;
- The ability to forage in a variety of habitats;
- The utilization of a wide elevational gradient for foraging and roosting;

- The consumption of a broad array of insect species and ability to change diet species with prey availability; and,
- The high capacity for reproductive output.

Occupancy is the proportion of an area occupied by a species or fraction of landscape units where the species is present, and can be used to estimate trends (MacKenzie et al 2019). The most current studies of the Hawaiian hoary bat population come from occupancy modeling on Hawai'i Island from 2007 – 2012, which show the population of the Hawaiian hoary bat is "stable to increasing" (Gorresen et al. 2013). On Hawai'i island mean occupancy of all survey areas for all times of year was 0.63. Preliminary results from an occupancy study underway island wide on the island of O'ahu found an initial occupancy rate estimated at 0.47, results of this study are subject to change as the study progresses. The proportion of nights that bats are detected gives an indication of relative abundance across sampling sites(Frick 2013). The proportion of nights with bats detected from 2007-2011 was measured at 38 percent across all sites from Hawaii Island (Gorresen et al. 2013). In comparison, bat detections at the Project (31 percent of nights with detections, Auwahi Wind 2015), Nakula NAR (31 percent of nights with detections, Todd et al. 2016) and Pu'u Makua (38 percent of nights with detections, Auwahi Wind 2017) indicate similar bat abundance across monitored areas. Because detection rates are associated with bat abundance, there are likely similarities between the occurrence on Hawai'i Island and Maui.

Exercise in estimating Hawaiian Hoary Bat Population

Taking in to consideration the indicators and occupancy modeling parameters considered above, a population estimate exercise is described below. In the absence of a population estimate, habitat characteristics could be used as a proxy to estimate Hawaiian hoary bat populations. Maui is approximately 465,280 acres of which approximately 32.2 percent is forested (NOAA 2018). This area equates to approximately 150,000 acres of forest on Maui. Approximately 3 percent of Maui represents developed lands, or areas occupied by human structures and impervious surfaces, and an additional 3.5 percent represents barren land. This land use assessment indicates that approximately 93.5 percent of Maui consists of forest, agricultural, rangelands, and wetlands (Figure 3-4), which at varying degrees provides suitable habitat for the Hawaiian hoary bats.

This exercise will look at density and distribution to estimate a population. All studies that examine bat use in varying habitats show Hawaiian hoary bats use habitats at varying densities. To ensure that the population estimate is conservative, both the estimate of density and the distribution are conservative. The estimate provided here assumes that only 30 percent of the area of Maui, or 140,000 acres, is potentially acceptable CUA for bats. This area is roughly based on the proportion of the forested area of Maui as a proxy for bat occurrence. This proxy is based on the association with mature forest (Gorresen et al. 2013) and the need for day roosts. However, this estimate may incorporate forest lands, and portions of the agricultural, and rangelands. Of the 30 percent of habitat that could be occupied, the area estimated to be occupied by bats is 60 percent based on the observations of occupancy from published findings from Hawai'i[3] (Gorresen et al. 2013). This habitat suitability assessment serves as a proxy for the estimated extent of occurrence on Maui.

In addition to the extent of occurrence, the density of bats on Maui must also be estimated to derive a population estimate. Measurements of Core Use Area (CUA) from Hawai'i Island provide estimates of CUA in acres per bat (Bonaccorso et al. 2015):

- The median CUA is 20.3 acres (DLNR 2015); and
- The interquartile range (IQR) is from 16 acres to 58 acres.

A typical measure of statistical dispersion is the IQR. If the lower quartile CUA (16 acres) is used to represent a high-end estimate for the density of bats on Maui and the upper quartile CUA (58 acres) represents a low-end for density, the population may range between approximately 1400 to 5200 individuals.

$$Low\ Population\ Estimate = 1400\ bats \approx \frac{140{,}000\ acres * 60\%\ occupied}{58\ \frac{Acres}{Bat}}$$

$$High\ Population\ Estimate = 5200\ bats \approx \frac{140{,}000\ acres * 60\%\ occupied}{16\ \frac{Acres}{Bat}}$$

As previously identified, this population exercise provides an indication of scale and risk analysis. Despite the use of conservative estimates of the proportion of the island utilized and occupancy, the exact numbers of the population should be treated with caution as the estimates may vary if the input parameters are altered. For example, bats have been documented to have seasonal variation in use, and also documented to use non-forested areas (Auwahi Wind 2017, Todd et al. 2016). Nevertheless, this population estimate, documented bat observations, and the life history characteristics described above all suggest the Hawaiian hoary is well adapted to a range of environments and resilient to small-scale changes in habitat condition and available resources.

Genetics

Recent research indicates that Hawaiian hoary bats on Maui may consist of two distinct lineages because of multiple colonization events (Baird et al. 2015, Russell et al. 2015, Baird et al. 2017). Currently only one bat species is recognized as present in Hawai'i, and it is listed as endangered; it is possible that federal and state regulatory agencies may make a revised listing determination in the future, considering new taxonomic information on the two potential lineages (DOFAW 2015). Potential impacts to the Hawaiian hoary bat are not expected to differ by lineage; therefore, the amendment should remain valid in the event of agency recognition of subpopulations.

---

[3] Measurements from Hawai'i Island included primarily natural or forested habitat and found 0.63 occupancy (and the average, site-specific occupancy excluding Hilo was 0.91), suggesting the use of 0.6 is conservative.

Research

The Hawaiian hoary bat recovery plan (USFWS 1998) and the ESRC Bat Guidance (DOFAW 2015) acknowledge the benefits of additional research to further understand the ecology and life history of the Hawaiian hoary bat. The USFWS, DOFAW, and ESRC approved several research projects that are being conducted on Maui, O'ahu, and Hawai'i Island to better understand some of the key limiting factors for the Hawaiian hoary bat. These studies should provide insight into the life history, population, and habitat needs of the Hawaiian hoary bat that could inform future minimization and mitigation measures to help reduce the impacts to Hawaiian hoary bats. The research projects are anticipated to conclude between 2020 and 2022.

3.8.1.2 Threats

Overview of Primary Threats to the Species

Little is known overall about specific threats to the Hawaiian hoary bat due to a lack of data, although the data that do exist indicate that there are three major observed threats, as well as several unquantified threats that have yet to be properly evaluated. The three greatest threats causing additive mortality to Hawaiian hoary bats, based on observed fatalities and as identified in the ESRC Bat Guidance (DOFAW 2015), are wind turbines, removal of trees during the bat pupping season, and barbed wire. These threats have the potential to cause a localized reduction in bat numbers.

Wind turbines are responsible for the highest number of observed fatalities of Hawaiian hoary bats statewide, but wind facility operation is also the only activity with data from intense, long-term monitoring. The risk of collision with wind turbines can be minimized through LWSC as has been documented in several mainland studies (Arnett et.al. 2010, Arnett et al. 2013, Martin et al. 2017). LWSC is defined as restricting operation of turbines to periods when the wind speed reaches a pre-determined speed that is greater than the manufacturer's recommended cut-in speed and feathering turbine blades into the wind below that set wind speed. "Feathering" means that the wind turbine blades are pitched parallel to the wind, resulting in very slow movement of the rotor, on the order of 1 to 3 rotations per minute depending on blade length. Nighttime LWSC has been associated with reduction in risk to bats (Arnett et al. 2011) because bat activity is typically associated with periods where wind speeds are lower. As wind speeds increase, the likelihood of bat activity decreases, and collision risk correspondingly decreases.

Despite the benefit of LWSC, the risk to bats posed by wind turbines cannot be eliminated without full nighttime shutdown. Complete, dusk to dawn, year-round shutdown is typically not feasible, as it could reduce power output to levels below that necessary to maintain economic feasibility and compliance with applicable PPA requirements of a project. Full nighttime shutdown is evaluated as an alternative in Section 8.1.

In 2010, barbed wire fences were the greatest known source of Hawaiian hoary bat fatalities (Zimpfer and Bonaccorso 2010). Annual mortality estimates range from zero to 0.8 Hawaiian hoary bats per 62 miles of barbed wire. It is believed Hawaiian hoary bats are more vulnerable to barbed wire fences that occur in open and forest edge areas than in heavily cluttered forested areas. Tree removal has the potential to impact juvenile bats because they may be unable to fly away from a tree when it is cut or disturbed; however, it is not known how much bat take occurs as a result of tree trimming and harvesting (DOFAW 2015). To address the threats posed by barbed wire and tree removal, several additional minimization measures are recommended by USFWS and DOFAW. Avoiding the use of barbed wire where possible when installing fencing or other such structures can reduce this source of mortality. USFWS recommends using smooth wire when replacing barbed wire fencing. Impacts to pups in roosting trees can be avoided or minimized by not removing trees during the pupping season.

The greatest unquantified threats to Hawaiian hoary bats are from habitat loss, fire, pesticides, reduction in prey, and predation (USFWS 1998, USFWS 2011). These threats may be widespread across the state, and can result in direct and indirect mortality, reduced reproductive success, and reduced distribution of the Hawaiian hoary bat. Finally, records from the mainland indicate that bats are susceptible to being trapped and drowned in troughs, tanks, and pools with steep sides (Boyle 2014, Taylor and Tuttle 2007, Taylor 2007).

Despite the status as endangered, the Hawaiian hoary bat appears to have a low risk of extinction. The bat was listed as endangered in 1970, largely based on a lack of information. Since the Hawaiian hoary bat was listed as endangered, the population has persisted without direct action taken to promote the survival of the species. At the time, USFWS assigned the Hawaiian hoary bat a "recovery priority number of 9, indicating a subspecies with a moderate degree of threat and a high potential for recovery" (USFWS 1998). The interim down-listing criteria is defined by the USFWS (USFWS 1998) as, "Hence, downlisting can occur when the population on Hawaii is determined to be stable or increasing for at least five consecutive years." The down-listing criteria outlined in the USFWS Hawaiian Hoary Bat Recovery Plan (USFWS 1998) was met with the publication of the five-year occupancy study from Hawaii island (Gorresen et al. 2013). When a species reaches it's down-listing criteria, it is an indication that the recovery goals for the species have been met, and the service considers changing the listing status such as from endangered to threatened.

Overview of Impacts Associated with Wind Energy in Hawai'i

Across the continental United States, the mainland hoary bat is one of the bat species most frequently killed by wind turbines, primarily during fall migration (Kunz et al. 2007, Arnett et al. 2008). Hawaiian hoary bats do not have long-distance migration movements which are characteristic of mainland hoary bats. As a result, Hawaiian hoary bats may be less susceptible to fatality at wind turbines than mainland hoary bats, because Hawaiian hoary bats tend to approach wind turbines less frequently than their more migratory mainland conspecifics (Gorresen et al. 2015). For the wind farms in Hawai'i with approved HCPs, post-construction mortality monitoring data from January 2006 through December 2017 indicate that 32 of 70 (45.7 percent) observed fatalities of Hawaiian hoary bats occurred in August and September, and at least one fatality occurred during each other month of the year (DOFAW 2018). However, the seasonal patterns in the fatalities are at least partially a result of the disproportionate number of observed Hawaiian hoary bat fatalities that have occurred at the Project on Maui and the Kawailoa Wind Farm on O'ahu. Overall, these data suggest the Hawaiian hoary bat is vulnerable to collision with wind turbines throughout the year, and that the temporal distribution of fatalities is likely dependent on multiple site-specific factors (e.g., the island where the project is located, habitat, elevation), and potentially the influx of newly volant young that may occur in August and September. Therefore, project-specific post-construction mortality monitoring data are the best predictor of seasonal patterns of future take, and the most informative when developing avoidance and minimization measures.

3.8.1.3 Occurrence in the Project Area

A variety of studies have documented the occurrences of the Hawaiian hoary bat on Maui as shown in Figure 3-4. The locations shown are a compiled list of bat detections, captures, or observations from three studies, observations from three wind farms or associated mitigation areas, and four incidental or other types of observations largely over the last 10 years. Four observations date back to 1970, as shown in Table 3-1. The locations where no bat detections were recorded are not shown, because the sampling effort differs between locations and the absence of detections does not mean an absence of bats (Gorresen et al. 2017). The detections on Maui are predominantly associated with accessible areas; thus, as more efforts are made to detect bats, they will likely be documented in additional locations across Maui.

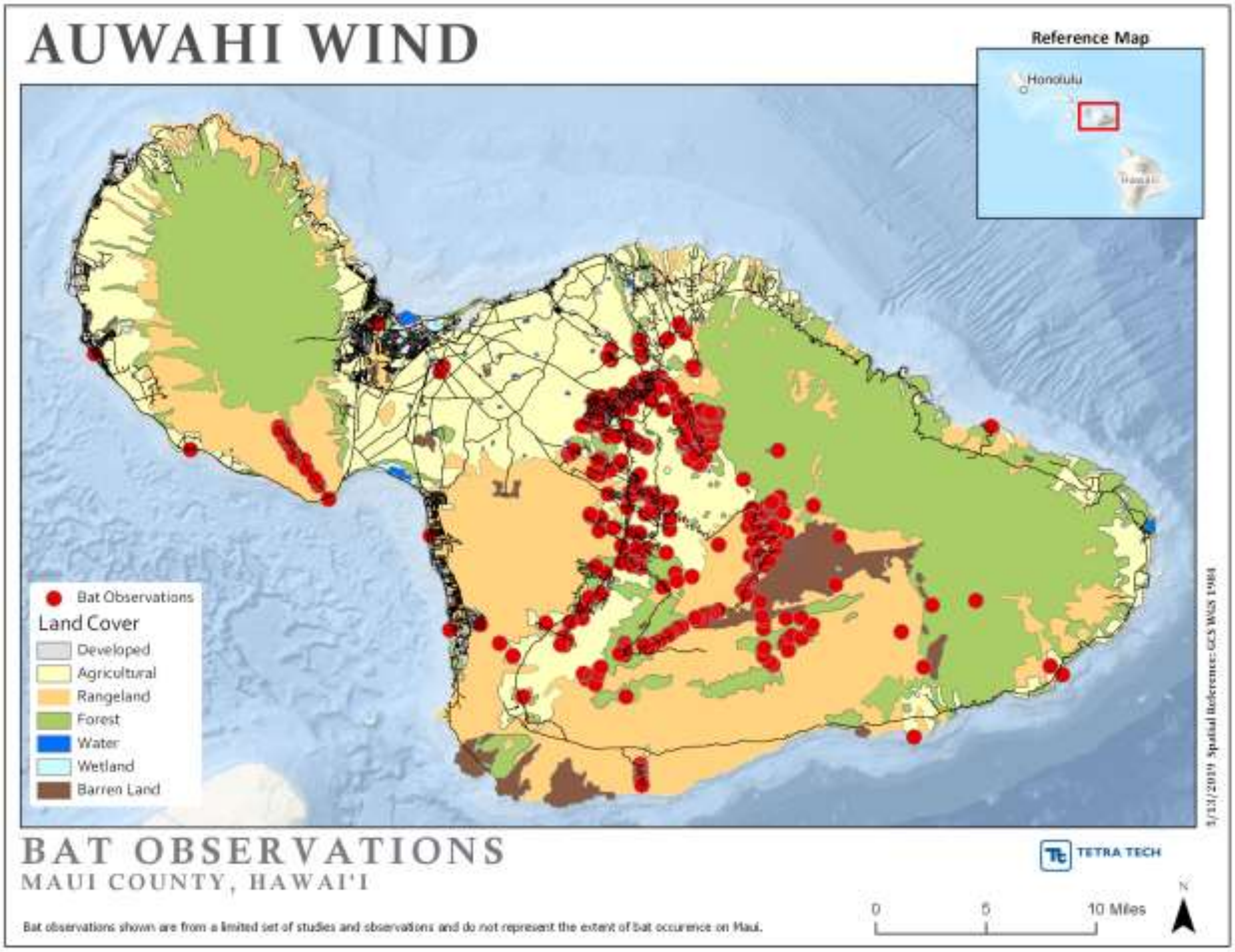


Figure 3-4. Documented Acoustic Bat Detections on Maui in Relation to Land Cover and Roads.

Table 3-1. Locations and Studies that Document Hawaiian Hoary Bat Observations on Maui as shown in Figure 3-2.

Location	Citation
Pu'u Kukui Preserve	DLNR 2005
Kahikinui Forest Reserve/Nakula Natural Area Reserve	Todd et al. 2016
Haleakalā National Park	Fraser et al. 2007
Auwahi Wind	Auwahi Wind 2017, Auwahi Wind 2018
Kaheawa Wind	KWP I 2017, KWP II 2017
Ulupalakua Ranch	Auwahi Wind 2017
Waikamoi	The Nature Conservancy 2011
Nu'u	Haleakalā National Park 2016
Olinda	Starr Environmental 2010
Kihei, Kahului, Lahaina, Leeward and Windward Haleakalā	USFWS 1998
West Haleakalā	H.T. Harvey and Associates 2019

Acoustic monitoring conducted at the Project using two ground-level acoustic monitors (Wildlife Acoustics SM2Bat+) placed at WTG 1 and WTG 6[4] from 2013 through 2015 documented low bat activity levels throughout most of the year, with increased activity August – October as shown in Figure 3-5. A total of 371 bat passes were recorded in 1632 detector nights (0.23 bat passes per night), with detections on 31 percent of nights over the monitoring period. The number of bat passes peaked 3 hours after sunset, with over 90 percent of detections occurring in the first 6 hours after dark, as shown in Figure 3-6 (Auwahi Wind 2015). Four nacelle-level acoustic monitors were placed at the Project at WTGs 2, 4, 5 and 7 in 2018 to record bat activity for 1 year; data are expected to be available in late 2019. Note that ground-based acoustic monitoring was not used as a proxy for risk at nacelle height because detections at nacelle height have been shown to be significantly different from ground-based detections (Collins and Jones 2009).

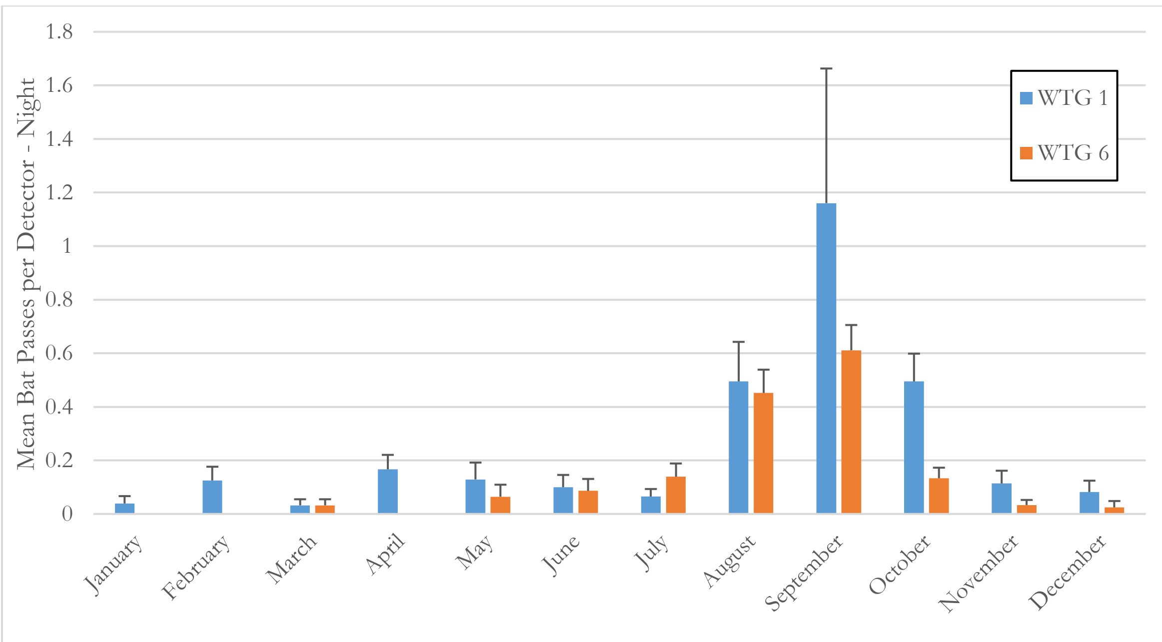


Figure 3-5. Acoustic data by month from ground detectors, 2013-2016.

[4] Turbines are numbered sequentially starting with the northernmost turbine being turbine 1, and the southernmost turbine being turbine 8.

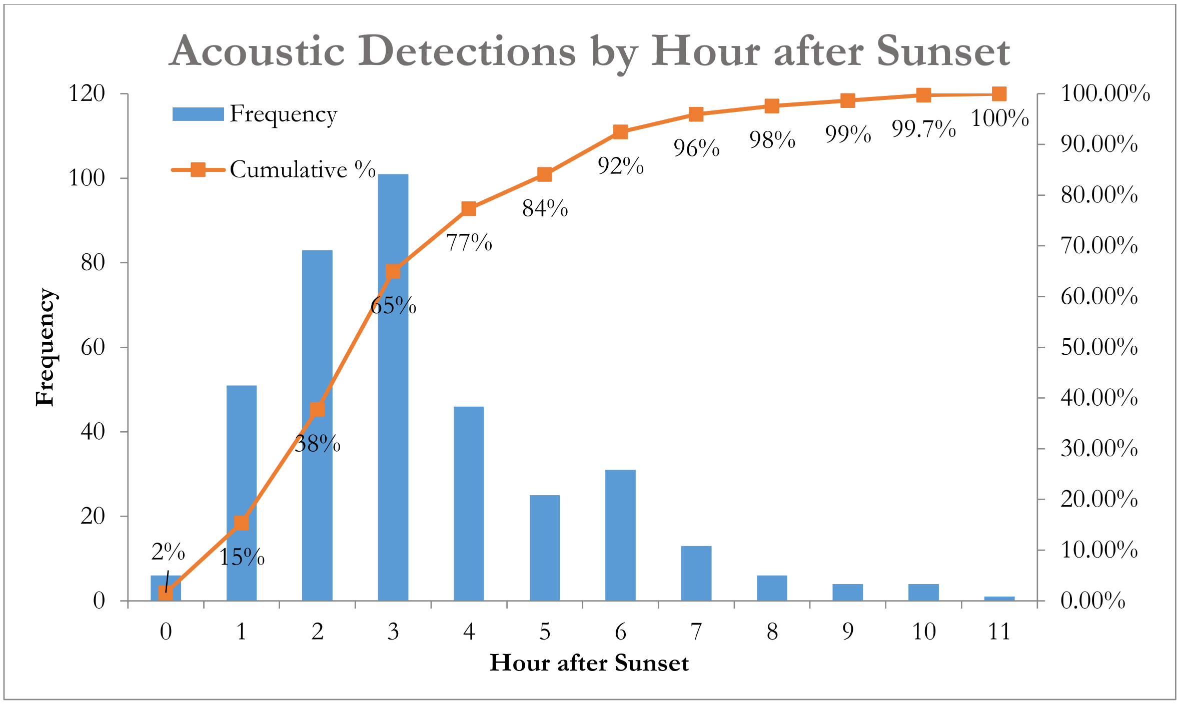
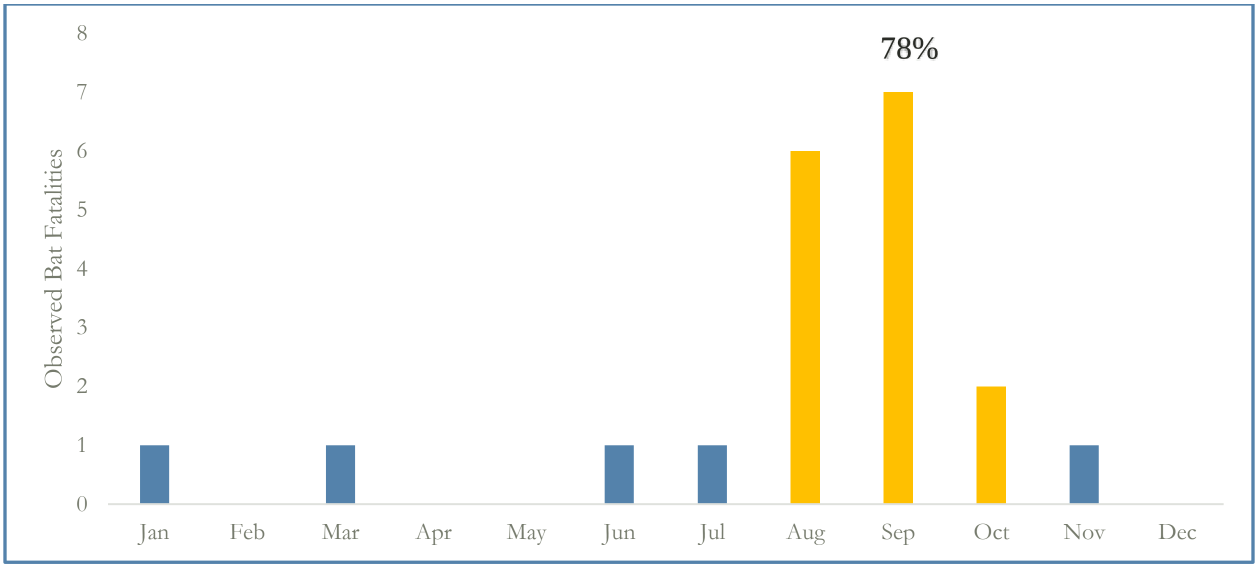


Figure 3-6. Acoustic data binned by hour after sunset from ground detectors, 2013-2016.

Post-construction mortality monitoring at the Project suggests a similar seasonal pattern in bat use based on the corresponding number of fatalities (Auwahi Wind 2013, Auwahi Wind 2014, Auwahi Wind 2015, Auwahi Wind 2016, Auwahi Wind 2017), as shown in Figure 3-7. As of December 31, 2017, 18 Hawaiian hoary bat fatalities have been documented; 16 of these fatalities were observed during post-construction mortality monitoring, and two were observed incidentally (outside search plot or regular search interval). Fourteen of the 18 observed fatalities (78 percent) occurred between August and October. Genetic determination of gender has been conducted by the U.S. Geological Survey (USGS) for 12 of the observed fatalities; their results indicate that approximately 50 percent of the fatalities were male and 50 percent female.



Note: Yellow bars indicate 78 percent of fatalities have occurred in the period from August through October.

Figure 3-7. Observed Bat Fatalities at the Project from 2013 through December 2017.

The variable timing of bat fatalities among the operational wind projects suggests that project-specific factors (e.g., topography or vegetation) influence bat fatality patterns. However, sample sizes are small, and no definitive conclusions can be drawn at the present time. The Project site is a relatively lowland location with elevations between 900 and 3,800 feet (Figure 1-2). Research from Hawai'i Island suggests that bats normally occupy higher elevations during the non-breeding season. Observation of fatalities during the non-breeding season suggest that there may also be island-specific factors that influence temporal trends in bat fatalities.

Based on observed fatalities at the Project, there may be inter-annual variability in Project take. During the first 3 years of monitoring (2013-2015), the number of observed bat fatalities per year was 1, 4, and 1, respectively. In 2016, seven bat fatalities were observed during systematic monitoring, despite the implementation of LWSC with a cut-in speed of 5.0 m/s, year-round. In 2017, three fatalities were observed during systematic monitoring. Overall detection probability estimated by EoA increased from 0.28 in year 1 to between 0.45 and 0.66 for all remaining years due to increases in search intensity and implementation of predator control. Average detection probability for all years of monitoring (2013-2017) is 0.5, with a standard deviation of 0.11, indicating that the number of observed fatalities per year is comparable among years. Appendix H contains more detailed information on the detection probability and estimation process. The causes of any inter-annual variability are unknown. Anecdotal data from 2016 suggest that causes of inter-annual variability may include anomalous weather patterns, drought cycles, or other phenomena. The average number of observed fatalities over the 5 years of monitoring is 3.2 observed fatalities per year. Therefore, 2017 represents a return to the average value.

For the Project, average monthly wind speeds recorded from dusk to dawn between years 2014 - 2018 ranged from 6.25 to 9.18 meters per second as seen in Figure 3-8. No correlation was found between fatalities and the wind regime at the site; average wind conditions during the three months (August through October) of highest bat fatalities at the Project were not lower than other months of the year. The lowest average wind speeds occurred in the months of January and February. For months with few observed fatalities, the risk to Hawaiian hoary bats is minimal, suggesting that additional wind turbine curtailment in these periods would not significantly reduce collision risk.

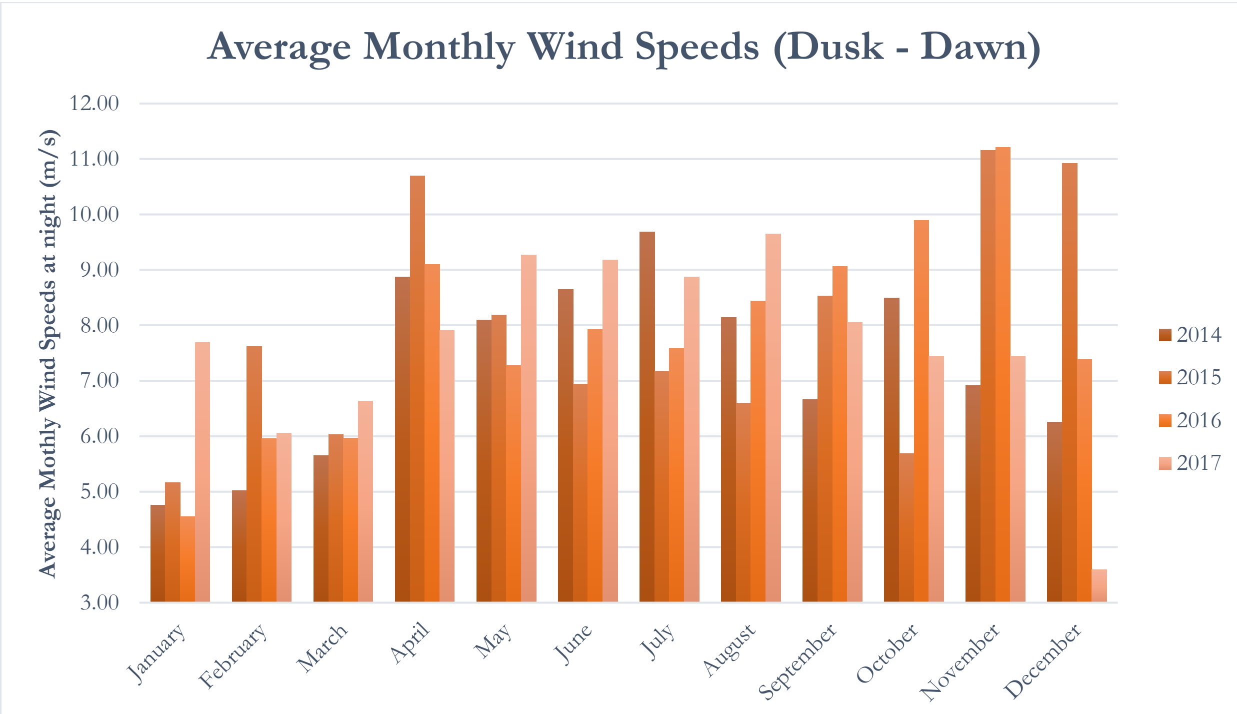


Figure 3-8. Wind Regime from Dusk to Dawn at Project Site from 2014-2017.

Another factor analyzed to help assess any potential patterns of observed bat fatalities was whether cattle were grazing in the Project area around the time of the reported bat fatalities. As illustrated by Figure 3-9, approximately 28 percent of observed fatalities have coincided with the grazing and 30-day post grazing period. The 30-day post grazing period accounts for insect abundance associated with cattle dung after the cattle have been removed.

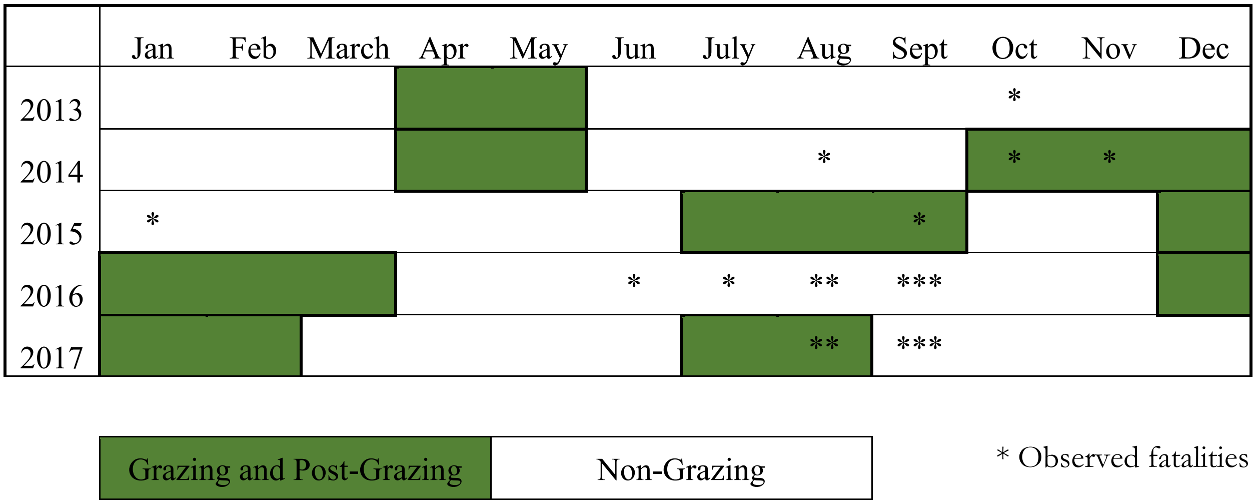


Figure 3-9. Cattle Grazing at Project Site from 2013 to 2017.

Other factors associated with observed bat fatalities are analyzed on an ongoing basis. These factors include the distance and direction that fatalities are detected from the turbines, wind speed, wind direction, rotor RPM, moon phase, weather patterns, and other potentially relevant factors. One of the primary challenges in analysis of such factors is the inability of the Project to know the exact timing of a fatality. The timing of the fatality is typically estimated to within seven days, meaning a large number of prior conditions must be evaluated, which makes correlation with any factor or factors difficult. The only pattern which has emerged is that more fatalities have been observed at turbines 1-4 than at turbines 5-8 after correcting for searched area. This pattern is discussed in more detail in Section 7.4.1.3 and included in provisions for adaptive management. Auwahi Wind is conducting studies to identify the factors associated with risk to Hawaiian hoary bats; see Section 7.4.1.2 for details on the studies.

3.8.2 Hawaiian Petrel

This section requires no edits for the HCP Amendment.

3.8.3 Nene

This section requires no edits for the HCP Amendment.

3.8.4 Blackburn's Sphinx Moth

This section requires no edits for the HCP Amendment.

3.9 Other Resources

This section requires no edits for the HCP Amendment.

4.0 GOALS AND CONSERVATION MEASURES

This section requires no edits for the HCP Amendment except as provided in the subsections below.

4.1 BIOLOGICAL GOALS AND OBJECTIVES

In addition to the biological goals and objectives of the approved HCP, the following provides biological goals and objectives for the HCP Amendment for the Hawaiian hoary bat.

4.1.1 Goals

Biological goals are intended to be broad, guiding principles that clarify the purpose and direction of the HCP (USFWS and NMFS 2016). The biological goals for the HCP Amendment are:

- Minimize impacts to the Hawaiian hoary bat to the maximum extent practicable in the Project area; and
- Mitigate remaining impacts to fully offset impacts and provide a net benefit to the Hawaiian hoary bat by protecting, enhancing and/or managing Hawaiian hoary bat foraging and/or roosting habitat.

4.1.2 Objectives

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 biological objectives for achieving the HCP Amendment goals are:

- Implement strategic minimization measures, and as needed, additional minimization actions at defined time periods according to a clear adaptive management plan, to reduce Hawaiian hoary bat take and ensure total permitted take is not exceeded for the remainder of the permit term; and
- Implement a mitigation project or projects that will protect, manage and/or enhance Hawaiian hoary bat habitat on Maui or within Maui Nui to promote foraging, roosting, and/or breeding habitat through the removal of threats or the addition of features necessary for those stages of the Hawaiian hoary bat life cycle.

Avoidance, minimization, and mitigation measures that will be used to achieve these goals and objectives, and the measures of success are described in detail in the subsequent sections of this HCP Amendment.

4.2 AVOIDANCE AND MINIMIZATION OF IMPACTS

This section requires no edits for the HCP Amendment.

4.2.1 General Project Development Measures

This section requires no edits for the HCP Amendment.

4.2.2 Pre-construction Surveys and Timing Considerations

This section requires no edits for the HCP Amendment.

4.2.3 Project Components and Siting Considerations

This section requires no edits for the HCP Amendment.

4.2.4 Invasive Plant Species Management

This section requires no edits for the HCP Amendment.

4.2.5 Fire Prevention During Construction and Operation

This section requires no edits for the HCP Amendment.

4.2.6 Measures to Minimize Environmental Impacts

This section requires no edits for the HCP Amendment.

4.2.7 Operational Avoidance and Minimization Measures for the HCP Amendment (New HCP Amendment Section)

Auwahi Wind is committed to reducing the risk of bat fatalities at the Project. Auwahi Wind considered the current literature from the mainland and recommendations in the ESRC Bat Guidance (DOFAW 2015) for identifying appropriate minimization measures for bats. LWSC is considered the best measure at this time to minimize impacts to bats while taking into consideration site-specific wind conditions and Project-specific energy generation or PPA requirements.

LWSC, as noted in Section 3.8.1.2, has been demonstrated to show a statistically significant reduction in bat fatalities. Based on current turbine technology, initiation of LWSC is determined by a 10-minute running average of wind speeds collected at the turbine nacelle. During curtailment, blades are feathered, reducing the speed of the blade to less than one RPM. Turbines take approximately 10 seconds to reach this rate of rotation when curtailment is initiated, and approximately 90 seconds to leave curtailment mode (depending on wind speeds, wind farm power output, and voltage/frequency requirements).

In response to the Project post-construction mortality monitoring results, Auwahi Wind began experimenting with LWSC regimes as adaptive management minimization measures to reduce impacts to the Hawaiian hoary bat, starting in late 2014. These measures are described below:

- Between November 2014 and January 2015, Auwahi Wind voluntarily implemented an operational protocol under which turbine blades were feathered below the manufacturer's recommended cut-in wind speed of 3.5 m/s, from at least 1 hour before sunset to at least 1 hour after sunrise.
- Beginning in February 2015, Auwahi Wind initiated voluntary year-round curtailment by feathering turbine blades at wind speeds below 5.0 m/s, from at least 30 minutes before sunset to at least 30 minutes after sunrise.

