To: Glenn Metzler, Staff HCP Planning Associate

From: Scott Fretz, ESRC Chair

Subject: Comments on the Auwahi draft HCP amendment dated September 2018

At its meeting of October 25, 2018, the ESRC requested that its members provide any additional comments on the Auwahi draft HCP amendment dated September 2018 to staff in writing. My comments pursuant to that request are provided below.

General comments

1) Population and cumulative impacts. My comments on this section of the Auwahi HCP are similar to the comments I provided for the Kawailoa HCP. This draft HCP address the statutory requirement to ascertain with reasonable certainty the population and cumulative impacts of the project by asserting that mitigation will fully offset take. I am not reasonably certain that this is the case.

2) It is not clear how the draft HCP complies with §195D-4(g)(1), which requires that the applicant, to the maximum extent practicable, minimize and mitigate the impacts of the take because it does not provide a commitment to include effective research, development, or deployment of deterrents. As written, the HCP could be implemented without the use of any deterrents, and result in the take of 140 bats. While further development of deterrent technology is desirable, a number of tools and applications are currently available with a reasonable likelihood of success in reducing take and yielding essential information needed to improve the effectiveness of available methods. The draft HCP acknowledges these tools and their potential, yet makes no commitment to use or develop them.

Research is ongoing to better understand HHB population biology and to improve the effectiveness of mitigation efforts to offset take. Until that research provides better information to guide planning, I recommend that the draft HCP be amended to request a lower level of authorized take, and to include the deployment of deterrent devices on all turbines immediately. The level of cumulative take authorized should represent a level for which the department is reasonably certain will not result in a decline in the population in the project area, and thereby preclude recovery benefits.

I understand that the authorized take level should represent a realistic take projection based on take models and estimated benefits of deterrents, and suggest that a lower take projection can be reasonably expected through a more aggressive program to deploy effective deterrents.

Specific comments

1) Chapter 3. Figure 3-3. 20 acres per bat is not consistent with guidance.
2) 4.2.7 Avoidance and minimization
   a) LWSC
      i) Appreciate the use of 6.9 for 3 months. Did not explain why this is not used in other months and whether further LWSC is practicable.
3) Chapter 5
   a) 5.1.3.1 Statement that HHB has persisted with no direct intervention to preserve or protect the species is misleading. Conservation agencies and partners have been supporting research and management actions to benefit HHB for decades, including research and habitat protection measures that have included land acquisition, management, and restoration of hundreds of

thousands of acres of native forests, including restoration efforts that have planted more than 250,000 native trees.

b) Claims that ongoing take demonstrates the project is not impacting the population. This conclusion is not warranted. Similar observations would result if the project is a sink that is impacting the population.

c) Assumes the bat population on Maui is 7300 and declares that requested take will not impact a population of that size. It is not scientifically justified to assume the population is 7300 bats.

4) Mitigation

a) Tier 4. Not likely to offset take. See notes from August 30, 2018 ESRC meeting. Mitigation project should be revised to provide justification that this mitigation will offset take and provide recovery benefits.

b) Tier 5-6. Mitigation is not specified. Mitigation for tiers 5-6 are only discussed in concept as a suite of conservation measured on an undetermined acreage. It is not possible to determine that they will serve to offset take or comply with statute or guidance. As written, they constitute a request for approval of an unknown future project in concept. Details are needed on the exact site, the current features of the site, HHB monitoring before and after, restoration targets in terms of biological objectives, etc.

5) Alternatives

a) States that full night time curtailment cannot be done because it would reduce power. Cites the PPA and implies HECO would not agree to an amendment to the PPA. Staff should confirm with HECO if this is the case and if so consider whether this makes HECO responsible for take.

b) States that alternatives would generate insufficient power. Applicant should provide additional information to indicate the minimum power production needed for viability in order to inform determination of the maximum practicable extent of minimization.

c) 20 acres per bat is not consistent with guidance

6) Section 8.3 Adaptive Management

a) Triggers and actions are general only and vague. The triggers as written do not provide a clear and effective action that is likely to reduce take.

b) Reversion. This section appears to have the intent to relax minimization and would therefore defeat the purpose of the tiers and be inconsistent with requirements to minimize take to the maximum extent practicable. This practice should not be employed and his section should be deleted form the draft.

Project: Auwahi Amendment
Mehrhoff Comments
October 17, 2018

General:

1. This project is requesting the take of 140 endangered Hawaiian hoary bats, up from a currently authorized 21 bats. The project has already taken 38 bats and is above their authorized take level.
2. The applicant has committed to implementing a mix of strong minimization action in the form of Low Wind Speed Curtailment at 6.9 m/s for high risk time periods and a weak minimization action of Low Wind Speed Curtailment at 5.0 m/s at lower risk time periods. This is an interesting and potentially effective strategy, though better documentation of the benefits of this proposal is needed. It is especially important for the applicant to provide all of the inputs needed to the ESRC so that we can attempt to replicate analyses under the Evidence of Absence software.
3. The proposed compensatory mitigation for bats is also interesting. The amount of restoration to be accomplished though falls short of recommendations in guidance documents, with no explanation of why a reduction is appropriate.
4. I have concerns about how the applicant hopes to reduce minimization actions if they prove successful.
5. Linking tiers of take to the effectiveness of proposed minimization efforts may be appropriate, but a discussion of why those thresholds were selected would help understand the likelihood of reaching the tiers.

My review of the literature as of October 15, 2018 indicates that the following characteristics of wind projects can have a significant effect on bats. Projects should avoid and minimize impacts by adopting the least impactful suite of characteristics. My assessment of this project is shown in the last columns.

Item	Characteristic	Better (1)	Worse (5)	Current Project	Score
1	Site proximity to known bat areas/high activity/high take.	Far from known problem areas	Within known problem areas	Originally thought to have low bat activity. Higher take occurred.	2
2	Site average wind speed. Increased take expected at low wind speeds.	>10 m/s	<6.5 m/s	7.0 – 8.0 m/s. Expect moderate to high take at this wind speed.	4
3	Site proximity to special features: cattle, forest,	Non-forested disturbed flat	Grazed open	Grazing, so increased take expected.	4

	ravines, cliffs, and water features increase bat activity and take.	areas without water/cattle	forest, wetlands and ravines		
4	Rotor size. Increases in rotor size increase take and reduce effects of LWSC.	<50 m diameter	>100 m diameter	101 m rotors. Correlated with a 60% increase in baseline take and a 42% reduction in LWSC benefits.	5
5	Turbine feathering. Feathering can reduce take significantly.	Feathered when not generating	No feathering	Night time feathering when not generating. Reduced take expected.	1
6	Low Wind Speed Curtailment (LWSC). Effectively reduces take up to at least 6.5 m/s.	>6.5 m/s	No LWSC	LWSC at 6.9 m/s August thru October; 5.0 remainder of year. This is strong LWSC for high risk times, weak other periods. Expect 80% reduction at high, 55% low. But, project needs a 42% penalty adjustment for use of large rotors.	2
7	Wind speed rolling average. One study showed a 30% reduction in take with 20 minute averages compared to 10 minute average.	20 minute	10 minute	10 minute rolling average. 30% reduction in take would be expected if 20 minute.	5
8	Wind speed monitoring. Recent study showed turbine meters overestimated wind speeds by 1.0 m/s and had an 81% increase in take.	Via met towers	Via turbine anemome ters	Turbine anemometers. Expect 81% increase in take compared to use of met tower data.	5
9	Deterrence actions. Studies have shown a 50-100% reduction in hoary bat fatalities.	Acoustic deterrence	No deterrence	No deterrence	5

Specific:

1. Is the purpose and need logical and accurate? Discussion of project purpose and need seems logical.
2. Project description:
   a. Site:

i. Location map that can be cross referenced to wind speed/other maps. Yes.
ii. Average daily wind speed at site: Unconfirmed, from wind maps assumed to be 7.0-8.0 m/s.
iii. Presence of special topographic features at site (cattle, water, forest, ravine/cliff). Grazing on site. No water features or forested areas. Dry ravines present. Grazing is correlated with increased bat activity/take.

b. Operations:
   i. MW production: 24 MW facility.
   ii. Number of turbines: 8 3.0 MW turbines.
   iii. Rotor diameter: 101 m in length.
   iv. Nacelle height: 130 m.
   v. Manufacturer: Siemens.
   vi. Base cut-in/cut-out speeds: 3.5m/s.
   vii. Feathering wind speed: Night-time feathering when in LWSC.
   viii. Low Wind Speed Curtailment (LWSC):
      1. Cut-in/cut-out speeds: High risk August thru October- Cut in/out at 6.9 m/s. Lower risk November thru July- Cut in/out at 5.0 m/s.
      2. Dates: see above.
      3. Hours: 30 minute prior to sunset until 30 minutes after sunrise.
   ix. Governing wind speed (LWSC) from met towers or turbine anemometers? Turbine anemometers to be used. Met tower measurements appear more accurate, with turbine meters overestimating wind by 1 m/s and killing 81% more bats. Use of turbine anemometers may need to increase LWSC by 1 m/s to reach anticipated benefits, since many of the baseline research studies on LWSC used met tower data.
   x. Governing wind speed (LWSC) based on 10 minute rolling averages. A 10 minute rolling average is not as good as a 20 minute average, from both economic and biological perspectives. Switching from 10 minute to 20 minute rolling averages for LWSC reduced bat take by 30%.
   xi. Deterrence actions. Not expected.
   xii. Operational bat activity monitoring. On-site monitoring of bat activity should be reinstated and continue for the duration of permit. This will aid determinations of take impacts and effectiveness of mitigation efforts.
   xiii. Operational bat take monitoring:
      1. CARE protocols. Doing standard protocol.
      2. SEEF protocols. Doing standard protocol.

3. Baseline studies:
   a. Pre-application TEC studies. Completed.
   b. Pre-application activity monitoring (2 years). Completed, showed low activity.
4. Impacts to species:
   a. Take estimates:

i. Total estimated take for Hawaiian hoary bat is 140. This is a requested increase in take from 21 to 140 bats over 20 years. Project has already taken 38 bats (7.6 per year) and exceeded their take authorization of 21 bats.
ii. Take estimate is logical, but I could not get the numbers to work out as presented in the HCP. It would be helpful if the take was calculate step by step with real numbers. Also, it is not possible to verify EOA analyses until all inputs have been provided.
iii. 80% likelihood thresholds were apparently used in EOA analyses.
iv. Explanations of impacts are provided. This is one of the better discussions of potential impacts to bat populations. The population estimate based on amount of forested habitat seems to assume 100% occupancy with a population at carrying capacity (or higher since 20 acres per bat is used).
v. Cumulative effects are discussed. Again, the discussion is generally good, but lacks hard substantiation.

b. Special case effects:
i. Site wind speed (on take). Areas with lower average wind speeds are expected to have greater bat activity and, thus, increased risk of take by wind projects. This project area has moderate wind speeds (7.0-8.0 m/s from wind maps). Actual average wind speeds should be provided.
ii. Site special features (on take). This project is a dry grassland/shrubland with grazing. Grazing seems to lead to increased risk of bat take.
iii. Rotor size has been shown to affect bat take. Larger rotors like the ones used in this project (101 m) are associated with higher rates of bat take (61% increase in take, Table 2). Larger rotors also have been shown to have reduced effectiveness when LWSC is applied (in this case a 42% reduction in benefits, Table 3).
iv. Nacelle height (on take). Some studies have shown height to be correlated with take, with higher towers more likely to have increased take. It is unclear if this would be logically true in Hawaii. This project has 130 m tall turbines.
v. Feathering (on take). Feathering turbines when they are not actively generating power can greatly reduce bat mortality. This project will feather turbines under LWSC.
vi. Low Wind Speed Curtailment. LWSC of at least 6.5 m/s has been demonstrated to reduce bat take. Average reductions in take for 5.0 m/s is 55%, for 5.5 m/s is 66%, and for 6.5 m/s is 77% (Table 1). This project proposes 5.0 m/s for lower risk time periods, which would be a 55% reduction and 6.9 m/s for the higher risk August thru October period with approximately an 80% reduction. However, correcting for large turbines results will reduce this (Table 3).
vii. Use of turbine anemometers. This project uses turbine monitoring of wind for LWSC. Expect 81% increase in take compared to use of met tower data. Recent study showed turbine meters overestimated wind speeds by 1.0 m/s and had an 81% increase in take. I would suggest discussing the addition of 20 minute rolling averages from met tower data for LWSC and looking at your data to see if your met tower and

nacelle monitors are showing the same concurrent wind speeds. If so, then you may not need to correct for generally higher nacelle values.

viii. Deterrence. Deterrence not expected. Few studies have been done on deterrence, but some of these have shown a 50-100% reduction in bat take for turbines using acoustic deterrence.

5. Compensatory mitigation: The strategy is generally good. Use of Ranch lands is also good, because the area is of high conservation value to many threatened and endangered species. ESRC guidance for mitigation is 40 acres per bat, not 20 acres per bat. A commitment letter from the landowner is needed.
   a. Mitigation monitoring. Specific monitoring protocols OK. Need to also monitor activity at the Project site to compare with mitigation areas.
   b. Outcomes of mitigation:
      i. Please provide a table with annual take expected and annual offsetting bat numbers showing take and offset.
      ii. Discuss how the above offset table shows that the impacts will, indeed, be offset. If there is a shortfall in offsets, please describe how that will be rectified.
6. Compliance:
   a. Take estimate of 140 bats is not completely clear. I could not replicate the numbers with the information in the text. All EOA inputs need to be provided so that numbers can be verified.
   b. Cumulative effects are discussed and generally make sense, but I did not have all the data to check the numbers and conclusions.
   c. Mandatory actions for take threshholds: This section is explicit, but does not result in any additional operational constraints if the take authorization is exceed or expected to be exceeded. This needs to be rectified.
      i. Take exceeded. The HCP needs to commit to more substantive actions, other than moving X number of curtailment hours around the Project site. Those actions should be more substantive, like if bat take is exceeded the project will implement a full night-time shutdown until agreement on interim operations is reached with DOFAW.
      ii. Pre-exceedance threshholds. The HCP needs to commit to specific actions if take is expected to exceed warning thresholds. Those actions should be more substantive, like if bat take reaches 75% of authorization, the project will implement a LWSC of 6.9 m/s on all turbines until agreement on interim operations is reached with DOFAW.
   d. The mitigation goal for bats is determinable, but see above for issues with calculations.
   e. Mandatory actions for mitigation threshholds:
      i. Mitigation failure is addressed in the HCP.
      ii. Pre-failure threshholds. Trigger points need to be added to help adaptive management efforts ensure that the mitigation effort is successful and to start “plan B” if they appear to be unsuccessful.
   f. Annual reporting:

i. Update the EOA graph, to include take estimates and threshholds for the entire project duration should be provided annually (and in the HCP amendment so that the public and readers can better understand the situation. A similar graph needs to be provided that shows how offsets to take progress over the 20 years of the permit.