However, in 2017 when bat take was projected to exceed the ITP/ITL authorized take limit, Auwahi Wind reviewed and updated the analysis of the best available information from the mainland to identify alternative LWSC regimes that could further reduce risk to bats. The primary means of increasing the effect of LWSC on potential impacts to bats is to increase the wind speed at which turbines return to service. As summarized in Table 4-1~~Table 4-1~~, estimates of the impact of LWSC regimes from studies on the mainland suggest a reduction in bat take ranging from 10 to 92 percent. Figure 4-1, below, applies a best fit regression analysis of percent reduction in bat fatalities for a given cut-in speed, as depicted by the dotted line. The analysis shows that above a certain point, increases in cut-in speed do not result in commensurate further increases in fatality reductions. For example, there is less than a 0.3 percent reduction in bat fatalities above cut-in speeds of 6.9 m/s. Although there is a theoretical maximum reduction of bat fatalities from the regression, extrapolation from such a dataset should be done with caution because there are numerous variables (e.g., site, wind regime, bat abundance, bat species) in addition to the LWSC, which may contribute to variation in bat fatality rates between sites, or treatments. Thus, the regression analysis predicts that increasing cut-in speeds above 6.9 m/s provides insignificant increases in risk reduction, making a LWSC regime of 6.9 m/s the maximum extent practicable for cut-in speed, based on the literature review. A summary of current literature on the effectiveness of LWSC is provided in Appendix G.

The regression analysis in Figure 4-1 indicates that a LWSC cut-in speed of 6.9 m/s should reduce the risk of bats fatalities by 76 percent. Similarly, a Technical Assistance Letter from the USFWS in response to the Draft Headwaters HCP, and Pioneer Trail Bird and Bat Conservation Strategy suggests that a LWSC cut-in speed of 6.9 m/s is sufficient avoidance that take of Indiana bats (*Myotis sodalis*) would not be expected (Headwaters Wind Farm 2018, Stantec 2015). Increases in LWSC cut-in speed beyond 6.9 m/s are not anticipated to have a significant impact on the risk to bats. Studies looking at the impacts of LWSC have used 6.9 m/s as the maximum cut-in speed; at this time there are no publicly available studies looking at higher cut-in speeds.

Observations of bat fatalities at the Project vary seasonally and post-construction mortality monitoring implemented by Auwahi Wind indicates that 78 percent (14 of 18) of observed fatalities at the Project have occurred in the months of August to October. Therefore, this timeframe (August 1 through October 31) was selected as the period of highest risk at the Project, and the period to prioritize for maximum risk reduction effort (i.e., most aggressive LWSC regime). As derived from the regression in Figure 4-1 and using a percent reduction in bat fatalities of 76 percent (based on implementing LWSC at 6.9 m/s year-round), applying LWSC at 6.9 m/s during the 3-month period of maximum risk (representing 78 percent of the observed take) results in an estimated 59 percent (76% x 78% = 59%) reduction in take rate.

The other key element of a LWSC regime is seasonal application of selected cut-in speeds. Seasonal adjustment of cut-in-speeds has been used at wind facilities on the mainland to minimize impacts to listed bat species such as Indiana bats and northern long-eared bats (*Myotis septentrionalis*). For example, some wind facilities will raise the cut-in speed to 5.0 m/s during the fall migration period (August 1 to October 15) or consider other seasonal adjustments as part of an adaptive management program (Stantec 2015). USFWS had deemed these appropriate avoidance and minimization measures for these listed bat species (WEST 2013, Stantec 2016). Although there is not a traditional migratory pattern in Hawai'i for Hawaiian hoary bats, there are seasonal movements that have been documented in the literature, acoustic data, and observed fatalities (Todd 2012, Bonaccorso et al. 2015, Kawailoa Wind Power 2017, Auwahi Wind 2015). From data observed at the Project and some other wind projects in Hawai'i, there generally appears to be a greater risk to bats in the months from June to November. At the Project, 5 years of post-construction mortality monitoring (2013-2017) indicates that 78 percent of observed fatalities have occurred in the months of August to October.

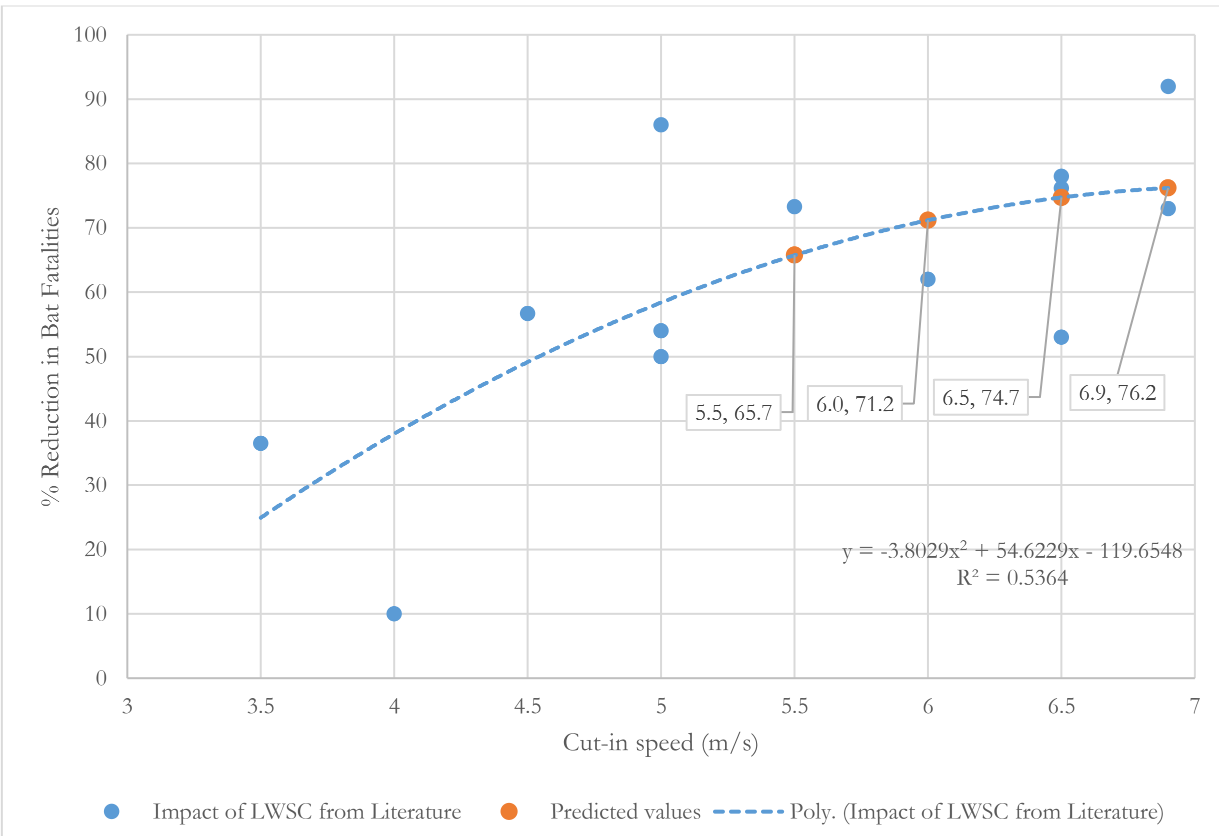


Figure 4-1. Synthesis of Low Wind Speed Curtailment Impact on Bat Fatalities

Table 4-1. Regression Analysis Data Used to Synthesize LWSC Impact on Bat Fatalities in Figure 4-1

Normal Cut-In Speed (m/s)	Treatment (m/s)	Percent Reduction (%)	Facility and Location	Analysis from Multi-species of Bats	Hoary Bats Included in Analysis	References
3.5	6.9	92	Laurel Mountain Wind Energy Project WV	Yes	Yes	Stantec 2015
3	5	54	Pinnacle Wind, WV	Yes	Yes	Hein et al. 2014
3	6.5	76.2	Pinnacle Wind, WV	Yes	Yes	Hein et al. 2014
4	6	62	Sheffield Wind Facility, VT	Yes	Yes	Martin et al. 2017
NA	6.9	73	Beech Ridge, WV	Yes	Yes	Tidhar et al. 2013
0	3.5	36.5	Fowler Ridge, IN	Yes	Yes	Good et al. 2012
0	4.5	56.7	Fowler Ridge, IN	Yes	Yes	Good et al. 2012
0	5.5	73.3	Fowler Ridge, IN	Yes	Yes	Good et al. 2012
0	4	10	Mount Storm, WV	Yes	Yes	Young et al. 2012
3.5	5	50	Fowler Ridge, IN	Yes	Yes	Good et al. 2011
3.5	6.5	78	Fowler Ridge, IN	Yes	Yes	Good et al. 2011
0	5	86	Casselman, PA	Yes	Yes	Arnett et al. 2011
0	6.5	53	Casselman, PA	Yes	Yes	Arnett et al. 2011

To have a likelihood Hawaiian hoary bat take, bats must be present at the wind farm while turbines are operating. Auwahi Wind developed its LWSC program to incorporate a seasonal approach, focusing on the periods of greatest risk to the bats at Auwahi to minimize impacts of incidental take to the maximum extent practicable. Auwahi Wind determined that it can implement a LWSC regime of 6.9 m/s during the 3 months (August through October) of highest bat fatalities at the Project based on the 5 years of post-construction monitoring (described below in more detail) and apply a LWSC regime of 5.0 m/s the remainder of months (November through July) when risk is lower. Auwahi Wind evaluated pertinent data on the months in which risk to bats is low. From the start of operation through December 2017, no fatalities were observed in the months of February through May, and December. One fatality was found in each of the months January, June, July, and November. The period of highest risk for bat fatalities at wind energy facilities tends to occur during relatively low-wind conditions (Arnett et al. 2008).

Auwahi Wind implemented the following as initial minimization measures starting in 2018 and will continue to do so for the duration of the permit, unless specific adaptive management triggers are reached that would initiate an adaptive management action. These minimization measures are:

- Implement LWSC for all eight turbines with a 5.0 m/s cut-in speed November through July (all months without LWSC at higher cut-in speeds), from 30 minutes before sunset to 30 minutes after sunrise; and
- Implement increased nighttime LWSC with a 6.9 m/s cut-in speed for all eight turbines, from 30 minutes before sunset to 30 minutes after sunrise, for the months of August to October (that is, the period for which data from the first 5 years of operation show that most bat fatalities have occurred).

Adaptive management of this operational avoidance and minimization strategy is discussed in Section 7.4.1. Alternative minimization strategies considered but not implemented are discussed in more detail in Section 8.

5.0 ASSESSMENT OF POTENTIAL IMPACTS AND TAKE LIMITS

Estimates of direct take and indirect take collectively inform the amount of additional take requested under this HCP Amendment (Section 5.1.3). Due to the uncertainty related to estimating take over the long term, the approved HCP developed a tiered approach for structuring requested take and associated mitigation. Under this HCP Amendment, three additional tiers of Hawaiian hoary bat take (Tiers 4 – 6) have been added to the three approved tiers. Tier structuring and triggers for initiating mitigation are described in detail in Section 5.1.3 and Section 6.2.5, respectively. The estimated take of other Covered Species has not been revised from the information presented in Sections 5.2 through 5.4 of the approved HCP.

5.1 HAWAIIAN HOARY BAT

Impacts to Hawaiian hoary bats associated with wind farm operation are described in Section 5.1 of the approved HCP. Collision risk has been verified through the results of post-construction mortality monitoring programs that have been implemented at the five Hawai'i wind farms that possess approved HCPs, including data collected since 2012 at the Project (see Section 3.8.1.3 for a summary of take observed through December 31, 2017). Despite the implementation of avoidance and minimization measures such as LWSC, the data show that at KWP II, Kawailoa Wind, and at the Project, the initially authorized ITP/ITL take limits have been exceeded. As a result, each of these wind farms are in the process of amending their HCPs to provide ITP/ITL coverage for additional bat take. KWP I and Kahuku wind farms are implementing their HCPs without requesting amendments.

Project-specific monitoring data were used in this HCP Amendment to predict take over the assumed 20-year operational period of the Project (December 2012 – 2032), consistent with the Project's current PPA. As noted in Section 2.2, the term of the ITP/ITL is 25 years (through 2037), which includes five years during which Auwahi Wind may consider extending the operational life of the Project through a new or revised PPA. Assuming the authorized take limits have not been reached, legal coverage under the ITP/ITL would remain in effect during this period.

5.1.1 Direct Take for the HCP Amendment

For this HCP Amendment, Auwahi Wind used the number of observed fatalities and monitoring detection bias (detection probability) from five complete years (2013 – 2017) of Project-specific post-construction mortality monitoring to predict future direct take. Search interval, searched area, carcass persistence, and searcher efficiency are used to inform the detection probability. Detection probability is used to adjust the number of observed fatalities to account for unobserved take. The projection of future take therefore accounts for uncertainty in the detection of carcasses, and the projection provides an estimate of take over the remaining years of the permit term.

To predict direct take over the 20-year operating life of the Project, the multi-year analysis module in the current EoA software (version 2.0, Dalthorp et al. 2017) was used to incorporate the post-construction mortality monitoring data collected through December 2017. The EoA software is the state-of-the-art analysis tool currently being employed by USFWS and DOFAW to evaluate compliance with the ITP/ITL, and therefore is currently the most appropriate tool for predicting direct take. Input parameters are provided in Table 5-1~~Table 5-1~~. An underlying assumption for this analysis is that detection probability and fatality rates derived from post-construction mortality monitoring are representative of future years. Using the current USFWS and DOFAW ITP/ITL compliance standard, the 80 percent upper credible limit value output from EoA is assumed to represent the credible maximum number of fatalities that could occur over the life of the Project. Using data from Project monitoring through December 31, 2017 it can be asserted with 80 percent certainty that Project-related direct take through 2017 does not exceed 38 bats. Using the same data to predict future take, the EoA model predicts a total direct take of 162 bats through the remainder of the ITP/ITL term if no additional minimization measures are implemented (i.e., baseline).

As described in Section 4.2.7, Auwahi Wind estimates that curtailment with a cut-in speed of 6.9 m/s for the months of August to October will reduce the fatality rate by 59 percent. However, there is uncertainty in extrapolating the effectiveness of LWSC in reducing bat fatalities from mainland studies on several bat species to the effectiveness of LWSC on the Hawaiian hoary bat. Data on the effectiveness of LWSC on bats in Hawai'i are lacking due to the relatively low number of fatalities (insufficient sample size precluding statistical analysis) or because some wind farms have implemented LWSC since the start of commercial operation, precluding a before/after comparison. The actual reduction in take rate at the Project may vary (higher or lower) from the modeled data.

To account for the uncertainty in the effectiveness of LWSC in reducing the risk to Hawaiian hoary bats, Auwahi Wind conservatively assumed a minimum 30 percent reduction of future direct take. The baseline EoA model was then modified to account for a minimum 30 percent reduction in future direct take by implementing this LWSC regime. As shown in Table 5-1~~Table 5-1~~, and based on assumptions described here, it can be asserted with 80 percent certainty that total Project-related direct take through 2032 will be no more than 129 bats with implementation of this LWSC regimen. This updated direct take estimate reflects only a reduction in take for future years, not an overall reduction of 30 percent from 162 bats. See Appendix H for additional detail on the take estimate and EoA software, including an explanation of the analysis periods and relative weights. This take estimate represents the highest level of direct take that would be anticipated given the monitoring data through December 2017. Considering the conservative 30 percent reduction of take applied due to minimization measures, the actual direct take will likely be lower than the 129 bats predicted.

Table 5-1. Predicting Bat Take: Model Input Parameters for EoA Multi-Year Analysis Based on 5 Years of Project Monitoring

Analysis Period Dates	Number of Fatalities Observed[1]	Detection Probability ($\hat{g}$)[2]	$\hat{g}$ Lower	$\hat{g}$ Upper	Relative Weight[2]	Basis for Values
January–December 2013	1	0.282	0.216	0.352	12	Post-construction mortality monitoring data January – December 2013
January 2014 – January 2015	4	0.548	0.445	0.648	13	Post-construction mortality monitoring data January 2014 – January 2015
February – December 2015	1	0.451	0.378	0.525	11	Post-construction mortality monitoring data February – December 2015, Period begins with implementation of LWSC at 5.0 m/s cut in speed.
January–December 2016	7	0.549	0.463	0.634	12	Post-construction mortality monitoring data January – December 2016
January –March 2017	0	0.668	0.592	0.74	3	Post-construction mortality monitoring data January – March 2017, Period ends with the end of the 3-day search interval
March – December 2017	3	0.58	0.479	0.677	9	Post-construction mortality monitoring data March – December 2017, 4-day search interval
January 2018 – December 2032	NA[3]	0.571	0.485	0.652	8.4 [3]	Estimated based on post-construction mortality monitoring data using canine search teams, minimum reduction (30 percent) in future fatalities expected for implementation of additional minimization measures (12 months * 70% = 8.4 relative weight)

1. Observed take counts only those fatalities observed in systematic monitoring. Carcasses found incidentally are accounted for through EoA modelling.

2. Detection probability and relative weights are inputs into the EoA software for projecting total Project Hawaiian hoary bat take over the permit term. Relative weights are months used in analysis.

3. Years over which take predicted; observed fatalities yet to be determined.

5.1.2 Indirect Take for the HCP Amendment

The direct take of an adult female bat during the time when young are dependent on her may result in the indirect loss or take of dependent offspring. The following variables used to predict the magnitude of this indirect take are based on parameters recommended in USFWS and DOFAW guidance (USFWS 2016a):

- A conservative estimate of direct take (Section 5.1.1);
- The proportion of take assumed to be adult females (only female bats care for young);
- The proportion of fatalities occurring during the period when young bats are dependent;
- The probability that the loss of a reproductively active female results in the loss of her offspring;
- The average reproductive success rate; and
- The proportion of young that survive to reproductive age.

The rationale and values used to predict indirect take are outlined in Table 5-2~~Table 5-2~~ and result in an indirect take prediction of 11 adult-equivalent bats during 20 years of operation. Because current mitigation frameworks only provide guidance relative to adult bats, indirect take was adjusted to bats (adults) by multiplying the predicted number of indirectly taken juveniles by the probability those juveniles would survive to become adults (Table 5-2~~Table 5-2~~, Line Numbers 2 through 5).

Table 5-2. Indirect Take Estimate Derived for Hawaiian Hoary Bat, Combined with the New Estimated Future Direct Take (observed and unobserved) for the HCP Amendment

Line Number	Component	Calculation of Count	Number of Bats	Calculation of Indirect Take[1]	Indirect Take Assessment
1	Observed[2] male fatalities, or observed fatalities outside the breeding season	Observed	8	No impact to dependent young, multiply by 0	0
2	Observed[2] female fatalities within the breeding season	Observed	2	Multiply by estimated reproductive rate 1.8 * proportion of offspring surviving to adulthood 0.3	1.08
3	Observed[2] fatalities of unknown sex within the breeding season	Observed	6	Multiply by proportion of population assumed to be female 0.5 * estimated reproductive rate 1.8 * proportion of offspring surviving to adulthood 0.3	1.62
4	Unobserved fatalities	38 estimated at 80% CI using EoA[3] minus 16 observed	22	Multiply by proportion of the population assumed to be taken with dependent young 0.25 * proportion of population assumed to be female 0.5 * estimated reproductive rate 1.8 * proportion of offspring surviving to adulthood 0.3	1.49
5[4]	Future direct take (unobserved)	129 predicted at the 80% CI using EoA[3] minus 38 current take estimated at the 80% CI	91	Multiply by proportion of the population assumed to be taken with dependent young 0.25 * proportion of population assumed to be female 0.5 * estimated reproductive rate 1.8 * proportion of offspring surviving to adulthood 0.3	6.14
6	**Future Indirect take**	Sum the indirect take assessment for line numbers 1-5, rounded up to the nearest whole number	11	Sum the indirect take assessment for line numbers 1-5, rounded up to the nearest whole number	11
7	**Total take estimated at the 80% CI**	Sum the count for line numbers 1-6	**140[5]**		

1. Calculations based on USFWS Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take, unless otherwise noted.
2. Observed take counts only those fatalities observed during systematic monitoring. Carcasses found incidentally are accounted for through EoA modelling.
3. Dalthorp et al. 2017.
4. Calculations of future indirect take are based on USFWS guidance and actual estimates of indirect take will depend on the timing and gender of observed fatalities.
5. The total take estimate includes 21 bats authorized under the approved HCP and 119 additional bats requested in the HCP Amendment.

5.1.3 Authorized Take Request for the ITP/ITL for the HCP Amendment

Based on the estimates of direct and indirect take discussed in Sections 5.1.1 and 5.1.2, respectively, the total take authorization for the Project would be 140 bats (129 direct and 11 indirect) under the HCP Amendment. This take amount consists of the 21 adult bats currently authorized under the approved ITP/ITL[5], and the additional authorized take of 119 bats requested through this HCP Amendment (Table 5-2~~Table 5-2~~). This requested take is based on several conservative assumptions such as the effectiveness of minimization measures; thus, the actual take that could occur may be lower than what is being requested. The assumptions or uncertainties that inform the conservative take request include the following:

- USFWS and DOFAW have recommended the 80 percent credible level be used when interpreting the results of the fatality data when using the EoA model which often inflates the fatality estimate.
- The prediction of future years of take relies on past data and incorporates uncertainty for future years which inflates the take estimate.
- The effectiveness of the minimization measures is uncertain; therefore, Auwahi Wind has chosen a conservative stance in predicting that the LWSC program will be 30 percent effective in reducing the overall number of fatalities. The best available information suggests that actual effectiveness may range between 59 percent and 76 percent, based on studies performed on the mainland.
- The take will occur slowly over time, as the highest take rate predicted in the HCP Amendment is 7 bats per year. This provides the opportunity for additional advancements in the development of new minimization measures as outlined in Section 7.4.

These factors combine to maximize the likelihood that the total take request will not be exceeded over the remaining permit term and the actual take will likely be less than the proposed amended take limit. Nonetheless, Auwahi Wind is committed to mitigate for the take requested.

The calculation of take for compliance with authorized take limits established under the ITP/ITL will use methods described in the long-term post-construction monitoring plan (Appendix E). To provide confidence that mitigation will precede or be concurrent with take, clear triggers and timing for the initiation of planning and implementation of mitigation in subsequent tiers are detailed in Section 6.2.

5.1.3.1 Potential for Population-Level Impacts

The potential Project impacts on the Hawaiian hoary bat can be assessed in relation to several of the bats' life history parameters including distribution, population size and resilience. As discussed in

[5] Per agreement with USFWS and DOFAW and biological assumptions presented in the approved HCP, 19 adults and 8 young permitted under the approved HCP were converted to 21 bats based on an assumed survival rate of juveniles to adulthood of 0.3 (Email correspondence with USFWS on April 28, 2015).

Section 3.8.1, the bat has a broad distribution across Maui that suggests the Project would only impact a small subset of the larger population on Maui. Since these bats have been documented to fly up to 7 miles in a night, the area of Maui within flight distance of the Project is approximately 11.7 percent of the island. Because the Hawaiian hoary bat has been shown to have strong fidelity to their respective roost trees (Bonaccorso 2010), this suggests that the scope of impacts would be limited. It would be improbable for all bats on Maui to traverse the Project area, and of those that do, not all would be impacted.

Additionally, the Project impacts on the Hawaiian hoary bat can also be analyzed in relation to the species' population size and resilience. The maximum estimated Project take is 6.45 bats per year over the life of the Project; but given the additional minimization measures outlined in Section 4.2.7, the total take is likely to be less than the maximum. The Maui population is estimated to be between 1400 and 5200 individuals (see Section 3.8.1), with maximum Project impact estimated to fall at 0.5 percent (or less) per year if considering the low end of the population estimate. Therefore, multiple layers of conservatism in favor of the species are built into these estimates (e.g., proportion of the island utilized by the bat, percent of land occupied, and fatality estimation), and given the low proportion of the estimated population impacted, it would be unlikely for the Project to have a significant negative impact on the Hawaiian hoary bat population of Maui.

While the impacts to the Maui population are likely to be low, the impacts of mitigation will provide a net benefit to the species. Auwahi Wind's land-based mitigation at Pu'u Makua has achieved its interim success criteria, and should continue to provide a benefit to the Hawaiian hoary bat (Auwahi Wind 2017). In addition, biological research being conducted for mitigation under Tiers 2 – 3 will contribute to filling in knowledge gaps that will lead to more effective on-the-ground management activities for the species. Additional mitigation for all Project-related take will be implemented on Maui (Sections 6.2.4 and 6.2.5) and will contribute to the species' recovery. The mitigation for Tier 4 will improve foraging habitat equivalent to 86 CUAs, exceeding the take request for Tier 4 (60 bats). Beyond the CUA analysis, bats have been shown to have overlapping foraging ranges and many more bats may benefit from the mitigation conducted than what is described in Section 6.2.4. Additionally, the habitat will last for multiple generations and outlast the permit term, and thereby providing further benefit for the species.

Notably absent from the life history traits and ecology of the Hawaiian hoary bat are factors associated with a declining population. Such factors may include:

- Low fecundity, such that the population of young does not replace adults lost to mortality[6];
- Significant loss of suitable habitat;
- Habitat specialization;

[6] The assessment of fecundity is based on the USFWS Recovery Plan and agency guidance on the calculation of indirect take (USFWS 1998 and USFWS and DOFAW 2016).

- Emigration, which is thought to be rare for Hawaiian hoary bats;
- Disease, which has not been documented in Hawaiian hoary bats; and
- Loss of food availability, which is unlikely for a prey generalist.

The Hawaiian hoary bat also has no known predators on Maui (Speakman 1995). A meta-analysis of risk factors identified large body size and limited geographic range or habitat specialization as being the strongest predictors of extinction risk (Chichorro et al. 2018). Small body size was noted to be a proxy for high fecundity and other life history traits, which are associated with a decrease in risk of extinction. Although the Hawaiian hoary bat is limited to occurrence in the Hawaiian Islands, "the mobility offered by flight renders virtually all the island from coastal embayments (Tomich 1986 and authors' personal observations) to the upper slopes of the highest mountains of Hawai`i accessible to foraging opportunities for Hawaiian hoary bats." (Gorresen et al. 2013). Data from the NOAA Coastal Change Analysis Program (CCAP) suggests the available habitat for Hawaiian hoary bat has not had a rapid decline and is unlikely to change substantially in the foreseeable future. CCAP data for Maui indicates a net increase in impervious surface of only 0.38 percent (to 3.45 percent in 2011), and a loss of forest cover of only 0.21 percent (to 32.2 percent in 2011) from 2005 to 2011, suggesting no substantial change to the available habitat over the period. This trend is an indication that the carrying capacity of the island is unlikely to undergo a rapid change due to development. The high fecundity, ability to utilize varied and spatially distributed resources, and documented distribution of the Hawaiian hoary bat suggest it is at low risk of extinction.

Recent genetic evidence suggests there have been significant inter-island dispersal events (Russell et al. 2015), but no conclusion was reached. The populations of individual islands are generally considered distinct (Baird et al. 2017). If the population of Hawaiian hoary bats on Maui is distinct, this suggests that impacts on Maui are unlikely to impact the population of other islands.

The best available information indicates that the Maui Hawaiian hoary bat population is widespread and abundant. No published or reported information suggests that either the Maui or statewide population is decreasing. Based on the best scientific data currently available, the Project is unlikely to cause adverse impacts to the species' overall population or recovery potential.

5.1.3.2 Cumulative Effects Associated with the HCP Amendment

Cumulative impacts relate to the impacts of the increased take associated with the HCP Amendment when considered in the context of past, present, and reasonably anticipated future actions that will also have an impact on the Hawaiian hoary bat population statewide and on Maui. On Maui, past development and other land use changes have resulted in the presumed loss of bat roosting and foraging habitat through the conversion of forest to agriculture and other uses (USFWS 1998). Resort or recreational developments, farming, road construction, pesticide use, and wildfires are expected to persist into the future, and have the potential to result in habitat loss or alteration, either directly or through the introduction or spread of invasive plant and insect species. Other direct impacts to bats associated with these activities may occur through collisions with structures, such as barbed wire fences, wind turbines, and communications towers, or disturbance at roost sites. These activities may also indirectly affect bats through the displacement or reduction in the number of prey resources. The cumulative impacts assessment considers several parameters including 1) take permitted on Maui, 2) take permitted on other islands, 3) potential future projects, and conservation measures such as protected lands, mitigation, and research as described below.

In addition to the Hawaiian hoary bat take authorized under the approved HCP, the only other authorized take of the Hawaiian hoary bat on Maui is from two other industrial-scale wind farms operating with approved HCPs. The Kaheawa Wind Phase I Project (20 GE 1.5-MW wind turbines) and Kaheawa Wind Phase II Project (14 GE 1.5-MW wind turbines) are located on west Maui and have authorized take levels of 50 bats and 11 bats over 20-year permit terms, respectively (KWP LLC 2006, SWCA 2011). Due to higher than anticipated incidental take levels of bats, Kaheawa Wind Phase II is in the process of amending its HCP (ESRC 2015), and has requested additional take of 27 bats. The take for all existing Maui projects is estimated at 11.4 bats per year. Based on the population estimate provided above for Maui, cumulative impacts are 1 percent (or less) of the population per year. The cumulative impact of all current Maui wind projects is not expected to have a significant impact on the population of Hawaiian hoary bats on the island, even without consideration of the associated mitigation activities of these projects.

The activities that directly impact bats on Maui (identified above), also occur on O'ahu and Hawai'i Island. The direct impacts from other authorized or proposed actions that could take bats include the following:

- Authorized take approved for two existing wind projects on O'ahu (Kawailoa is seeking an amendment to increase the amount of authorized Hawaiian hoary bat take);
- Requested take for one proposed wind project on O'ahu; and
- Requested take for two existing wind projects and one restoration project on Hawai'i Island.

Take authorization for these wind farms is contingent upon approved mitigation, which is expected to fully offset these projects' take or mitigate to the maximum extent practicable. However, movement of bats between islands is anticipated to be rare; therefore, the Project would only be expected to contribute to any cumulative impacts to the population on Maui alone.

Table 5-3. Current and Requested Take Authorizations for the Hawaiian Hoary Bat through Habitat Conservation Plans Associated with Wind Farms and Other Development in Hawai'i

Applicant	Permit Duration	Megawatts	Location	Current Take Authorization[1]	Take Request for Future HCP or HCP Amendment[1,2]
Kahuku Wind Power, [3]	2010 – 2030	30	Kahuku, O'ahu	32 bats	NA
Kaheawa Wind Power I	2006 – 2026	30	Maalaea, Maui	50 bats	NA
Kaheawa Wind Power II	2012 – 2032	21	Maalaea, Maui	11 bats	38 bats
Kawailoa Wind Power	2012 – 2032	69	Kawailoa, O'ahu	60 bats	222 bats
U.S. Army Kahuku Training Area Single Wind Turbine[3]	2010 – 2030	NA	Kahuku, O'ahu	2 adults, 2 juveniles bats	NA
Auwahi Wind	2012 – 2037	24	Ulupalakua Ranch, Maui	21 bats	140 bats
Na Pua Makani Wind Farm	2019-2040	25	Kahuku, O'ahu	51 bats	NA
Pakini Nui Wind Farm	Draft requested (20 years)	21	Hawai'i Island	NA	26 bats
Lalamilo Wind Farm	Draft requested (20 years)	3.3	Hawai'i Island	NA	6 bats
Pelekane Bay Watershed Restoration Project[3]	2010 – 2030	NA	Hawai'i Island	16 bats	NA

1. Total take authorization includes adult and juvenile bats; number of adult equivalents provided by D. Sether, USFWS, 2018.

2. Total includes previous authorized take.

3. Take authorized under ESA Section 7 Biological Opinion.

These take rates are likely to decline as the risk factors associated with Hawaiian hoary bat fatalities are researched, and minimization measures are improved for wind farms. Additionally, several companies are working to develop effective bat deterrents and conducting research into ultrasonic and ultraviolet deterrents to reduce the risk of bat fatalities at wind farms. The future installation of bat deterrents at wind farms in Hawai'i is anticipated, and would further reduce the risk of cumulative impacts to the bat if implemented for operational and future projects.

The likelihood of new development must also be considered in the impacts to species. The Hawaiian Electric Companies (HECO) issued a renewable energy request for proposals seeking to develop an additional 60 MW of renewable energy on Maui (HECO 2018) in Phase 1 and issued a draft proposal for Phase 2. No new wind energy projects were identified for Maui in 2018 and it is not known what type of projects will be selected for Phase 2. It is not known if HECO will initiate new requests in the next 5 years, but the start of operations of a new project in the next 5 years as part of a new RFP is unlikely, given that no projects were identified in 2018. The Hawai'i Clean Energy Initiative (HRS 196-10.5) and Renewable Portfolio Standards (HRS 269-92) specifies that the State of Hawai'i will establish a renewable portfolio standard of 100 percent of net electricity sales from renewable sources by 2045. The new wind projects would be anticipated to be proposed in the future, but the timing, approval, construction, and operation of such projects is uncertain, and therefore it is not possible to incorporate such information into the analysis of cumulative impacts.

Additionally, Hawaiian hoary bats have been documented on Kaua'i, Molokai, and Lana'i. These three islands have no wind energy projects, and the populations would not be expected to be impacted by any of the existing wind projects or likely any future projects. As previously stated, the populations of individual islands are considered distinct. The existence of the species on these islands is a further assurance of the persistence of the Hawaiian hoary bat.

Another documented mortality source for Hawaiian hoary bats involves the bats becoming snagged on barbed wire; this is a concern statewide, with rates on Maui expected to be similar to the statewide range of 0.0-0.8 Hawaiian hoary bats per 62 miles of barbed wire (Zimpfer and Bonaccorso 2010). Observed fatalities are uncommon, because most fences are not checked regularly, and bats caught on these fences may quickly be taken by predators or scavengers. Based on the low estimates of mortality related to bat impalement on barbed-wire fences, the impact of the HCP Amendment in combination with this impact is not expected to result in significant cumulative impacts to the species on Maui, or statewide. Other anthropogenic sources of take potentially include: timber harvesting, drowning, pesticides, predation or competition from introduced species, and climate change. The scale of the impacts from the identified activities is not monitored, but it is thought to be minimal (USFWS personal communication April 2019).

Another consideration for impact assessment is the abundance of forested and/or protected lands on Maui and statewide that would serve as habitat for the Hawaiian hoary bat. Conservation lands across the state protect habitat likely to be used by Hawaiian hoary bats. Approximately 205,500 acres of conservation lands occur on Maui; over 2 million acres of conservation lands occur statewide. In addition to the 150,000 acres of forest on Maui, an estimated 1.5 million acres of forest habitat occur across the state. These lands would be expected to provide available habitat that would enable the Hawaiian hoary bat to continue to survive and reproduce, despite anthropogenic losses.

Approved and pending authorized levels of bat take would be expected to be fully mitigated, with the exception of the U.S. Army Kahuku Training Area and Pelekane Bay Watershed Restoration Project, for which mitigation is a recommendation under the USFWS's ESA Section 7 Biological Opinion (USFWS 2003), but not required. The approved and pending HCPs include a combination of habitat restoration and research (see Section 6.0 for Project-specific Hawaiian hoary bat mitigation under the HCP Amendment). Habitat restoration is intended to create or improve the quality of bat foraging and roosting habitat; the Hawaiian hoary bat recovery plan (USFWS 1998) identifies the loss and degradation of habitat as a major factor impacting the species. Restoration actions incorporated into the approved and pending HCPs include installation of ungulate fencing, the removal of non-native ungulates and invasive plant species, and/or planting of native trees and shrubs. Over time, these actions are anticipated to create high quality, sustainable, native foraging and roosting habitat, benefiting bats beyond the ITP/ITL terms, and thereby resulting in a net benefit to the species.

The research component of the mitigation is critical to filling data gaps about the species, and was identified as a priority recovery action in the Hawaiian hoary bat recovery plan (USFWS 1998). Research projects approved by USFWS and DOFAW are designed to gain an understanding of basic life history parameters and develop effective mitigation measures for the species (DOFAW 2015), which will ultimately guide future management and recovery efforts.

The impacts of the Project and the cumulative impacts of wind energy on Maui are unlikely to have a significant negative impact on the Hawaiian hoary bat population. The process of estimating take for the HCP Amendment using EoA and PCMM data provides a high degree of certainty that actual take will be less than predicted take. Current and pending actions of HCPs are expected to fully mitigate for their take, and provide a net benefit as required by Hawaii law, thus the cumulative impact to the Hawaiian hoary bat associated with the increased take from the HCP Amendment is expected to be none to minimal. Pursuant to USFWS and DLNR ITP/ITL issuance criteria, the provisions described in the HCP amendment, including the avoidance and minimization measures, mitigation, and adaptive management program, identify how any bat take will not jeopardize the survival and recovery of the species. The mitigation described in Section 6.2.4 and 6.2.5 increases the chances of survival and the likelihood of recovery for the listed species by providing a net benefit to the species.

5.1.4 Tiers of Take

To address the uncertainty associated with the effectiveness of the proposed LWSC program in reducing direct bat take (Section 4.2.7) and the conservative assumptions used in estimating future take as described above, Auwahi Wind divided the new requested take into three additional tiers (Tiers 4 – 6; Table 5-4~~Table 5-4~~). The additional tiers are based on varying percentages of reduction in bat take as a result of effectiveness of LWSC, ranging from 30 to 70 percent.

The three proposed tiers of take are representative of the uncertainty associated with the degree of effectiveness minimization and adaptive management measures will have in terms of reducing the take of Hawaiian hoary bats. The best available public information (Appendix G) suggests LWSC minimization measures may reduce bat take up to 76 percent relative to the current estimated take. Auwahi Wind assumes a more conservative approach, because the effectiveness documented in other studies is subject to site-specific conditions and may vary with different sites. Auwahi Wind based the new tiers on three take rates to represent the uncertainty of the effectiveness of LWSC: 70 percent reduction from current take rates (Tier 4), 50 percent reduction from current take rates (Tier 5), and 30 percent reduction from current take rates (Tier 6). For example, reducing the take rate by only 30 percent would equate to an average take of 7.00 bats per year (140 bats/20 years) over the life of the Project and a higher overall take estimate. However, if the take rate is reduced by 70 percent relative to past monitored years, the take rate over the life of the Project would be expected to be an average of 4.05 or fewer bats per year (81 bats/20 years). These projections of take form the biological basis for Tiers 4 – 6.

For the potential future scenarios, the EoA analysis utilized data through December 31, 2017, and an average detection probability (ghat) value from canine searching, as well as 2017 study parameter data, to estimate take in years 2018 – 2032. The values of estimated take associated with each percentage of reduction in take rate, were allotted to each tier based on USFWS recommendations for tiered take at wind facilities (USFWS 2016b). Each tier represents the cumulative total take (direct and indirect) requested (i.e., take is not additive among tiers).