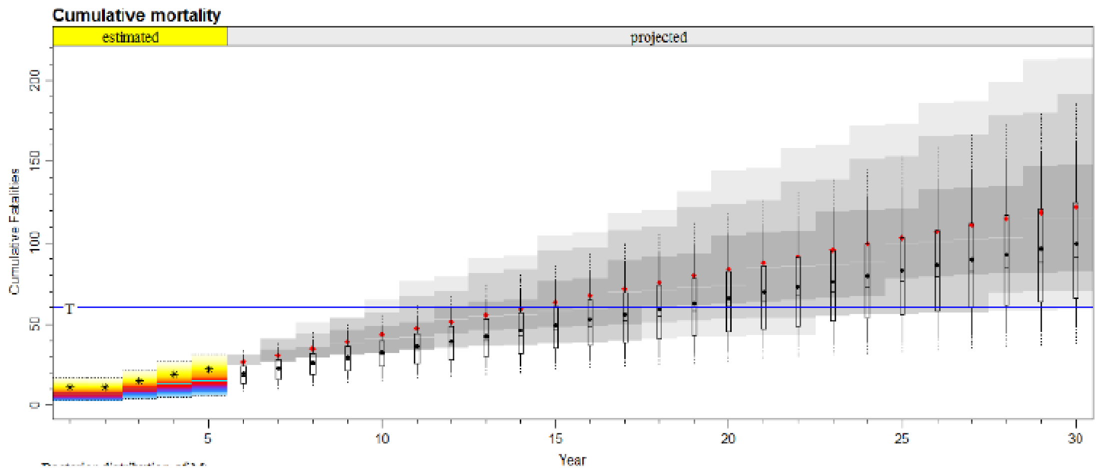

Figure 1. Example Evidence of Absence graph. Similar graphs for the project should be included in the Annual Reports and a revised HCP.

ii. Annual bat activity at site needs to be provided in order to both get an understanding of bat activity over time as well as to help understand when take is most likely to occur.
iii. Annual take at site, with associated data on the take is expected to be in annual reports.
iv. Annual results of mitigation monitoring efforts should be reported annually.
v. Annual discussion of adaptive management efforts should be provided.

7. Cost-Benefit of:
   a. Avoidance. Night-time curtailment was discussed and deemed uneconomical as was year round LWSC at 6.9 m/s, and part year night-time curtailment.
   b. Minimization. Minimization efforts are discussed, and were creative.
   c. Anti-minimization (reversion). I found this section to be quite difficult to understand and to get the numbers to work out as stated.
8. Review of 195D requirements:
   a. Addresses island-wide cumulative impacts to the species. The discussion is a good initial step in support of the requested level of take. However, it still needs to be more quantitative and compelling.
   b. Project:
      i. Avoidance measures taken. Night-time curtailment was discussed and deemed uneconomical.

ii. Minimization measures taken. Minimization efforts are included and generally good. But, the numbers need to be validated and some corrections made for large rotors, short time periods for rolling wind speed averages, etc. Solid, substantive actions need to be added if take is, once again, expected to be exceeded or is actually exceeded. The concept of reversion of minimization actions needs more work and discussion with ESRC.

iii. Mitigation measures taken. The proposed mitigation uses a 20 acre per bat offset. ESRC has recommended 40 acres per bat. Mitigation at the 20 acre level is probably not adequate.

c. If revised somewhat, the project could be generally consistent with the intent of bat recovery.

d. All negative impacts are minimized or mitigated. Impacts on the bat may be adequately minimized, but need to be validated and additional mitigation provided.

Table 1. Estimating mortality reduction due to Low Wind Speed Curtailment. All scenarios should require feathering of turbines when not generating power.

Purpose of Action	Season	Duration	Wind Speed	Interval Met Tower	Mortality Reduction
Take avoidance	Year-round	Dusk-dawn	No night operation	N/A	100%
Strong minimization	Year-round	Dusk-dawn	>8.0 m/s	20 minute	90%?
High minimization	Year-round	Dusk-dawn	>6.5 m/s	20 minute	77%
Moderate minimization	Year-round	Dusk-dawn	>6.0 m/s	20 minute	71%
Minimal minimization	Year-round	Dusk-dawn	>5.5 m/s	20 minute	66%
Weak minimization	Year-round	Dusk-dawn	>5.0 m/s	20 minute	55%

Table 2. Correction factor to estimated baseline mortality due to large rotor sweep. Mortality estimates for rotor sizes in the table below should be corrected by multiplying the baseline mortality estimate by the multiplier for the appropriately sized rotor. Mortality reductions for larger rotors will need customized analyses.

Rotor Sweep (m)	Addition factor (%)	Multiplier
90-95	9	1.09
96-100	30	1.30
101-110	60	1.61
111-120	100	2.00

Table 3. Correction factor to estimated LWSC mortality reductions due to large rotor sweep. Mortality reductions for larger rotors will need customized analyses.

Rotor Sweep (m)	Reduction factor (%)	Multiplier
90-95	14	0.86
96-100	25	0.75
101-110	42	0.58
111-120	65	0.35

Additional Comments on Auwahi and Kawailoa draft HCP amendments_Mehrhoff_110218.txt
From: Loyal Mehrhoff <LMehrhoff@biologicaldiversity.org>
Sent: Friday, November 02, 2018 11:33 AM
To: Taylor, Lauren; Fretz, Scott; Kawika Winter; Jacobi, James; gtribble@usgs.gov; Lisa Spain; kburnett@hawaii.edu; michelle_bogardus@fws.gov; darren_leblanc@fws.gov
Cc: Metzler, Glenn M; Cullison, Katherine
Subject: RE: Comments on Auwahi and Kawailoa draft HCP amendments

Thanks Lauren,

My only additional comment is the following:

While I share concerns about how to properly mitigate for bat take, I do think that habitat restoration or preservation may be a viable option for offsetting bat take. Since bats have been observed using both native and non-native forests as habitat, mitigation could involve the creation/enhancement of native or non-native forests. The restoration/protection of native forests requires the control of key invasive species, including ungulates (e.g., pigs, goats, deer, and cows). Consequently, when mitigation aims to create, restore, or protect native forests the control/eradication of ungulates should be a requirement. Ungulate control would not necessarily need to be undertaken when non-native forests are the goal of habitat creation for bats. Some data shows that grazing by cows (an ungulate) is correlated with increased bat activity. I feel that native forests are a better option for bat-related restoration because they are the forests these bats evolved with and, additionally, native forests provide habitat for other endangered species that are dependent upon native forests. When habitat restoration/protection occurs in endangered species critical habitat (or areas where critical habitat was not designated because of landowner conservation efforts) the end target should be native habitat restoration, not the creation or perpetuation of non-native forests.

Loyal

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From: Kawika Winter <kwinter@ntbg.org>
Sent: Thursday, November 01, 2018 5:16 PM
To: Fretz, Scott
Cc: Jacobi, James; Metzler, Glenn M; Darren LeBlanc; Gordon Tribble; Kimberly Burnett; Lisa Spain; Loyal Mehrhoff; Bogardus, Michelle; Cullison, Katherine; Taylor, Lauren
Subject: Re: [EXTERNAL] Reminder for comments on Auwahi and Kawailoa draft HCP amendments
Attachments: Kawailoa Ammended HCP - KWinter comments 2018Nov1.pdf

Aloha Glenn,

I have reviewed and comments submitted by Mehrhoff, Jacobi, and Fretz for both Auwahi and Kawailoa, and am in concurrence with their comments. I only have additional comments for Kawailoa, and they are attached here for your inclusion.

Mahalo,

Kawika Winter, Ph.D.
Research Associate (Social-Ecological Systems)
National Tropical Botanical Garden

Mobile: [redacted]
The mission of the National Tropical Botanical Garden is to enrich life through discovery, scientific research, conservation, and education by perpetuating the survival of plants, ecosystems, and cultural knowledge of tropical regions.

From: Kimberly Burnett <kburnett@hawaii.edu>
Sent: Friday, November 02, 2018 3:22 PM
To: Fretz, Scott
Cc: Loyal Mehrhoff; Taylor, Lauren; Kawika Winter; Jacobi, James; gtribble@usgs.gov; Lisa Spain; michelle_bogardus@fws.gov; darren_leblanc@fws.gov; Metzler, Glenn M; Cullison, Katherine
Subject: Re: Comments on Auwahi and Kawailoa draft HCP amendments

A few more comments below.

Auwahi comments

Appendix 1: should the cost of higher tiers be proportional to mitigation costs of previous tiers as stated (in this case, tier 4?) I would imagine that mitigation may become increasingly expensive as take increases, since would probably do the conservation easements, water trough modifications, plantings, fencing, etc. in lowest cost areas first. If this is not the case, maybe provide reasoning for why increased mitigation would be a similar cost as previous levels of mitigation.

Kawailoa comments

p. 39: Is there a breakdown of costs for the mitigation funding activities, including monitoring activity of nesting seabirds and predator activity in Hanakapiai and Hanakoa, focused removal of predators, and controlling non-native barn owls?

p. 50: Can a measure of success be provision of funding and ownership transfers? Shouldn’t these be biologically-based measures of success?

pp. 5, 45, Appendix 19: the $2,750,000 includes the purchase of the 2,900-acre HWA, but what is the funding plan for DOFAW management into the future?

Kim

Metzler, Glenn M

From: Jacobi, James <jjacobi@usgs.gov>
Sent: Wednesday, October 31, 2018 9:44 AM
To: Metzler, Glenn M
Cc: LeBlanc, Darren; Gordon Tribble; Kimberly Burnett; Hadway, Lisa; Loyal Mehrhoff; Michelle Bogardus (michelle_bogardus@fws.gov); Fretz, Scott; Kawika Winter; Cullison, Katherine; Taylor, Lauren
Subject: Re: [EXTERNAL] Reminder for comments on Auwahi and Kawailoa draft HCP amendments
Attachments: Auwahi Wind Farm Draft HCP Amendment - Jacobi comments.pdf; Gorresen etal 2018 PlosOne multi-state occupancy foraging habitat use Hawaiian hoary bat Lasiurus.pdf

Hi Glenn,

I have reviewed the proposed Auwahi ammendment document and provided my comments directly on the attached copy. I refrained from duplicating comments that I agreed with on sections that had been previously reviewed by Loyal, and the DOFAW staff.

Overall, I like the direction they are proposing for mitigation with mixed habitat landscape management. However, I feel that the mitigation management response monitoring, relative to bats, is rather weak. I am concerned that the proposed use of acoustic monitoring, specifically focusing on feeding buzzes, will likely result in data that will be difficult to analyze and not yield results that can adequately detect change response to the management actions. A new paper has just been published that demonstrates the value of a multi-state occupancy analysis that incorporates both acoustic and thermal detection, coupled with results from insect biomass sampling, to assess change in bat response. Here is the reference and I attached a copy of their paper too:

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

I also looked over the proposed Kawailoa ammendment document and felt that most of the comments provided at our last meeting, in conjunction with those already provided by DOFAW and Loyal, covered most of the important points of my concerns. However, I felt that the mitigation response monitoring in this document was extremely brief and did not provide adequate details on how they are planning to assess changes in bat activity relative to management actions (either acquisition or on-ground management). Again, they might want to consider the use of the bat activity and habitat use monitoring methods described in the attached publication. I feel that the response monitoring needs to be expanded considerably in their proposal. Additionally, I question the proposed contribution to acquisition of the "Waimea forest" as mitigation to offset incidental take of HHB, given the proximity of this site to the current project where incidental take is currently occurring.

Please let me know if you need any additional information on my comments on these two documents.

Jim Jacobi

U.S. Geological Survey
Pacific Island Ecosystems Research Center
Kilauea Field Station

AUWAHI WIND FARM
HABITAT CONSERVATION PLAN

Draft Amendment

Prepared for

Auwahi **Wind**
Auwahi Wind Energy, LLC

Prepared by

TETRA TECH

28 September 2018

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LIST OF FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

asl	above sea level
Auwahi Wind	Auwahi Wind Energy, LLC
BCI	Bat Conservation International
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
HCP	Habitat Conservation Plan
HILT	Hawaiian Islands Land Trust
HRS	Hawai'i Revised Statute
ITL	incidental take license
ITP	incidental take permit
km	kilometer
kV	kilovolt
LWSC	low wind speed curtailment
m	meter(s)
m/s	meters/second
MW	megawatt
NAR	Natural Area Reserve
PCMP	post-construction monitoring plan
Project	Auwahi Wind Farm
RPM	rotation per minute
USFWS	U.S. Fish and Wildlife Service

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.

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 (15-kilometer [km]) 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.

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) at the Project in 2015 to reduce the risk to bats. The requested total bat take authorization for this amendment is 140 bats (119 in addition to the 21 already 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 for these tiers is outlined in Section 6.2. Adaptive management of minimization and mitigation associated with the varying levels of take can be found in Section 9.5.

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 to the maximum extent practicable 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 and 6.2).

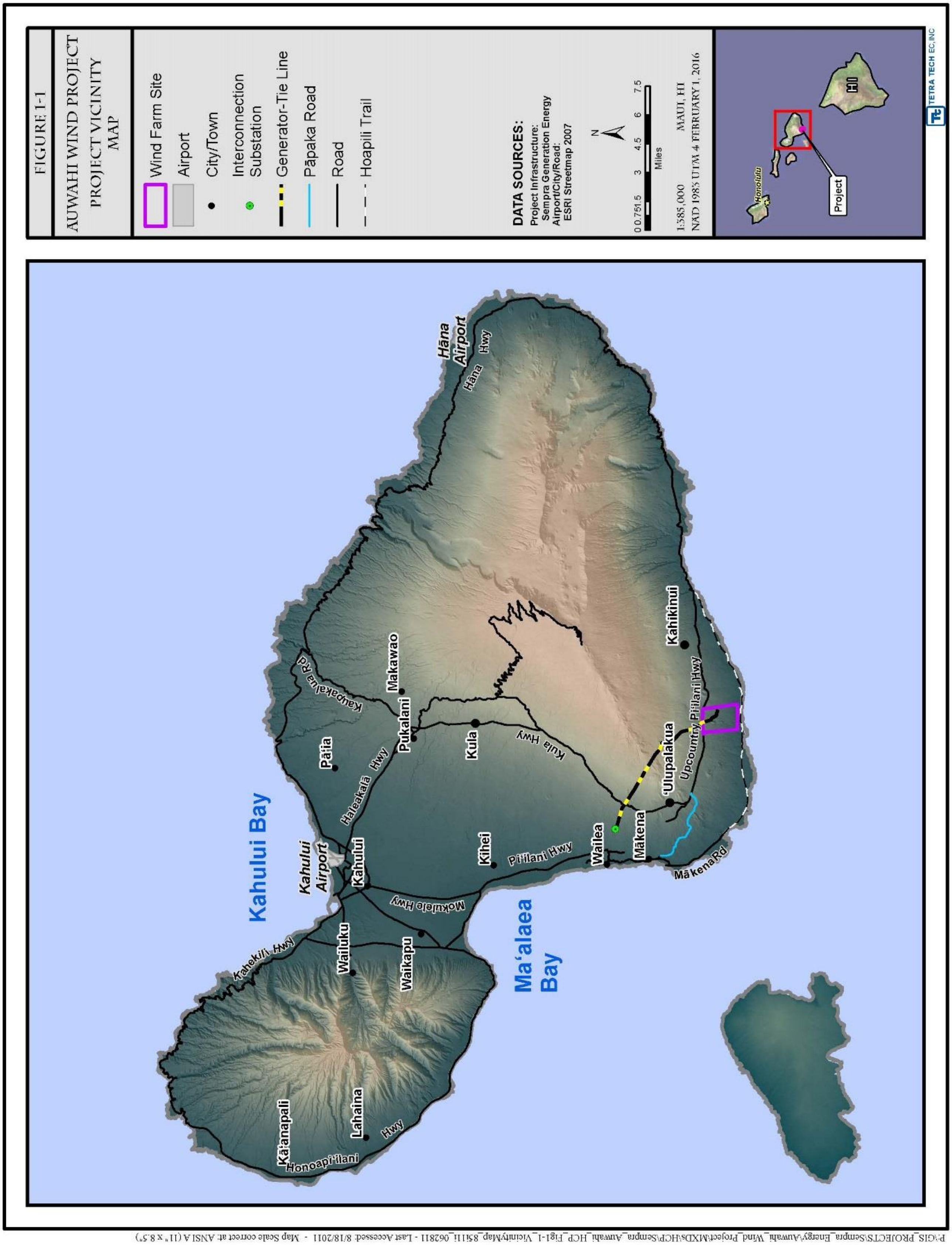
FIGURE 1-1
AUWAHI WIND PROJECT
PROJECT VICINITY MAP
Wind Farm Site
Airport
City/Town
Interconnection Substation
Generator-Tie Line
Pāpaka Road
Road
Hoapili Trail
DATA SOURCES:
Project Infrastructure: Sempra Generation Energy
Airport/City/Road: ESRI Streetmap 2007
N
0 0.75 1.5 3 4.5 6 7.5
Miles
1:585,000
NAD 1983 UTM 4
MAUI, HI
FEBRUARY 1, 2016
Honolulu
HI
Project
TETRA TECH EC, INC
Kahului Bay
Kahului Airport
Hāna Airport
Hāna Hwy
Kaupakalua Rd
Makawao
Pukalani
Pā'ia
Haleakalā Hwy
Kula
Kula Hwy
Kahului
Kīhei
Pi'ilani Hwy
Wailea
Mākena
Mākena Rd
'Ulupalakua
Upcountry Pi'ilani Hwy
Kahikinui
Mokulele Hwy
Kahekili Hwy
Wailuku
Waikapu
Ma'alaea Bay
Kā'anapali
Lahaina
Honoapi'ilani Hwy
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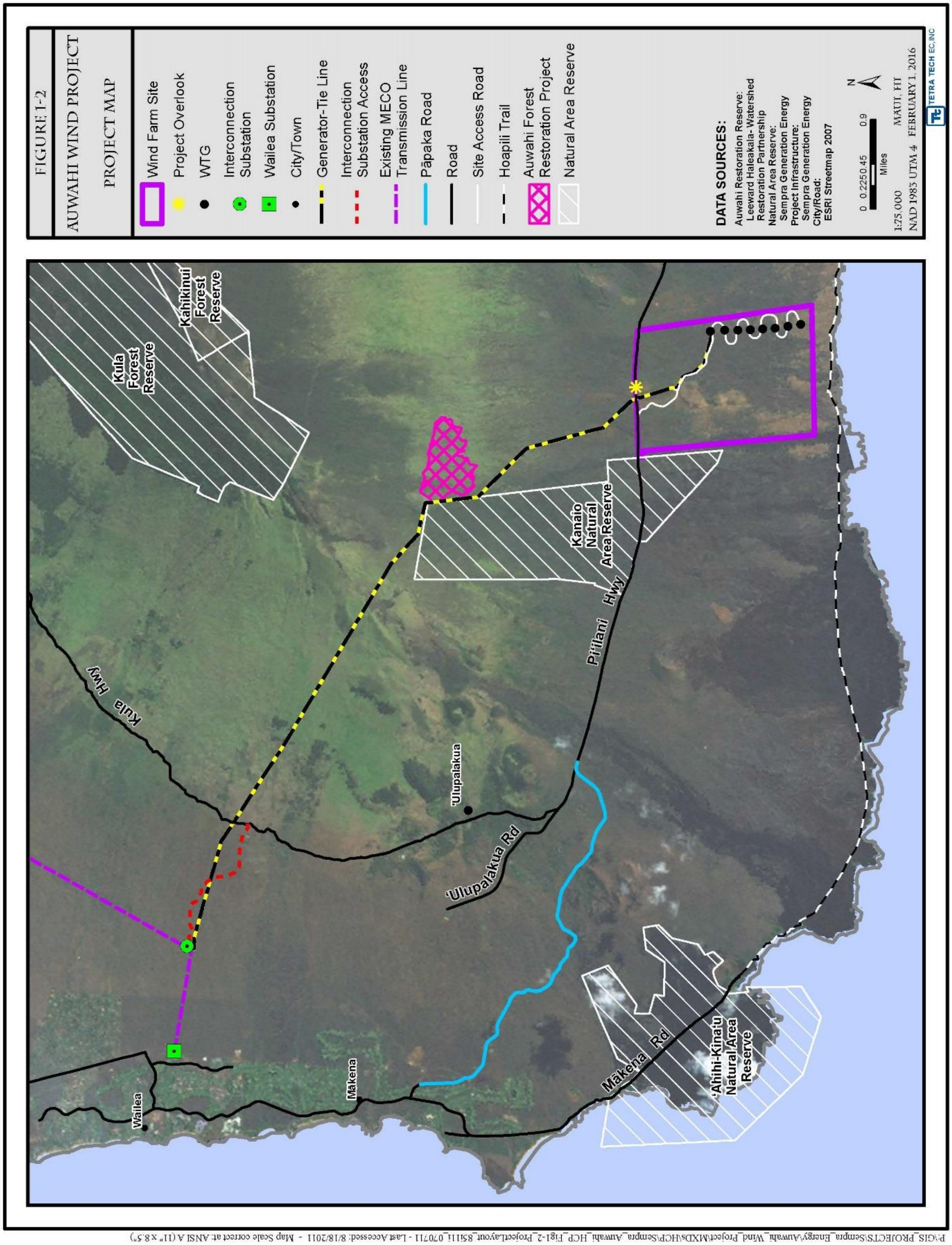


FIGURE 1-2
AUWAHI WIND PROJECT
PROJECT MAP
Wind Farm Site
Project Overlook
WTG
Interconnection Substation
Wailea Substation
City/Town
Generator-Tie Line
Interconnection Substation Access
Existing MECO Transmission Line
Pāpaka Road
Road
Site Access Road
Hoapili Trail
Auwahi Forest Restoration Project
Natural Area Reserve
DATA SOURCES:
Auwahi Restoration Reserve:
Leeward Haleakala-Watershed Restoration Partnership
Natural Area Reserve:
Sempra Generation Energy
Project Infrastructure:
Sempra Generation Energy
City/Road:
ESRI Streetmap 2007
0 0.225 0.45 0.9
Miles
1:75,000
MAUI, HI
NAD 1983 UTM 4
FEBRUARY 1, 2016
TETRA TECH EC, INC
Kula Forest Reserve
Kahikinui Forest Reserve
Kula Hwy
'Ulupalakua
'Ulupalakua Rd
Kanaio Natural Area Reserve
Pi'ilani Hwy
Wailea
Mākena
Mākena Rd
'Āhihi-Kina'u Natural Area Reserve
P:\GIS_PROJECTS\Sempra_Energy\Auwahi_Wind_Project\MXDs\HCP\Sempra_Auwahi_HCP_Fig1-2_ProjectLayout_85i11i_070711 - Last Accessed: 8/18/2011 - Map Scale correct at ANSI A (11" x 8.5")

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 Sempra Renewables, LLC and BP Wind Energy North America Inc. The Project is operated by Sempra Renewables, which is an indirect subsidiary of Sempra Energy, a Fortune 500 energy services holding company based in San Diego, California.

1.3 PROJECT DESCRIPTION

No additional Project development as outlined in Section 1.3 of the approved HCP 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] The Tax Map Key (property lot identification in Hawai'i) for the HCP Amendment is (2) 1-9-001:006.

2. The approved HCP included statements that Project wind turbine generators had a net generating capacity of 21 MW and were expected to be curtailed at night on a regular basis based on expected MECO demands. Subsequently, MECO implemented a dispatch process that optimizes use of renewable energy generators, and 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

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

This section requires no edits for the HCP Amendment.

generated the full 24 MW, there is no increased risk to bats because the rotations per minute (RPMs) of the turbine blades are the same at 3 MW as at 2.6 MW.

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. Additionally, advancements have been made in how future fatality rates are statistically modeled. When the approved HCP was prepared, post-construction mortality monitoring data from Hawai'i wind farms were limited, and 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 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).

The HCP Amendment employs the EoA statistical software, with the benefit of Project-specific post-construction mortality monitoring data (see Section 5.0), which improves the understanding of inter-annual variability in fatality rates and other Project-specific uncertainties. It is therefore anticipated that this HCP Amendment more accurately estimates 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

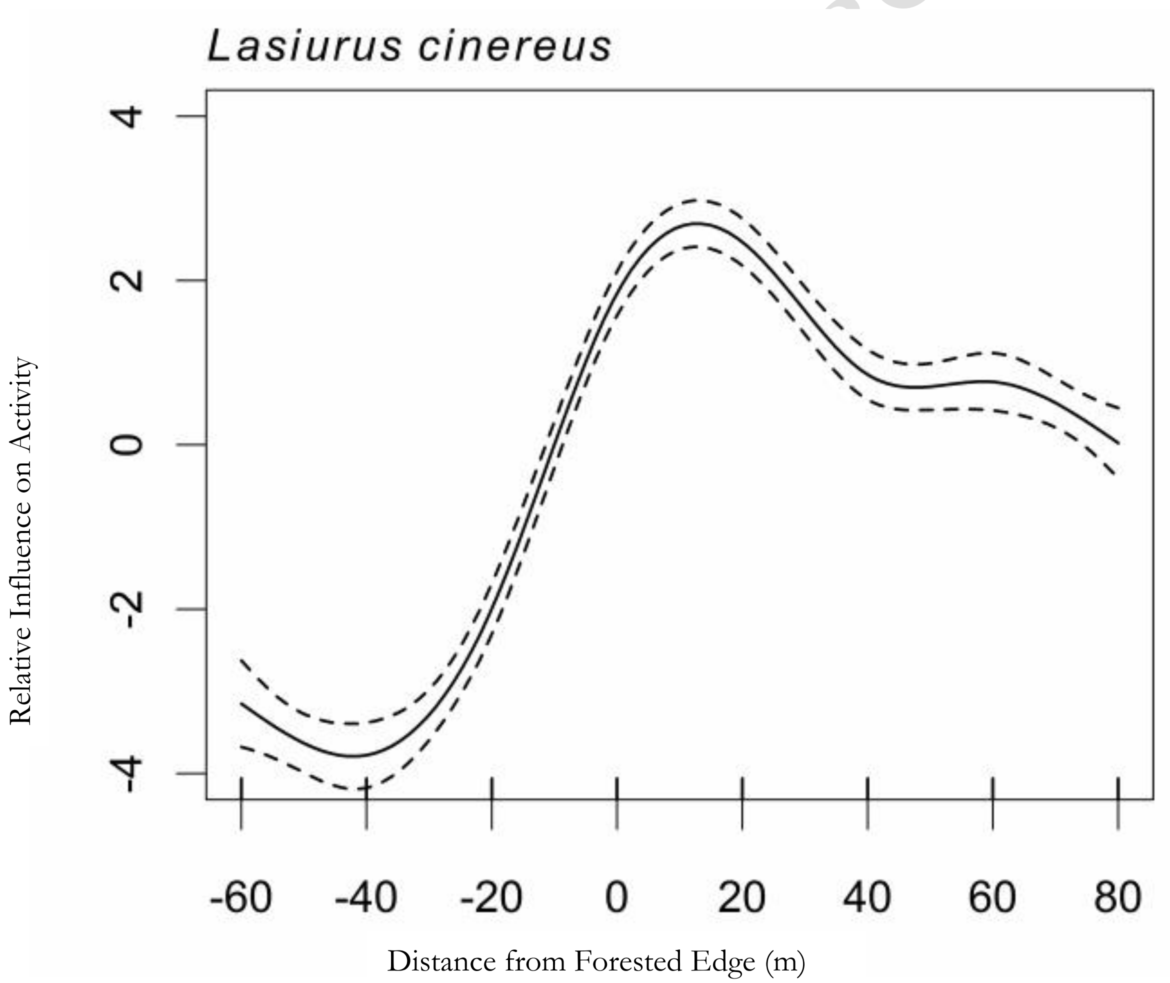
The Hawaiian hoary bat is the only fully terrestrial, native mammal in the Hawaiian Islands. The bat is widely distributed across all the major volcanic islands of the Hawaiian Archipelago (Gorresen et al. 2013). The Hawaiian subspecies of the hoary bat has been recorded on Kaua'i, O'ahu, Moloka'i, Maui, Lāna'i, Hawai'i, and Kaho'olawe, but no historical or current population estimates exist. Recent studies and ongoing research have shown that bats have a wide distribution across the islands and breeding populations are known to occur on all of the main Hawaiian Islands except Ni'ihau and Kaho'olawe (Bonaccorso et al. 2015). 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). Currently only one bat species is recognized as present in Hawai'i, and it is listed as endangered; however, 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.