This tier framework helps address variation and uncertainty due to 1) the inter-annual variability in observed take, 2) the effect of small sample sizes on take predictions, 3) the potential for a stochastic event in 2016 to have disproportionately influenced predictions of future take, and 4) the high degree of conservatism used in the estimation process. The tier framework also allows for new information, to be incorporated into future tier mitigation projects (see Section 3.8.1 and Section 7.4.1.2). Triggering of mitigation for the associated tiers of take is discussed in Section 6.2.5.

Table 5-4. Tiers of Take for the Hawaiian Hoary Bat

Tier[1]	Cumulative Estimated Take	Take in Tier	Basis for Take within Designated Tier[2]
1	5	5	Estimate developed in approved HCP.
2	11	6	Estimate developed in approved HCP.
3	21	10	Estimate developed in approved HCP.
4 (New)	81	60	Assumed reduction in take rate of 70% in years 2018-2032 (relative to the current take rate).
5 (New)	115	34	Assumed reduction in take rate of 50% in years 2018-2032 (relative to the current take rate).
6 (New)	140	25	Assumed reduction in take rate of 30% in years 2018-2032 (relative to the current take rate). Represents baseline condition for estimated take request.

1. Each tier represents the total take requested (i.e., take is not additive across tiers).

2. The scenarios described are representative of the conditions that could result in take being limited to each specific tier. Many factors may affect estimates, and none of these can be known in advance. All scenarios utilize EoA analysis utilizing data through December 31, 2017, and overall detection probability derived from canine searching.

5.2 HAWAIIAN PETREL

This section requires no edits for the HCP Amendment.

5.3 NENE

This section requires no edits for the HCP Amendment.

5.4 BLACKBURN'S SPHINX MOTH

This section requires no edits for the HCP Amendment.

6.0 COMPENSATORY MITIGATION FOR POTENTIAL IMPACTS

This section requires no edits for the HCP Amendment.

6.1 MITIGATION LOCATIONS

This section requires no edits for the HCP Amendment.

6.2 HAWAIIAN HOARY BAT

Mitigation for additional tiers of take under the HCP Amendment was informed by the recovery priorities described in the Hawaiian Hoary Bat Recovery Plan (USFWS 1998), the best available information on the Hawaiian hoary bat and other bat species, and supplemented by the April 2015 ESRC workshop, the resulting ESRC Bat Guidance (DOFAW 2015) for projects that have the potential to positively impact the species. The results of this workshop and subsequent ESRC Bat Guidance included:

- Recognition of the need for more research to understand the Hawaiian hoary bat life history and limiting factors;
- Identification of research priorities that would help develop effective mitigation strategies; and,
- Recognition of the need to closely monitor a variety of habitat restoration projects to measure their benefits to the Hawaiian hoary bat.

As described in Section 3.8.1.1, several research projects were approved as mitigation for wind HCPs based on research priorities and costs identified in the ESRC Bat Guidance (DOFAW 2015). The ESRC Bat Guidance recommends mitigation for the Hawaiian hoary bat be valued at $50,000 per bat (DOFAW 2015); however, USFWS provided revised verbal guidance in May 2018 to clarify that the $50,000 per bat rate only applies to research approved as mitigation for bats. Furthermore, USFWS and DOFAW current guidance (USFWS and DOFAW meetings May 1, 2018) is that land-based mitigation projects are preferred, and research is considered to be a lower priority until the results of the current research projects are known. Land-based mitigation efforts should have clear biological goals and objectives, and thus, measures of success that tie directly or by proxy, to increases in reproductive success, or increases in rates of use by the Hawaiian hoary bat. No additional research-based mitigation is proposed for Tiers 4-6 under this HCP amendment.

6.2.1 Tier 1 Mitigation

Tier 1 mitigation for the Hawaiian hoary bat is on-going and has met Interim Success Criteria; it consists of Hawaiian hoary bat habitat restoration measures and on-site acoustic monitoring. The Puʻu Makua parcel of the Waihou Mitigation Area was placed into a conservation easement held by the Hawaiian Islands Land Trust (HILT) on December 18, 2012. Restoration measures for approximately 130 acres of pastureland in the parcel were initiated following issuance of the

ITP/ITL. In September 2013, an ungulate-proof fence surrounding the parcel was completed, and all ungulates were removed from the parcel by January 2014. Following initial baseline vegetation monitoring of the parcel in March 2014, biannual sweeps to remove primary invasive plant species were initiated. A second baseline survey was conducted in February 2015, and native tree out-planting began in spring 2015. Thirty-nine acres of native trees were out-planted in 2015 (Figure 6-1). Native reforestation, vegetation monitoring, and invasive species removal efforts are ongoing. In addition, acoustic monitoring of bats was conducted at the Project from July 2013 through December 2015 using two ground-based acoustic monitoring units as required.

Auwahi Wind has exceeded the Interim Success Criteria established for Year 3 (FY 2018). The target for non-native plant cover (excluding kikuyu grass, *Pennisetum clandestinum*) for Year 3 was set at less than 75 percent; measured non-native plant cover in FY 2018 was 4.5 percent. The target for native species outplantings survival for Year 3 was set at 75 percent; actual survival was 87 percent survival across plots for Year 2, and ongoing outplantings to replace lost plants (May 2017–June 2018) ensures that the interim and long-term mitigation targets are reached.

Figure 6-1. Aerial Image of Most Outplantings (image taken using a DJI inspire drone and shot in June 2018)

6.2.2 Tier 2 and Tier 3 Mitigation

Tier 2 and Tier 3 mitigation is also on-going and being successfully implemented. The mitigation includes funding of Hawaiian hoary bat research that contributes to knowledge of the species on Maui. Beginning in 2013, Tetra Tech, Inc. and Dr. Frank Bonaccorso (USGS) worked together to develop a phased research plan to use acoustic monitoring and radio telemetry methods to:

- Evaluate home range size and habitat composition;

- Evaluate seasonal patterns of bat activity at the Waihou Mitigation Area; and
- Examine prey abundance and diet composition by bats in the Waihou Mitigation Area.

The Tier 2 research plan was approved by USFWS and DOFAW in February 2014. Acoustic monitoring efforts were initiated at the Waihou Mitigation Area in March 2015. Subsequently, the Tier 3 research plan expanded the sampling and scope of the approved Tier 2 research plan. The final Tier 2 – 3 research plan was approved by USFWS and DOFAW in May 2016. This research plan includes acoustic monitoring (2015 – 2018), seasonal radio telemetry (2016 – 2017) with two additional phases of radio-telemetry to be completed and timed based on results from on-going acoustic monitoring efforts, an insect prey base study (2016), and a food habit assessment (2016 – 2017). The radio-telemetry component of this project was replaced in 2017 with additional monitoring (outlined below) through adaptive management in consultation with USFWS and DOFAW due to broadcast tower interference with radio-telemetry signals. Adaptive management measures to the research component include:

1) Increase in the staff effort devoted to nights of mist-netting at Pu'u Makua and outlying areas within the Ranch, to capture bats for genetic sampling and fecal collection;
2) Add a second season of insect prey base sampling at the Waihou Mitigation Area and mist net sites, where only a single season was previously planned/budgeted;
3) Increase the number of insect prey species (up to 150 insect samples) that will be bar-coded for a larger library to match with insect fecal pellets in a dietary study;[7] and
4) Add other potential items to the scope of work if field time and funds allow:
    a. Adding one acoustic meter near the location called Duck Ponds; and
    b. Adding insect prey base sampling at the Project.

These efforts are on-going with results to be provided in HCP annual reports.

While no capture rates are recorded prior to mitigation and as such no baseline is available for comparison, the initial results of this work indicate a higher use rate than predicted by mitigation targets for Tier 1. The USGS tagged 11 Hawaiian hoary bats in the Waihou Area while conducting monitoring for Auwahi Wind under Tier 2-3 mitigation.

6.2.3 Tiers 4 – 6

The mitigation described in this HCP Amendment for Tiers 4 – 6 will offset the requested bat take. A detailed outline for Tier 4 Mitigation is provided in Section 6.2.4, while the mitigation program for Tiers 5 and 6 is described in Section 6.2.5. Adaptive management for Tiers 5 and 6 mitigation will

[7] This effort is distinct from the USGS proposal currently accepted by the ESRC, although the analysis will be in parallel.

provide an opportunity for Auwahi Wind to incorporate the best available science and results from ongoing research described in Section 3.8.1.1 and the results of Tier 2-3 mitigation.

In addition to the mitigation provided for Tiers 4 - 6, Auwahi Wind will conduct a single-year occupancy study of the Hawaiian hoary bat on Leeward Haleakalā. The study area spans from Ahihi-Kinau Natural Area Reserve to Kaupō gap, and from the summit of Haleakalā to the coast. The study methods are consistent with, and comparable to, the multi-year occupancy study occurring on O’ahu developed in collaboration with the ESRC Bat Task Force. Based on prior studies (Todd et al. 2016, Starcevich et al. 2019), a sample of 20 detectors will be installed. The study begins in July 2019 and continues for 1 year. Single-year occupancy models (MacKenzie et al. 2019) will be used to estimate occupancy rates and detection probabilities, and covariate relationships where possible (MacKenzie et al. 2019). Although Auwahi Wind’s mitigation is consistent with the ESRC Bat Guidance recommendations as described below, this occupancy study provides a significant additional research benefit.

6.2.4 Tier 4 Mitigation

The objective of the Tier 4 Mitigation is to protect, manage, and enhance habitat that is suitable for bat foraging and roosting through the addition of features necessary for those stages of the Hawaiian hoary bat life cycle. Auwahi Wind has leveraged results of the research and restoration efforts conducted in Tiers 1 – 3, data from other applicable studies, and USFWS and DOFAW mitigation guidance, to identify appropriate Tier 4 mitigation that will offset the incidental take of at least 60 bats.

Auwahi Wind’s Hawaiian hoary bat Tier 4 Mitigation will be located on 1,752 acres of Leeward Haleakalā, on Ranch land (Mitigation Area; Figure 6-2). The proposed Tier 4 Mitigation Area is of relatively high elevation and would be expected to provide primarily foraging and roosting habitat since pupping generally occurs at lower elevations (C. Pinzari, personal communication August 1, 2018). The mitigation actions included in the Tier 4 Mitigation will protect existing bat habitat as well as enhance bat habitat through the addition of resource features to increase bat foraging and roosting in the near and long term and augment the connectivity between nearby State Forest Reserves and other conservation areas that currently provide bat habitat. Auwahi Wind anticipates that the mitigation project will more than fully offset the incidental take of 60 Hawaiian hoary bats and provide a net benefit based on the following:

- The median CUA for one Hawaiian hoary bat is approximately 20.3 acres (Bonaccorso 2015); the 1,752 acres will provide 29.2 acres for each of the 60 bats covered in Tier 4;
- The size of the CUA of Hawaiian hoary bats varies based on the specific habitat types and features located within a given area;
- Enhancement of bat habitat through the addition of key resource features can reduce the size of an area required for Hawaiian hoary bats to meet foraging needs; and

- Specific habitat enhancements documented in the available literature to be associated with higher bat use rates will be selected and implemented to improve the mosaic of habitat structure.

The following sections provide an overview of the proposed Tier 4 Mitigation by describing 1) the Mitigation Area, 2) the management actions that will be implemented to benefit bats, 3) the estimation of take offset/net benefit, 4) the measures of success to achieve the take offset/net benefit, 5) a monitoring plan, 6) an adaptive management strategy, and 7) a timeline for implementation.

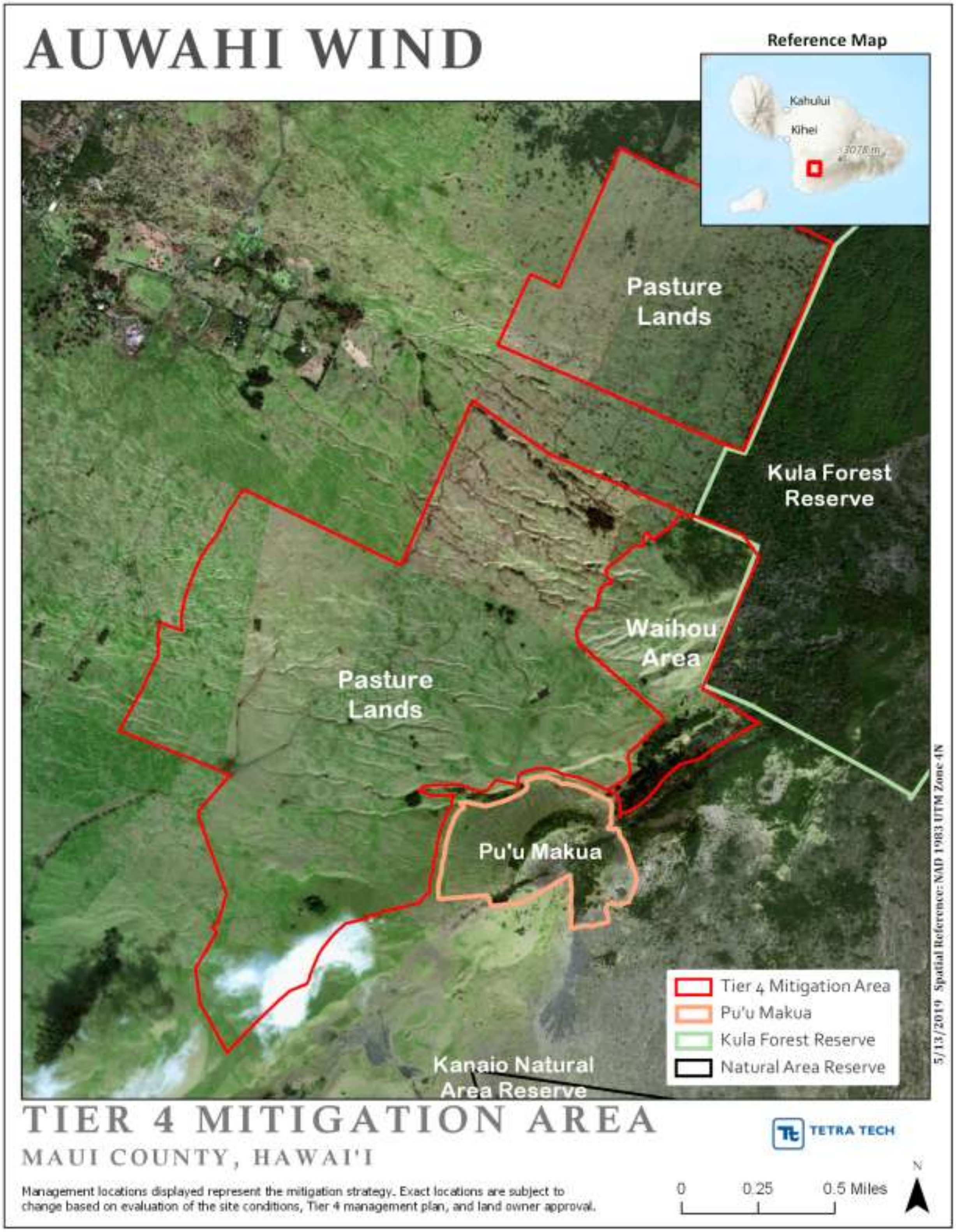


Figure 6-2. Site Location, Aerial Imagery, and Proposed Layout of Mitigation Parcels within the Mitigation Area

6.2.4.1 Mitigation Area

Habitat Description

Auwahi Wind has identified the 1,752 acre Mitigation Area as being a priority parcel for protection and management actions for the Hawaiian hoary bat. The Mitigation Area includes the Waihou Area, the Duck Ponds, Cornwell, and Kaumea Loko parcels identified in the Auwahi Wind HCP as potential mitigation areas. These parcels within the Waihou Area were identified in the approved HCP for future possible mitigation tiers, but were not used for the approved HCP. Bats have been documented within and adjacent to the Mitigation Area. USGS mist netting has resulted in the tagging of 11 individual Hawaiian hoary bats at the Duck Ponds, and USGS has documented bat use of the forest patches within the Waihou Area (Auwahi Wind 2017). Additionally, USGS researchers have recorded bat calls at the nearby Pu'u Makua Mitigation Site (Figure 6-2; Auwahi Wind 2017). Results from USGS research indicate that bats are present year-round at Pu'u Makua. The detectability of Hawaiian hoary bats at Pu'u Makua has varied but fluctuates around the average detectability of 0.38. Detectability represents the nightly frequency of bat presence on a scale of 0 to 1, with 0 describing no bat activity and 1 representing acoustic activity every night within a survey period.

The elevation of the Mitigation Area ranges between 3,300 and 5,500 feet asl, and the land use is commercial cattle ranching. Recent research suggests that resource availability at high elevation sites may be an important limiting factor for Hawaiian hoary bats in the non-breeding season (Gorresen et al. 2018). Under the proposed Tier 4 Mitigation, the property and existing pastures will continue to be used for seasonal grazing, but new management actions will be implemented to protect and enhance bat foraging and roosting habitat, as described in Section 6.2.4.2 below. Protecting and managing these lands with a conservation easement to restrict any future incompatible uses will ensure long-term benefit to the bat and enhance the connectivity to the nearby Kula State Forest Reserve, and the 120-acre Pu'u Makau Restoration Site that provide protected bat roosting habitat (Figure 6-2, Lance DeSilva, DOFAW, personal communication, 10 August 2018; Auwahi Wind 2017). Further details of the legal protections that will be included as part of Tier 4 Mitigation are included under Mitigation Actions (Section 6.2.4.2).

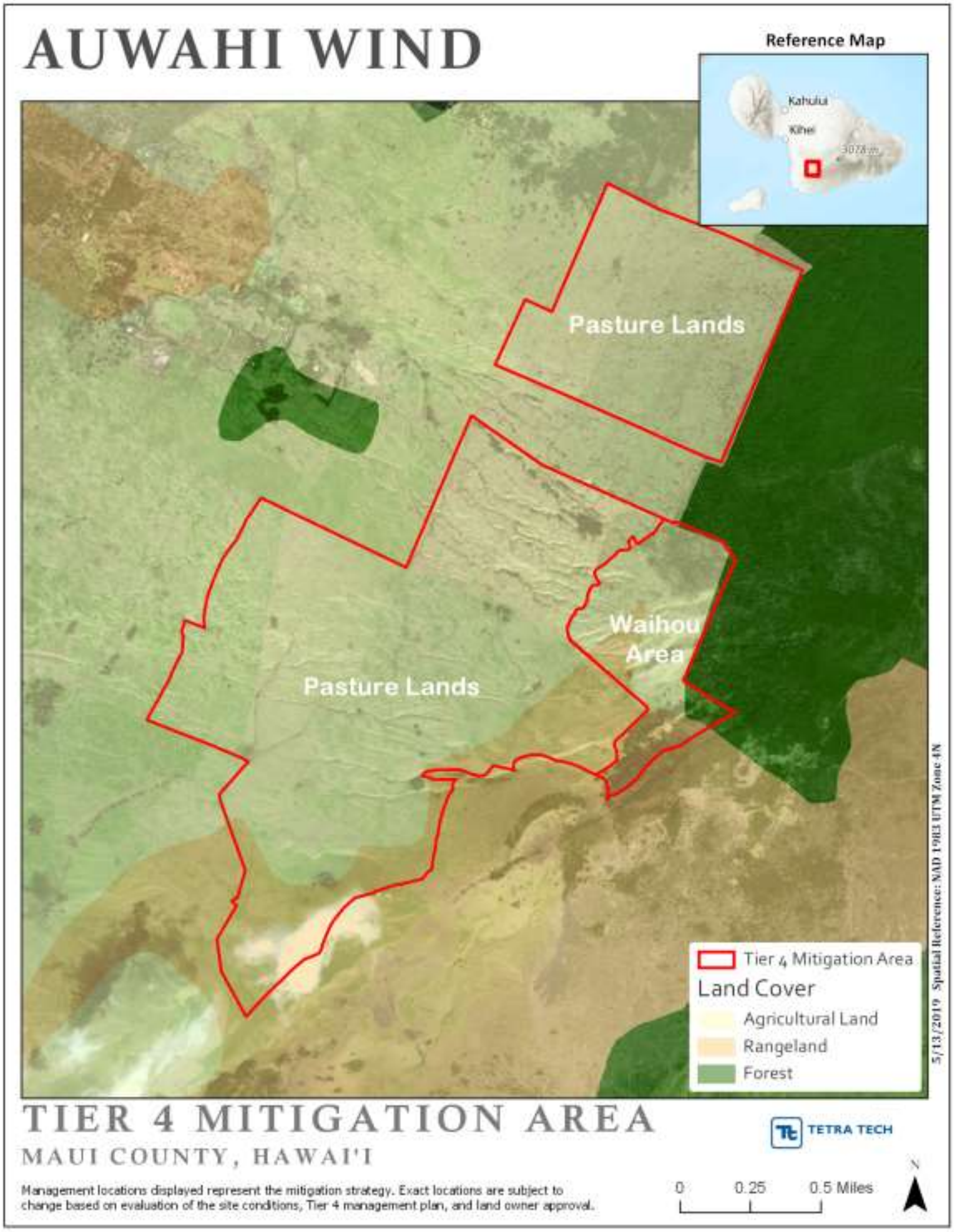
The Mitigation Area consists primarily (more than 95 percent) of sloping open grasslands, interspersed with gulches, and a few forested patches and hedgerows (Figure 6-3). The grasslands consist primarily of Kikuyu grass (*Pennisetum clandestinum*) as well as a mix of other non-native species. The existing open habitats would be expected to provide little benefit to bats except foraging near hedgerows or limited use by bats transiting the area. Although bats have been documented to traverse open areas, their foraging is associated with insect abundance (Bellwood and Fullard 1984), and insect abundance is inversely corelated with distance from woody vegetation (Lewis 1969). The distance to the nearest forest edge has similarly been found to be inversely corelated with bat activity (Downs and Sanderson 2010). The gulches on the property are primarily contained within a 150-acre parcel and have been noted by USGS to provide structure that would likely be utilized by bats. Scattered clusters of trees occur throughout the habitat and several sections of forest which connect to the Kula Forest Reserve. Bats may use these scattered trees (Auwahi Wind 2017).

Auwahi Wind has broken the management program into two units: the Waihou Area and the Pasture Lands (Figure 6-3). The Pasture Lands are 1,556 acres of primarily grasslands as described above. There is a gap in the Pasture Lands parcels which is not owned by the Ranch. The Waihou Area is 196 acres and has approximately 20 percent forest cover, 80 percent grasslands. The general habitat types are shown in the aerial imagery in Figure 6-2 and in Figure 6-4, from data by the Geographic Information Retrieval and Analysis System (GIRAS) provided on the State of Hawaii: Office of Planning website (State of Hawaii 2018).

Water is a scarce resource in Leeward Haleakala, and water resources in the Mitigation Area consist of 5 ponds, seasonally active water troughs, and dry or perennial small streams (Figure 6-5, USGS 2013). The area surrounding the existing ponds is not grazed by cattle and are generally vegetated by non-native grasses (e.g., kikuyu grass; Figure 6-3). The ponds within the Mitigation Area are man-made and consist of an excavated depression up to 10 feet deep and range in size from 40 by 50 feet up to 60 by 120 feet. The ponds are lined with a plastic liner and back-filled, the liner is able to capture rainwater sufficient to recharge a pond within 9 months after that pond has been emptied (Ulupalakua Ranch, personal communication, October 23, 2018).

Hawaiian hoary bats have been documented to use the existing ponds in the Duck Ponds parcel (Auwahi Wind 2017). Created ponds such as those in the Duck Ponds are the only consistent sources of open water in the vicinity (Figure 6-5). Flow lines noted in the National Hydrography Dataset are normally dry and only fill when major flooding occurs. Other water sources such as cattle troughs are only active seasonally, specific to cattle use, approximately 2 to 4 months per year. Fifteen water troughs currently exist within the Mitigation Area (Figure 6-5). Figure 6-3 displays the existing habitat ponds.

Figure 6-3. Pictures of the Mitigation area (top), and one of the existing ponds within the Mitigation Area (bottom).



Source: GIRAS, State of Hawaii Office of Planning 2018

Figure 6-4. Land Cover in the Mitigation Area from Geographic Information Retrieval and Analysis

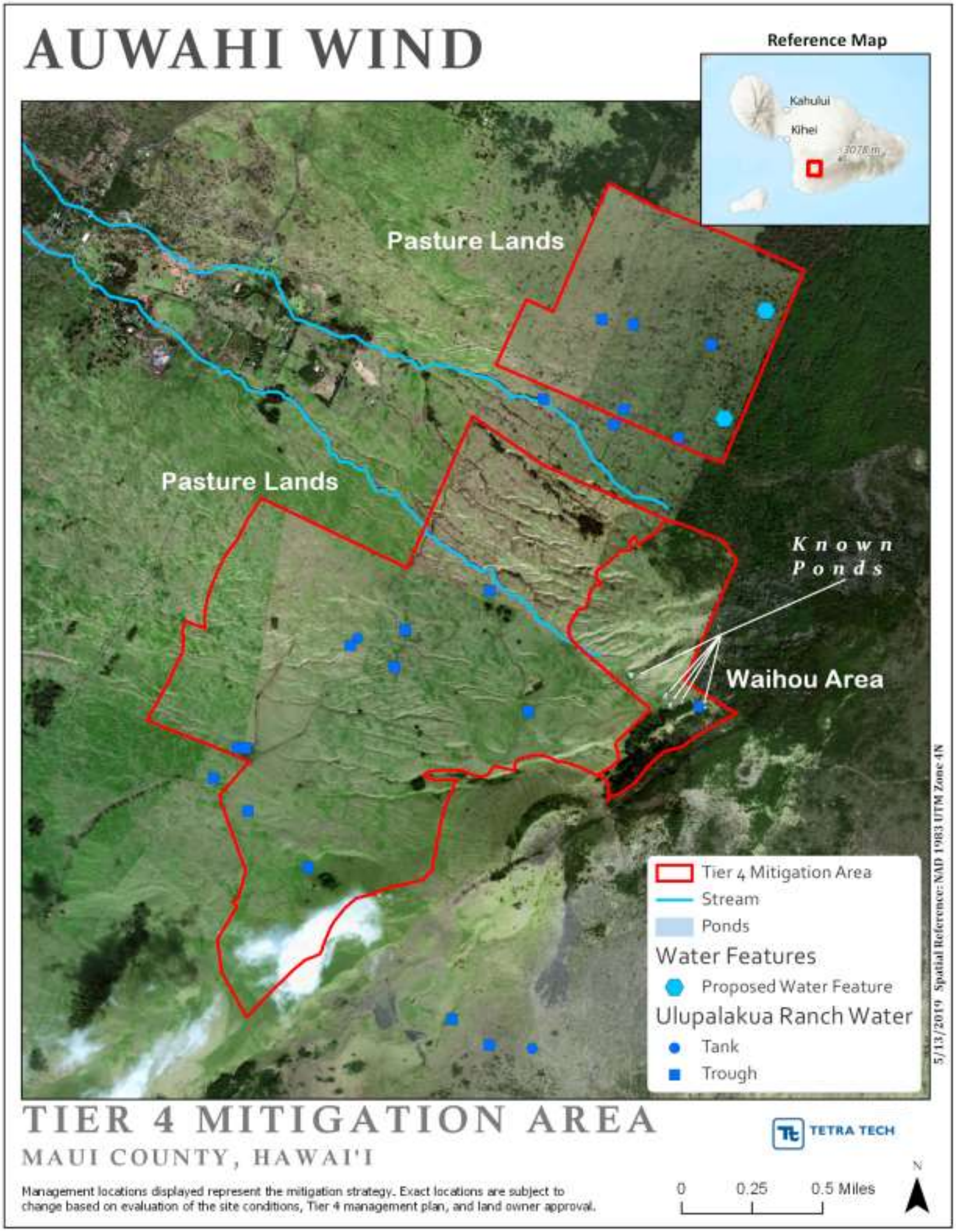


Figure 6-5. Water Resources, Known and Proposed Within the Mitigation Area

Existing Legal Protection

The Mitigation Area has a minimal level of existing legal protection that includes agricultural easements which limit its use to ranching and other agricultural activities and restricts the number of dwellings. Uses inconsistent with the existing easement include: surface mining, subdivision, industrial activities, significant alteration of the surface of the land, activities causing significant erosion or water pollution, alteration of water courses, waste disposal, or the addition of commercial signs or advertising. Other applicable restrictions do not appreciably alter the suitability of the site for the Hawaiian hoary bat and can be found recorded with the State of Hawai'i Bureau of Conveyances. Notably absent from the existing restrictions are limitations on the removal of trees; removal of existing tree cover on the Ranch lands could substantially impact existing bat habitat which occurs in scattered clusters across the Ranch. There are no restrictions on the use of insecticides or stocking ponds with insectivorous fish, which could impact Hawaiian hoary bats.

In the absence of the proposed mitigation's conservation easement, bat habitat quality, and the use of the Mitigation Area by bats, would likely remain low and could diminish in the event that currently permitted changes to land use occur. These lands are not managed for bat habitat purposes, and property features (trees, water features) which provide habitat benefits for bats are not required to be maintained. The Ranch anticipates increasing the number of cattle on their property (Ulupalakua Ranch, personal communication, August 13, 2018), and with land resources scarce in Hawaii, would likely use and manage the existing lands more intensively. Cuddihy (1984) evaluated the difference between grazed and park lands on Hawai'i Island, and showed that grazing is correlated with decreases in structural complexity and increases in cover of non-native grasses despite similarity in soils between treatment and control sites. This study found tree density increased significantly less in a grazed site than adjacent park parcels, suggesting that existing grazing in the Mitigation Area would continue to impair the long-term suitability of the site for Hawaiian hoary bat use, if not managed through the Tier 4 Mitigation.

Mitigation Site Summary

The Mitigation Area is a priority for the following reasons:

1. Resource availability at high elevation sites is suggested to be an important limiting factor for bat populations;
2. The Mitigation Area is located adjacent to existing bat roosting habitat in the Kula Forest Reserve and the Pu'u Makua Mitigation site;
3. The Wind Farm is distant from the Mitigation Area (approximately five miles);
4. The mitigation is occurring on the same island where take is occurring;
5. Bat occurrence has been documented in the Mitigation Area;
6. The Mitigation Area currently consists of low quality habitat, which will be improved through management actions, to increase bat use;

7. The Mitigation Area currently has minimal legal protections, which will be enhanced for the Hawaiian hoary bat, with a permanent conservation easement; and
8. The land owner is a USFWS conservation partner and supportive of the easement and management actions proposed.

6.2.4.2 Mitigation Actions

The mitigation actions described here draw heavily upon literature outlined in Section 3.8.1 above, guidance derived from Bat Conservation International (BCI) for the management of water features (Taylor and Tuttle 2007), and recommendations from the Joint Nature Conservation Committee[8]. The Joint Nature Conservation Committee is a statutory advisory committee for the government of the United Kingdom (Entwistle et al. 2001), which provide guidance for rangeland managers to promote bat use on rangelands. To achieve the mitigation objective of protecting and enhancing bat foraging and roosting habitat in the Mitigation Area, Auwahi Wind will 1) create forested linear landscape features (i.e., hedgerows) that can be used as foraging and night roosting substrate and travel corridors, and 2) provide suitable, consistent water resources for the bat. These added features will increase the amount of available foraging and roosting resources for Hawaiian hoary bats on Maui. Furthermore, the location of the added resources will reduce the energetic costs associated with foraging and drinking by providing suitable foraging grounds and water sources in proximity to day roosting habitat, where none previously existed. In addition to the creation of these two feature types, Auwahi Wind will also implement fire management and legal protection of the Mitigation Area. The combination of these specific mitigation actions will provide immediate, near-term, and long-term benefits to bats.

Reforestation of Hedgerows

Reforestation of fence line hedgerows is recommended to facilitate bats transiting the Mitigation Area and serve as a foraging and roosting substrate (Entwistle et al. 2001, Jantzen 2012).

The reforestation of these hedgerows will provide the Hawaiian hoary bat a patchwork of open foraging areas, edge habitat, and closed canopy which provide shelter from strong winds, night roost habitat, and available prey for foraging. Bats and dung beetles at study sites in Nicaragua were more abundant at hedgerows than in pasture lands with low tree cover (Harvey et al. 2006). Hedgerows serve as both shelter and habitat for insects with insect abundance typically greater in the lee of hedgerows. This pattern of hedgerow use applied for beetle species (*Lathridiidae*) and flies (*Scatopsidae* and *Sphaeroceridae*) while moths were more commonly found within the hedge (Lewis 1969). Hedges are one of the most important non-crop habitats on farmland and support a high biomass of arthropods (Pollard and Holland 2006).

Information on the insect species associated with reforestation of grassland on Maui is available in conjunction with reforestation efforts at the Nakula Natural Area Reserve (NAR) conducted by the

[8] The recommendations of BCI and the Joint Nature Conservation Committee are not species-specific.

Maui Forest Bird Recovery Project since 2011. Reforestation efforts in the Nakula NAR have resulted in 98 acres of reforested grasslands. The insect abundance in the Nakula NAR was evaluated in 2011 (Peck et al. 2015) in the existing koa stands to look for food species of the kiwikiu (Maui parrotbill; *Pseudonestor xanthophrys*) and Maui ʻalauahio (Maui creeper; *Paroreomyza montana*). The diet of these two forest birds includes significant portions of moth larvae and beetles, which suggests an overlap with bats in the insect species consumed (bats are not expected to feed on larvae, but rather, flying adult moths and beetles, Todd 2012). Species composition was dominated by moths with a significant portion of beetles. Total insect biomass was not significantly different than Waikamoi (which is mature native forest), suggesting the Nakula NAR prey base can support Hawaiian birds. Analysis of insects at Waihou also demonstrates that koa and a'ali'i support lepidopteran and coleopteran species (Auwahi Wind 2017). The availability of these insects would also be expected to benefit Hawaiian hoary bats by providing available insect biomass for foraging. All of these studies indicate that hedgerows of koa and a'ali'i in the Mitigation Area would be anticipated to increase the insect biomass available for foraging bats.

The continued grazing of pastures between hedgerows is anticipated to facilitate bat foraging in the Mitigation Area and expected to provide insect biomass for bat foraging. Studies recommended by C. Pinzari (Corinna Pinzari, HCSU, personal communication, 7 Aug 2018) showed that bats in Italy and the United Kingdom use cattle grazing areas as a foraging resource with bat activity increasing with herd size (Ancillotto et al. 2017, Downs and Sanderson 2010). Additionally, the distance to the nearest forest edge and nearest tree were significant covariates of bat activity and distance was negatively correlated with activity. The significance of distance to forest edge shows that the addition of hedgerows fundamentally changes a bat's ability to access foraging resources in pasture lands. The species studied above are hawking insectivorous bats, a trait common with the Hawaiian hoary bat. The habitat needs for these species is associated with grazing and this combination of habitat features is expected to enhance bat foraging, because bats utilize insects associated with cattle and cattle dung as prey (Ancillotto et al. 2017, Downs and Sanderson 2010). Moth abundance is associated with an intermediate level of grazing (Pöyry et al. 2004). Similarly, grazing can reduce the vegetation cover to promote conditions where bats could more easily capture prey (Rainho et al. 2010). In Hawai'i, a decrease in Hawaiian hoary bat activity was linked to the elimination of ungulates in the Kahikinui Forest Reserve on Maui (Todd et al. 2016). The consumption of dung beetles has been noted in the diet of Hawaiian hoary bats (Whitaker and Tomich 1983). These studies suggest that grazing is a compatible land use with the actions taken to benefit the Hawaiian hoary bat.

Therefore, Auwahi Wind will reforest the hedgerows within the 1,556 acres of Pasture Lands Mitigation Area (excludes the Waihou Area). The Pasture Lands will be reforested to a minimum density of approximately 20 percent or 311 acres of forest cover (Figure 6-6), which corresponds to the first statistically significant peak in mainland hoary bat utilization (Jantzen 2012). For Hawaiian hoary bats, canopy cover has been documented to be negatively related to bat detection (Gorresen et al. 2015) supporting the findings from mainland hoary bats, which suggest open areas for foraging in proximity to trees is important.

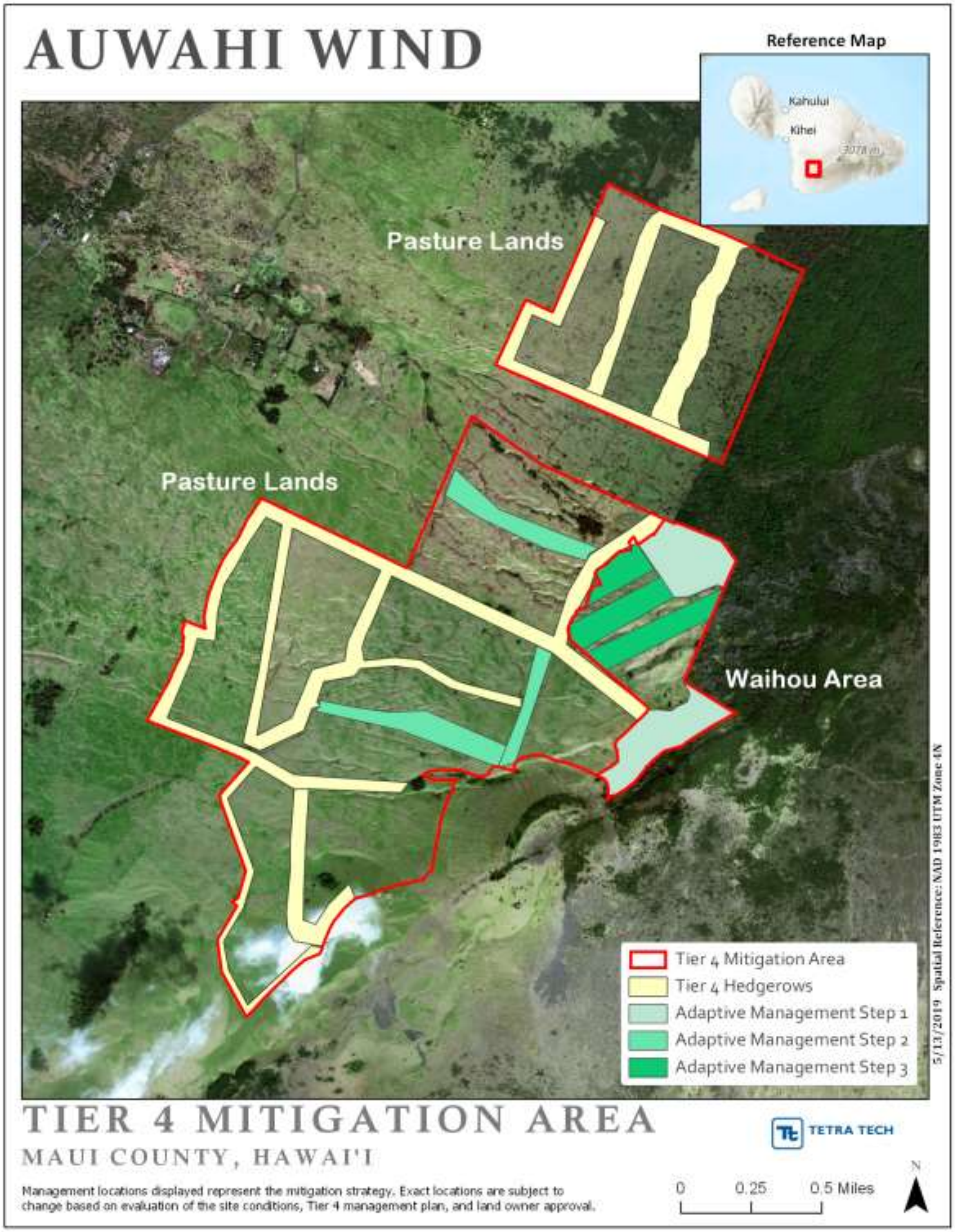


Figure 6-6. Management Plan for the Reforestation of Hedgerows

Within the hedgerows, trees will be planted to a density of approximately 200 trees per acre or 15-foot (4.6-m) spacing. The hedgerows will be at least 80 feet wide (6 trees across) to provide linear landscape features, wind breaks, and foraging substrates for the Hawaiian hoary bat. The width of hedgerows was developed in consultation with USGS. U.S. Geological Survey researchers indicated that the hedgerows, regardless of width, would primarily be used as a foraging substrate and potentially as a night roost[9], but day roosting would likely occur in the nearby Kula Forest Reserve. Consultation with the Ranch, evaluation of the predominant weather patterns in the area, and data from Böhm et al. (2014) suggest that hedgerows of 80 feet should provide sufficient shelter from the wind and could reduce wind speeds by over 50 percent relative to open pastures. Numerous studies of bat species using hedgerows have documented hedgerow width ranging from 15 feet or single trees in width to 80 feet (Jantzen 2012, Lacoeuilhe et al. 2018, Kelm et al. 2014, Böhm et al. 2014). Gaps in hedgerows, such as for gates, will be minimized, ideally less than 30 feet and not exceed 650 feet each.

The hedgerows will be planted with fast growing native trees and understory species. The selection of tree species will be subject to availability and the suitability of tree species for Hawaiian hoary bats. Koa (*Acacia koa*) is preferred as it is expected to provide available insect biomass, available night roost locations, and is fast growing. A'ali'i (*Dodonaea viscosa*) is preferred for the understory. Koa and a'ali'i are selected as preferred hedgerow species because they have been demonstrated to be associated with both an increased abundance and diversity of insect species (Peck et al. 2015, Auwahi Wind 2018), including (Coleopterans) and moths (Lepidopteran), that are prey items for Hawaiian hoary bats (Todd 2012).

The hedgerows are intended to be fenced to prevent ungulates from damaging the out-planted trees. Auwahi Wind will utilize existing fences where available and install additional fencing[10] to surround the reforestation areas where necessary to prevent the ingress of ungulates and promote the long-term habitat suitability of the reforested areas.

Water Feature Management

Water Trough Egress Structures

Following recommendations from BCI for bats in general (Taylor and Tuttle 2007), Auwahi Wind will retrofit the existing troughs with wildlife egress structures. The egress structures ensure that any bats or other wildlife which fall into the troughs are able to escape and avoid drowning. The retrofit of troughs will decrease the risk of drowning for available water troughs within the Mitigation Area.

Pond Installation

Auwahi Wind will install two new ponds to increase the availability of water sources in the Mitigation Area. The ponds will have an approximate minimum size of 20 feet (6.1 m) in diameter

[9] Night roosting is differentiated from day roosting. Night roosting bats use available substrates to rest and digest after eating.

[10] All fencing used will be bat-safe, and free of barbed wire.

and a volume of 50,000 gallons. The minimum size of the pond was selected based on BCI recommendations for ponds which can be utilized by most bat species, and a greater surface area will be utilized where possible. The exact size and shape of the ponds will depend on the site conditions. Larger ponds are currently utilized by hoary bats at the nearby Duck Ponds site, and the installation of such ponds would be expected to significantly increase bat foraging and drinking resources. The pond design would incorporate varying water depth to facilitate insect species associated with shallows that serve as prey for bats. The ponds will be fenced to exclude cattle, and such fencing will be sufficiently far from the pond so as not to pose a collision hazard for bats. The existing ponds are naturally replenished by rainfall, which can be up to 60 inches per year (Ulupalakua Ranch, personal communication, 23 October 2018). The newly installed ponds would be expected to be naturally replenished by rainfall as well. Should rainfall be insufficient, management of the water supply will be modified through adaptive management (Section 6.2.4.7).

Fire Prevention

Fires are identified as one of the threats to the Hawaiian hoary bat (Section 3.8.1.2), and are a constant threat in Hawai'i, having increased fourfold in recent decades (Trauernicht and Pickett 2016). In Leeward Haleakalā, fires are recorded between Ulupalakua and Kaupo gap regularly. Fires in Kula State Forest reserve are rare but devastating, with major fires recorded in 1954, 1984, and 2007. In 2007, one of the most devastating wildfires burned 2,300 acres of the Kula Forest Reserve. The 2017 Kula Forest Reserve management plan cites this as the most devastating fire to happen in Hawai'i in decades. Fires threaten to destroy essential bat roosting habitat in the Kula State Forest reserve, Kanaio Natural Area Reserve, Waihou Area, and other available roosts. Additionally, fires can destroy the vegetation and insects which support Hawaiian hoary bat foraging. Therefore, fire prevention actions taken by Auwahi Wind will provide additional protection of bat foraging and roosting habitat.

In wildland firefighting, helicopters carrying 100-gallon tanks are used to supply water to prevent the spread of the fire. DLNR Division of Forestry has been seeking additional water sources in the Leeward Haleakala area but has been unable to secure funding and landowner support (Lance DeSilva, personal communication, August 10, 2018). The two 50,000-gallon ponds described above, sited adjacent to the Kula Forest reserve, will be designed to facilitate the aerial firefighting efforts essential for wildland fire prevention and serve as dip tanks. The addition of these larger ponds will allow for helicopters to fight fires to protect not only the Mitigation Area, but also adjacent lands including the Kula State Forest Reserve, Waihou Area, and the Kanaio Natural Area Reserve. The pond would be replenished over time from available water sources (i.e., rainfall).

Legal Protection

A permanent conservation easement will be conveyed over the Mitigation Area to the HILT. Certain covenants and restrictions will be placed on the protected Mitigation Area and shall be funded by Auwahi Wind, LLC. This easement will not supersede the existing agricultural easement but will impose additional servitudes which are necessary and appropriate for carrying out the Mitigation

Area bat-focused conservation measures, identified in the proposed Tier 4 Mitigation plan. As the easement grantee, HILT will ensure compliance with the covenants, terms, conditions and restrictions contained in the easement. Where the conservation easement differs from the agricultural easement the more restrictive easement shall apply.

The additional protections or restrictions which will be imposed on the Mitigation Area through the conservation easement include:

- Prohibiting removal of trees over 15 feet tall during the bat pupping season (April 1 through September 15);
- Protection of the hedgerows from removal;
- Maintaining ponds according to this mitigation plan;
- Prohibitions on the use of insecticides;
- Prohibiting artificial stocking of ponds with fish known to reduce insect populations; and
- Prohibiting the use of barbed wire when installing fencing or other such structures.

The parcel management provided by HILT includes:

- Holding rights surrendered by the landowner;
- Protection and preservation of the property set forth in the easement;
- Enforcement of the restrictions put forth in the easement; and
- Access to the lands in the easement for annual or more frequent monitoring for compliance with easement conditions.

The legal protection of the parcel ensures that future management actions are consistent with conditions that are favorable to bats, that are provided by the management actions above. These restrictions would prohibit removal of the hedgerows for all future land owners ensuring baseline reforestation efforts outlined above are maintained for many generations of bats. Koa is a long-lived species and thus would benefit many generations of bats. The maximum age of koa recorded by the U.S. Department of Agriculture (Baker 2009) range between 50 and 80 years. Koa can live much longer than 80 years, but the length of the data sets limit the maximum ages recorded. Therefore, the legal protection outlined here would protect the reforested hedgerows for an additional 50 to 80 years or more without additional restoration efforts. The addition of ponds is documented to facilitate bat use as described above. The restrictions on insecticides provide assurances that the insect prey is not removed for ranching (or other) purposes. The prohibition on the stocking of ponds with insectivorous fish prevents the features installed from being degraded or reduced in their suitability to support the additional bats protected in this plan. Finally, the prohibition on the use of barbed wire in the easement confirms that the threat of snagging bats (a documented threat) is an inconsistent land use.

6.2.4.3 Take Offset/Net Benefit

The Auwahi Wind Tier 4 mitigation package provides a combination of permanent habitat preservation, habitat restoration and enhancement, and research measures for the Hawaiian hoary bat; each mitigation measure is identified as a priority for recovery of the species by the ESRC Bat Guidance (DOFAW 2015) and the USFWS Recovery Plan (USFWS 1998). The mitigation package provides permanent legal protection of 1,752 acres, which are located adjacent to the Kula Forest Reserve and the Pu'u Makua restoration area, larger areas that support bats. In addition, the prescriptive management actions will enhance bat foraging and roosting habitat. As currently utilized, the 1,752 acres are of only marginal quality as bat habitat, and without Auwahi's bat-focused management plan, its suitability for bats will likely decrease over time. The combination of location, permanent legal protection, habitat restoration and enhancement, and habitat management, will fully offset the take of 60 Hawaiian hoary bats and provide a net benefit to the species. This multi-faceted mitigation approach is consistent with the ESRC Bat Guidance which states that habitat restoration that enhances or increases forested and foraging areas for bats is an optimum mitigation approach (DOFAW 2015).

USFWS and DOFAW consider protecting or enhancing habitat within the CUA of a bat as a benefit to the species. An acreage-based offset of 20.3 acres per bat is based on the best available science and is supported by USFWS (USFWS 2018) and DOFAW (DLNR 2018).[11] The Auwahi Tier 4 mitigation area exceeds this offset standard by permanently preserving approximately 29 acres per bat (1752 acres/60 bats = 29.2 acres/bat). Thus, utilizing the agencies' 20.3 acres per bat standard, the Auwahi Tier 4 mitigation actually offsets the take of 86.3 bats (1,752 acres ÷ median CUA of 20.3 acres per bat = 86.3 bats).

Auwahi's habitat restoration, enhancement and management measures for the 1,752 acres ensure that the benefits to bats of the Tier 4 mitigation package will be substantially greater than only acreage-based land preservation. These additional Tier 4 mitigation measures were developed to maximize the benefit to bats and increase connectivity to other nearby protected parcels containing bat habitat. The combination of hedgerows, water features, and grazed areas creates a concentration of optimal foraging resources, documented in numerous studies to increase bat activity. Bats are likely to overlap in the use of the Mitigation Area; the mitigation actions in Tier 4 target foraging resources, and foraging ranges are known to overlap (Bonaccorso et al. 2015, Bellwood and Fullard 1984). Hawaiian hoary bats are likely to have a roost outside the Mitigation Area, suggesting less than 20.3 acres per CUA will be utilized within the Mitigation Area. Bat capture rates increase by a factor of 3.3 for every 6.21 miles of additional edge (Duff and Morrell 2007). Applying this metric linearly, the new edge habitat in the Mitigation Area should increase bat capture rates by a factor of 12 or more. This is

[11] "We have determined the HWA [Helemano Wilderness Area] project continues to meet FWS guidance and the benefits of the project are anticipated to offset, at a minimum, the take of 55 bats (Tier 4) based on a median male bat core use area of 20.3 acres." (USFWS 2018).
"We concur with the USFWS . . . that mitigation credit for the Helemano Wilderness Area acquisition is properly assessed . . . Based on a median core use area of 20.3 acres per bat, this equates to a mitigation credit of at least 55 bats. We confirm that we agree with this method of calculating mitigation credit, including assessment based on the median bat core use area." (DOFAW 2018).

further evidence that the benefit of the Tier 4 mitigation package will far exceed the 60 bats necessary for the offset of take authorized in Tier 4.

Time is a key factor to consider when evaluating the impact of mitigation actions. The conservation easement will be permanent, and thus will protect the out-planted koa and other native tree species which are expected to last more than 50 years (regeneration of trees in the hedgerows will likely produce much longer benefits). Similarly, the newly installed water features, and removal of barbed wire will last well beyond the permit term. This will continue to provide new habitat benefits for five or more generations of bats, or a total of at least 300 bats. These measures will provide benefits to bats that will extend well beyond the term of the incidental take authorizations and accrue to multiple generations of bats.

Auwahi Wind's Tier 4 mitigation provides additional benefits to bats by reducing three known risks to bats: removing barbed wire, adding wildlife egress structures to water troughs, and providing new water sources for preventing wildfires. Hawaiian hoary bats are documented to have been snagged on barbed wire; barbed wire removal within the mitigation area increases the bats survivability. Hawaiian hoary bats have been documented to drown in pools, and therefore installation of wildlife egress structures reduces the likelihood of that occurring. Furthermore, to reduce the potential for wild fires which can destroy habitat, Auwahi Wind is creating new ponds to be used as dip tanks to prevent fires within and adjacent to the Mitigation Area. These new year-round water sources will increase the chances of preventing devastating fires such as the destructive 2,300-acre fire that occurred in the adjacent Kula Forest Reserve in 2007.

The Tier 4 package also includes several research elements. Auwahi Wind's Tier 4 mitigation provides a research-quality monitoring regime that exceeds what is necessary to demonstrate compliance. Mitigation monitoring incorporates: 1) thermal video for bat behavioral studies, 2) insect (i.e., prey) assessment, and 3) an extensive acoustic monitoring protocol to provide valuable insight into bat life history, habitat needs, and responses to management actions. Additionally, Auwahi Wind will also conduct a single-year occupancy study of the Hawaiian hoary bat on Leeward Haleakalā as described in Section 6.2.3. These studies enhance the benefits that land preservation and habitat management (described above) provide to the bat and are critical to the recovery of the species.

In addition to the biological demonstration of benefits outlined above, the Tier 4 mitigation meets and exceeds the bat mitigation recommendations in the ESRC Bat Guidance (DOFAW 2015). The purpose of the ESRC Bat Guidance is "to develop cohesive, consistent guidelines for project proponents attempting to avoid, minimize, and mitigate for incidental bat take, and for the regulators tasked with overseeing those projects." The ESRC Bat Guidance first "suggests that an appropriate estimated cost for mitigation take of one bat is $50,000. This may be applied to different types of mitigation options outlined below. . . ." The Guidance then presents three mitigation options:

1. Habitat Management (forest restoration or wetland restoration). The Guidance states that forest restoration mitigation projects should be calculated based on a rate of 40 acres per bat.

2. Land Acquisition. The Guidance states that land acquisition "provides benefits when the acquisition safeguards the land from future development, protects existing habitat, or provides an opportunity for restoration/creation of habitat." The Guidance does not recommend any specific amount of per-bat mitigation acreage. Instead, the Guidance states that "Larger parcels are typically preferable to smaller parcels. However, the location of a smaller parcel (e.g., adjacent to another larger area that supports bats or is being restored to support bats) could make it more attractive as a mitigation site." The Guidance goes on to say that Land acquisition proposals will be evaluated based on the following factors: acquisition alone or acquisition plus a management plan, current status of and threats to the parcel, size of parcel, and whether the acquisition and preservation will be in perpetuity.

3. Research. The Guidance states that research "is not generally a preferred mitigation strategy" but can be used where research "can enable better management of the species." "In order for research to be credited as mitigation, research projects should be targeted to provide information on better management actions for the Hawaiian hoary bat that will lead to increasing the recovery of the species." The Guidance then identifies specific research priorities.

The estimated cost of Auwahi's multi-faceted Tier 4 mitigation package is approximately $63,700 per bat (Appendix I, including adaptive management), which exceeds the ESRC's recommended $50,000 benchmark by more than 27%. Auwahi has applied that cost mainly to the land acquisition and habitat management mitigation options, as detailed above, consistent with the ESRC Bat Guidance.

The amount and types of multi-faceted mitigation measures included in the Tier 4 mitigation package provide reasonable certainty that the mitigation will provide a net benefit to bats and increase the likelihood of the species' recovery. This reasonable certainty is further supported by the very conservative nature of the underlying take estimates. As explained previously, take is estimated using the 80-percent credible limit, and estimates of mortality are increased relative to estimates at the 50-percent credible limit (Appendix H). Take estimates assume all females taken between April 1 and September 15 have dependent young, and that all young lost as a result of Project operation would have survived to adulthood. These conservative assumptions thereby purposefully overestimate likely impacts to the bat. By fully mitigating for this likely overestimate of take impacts, the level of certainty regarding the effectiveness of the mitigation package is greatly increased.

In summary, the mitigation actions will lead to permanent protection of and substantial increases in the use of the Mitigation Area by Hawaiian hoary bats resulting in an overall significant net benefit to the species and increasing the likelihood of recovery. As identified above, benefits of the Tier 4 mitigation package include:

- Providing a multi-faceted mitigation plan that includes land acquisition, bat-focused habitat management, and research;
- Permanently protecting and preserving 1,752 acres of bat habitat;

- Increasing bat foraging and night roost habitat through enhancements of pastures with new hedgerows of native canopy and understory species;
- Creating additional water sources in new ponds, adding year-round water availability;
- Enhancing connectivity to other State reserve areas provided by the Mitigation Area's location;
- Benefiting multiple generations of bats over the life of the permit and beyond;
- Removing barbed wire that is a supplemental benefit to generations of bats that extend beyond the term of the incidental take authorizations;
- Increasing the survivability of bats with installation of water egress structures;
- Reducing the risk of wildfires with installation of new ponds with benefits that extend beyond the term of the incidental take authorizations;
- Implementing a research-quality monitoring regime which will provide valuable insight into the behavior, prey, life history, habitat needs, and responses to management actions;
- Providing critical research into the landscape level occupancy and distribution of the Hawaiian hoary bat, identified by the ESRC to be necessary for the recovery of the species;
- Consistency with the ESRC Bat Guidance which states "… the ESRC suggests that an appropriate estimated cost for mitigating take of one bat is $50,000" (DOFAW 2015). The Tier 4 mitigation estimated cost is $63,700 per bat (Appendix I); and
- Reducing the uncertainty in how to manage lands for bats.

6.2.4.4 Measures of Success

Because the Hawaiian hoary bat is a solitary tree roosting species, monitoring can be difficult. Tools for assessing feeding in a given area have been identified to assess the impacts of mitigation. Efforts at proxy measurements have focused on acoustic monitoring of bat activity, and evaluating calls has been recommended by Hawaiian hoary bat research (Gorresen et al. 2018, Todd 2012). Additionally, overall population trends and habitat occupancy on Maui have not been studied and such a baseline may take years to determine.

Auwahi Wind has developed success criteria to ensure that the objectives of protecting and enhancing bat foraging and roosting habitat are being met. Additionally, the monitoring (see Section 6.2.4.5) is designed to determine the overall trends in calls for the site.

Success criteria:

- Protect the mitigation parcel in perpetuity through a conservation easement including protections outlined in Section 6.2.4.2 with oversight of the parcel by HILT (or other appropriate conservation entity).

- Install two additional ponds in the Mitigation Area according to this management plan, or other number as specified through adaptive management.
- Increase forest cover to 20 percent within the pasture parcels through hedgerow reforestation at approximately 200 trees per acre, or other cover and parcels as specified through adaptive management.
- Record an increase in bat activity through acoustic monitoring over the baseline monitoring year(s), see Monitoring below. The statistical power with which the increase is recorded will also be reported.
- Summarize and report the results of monitoring (Section 6.2.4.5) in annual reports.

Long-term success criteria:

- Ensure mitigation parcel is managed according to the conditions within the conservation easement including protections outlined in Section 6.2.4.2 with oversight of the parcel protection by HILT (or other applicable entity).

6.2.4.5 Monitoring

As identified above, the current tools available to monitor for Hawaiian hoary bats are limited, which limits the ability to determine population size and population effects after implementation of management actions. The common methods for monitoring bats are acoustic monitoring, thermography, radio tracking, and mark-recapture. Acoustic monitoring has been most widely used, but recent studies (Gorresen et al. 2017) have shown that a bat may traverse acoustic detectors without calling, thereby causing underestimation of bat activity in the monitored area. The acoustic detectors also cannot provide counts of individuals. Therefore, acoustic monitoring is most suitable for long-term or spatially distributed studies. Thermography is both expensive to implement and has the limitation of being directionally focused, limited in focal depth, and unable to differentiate if bats are transiting the area or foraging. Thermography is valuable for specific applications, such as behavior monitoring. Mark-recapture studies are a traditional tool used for estimating population sizes. Bats have been difficult to capture, and recapture of bats are rare; for this reason no population-level mark recapture studies have been performed to date. Furthermore, GPS transmitter technology is not yet sufficiently light (less than 5 percent of body mass, or 0.4 grams) to be used on a Hawaiian hoary bat. Site-specific considerations also have implications for study design. Prior studies attempting to utilize radio tracking in the Mitigation Area were precluded by the unsuitability of the site due to electromagnetic interference from nearby transmission sources and USGS recommended no further telemetry studies there (Auwahi Wind 2017).

The primary monitoring success criteria will be to discern an increase in bat activity at the site. Secondary goals include determining the impacts of management actions and verification that management actions are consistent with the management program. Overall, the ability to estimate the actual bat population is limited by the available tools, and determining population size and population impacts have been difficult to discern. The management actions target increasing foraging habitat; therefore, using acoustic monitoring to monitor calls is proposed as the most appropriate tool to assess the impacts of the management.

Acoustic Monitoring

Acoustic monitoring will be the primary means of assessing the bat utilization at the Mitigation Area. Increasing foraging at the Mitigation Area is an essential part of the objective for the proposed Tier 4 Mitigation. The total number of calls will be documented. Acoustic monitoring provides information on the level of use or activity. Areas with greater levels of acoustic activity are assumed to provide better habitat than sites with lower activity (Frick 2013). The inclusion of all calls, rather than specifying call types (i.e., feeding buzzes) is supported by recent literature which notes the lower amplitude of feeding buzzes makes them more difficult to detect, and the monitoring of all calls is an appropriate measure of abundance (Gorresen et al. 2018).

Acoustic detectors[12] will be placed across the Mitigation Area at 10 sampling locations targeting each sub-habitat: open grasslands, forest edges (hedgerows or otherwise), and water troughs, for a minimum of 30 detectors plus one acoustic detector at each pond (the number of sampling locations is subject to change after power analysis). An additional ten locations will be identified across the landscape. At these ten locations, up to five additional detectors will be selected annually to collect monitoring data. Baseline monitoring will also be conducted at up to five locations outside of the Mitigation Area (exterior detectors) in appropriate similar habitat. The exact location of detectors will be selected from a grid of 328 x 328-foot cells overlaid on the site. The cells will be selected with generalized random tessellation stratified sampling. The random selection process will identify cells containing suitable sampling locations and the first ten suitable sites of each type will be selected. An approximation of the distribution of monitoring locations is detailed in Figure 6-7. Current acoustic detectors have an approximate detection radius of 30 feet. Detectors sited at water sources will be less than 30 feet from the water source to capture bat activity associated with troughs and ponds. Detectors at forest edges will be placed 30 feet from the forest edge to capture the anticipated peak in activity between zero and 60 feet from the forest edge.

Several potential confounding factors may influence the acoustic detections at exterior detectors including:

1. The flight distance of Hawaiian hoary bats is up to 7 miles, and it is not known how far the effects of the mitigation actions will impact the utilization of the surrounding area;
2. The climate conditions change significantly less than 0.5 miles to the east of the Mitigation Area as the topography transitions to the leeward side of the island;

[12] Detector selection will be based on the current industry standard. Changes in detectors will be minimized, documented, and for a change in detectors, a comparison of the two will be documented, ideally being a period of overlap that would allow direct comparison of results.

3. Changes in elevation in the area also bring significant differences in habitat conditions; and
4. The land use can significantly alter the habitat. Nearby residential, or forest parcels may not be suitable for comparison with pasture lands.

The exterior detectors will therefore be used for reference but will not be used to evaluate success criteria.

The detectors will be checked quarterly to download data and ensure the detectors are working properly. Additionally, the following data will be recorded for each detector at each data collection:

- Detector status;
- Nearest water source (pond or trough);
- Distance to nearest water source;
- Habitat type (grassland or edge);
- Distance to nearest forest edge;
- Classification of nearest forest edge:
  - Low Hedgerow (less than 10 feet tall);
  - Hedgerow (more than 10 feet tall); and
  - Forest (mature forest found in adjacent forest reserve or several stands in Waihou)'
- Presence or absence of cattle within the pasture where the detector is placed[13]; and
- Notes.

Monitoring data prior to the installation of water features will serve as the baseline period for the number of calls. Acoustic monitoring will occur year-round for the baseline period, after which a power analysis will be conducted to determine the number of detectors and the timing of deployment. Baseline monitoring will occur for at least one year.

The number of calls will be the primary tool to evaluate the success of management actions. An active detector night is when the acoustic detector remains active for more than half of the hours from sunset to sunrise. Each detector will be evaluated for active detector nights, thus 1 night with 30 active detectors is 30 active detector nights. The number of calls will be evaluated and compared to the location of water features and hedgerows that have been installed. Two metrics will be evaluated: 1) the call abundance (total number of calls recorded per active detector night), and 2) call nightly detection (proportion of total active detector nights with calls).

$$Call\ Abundance = \frac{Total\ calls}{Total\ active\ nights}$$

[13] May be supplemented with Ranch records.

$$Call\ Nightly\ Detection = \frac{Total\ nights\ with\ calls}{Total\ active\ nights}$$

An increase in average calls is expected in the monitoring year following the year(s) in which pond installations are completed. The overall probability of calls will be evaluated per habitat type to provide insight into the impacts of the individual and combined effects of the variables: open pasture, forest edge, trough, pond, and presence or absence of cattle.

The data will be analyzed after years 0, 1, 2, 3, 5, 7, 9, and 11. Data analysis will compare the covariates of ponds, and hedgerows to determine the impacts of each management action and the overall abundance and detectability at the site. The results of this analysis will be summarized in the annual report following the completion of each year.

Power Analysis

Following the first year of data collection, call abundance and call nightly detection will be analyzed to determine if it varied by factors such as distance to nearest water source, habitat type, and distance to nearest forest edge. These data will then be used in a power analysis to estimate the probability of detecting increases in calls of different magnitudes with different numbers of detectors. The factors that were found to be important in the initial analysis as well as the variability encountered will inform the structure of the power analysis.

Under each scenario, the number of calls will be increased for each site based on a given percent increase and with a given variability in the response. The data will be analyzed and the significance level for the year (pre and post) variable will be recorded. This process will be repeated several thousand times and the proportion of simulations with a p-value less than or equal to 0.05 will be the estimate of the power to detect a difference for that increase in calls. The number of sites included can be varied to determine how the power to detect an increase in calls changes in response to sample size.

Potential scenarios to evaluate include:

- A 50, 100, or 150 percent increase in call abundance at all sites;
- The increase in call frequency varies by habitat type;
- The increase in call frequency varies by month or season; and
- Low, medium, or high variability in response among sites.

As a result of the power analysis, the number of acoustic detectors or sampling regime may be reduced by Auwahi Wind when there is sufficient power to detect a 50 percent change in occupancy across the site with a power of 0.5 or greater. The results of the power analysis and resulting changes to the monitoring protocol will be reported to the USFWS and DOFAW and recorded in the annual report.

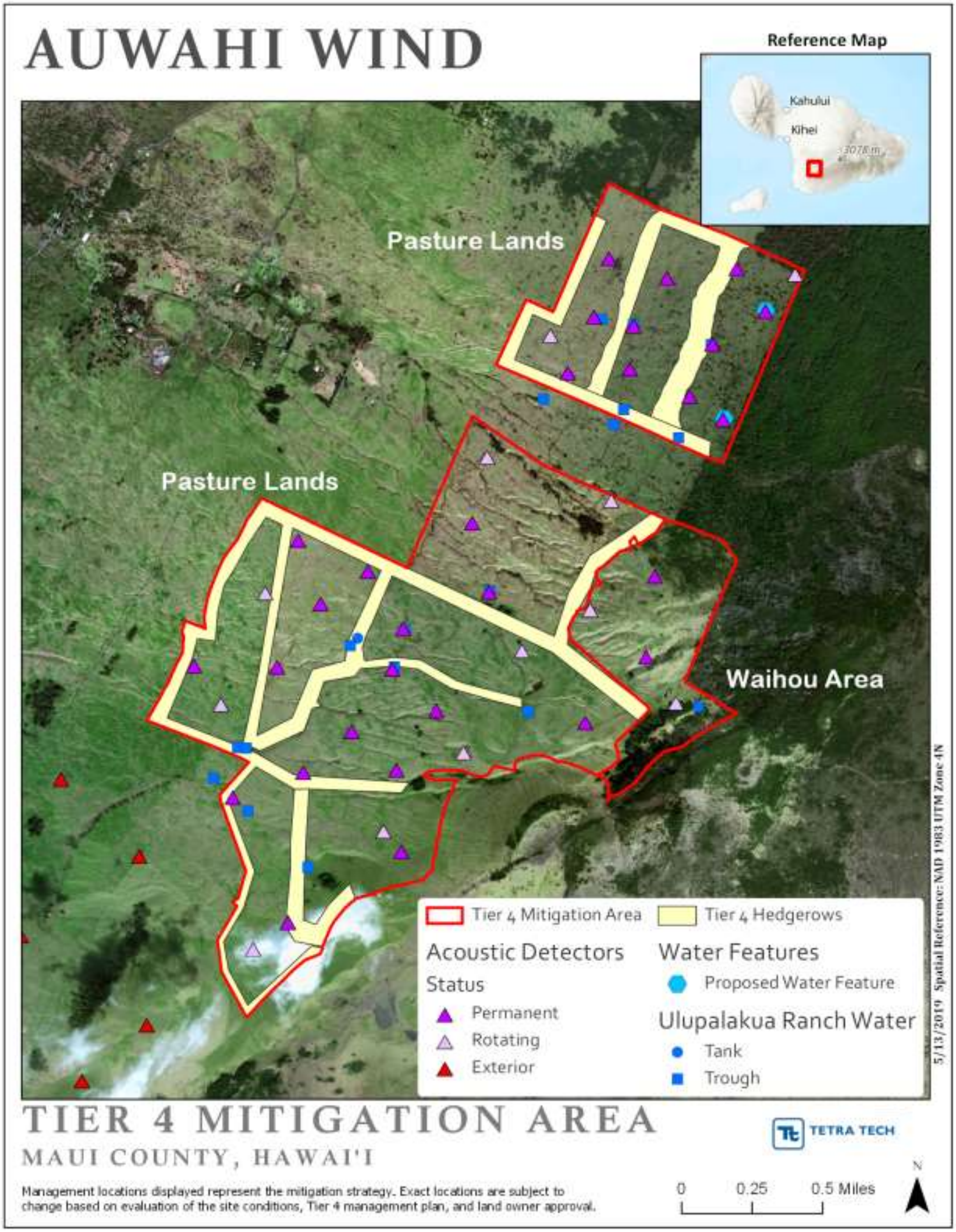


Figure 6-7. Locations of Acoustic Detectors Relative to Management Actions

Data Analysis

The data collected during the acoustic monitoring portion of this study will be summarized as call abundance and call nightly detection for each site during each month as described previously. The frequency and spatial distribution of call occurrence will not be known until data collection begins; therefore, data analysis methods may need to be modified if these values differ greatly from expected (e.g., large number of sites with no calls recorded or calls recorded every night). Call abundance is count variable and call nightly detection is a proportion, but both can be analyzed within the generalized linear mixed model framework. Count data can be modeled with a Poisson distribution or, if over-dispersion is observed, a negative binomial model can be used. The proportion of nights with a call can be modeled as a binomial distribution that models the number of successes during some number of trials. The results from each monitoring location will be autocorrelated and results adjusted to include location as a random variable. The power will likely be increased by comparing pre- and post- changes for each location directly.

This analysis provides flexibility for different data types and additional complexity of the model. If a substantial portion of monitoring locations have no calls recorded, a more complex zero-inflated model could be considered. Competing models can be compared using Akaike information criterion (AIC) values (Akaike 1973). AIC is a quantitative comparison of models and provides a means of model selection. Models within 2 AIC units of the best model will be considered to have some support (Burnham and Anderson 2002) and model averaged parameter values could be calculated.

This model framework treats monitoring locations as spatially independent. Acoustic monitors will be distributed widely to minimize the spatial autocorrelation among adjacent monitors. The 1,752 acres within the Mitigation Area could support 86 bat CUAs of 20.3 acres each, therefore 30-40 monitors widely dispersed could be largely independent. If large spatial correlation is suspected, analysis methods to take this into account can be considered (Dormann et al. 2007). The results of this study could also be influenced by changes in the overall bat population on the island. The data from acoustic monitors outside of the Mitigation Area will be analyzed to attempt to assess bat trends independent of the mitigation measures.

Percent Forest Cover

Optimal forest cover as documented by Jantzen (2012) is 20 to 25 percent cover of the parcel to optimize hoary bat utilization of the site. The percent cover of the parcel will be assessed through GIS analysis. The perimeter of each forested area will be traversed and recorded via GPS to generate a polygon. All woody vegetation with an apical stem greater than 10 feet in height will be included to assess the total vegetated area. The perimeter of the outer branches will determine the boundary. Continuity of forest will be determined by separation of tree base and height of apical stems, separation of the base of trees is not to exceed 22 feet (diagonal distance estimated by 15-foot spacing). Percent forest cover will be reported in monitoring years after year five. If any monitoring period shows the forest cover is below 20 percent, Auwahi Wind will replant trees necessary to bring the forest cover up to 20 percent. Auwahi Wind may first error check and/or resample the

Mitigation Area within three months to ensure that any measurement that does not meet success criteria was not the result of seasonal variation or inconsistencies in the data collection method. In any year when aerial imagery was taken for the Mitigation Area, GIS analysis of the aerial imagery may be substituted for a field survey of the perimeter.

Thermal Videography

Auwahi Wind will use thermal cameras to document the behavior of bats at ponds and/or water troughs. The effort and duration of monitoring will be determined by Auwahi Wind. The results of the monitoring will be reported in the annual report.

Insect Monitoring

Auwahi Wind will conduct quarterly insect monitoring for the baseline monitoring period for each of the following substrates: pond, future hedgerow location, and pasture. Following the baseline monitoring, semiannual (twice yearly) insect monitoring will be conducted in years 1, 2, 3, 5, 7, 9, and 11. Monitoring will consist of one malaise trap set-up for 1 month at each of the three locations. Following the sampling the lepidopteran and coleopterans will be identified and the abundance of each order (for insects over 10 mm) will be reported in the annual report.

Pond Monitoring

The ponds within the Mitigation Area will be checked quarterly to ensure they are operating correctly. Should repairs be required they will be made as soon as is practicable and before the next quarterly check.

Other Monitoring

Other monitoring may be added to the monitoring protocol if is determined that the monitoring outlined above is not sufficient to determine the response of Hawaiian hoary bats to the mitigation actions.

6.2.4.6 Reporting

The success criteria will be the primary metrics for analysis. Auwahi Wind will include in the annual report a summary of the data by year, including the baseline monitoring year. Specifically, Auwahi Wind will include:

- The date the conservation easement was recorded, and annual inspection records if available from HILT;
- Photos of existing ponds and created ponds;
- A summary of acoustic monitoring data and a comparison to the baseline monitoring year, including the statistical power with which any change is documented. The results of the generalized linear mixed modeling including the AIC of all models;
- The percent forest cover and a summary of the analysis;

- A summary of insect assessment, by season and year, and a comparison to acoustic monitoring results;
- A qualitative report of behavior documented for all periods when thermal imagery was recorded. An evaluation of the total number of observations documented and a comparison to the level of effort;
- Any adaptive management actions taken; and
- Any additional pertinent summary information needed to provide a full picture of mitigation actions.

6.2.4.7 Adaptive Management

Because the benefit of each of the mitigation actions are likely to vary, adaptive management will be an essential component of the HCP and the Tier 4 Mitigation. All initial mitigation actions will be evaluated against the success criteria in years 5, 7, 9, and 11 of the HCP Amendment. Each evaluation will be an opportunity for adaptive management to be triggered. Triggering of any adaptive management will also trigger monitoring for the next 2-year interval to ensure that success criteria are met.

The following triggers for success criteria and adaptive management are based on the evaluation of management actions described below. These triggers include:

- If either the call abundance or call nightly detection is doubled or greater, relative to baseline monitoring, no adaptive management actions will be necessary;
- Adaptive management will be triggered if both call abundance and call nightly detection are less than or equal to the baseline; and
- Adaptive management may be triggered if either call abundance or call nightly detection are less than or equal to the baseline. If either the call abundance or call nightly detection is equal to or less than the baseline, and the other variable is not doubled or greater, adaptive management will be triggered.

If adaptive management is triggered, Auwahi Wind will also assess the insect composition relative to the baseline conditions. If the insect monitoring does not show that species needed for bat foraging are present (principally moths and beetles, or other species documented through diet analysis of the Hawaiian hoary bat), Auwahi Wind will either[14]:

1. Change the species composition or replace trees that have not survived with new canopy species shown to support Hawaiian hoary bat foraging; or

[14] Auwahi Wind may initiate either action earlier than the triggering of adaptive management. The initiation of these actions prior to adaptive management triggers will be considered adaptive management.

2. Supplement the understory species within the hedgerows with a minimum of 5,000 individuals of a native plant species shown to support Hawaiian hoary bat foraging.

Modification of Management Actions

The goal of adaptive management actions is to collect data on the effectiveness of the management actions and respond with measures that are shown to be effective at having a positive influence on success criteria. As there is uncertainty in the response of Hawaiian hoary bats to the management actions, Auwahi Wind has a number of options available for modifying the proposed management actions including:

1. Additional ponds;
2. Additional hedgerows;
3. Reforestation at higher densities within the Waihou parcel;
4. Alteration of canopy species; and
5. Alteration of understory species.

By having a selection of options for future adaptive management, Auwahi Wind avoids implementing management actions that do not positively impact the Hawaiian hoary bat population and prioritizes management actions that are correlated with increased Hawaiian hoary bat activity. If adaptive management is triggered, modifications to the proposed management actions (described below, summarized in Table 6--1~~Table 6-1~~) will be implemented.