Numerous research studies have been conducted on the Hawaiian hoary bat in the last decade; nonetheless, data regarding its population status remain limited. 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). 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). However, additional data on the status of bats on Hawai'i Island and other islands are needed (Gorresen et. al. 2015; USFWS 2011). The USFWS is currently conducting its 5-year review of the Hawaiian hoary bat.

The Hawaiian hoary bat recovery plan (USFWS 1998) and the ESRC Bat Guidance (DOFAW 2015) acknowledge the paucity of data pertaining to Hawaiian hoary bat conservation and that measurements of the biological metrics that are used to understand limiting factors of bats and estimate Hawaiian hoary bat populations are largely unknown. 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 critical 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.

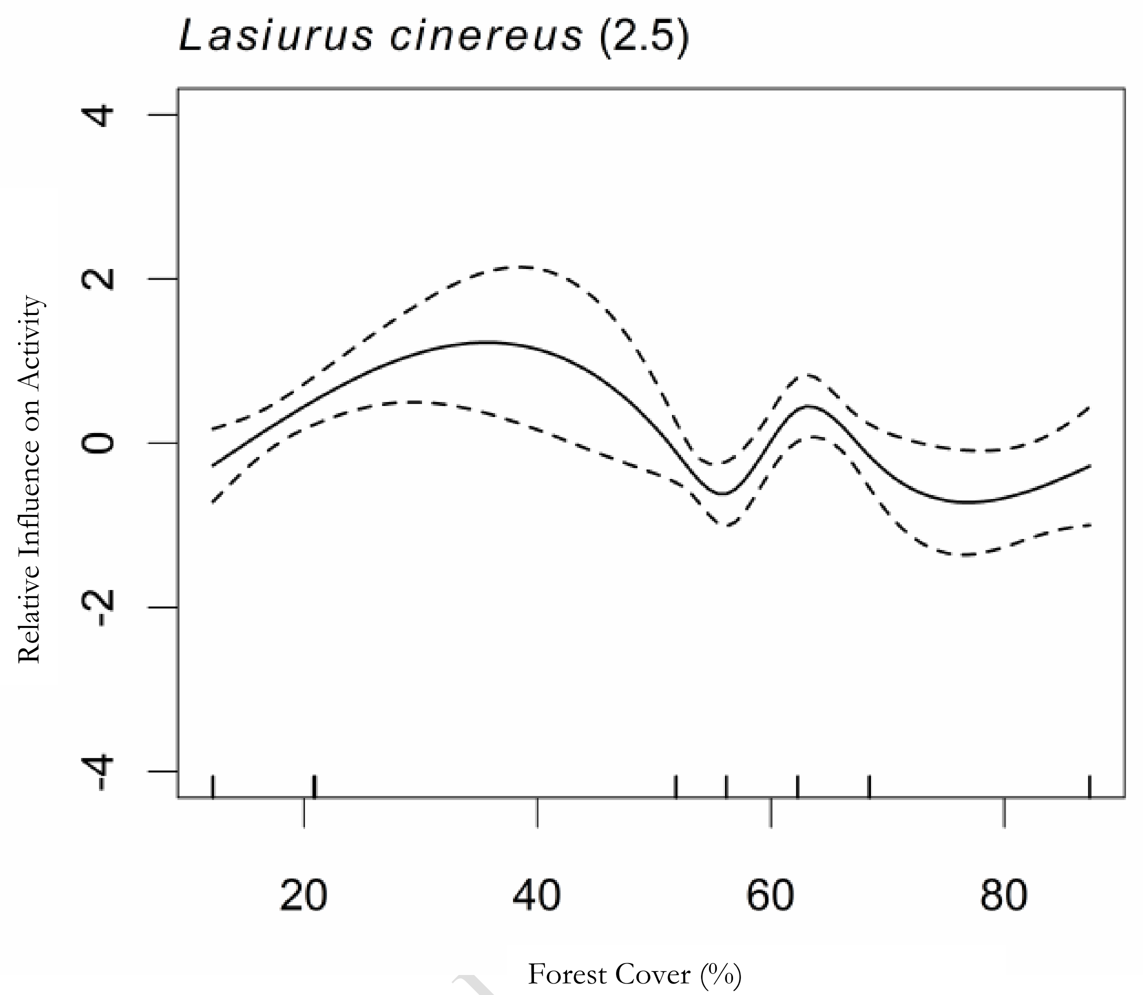
The Hawaiian hoary bat has been observed in a variety of habitats, including open pastures and more heavily forested areas, and in both native and non-native habitats (DLNR 2015, Gorresen et al. 2013). In addition to utilizing undeveloped areas, foraging and roosting has been documented in a variety of developed areas (golf courses, urban, suburban, rural, and military/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). Based on wing structure and echolocation characteristics, Fenton (1990) suggested mainland hoary bats (*L. cinereus*) would be considered open area foragers; however, Hawaiian hoary bats weigh about 45 percent less than mainland hoary bats, 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. Jantzen (2012) looked at the habitat density and distance from forest habitats that are correlated with higher use rates by bat species. For mainland hoary bats, a significant increase in activity at 41 feet (12.6 meters) from the edge of forests (Figure 3-1) was identified, with increased use recorded out to 262 feet (80 meters). Jantzen (2012) also conducted a 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 at 20 to 25 percent forest cover and 70 percent forest cover were noted. The data from the 1.5-mile spatial scale suggest increased activity may be gained at up to 40 percent forest cover (Figure 3-2). Jantzen (2012) lists 8 study sites which vary from 12.2 to 87.3 percent forest cover. The low-density sites contain isolated patches of remnant forest, while the high-density sites contain mostly forest with agricultural lands at various densities.



Source: Jantzen 2012

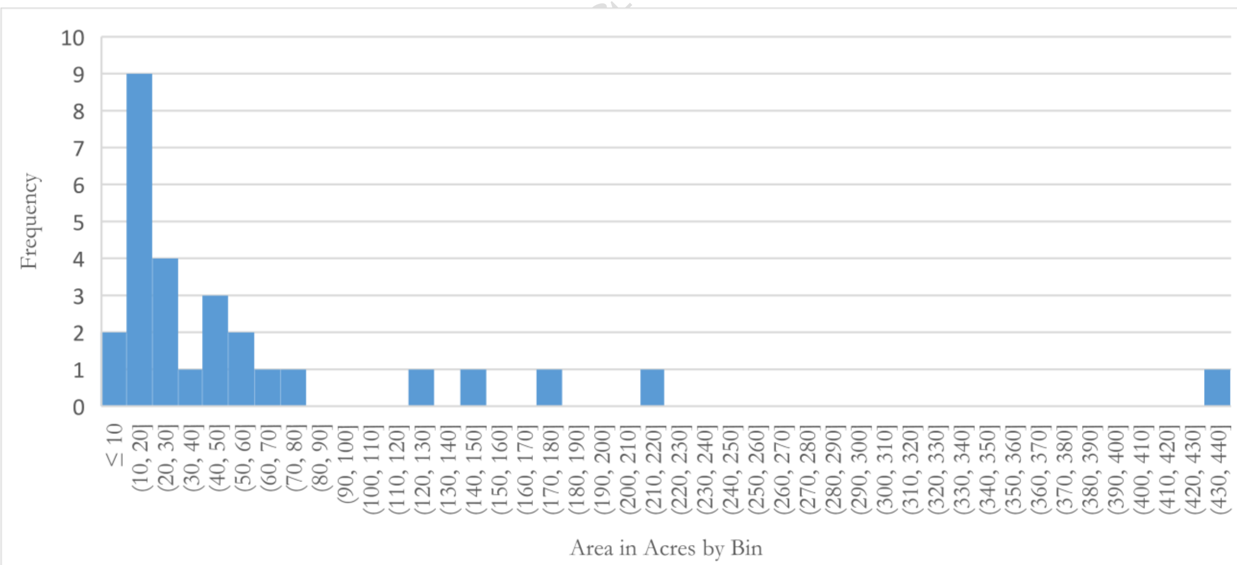
Figure 3-1. Relative Bat Activity Compared to the Distance from a Forest Edge



Source: Jantzen 2012

Figure 3-2. Hoary Bat Activity Relative to the Forest Density at the 1.5-mile (2.5-km) Spatial Scale

A Hawaiian hoary bat's foraging range contains the area used by an individual bat foraging for food, and also includes movements to and from day roosts and night roosts (Bonaccorso et al. 2015). Bonaccorso et al. (2015) found that 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 area was concentrated within small core use areas (CUA; 11.1 percent of mean foraging range) that exhibited limited individual overlap. Bonaccorso et al. (2015) defined CUAs as areas within the foraging range that have very intensive use.[2] Thus, individual Hawaiian hoary bats may have overlapping foraging ranges, but do not appear to 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 results of Bonaccorso et al. (2015) indicate that the median CUA size for adult and subadult bats of both sexes combined is 22.5 acres. This median value for Hawaiian hoary bat CUA excludes the one bat recorded to have a CUA over 434 acres as an outlier (Figure 3-3). In comparison, the median value of 20.3 acres (DOFAW 2015) excludes the CUA of five bats assumed to be outliers (Figure 3-3) but which may be representative of natural variation in CUA size depending on age, habitat suitability, and foraging efficiency (Bonaccorso et al. 2015, Pinzari 2014). Pinzari (2014) states that "young bats are inefficient hunters of insect prey and presumably remain active for longer periods than adult bats." Data from Bonnocorso et al. (2015) suggests that although there is variability in size of CUAs, subadults tend to use larger core use areas than adults (Figure 3-4).



Source: Bonaccorso et al. 2015

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

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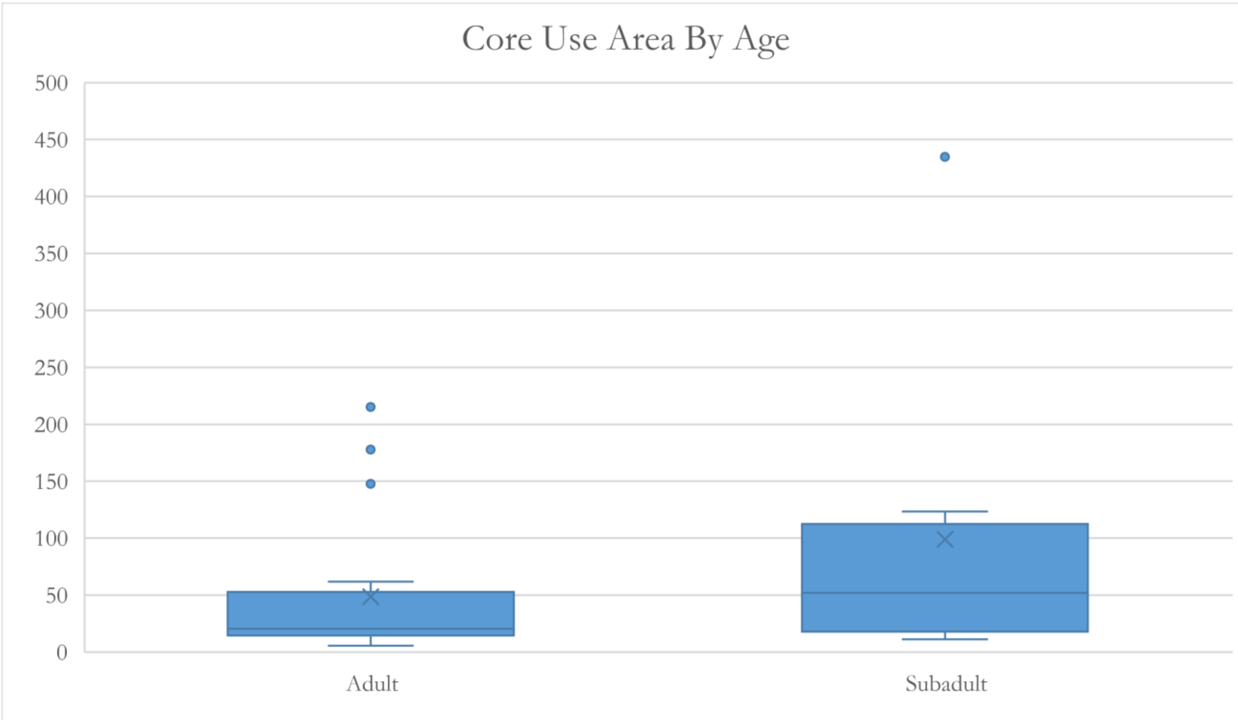
[2] A least squares cross-validation was used to determine a smoothing parameter with minimum estimated error for fixed-kernel estimates. The core use area was defined by the 50% fixed kernel.



Source: Bonaccorso et al. 2015

Figure 3-4. Box and Whisker Plot Showing Core Use Area by Age

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 (600 meters) 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; thus, increasing the insect availability is likely to increase the suitability of a site for bats (Todd 2012).

Water provides an essential habitat component for foraging, reproductive, and basic physiological requirements for bat species as well as a foraging substrate for prey insect species. Water sources have been shown to increase Hawaiian hoary bat activity relative to surrounding habitats (SWCA 2012). Hawaiian hoary bats have been documented using artificial water sources such as reservoirs (Jackrel and Matlack 2010, Vindigni et al 2009, Uyehara and Wiles 2009); bats have been captured foraging for moths over open water (Todd 2012, USFWS 1998). Additionally, bat use of water sources as foraging substrates is well documented (Brooks and Ford 2005, Heim et al. 2018, Vindigni et al. 2009), specifically including water troughs in arid regions of the mainland United States (Jackrel and Matlack 2010, Tuttle et al. 2006, Vindigni et al. 2009). Trough shape and size, and proximity to vertical structure (fence, vegetation, etc.) can impact the usability of troughs by bats (Tuttle et al. 2006, Taylor and Tuttle 2007).

Hawaiian hoary bats are known to have solitary 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).

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 m) asl or lower; however, a pregnant female was captured in June 2017 above 5,000 feet (1,524 m) asl (DOFAW 2015; Corinna Pinzari, USGS, personal communication). Bonaccorso et al. (2015) studied the foraging range of the Hawaiian hoary bat on Hawai'i Island, and defined the foraging range as the area traversed by an individual as it forages and moves between day roosts and nocturnal activity areas (foraging areas). This research documented bats traveling up to 7 miles (11.3 km) per night.