The adaptive management action will be determined from the monitoring response of the prior management actions implemented. A maximum impact for each of the management actions implemented is assumed but that maximum is not known. To determine if management actions are positive, the measurement of distance to features will be used to conduct a generalized linear mixed model, selecting multiple input models. The model with the lowest AIC value will be selected to determine which covariates provide the greatest prediction of bat activity. If no significance can be determined, the data will also be summarized for trends. A map of the scale of results will also be produced to determine if there are geographic trends. Therefore, the impact of the prior management actions will be compared, and the management action (either hedgerows or water features) that elicited a greater response will be implemented for adaptive management. If both hedgerows and water features have a similar response, hedgerows will be prioritized for years 5 and 7 so that the impact may be realized within the permit term. Water features will be prioritized in years 9 and 11 given that their impact will be realized quickly.

Reforestation of Hedgerows

Through adaptive management, Auwahi Wind seeks to provide habitat that would ensure the needs of the Hawaiian hoary bat are met. Through adaptive management, Auwahi Wind will target the Waihou parcels for higher levels of reforestation.

Three opportunities for adaptive management with respect to reforestation occur with one each in years 5, 7, and 9 (Figure 6-6). Reforestation actions taken in year 11 of the HCP Amendment would be unlikely to have impacts on the success criteria within the remaining years of the permit term, and thus are not included. Each step of adaptive management will be implemented successively. Therefore, if step one is not implemented at year 5, and adaptive management is triggered in year 7, step one will be implemented in year 7.

1. First step of adaptive management for hedgerows:

If additional reforestation actions are triggered at the initial evaluation of success criteria, reforestation of the Waihou Area parcels of Cornwell, Kaumea Loco, and Duck Ponds will be implemented. Initial efforts to reforest these sites will increase the forest cover in the Waihou Area to 40 percent in Figure 6-6 (79.2 acres of forest). Reforestation at 40 percent of total cover within 1.5 miles of study sites represents an increased use rate observed for hoary bats (Jantzen 2012).

2. Second step of adaptive management for hedgerows:

If additional reforestation actions are triggered, hedgerows within the pasture lands will be increased so that total cover will be increased to 25 percent within the Pasture parcel, or an additional 78 acres of hedgerows. Target sites will be selected to optimize habitat connectivity, as well as maximize the opportunity for bat use. The siting of additional hedgerows will consider the past out-planting success, the call abundance and call nightly detection in similar site conditions, the connectivity to other habitat features utilized by the Hawaiian hoary bat, and the logistics of site management.

3. Third step of adaptive management for hedgerows:

If additional reforestation actions are triggered, the forest cover will be increased to 70 percent of the area within the Waihou Area or 59.4 additional acres of reforested area (Figure 6-6; Jantzen 2012). Increasing forest cover to 70 percent cover represents the second peak observed in the activity of hoary bats.

Table 6--1. Management Actions by Parcel: Baseline and Proposed

Parcel	Acreage	Land Cover	Baseline	Initial Reforestation	Adaptive Management
Pasture	1,~~198~~554	Forest	0%	20%	25% (Step 2)
Waihou	198	Forest	25%	25% (unchanged)	40% (Step 1) and 70% (Step 3)

Ponds

Adaptive management will be evaluated at four intervals: Years 5, 7, 9, and 11. If new ponds are determined to be necessary through adaptive management, the evaluation of ponds will compare the call abundance of the added ponds. The siting of such features will take into consideration the existing water features, the distance to existing water lines, and the nearness to roosting habitat.

Alternative Management Actions

If neither reforestation of hedgerows or the addition of ponds is indicated, Auwahi Wind will work with USFWS and DOFAW to identify appropriate alternative actions based on the monitoring data.

Water Availability

If the quarterly monitoring of ponds finds that they are consistently (three consecutive quarters, or the same quarter for three years) not supplied with sufficient water to keep them full, Auwahi Wind will investigate the cause and rectify the problem. Such resolutions may include (depending on the source of the problem): repair of structure or liner, securing alternative sustainable sources of water (such as known springs or catchment systems), alteration of the system to provide additional resilience, or other methods to maintain the water sources.

Monitoring

The monitoring plan may be adjusted based on the result of the power analysis and updated in subsequent years if assumptions are found to be incorrect.

Any change to monitoring will be reported to the USFWS and DOFAW, and noted in the annual report.

6.2.4.8 Timeline

There is an immediate need for action to mitigate the impacts of taking Hawaiian hoary bats at the Project. Auwahi Wind will begin mitigation actions upon issuance of the amended ITP/ITL. Auwahi Wind will provide a copy of the easement to DOFAW and USFWS within 30 days of ITP/ITL issuance. Agencies will review or respond within 30 days or the form of the easement shall be deemed acceptable.

Baseline monitoring is important to documenting changes to the landscape and demonstrating that success criteria are met. Logistical needs for implementation are expected to take approximately one year to complete including the installation of water trough egress structures, installation of ponds, hedgerow fence installation, and other infrastructure improvements. Auwahi Wind will use the time required for infrastructure improvement to conduct baseline monitoring. The timeline of actions is outlined below in Table 6-2~~Table 6-2~~.

Table 6-2. Timeline for Actions to be Implemented

HCP Amendment Year	Actions	Evaluation
0	• Parcel protected through conservation easement • Baseline monitoring conducted • Infrastructure improvements: water line installation, fencing, water trough egress installation, and pond installation to begin • Quarterly Insect Monitoring	• Conservation easement recorded • Baseline monitoring conducted • Management actions implemented
1	• Continued infrastructure improvements: continuation of year 0 actions	• Acoustic monitoring occurring at water troughs and ponds and pasture lands

HCP Amendment Year	Actions	Evaluation
	• Completion of installation of ponds, all water features filled according to management plan • Initial reforestation of hedgerows • Power analysis for acoustic detectors • Acoustic monitoring • Semiannual Insect Monitoring • Thermal videography behavioral monitoring at water troughs and ponds • Quarterly water pond inspection	
2 and 3	• Continued infrastructure improvements from years 0 and 1 • Replanting of hedgerows to replace losses • Fence maintenance • Acoustic monitoring • Semiannual Insect Monitoring • Quarterly water pond inspection	• Acoustic monitoring occurring at water troughs, pasture lands, and hedgerows • Hedgerows out-planted cover 20% of the Mitigation Area at 15-ft spacing, with average height less than 5 ft
5	• Fence and infrastructure maintenance • Acoustic monitoring • **Evaluation of monitoring to determine the need for adaptive management to meet success criteria** • If warranted: adaptive management actions as specified by the adaptive management plan • Semiannual Insect Monitoring • Quarterly water pond inspection	• Acoustic monitoring occurring at water troughs, pasture lands, and hedgerows • Evaluation of success criteria.
7	• Fence and infrastructure maintenance • Acoustic monitoring • **Evaluation of monitoring to determine the need for adaptive management to meet success criteria** • If warranted: adaptive management actions as specified by the adaptive management plan • Semiannual Insect Monitoring • Quarterly pond inspection	• Acoustic monitoring occurring at water troughs, pasture lands, and hedgerows • Evaluation of success criteria
9	• Fence and infrastructure maintenance • Acoustic monitoring • **Evaluation of monitoring to determine the need for adaptive management to meet success criteria** • If warranted: adaptive management actions as specified by the adaptive management plan • Semiannual Insect Monitoring • Quarterly pond inspection	• Acoustic monitoring occurring at water troughs, pasture lands, and hedgerows • Evaluation of success criteria
11	• Fence and infrastructure maintenance • Acoustic monitoring • **If success criteria are not met in year 9, evaluate monitoring results to determine the need for adaptive management** • If warranted: adaptive management actions as specified by the adaptive management plan • Semiannual Insect Monitoring • Quarterly pond inspection	• Acoustic monitoring occurring at water troughs, pasture lands, and hedgerows • Evaluation of success criteria

6.2.5 Tier 5 and Tier 6 Mitigation

Auwahi Wind has identified land restoration/management as the primary type of mitigation for Tiers 5 and 6, to enhance bat foraging and roosting habitat and provide an overall benefit to the species. Tier 5 and 6 mitigation is based on criteria similar to that used for Tier 4 mitigation, and targets many of the same management goals and actions known to have positive benefits for bats, as previously described in Sections 3.8.1 and 6.2.4. Tier 5 and 6 mitigation will be implemented in the Kamehamenui Forest/Von Tempsky Parcel (Kamehamenui Forest) located in east Maui. DOFAW recommended that Auwahi Wind consider conducting mitigation actions in the Kamehamenui Forest, which is proposed for DLNR acquisition, to mitigate for Tier 5 and 6 take levels of 34 and 25 bats, respectively. Auwahi Wind would improve 690 acres of habitat in Tier 5 and 508 acres in Tier 6 (see the Take Offset/Net Benefit section under Section 6.2.5.1 below), based on the median bat CUA size of 20.3 acres (DOFAW 2015).

Triggers for Mitigation

Planning for the next tier of mitigation will occur prior to reaching the amount of take authorized in the current tier. The triggers for initiating mitigation for Tiers 5 and 6 are described in Table 6-3 below. Mitigation planning for the next higher tier would be triggered by reaching 75 percent of allowed take in the current tier (direct and indirect), as outlined in guidance from USFWS (USFWS 2016b). Based on expectations of the effectiveness of LWSC, it is likely that Tiers 5 and 6 may not be reached until much later in the permit term, if at all (Section 5.1.1 provides information on the take estimation, and Appendix H provides details on the estimation process).

Table 6-3. Tiers 5 and 6 Triggers for Initiating Hawaiian Hoary Bat Mitigation

Trigger for Initiating Additional Mitigation[1]	Mitigation Tier Triggered
Cumulative Take Estimate > 66 bats	Tier 5
Cumulative Take Estimate > 106 bats	Tier 6

1. The EoA software will be used to calculate the 80 percent upper credible limit of cumulative direct take; the calculation of indirect take is described in Appendix H. If the 80 percent upper credible limit of cumulative take (direct + indirect) is reached, the tier will be triggered.

6.2.5.1 Kamehamenui Forest/Von Tempsky Parcel Project

The Kamehamenui Forest will serve as the mitigation area for the Auwahi Wind Tier 5 and 6 bat mitigation, should those tiers be triggered, as it provides a unique restoration opportunity that will benefit the Hawaiian hoary bat. DOFAW suggested the Kamehamenui Forest to Auwahi Wind as a desirable site to consider for bat mitigation (Fretz 2018, pers. comm.). Upon learning more about the parcel's characteristics and DOFAW's proposed management goals for the property, Auwahi Wind decided to move forward with the Kamehamenui Forest as its proposed Tier 5 and 6 mitigation area.

Site Description

The Kamehamenui Forest parcel is located on the north slopes of Haleakalā. It is approximately 3,400 acres and stretches from upper Kula (3,400 feet asl) to nearly the summit of Haleakalā (9,800 feet asl). Haleakalā National Park is adjacent to the parcel to the east, and the Kula Forest Reserve is adjacent to the parcel to the south (Figure 6-8). The upper elevations (>8,000 feet) are designated federal critical habitat for 10 rare plant and bird species. The lower elevations are primarily pasture lands that are well-suited for reforestation.

The DLNR is actively pursuing the acquisition of this land for incorporation into the State Forest Reserve system under the management of DOFAW. DLNR considers this parcel "strategically critical" for the Watershed Partnerships (USDA Forest Service 2018). DOFAW has prepared several documents about the property that describe 1) the benefits of protecting the parcel, 2) DOFAW's management goals, and 3) its process for preparing a detailed management plan that outlines proposed management actions to accomplish their goals for the parcel (USDA Forest Service 2018, DLNR n.d., BLNR 2019; compiled as Appendix J). DOFAW requested approval of the parcel acquisition from the Board of Land and Natural Resources (BLNR) on March 8, 2019 (BLNR 2019). The request for approval document, submitted to the BLNR, provides a detailed outline of DOFAW's plan for the parcel that includes management to benefit the Hawaiian hoary bat and calls out the compatibility of this parcel as mitigation for listed species. Pertinent excerpts from the DLNR (BLNR 2019) state:

> If acquired by the State, the intent is to add the Parcel [Kamehamenui Forest] to the Forest Reserve System. The division will develop a comprehensive multi-use management plan, guided by community and stakeholder input."
>
> "This project will protect the Property's ecosystems, including a native subalpine ecosystem in the upper elevations (>8000'[feet]), which are designated federal critical habitat for 10 rare plant and bird species. These areas are relatively intact and native species are expected to regenerate naturally once the area is protected from feral ungulates. These areas are expected to be important for species adaptation to climate change as habitats shift under changing conditions. Lower elevation portions of the property are well suited for reforestation with ecologically and economically valuable species such as koa (*Acacia koa*) and sandalwood (*Santalum haleakalae* var. *haleakalae*).

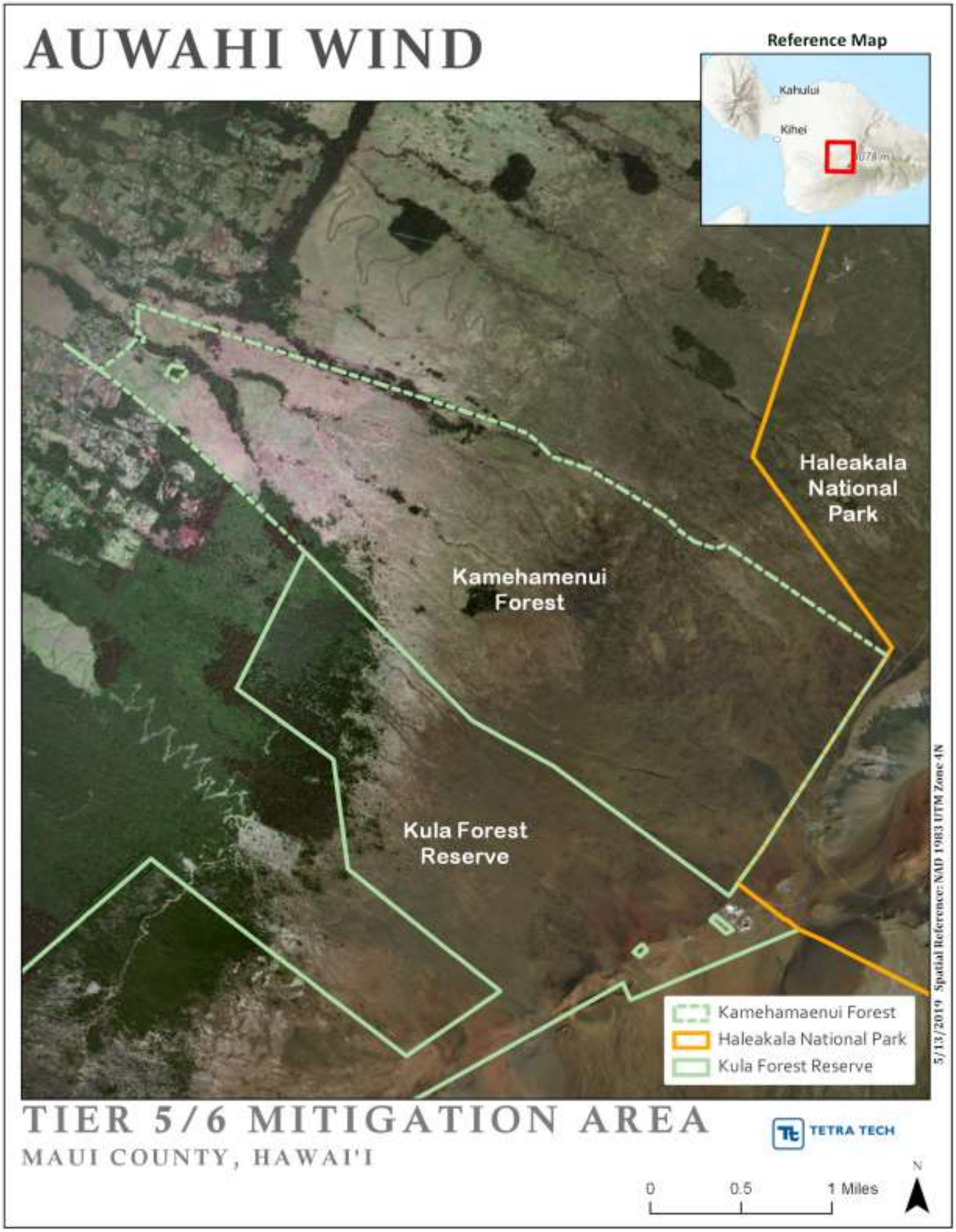


Figure 6-8. Location and Aerial Imagery of Kamehamenui Forest

> Once acquired, the Division is planning habitat management and habitat restoration to enhance recovery efforts for the endangered wildlife including the ‘ua’u, or Hawaiian petrel (*Pterodroma phaeopygia sandwichensis*), nēnē or Hawaiian goose (*Branta sandvicensis*), Hawaiian hoary bat – ‘ōpe‘ape‘a (*Lasirus cinereus semotus*), Maui Parrotbill – kiwikiu (*Pseudonestor xanthophrys*), and the crested honeycreeper – ‘ākohekohe (*Palmeria dolei*). Acquisition of the Property will also provide additional outplanting and recovery sites for several critically endangered plant species including the ‘ahinihina or Haleakalā silversword (*Argyoxiphium sandwicense* subsp. *macrocephalum*). These areas will be vital for species migration due to climate change.
>
> On the island of Maui, three wind energy complexes provide 72MW of power, but have also resulted in incidental take of the federally listed endangered ua’u, nēnē, ‘ōpe‘ape‘a, and Blackburn’s sphinx moth (*Manduca blackburni*). Acquisition of the Kamehamenui Property will complement required mitigation being performed pursuant to the respective Habitat Conservation Plans for these species by protecting and restoring suitable habitat, managing threats, and increasing survival and reproductive success and contributing [to] the overall recovery of those species…

In addition to benefiting the Hawaiian hoary bat, improvement of the Kamehamenui Forest habitat is expected to provide other environmental and community benefits. DLNR has estimated that reforestation of the parcel is anticipated to increase the water collection in the Makawao aquifer from 3.4 million to 4.2 million gallons of water per day (DLNR n.d.). The native forest also provides carbon sequestration at a time when the impacts of greenhouse gases are of critical concern.

The DLNR acquisition and restoration of the Kamehamenui Forest provides an opportunity for future additional, complementary management actions by Auwahi Wind to mitigate impacts to the Hawaiian hoary bat. As identified above, DOFAW will develop a detailed management/restoration plan once the parcel is acquired, and several key management actions have been identified that, when completed, would benefit bats. The lower two-thirds of the parcel (2,233 acres) is pasture land (Figure 6-9) and is well-suited for reforestation due to its accessibility, precipitation, deep fertile soil, gentle slope, and proximity to other forests. The habitat improvements proposed by DOFAW are intended to increase the available roosting and foraging habitat for bats. Additionally, Hawaiian hoary bats have been noted to use gulches (C. Pinzari, pers. comm. 2018); Pinzari & Bonaccorso 2016; H.T. Harvey 2019), and the parcel contains several prominent gulches that could also provide priority habitat for the Hawaiian hoary bat. Hawaiian hoary bats have also been documented to use high elevation foraging grounds when inclement weather at low elevation reduces foraging opportunities (Bonaccorso et al. 2016). This aspect of Hawaiian hoary bat behavior increases the value of the parcel for bats (and other species), as the parcel spans a wide elevational gradient, providing high elevation habitat above the inversion layer.

Figure 6-9. Aerial Photo of the Current Conditions of the Kamehamenui Forest Parcel (photo credit: DLNR n.d.)

Hawaiian hoary bats have been documented near the Kamehamenui Forest parcel. Data from the Hawaiian Heritage Database, the USGS Bison database, and preliminary results from ESRC-approved research (H.T. Harvey 2019) have provided acoustic bat detection data collected to date. Hawaiian hoary bats have been documented at numerous locations surrounding the parcel, suggesting the Hawaiian hoary bat would likely be detected within the parcel. Figure 6-10 shows the documented bat occurrence in the surrounding parcels.

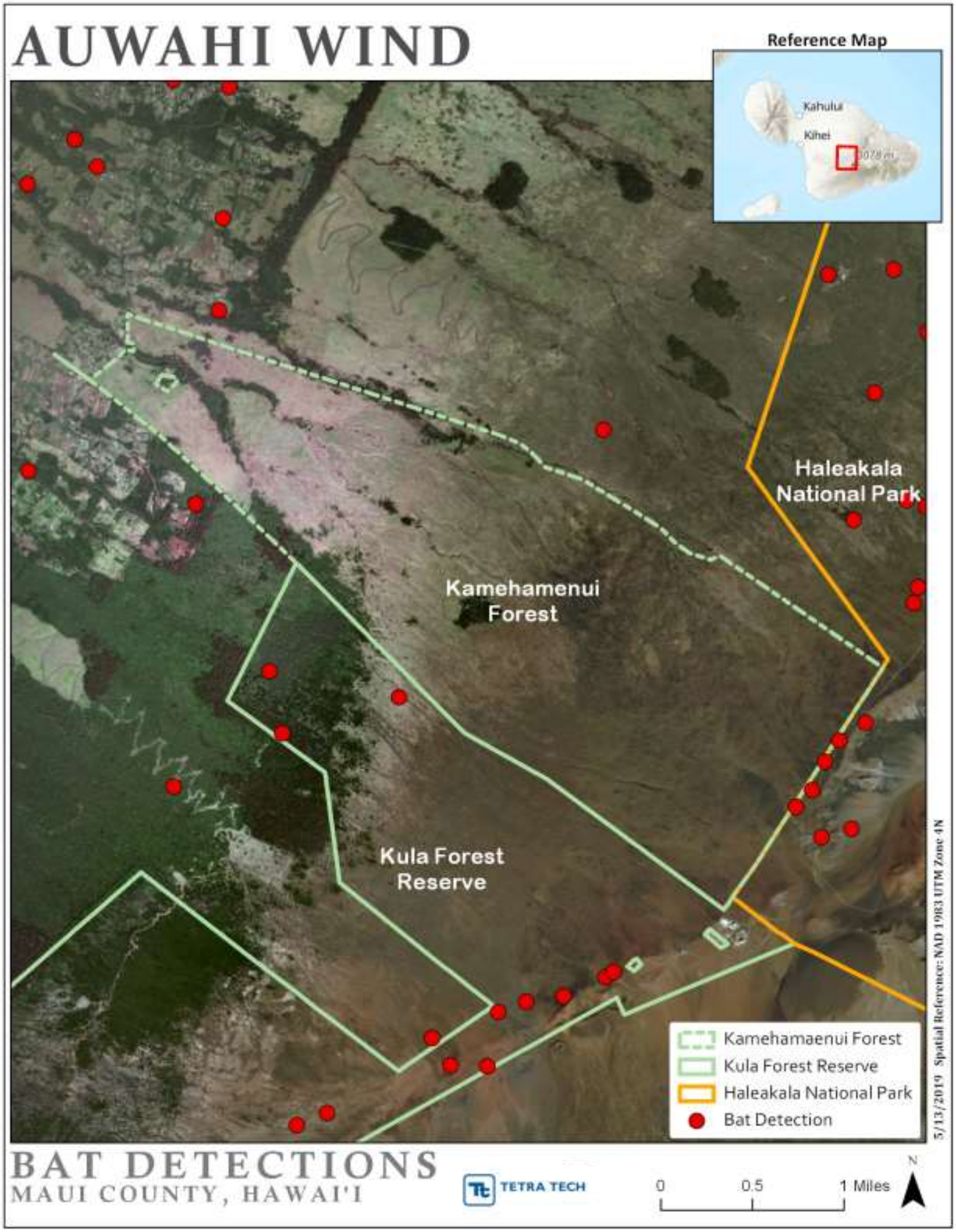


Figure 6-10. Bat Detections in the Vicinity of the Kamehamenui Forest

As described above and in the BLNR (2019) report (see Appendix J), DOFAW identified several management activities that would be incorporated into its management plan for Kamehamenui Forest. These management actions are compatible with Hawaiian hoary bat habitat needs as the bat is identified as a key species that would benefit from the acquisition (BLNR 2019, DLNR n.d.). The actions proposed by DOFAW include protection and creation of native habitat through fencing, removal of non-native ungulates and plants, and outplanting of koa and sandalwood (*Santalum haleakalae* var. *haleakalae*) While DOFAW intends to implement management actions itself over the long term, DOFAW anticipates that there will be opportunity for Auwahi Wind to also implement additional, complementary management actions on the parcel if Tier 5 and/or 6 are triggered.

Pre-Trigger, Baseline Monitoring

Before Tier 5 or 6 are triggered, preliminary baseline monitoring for the Hawaiian hoary bat will be conducted in the mitigation area. Auwahi Wind will collaborate with DOFAW to establish two acoustic monitoring locations to document parcel-specific Hawaiian hoary bat activity. This acoustic monitoring will confirm Hawaiian hoary bat occurrence in the parcel, provide expected activity rates, and inform seasonal fluctuations in activity at the mitigation site, and be used to perform a power analysis determine the power with which a change can be detected.

Early implementation of baseline monitoring will inform the development of Auwahi Wind's management plan. Before the pre-trigger, baseline acoustic monitoring can be initiated, the following conditions must be met: 1) Auwahi Wind must receive the amended ITP and ITL, 2) DOFAW has confirmed to Auwahi Wind in writing that the parcel has been acquired and ownership/management has been transferred to DLNR/DOFAW, and 3) Auwahi Wind has received the necessary permits and approvals to implement baseline monitoring within the parcel. Once these conditions are met, Auwahi Wind will begin preliminary baseline acoustic monitoring at the mitigation area within 3 months or as soon as is practicable. Auwahi Wind will conduct baseline acoustic monitoring for 2 years from the time the monitoring starts.

Tier 5 and 6 Mitigation Planning

As noted above, Tier 5 and 6 mitigation will likely not be triggered for many years, if ever. As a result, Auwahi Wind has identified the types of habitat management actions it would likely implement on the Kamehamenui Forest parcel for Tier 5 and 6 mitigation (discussed further below), which are compatible with the broader management goals identified by DOFAW. If Tier 5 or 6 is triggered, Auwahi Wind will then work with the USFWS and DOFAW to develop a Site-Specific Mitigation Implementation Plan (SSMIP) that is based on current information and circumstances. This will ensure that the SSMIP will complement management actions to benefit bats that DOFAW may have already initiated within the parcel. It will also be based on then-current baseline monitoring, which will be performed after DOFAW has secured ownership and management of the parcel. The SSMIP will be based on and reflect the best available science, new technological advances, and current agency guidance. For example, the SSMIP will be able to incorporate the latest results of Hawaiian hoary bat mitigation and research projects currently underway and thereby maximize the mitigation benefits.

The SSMIP will document then-current habitat conditions and deficiencies, and specify the management actions Auwahi Wind will implement to increase habitat suitability sufficiently to increase the parcel's bat carrying capacity and provide a net benefit for the species. The SSMIP must be reviewed and approved by USFWS and DOFAW prior to implementation.

The SSMIP will address the following topics in detail:

- Baseline habitat conditions;
- Specific location(s) of mitigation actions;
- Specific type(s) of mitigation actions;
- Timing of mitigation action implementation;
- Success criteria;
- Monitoring of mitigation implementation and success, and presence of Hawaiian hoary bat;
- Adaptive management;
- Demonstration of how the mitigation will offset take; and
- Cost estimates.

Once Tier 5 (or 6) is triggered, Auwahi Wind calculates that it will take between one and two years before the take estimate is equal to or greater than the incidental take authorized in the current tier (Section 6.2.6). This will provide ample time for Auwahi Wind to develop, and obtain USFWS and DOFAW approval of, the SSMIP. Auwahi Wind will submit its proposed SSMIP within 5 months of tier triggering.[15]

Proposed Auwahi Wind Management Actions

To expand upon the concepts identified by DOFAW in the acquisition proposals for Kamehamenui Forest, Auwahi Wind has identified specific management actions to enhance bat foraging and roosting habitat that it anticipates implementing for Tier 5 and 6 mitigation. The focus of these management actions will be to increase bat roosting, foraging habitat, and/or prey availability. One such action consists of the out-planting of native tree species, which will help build the vertical vegetative structure and canopy cover that is necessary for bat roosting. A heterogeneous vegetative structure provides shelter for insect species that are the prey for Hawaiian hoary bats, and preferred edge habitat for Hawaiian hoary bat foraging (Jantzen 2012, H.T. Harvey 2019). Another anticipated action is the creation of water features, which will also likely increase bat usage of the site, as noted in Section 6.2.4. Finally, Auwahi Wind anticipates removing invasive plant and animal species, which

[15] As discussed in Section 6.2.6, Auwahi Wind will submit its proposed SSMIP to the agencies within five months of the next tier being triggered.

can negatively affect the Hawaiian hoary bat habitat by reducing available roosting trees, competing with native species, decreasing vegetative diversity that affects prey availability or diversity, or predating or competing with bats (D'Antonio et al. 2011, DOFAW 2017, USDA 2019, Anderson 1999, Vanderwerf 2009, Bernard and Mautz 2016).

Auwahi Wind will coordinate with DOFAW once its "comprehensive multi-use management plan, guided by community and stakeholder input" is developed to ensure that Auwahi Wind's SSMIP is compatible (BLNR 2019). Additionally, in collaboration with DOFAW, Auwahi Wind may decide that the most appropriate bat mitigation at the time of triggering is to implement distinct portions of the DOFAW management plan. This will be fully described in the SSMIP, should Auwahi Wind decide that is the most prudent option based on the best available information.

Take Offset/Net Benefit

Should Tier 5 or Tier 6 be reached, Auwahi Wind will provide a net benefit to the species by implementing a mitigation program supported as critical to the recovery of the Hawaiian hoary bat by the available literature and agency guidance (see Section 6.2.4). The mitigation is based on the median CUA size of 20.3 acres (DOFAW 2015). The improvement of 20.3 acres is anticipated to offset the take of one bat based on the evaluation of core use area and agency guidance (Bonaccorso et al. 2015, DOFAW 2015). For Tier 5, 690 acres will be improved, and for Tier 6, 508 acres will be improved. Auwahi Wind will include a bat monitoring program to document an increase in bat activity at the site. If habitat is improved for the benefit of bats as determined through monitoring, the habitat will be considered to offset bat take.

Success Criteria

Hawaiian hoary bat activity on the parcel will be monitored to evaluate the effectiveness of the mitigation and whether the objectives of the mitigation are met. Increasing bat activity at the site as measured through acoustic monitoring will be the primary success criteria for the mitigation actions. In developing SSMIP success criteria for restoration/land-management actions, Auwahi Wind will create management actions that are specific, measurable, achievable, relevant, and time-bound. Restoration/land-management at Kamehamenui will include the following provisions as success criteria in addition to specific measurements included in the SSMIP:

- A USFWS and DOFAW-approved SSMIP is developed and implemented;
- A mitigation monitoring program is established and implemented to evaluate the progress of achieving the success criteria; and
- Acoustic (or other) monitoring for bat activity is successfully implemented at the mitigation site. The data are analyzed and reported, and the results show that the success criteria (as identified in the SSMIP) have been achieved.

Compliance Monitoring

After Tier 5 or 6 is triggered and the SSMIP is approved and implementation begins, Auwahi Wind will conduct compliance monitoring to determine the response of the Hawaiian hoary bat to the management actions implemented in the mitigation site. Auwahi Wind will conduct acoustic monitoring no less than every other year for the remaining permit term; acoustic monitoring will begin approximately 3 months after management actions have started. Acoustic monitoring will be established at nine locations for Tier 5 and six locations for Tier 6. The locations are based on a ratio of one or more detectors for approximately every 85 acres, which is 3 to 7 times greater density than similar studies (Gorresen et al. 2015, Todd et al. 2016) to provide a high level of granularity in bat use and response to management within the mitigation site. As identified in Section 6.2.4.5, the analysis is expected to use the metrics Call Abundance and Call Nightly Detection for analysis using the generalized linear mixed model framework. Insect sampling with a malaise trap will occur for one month, two times per year, in the years in which acoustic monitoring is conducted. Additionally, other monitoring will be detailed in the SSMIP to ensure that the project meets interim success goals.

Reporting

Auwahi Wind will summarize the results of the management actions implemented and monitoring in annual reports. The success criteria will be the primary metrics for analysis. Specifically, Auwahi Wind will include the following, and the SSMIP may detail additional reporting requirements:

- In the years in which the baseline acoustic monitoring is conducted, Auwahi Wind will report the results.;
- Auwahi Wind will also summarize the management actions implemented and associated results of changes that occur during the restoration process. These parameters may include:
    - Number of trees planted, acreage, and/or percent of tree cover;
    - Length of edge habitat created;
    - Number and/or surface area of water features added; and/or
    - Invasive species removed;
- A summary of acoustic monitoring data and a comparison to the baseline monitoring, including the statistical power with which any change is documented.;
- A summary of insect assessment, by season and year, and a comparison to acoustic monitoring results;
- Any adaptive management actions taken; and
- Any additional pertinent summary information needed to provide a full picture of mitigation actions.

Adaptive Management

Auwahi Wind will evaluate the best available science and latest information from peer-reviewed literature at the time Tier 5 or 6 are triggered and will define the adaptive management actions in the SSMIP. Adaptive management for restoration/management-based mitigation will ensure that mitigation activities are working as intended and offsetting the impact of the take, based on the results of monitoring:

- Interim success criteria will be developed to ensure that the long-term success criteria are met;
- If restoration/land-management efforts fail to meet the success criteria set forth in the SSMIP, corrective actions will be taken, based on the results of monitoring, such as:
  - Increase the intensity or extent of the current management actions, such as increasing the number of trees planted;
  - Increase the diversity of management actions, such as adding additional canopy or understory species;
  - Alter the management actions implemented, such as moving from reforestation to other limiting factors identified by research; and/or
  - Other actions based on the best available science and technological advances, and/or recommendations from USFWS and DOFAW, at that time.

6.2.5.2 Other Mitigation Options

Should the Kamehamenui Forest not be available for Auwahi Wind mitigation actions at the time Tier 5 or 6 are triggered, or should Auwahi Wind determine in coordination with USFWS and DOFAW that Kamehamenui Forest is no longer acceptable for mitigation, Auwahi Wind will work with the USFWS and DOFAW to identify an alternative site or other acceptable mitigation option as described below.

- *Mitigation Banking:* Mitigation banking has been identified by DOFAW as a needed addition for HCP planning. If Hawaiian hoary bat mitigation banking is established, it may provide an alternative for mitigation. Should a Hawaiian hoary bat mitigation bank(s) be established, Auwahi Wind will consult with USFWS and DOFAW on whether such a bank(s) could be used for Tier 5 and/or 6.
- *Land Protection*: Land and suitable habitat shown to support Hawaiian hoary bats may be threatened with imminent degradation, such as development or deforestation. These threats decrease the suitability of the lands to support the current population of Hawaiian hoary bats. Preservation of such lands would prevent the anticipated degradation and thereby increase the population over a potential future scenario. Should land protection be an alternative for future tiers of mitigation, Auwahi Wind will work with the USFWS and DOFAW to develop a SSMIP for the acquisition which details the plan area, the mitigation

actions, measures of success, monitoring documenting Hawaiian hoary bat use of the parcel, how the mitigation will offset take, and cost estimates.

- *Other Options:* Should other to-be-determined mitigation options be deemed more appropriate than the land-based mitigation described above for Tier 5 or Tier 6, Auwahi Wind will coordinate with the USFWS and DOFAW to identify the most appropriate mitigation measures. As identified above, the ongoing research may indicate that other mitigation measures may be more effective in offsetting bat take than the land-based option and this could include future research. Although the USFWS has indicated that research in the future Tier 5 or Tier 6 is less likely to be acceptable as mitigation, the agencies may identify that critical information is still needed. Any other mitigation option would be subject to approval by the USFWS and DOFAW.

6.2.6 Triggers for Mitigation at each Tier

In identifying the need for three additional tiers, Auwahi Wind considered:

- Refinement of the estimated Project impacts to the most precise range possible;
- Benefits of implementing phased mitigation, should take exceed a given tier, allowing for incorporation of the results from the latest research available into a mitigation plan for the subsequent tier; and
- Need for sufficient planning time to identify and implement appropriate mitigation for each potential tier of take.

Each tier of take has associated mitigation (**Error! Reference source not found.**see Section 6). To ensure that the implementation of mitigation precedes or occurs concurrently with take, the initiation of mitigation planning for the next higher tier would be triggered by reaching 75 percent of allowed take in the current tier (direct and indirect), as outlined in USFWS 2016b.**Error! Reference source not found.** provides a detailed timeline for mitigation planning and implementation under the tiered structure. Based on the prediction of take in the HCP Amendment, the annual take rate will be below 6.45 bats per year. This take rate is used to approximate a minimum estimated time between trigging a tier and the maximum take within the tier. The total take between the trigger and the tier take limit was calculated and divided by the current annual take rate. The timing between triggering planning and reaching the current tier limit is estimated to be between 1 and 2 years for Tiers 5 and 6. It is assumed that Tier 4 Mitigation will be initiated upon issuance of the requested amendment. Given one year of planning, Auwahi would have sufficient time to provide a mitigation plan for the subsequent tier, provided mitigation guidance is not altered within that timeframe.

Should triggering of subsequent tiers occur as defined in Table 6-3**Error! Reference source not found.**, Auwahi Wind will:

1. Provide notice to DOFAW and USFWS that planning for the next tier of mitigation is being initiated within 3 weeks of triggering;

2. Provide funding assurances as outlined in Section 9.4 and Appendix I within 60 days of notice that triggering has occurred;
3. Coordinate with USFWS and DOFAW to develop a specific mitigation plan for the next tier of mitigation;
4. Submit a mitigation plan to USFWS and DOFAW for the next tier of mitigation, as described in Table 6-3**Error! Reference source not found.**, within 5 months of reaching the tier trigger;
5. USFWS and DOFAW will review, revise if needed, and approve the mitigation plan within three months of receiving the final plan from Auwahi Wind. The mitigation plan will include the following information:
    I. Site-specific biological goals and objectives, including measures of success and a monitoring/evaluation program to determine the progress of meeting success criteria;
    II. Site feasibility or monitoring data if appropriate, to explain clearly why the site is suitable for bat habitat or bat survival and recovery, based on best available information;
    III. A project budget, including funding for a monitoring program and all steps necessary as identified in the plan; and
    IV. Sufficient funding assurances to cover the entire mitigation plan, including funding to respond to changed circumstances; and
6. If the mitigation plan is approved three months before the subsequent tier has been reached, Auwahi Wind may begin implementation of mitigation actions immediately, but not later than one month before the tier is reached as estimated by EoA.[16]

A description of each mitigation tier and the timing of triggering is provided in Table 6-3**Error! Reference source not found.**.