Hawaiian hoary bats are found in both wet and dry areas from sea level to 13,000 feet (2,962 meters [m]) above sea level (asl), with most observations occurring below 7,500 feet (2,286 m). Although the Hawaiian hoary bat may migrate among islands and 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).

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 limited 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 up to 10 years (DOFAW 2015).

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 power purchase agreements 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 (100 kilometers) 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).

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 on a per-encounter basis 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 (Table 3-1). However, the seasonal patterns in the fatalities in this combined dataset 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. Table 3-1 indicates significant variability in the seasonal distribution of fatalities by wind farm; the table does not reflect the magnitude of fatalities at each facility. 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.

Table 3-1. Timing of Observed Hawaiian Hoary Bat Fatalities at Existing Wind Farms in the Hawaiian Islands through December 31, 2017[1]

Month	Auwahi (Maui)	KWP I (Maui)	KWP II (Maui)	Kawailoa (O'ahu)	Kahuku (O'ahu)
January	X				
February		X	X	X	
March			X	X	
April		X			X
May		X		X	
June	X			X	
July	X			X	

Month	Auwahi (Maui)	KWP I (Maui)	KWP II (Maui)	Kawailoa (O’ahu)	Kahuku (O’ahu)
August	X	X		X	X
September	X	X		X	X
October	X			X	
November	X	X	X	X	
December		X		X	
Source: G. Metzler, DOFAW, 2017, pers. comm. 1. “X” indicates an observed fatality was detected in that month.					

3.8.1.3 Occurrence in the Project Area

Acoustic monitoring conducted at the Project from 2013-2015 documented low bat activity levels throughout most of the year, with increased activity August – October. Recorded bat calls occurred at an average rate of 0.23 bat passes per night over the monitoring period (Auwahi Wind HCP Annual Report 2015). Post-construction mortality monitoring results suggest a similar seasonal pattern in bat fatalities (Auwahi Wind 2013, 2014, 2015, 2016, 2017). 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). 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 2 were observed incidentally (outside search plot or regular search interval). Fourteen of the 18 observed fatalities occurred between August and October. It is unclear if sex plays a role in the temporal distribution of fatalities, because only 6 bat fatalities have been tentatively identified to sex (4 male and 2 female). The results of a genetic analyses to determine the sex of the other observed fatalities is forthcoming from USGS.

The variable timing of bat fatalities among the operational wind projects (Table 3-1) 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 (274 and 1,158 meters) (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. 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 over all years of monitoring (2013-2017) is 0.5, with a standard deviation of 0.11, indicating that the number observed of fatalities per year is comparable among years. Appendix H contains more detailed information on the detection probability and estimation process. The causes and magnitude of any inter-annual variability are unknown. Anecdotal data from 2016 suggest that if significant inter-annual variability exists, causes may include anomalous weather patterns, drought cycles, cattle grazing rotations, or other phenomenon. 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.

Other factors associated with observed bat fatalities are analyzed on an ongoing basis. These factors include the distance and direction from the turbines, wind speed, wind direction, rotor rotations per minute (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 7 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 occurred 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 to the maximum extent practicable 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 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 power purchase agreement 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 will be determined by a 10-minute running average of wind speeds collected at the turbine nacelle. During curtailment, blades will be feathered, reducing the speed of the blade to less than one RPM. Turbines will 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 meters/second (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 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, 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. 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 would not be expected (Draft 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 reduction in take rate of 59 percent (76% x 78% = 59%)

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 (*Myotis sodalist*) 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 HCP Annual report 2017, Auwahi Wind HCP Annual report 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.

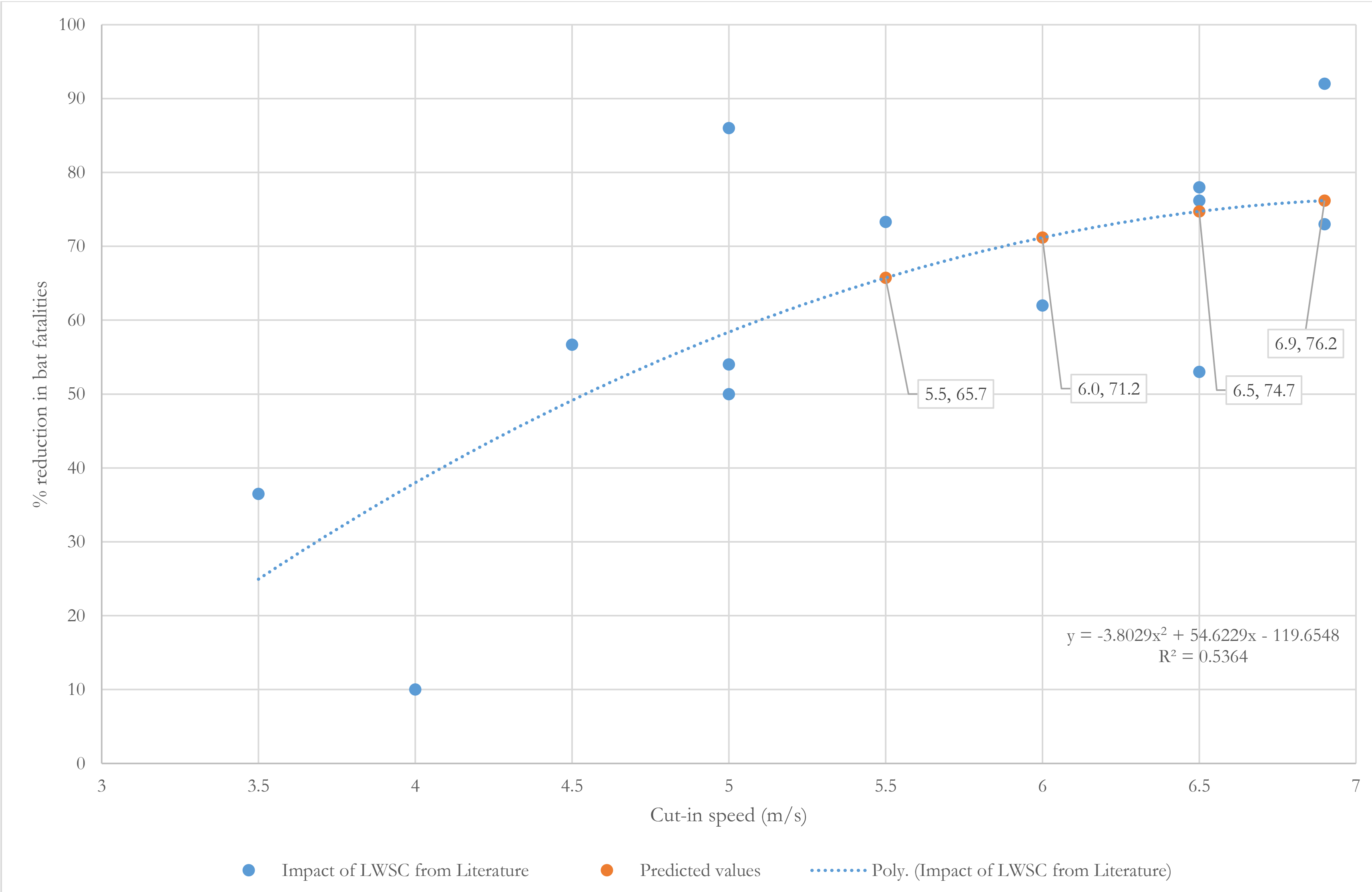


Figure 4-1. Synthesis of Low Wind Speed Curtailment on Direct Take of Bats

Table 4-1. Regression Analysis Data for 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

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To have a likelihood of take of Hawaiian hoary bats, bats must be present at the wind farm while turbines are operating. Auwahi Wind proposes to take a seasonal approach to its LWSC program during 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). For months with few observed fatalities, the risk to Hawaiian hoary bats is minimal, suggesting that additional curtailment in these periods would have insignificant gains. Adaptive management of the minimization strategy is identified in Section 7.4.1 and alternative minimization strategies are discussed in more detail in Section 8.

Auwahi Wind proposes to implement the following as baseline minimization measures starting in 2018 and continuing 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, when data from the first 5 years of operation has shown that most bat fatalities have occurred. Please refer to Section 7.4 for the adaptive management plan.

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, and the anticipated benefits of mitigation, the approved HCP developed a tiered approach for structuring requested take and associated mitigation. Under this HCP Amendment, three additional tiers of take (Tiers 4 – 6) have been added to the three approved tiers for the Hawaiian hoary bat. 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 power purchase agreement. As noted in Section 2.2, the term of the ITP/ITL is 25 years (through 2037), which includes 5 years during which Auwahi Wind may consider extending the operational life of the Project through a new or revised power purchase agreement. 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 5 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. 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 the extrapolation of the effectiveness of LWSC in reducing bat fatalities from mainland studies on several bat species to the effectiveness 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, 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, 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 by multiplying the predicted number of indirectly taken juveniles by the probability those juveniles would survive to become adults (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

Line Number	Component	Calculation of Count	Number of Bats	Calculation of Indirect Take[1]	Indirect Take Assessment
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[3], and the additional authorized take of 119 bats requested through this HCP Amendment (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 mandated 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 6.45 bats per year. This provides the opportunity for additional advancements in the development of new minimization measures as outlined in Section 7.4.

3 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).

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

Since the Hawaiian hoary bat was listed as endangered in 1970 under the ESA, the population has persisted with no direct action taken to promote the survival of the species. As mentioned above, the most current studies show the population of the Hawaiian hoary bat on the island of Hawai'i is "stable to increasing" (Gorresen et al. 2013). Although the greatest overall numbers of this species are thought to occur on the islands of Hawai'i and Kaua'i (Menard 2001), systematic monitoring has not been conducted on Maui to estimate the size of its local population. Prior estimates of the bat population were low and based on incomplete information or limited monitoring (USFWS 1998, Tomich 1986). Observations of the Hawaiian hoary bat show that the bat is more widespread and abundant than previously thought, as observed through monitoring at wind farms and associated mitigation sites (Auwahi Wind 2017, KWP I 2017, KWP II 2017), and research (Gorresen et al. 2013, Bonaccorso et al. 2015).

Evidence from post-construction mortality monitoring studies at wind farms on Maui (Auwahi Wind 2017, KWP I 2017, KWP II 2017) suggests that the Hawaiian hoary bat occurs in higher numbers on Maui than previously thought. The detection of fatalities is an indication that the species has a significant population on Maui that continues to persist despite the existence of the several threats discussed in Section 3.8.1.2, including wind energy projects. It is unlikely that the Project or the habitat within the Project is a draw for bats or that bats preferentially occupy this area. Instead, the bats appear to be distributed (somewhat evenly) across the leeward side of the island, given the similarity in habitat and as demonstrated by acoustic detections at the Project (0.23 bat passes per night, Auwahi Wind 2015) and research sites (0.38 detectability, Auwahi Wind 2017) on Leeward Haleakala. If fatality rates declined without explanation, this could be an indication that the local population was in decline. Measures that could account for a decline in bat fatality rates would be a reduction in risk achieved through LWSC, reduction in search area, or other such measures. In 5 years of operation, the fatality rate at the Project and other wind energy projects has not had an unexplained decline. Bats continue to be detected in ongoing research projects (H.T. Harvey 2016, Kaheawa Wind Power I 2017, Kaheawa Wind Power II 2017, Auwahi Wind 2017), and no preliminary data, public information or published literature to date suggest that the bat population is in decline.

In considering potential population impacts, what is known about the biology of the bat species in relation to the projected take for the Project must be considered. The estimated Project take is 6.45 bats per year over the life of the Project. Each female is estimated to produce 0.54 offspring per year, based on the USFWS 2016 guidance. The lifespan of the Hawaiian hoary bat has been estimated to be between 4 years and 10 years (Bonaccorso 2016, DOFAW 2015). A population model based on these demographic parameters, coupled with a starting population estimate based on forested acres below, suggest an increasing population on Maui.

As mentioned above, the median CUA for one bat calculated by DOFAW is 20.3 acres (DOFAW 2015, Bonaccorso et al. 2015). The total number of acres for the island of Maui is 465,280 of which approximately 32.2 percent is forested (NOAA Coastal Change Analysis Program; CCAP 2011). This equates to approximately 150,000 acres of forest on Maui, which translates to an estimated bat population of 7,300 based on a CUA size of 20.3 acres. This population estimate is a rough estimate because bats have been documented to have seasonal variation in use, and also documented using non-forested areas (Auwahi Wind 2017, Todd 2016). Given the reproductive estimates of bats provided in the USFWS guidance for calculation of indirect take (see Section 5.1.2) the estimated offspring from this population would range from 1,000 to 2,000 new adults produced each year. Therefore, based on a median CUA of 20.3 acres per bat, the take of 6.45 bats per year by the Project pursuant to the HCP Amendment would not be anticipated to have a significant impact on the population of Hawaiian hoary bats on the island of Maui, or cause the loss of genetic representation of the Hawaiian hoary bat population on Maui. This expected level of impact falls below the standard of jeopardy as defined by the UFSWS and DLNR success criteria in the ESA and HRS-195D, respectively.

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. 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 presence of robust populations on Maui that are critical to the recovery of the species (USFWS 1998), indicates that incidental take on Maui is not likely to impact the status of the species on other islands.

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). Additional mitigation for all Project related take will be implemented on Maui as described in Sections 6.2.4 and 6.2.5 and will contribute to the species' recovery. In addition, biological research being conducted for mitigation under Tiers 2 – 3 will contribute to filling in knowledge gaps that will lead to effective on-the-ground management activities for the species. The best available information indicates that the Maui bat population is significant. There is no published or reported information which suggests that either the Maui or statewide population is decreasing. Based on the best scientific data currently available as discussed above, 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 HCP Amendment when considered in the context of past, present and reasonably anticipated future actions that will also have an impact on the bat, both on Maui and statewide. On Maui, past development and other land use changes have resulted in the loss of bat roosting and foraging habitat through the conversion of forest to agriculture and other uses. 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 further 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.

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 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, 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.

The Hawaiian Electric Companies issued a renewable energy request for proposals seeking to develop an additional 60 MW of renewable energy on Maui (HECO 2018). If all of the proposed renewable energy development only includes wind-based energy, the average annual take for current and proposed Maui-based development would be approximately 20 bats based on the average requested take per megawatt per year for Maui (Table 5-3). Based on the population estimate provided above for Maui, the cumulative impact for current, and proposed future wind energy development is not expected to have a significant impact on Maui's hoary bats.

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 installation of bat deterrents at wind farms in Hawaii is anticipated within the next 5 years and would further reduce the risk of cumulative impacts to the bat.

Becoming snagged on barbed wire is a documented mortality source for bats statewide, with rates on Maui expected to be similar to the statewide range of zero to 0.8 Hawaiian hoary bats per 100 km of barbed wire (Zimpfer and Bonaccorso 2010). Observed fatalities are uncommon because most fences are not checked regularly and any bats that may be caught on these fences may be quickly 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.

The activities that directly impact bats on Maui (identified above), also occur statewide. The direct impacts from other authorized or proposed actions which could take bats include the following: 1) 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), 2) requested take for one proposed wind project on O'ahu, and 3) requested take for two existing wind projects and one restoration project on Hawai'i Island (Table 5-3). Take authorization for these wind farms is contingent upon approved mitigation, which is expected to fully offset these projects' take. 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	Final requested (21 years)	25	Kahuku, O'ahu	NA	51 bats
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

Applicant	Permit Duration	Megawatts	Location	Current Take Authorization[1]	Take Request for Future HCP or HCP Amendment[1,2]
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, 2017. 2. Total includes previous authorized take. 3. Take authorized under ESA Section 7 Biological Opinion.					

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 loss and degradation of which has been identified as a major factor contributing to decline of the species (USFWS 1998). 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. Additionally, 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 take estimation process provides a high degree of certainty that actual take will be less than predicted take. Additionally, authorized take is typically higher than actual take, suggesting that the actual impacts are likely to be less than the maximum proposed, while mitigation offsets for the full take authorization.[4] Because current and pending actions with HCPs are expected to fully mitigate for their take and provide a net benefit as required by Hawaii law, there is no anticipated significant, adverse, cumulative impact to the Hawaiian hoary bat from the HCP Amendment.

The HCP provides mitigation for any take that cannot be avoided. Pursuant to USFWS and DLNR ITP/ITL issuance criteria, the provisions described in the HCP including the avoidance and minimization measures, mitigation, and adaptive management program, identify how any bat take

4 Full take authorization for bats may be in reference to tiered take, rather than the full take request.

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. Additionally, the mitigation identifies benefits to species not covered by the HCP so as to provide a net environmental benefit and does not threaten or jeopardize the existence of any other native 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 4.2.4) 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). 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 6.45 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, such as the results of ongoing research, to be incorporated into future tier mitigation projects such as the results of ongoing research (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	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) and supplemented by the April 2015 ESRC workshop and resulting ESRC Bat Guidance (DOFAW 2015) for projects that have the potential to impact the species. The results of this workshop 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;
- Recognition of the need to closely monitor a variety of habitat restoration projects to measure their benefits to the Hawaiian hoary bat; and
- Development of the ESRC Bat Guidance (DOFAW 2015).

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 and DOFAW 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.

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. It includes funding of Hawaiian hoary bat research that contributes to knowledge of the species on Maui. Beginning in 2013, Tetra Tech 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.[5]
4) Additional items may be added to the scope of work if field time and funds allow:
    a. Adding one acoustic meter near the location called Duck Ponds.
    b. Adding insect prey base sampling at the Project.

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

The initial results of this work indicate a higher use rate than predicted by mitigation targets for Tier 1. Although mitigation for Tier 1 targeted mitigation offset for 6 bats, 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 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.

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

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. This 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 22.5 acres (Bonaccorso 2015);
- 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.

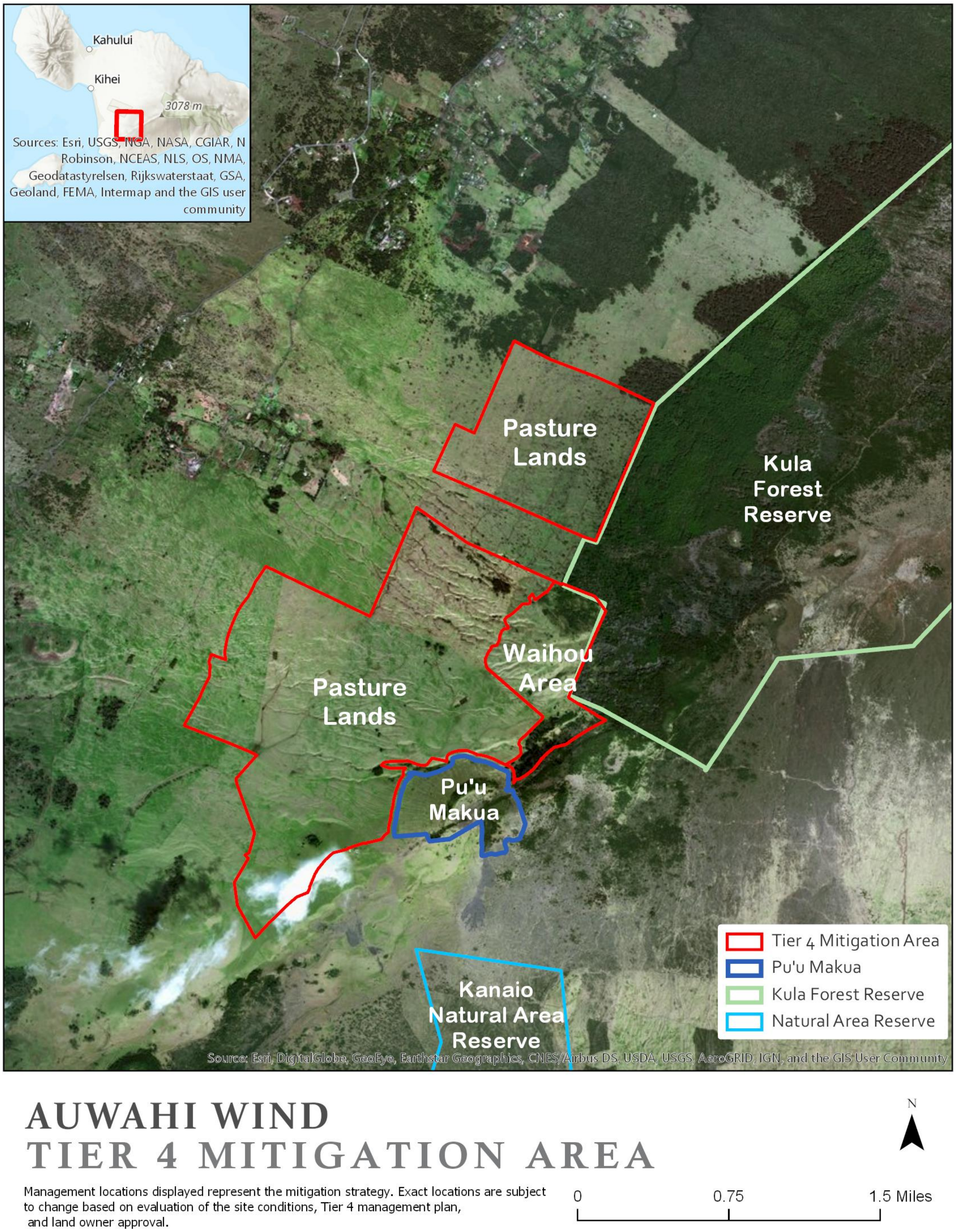


Figure 6-2. Site Location, Aerial Imagery, and Proposed Layout of Mitigation Parcels within the Mitigation Area

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 (p) 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.

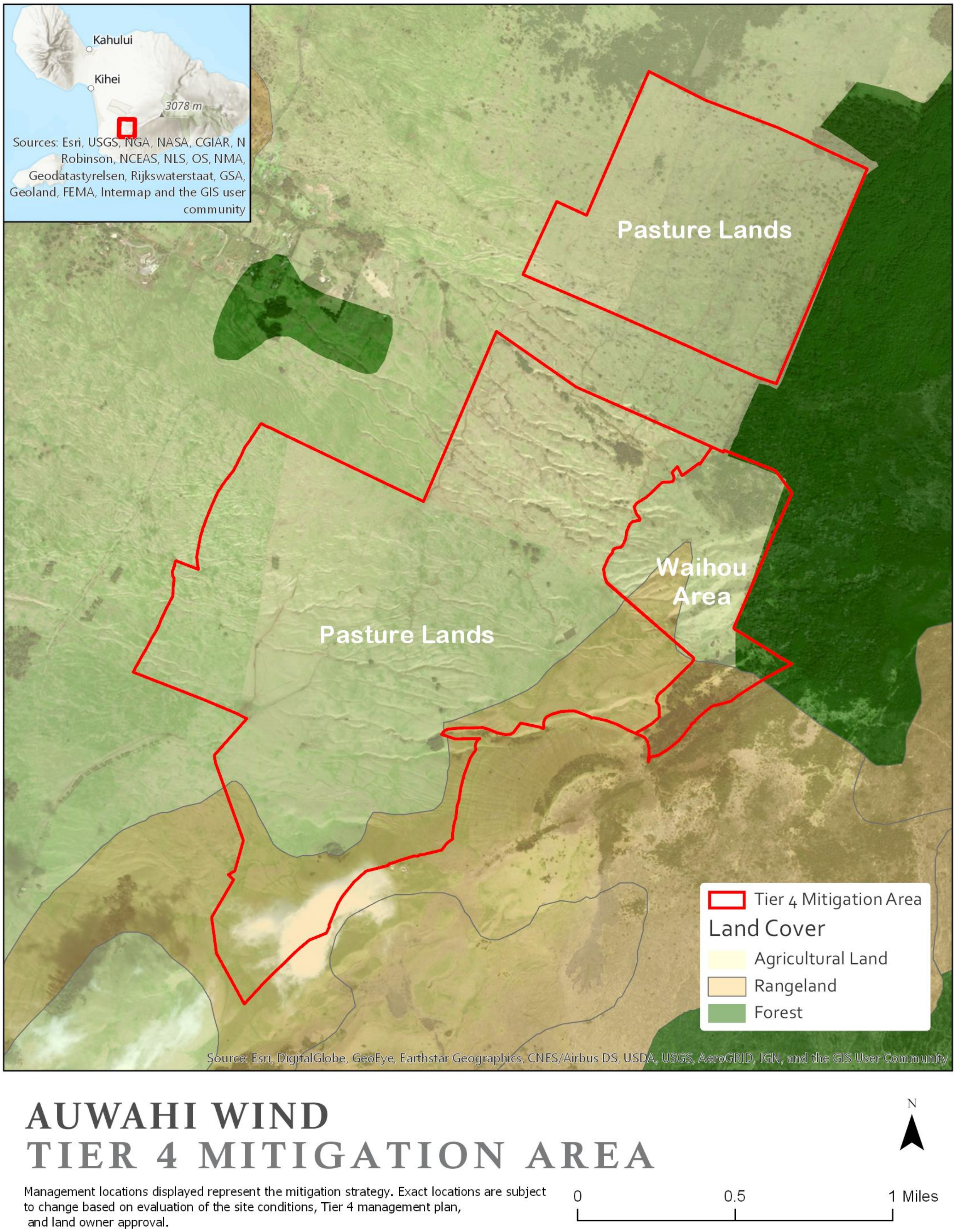
The elevation of the Mitigation Area ranges between 3,300 and 5,500 feet (1,676 meters) asl, and the land use is commercial cattle ranching. Under the proposed Tier 4 Mitigation the property and existing pastures will continue to be used for seasonal grazing, but new management actions will be implemented 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, pers. comm. 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. 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 Waihou

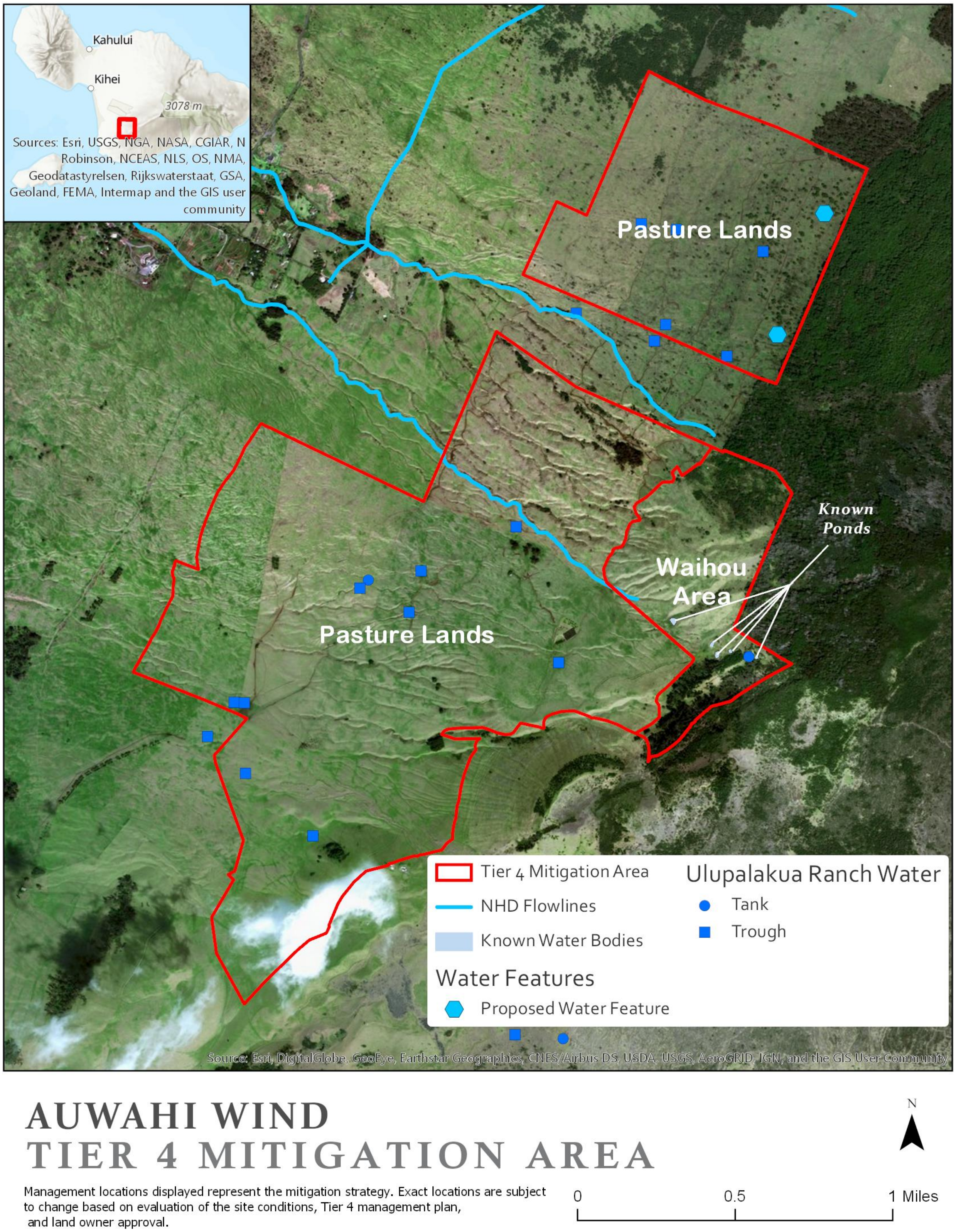
Area also contains five small ponds that range in size from 40 by 50 feet (12.2 by 15.2 meters) up to 60 by 120 feet (18.3 by 36.6 meters). The area surrounding the existing ponds is grazed by cattle (when rotated to that site), and are generally vegetated by non-native grasses. The general habitat types are shown in the aerial imagery in Figure 6-2 and in Figure 6-3, 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 consist of just a few cattle ponds, seasonally active water troughs, and dry or perennial small streams (Figure 6-4, USGS 2013). 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 6-4). 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. Fifteen water troughs currently exist within the Mitigation Area (Figure 6-4). The composition of ranch water troughs varies widely and includes wood, metal, or other repurposed materials such as tires, bathtubs, etc. The existing structures also vary widely in size and shape. Additionally, structures (e.g., fences, vegetation) surrounding the water troughs may be unsuitable for utilization by bats. Currently, the existing troughs contain water only when grazing cattle are utilizing the pasture, approximately 2 to 4 months per year. Figure 6-4 displays the existing troughs, tanks and ponds.