6.2.7 Funding Assurance

The cost of the Tier 4 Mitigation is outlined in Appendix I including adaptive management actions. The cost of mitigation for Tiers 5 and 6 will depend on the mitigation action selected for the tier. Based on current information, the implementation of mitigation actions in line with Tier 4 are planned for Tiers 5 and 6 should take exceed Tier 4. The total funding assurance for Tier 4 will be $4 million. Funding assurances to support the mitigation measures will be in the form of a bond,

[16] Estimation of future fatalities will use the best available information; however, the timing of future fatalities may not be known in advance. The timing of mitigation outlined here is intended to ensure that mitigation precedes take. Should take occur in the time between plan approval and implementation of the mitigation plan which increases the mortality estimate to the current tier maximum, Auwahi Wind will begin implementation of the mitigation plan immediately.

letter of credit (LOC), or similar instrument naming the USFWS and DLNR as beneficiaries. The LOC or similar financial instrument will be in place within 60 days of issuance of the ITP and ITL.

Funding assurances for Tiers 5 and 6, should they be triggered, are currently based on estimates of the cost of mitigation for Tier 4. Funding assurances for Tiers 5 and 6 have been calculated using the maximum potential acreage to be protected, the expected cost of the easement, and proportional to the take required within the tier. The cost will be adjusted for inflation using either the Federal House price index or other appropriate index, whichever more closely matches the cost of easements in the Project area at the time of triggering. Funding assurances will be put in place in accordance with the schedule for triggering outlined in Section 6.2.6. A detailed estimate of funding assurances is provided in Appendix I. Additional discussion of funding assurances can be found in Section 9.4.

6.2.8 Contingency Funds/Adaptive Management

Auwahi Wind will establish a contingency fund for the Hawaiian hoary bat for the mitigation described for Tiers 4 – 6. This fund will be 5 percent of the estimated cost of the mitigation to ensure the mitigation will be implemented. The funding of this contingency fund will be assured through the LOC described in Section 9.4.

6.3 Hawaiian Petrel

This section requires no edits for the HCP Amendment.

6.4 Nēnē

This section requires no edits for the HCP Amendment.

6.5 Blackburn's Sphinx Moth

This section requires no edits for the HCP Amendment.

7.0 MONITORING, REPORTING, AND ADAPTIVE MANAGEMENT

This section requires no edits for the HCP Amendment except as provided in the subsections below.

7.1 PROJECT-SPECIFIC TAKE

7.1.1 Monitoring Direct Take

As part of the approved HCP, a PCMP was developed and implemented to document impacts to the Covered Species as a result of operation of the Project, and to ensure compliance with the authorized provisions and take limitations of the HCP and the associated ITP/ITL (Appendix E of the approved HCP). As part of the HCP Amendment, a long-term PCMP is also provided in Appendix E. This protocol supplements the original PCMP and incorporates changes approved by and developed in consultation with USFWS and DOFAW, and the latest science with respect to wind farm post-construction mortality monitoring protocols and analysis methods.

Under the HCP Amendment and as described in the long-term PCMP (Appendix E), systematic monitoring will be conducted weekly year-round on roads and pads at operating wind turbines throughout the permit term. Searcher efficiency and carcass persistence trials will also be conducted as described in Appendix E. Post-construction mortality monitoring data will provide the information necessary to assess compliance with authorized levels of incidental take and determine if and when additional mitigation tiers are triggered.

The Wildlife Education and Incidental Reporting program is ongoing and will continue to be executed for contractors, Project staff members, and other Ranch staff who are on-site on a regular basis as outlined in the approved HCP.

The protocol for recovery, handling, and reporting of downed wildlife has been developed in cooperation with the USFWS and DOFAW. Regular Project staff will be trained in this protocol during the wildlife education briefings and will be responsible for documenting observed fatalities or injury to wildlife. The USFWS and DOFAW will be notified promptly upon discovery of an injured or dead state- or federal-listed species. The current Downed Wildlife Protocol is included in the Project PCMP (USFWS and DOFAW 2017; Attachment 1 of Appendix E). This protocol includes:

- Procedures to follow upon the discovery of a downed seabird or bat including a prioritized contact list of DOFAW and USFWS staff; and
- Guidelines for handling, if permitted, injured wildlife or carcasses.

Federal- or state-listed species found injured or dead will be treated as directed in the Downed Wildlife Protocol guidance provided by USFWS and DOFAW. Non-listed species may be collected by staff members included on the USFWS Special Purpose Permit and the DOFAW Protected Wildlife Permit issued for the Project, which grant permission and include provisions for handling native wildlife.

7.1.2 Estimating Indirect Take

As described in Section 5.1.2, take of a female bat during the breeding season may result in the indirect loss of dependent offspring. Females are solely responsible for the care and feeding of young. Therefore, indirect take is only associated with the death of an adult female bat in the breeding season. Indirect take estimation methodology and the variables used to quantify indirect take associated with the total Project direct take are listed in Appendix E and are based on Auwahi Wind data and current agency guidance (USFWS 2016a).

7.2 Non-Fatality Monitoring

7.2.1 Hawaiian Hoary Bats

Non-fatality acoustic and thermal imagery monitoring will be conducted the Project site and the mitigation site as described in Section 7.4.1.2

7.2.2 Hawaiian Petrels

This section requires no edits for the HCP Amendment.

7.3 Reporting

Auwahi Wind will prepare and submit semi-annual and annual reports consistent with the description in the approved HCP with the following clarifications:

- The Project will provide annual and semi-annual updates on the 80 percent upper credible limit of take to identify tier triggers and assess compliance with tier limits and the authorized take limit;
- Annual reports will include updated post-construction mortality monitoring detection probability correction results through June 30 of the report year;
- Annual reports will detail the progress of meeting mitigation success criteria, for all tiers;
- Annual reports will describe any adaptive management measures implemented, the timeline for their implementation, and how the measures will improve the ability to meet minimization or mitigation objectives; and
- Annual reports will include the update of funding and funding assurances.

An annual presentation on status and results of any mitigation-funded research projects will be made to the ESRC or subcommittee during the research project's period of performance, and a final research report and associated data for any mitigation-funded research projects will be prepared as described in Section 6.

7.4 Adaptive Management

The U.S. Department of the Interior defines adaptive management as a structured approach to decision-making in the face of uncertainty that makes use of the experience of management and the results of research in an embedded feedback loop of monitoring, evaluation, and adjustments in management strategies (Williams et al. 2009). Uncertainties may include the lack of knowledge regarding biological information for the Covered Species; the effectiveness of minimization, mitigation, or management techniques; or the anticipated effects of the Project. Adaptive management is a required component of HCPs that allows for flexibility over time during the implementation of the HCP as new information becomes available. Adaptive management requires explicit and measurable objectives, and identifies what actions are to be taken and when.

7.4.1 Adaptive Management of Minimization Measures

Auwahi Wind developed an adaptive management strategy to evaluate not only initial minimization measures currently being implemented but to also provide for potential future adjustments to minimization measures as new information or technology becomes available over the Project permit term. The Auwahi Wind adaptive management strategy described in this section includes the following elements:

1. Initial minimization measures (Section 7.4.1.1);
2. Monitoring of the fatality rate (Section 7.4.1.2) to determine the effectiveness of implemented initial minimization measures, and whether changes to such measures are needed;
3. A risk analysis (Section 7.4.1.3) to determine the factors that correlate with periods of risk for bats;
4. An Adaptive Management Plan (AMP; Appendix K) that identifies specific measures to reduce the risk to bats using the risk analysis results and the best available information (Section 7.4.1.4);
5. A schedule for evaluating minimization effectiveness, and quantitative triggers for implementing adaptive management measures (Section 7.4.1.5); and
6. A means of incorporating new information and technology into the AMP (Section 7.4.1.6).

The key terms used in developing and implementing the AMP are defined below:

- **Threshold Value** – The Threshold Value is calculated as the total requested direct take (129 bats) divided by the expected operational life of the Project (20 years). For Auwahi Wind, the Threshold Value is 6.45 direct take per year (129 direct take estimated by EoA / 20 years of operation). The Threshold Value for this Amendment is based on a projected 30% reduction in take rate from current levels (2012-2018) for the remaining life of the Project (2019-2032) and represents a take rate that would result in a take estimate equal to the Tier 6 maximum take at the end of the permit term.
- **Baseline Fatality Rate** – Auwahi Wind will use the EoA model (Dalthrop et al. 2017) to analyze both current and prior years of PCMM data to calculate the current average annual

direct fatality rate, referred to as the Baseline Fatality Rate. This fatality rate considers all prior years of PCMM data (relative to a rho value of 1). The result is a direct fatality rate from the start of monitoring to the most recent data at the 80 percent credible level. (Examples of the outputs of EoA including the Baseline Fatality Rate are provided in Appendix H and can be found in the Auwahi Wind Annual report for FY 2017.) Adaptive management, as detailed in the AMP, will be required if the Baseline Fatality Rate exceeds the Threshold Value.

- **Curtailment Night -** Auwahi Wind is using the concept of "curtailment nights" to optimize the implementation of LWSC to reduce risk to bats. A curtailment night is the equivalent of one turbine curtailed to the highest LWSC cut-in speed (6.9 m/s) for one night (30 minutes before sunset to 30 minutes after sunrise). The Initial Minimization Measures include 728 continuous curtailment nights per year (8 turbines curtailed to 6.9 m/s from August through October). The application of adaptive management to curtailment nights allows for specificity in curtailment implementation, while maintaining flexibility to implement the curtailment in the highest risk periods. Examples of applying curtailment nights could include:
    - Two turbines curtailed for half of the night equals 1 curtailment night.
    - One turbine curtailed for the entire night, with a cut-in speed of 6.9 year-round, equals 365 curtailment nights.

7.4.1.1 Initial Minimization Measures

In response to the higher than anticipated take of bats, Auwahi Wind previously began implementing voluntary adaptive management measures to reduce the risk of bat take as described in Section 4.2.7. Auwahi Wind also voluntarily incorporated canine searching into the downed wildlife monitoring protocol (January 2018) to increase the probability of detection of downed wildlife. As described in Section 4.2.7, these voluntary measures, referred to here as the "initial minimization measures," include:

1. Implement LWSC of 5.0 m/s for all eight turbines from 30 minutes before sunset to 30 minutes after sunrise for the months of November through July.
2. Implement LWSC of 6.9 m/s for all eight turbines from 30 minutes before sunset to 30 minutes after sunrise for the months of August through October.

7.4.1.2 Monitoring

Monitoring is an essential element of the minimization measures and informs the adaptive management strategy. The Post-Construction Mortality Monitoring (PCMM) protocol is outlined in the monitoring plan (Section 7.1.1, Appendix E). The purpose of this monitoring is to evaluate the efficacy of the minimization measures and determine if there is a need to implement adaptive management actions to ensure minimization goals and objectives are met.

7.4.1.3 Risk Analysis

As summarized in Section 3.8.1.3, the current understanding of bat behavior at turbines and associated environmental conditions is limited. Based on the current best available information, factors thought to correlate with bat risk include temperature, barometric pressure, moon phase, insect abundance, time of night, geographic features, and other site-specific parameters.

Auwahi Wind is conducting nacelle acoustic monitoring and ground based thermal imagery studies in 2018 -2019 to determine bat exposure rates and identify factors correlated with risk to bats at the Project. These studies will look at general trends in timing of bat observations, patterns of behavior, and other factors that may allow Auwahi Wind to optimize minimization measures or turbine operations that could further reduce the risk to bats. The studies are described below:

1) Four turbine nacelles were instrumented with acoustic monitoring devices. The monitoring is to be conducted for 12 months (July 2018 – June 2019). Simultaneously, meteorological data will be collected at these turbine nacelles.
2) A thermal video system was installed with support from USGS. This system collected data in combination with the acoustic monitoring devices for 3 months (August – October 2018).
3) Data will be analyzed in between November and December, 2019 to investigate: 1) the proportion of acoustic detections also observed with the thermal video system to assess whether acoustic activity is a good proxy for exposure; 2) the behaviors bats are exhibiting while interacting with the turbines; 3) the range and upper thresholds of wind speeds at which bats are observed; and 4) if other environmental factors or behaviors correlate with risk in such a manner that they can be used to mitigate risk.

Auwahi Wind will analyze the results of these studies, as well as other research being conducted by others specific to Hawaiian hoary bats, in the 4th quarter of 2019, to identify the time periods and conditions which present the greatest risk to bats, and use that to revise the Interim AMP (Appendix K).

7.4.1.4 Adaptive Management Plan

Auwahi Wind has developed an interim AMP to describe the schedule and actions based on the knowledge available at the time the HCP Amendment was developed. As noted in Section 7.4.1.3, currently it is not fully understood how environmental conditions and bat behavior may influence risk to bats from turbines. Therefore, Auwahi Wind will use the research results and risk analysis discussed above, and use that best available, Project-specific information to update the Interim AMP (Appendix K) into the working AMP in late 2020 (hereafter referred to as the AMP). The AMP specifies adaptive management measures to further minimize risk to bats. Such measures would then be implemented if adaptive management is required as described below in Section 7.4.1.5.

The AMP includes a schedule for evaluating the Baseline Fatality Rate and associated triggers for implementation of adaptive management. Thus, the AMP includes:

1. Ongoing review of developments in minimization measures;
2. The specific minimization measures planned for application to further reduce the risk to bats if adaptive management is triggered;
3. The schedule for evaluation of the Baseline Fatality Rate (Section 7.4.1.5); and
4. The triggers for implementation of adaptive management (Section 7.4.1.5).

When coordinating with USFWS and DOFAW, the timing of developing the AMP and implementing adaptive management measures will consider the following:

- After the 2019 third quarter risk analysis (Section 7.4.1.3), the AMP will be revised (from the interim AMP) and describe specific minimization measures to be implemented at the Project through adaptive management. The AMP will be provided to the USFWS and DOFAW for review and approval by April 30, 2020 prior to the evaluation of the Baseline Fatality Rate in 2020.
- If evaluation of the Baseline Fatality Rate indicates that adaptive management is required but Auwahi Wind has not received approval of the AMP by USFWS and DOFAW, Auwahi Wind will implement the adaptive management measures identified in the AMP as an interim measure pending agency approval of the AMP.
- If subsequent data warrant any change to the AMP previously submitted to USFWS and DOFAW, Auwahi Wind will submit a revised AMP to USFWS and DOFAW for approval. The revised AMP may be implemented as an interim measure, pending approval by USFWS and DOFAW.

Adaptive Management Responses

The AMP identifies specific responses to further reduce bat risk, which will be implemented if triggered by the results of the Baseline Fatality Rate assessments discussed in Section 7.4.1.2. These responses include modifications to the LWSC program or other actions, based on the best available science. Project post-construction mortality monitoring data and results from bat activity monitoring will be used to determine the most appropriate responses. Factors considered in the adaptive management response analysis include:

- The spatial distribution of fatalities at the wind farm;
- The timing of fatalities in terms of season and/or months of the year;
- The available data provided from bat activity monitoring (2018-19 thermal and acoustic studies) including nightly bat activity peaks, bat behaviors, correlation of activity to environmental conditions, etc.;
- The availability of new technologies that may further reduce risk to bats; and
- Other newly available literature or data.

The AMP prioritizes temporal and spatial adjustments of the initial curtailment nights if the Baseline Fatality Rate exceeds the Threshold Value. For any redistribution of curtailment nights, the curtailment night will be applied to the highest period of risk (or other correlate of risk). Regardless of adjustment in curtailment nights, no cut-in speed will be lower than 5 m/s.

Future studies may indicate patterns of risk that then inform whether and how curtailment nights should be redistributed. The AMP describes how Auwahi Wind will adjust curtailment nights from periods of lower risk to higher risk, if warranted. Should redistribution of curtailment nights not provide the necessary take rate reduction, additional adaptive management measures will be implemented and are described in the AMP. Auwahi Wind may also implement additional voluntary minimization measures beyond those outlined in this section.

7.4.1.5 Schedule and Triggers

This adaptive management strategy will ensure the Project remains in compliance with its ITP/ITL take limit. Auwahi Wind coordinates annually with USFWS and DOFAW and provides annual and semi-annual reports on the HCP as described in Section 7.3. Additionally, Auwahi Wind provides USFWS and DOFAW updated take estimates after each fatality observed in Post-construction monitoring. This schedule of take estimation, and calculation of the Baseline Fatality Rate, allows the project to track closely the Baseline Fatality Rate between scheduled evaluations.

The timing of the scheduled evaluations will provide sufficient data to evaluate the effect of the minimization measures. The Baseline Fatality Rate is key to determining if adaptive management is necessary and will be the basis for implementing the AMP. Auwahi Wind will calculate the Baseline Fatality Rate, and then compare that to the Threshold Value, at scheduled evaluations in 2020, 2025, and 2030, to determine if adaptive management actions are required. Comparing the Baseline Fatality Rate to the Threshold Value will allow Auwahi Wind, USFWS, and DOFAW to ensure the Project is on track to remain below the permitted take.

For the years in which the Baseline Fatality Rate will be compared to the Threshold Value (i.e., 2020, 2025, 2030) to determine if adaptive management actions are required, the evaluation will be completed in February and will be based on data from January 2013 through December 31 of the preceding year. If adaptive management measures are required, they will be implemented as soon as possible, but no later than March 31.

Possible future scenarios are:

- Should the Baseline Fatality Rate exceed the Threshold Value at a given scheduled evaluation, the actions identified in the AMP will be implemented. In this scenario, evaluation of the fatality rate will occur again 2 years following the implementation of additional measures to assess effectiveness.
- Should the Baseline Fatality Rate be equal to or fall below the Threshold Value, no adaptive management action will be required.

Any change to minimization measures will be assessed for its effect on the Baseline Fatality Rate after two years using post-construction mortality monitoring data. At that time, the Baseline Fatality Rate will be compared to the Threshold Value to determine if further adaptive management is triggered. Should the Baseline Fatality Rate exceed the Threshold Value at that time, further adaptive management actions will be taken per the AMP, and the Baseline Fatality Rate will be re-evaluated again at 2-year intervals until the Baseline Fatality Rate is equal to or less than the Threshold Value. Should an adaptive management adjustment be triggered less than 2 years from a scheduled evaluation year (2020, 2025, 2030), the next evaluation will occur 2 years after the adjustment instead of at the scheduled evaluation. Auwahi Wind has adopted this assessment approach given that observed fatalities are relatively rare events; and therefore, data from a single year of implementation may lack sufficient statistical power to detect an effect.

In summary, the AMP provides for multiple check-ins (minimum annual basis) on the fatality rate and opportunities to implement additional adaptive management measures. The scheduled evaluations provide a hard trigger for a mandatory full assessment. For example:

1. If the Project is predicted to exceed the permit authorization at the evaluation in 2020, adaptive management actions must be implemented to reduce the fatality rate. Following the implementation of adaptive management actions, the fatality rate will be evaluated again in 2022 to determine if additional adaptive management actions are required. This process will be repeated every two years until the Project is no longer predicted to exceed the permitted take authorization.
2. Alternatively, if the projection suggests the Project will remain within the permitted take authorization at the 2020 scheduled evaluation, no adaptive management action will be required. The next evaluation to determine if adaptive management actions are required will be in 2025.

Should a projection at any routine evaluation predict that the Project will exceed the permitted take authorization between scheduled evaluations, Auwahi Wind, in coordination with USFWS and DOFAW, will determine if adaptive management actions are warranted. Additionally, the AMP will be reviewed annually, and updated if appropriate, to incorporate and prioritize the best available minimization measures.

7.4.1.6 Future Technologies/Research

Numerous studies related to bat activity around wind turbines are being conducted in North America and Europe to understand the risk to bats. These studies include looking at influences of weather, wind speeds, LWSC, etc. on bat fatalities in addition to developing avoidance technologies such as deterrents. Results of some studies show promise, while others may introduce new questions for future study. For example, BCI looked at the impact of 20-minute averaging to control the implementation of LWSC, but found no statistically significant difference in the number of observed fatalities between control and treatment (Schirmacher et. al 2018). Additionally, BCI looked at the use of met tower data to control the implementation of LWSC; however, the met tower measured a lower wind speed than turbine wind speeds, which effectively resulted in an increase of the cut-in speed by 1 m/s, reducing the minimization effect. As these efforts to find effective alternative minimization measures for bats continues, Auwahi Wind will actively monitor the availability of new information that may inform its AMP, and potentially incorporate new minimization measures that may be more effective and feasible than those outlined in this HCP Amendment.

This HCP Amendment anticipates that an effective, economical, and commercially-viable Hawaiian hoary bat deterrent will ultimately be developed. However, such technology is still in the testing phase, and although it shows promise for reducing bat take (Weaver et. al 2018), there are no commercially available systems at this time proven to be effective in Hawaii. However, preliminary research indicates that technologies may be developed during the Project permit term that could deter the Hawaiian hoary bat from flying into the airspace near the wind turbine blades (Szewczak and Arnett 2007, Arnett et al. 2013, Hein and Schirmacher 2013). In 2017 and 2018, studies from mainland wind farm sites showed that deterrents could reduce mainland hoary bat fatalities between 20 percent and 100 percent. (Morton 2017, Weaver et. al 2018). Thus, there is still uncertainty as to the effectiveness of deterrents that are available to be tested. Additionally, in 2018 a deterrent test was initiated in Hawai'i at an operating wind farm where LWSC is also being implemented. Preliminary results of this Hawai'i research are expected to be available in May 2019, and peer-reviewed publications on results of deterrent effectiveness for mainland studies are anticipated in 2020 or later. Should LWSC adaptive management strategies not be effective in minimizing impacts to bats, deterrents or similar technologies will be a priority. Should a redistribution of curtailment nights not provide sufficient minimization to keep the Project within the total take authorization, Auwahi Wind will implement an acoustic deterrent system or an alternative minimization technology (provided they are commercially available, demonstrated to be effective in Hawai'i, and determined not to negatively impact other wildlife). Deterrent technology is incorporated in the adaptive management measures described in the AMP with the proposed measures provided to USFWS and DOFAW for review and approval.

In addition, the BLNR required the following condition for approval:

> If, during the permit term, DOFAW determines that reliable scientific evidence shows that a commercially-available bat deterrent technology will be effective in reducing the take of ope'ape' a [or Hawaiian hoary bat], at this site, at a reasonable cost considering the expected reduction in take, DOFAW shall require the Applicant to implement the technology after consultation with the Applicant and ESRC. Without Limitation on other means of determining whether the cost is reasonable, it shall presumptively be considered reasonable if the cost per bat expected to be saved does not exceed the per-bat mitigation cost ($50,000 per bat). In case of a disagreement between Applicant and DOFAW over the implementation of this condition, the matter shall be brought to the ESRC for its review and recommendation, then to the [BLNR] for final decision.

7.4.2 Adaptive Management of Mitigation

7.4.2.1 Tier 4 Mitigation

Adaptive management actions for Tier 4 are specified in Section 6.2.4

7.4.2.2 Tier 5 and Tier 6 Mitigation

Adaptive management actions for Tiers 5 and 6 are specified in Section 6.2.5

8.0 ALTERNATIVES

8.1 FULL NIGHTTIME SHUTDOWN

This alternative would consist of ceasing nighttime operations by feathering turbine blades year-round from one hour before sunset to one hour after sunrise at all Project turbines to avoid additional Hawaiian hoary bat take. While this alternative would prevent future take, because the 80 percent upper credible limit of take exceeds the level authorized in the approved HCP, this alternative would still require an HCP Amendment. The approved HCP, which identifies existing avoidance and minimization measures, authorized take, mitigation measures, and monitoring commitments for Covered Species, would be modified to include take authorization up to the current 80 percent upper credible limit value. This alternative was not selected for consideration because ceasing operations at night year-round would trigger a clause in the PPA that would modify Auwahi Wind's priority for providing power to Maui Electric Company (MECO). This action is irreversible and will result in the Project being heavily curtailed for the remainder of the PPA term, to the point where the Project could no longer operate due to the financial impact.

8.2 YEAR-ROUND CURTAILMENT AT 6.9 M/S

This alternative would consist of curtailing at 6.9 m/s year-round. The evaluation of risk to bats also includes the potential benefit to bats of the added months of curtailment. Pertinent data on the months in which risk is low were evaluated. From the start of operation through December 2017, no fatalities were observed in the months of February through May, and December. One fatality was found in each of the months January, June, July, and November. Auwahi Wind did not select this minimization alternative because it did not correspond with the seasonal differences in risk to Hawaiian hoary bat identified in five years of Project-specific monitoring. Adding curtailment nights to periods where bats are not present or where the risk is not significant will not have an appreciable benefit to the Hawaiian hoary bat but would significantly impair the ability of the Project to meet its energy output obligations, operate in an economically reasonable manner, and would lessen generation of nighttime clean energy on Maui which is principally derived from wind energy. For all of the above reasons, this alternative was not selected for implementation.

8.3 FULL NIGHTTIME SHUTDOWN FROM AUGUST TO OCTOBER

This alternative would consist of shutting down the Project at night from August through October. The benefit of LWSC with cut-in speeds of 6.9 m/s proposed in the HCP Amendment (Section 4.2) is estimated to reduce bat fatalities by 76 percent. For cut-in speeds above 6.9 m/s insignificant gains in take reduction are predicted. Additionally, as cut-in speeds are increased, the amount of potential power loss increases exponentially up to 10 m/s. Figure 8-1 shows a representative power curve for a Siemens SWT-3.0 where power generation typically increases significantly beyond 5.0 m/s. Adding curtailment to period of higher wind speeds when bat risk is minimal would not be expected to have a significant benefit to bats but would significantly impair the ability of the Project to meet its energy output obligations and operate in an economically reasonable manner. Maui Additionally, nighttime clean energy generation on Maui is principally derived from wind energy, which would be impaired in this alternative. Given that risk to bats is significantly reduced at greater wind speeds and the power losses are exponential, full nighttime shutdown at Auwahi Wind for the months of August to October was not selected for implementation.

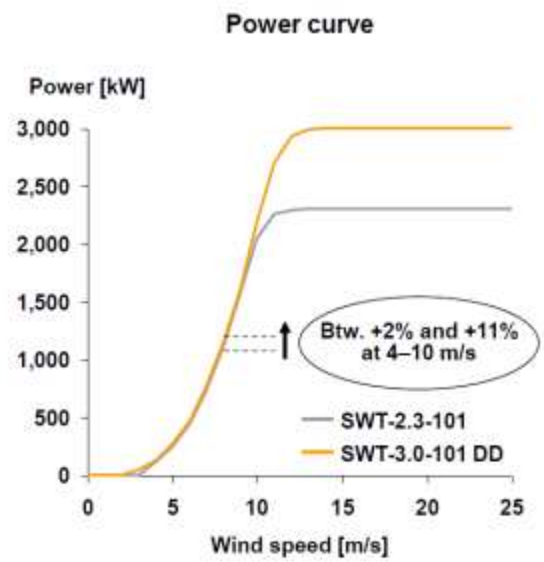


Figure 8-1. Power Curve for a Siemens SWT-2.3 and SWT-3.0 (NREL 2010)

8.4 Reduced Permit Term

This alternative would consist of amending the Auwahi Wind HCP to increase authorized bat take for a reduced permit term of ten years and assumes the development and deployment of a 100 percent effective, economical, and commercially-viable bat deterrent by 2022 (which would prevent any additional incidental take and thus preclude the need for additional years of take authorization). After nearly five years of Project operation, the 80 percent upper credible limit of Hawaiian hoary bat take exceeds the authorized take limit. Therefore, even with the implementation of avoidance and minimization measures such as LWSC, Auwahi Wind would need to amend the HCP to increase authorized bat take (Auwahi Wind 2017). Reducing the permit term has the potential to create a legal liability or the need for a future Major Amendment for Auwahi Wind associated with non-compliance with the ESA and Chapter 195D should such a deterrent system not become available and incidental take at the Project exceed take authorized in the ITP/ITL. Although initial research from North America has suggested bat deterrent technology may be an effective minimization measure for reducing take of migratory tree-roosting bats (Szewczak and Arnett 2007, Arnett et al. 2013, Hein and Schirmacher 2013, Weaver et al. 2018), it is highly uncertain whether or not future advancements in the technology will be sufficient to ensure take of the resident Hawaiian hoary bat can be avoided completely by 2022. For these reasons, this alternative was not selected for implementation.

9.0 PLAN IMPLEMENTATION

9.1 RESPONSIBILITIES

This section requires no edits for the HCP Amendment.

9.2 SCOPE AND DURATION

This section requires no edits for the HCP Amendment.

9.3 CHANGED CIRCUMSTANCES, UNFORESEEN CIRCUMSTANCES, AND NO SURPRISES POLICY

This section requires no edits for the HCP Amendment.

9.4 FUNDING AND ASSURANCES

Section 10(a)(2)(B)(iii) of the ESA and HRS Section 195D-4(g) require that HCPs ensure that adequate funding will be made available to implement the HCP including the proposed monitoring and mitigation plans. Measures requiring funding for HCP implementation typically include activities associated with Project implementation (e.g., pre-construction surveys or post-construction mortality monitoring), as well as on-site and off-site mitigation measures (e.g., acquisition of mitigation lands, restoration, or contributions to research), measures to respond to foreseeable Changed Circumstances, and funding for DLNR HCP technical assistance and compliance monitoring. Section 195D-4(g) also requires the applicant to "post a bond, provide an irrevocable letter of credit, insurance, or surety bond, or provide other similar financial tools, including depositing a sum of money in the endangered species trust fund created by Section 195D-31, or provide other means approved by the board, adequate to ensure monitoring of the species by the State and to ensure that the applicant takes all actions necessary to minimize and mitigate the impacts of the take."

Auwahi Wind will post a LOC with a banking institution subject to regulation by the United States or other acceptable financial assurance measure for up to $4,013,047 to cover the costs of implementing all of its obligations for the HCP Amendment and Tier 4 bat mitigation (including DLNR technical assistance and compliance budgets, see Appendix I for the funding matrix). The total value of this LOC (or other acceptable financial assurance) may be adjusted periodically over time to account for financial obligations that have been fulfilled. This LOC (or other acceptable financial assurance) will be provided within 60 days of issuance by USFWS of the amended ITP, issuance by DLNR of the ITL, and execution of any needed amendment to the Implementation Agreement. The take authorization contained in the amended ITP/ITL is not effective until Auwahi Wind provides to the USFWS and DLNR executed copies of the LOC (or other acceptable financial assurance) containing terms acceptable to the USFWS and DLNR. If a subsequent tier of mitigation is triggered, financial assurances for that tier (not met through the existing financial assurances, accounting for yet unfulfilled HCP financial obligations) will be provided to ensure funding for mitigation obligations under that tier. A commitment to make such future funding assurances will be included in the revised Implementing Agreement for the Amendment.

Funding assurances for Tiers 5 and 6, should they be triggered, are currently based on costs anticipated for expanding the mitigation outlined in Tier 4 to additional lands. Funding assurances for Tiers 5 and 6 will be calculated as was Tier 4 using the maximum potential acreage to be protected, the expected cost of the mitigation, and proportional to the take required within the tier. The cost will be adjusted for inflation using an appropriate index, which closely matches the cost of mitigation actions in the Project area at the time of triggering. Funding assurances will be put in place in accordance with the schedule for triggering outlined in Section 6.2.6. A detailed estimate of funding assurances is provided in Appendix I.

The funding assurance amounts for Tiers 5 and 6 would be approximately $2,274,059 and $1,672,102, respectively, using Tier 4 costs as a basis and adjusted accordingly to the mitigation to be implemented at the time the tier is triggered. If planning for the next higher tier is triggered, any required additional funding assurances for tiers above Tier 4 will be provided no later than 60 days of notifying USFWS and DOFAW of triggering. An estimate of the costs for implementing the additional mitigation under the HCP Amendment is provided in Appendix I. These estimates and the funding assurance will be adjusted once a mitigation plan is approved by USFWS and DOFAW.

Post-construction mortality monitoring costs are estimated at $100,000 per year and are included in the Project operations costs. No financial assurance is required for monitoring costs because take authorization is contingent upon compliance with this HCP, and monitoring must occur simultaneous with Project operations. DLNR compliance costs are estimated at $10,000 annually and will be paid out of Project funds each year.

The LOC will be issued by a financial institution organized or authorized to do business in the United States and identify the DLNR as the sole payee with the full authority to demand immediate payment in the case of default in the performance of the terms of the permit and HCP. The LOC presented for approval will contain the following provisions:

- The LOC will be payable to the State of Hawaiʻi DLNR;
- The expiration date will not be less than one year from the effective date of the LOC and will contain a provision for automatic renewal for periods of not less than one year unless the bank provides written notice of its election not to renew to the DLNR at least 90 days prior to the originally stated or extended expiration date of the LOC;
- The LOC will contain provisions allowing collection of the remainder of the costs by the DLNR for failure of the permittee to replace the LOC when a 90-day notice is given by the bank that the LOC will not be renewed and the LOC is not replaced by another LOC approved by the USFWS and DLNR at least 30 days before its expiration date; and

- The LOC will be payable to the DLNR upon demand, in part or in full, upon notice stating the basis thereof, which possible bases will be identified in the Implementing Agreement (e.g., default in compliance with the permit or HCP or the failure to have a replacement for an expiring LOC).
- The LOC will include security for 1) mitigation obligations, and 2) sufficient contingency funds to cover inflation and changed circumstances, as reflected in the funding matrix (see Appendix I). The LOC will be renewed annually based on the outstanding mitigation cost at the start of the following year. The purpose of the LOC will be to secure the necessary funds to cover costs in the unlikely event that the applicant does not fulfill its obligations under the ITP/ITL and HCP Amendment.

9.5 ADAPTIVE MANAGEMENT

[Moved to Chapter 7.4]

9.6 REVISIONS AND AMENDMENTS

This section requires no edits for the HCP Amendment.

9.6.1 Minor Amendments to the HCP

This section requires no edits for the HCP Amendment.

9.6.2 Major Amendments to the HCP

This section requires no edits for the HCP Amendment.

10.0 REFERENCES

The following references were used in the development of the HCP Amendment.

Akaike, H. 1973. "Information theory and an extension of the maximum likelihood principle", in Petrov, B. N.; Csáki, F., 2nd International Symposium on Information Theory, Tsahkadsor, Armenia, USSR, September 2-8, 1971, Budapest: Akadémiai Kiadó, pp. 267–281.

Ancillotto, Ariano, Nardone, Budinski, Rydell, & 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.

Anderson, S.B. 1999. Axis Deer Overview & Profile. www.hear.org/hnis/reports/HNIS-AxiAxiV01.pdf.

Arnett, E. B., M. M. P. Huso, J. P. Hayes, and M. Schirmacher. 2010. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX, USA.

Arnett, E., M. Huso, M. Schirmacher, and J. Hayes. 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. Ecol. Environ. 9(4) pp 209-214.

Arnett, E.B., C.D. Hein, M.R. Schirmacher, M.M.P. Huso, and J.M. Szewczak. 2013. Evaluating the effectiveness of an ultrasonic acoustic deterrent for reducing bat fatalities at wind turbines. PLoS ONE 8(6): e65794. Doi:10.1371/journal.pone.0065794

Arnett, E.B., W.K. Brown, W.P. Erickson, J.K. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Koford, C.P. Nicholson, T.J. O'Connell, M.D. Piorkowski, and R.D. Tankersley, Jr. 2008. Patterns of bat fatalities at wind energy facilities in North America. *Journal of Wildlife Management* 72:61–78.

Auwahi Wind (Auwahi Wind Energy LLC). 2012. Final Auwahi Wind Farm Project Habitat Conservation Plan. Prepared for Auwahi Wind Energy LLC by Tetra Tech EC, Inc. January 2012.

Auwahi Wind. 2013. Auwahi Wind Farm Habitat Conservation Plan FY 13 Annual Report: Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17. August 2013, Kula, HI.

Auwahi Wind. 2014. Auwahi Wind Farm Habitat Conservation Plan FY 14 Annual Report: Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17. August 2014, Kula, HI.

Auwahi Wind. 2015. Auwahi Wind Farm Habitat Conservation Plan FY 15 Annual Report: Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17. August 2015, Kula, HI.

Auwahi Wind. 2016. Auwahi Wind Farm Habitat Conservation Plan FY 16 Annual Report: Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17. August 2016, Kula, HI.

Auwahi Wind. 2017. Auwahi Wind Farm Habitat Conservation Plan FY 17 Annual Report: Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17. August 2016, Kula, HI.

Auwahi Wind. 2018. Auwahi Wind Farm Habitat Conservation Plan FY 19 Annual Report: Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17. August 2018, Kula, HI.

Baird, A.B., J.K. Braun, M.A. Mares, J.C. Morales, J.C. Patton, C.Q. Tran, and J.W. Bickham. 2015. Molecular systematic revision of tree bats (Lasiurini): doubling the native mammals of the Hawaiian Islands. *Journal of Mammalogy* 96(5):1–20.

Baird AB, Braun JK, Engstrom MD, Holbert AC, Huerta MG, Lim BK, et al. (2017) Nuclear and mtDNA phylogenetic analyses clarify the evolutionary history of two species of native Hawaiian bats and the taxonomy of Lasiurini (Mammalia: Chiroptera). PLoS ONE 12(10): e0186085. https://doi.org/10.1371/journal.pone.0186085

Baker, P.J., Scowcroft, P.G., Ewel, J.J. 2009. Koa (*Acacia koa*) Ecology and Silviculture. United States

Bellwood, J.J. and J.H. Fullard. 1984. Echolocation and foraging behavior of the Hawaiian hoary bat (Lasiurus cinereus semotus). Can. J. Zoology 62:21132120.Bogan, M.A. 1972. “Observations on Parturition and Development in the Hoary Bat, Lasiurus cinereus.” Journal of Mammalogy 53(3):611–614.

Bernard, R., and Mautz, W. 2016. Dietary overlap between the invasive coquí frog (*Eleutherodactylus coqui*) and the Hawaiian hoary bat (*Lasiurus cinereus semotus*) on the Island of Hawai’i. Biological Invasions. 18. 10.1007/s10530-016-1232-0.

BLNR (Board of Land and Natural Resources). 2019. Land Board Submittals -- 03/09/19. Agenda for the Meeting of the Board of Land and Natural Resources, Item C-1: Division of Forestry and Wildlife Request. https://dlnr.hawaii.gov/wp-content/uploads/2019/03/C-1.pdf.

Böhm, C., Kanzler, M., Freese, D., 2014. Wind speed reductions as influenced by woody hedgerows grown for biomass in short rotation alley cropping systems in Germany. Agroforest Syst (2014) 88:579–591

Bonaccorso, F.J., 2010. Ope'ape'a: Solving the puzzles of Hawaii's only bat, Bat’s Magazine article. Volume 28, Issue 4, Winter 2010.