Source: GIRAS, State of Hawaii Office of Planning 2018

Figure 6-3. Land Cover Data in the Mitigation Area from Geographic Information Retrieval and Analysis



Source: GIRAS, State of Hawaii Office of Planning 2018

Figure 6-4. 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 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 availability of water in troughs or ponds. There are no restrictions on the use of insecticides or stocking ponds with insectivorous fish, which could impact Hawaiian hoary bats.

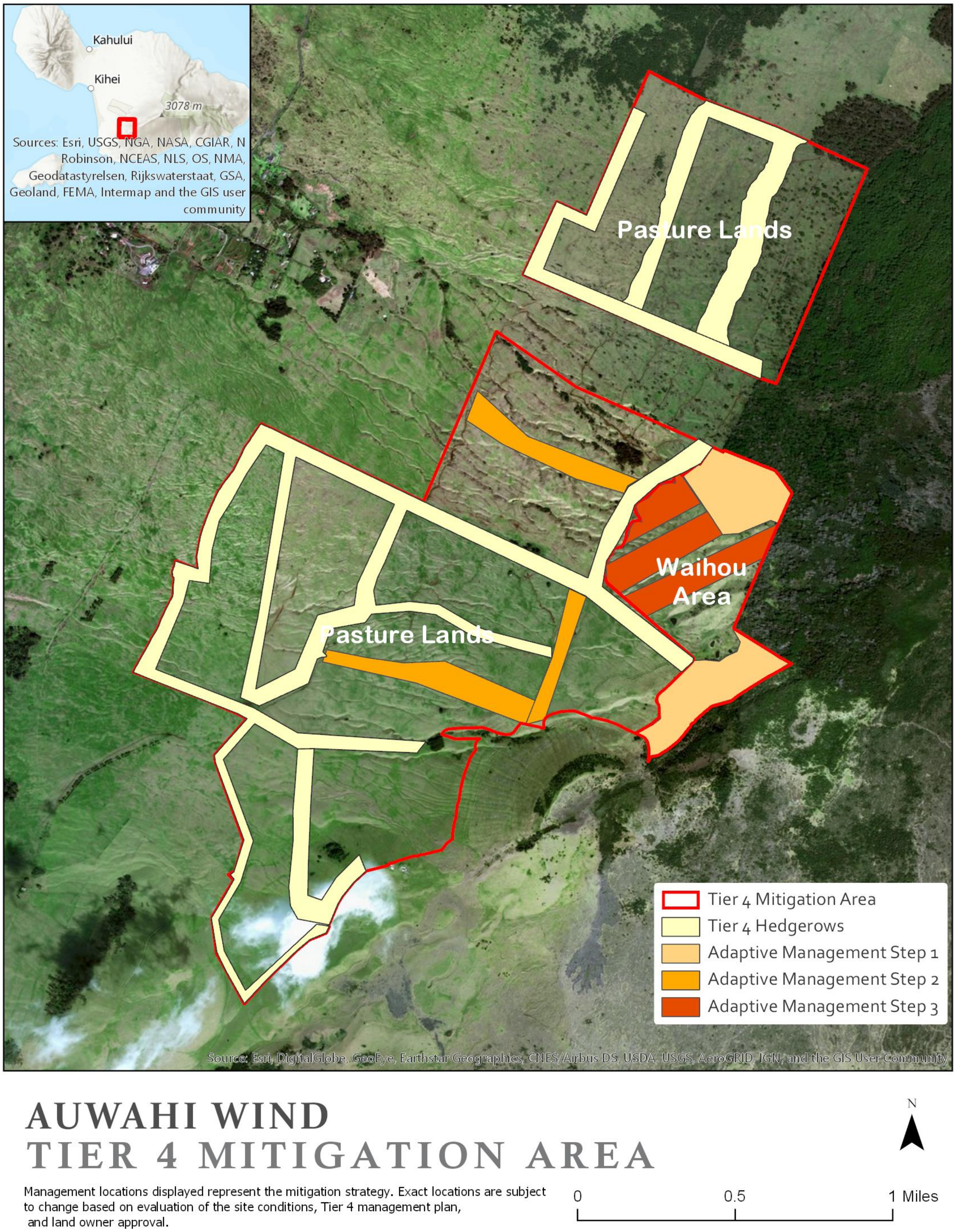
Bat habitat quality, and the use of the Mitigation Area by bats, would likely diminish over time in the absence of the proposed Tier 4 Mitigation. These lands are not managed for bat habitat purposes, and property features (trees, water features) which provide habitat benefits for bats are not required 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.

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 BCI for the management of water features (Taylor and Tuttle 2007), and recommendations from the Joint Nature Conservation Committee that is a statutory advisory committee for the government of the United Kingdom (Entwistle et al. 2001). 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 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 as well as serve as a foraging and roosting substrate (Entwistle et al. 2001, Jantzen 2012). Therefore, Auwahi Wind will reforest the hedgerows within the 1,556 acres of Pasture Lands of 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 6-5), which corresponds to the beginning of the first peak in mainland hoary bat utilization (Jantzen 2012; Figure 3-3).



Source: GIRAS, State of Hawaii Office of Planning 2018

Figure 6-5. 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 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. USGS researchers indicated that the hedgerows, regardless of width, would primarily be used as a foraging substrate and potentially as a night roost[6], 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 (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 2014). Gaps in hedgerows, such as for gates, will be minimized, ideally less than 30 feet and not exceed 650 feet (200 meters) each.

The hedgerows will be planted with fast growing native or non-native (non-invasive) trees and understory species, with a preference for fast-growing native 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). No tree species known to be a threat to native ecosystems will be used, as determined by Hawaii Weed Risk Assessment (Daehler et al. 2004).

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 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 by Peck et al. (2015) in the existing koa stands within the Nakula NAR to look for food species of the kiwikiu (Maui parrotbill; *Pseudonestor xanthophrys*) and Maui 'alauahio (Maui

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

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. 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, pers. comm. 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 and 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). Pöyry et al. (2004) found that moth abundance was associated with an intermediate level of grazing. Similarly, Rainho et al. (2010) found that grazing reduced the vegetation cover to promote conditions where bats could more easily capture prey. 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). These studies together suggest that grazing is a compatible land use with the actions taken to benefit the Hawaiian hoary bat.

The hedgerows are intended to be fenced to prevent ungulates from damaging the out-planted trees. Auwahi Wind will install fencing to surround the reforestation areas where required, and prevent the ingress of ungulates and promote the long-term habitat suitability of the reforested areas.

Water Feature Management

Water Trough Replacement or Retrofit

The availability of water in the Mitigation Area is limited; therefore, retrofitting or replacing cattle water troughs is expected to enhance bat foraging habitat and serve basic physiological requirements. Because CUAs do not overlap (Bonaccorso et al 2015) and behavioral studies have documented antagonistic interactions between individuals (Belwood and Fullard 1984); distributed water resources are expected to benefit more bats than a small number of larger ponds which could result in competition among individuals.

Following recommendations from BCI (Taylor and Tuttle 2007), Auwahi Wind will retrofit or replace 15 existing troughs. These retrofitted troughs will have a minimum surface area of 10 feet by 2.5 feet and an approximate depth of 1 to 2 feet (Taylor and Tuttle 2007). Nearby vegetation and fencing that controls livestock access to the water features will be removed if necessary (or fence lines will be rerouted if appropriate) based on recommendations by Jackrel and Matlack (2010) and Taylor and Tuttle (2007) to ensure that bat flight paths to the water tanks are not obstructed. The long axis of the water troughs will be parallel to the prevailing wind direction to facilitate in-flight drinking. Where possible, the troughs will be placed in the lee of windbreaks to also facilitate drinking. Troughs will also be fitted with wildlife egress points to ensure that any bats or other wildlife which fall into the troughs are able to escape and avoid drowning. The water troughs will be maintained with the water level near the rim (at least 80 percent full) based on recommendations by Jackrel and Matlack (2010), and will be metered using an enclosed float valve (or other appropriate mechanism) that would not present a collision hazard to bats.

The replacement or retrofit of troughs will increase the number of available water sources within the Mitigation Area, by converting a few seasonally active water troughs to a minimum of 15 troughs filled year-round. This increases the period of time with distributed, available water sources by up to 83 percent over the existing conditions. The alterations described would be expected to increase the number of bats using the water troughs and decrease the risk of drowning or injury to Hawaiian hoary bats using these water troughs.

Pond Installation

In addition to the water trough modification, Auwahi Wind will install two new larger ponds. The ponds will have an approximate minimum size of 20 feet in diameter 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 in addition to the water trough modifications. The pond design would incorporate varying water depth to facilitate insect species associated with shallows that serve as prey for bats (Figure 6-6).

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 Hawaii, 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 Hawaii 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. A proposed design is outlined in Figure 6-6 (subject to modification based on additional input from stakeholders). The proposed design would allow for maximum utilization of the pond to fight fires, potentially allowing for sufficient water for one helicopter to utilize for 22 hours (estimating 100 gallons per dip and one dip every 3 minutes). The pond would be replenished over time from available water sources.

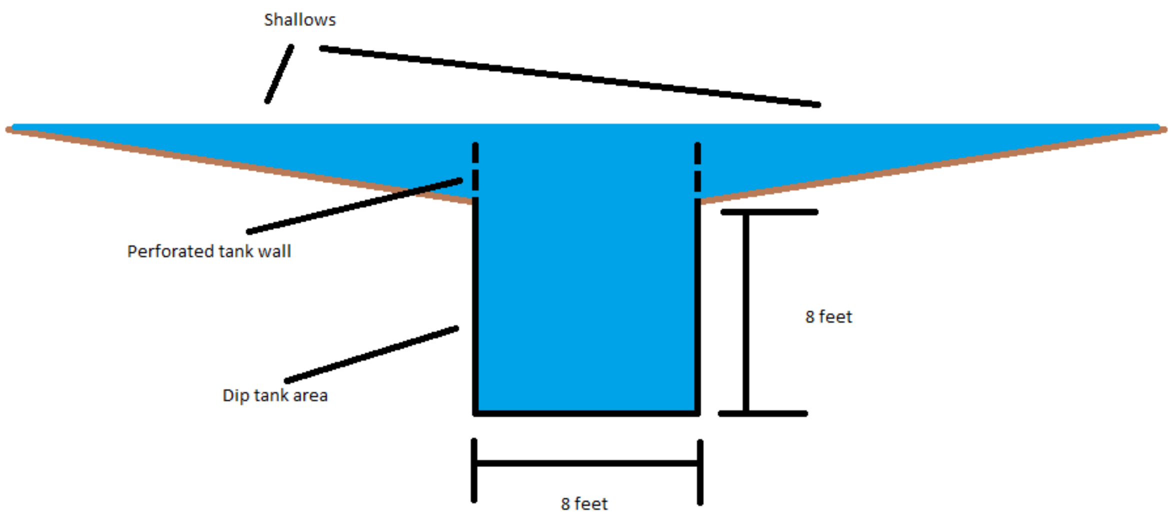


Figure 6-6. Generalized Pond Design to Allow for Both Shallows and Dip Tank

Legal Protection

A permanent conservation easement over the Mitigation Area will be conveyed 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 and troughs according to this mitigation plan;
- Maintaining water in all troughs and ponds year around;
- 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 maintenance of troughs and ponds full of water 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 proposed Tier 4 Mitigation protects, manages and improves the suitability of the Mitigation Area lands for the Hawaiian hoary bat. In addition to providing permanent legal protection to 1,752 acres adjacent to existing preserved bat habitat, the prescriptive management actions will enhance foraging and roosting habitat. As currently utilized, the 1,752 acres of the Mitigation Area is of only marginal quality as bat habitat, and without a bat-focused management plan, its suitability for bats will likely decrease over time. The combination of location, permanent legal protection, management, and enhancement will fully offset the take of 60 Hawaiian hoary bats and provide a net benefit to the species.

Because little is known about the limiting factors for the bat, USFWS and DOFAW consider protecting or enhancing habitat within the CUA of a bat as a benefit to the species. As described above, the management actions in the proposed Tier 4 Mitigation improve the existing bat habitat sufficient to offset the take of 77.9 bats (1,752 acres ÷ median CUA of 22.5 acres per bat = 77.9 bats). The acreage of the parcel was selected to account for 11 bats documented to currently utilize the area and the existing edge habitat provided by the parcel (approximately 60 acres). The existing benefit to bats will be significantly increased as a result of the increased connectivity provided by virtue of the Mitigation Area's location; the habitat enhancements of new hedgerows, restored and new water features, and the new year-round availability of water. Additionally, the fire prevention benefits which the new water ponds will provide will extend well beyond the term of the incidental take authorizations and accrue to multiple generations of bats. Cumulatively, these mitigation actions will lead to substantial increases in the use of the Mitigation Area by Hawaiian hoary bats, in foraging and roosting opportunities, and in the population, resulting in an overall significant net benefit to the species.