Bonaccorso, F.J. 2016. Modeling foraging habitat suitability of the Hawaiian hoary bat. A Proposal Prepared for State of Hawaii Endangered Species Committee Submitted: July 15, 2016 From: U. S. Geological Survey, Pacific Island Ecosystems Research Center https://dlnr.hawaii.gov/wildlife/files/2016/06/1-USGS-Modeling-foraging-habitat-suitability-for-the-Hawaiian-hoary-bat-rev15Sept2016_topost.pdf

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.

Bonaccorso, F., Montoya-Aiona, K., Pinzari, C., Todd, C. 2016. Winter distribution and use of high elevation caves as foraging sites by the endangered Hawaiian hoary bat, *lasiurus cinereus semotus*. Technical Report HCSU-068. Hawai`i Cooperative Studies Unit University of Hawai`i at Hilo 200 W. Kawili St. Hilo, HI 96720 January 2016

Boyle, R. 2014. How to Help Bats Taking A Dip in Our Backyard Pools. Popular Science. https://www.popsci.com/blog-network/eek-squad/how-help-bats-taking-dip-our-backyard-pools Accessed 13 August 2018.

Brooks, R. T., and Ford, W. M. 2005. Bat activity in a forest landscape of central Massachusetts. Northeastern Naturalist, 12(4), 447-462.

Burnham, K. P., and D. R. Anderson. 2002. Model Selection and Multimodel Inference: A Practical Information–Theoretic Approach. 2nd edition. Springer–Verlag, New York. 488 pp.

Chichorro, F., Juslén, A., Cardoso, P. 2018. A systematic review of the relation between species traits and extinction risk. 10.1101/408096.

Collins, J. and Jones, G. 2009. Differences in Bat Activity in Relation to Bat Detector Height: Implications for Bat Surveys at Proposed Windfarm Sites. Acta Chiropterologica, 11(2), 343-350.

Cuddihy, L.W., 1984. Effects of cattle grazing on the mountain parkland ecosystem, Mauna Loa, Hawaii. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Department of Botany

D'Antonio, C.M., Hughes, R.F., Tunison, J.T. 2011. Long-term impacts of invasive grasses and subsequent fire in seasonally dry Hawaiian woodlands. Ecological Applications, 21(5), 2011, pp. 1617–1628 2011 by the Ecological Society of America

Daehler, C., Denslow, J., Ansari, S., & Kuo, H. 2004. A Risk-Assessment System for Screening Out Invasive Pest Plants from Hawaii and Other Pacific Islands. Conservation Biology, 18(2), 360-368.

Dalthorp, D., M. Huso, and D. Dail. 2017. Evidence of absence (v2.0) software user guide: U.S. Geological Survey Data Series 1055, 109 p., https://doi.org/10.3133/ds1055.

DLNR (Division of Land and Natural Resources). 2005. ʻŌpeʻapeʻa or Hawaiian Hoary Bat. Hawaii's Comprehensive Wildlife Conservation Strategy. October 1.

DLNR. 2015. Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance Document.

DLNR (Department of Land and Natural Resources). No date. Kamehamenui Forest Project, the Trust for Public Land Flier. 4 pages.

DLNR. 2018. HCP and ITL Tier 4 Mitigation Concurrence Letter for Kawailoa Wind. David G. Smith (DLNR) to Adam Young (Kawailoa Wind, LLC). Emailed September 21, 2018.

DLNR. 2019. http://dlnr.hawaii.gov/hisc/info/species/cats-claw/ accessed 22 Feb 2019

DOFAW. 2017. Kula Forest Reserve and Papaʻanui Tract of Kahikinui Forest Reserve Management Plan. https://dlnr.hawaii.gov/forestry/files/2013/02/KulaFR_plan_Final.pdf accessed 1 March 2019.

DOFAW (Department of Forestry and Wildlife). 2015. Endangered Species Recovery Committee Hawaiian hoary bat guidance document. State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu, HI. Draft dated December 2015.

DOFAW. 2018. Approved HCPs and Annual Reports. Available at: http://dlnr.hawaii.gov/wildlife/hcp/approved-hcps/. Accessed November 13, 2018.

Dorman, C.F., J.M. McPherson, M.B. Araújo, R. Bivand, J. Bolliger, et al. 2007. Methods to account for spatial autocorrelation in the analysis of species distributional data: a review. Ecography 30: 609–628.

Downs, N., and Sanderson, L. 2010. Do Bats Forage Over Cattle Dung or Over Cattle? Acta Chiropterologica, 12(2), 349-358.

Duff, A., Morrell, T.E. 2007. Predictive Occurrence Models for Bat Species in California. Journal of Wildlife Management; May 2007; 71, 3; Research Library pg. 693

Entwistle, A.C., Harris, S., Hutson, A.M., Racey, P.A., Walsh, A., Gibson, S.D., Hepburn, I., Johnston, J. 2001. Habitat management for bats A guide for land managers, land owners and their advisors Joint Nature Conservation Committee.

ESRC (Endangered Species Recovery Committee). 2015. Agenda item 5: SunEdison request for major amendment. Posted on the State of Hawaii, Division of Forestry and Wildlife, Wildlife Programs, ESRC website archives.

Fenton, M.B. 1990. The foraging behavior and ecology of animal-eating bats. CAN. J. ZOOL./J. CAN. ZOOL, 68(3), 411-422.

Frasier, H.R., Parker-Geisman, V., Parish IV, G.R., 2007. Hawaiian hoary bat inventory in national parks on Hawai`i, Maui and Moloka`i. PCSU TR-140.

Frick, W.F. 2013. Acoustic Monitoring of bats, considerations of options for long-term monitoring. THERYA Vol.4(1):69-78.

Good, R. E., W. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay, and C. Fritchman. 2011. Bat Monitoring Studies at the Fowler Ridge Wind Energy Facility Benton County, Indiana, April

13–October 15, 2010. Prepared for: Fowler Ridge Wind Farm. Prepared by WEST Inc., Cheyenne, Wyoming.

Good, R.E., A. Merrill, S. Simon, K. Murray, and K. Bay. 2012. Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: April 1–October 31, 2011. Technical report prepared by WEST, Inc. and submitted to Fowler Ridge Wind Farm.

Gorresen, P., Cryan, P., Montoya-Aiona, K., & Bonaccorso, F. 2017. Do you hear what I see? Vocalization relative to visual detection rates of Hawaiian hoary bats (*Lasiurus cinereus semotus*). Ecology and Evolution, 7(17), 6669-6679.

Gorresen, P., Miles, A., Todd, C., Bonaccorso, F., & Weller, T. 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 Hawaii. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo, Technical Report 41.

Gorresen PM, Brinck KW, DeLisle MA, Montoya-Aiona K, Pinzari CA, Bonaccorso FJ. 2018. Multi-state occupancy models of foraging habitat use by the Hawaiian hoary bat (*Lasiurus cinereus semotus*). PLoS ONE 13(10): e0205150. https://doi.org/10.1371/journal.pone.0205150

Gorresen, P.M., P.M. Cryan, M.M. Huso, C.D. Hein, M.R. Schirmacher, J.A. Johnson, K.M. Montoya-Aiona, K.W. Brinck, and F.J. Bonaccorso. 2015. Behavior of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) at wind turbines and its distribution across the North Ko'olau Mountains, O'ahu. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo, Technical Report HCSU-064.

Grindal, S.D, and R.M. Brigham. 1999. Impacts of forest harvesting on habitat use by foraging insectivorous bats at different spatial scales. Ecoscience 6(1):25 – 34.

Haleakalā National Park 2016. Haleakalā National Park Management and Removal of Feral Animals in Upper Elevations of Nu'u, Maui Environmental Assessment Finding of No Significant Impact Determination of No Impairment Errata and Response to Comments. National Park Service U.S. Department of the Interior Haleakalā National Park, Makawao, Hawai'i

HT Harvey and Associates. 2016. Basic research of the home ranges, seasonal movements, habitat utilization, diet, and prey availability of the Hawaiian hoary bat on the island of Maui In Response to the RFP: Hawaiian Hoary Bat Research July 15, 2016 https://dlnr.hawaii.gov/wildlife/files/2016/06/1-8534A-HTHarvey-HHB-Proposal-Revision-15Sept16_topost.pdf

H.T. Harvey and Associates. 2019. Ecological studies of the Hawaiian hoary bat on Maui –An update. PowerPoint presentation to the ESRC on January 24, 2019, by D. Johnston, K. Jonasson, B. Yuen, M. Childs, K. Wolf, M. Medeiros, K. Magnacca, V. Brown, E. Clare, R. Duke, and P. Conry.

Harvey, C., Medina, A., Sánchez, D., Vílchez, S., Hernández, B., Saenz, J., Sinclair, F. 2006. Patterns of Animal Diversity in Different Forms of Tree Cover in Agricultural Landscapes. Ecological Applications, 16(5), 1986-1999.

Headwaters Wind Farm. 2018. Indiana Bat and Northern Long-Eared Bat Habitat Conservation Plan https://www.fws.gov/midwest/endangered/permits/hcp/pdf/HeadwatersDraftHCP.pdf. Accessed August 25, 2018

HECO (Hawaiian Electric Company). 2018. Hawaiian Electric Companies seek new renewable generation. Maui Electric. February 27. Accessed at: https://www.mauielectric.com/hawaiian-electric-companies-seek-new-renewable-generation.

Heim, O., Lenski, J., Schulze, J. Jung, K., Kramer-Schadt, S., Eccard, J.A., Voigt, C.C. 2018. The relevance of vegetation structures and small water bodies for bats foraging above farmland. Basic and applied ecology 27 (2018) 9-19.

Hein, C. D., A. Prichard, T. Mabee, and M. R. Schirmacher. 2014. Efficacy of an operational minimization experiment to reduce bat fatalities at the Pinnacle Wind Farm, Mineral County, West Virginia, 2013. An annual report submitted to Edison Mission Energy and the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Hein, C.D., and M.R. Schirmacher. 2013. Preliminary field test of an ultrasonic acoustic deterrent device with the potential of reducing Hawaiian hoary bat (*Lasiurus cinereus semotus*) fatality at wind energy facilities. Unpublished report submitted to First Wind, Portland, ME by Bat Conservation International, Austin, TX.

Jackrel, S. L., & Matlack, R. S. 2010. Influence of surface area, water level and adjacent vegetation on bat use of artificial water sources. American Midland Naturalist, 164(1), 74-79.

Jacobs, D.S. 1994. Distribution and Abundance of the Endangered Hawaiian Hoary Bat, *Lasiurus cinereus semotus*, on the Island of Hawai'i. University of Hawaii Press Pacific Science (1994), vol. 48, no. 2: 193-200.

Jacobs, D. 1996. Morphological Divergence in an Insular Bat, *Lasiurus cinereus semotus*. Functional Ecology, 10(5), 622-630. doi:10.2307/2390172.

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

KWP I (Kaheawa Wind Power). 2017. Kaheawa Habitat Conservation Plan- FY-2017 Annual Report Year 2017. August 2017.

KWP II (Kaheawa Wind Power II). 2017. Kaheawa Habitat Conservation Plan- FY-2017 Annual Report Year 2017. August 2017.

Kawailoa Wind Power (Kawailoa Wind Power, LLC). 2013. Kawailoa Habitat Conservation Plan—ITL 14: FY 2013 Annual Report—Year 1. Haleiwa, HI.

Kawailoa Wind Power. 2014. Kawailoa Habitat Conservation Plan- FY-2014 Annual Report Year 2014. August 2014.

Kawailoa Wind Power. 2017. Kawailoa Habitat Conservation Plan- FY-2017 Annual Report Year 2017. Oct 2017.

Kelm, D.H., Lenski, J., Kelm, V., Toelch, U., Dziock, F. 2014. Seasonal bat activity in relation to distance to hedgerows in an agricultural landscape in central Europe and implications for wind energy development. Acta Chiropterologica, 16(1): 65–73, 2014.

Kepler, C.B., and J.M. Scott. 1990. Notes on distribution and behavior of the endangered Hawaiian hoary bat (Lasiurus cinereus semotus), 1964-1983. ʻElepaio 50(7):59—64.

Knight, T., Jones, G. 2009. Importance of night roosts for bat conservation: roosting behaviour of the lesser horseshoe bat Rhinolophus hipposideros. Endang Species Res 8: 79–86, 2009

Kunz, T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. *Frontiers in Ecology* 5:315–324.

Kunz, TH. 1982. Roosting ecology. In: Kunz TH (ed) Ecology of bats. Plenum Press, New York, p 1–55

KWP LLC. 2006. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan.

Lacoeuilhe, A., Machon, N., Julien, J., Kerbiriou, C. 2018. The Relative Effects of Local and Landscape Characteristics of Hedgerows on Bats. Diversity 10, 72; doi:10.3390/d10030072.

Langhans, S.D., and K. Tockner. 2014. Edge effects are important in supporting beetle biodiversity in a gravel-bed river floodplain. PLoS ONE 9(12): 1-19.

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

Mackenzie, D.I., Nichols, J.D., Royle, J.A., Pollock, K.H., Bailey, L.L., Hines, J.E. 2019. Occupancy Estimation and Modeling 2nd Edition. Academic Press, San Diego, California.

Martin C., E. Arnett, R. Stevens, and M. Wallace. 2017. Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation. Journal of Mammalogy 98(2):378-385.

Menard, T. 2001. Activity Patterns of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) in Relation to Reproductive Time Periods. M.S Thesis. University of Hawaii.

NOAA (National Oceanic and Atmospheric Administration). 2018. Office for Coastal Management. "Name of Data Set." Coastal Change Analysis Program (C-CAP) Regional Land Cover. Charleston, SC: NOAA Office for Coastal Management. Available at www.coast.noaa.gov/ccapftp. Accessed March 2018.

NREL. 2010. SWT-3.0-101 An example of Systems Engineering. https://www.nrel.gov/wind/assets/pdfs/se_workshop_paliszewski.pdf.

Morton, B. 2017. NRG Bat Deterrent System Webinar.

NRG Systems. Personal communication. 2017.Peck, R. W., Banko, P.C., Cappadonna, J., Steele, C., Leonard, D.L., Mounce, H.L., Becker, C.D., Swinnerton, K. 2015. An Assessment of Arthropod Prey Resources at Nakula Natural Area Reserve, a Potential Site of Reintroduction for Kiwikiu (*Pseudonestor xanthopyrys*) and Maui 'alauahio (*Paroreomyza montana*) Hawai'i Cooperative Studies Unit Technical Report HCSU-059.

Pinzari, C.A. 2014. Hawaiian Hoary bat occupancy at Kalokohonokōhau National Historical park. HCSU Technical report HCSU- 051Pollard, K., & Holland, J. (2006). Arthropods within the woody element of hedgerows and their distribution pattern. Agricultural And Forest Entomology, 8(3), 203-211.

Pinzari, Corinna; and Bonaccorso, Frank. 2018. A Test of Sex Specific Genetic Markers in the Hawaiian Hoary Bat and Relevance to Population Studies. doi:10.5066/P9R7L1NS.

Pollard, K., & Holland, J. (2006). Arthropods within the woody element of hedgerows and their distribution pattern. Agricultural And Forest Entomology, 8(3), 203-211.

Pöyry, J., Lindgren, S., Salminen, J., & Kuussaari, M. 2004. Restoration of Butterfly and Moth Communities in Semi-Natural Grasslands By Cattle Grazing. Ecological Applications, 14(6), 1656-1670.

Rainho, A, Augusto, A. M. and Palmeirim, J. M. 2010. Influence of vegetation clutter on the capacity of ground foraging bats to capture prey. Journal of Applied Ecology, 47: 850-858. doi:10.1111/j.1365-2664.2010.01820.x.

Russell, A.L., C.A. Pinzari, M.J. Maarten, K.J. Olival, and F.J. Bonaccorso. 2015. Two Tickets to Paradise: Multiple Dispersal Events in the Founding of Hoary Bat Populations in Hawai'i. PLoS ONE 10(6): e0127912. doi:10.1371/journal.pone.0127912.

Schirmacher, M. S., A. Prichard, T. Mabee, and C. D. Hein. 2018. Evaluating a Novel Approach to Optimize Operational Minimization to Reduce Bat Fatalities at the Pinnacle Wind Farm, Mineral County, West Virginia, 2015. An annual report submitted to NRG Energy and the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Speakman, JR. 1995. Chiropteran nocturnality. Pp. 187–201. In: Ecology, Evolution and Behaviour of Bats (PA Racey and SM Swift, eds.). Oxford University Press, New York. Symp. Zool. Soc. Lond. (1995) No. 67.

Stantec (Stantec Consulting Services Inc.). 2015. Pioneer Trail Wind Farm Habitat Conservation Plan for the Indiana Bat and Northern Long-eared Bat H. Prepared by Pioneer Trail Wind Farm, LLC, in consultation with Stantec Consulting Services Inc.

Stantec. 2016. Wildcat Wind Farm Phase 1, Indiana Bat and Northern Long-eared Bat Habitat Conservation Plan. Prepared by Wildcat Wind Farm 1, LLC, in consultation with Stantec Consulting Services Inc.

Starcevich, L.A., Thompson, J., Rintz, T., Adamczyk, E., Solick, D., 2019. Oahu Hawaiian Hoary Bat Occupancy and Distribution Study. Project Update and First-Year Analysis Prepared for: Hawaii Endangered Species Research Committee

Starr Environmental 2010. http://www.starrenvironmental.com/images/image/?q=24958036981 accessed December 2018

State of Hawai'i. 2018. http://planning.hawaii.gov/gis/download-gis-data/ Accessed 8 August 2018

SWCA. 2011. Kawailoa Wind Power Habitat conservation plan. Prepared for Kawailoa Wind Power LLC by SWCA Environmental Consultants.

Szewczak, J.M. and E.B. Arnett. 2007. Field test results of a potential acoustic deterrent to reduce bat mortality from wind turbines. 14 pp. Report submitted to The Bats and Wind Energy Cooperative and Bat Conservation International, Austin, TX.

Taylor, D.A.R. 2007. Helping Western Bats Find a Place to Drink. BATS Magazine. Bat Conservation International. http://www.batcon.org/resources/media-education/bats-magazine/bat_article/168. Accessed August 13, 2018

Taylor, D.A.R. and M.D. Tuttle. 2007. Water for Wildlife: A Handbook for Ranchers and Range Managers, Bat Conservation International.

The Nature Conservancy. 2011. DRAFT Long-Range Management Plan. Fiscal Years 2013–2018. Submitted to the Department of Land & Natural Resources Natural Area Partnership Program https://dlnr.hawaii.gov/ecosystems/files/2013/09/Waikamoi_FY2013_2018_LRMP_DRAFT.pdf

Tidhar, D., Sonnenberg, M., Young, D. 2013. 2012 Post-construction Carcass Monitoring Study for the Beech Ridge Wind Farm Greenbrier County, West Virginia Final Report April 1 – October 28, 2012 Prepared for: Beech Ridge Wind Farm Beech Ridge Energy, LLC One South Wacker Drive, Suite 1900 Chicago, Illinois 60606

Todd, C.M. 2012. Effects of Prey Abundance on Seasonal Movements of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*).

Todd, C.M., Pinzari, C.A., Bonaccorso, F.J. 2016. Acoustic Surveys of Hawaiian Hoary Bats in Kahikinui Forest Reserve and Nakula Natural Area Reserve on the Island of Maui. Hawaii Cooperative Studies Unit Technical Report HCSU-078.

Tomich, P. Quentin. 1986. Mammals in Hawaii, second edition. Bernice P. Bishop Museum Special Publication 76. Honolulu: Bishop Museum Press. 375 pp. ISBN: 0-93087-10-2.

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

Tuttle, S., Chambers, C., and Theimer, T. 2006. Potential Effects of Livestock Water-Trough Modifications on Bats in Northern Arizona. Wildlife Society Bulletin, 34(3), 602-608.

USDA (United States Department of Agriculture). 2019. Introduced, Invasive, and Noxious Plants: Hawaii State-listed Noxious Weeds. https://plants.usda.gov/java/noxious?rptType=State&statefips=15

USDA Forest Service. 2018. Forest Legacy Project Kamehamenui Forest Project Maui County Hawaii, Report prepared from FY 2018 Proposed Projects Archive.

USFWS (U.S. Fish and Wildlife Service). 1998. Recovery Plan for the Hawaiian Hoary Bat. U.S. Fish and Wildlife Service, Portland, OR.

USFWS. 2003. Biological opinion of the U.S. Fish and Wildlife Service for routine military training and transformation of the 2nd brigade 25th infantry division (light) U.S. Army Installations Island of Oahu. Unpublished.

USFWS. 2011. Revised Draft Guidelines for Land-based Wind Farm Development. July 12, 2011. Available online at: http://www.fws.gov/windenergy/

USFWS. 2016a. Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take. USFWS Pacific Islands Field Office. Honolulu, HI. October 2016.

USFWS. 2016b. USFWS Recommendations Regarding the Content of HCPs for Wind Energy Projects in Hawaii 2016.

USFWS. 2018. Letter Regarding Land Acquisition of the Helemano Wilderness Area for Tier 4 Hawaiian Hoary Bat Mitigation for Kawailoa Wind, LLC's Proposed Habitat Conservation Plan Amendment, Oahu. Michelle Bogardus (USFWS) to Adam Young (Kawailoa Wind, LLC). Emailed September 26, 2018.

USFWS and DOFAW. 2016. Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take. Honolulu, Hawaii. Version dated October 1, 2016.

USFWS and DOFAW. 2017. Standard protocol for State of Hawaii Incidental Take License and U.S. Fish and Wildlife Service Incidental Take Permit holders responding to dead or injured wildlife including threatened and endangered species and MBTA species. Version dated March 1, 2017.

USFWS and NMFS (National Marine Fisheries Service). 2016. Revised Habitat Conservation Planning and Incidental Take Permit Processing Handbook. Version dated December 21, 2016. Available at: https://www.fws.gov/endangered/what-we-do/hcp_handbook-chapters.html.

USGS (U.S. Geological Survey). 2013. National Hydrography Geodatabase: The National Map viewer available on the World Wide Web (https://viewer.nationalmap.gov/viewer/nhd.html?p=nhd), accessed 16 March 2018.

Uyehara, Kimberly & Wiles, Gary. 2009. NRCS Biology Technical Note No. 20 – Bats of the U.S. Pacific Islands. USDA Natural Resources Conservation Service - Biology Technical Note. 20. 1-34.

Vanderwerf, E.A. 2009. Importance of nest predation by alien rodents and avian poxvirus in conservation of oahu elepaio. Journal of Wildlife Management, 73(5), 737-746. Retrieved from http://access-proxy.sno-isle.org/login?url=https://search-proquest-com.access-proxy.sno-isle.org/docview/234255354?accountid=1168

Van Helverson, O., Reyer, H.U. 1984. Nectar intake and energy expenditure in a flower visiting bat. Oecologia. Berlin. 63:178-184.

Vindigni, Morris, Miller, & Kalcounis-Rueppell. 2009. Use of modified water sources by bats in a managed pine landscape. Forest Ecology and Management, 258(9), 2056-2061.

Weaver, S., Hein, C., Castro-Arellano, I., Simpson, T., 2018. Testing ultrasonic acoustic deterrents for reducing bat fatalities at wind turbines in south Texas. Presentation to the Wind Wildlife Meeting XII 29 November 2018.

WEST. 2013. Fowler Ridge Wind Farm Indiana Bat Habitat Conservation Plan. Prepared by Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge IV Wind Farm LLC, in consultation with Western EcoSystems Technology, Inc.

Whitaker, J.O., Jr., and P.Q. Tomich. 1983. Food habits of the hoary bat, *Lasiurus cinereus*, from Hawaii. *Journal of Mammalogy* 64:151–152.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC.

Young, D.P., Jr., S. Nomani, W. Tidhar, and K. Bay. 2011. NedPower Mount Storm Wind Energy Facility Post-Construction Avian and Bat Monitoring, July – October 2010. Technical report prepared by WEST, Inc. and submitted to NedPower Mount Storm, LLC.

Young, D., Nomani, S., Courage, Z., Bay, K. 2012. NedPower Mount Storm Wind Energy Facility Post-Construction Avian and Bat Monitoring July - October 2011 Prepared for: NedPower Mount Storm, LLC 910 Louisiana Street, Suite 1050 Houston, Texas 77002 Prepared by: Western EcoSystems Technology, Inc. 2003 Central Ave Cheyenne, Wyoming, 82001 February 27, 2012

Zimpfer, J. and Bonaccorso, F. 2010. Barbed wire fences and Hawaiian hoary bats: what we know. Hawaii Conservation Conference Abstract https://hawaii.conference-services.net/reports/template/onetextabstract.xml?xsl=template/onetextabstract.xsl&conferenceID=2069&abstractID=410279. Accessed 10 August 2018.

APPENDIX A

BOTANICAL, AVIAN AND TERRESTRIAL MAMMALIAN SURVEYS CONDUCTED FOR THE AUWAHI WIND FARM PROJECT, ULUPALAKUA RANCH, ISLAND OF MAUI

This Appendix requires no edits for the HCP Amendment

APPENDIX B

AUWAHI WIND PROJECT REVEGETATION POTENTIAL PLANT LIST

This Appendix requires no edits for the HCP Amendment

APPENDIX C

AUWAHI WIND FARM FIRE MANAGEMENT PLAN

This Appendix requires no edits for the HCP Amendment

APPENDIX D

AUWAHI WIND CULTURAL RESOURCES AVOIDANCE, MINIMIZATION, AND MITIGATION

This Appendix requires no edits for the HCP Amendment

APPENDIX E

AUWAHI WIND FARM PROJECT
POST-CONSTRUCTION MONITORING PLAN

Revised for the HCP Amendment

APPENDIX F

AVIAN RISK OF COLLISION ANALYSIS FOR THE SOUTH AUWAHI WIND RESOURCE AREA, MAUI, HAWAII

This Appendix requires no edits for the HCP Amendment

APPENDIX G

LWSC REVIEW

New Appendix associated with HCP Amendment

Literature Review of Low Wind Speed Curtailment Effectiveness on Bat Mortality

1.0 INTRODUCTION

Tetra Tech, Inc. prepared a literature review to summarize the best available science on the effectiveness of low wind speed curtailment (LWSC) and its potential for minimizing impacts to bats. This review focused on studies that implemented experimental treatments to test the effectiveness of changing turbine cut-in speeds and other operational measures on reducing bat fatalities, or syntheses of such studies. Studies included those that compared bat fatalities under the wind turbine manufacturer's cut-in speed (typically 3.5 to 4 meters per second [m/s]) and a single LWSC treatment (e.g., Martin et al. 2017, Stantec 2015, Young et al. 2012), as well as studies that compared multiple LWSC treatments (e.g., Hein et al. 2014; Good et al. 2011, 2012; Arnett et al. 2011) or the effectiveness of other operational measures (e.g., Baerwald et al. 2009, Young et al. 2011).

2.0 SUMMARY

The following synthesizes the key findings of this review. Table 1 presents the details of the studies that were evaluated.

- Increasing cut-in speeds between 1.5 and 3.0 m/s above the manufacturer's cut-in speed has been shown to yield substantial reductions in bat fatalities, ranging from 10 to 92 percent (Table 1), with at least a 50 percent reduction in bat fatalities when turbine cut-in speed was increased by 1.5 m/s above the manufacturer's cut-in speed (Arnett et al. 2013).
- Significant additional reductions in bat fatality rates have been demonstrated when cut-in speeds are raised incrementally from 3.5 to 4.5 to 5.5 m/s (Good et al. 2012), but the results of studies evaluating the additional benefits of raising cut-in speeds above 5.0 m/s are ambiguous.
    - Good et al. (2011) demonstrated a significant additional reduction in bat fatalities at Fowler Ridge (Indiana) when cut-in speeds were raised from 5.0 to 6.5 m/s; however, Hein et al. (2014) at Pinnacle Wind (Vermont) and Arnett et al. (2011) at Casselman (Pennsylvania) found no statistically significant difference between these cut-in speeds. Hein et al. (2014) does indicate, however, that even though the results were not statistically significant the estimated mortality rate for the 6.5 m/s treatment was lower than the 5.0 m/s treatments. The researchers suggest that the lack of significant differences between treatments may have been the result of the small proportion of time (18.6 percent) wind speeds were between 5.0 and 6.5 m/s (Hein et al. 2014). Thus, the difference in results may be attributed to differences in wind regimes at each project (Arnett et al. 2013).

  - Tidhar et al. (2013) documented an approximately 89 percent reduction in bat fatalities at Beech Ridge (West Virginia) when turbines were curtailed at 6.9 m/s; however, the reduction was based on a comparison to other regional facilities (Mount Storm and Mountaineer), rather than on a comparison of experimental treatments implemented at other turbines at the Beech Ridge site.
  - Stantec (2015) found a significant difference in bat fatalities observed between LWSC at 6.9 m/s and operation at the manufacturer's cut-in speed of 3.5 m/s with a 92 percent reduction in bat fatalities at the Laurel Mountain Wind Energy Project. However, the study did not evaluate the incremental reduction of raising the cut-in speed to 5.0 m/s compared to 6.9 m/s.
- Some studies have shown that equally beneficial reductions in bat fatalities may be achieved by feathering blades (pitched 90° and parallel to the wind) or slowing rotor speed up to the turbine manufacturer's cut-in speed (low-speed idling approach) without LWSC (Baerwald et al. 2009; Young et al. 2011, 2012; Good et al. 2017). While there may be additional benefits to bats associated with progressively higher levels of LWSC, the effectiveness of LWSC is dependent on project-specific characteristics such as wind regime, bat species at risk, surrounding land uses, and other factors (Arnett et al. 2013). This uncertainty is reflected in the incorporation of LWSC in HCPs for wind projects both in Hawai'i and on the U.S. mainland, where 5.0 m/s is a typical baseline cut-in speed for projects with potential impacts to listed bats.
- Identifying when bat collision risk could be high based on environmental parameters could optimize the timing of LWSC implementation and minimize power loss (i.e., smart curtailment; Good et al. 2011; Weller and Baldwin 2012; Arnett et al. 2016; Martin et al. 2017). Parameters such as wind speed, ambient temperature, season, and time of day as well as levels of bat activity may be considered for defining a set of operational rules for dictating when turbines are curtailed (Good et al. 2011, Arnett and May 2016, Arnett et al. 2016, EPRI 2017).
  - Fatalities appear to increase as ambient temperature rises, at least in North America and Europe, and with decreasing relative humidity. These studies suggest that fatalities may be correlated with periods of high insect activity, which generally is most likely to occur under warm and dry conditions (Arnett et al. 2016).
  - Martin et al. (2017) incorporated temperature as part of the experimental treatment, curtailing treatment turbines only at temperatures above 9.5°C and wind speeds above 6.0 m/s, and found that these parameters had a significant effect on reducing bat fatalities.
  - Baerwald and Barclay (2011) reported that species-specific fatalities were affected by greater moon illumination. They also observed that falling barometric pressure and

the number of deaths were correlated and that whereas fatalities of silver-haired bats increased with increased activity of this species, moon illumination, and south-easterly winds, hoary bat mortality increased most significantly with falling barometric pressure. Interestingly, neither hoary bat activity nor fatality was influenced by any measured variables other than falling barometric pressure. This could result from decreasing barometric pressure that triggers insect flight activity and therefore may motivate foraging efforts among bats by indicating a potential increase in food availability (Arnett et al. 2016).

- The available studies do not provide sufficient detail to discern patterns or differences in effectiveness of LWSC between bat species. This is typically because the number of bat fatalities found is too low to provide a meaningful comparison of operational mitigation by species (Martin et al. 2017), or the particular study designs are not set up to do so.
- Regarding the role that turbine model plays in LWSC, Good and Adachi (2014) reported that the effectiveness of LWSC cut-in speed may also depend on the deceleration and acceleration profile of the specific turbine model. That is, the behavior of the turbine prior to reaching cut-in speed. Good et al. (2017) reported fatality rates at the Fowler Ridge Wind Farm were highest in association with Siemens turbines, followed by Clipper, Vestas, and GE under a 5.0 m/s LWSC regime. Although this report did not speak to specific turbine differences responsible for this trend, an earlier report, Good et al. (2012) noted that turbine models at Fowler Ridge with the most fatalities spun more and at greater speeds below the cut-in speed than the other turbine models, resulting in less actual down time.

Table 1. Comparison of Available Research Studies on the Effectiveness of Changing LWSC Cut-in Speeds

Study Location	Study Year	Number of Turbines in Study	Turbine Type	Normal Operation Cut-in Speed (Control) m/s	LWSC Treatment m/s	Percent Reduction in Bat Fatalities	Study Summary	Reference
Laurel Mountain Wind Energy Project WV	2014	24	GE XLE 1.6 MW, 80-m hub height, 82.5-m rotor diameter	3.5	6.9	92	Significant difference in bat fatalities observed between LWSC at 6.9 m/s and operation at the manufacturer's cut-in speed of 3.5 m/s. LWSC was implemented from sunset to sunrise, between April 1 and November 15. Bat fatalities – eastern red bats (*Lasiurus borealis*), silver-haired bats (*Lasionycteris noctivagans*), hoary bats *(Lasiurus cinereus*), and big brown bats (*Eptesicus fuscus*).	Stantec 2015
Pinnacle Wind, WV	2013	12	Mitsubishi 2.4 MW, 80-m hub height, 95-m rotor diameter	3.0	5.0 6.5	54.4 76.2	Bat fatality rates were not significantly different between LWSC cut-in speeds of 5.0 and 6.5 m/s; however, both treatment cut-in speeds had significantly lower fatalities than the manufacturer's cut-in speed of 3.0 m/s. Turbines were fully feathered below the LWSC cut-in speeds. LWSC was implemented from sunset to sunrise, 15 July and 30 September. Bat fatalities – Eastern red bats, hoary bats, silver-haired bats, tri-colored bats (*Perimyotis subflavus*), and big brown bats.	Hein et al. 2014
Sheffield Wind Facility, VT	2012/13	16	Clipper 2.5 MW, 80-m hub height, 93-m rotor diameter	4.0	6.0	62	Cut-in speed at treatment turbines was raised from 4.0 to 6.0 m/s whenever nightly wind speeds were < 6.0 m/s and temperatures were > 9.5°C, 3 June to 30 September to capture spring and fall migration. Significant reduction in fatalities at 6.0 m/s as compared to 4 m/s cut-in speeds. Bat fatalities – Hoary bat, eastern red bats, silver-haired bats.	Martin et al. 2017

Study Location	Study Year	Number of Turbines in Study	Turbine Type	Normal Operation Cut-in Speed (Control) m/s	LWSC Treatment m/s	Percent Reduction in Bat Fatalities	Study Summary	Reference
Beech Ridge, WV	2012	67	GE SLE 1.5 MW, 80-m hub height, 70-m rotor diameter	Regional Comparison	6.9	73	Compared fatalities at the project, with implementation of LWSC at 6.9 m/s, to average fatality rates at other wind farms in the region (Mount Storm and Mountaineer); fatalities at the project were significantly lower than regional averages. LWSC was implemented one-half hour before sunset to one-quarter hour after sunrise, 1 April to 15 November. Bat fatalities – Eastern red bat, hoary bat, silver-haired bat, tricolored bat.	Tidhar et al. 2013
Fowler Ridge, IN	2011	126	GE SLE 1.5 MW, 80-m hub height, 77-m rotor diameter; Vestas V82 1.65 MW, 80-m hub height, 82-m rotor diameter; Clipper C96 2.5 MW, 80-m hub height, 96-m rotor diameter	(NO LWSC)	3.5 4.5 5.5	36.5 56.7 73.3	Bat fatality rates were measured under three different cut-in speed "treatments" (with blades feathered) and two sets of "control" turbines with no cut-in speed adjustment. Reductions in bat fatalities under each treatment were significantly different from each other and from the control turbines. LWSC implemented 1 April to 15 May and 15 July to 29 October. Bat fatalities – Eastern red bat, hoary bat, silver-haired bat, big brown bat, evening bat (*Nicticeius humeralis*),tri-colored bat, Seminole bat (*Lasiurus seminolus*), little brown bat (*Myotis lucifugus*).	Good et al. 2012
Mount Storm, WV	2011	24	Gamesa G80 2.0 MW, 78-m hub height, 80-m rotor diameter	4.0 (free-wheel)	4.0 (feathered)	10	Study evaluated the effect of feathering only, without increasing cut-in speed. Implemented 16 July to 15 October. No significant difference in fatalities was found between control turbines and feathered turbines. Bat fatalities – Hoary bat, eastern red bat, silver-haired bat, tricolored bat, big brown bat.	Young et al. 2012
	2010	27	GE SLE 1.5 MW, 80-m hub	3.5	5.0	50	Reductions in bat fatality rates under both LWSC cut-in speed treatments were	

Study Location	Study Year	Number of Turbines in Study	Turbine Type	Normal Operation Cut-in Speed (Control) m/s	LWSC Treatment m/s	Percent Reduction in Bat Fatalities	Study Summary	Reference
Fowler Ridge, IN			height, 77-m rotor diameter; Vestas V82 1.65 MW, 80-m hub height, 82-m rotor diameter; Clipper C96 2.5 MW, 80-m hub height, 96-m rotor diameter		6.5	78	significantly different from each other and from the control turbines. LWSC implemented 1 August to 15 October. Bat fatalities – Eastern red bat, hoary bat, silver-haired bat, big brown bat, tri-colored bat, Indiana bat (*Myotis sodalis*), little brown bat.	Good et al. 2011
Mount Storm, WV	2010	24	Gamesa G80 2.0 MW, 78-m hub height, 80-m rotor diameter	4.0 (free-wheel)	4.0 (feathered)	47/22	Treatments were compared for first half vs. second half of the night, 15 July to 15 October. Feathered turbines (treatment) had significantly fewer mortalities than unfeathered, free-wheeling (control) turbines. Bat fatalities were significantly lower for feathered turbines during the first half of the night vs the second half. The study was conducted mid-July to mid-October. Bat fatalities – Eastern red bat, hoary bat, silver-haired bat, big brown bat, tri-colored bat, little brown bat, Seminole bat.	Young et al. 2011
Casselman, PA	2008-09	12	GE SLE 1.5 MW, 80-m hub height, 77-m rotor diameter	3.5	5.0 6.5	2008 – 82 2009 – 72	No significant difference in fatality rates between 5m/s and 6.5 m/s LWSC treatments; however, both cut-in speeds had significantly lower fatalities than turbines operating at the manufacturer's cut-in speed of 3.5 m/s. LWSC implemented in experimental units 27 July to 9 October 2008, and 26 July to 8 October 2009. Bat fatality species not identified.	Arnett et al. 2011
Alberta, Canada	2008	21	Vestas V80 1.8 MW, 65-m hub height, 80-m rotor diameter	4.0 m/s	Blade feathering, low speed idle strategy	60	Blades were angled 45^0 to reduce rotor speed at low wind speeds which resulted in a significant reduction in bat fatalities by 60 percent. Blade angling implemented sunset to sunrise, 15 July to 30 September.	Baerwald et al. 2009

3.0 References

Arnett, E.B., Baerwald, E.F., Mathews, F., Rodrigues, L., Rodríguez-Durán, A., Rydell, J., Villegas-Patraca, R., Voigt, C.C. 2016. Impacts of wind energy development on bats : a global perspective. Bats in the Anthropocene: Conservation of Bats in a Changing World. Springer International Publishing, Cham: pp.295–323.

Arnett, E. B., M. M. P. Huso, J. P. Hayes, and M. Schirmacher. 2010. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX, USA.

Arnett, E., M. Huso, M. Schirmacher, and J. Hayes. 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. Ecol. Environ. 9(4) pp 209-214.

Arnett, E. B., G. D. Johnson, W. P. Erickson, and C. D. Hein. 2013. A synthesis of operational mitigation studies to reduce bat fatalities at wind energy facilities in North America. A report submitted to the National Renewable Energy Laboratory. Bat Conservation International. Austin, TX, USA.

Arnett, E. and R. May. 2016. Mitigating wind energy impacts on wildlife: approaches for multiple taxa. Human–Wildlife Interactions 10(1):28–41.Baerwald, E.F., Barclay, R.M.R., 2011. Patterns of activity and fatality of migratory bats at a wind energy facility in Alberta, Canada. Journal of Wildlife Management 75, 1103–1114.

Baerwald, E., J. Edworthy, M. Holder, and R. Barclay. 2009. A large-scale mitigation experiment to reduce bat fatalities at wind energy facilities. Journal of Wildlife Management 73(7):1077-1081

EPRI (Electric Power Research Institute). 2017. Bat Detection and Shutdown System for Utility-Scale Wind Turbines. Palo Alto, CA. Prepared by Normandeau Associates, Inc. 451 NW 6th Street, Suite A, Gainesville, FL 32609.

Good, R.E. and K. Adachi. 2013. Fowler Ridge Research Summary. Poster presented at the 2014 National Wind Coordinating Collaborative, Research Meeting X, December 2-5, 2014, Broomfield, CO. Western EcoSystems Technology, Inc. Bloomington, Indiana.

Good. R. E., A. Ciecka, G. Iskali, and K. Nasman. 2017. Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: August 3 – October 12, 2016. Prepared for Fowler Ridge Wind Farm, Fowler, Indiana. Prepared by Western EcoSystems Technology, Inc. Bloomington, Indiana.

Good. R. E., W. Erickson, A. Merrill, S. Simon, K. L. Murray, K. Bay, and Chris Fritchman. 2011. Bat monitoring studies at the Fowler Ridge Wind Energy Facility Benton County, Indiana, April 13 – October 15, 2010. Prepared for Fowler Ridge Wind Farm, Fowler, Indiana. Prepared by Western EcoSystems Technology, Inc. Cheyenne WY.

Good. R. E., A. Merrill, S. Simon, K. L. Murray, and K. Bay. 2012. Bat monitoring studies at the Fowler Ridge Wind Farm, Benton County, Indiana. Final Report: April 1 – October 31, 2011. Prepared for Fowler Ridge Wind Farm, Fowler, IN. Prepared by Western EcoSystems Technology, Inc. Bloomington, IN.

Hein, C. D., A. Prichard, T. Mabee, and M. R. Schirmacher. 2014. Efficacy of an operational minimization experiment to reduce bat fatalities at the Pinnacle Wind Farm, Mineral County, West Virginia, 2013. An annual report submitted to Edison Mission Energy and the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX, USA.

Martin C., E. Arnett, R. Stevens, and M. Wallace. 2017. Reducing bat fatalities at wind facilities while improving the economic efficiency of operational mitigation. Journal of Mammalogy 98(2):378-385.

Martin C., E. Arnett, and M. Wallace. 2012. Evaluating bird and bat post-construction impacts at the Sheffield Wind Facility, Vermont. Annual Report prepared for Bat Conservation International and First Wind.

Stantec (Stantec Consulting Services Inc). 2013. Final Buckeye Wind Project Habitat Conservation Plan. Prepared for Buckeye Wind LLC.

Stantec. 2015. Bird and bat post-construction monitoring report – Laurel Mountain Wind Energy Project. Prepared for: AES Laurel Mountain Wind, LLC 95 Turbine View Road Belington, WV 26250.

Tidhar, D., M. Sonnenberg, and D. Young. 2012. Post-construction carcass monitoring study for the Beech Ridge Wind Farm Greenbrier County, West Virginia. Western EcoSystems Technology, Inc. Prepared for: Beech Ridge Wind Farm Beech Ridge Energy, LLC, One South Wacker Drive, Suite 1900 Chicago, IL 60606.

Weller, T., and J. Baldwin. 2012. Using echolocation monitoring to model bat occupancy and inform mitigations at wind energy facilities. Journal of Wildlife Management, 76(3) pp 619-631.

WEST. 2013. Fowler Ridge Wind Farm Indiana Bat Habitat Conservation Plan. Prepared by Fowler Ridge Wind Farm LLC, Fowler Ridge II Wind Farm LLC, Fowler Ridge III Wind Farm LLC, and Fowler Ridge IV Wind Farm LLC, in consultation with Western EcoSystems Technology, Inc.

Young, D.P., Jr., K. Bay, S. Nomani, and W.L. Tidhar. 2011. NedPower Mount Storm Wind Energy Facility post-construction avian and bat monitoring: July - October 2010. Prepared for NedPower Mount Storm, LLC, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, WY.

Young, D.P., Jr., S. Nomani, Z. Courage, and K. Bay. 2012. NedPower Mount Storm Wind Energy Facility post-construction avian and bat monitoring: July - October 2011. Prepared for NedPower Mount Storm, LLC, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming.

Young, D.P., Jr., C. Nations, M. Lout and K. Bay. 2013. 2012 post-construction monitoring study, Criterion Wind Project, Garrett County, Maryland: April – November 2012. Prepared for Criterion Power Partners, LLC. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, WY.

APPENDIX H

EVIDENCE OF ABSENCE ANALYSIS

New Appendix associated with HCP Amendment

1.0 INTRODUCTION

This appendix describes the approach Auwahi Wind, LLC (Auwahi Wind) used for estimating total Project-related take of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) at the Auwahi Wind Project (Project) over the remaining years of the term of the Incidental Take Permit (ITP)/Incidental Take License (ITL) for this Habitat Conservation Plan (HCP) Amendment. The appendix is provided to give additional detail on the estimation process. The current standard for fatality estimation when the annual level of take is low (i.e., less than seven observed fatalities per year per Dan Dalthorp, personal communication., March 2, 2018) is to use the Evidence of Absence software (EoA; Dalthorp et al. 2017). EoA is a statistical software package that considers the observed fatalities as well as other study parameters to account for fatalities that may have been missed during regular searches. A summary of the methods used to calculate the direct take using EoA is provided. The information provided here assumes the reader is familiar with Evidence of Absence and has a familiarity with statistics.

The estimate of total Project-related take includes the take currently authorized under the approved HCP and the additional take estimated to occur during the remaining years of the Project's ITP/ITL term and requested under the HCP Amendment. Hawaiian hoary bat ecology and potential Project-related sources of take are described in detail in Sections 3.8.1 and 5.1 of the HCP Amendment, respectively, and are not discussed further.

2.0 DIRECT TAKE

The EoA software package was used to model potential fatality levels (direct take only) over the 20-year operating period of the ITP/ITL based on Project-specific fatality data and to estimate a requested take limit. For estimating direct take, the software produces a probability function that estimates the likelihood that estimated mortality is equal to actual mortality. The probability function is illustrated in Figure 1.

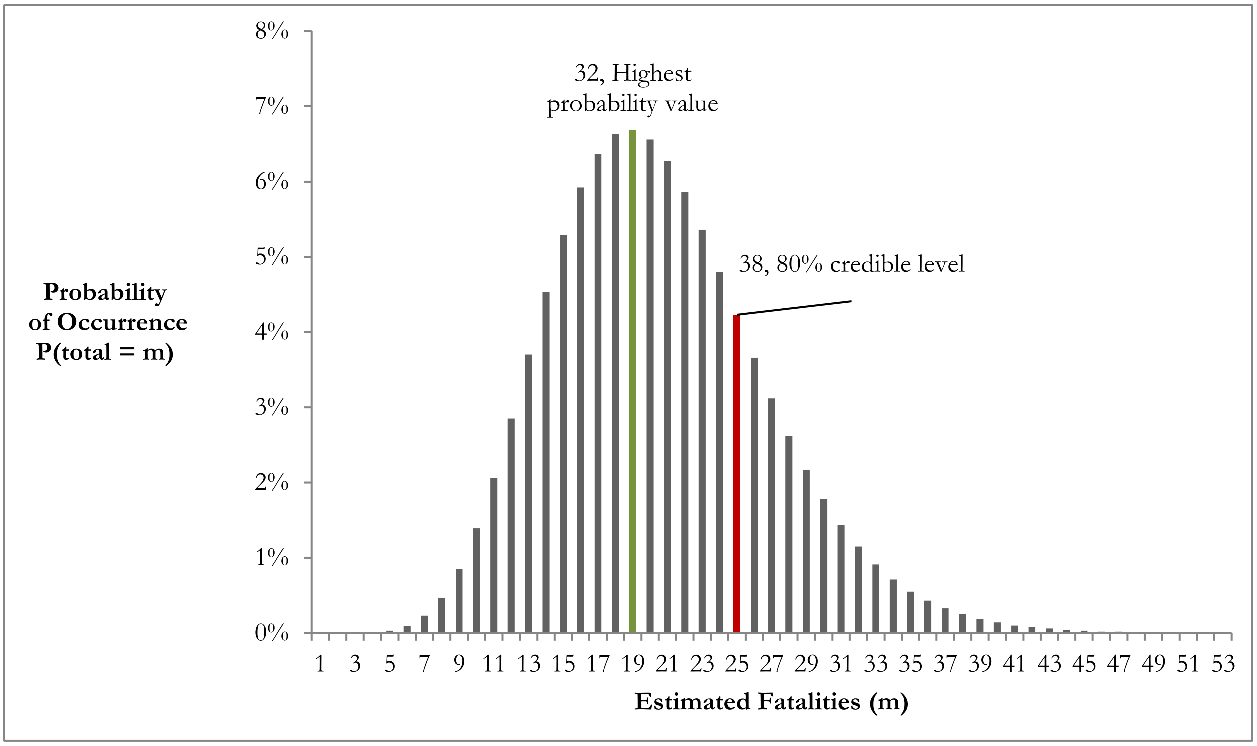
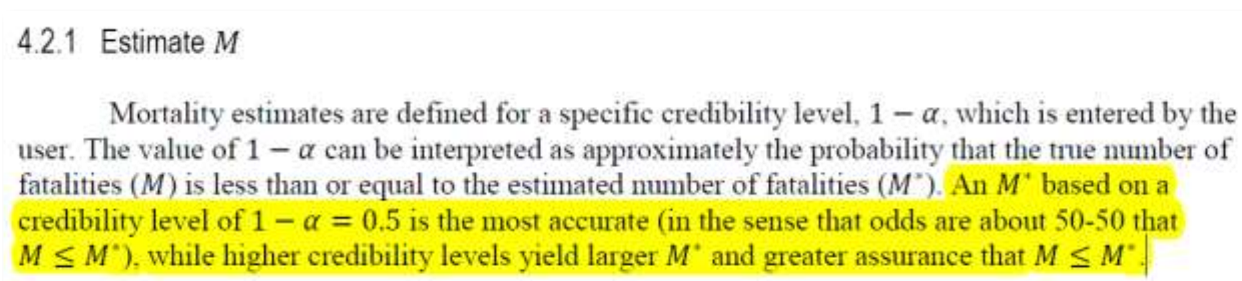


Figure 1. EoA Estimated Mortality Probability Function: Predicted vs Actual Mortality


4.2.1 Estimate M

Mortality estimates are defined for a specific credibility level, $1-\alpha$, which is entered by the user. The value of $1-\alpha$ can be interpreted as approximately the probability that the true number of fatalities (M) is less than or equal to the estimated number of fatalities (M^*). An M^* based on a credibility level of $1-\alpha=0.5$ is the most accurate (in the sense that odds are about 50-50 that $M \leq M^*$), while higher credibility levels yield larger M^* and greater assurance that $M \leq M^*$.

Figure 2. Excerpt from the EOA user's manual page 31 (Dalthorp 2017).

The user's manual for EoA recommends a credible level of 50 percent as being the most accurate in terms of take being equally likely to exceed or fall below the predicted value (Figure 2), and that the use of a higher credibility level will lead to a larger take estimate with greater assurance that actual take will be less than estimated take. The credibility level represents the likelihood that the predicted mortality exceeds the actual mortality. The alpha value is related to the credible level by the function:

$$Credible\ level = 100\% * (1 - alpha)$$

This means that an alpha value of 0.2 is equal to a credible level of 80 percent.

The U.S. Fish and Wildlife Service (USFWS) and Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) have required that permittees use the 80 percent credibility level to assess compliance with an ITP/ITL. Therefore, the estimate of total Project-related take for the HCP Amendment also uses this value. This results in higher take estimates with greater certainty that actual mortality is less than estimated mortality. The 80 percent credible level means there is an 80 percent probability that actual mortality is equal to or less than the predicted mortality. The 80 percent credible level includes all values below, providing confidence that actual take would be less than the estimated take.[17] All subsequent predictions and estimations are therefore provided at the 80 percent credible level.

Data from post-construction monitoring conducted at the Project and planned monitoring efforts for future years were incorporated into the EoA analysis. The Project-specific data (Table 5-1~~Table 5-1~~ of the HCP Amendment) was input into the multi-year module of the EoA to evaluate the probability of occurrence for various potential future take scenarios. The model runs 10,000 simulations from the observed data and the output provides the user with the levels of confidence that estimates of take at a user-defined credibility level would not be exceeded over the permit term. Results are a function of the user-defined credibility level, observed fatalities, and past and projected future monitoring efforts. Auwahi Wind selected the 75th percentile value of the probability distribution to provide confidence that the assessed level of take would not be exceeded during the permit term. In other words, Auwahi Wind is 75 percent certain that when fatalities are estimated at the agency-recommended 80 percent upper credible limit, the estimate will not exceed the requested permitted take limit over the permit term based on current data.

Bat fatalities and bias correction data recorded during post-construction mortality monitoring surveys conducted during 5 years of Project operation were assumed to be representative of baseline fatality trends expected over the ITP/ITL permit term and provided input values that were incorporated into the model. Inputs include the number of observed fatalities, searcher efficiency and carcass persistence data, and the proportion of the carcass distribution searched to get the overall detection probability. For the remaining years of operation within the permit term (2018–2032), model input parameters were estimated based on data collected under the current monitoring protocol (assumptions described further below). Input parameters are shown in Table 5-1 of the HCP Amendment. These model inputs created a 20-year dataset that was analyzed using the EoA software to model the predicted credible maximum number of fatalities (based on the selected 80 percent credibility level) that could be taken over the life of the Project.

`[17] In the EoA output in figure 3a, the line above item 1 provides an illustration of the difference between actual mortality and estimated mortality within EoA. The mean take estimate was 120, or 7 less than the 127 direct take estimate at the 80% credible level for all scenarios among projects with triggering (i.e. EoA indicates take exceeded the permitted amount).

Several assumptions were made to develop input parameters for the remaining years of the ITP/ITL permit term, and are described in the bullets below.

- The level of monitoring will continue at the level initiated in Jan 2018.
- The detection probability (g) will remain consistent throughout the Project's ITP/ITL permit term. Model input values for these parameters were based on the 2018 monitoring, as current conditions are assumed to best represent ongoing monitoring.
- The Project assumes minimization measures described in the HCP Amendment will be effective at reducing the take rate by 30 percent to 70 percent, for all future years. This is incorporated into the estimate of future take as a rho value. (A rho value represents the relative risk at the site. A rho of 0.5 would represent a risk of half and could be thought of as reducing the number of turbines by half or an equivalent method of reducing risk. Rho values can also be used to represent a portion of the year.) Because the effectiveness of minimization is uncertain, the values of 30 percent reduction (rho=0.7), 50 percent reduction (rho=0.5), and 70 percent reduction (rho=0.3) were applied to all future years to project future take.
- Based on the model inputs and assumptions described above, the EoA software analysis estimates the current direct take is 38 (Figure 3b, Item 3). These data are incorporated into the projection of future take, for which there are three possible scenarios as described in the assumptions. The maximum total direct take estimated is 129 (Figure 3a, Item 2) which is selected from the 75th quantile of the projections of future take where minimization measures result in a 30 percent reduction in take. Given this direct take estimate, EoA predicts a 79 percent probability that the direct take estimate will not exceed the 129 over the remaining years of operation (Figure 3a, Item 1).

```
================================================================================
Summary statistics from posterior predictive distributions for 10000 simulated projects
------------------------------------
Estimated annual baseline fatality rate (lambda for rho = 1): mean = 6.81, 95% CI = [3.9, 10.5]

Projected fatalities and fatality estimates...
p(M > Tau within 21 years) = 0.1218  [exceedance]
p(M* > Tau within 21 years) = 0.2115  [triggering]
M* based on credibility level 1 - alpha = 0.8

Among projects with triggering (21.03%), mean(M) = 120.07 at time of triggering, with median = 119 and IQR = [113, 126]
Among projects with no triggering (78.97%)  mean(M) = 97.54 at end of 21 years, with median = 98 and IQR = [87, 109]

Years of operations without triggering:
 Mean = 20.62, with median =  21 and IQR = [21, 21]

----------------------------------------
Summary statistics for projection years
----------------------------------------------------------------------------------------------------
Yr   Mean             quantiles of M                          | quantiles of M*
        M        M*  0.05  0.10  0.25  0.50  0.75  0.90  0.95 |  0.05  0.10  0.25  0.50  0.75  0.90  0.95
----------------------------------------------------------------------------------------------------
1      38.4   43.5    28    30    34    38    43    47    50 |   37    39    39    44    46    48    50
2      43.1   48.3    32    34    38    43    48    53    56 |   41    41    45    47    51    55    59
3      47.8   53.0    36    38    42    47    53    58    62 |   42    44    48    52    58    62    66
4      52.6   57.7    39    42    46    52    58    64    68 |   45    47    51    57    63    69    73
5      57.4   63.3    42    45    50    57    64    70    75 |   49    51    55    63    69    76    82
6      62.2   68.1    46    49    54    62    69    76    81 |   50    54    60    68    76    84    89
7      66.9   72.9    49    52    58    66    74    82    87 |   54    58    63    71    81    90    96
8      71.6   77.8    52    56    63    71    80    89    94 |   57    61    67    76    86    97   103
9      76.3   82.7    55    59    66    75    85    95   101 |   59    64    72    82    93   103   110
10     81.1   87.6    58    63    70    80    91   101   108 |   62    68    75    87    98   109   117
11     85.8   92.5    61    66    74    85    96   107   114 |   66    69    79    90   103   116   124
12     90.6   97.4    64    69    78    89   102   114   121 |   69    73    84    95   110   123   131
13     95.3  102.4    67    73    82    94   107   120   128 |   71    76    87   101   115   130   139
14    100.1  107.2    70    76    86    99   113   126   134 |   74    80    91   106   121   137   146
15    104.8  112.1    74    79    90   103   118   133   141 |   78    83    96   111   127   142   153

================================================================================
```

Notes:

- The quantiles shown are derived from bootstrapped samples and subject to minor fluctuation (±2 is common) over multiple runs. The value of 129 estimated direct take represents the highest expected value for the 75th quantile.
- The division of 2017 into 2 periods adds a ‘year’ to the calculations, so projections account for 21 years instead of 20 years.

Figure 3a. Output of the EoA Used for Prediction of Future Years Given the 30% Reduction in Take Rate Scenario (Page 1 of 2)

```
Governing parameters: Tau = 129, alpha = 0.2

Data for 6 years of monitoring:
             yr    x    g     glwr   gupr  rho  M*
           2013    1 0.2817 0.2120 0.3513  1    8
           2014    4 0.5476 0.4436 0.6515  1.08  16
           2015    1 0.4508 0.3761 0.5256  0.917  18
           2016    7 0.5490 0.4618 0.6363  1  34
           2017    0 0.6683 0.5925 0.7441  0.17  33
          2017b    3 0.5797 0.4787 0.6807  0.83  38

Parameters for future monitoring and operations:
  Number of years:  15
  g = 0.6, 95% CI  [0.5, 0.65]
  Relative weight (rho): 0.7
*****************************************************************************************
Summary statistics for mortality estimates through 6 years
------------------------------------
Results
Totals through 6 years
        3
M* = 38 for 1 - alpha = 0.8, i.e., P(M <= 38) >= 80%
Estimated overall detection probability: g = 0.486, 95% CI = [0.449, 0.524]
    Ba = 327.85, Bb = 346.27
Estimated baseline fatality rate (for rho = 1): lambda = 6.805, 95% CI = [3.9, 10.5]

Cumulative Mortality Estimates
Year          M*   median   95% CI   mean(lambda) 95% CI
2013           8     4      [1, 13]  5.4510    [0.3849,  17.28]
2014          16    12      [6, 22]  13.2200    [ 4.525,  26.68]
2015          18    14      [8, 25]  15.2200    [ 5.815,  29.19]
2016          34    28      [19, 42]  29.4900    [ 15.79,  47.55]
2017          33    28      [19, 41]  28.9500    [ 15.51,  46.63]
2017b         38    33      [23, 46]  34.0100    [ 19.51,  52.59]

Annual Mortality Estimates
Year          M*   median   95% CI   mean(lambda) 95% CI
2013           8     4      [1, 13]  5.4510    [0.3849,  17.28]
2014          10     7      [4, 13]  8.3330    [ 2.453,  17.95]
2015           4     2      [1, 7]  3.3620   [0.2398,  10.56]
2016          16    13      [8, 21]  13.7900    [ 5.661,  25.71]
2017           0     0      [0, 1]  0.7517   [0.0007532,  3.783]
2017b          7     5      [3, 10]  6.1080    [ 1.454,  14.17]


Test of assumed relative weights (rho) and potential bias            Fitted rho
Assumed rho      95% CI
        1      [0.060, 1.815]
     1.08      [0.378, 2.150]
    0.917      [0.042, 1.282]
        1      [0.825, 2.967]
     0.17      [0.001, 0.549]
     0.83      [0.220, 1.683]

p = 0.32609 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 1.036

--------------------------------------------------------------------------------
Input
Year (or period) rel_wt  X    Ba     Bb   ghat    95% CI
2013              1.000  1   46.7  119.1 0.282 [0.216, 0.352]
2014              1.080  4  49.68  41.05 0.548 [0.445, 0.648]
2015              0.917  1  79.43  96.75 0.451 [0.378, 0.525]
2016              1.000  7   70.9  58.24 0.549 [0.463, 0.634]
2017              0.170  0  102.4  50.82 0.668 [0.592, 0.740]
2017b             0.830  3  54.79  39.72 0.580 [0.479, 0.677]
```

Figure 3b. Output of the EoA Used for Prediction of Future Years Given the 30% Reduction in Take Rate Scenario (Page 2 of 2)

3.0 INDIRECT TAKE

After estimation of direct take, indirect take was calculated based on the calculations outlined in the HCP Amendment Section 5.1.3 using the guidance provided by the USFWS. The direct take of an adult female bat during the time when young are dependent on her may result in the indirect loss or take of dependent offspring. Variables used to predict the magnitude of this indirect take are based on parameters recommended in USFWS and DOFAW guidance (USFWS 2016):

- A conservative estimate of direct take (Section 5.1.1);
- The proportion of take assumed to be adult females (only female bats care for young);
- The proportion of fatalities occurring during the period when young bats are dependent;
- The probability that the loss of a reproductively active female results in the loss of her offspring;
- The average reproductive success rate; and
- The proportion of young that survive to reproductive age.

The rationale and values used to predict indirect take are outlined in Table 5-2~~Table 5-2~~ of the HCP Amendment, and result in an indirect take prediction of 11 adult-equivalent bats during 20 years of operation. Because current mitigation frameworks only provide guidance relative to adult bats, indirect take was adjusted to adult equivalents by multiplying the predicted number of indirectly-taken juveniles by the probability those juveniles would survive to become adults (Table 5-2~~Table 5-2~~, Rows 2-5).

4.0 TOTAL ADJUSTED TAKE

The sum of direct and indirect take estimates was used for the total take estimate shown in Table 1. Applying this approach to the Project HCP Amendment and Project data produces a requested take limit of 140 bats (including estimates of both indirect and direct take) through 2032. Calculations for the 50 and 70 percent reductions follow the guidance used above, and using a rho value as indicated in section 2 for future years.

Table 1. Tier Structure

Tier	Cumulative Direct take	Cumulative Indirect take[1]	Take within Tier[2]	Potential Scenario
1-3	18	3	21	Authorized in approved HCP
4	79	7	22 – 81[3]	Reduction in take rate of 70% through additional minimization measures.
5	102	9	82 – 115[3]	Reduction in take rate of 50% through additional minimization measures.

Tier	Cumulative Direct take	Cumulative Indirect take[1]	Take within Tier[2]	Potential Scenario
6	129	11	116 – 140	Reduction in take rate of 30% through additional minimization measures.

1. Estimation of indirect take is based on USFWS guidance for calculating indirect take. Actual estimation of future indirect take will vary based on the timing and gender of observed fatalities.

2. Take occurring within tier and assessing compliance with the authorized take limit is based on the 80% credible level estimate of take using EoA (or then current best available science) plus indirect take.

3. Take within Tiers 4 and 5 was adjusted to account for agency guidance to have a minimum of 25% of take within any tier, no more than 50% of take occurring within any tier, as well as having the last tier account for the smallest amount of take.

5.0 REFERENCES

Dalthorp, D. and M. Huso. 2017 (in review). Evidence of absence software user guide v.2: U.S. Geological Survey Data Series 881.

Dalthorp, D. Personal communication. March 2, 2018.

USFWS. 2016. Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take. USFWS Pacific Islands Field Office. Honolulu, HI. October 2016.

APPENDIX I

AMENDMENT TO FUNDING MATRIX

New Appendix associated with HCP Amendment

Table 1. Tier 4 Funding by Action

Action	Cost per unit	Units	Source	Quantity	Total
Conservation Easement	100,000	Total	HILT	1	100,000
Water trough modification	10,000	Per trough	Eco Products	15	150,000
Koa Planting	1,965	Per acre	Forestry Solutions	384	754,560
Fencing	5	Per foot	ʻUlupalakua Ranch	195,000	975,000
Pond installation	92,000	Per Pond	Goodfellow Brothers	2	180,000
Person Hours (maintenance, monitoring)	25	Per hour	Tier 1 mitigation costs	87,36	218,400
Acoustic monitoring	1,500	Per detector per year	Tetra Tech	333	499,500
Insect monitoring	3,000	Per sampling	Tier 1 mitigation costs	18	54,000
Thermal videography	10,000	Per camera per month	Estimate	3	30,000
				Sub-Total	**2,961,460**
Adaptive Management					
Koa Planting	1,965	Per acre	Forestry Solutions	197.5	463,740
Pond installation	92,000	Per Pond	Goodfellow Brothers	4	368,000
Person Hours (maintenance, monitoring)	25	Per hour	Tier 1 mitigation costs	1,150	28,750
				Sub-Total	**860,490**
				Combined Sub-Totals	**$3,821,950**
				DOFAW Contingency	**$191,097**
				Total	**$4,013,047**

Table 2. Funding Assurances

Tier	Category[1/]	One-time Cost[2/]	Cost per year	Years of Effort	Total	Notes
Tier 4	Protection, and restoration	$3,821,950	---	---	$3,821,950	Planning for mitigation initiated; Parcel selection criteria identified in Section 6.2.4. Letter of credit to be provided within 60 days of issuance ITP/ITL and execution of amendment to Implementation Agreement, if needed.
Tier 4	DOFAW Contingency	$191,097			$191,097	Estimated at 5 percent of mitigation. Contingency funding/adaptive management covers any outstanding mitigation obligations should Auwahi Wind be unable to fulfill obligations under the current tier or if adaptive management requires additional funds.
Tier 4 total		**$4,013,047**			**$4,013,047**	
Future Tiers						
Tier 5[2]	Additional mitigation	$2,165,771	---	---	$2,165,771	Dollars estimated in 2018. The actual cost of the mitigation will vary based on, inflation and the timing of mitigation, and the mitigation actions selected. The cost is outlined relative to the number in the bats in the tier proportional to the mitigation costs of Tier 4. Timing to be determined in consultation with and approval by DOFAW and USFWS; funding assurances to be provided within 90 days of triggering planning for this tier.
Tier 5[2]	DOFAW Contingency	$108,288			$108,288	Estimated at 5 percent of mitigation
Total Tier 5		**$2,274,059**			**$2,274,059**	
Tier 6[2]	Additional mitigation	$1,592,479	---	---	$1,592,479	Dollars estimated in 2018. The actual cost of the mitigation will vary based on, inflation and the timing of mitigation, and the mitigation actions selected. The cost is outlined relative to the number in the bats in the tier proportional to the mitigation costs of Tier 4. Timing to be determined in consultation with and approval by DOFAW and USFWS; funding assurances to be provided within 90 days of triggering planning for this tier.
Tier 6[2]	DOFAW Contingency	$79,623			$79,623	Estimated at 5 percent of mitigation
Total Tier 6		**$1,672,102**			**$1,672,102**	

1. Other mitigation measures, and thus a revised mitigation budget would be agreed upon and consistent with USFWS/DOFAW guidance at the time each specific mitigation tier is considered.

2. Prices estimated in 2018 dollar equivalents, prices to be adjusted for increase in costs described in Section 9.4.

Table 3. Operational Costs

Category	Annual costs	Notes
Ongoing Compliance	$100,000	Wildlife Education and Incidental Reporting Program, Post-Construction Monitoring and Reporting and Mitigation Monitoring.
DLNR Compliance	$10,000	Estimated cost of DOFAW compliance monitoring conducted only if needed.
Total Operational Costs	**$110,000**	

APPENDIX J

DLNR PROPOSALS FOR KAMEHAMENUI

New Appendix associated with HCP Amendment

APPENDIX K

Interim Adaptive Management Plan

New Appendix associated with HCP Amendment

1.0 Introduction

This Interim Adaptive Management Plan (AMP) identifies specific measures that Auwahi Wind will implement if the estimated fatality rate, evaluated as described below, exceeds the value needed to ensure compliance with the permitted take value over the permit term. As discussed in Section 4.1.7 of the HCP Amendment, Auwahi Wind implemented baseline minimization measures in 2018 and will continue to apply these measures for the duration of the permit, unless specific adaptive management triggers are reached that would initiate an adaptive management action. The Interim AMP will be in effect upon permit issuance and until it is superseded by the AMP. The AMP will be developed using the results of the ongoing risk analysis (Section 7.4.1.3 of the HCP Amendment) and will be provided to the US Fish and Wildlife Service (USFWS) and State of Hawaii Department of Land and Natural Resources: Division of Forestry and Wildlife (DOFAW) for review by April 30, 2020. All terms and acronyms are defined in the Auwahi Wind HCP Amendment.

2.0 Evaluation Schedule

The effectiveness of the minimization measures in place at Auwahi Wind will be evaluated on a routine basis to ensure compliance with the permitted take value. These evaluations will take place as part of routine reporting tasks and scheduled agency reviews, as well as in response to observed take.

Table 1. Schedule for Regular Evaluation of Minimization Measures.

Period	Action	Timeframe
Immediate Evaluations	Summary of Take Report	Due within 3 weeks of observed take
Semi-Annual Evaluation	HCP Semi-Annual Compliance Report	Due January 31
Annual Evaluations	HCP Annual Compliance Report	Due August 31
	AMP Review	Scheduled with USFWS and DOFAW after Annual Report
Scheduled Evaluations	Adaptive Management Action Review	Due February 28
	If adaptive management actions are required, implement adaptive management actions[1]	Due March 31

1. See Follow-up Evaluation in Section 2.4.

To track compliance, Auwahi Wind will use Evidence of Absence (EoA) to evaluate the Post-Construction Mortality Monitoring (PCMM) data and calculate the Baseline Fatality Rate (BFR) which is then compared to the Threshold Value (TV). The TV for Auwahi Wind is 6.45 based on analysis presented in Section 7.4.1.1 of the HCP Amendment.

Additionally, Auwahi Wind will track the BFR relative to each of the tiers of take (Table 2) to support agency discussions during routine reviews.

Table 2. Average Take Rates for Each Tier Over 20 Years.

Tier	Maximum Take	Average BFR
4	81	4.05
5	115	5.75

The details from the schedule are described in the following subsections.

2.1 Immediate Evaluations

Summary of Take Report (on Observed Fatalities): Auwahi Wind notifies USFWS and DOFAW of any bat fatality observed during PCMM or incidentally and submits a Summary of Take report within 3 weeks. The Summary of Take report is described in Appendix E and will include the following items related to adaptive management (in addition to other reporting requirements):

- Direct Take estimate;
- Direct Take projection;
- Calculation of the BFR and comparison of BFR to TV; and
- Comparison of BFR to tier based rates.

2.2 Semi-Annual Evaluations

HCP Compliance Report: Auwahi Wind summarizes the HCP compliance in a semi-annual report provided to USFWS and DOFAW in January each year. The semi-annual report will include the following items related to adaptive management (in addition to other reporting requirements):

- Direct Take estimate;
- Direct Take projection;
- Calculation of the BFR and comparison of BFR to TV; and
- Comparison of BFR to tier based rates.

2.3 Annual Evaluations

HCP Compliance Report: Auwahi Wind summarizes HCP compliance in an annual report provided to USFWS and DOFAW in August each year. In an annual meeting, Auwahi Wind reviews the HCP compliance status summary and take estimate projections with USFWS and DOFAW. The annual reports will include the following items related to adaptive management (in addition to other reporting requirements):

- Direct Take estimate;
- Direct Take projection;
- Calculation of the BFR and comparison of BFR to TV;
- Comparison of BFR to tier based rates; and,
- Adaptive management actions triggered or taken during the reporting year.

AMP Review: The AMP is intended to be a living document and will be updated as new information becomes available. Auwahi Wind will review the current AMP during the annual meeting with USFWS and DOFAW. Prior to the annual meeting, Auwahi Wind will review and summarize new literature relating to the development and effectiveness of minimization measures for the Hawaiian hoary bat and similar bat species. Literature to be reviewed includes: site-specific data, peer-reviewed literature, annual reports, industry publications, literature recommended by USFWS and DOFAW, or other sources. If Auwahi Wind determines, in consultation with USFWS and DOFAW, that new minimization measures are applicable and likely to be an improvement over those currently implemented or proposed in the AMP, the AMP will be updated to include the new measures and provided to the agencies for approval.

2.4 Scheduled Evaluations

Adaptive Management Action Review: Auwahi Wind will evaluate the PCMM data from the start of monitoring through December 31 of the preceding year (the most recent complete calendar year) to calculate the BFR using EoA in years 2020, 2025, and 2030. Auwahi Wind will then compare the BFR to the TV.

- If the BFR exceeds the TV, adaptive management actions, as described in Section 3 of the Interim AMP, will be implemented no later than March 31. See Follow-up Evaluation below.
- If the BFR does not exceed the TV, no action will be required.

Should a projection predict that the Project will exceed the permitted take authorization between scheduled evaluations, Auwahi Wind, in coordination with USFWS and DOFAW, will determine if adaptive management actions are warranted.

Follow-up Evaluation: When adaptive management actions are implemented, the effectiveness of the actions will be assessed after two years using PCMM data. At that time, the BFR will be compared to the TV to determine if additional adaptive management actions are warranted. Should the BFR exceed the TV at that time, adaptive management actions will be implemented as described in Section 3 of the Interim AMP, and the BFR will be re-evaluated again at 2-year intervals until the BFR is equal to or less than the TV. Should adaptive management actions be implemented less than 2 years from a scheduled evaluation year (2025 or 2030), the next evaluation will occur 2 years after the adaptive management actions instead of at the scheduled evaluation.

3.0 Adaptive Management Actions

Auwahi Wind has identified initial adaptive management actions based on understanding of Hawaiian hoary bat life history, PCMM, observations at the site, peer reviewed literature, and preliminary results of nacelle-level acoustic and thermal imagery studies conducted in 2018 and 2019. These findings demonstrate:

1. The majority of bat activity occurs in the first 6 hours of the night.
2. The months of May through October represent the highest continuous months of observed fatalities.
3. The geographic distribution of fatalities shows Turbines 1-4 have a higher proportion of observed fatalities than Turbines 5-8.

Adaptive management actions will be required if, at a Scheduled Evaluation or Follow-up Evaluation, the BFR exceeds the TV. If adaptive management actions are required, Auwahi Wind will implement adaptive management actions in the order listed below.

1. Temporal redistribution of curtailment nights: Curtailment at 6.9 m/s would be continued for the first 6 hours of the night for the months of August through October. Cut-in speeds for the remaining hours of the night would be 5.0 m/s. This would provide an additional 704 Curtailment Nights (see definition in Section 7.4.1.1 of the HCP Amendment), with cut-in speeds of 6.9 m/s for the first 6 hours of the night, to be redistributed. These additional Curtailment Nights would be applied May 5 through July 31 to address the intermediate risk months.
2. Spatial redistribution of curtailment nights: A higher proportion of fatalities have been observed at turbines 1-4 than at turbines 5-8. Redistribution of curtailment nights from turbines 5-8 to turbines 1-4 would be the second adaptive management action. The redistribution will allocate Curtailment Nights from turbines 5-8 from May 5 through July 31 to turbines 1-4 either nightly or seasonally. Selection of nightly or seasonal application would be based on post construction monitoring results following the implementation of the redistribution described above in action 1.
3. Should a redistribution of curtailment nights not provide sufficient minimization to keep the Project within the total take authorization, Auwahi Wind will implement an acoustic deterrent system or an alternative minimization technology (provided they are commercially available, demonstrated to be effective in Hawai'i, and determined not to negatively impact other wildlife).

4.0 Adaptive Management of Baseline Minimization

The suite of minimization measures available to reduce the risk to bats may change over time because of ongoing industry research and development of new technology. Auwahi Wind may propose a change to baseline minimization measures identified in the HCP Amendment (Section 4.2.7) or adaptive management actions in the AMP, such as replacement of low wind speed curtailment with bat deterrent technology. Such a change would be subject to review and approval by USFWS and DOFAW prior to being implemented at the Project.