The uncertainty associated with the actual number of bats benefiting from the Tier 4 Mitigation is associated with the limitations of available monitoring methods (Section 6.2.4.5). To address this uncertainty, Auwahi Wind has built in several factors for which no mitigation credit is requested, which ensure that more bats will benefit from the parcel than are taken by the Project. The acreage of habitat protected by the conservation easement and improved by this mitigation program exceeds the acreage needed to offset 60 bats. The habitat equivalency assessment for the Tier 4 Mitigation has used the more conservative assessment of only 1 outlier to reach a median CUA of 22.5 acres per bat. The conservation easement is recorded in perpetuity, outlasting the permit term, and imposing additional servitudes on the Mitigation Area. This conservation easement on the land provides a mandate for year-round water availability for bats, at multiple additional locations, in perpetuity. The conservation easement will protect the out-planted koa (or other native tree species) which will likely last more than 50 years (assuming no regeneration) and thus will continue to provide new habitat benefits for 5 or more generations of bats.

Should the benefit of these features be realized by five generations, 300 or more bats could benefit from the mitigation actions. Auwahi Wind is providing ponds to be used as dip tanks to prevent fires within and adjacent to the Mitigation Area. Reducing the risk of large habitat-destroying fires, both in the Mitigation Area and on adjacent protected bat habitat, by creating and providing helicopter access to new large water sources will provide a substantial benefit. 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 mitigation includes a detailed monitoring regimen including thermal video for behavioral studies, insect assessment, and an extensive acoustic monitoring protocol which will create a data set that exceeds the information gathered from similar research projects and can provide valuable insight into the life history, habitat needs, and responses to management actions. Finally, the management actions provide a novel concept for Hawaii, supported by literature to benefit bats, and a means for integrating the Hawaiian hoary bat into the contemporary landscape. The management actions outlined here provide tools for land managers of the 750,000 acres of pasture lands in Hawaii to greatly expand the benefit to the Hawaiian hoary bat. These mitigation actions ensure that the benefits to the Hawaiian hoary bat exceed the mitigation offset required and provide a net benefit to the Hawaiian hoary bat.

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 feeding buzzes has been recommended by past research (Gorresen et al. 2013, 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 feeding buzzes 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. Photos of existing troughs and modified troughs will be included in the annual report.
- Increase forested habitat to 20 percent forest cover 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 (i.e., average feeding buzzes) over the baseline monitoring year(s), see Monitoring below.

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 and limited in focal depth. Thermography has been valuable for specific applications, such as behavior monitoring, but broad scale application has not been used for population studies. 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. 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 HCP Annual Report 2017). To date, no GPS transmitter is sufficiently light (less than 5 percent of body mass, or 0.4 grams) to be used on a Hawaiian hoary bat.

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 determination of population size and population impacts have been difficult to discern. The management actions target increasing foraging habitat; therefore, using acoustic monitoring to monitor feeding buzzes is proposed as the most appropriate tool to assess the impacts of the management.

Feeding Buzzes

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. Feeding buzzes are distinct calls that indicate a bat is using the habitat for foraging. The total number of calls (including calls other than feeding buzzes) will also 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).

Acoustic detectors[7] 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 10 locations will be identified across the landscape. At these 10 locations, up to five additional detectors will be selected annually to collect monitoring data. Baseline monitoring will also be conducted at up to 5 locations outside of the mitigation area (exterior detectors) in appropriate similar habitat. The exact location of detectors will be selected from a grid of 100x100m 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 10 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.
3. Changes in elevation in the area also bring significant differences in habitat conditions.
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 monthly 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)

[7] 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.

- 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)
    - 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[8]
- Notes

Monitoring data prior to the installation of water features will serve as the baseline period for the number of feeding buzzes. 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 1 year.

The number of feeding buzzes will be the primary tool to evaluate the success of management actions. The number of feeding buzzes will be evaluated and compared to the location of water features and hedgerows that have been installed. Two metrics will be evaluated: 1) the feeding buzz abundance (total number of feeding buzzes recorded per active night), and 2) feeding buzz nightly detection (proportion of total active nights with feeding buzzes). A detector will be considered active for the night if the detector was active for more than half of the hours from sunset to sunrise.

$$Feeding\ Buzz\ Abundance = \frac{Total\ feeding\ buzzes}{Total\ active\ nights}$$

$$Feeding\ Buzz\ Nightly\ Detection = \frac{Total\ nights\ with\ feeding\ buzzes}{Total\ active\ nights}$$

An increase in average feeding buzzes is expected in the monitoring year following the year(s) in which water feature modifications (troughs and ponds) are completed. The overall probability of feeding buzzes 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 trough, 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

[8] May be supplemented with Ranch records.

Following the first year of data collection, feeding buzz abundance and feeding buzz detectability 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 feeding buzzes of different magnitudes with different numbers of monitors. 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 feeding buzzes 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 feeding buzzes. The number of sites included can be varied to determine how the power to detect an increase in feeding buzzes changes in response to sample size.

Potential scenarios to evaluate include:

- A 50, 100, or 150 percent increase in feeding buzz 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.

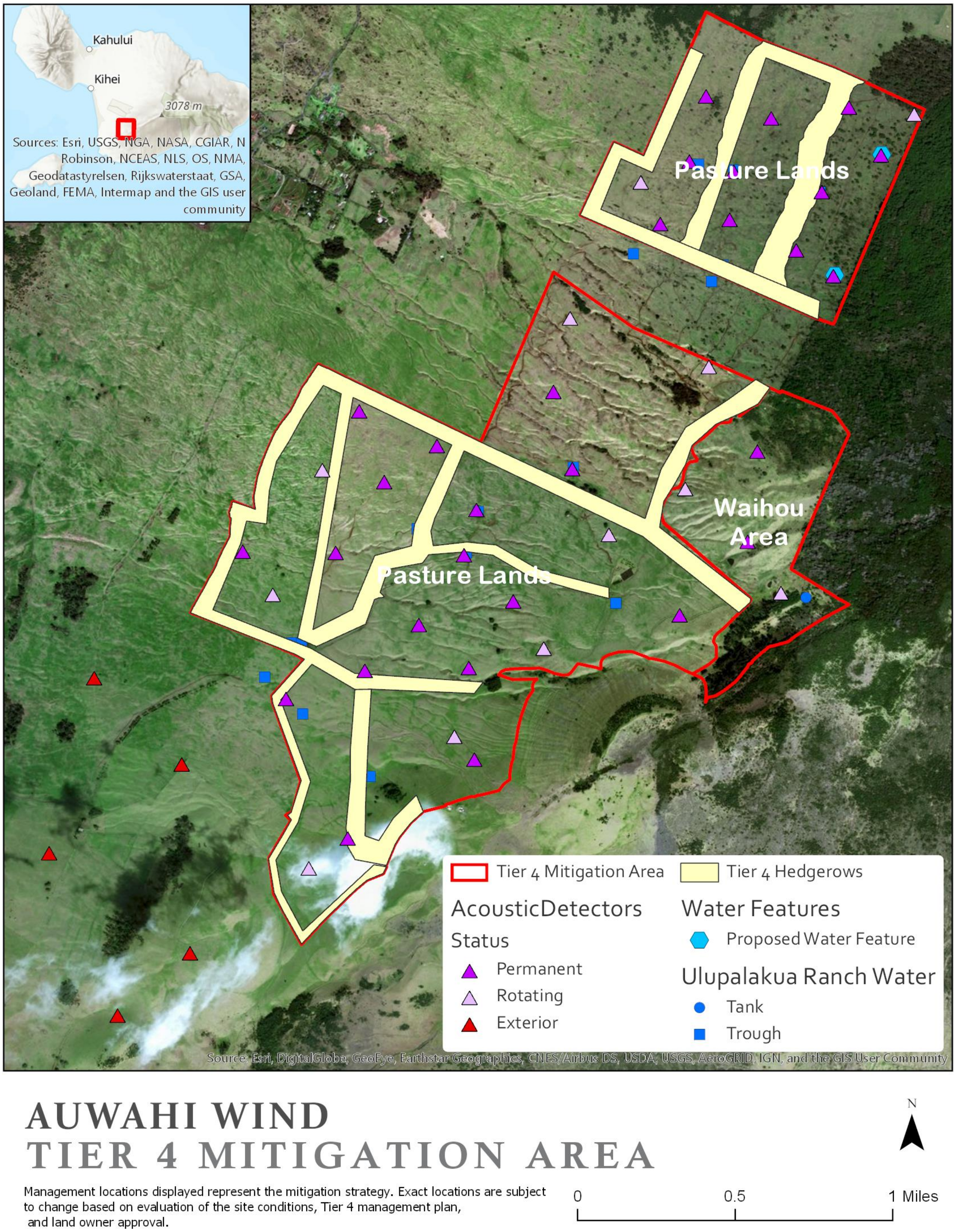


Figure 6-7. Locations of Acoustic Detectors Relative to Management Actions

Data Analysis

The data collected during the acoustic monitoring portion of this study will be summarized as feeding buzz abundance and feeding buzz detectability for each site during each month as described previously. The frequency and spatial distribution of feeding buzz occurrence will not be known until data collection begins and, therefore, data analysis methods may need to be modified if these values differ greatly from expected (e.g., large number of sites with no feeding buzzes recorded or feeding buzzes recorded every night). Feeding buzz abundance is count variable and feeding buzz 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 feeding buzz 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 feeding buzzes 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 77 bat CUAs of 22.5 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 5. 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 3 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 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 1 malaise trap set-up for 1 month at each of the three locations. Following the sampling the insects will be identified to order and the abundance of each order will be reported in the annual report.

Trough Monitoring

The water troughs 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 Adaptive Management

Because of the uncertainty of the limiting factors on the Hawaiian hoary bat population, 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 as specified in Section 7.4. 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 feeding buzz abundance or feeding buzz nightly detection is doubled or greater, relative to baseline monitoring, no adaptive management actions will be necessary.

- Adaptive management will be triggered if both feeding buzz abundance and feeding buzz nightly detection are less than or equal to the baseline.
- Adaptive management may be triggered if either feeding buzz abundance or feeding buzz detectability are less than or equal to the baseline. If either the feeding buzz abundance or feeding buzz 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[9]:

1. Change the species composition or replace trees that have not survived with new canopy species shown to support Hawaiian hoary bat foraging, or;
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. There is uncertainty in the response of Hawaiian hoary bats to management actions. Auwahi has a number of options available for modifying the proposed management actions including:

1. Additional water troughs
2. Additional ponds
3. Additional hedgerows
4. Reforestation at higher densities within the Waihou parcel
5. Alteration of canopy species
6. 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) will be implemented.

The adaptive management action will be determined from the monitoring response of the prior management actions implemented. It is assumed that there is a maximum impact for each of the management actions implemented, but that maximum is not known. To determine if the impacts of

[9] 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.

managing 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.

There will be three opportunities for adaptive management with respect to reforestation—one each in years 5, 7, and 9 (Figure 6-4). 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 6-2 (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 feeding buzz abundance and feeding buzz 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 (Table 6-2; 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	Forest	0%	20%	25% (Step 2)
Waihou	198	Forest	25%	25% (unchanged)	40% (Step 1) and 70% (Step 3)

Water Features

Adaptive management will be evaluated at four intervals: Years 5, 7, 9, and 11. If additional water features are determined to be necessary through adaptive management, the evaluation of water features will compare the feeding buzz abundance of the added ponds and new water troughs. If either ponds or troughs has a significantly greater benefit, the feature with the greater benefit will be selected for additional installations.

- If troughs are selected, two additional troughs will be added.
- If ponds are selected, one additional pond will be added.

The siting of such features will take into consideration the existing water features, the distance to existing water lines, the relative benefit of troughs and ponds and the nearness to roosting habitat.

Alternative Management Actions

If neither reforestation of hedgerows or the addition of water features 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 troughs finds that the troughs are consistently (3 consecutive quarters, or the same quarter for 3 years) not supplied with sufficient water to keep them above 80 percent full, Auwahi Wind will investigate the cause and make attempts to rectify the problem. Such resolutions may include (depending on the source of the problem): water system (line, valve, trough) repair, securing alternative sustainable sources of water, 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.

6.2.4.7 Timeline

There is an immediate need for action to mitigate the impacts of taking Hawaiian hoary bats at Auwahi Wind. There is also a need for baseline monitoring. Auwahi Wind will begin mitigation actions upon issuance of the amended ITP/ITL. Logistical needs for implementation are expected to take approximately 1 year to complete including the retrofit of water troughs, 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 6-3.

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 modifications, 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 • Completion of water trough installation, 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 • Quarterly water trough and pond inspection	• Acoustic monitoring occurring at water troughs and pasture lands
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 trough and 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	• Acoustic monitoring occurring at water troughs, pasture lands, and hedgerows • Evaluation of success criteria.

HCP Amendment Year	Actions	Evaluation
	• Quarterly water trough and pond inspection	
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 water trough and 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 water trough and 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 water trough and 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

The objective of the Tier 5 and Tier 6 Mitigation is to protect and enhance habitat to promote the foraging, roosting, and breeding of the Hawaiian hoary bat. Mitigation projects for Tiers 5 and 6 will be responsive to recovery goals identified in the Hawaiian hoary bat recovery plan (USFWS 1998), and will consider the best available science and current state of knowledge on the Hawaiian hoary bat; any new information will be addressed through adaptive management. Furthermore, any proposed mitigation will be reviewed and approved by USFWS and DOFAW prior to implementation. The Tier 5 and 6 take levels require mitigation for 34 and 25 bats, respectively (Table 6-5), the timing of mitigation is detailed in Section 6.2.6. Based on expectations of the effectiveness of LWSC and the uncertainty about the potential for reoccurrence of a relatively large number of fatality events in one year (such as occurred in 2016), 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 6-5. Triggers for Initiating Hawaiian Hoary Bat Mitigation in Each Tier

Tier[1]	Cumulative Authorized Take Under ITP/ITL (No. of Bats)	Allowed Take in Each Tier (No. of Bats)	Trigger for Initiating Additional Mitigation [2]
Tiers 1 – 3	0 – 21	21	Mitigation completed or initiated for Tiers 1 – 3; planning for Tier 4 Mitigation has been initiated in conjunction with this Amendment.
Tier 4 (New)	22 – 81	60	If the 80 percent upper credible limit of cumulative take (direct + indirect) ≥ 66 bats, initiate finalizing Tier 5 mitigation plan.
Tier 5 (New)	82 – 115	34	If the 80 percent upper credible limit of cumulative take (direct + indirect) ≥ 106 bats, initiate finalizing Tier 6 mitigation plan.
Tier 6 (New)	116 – 140	25	If the 80 percent upper credible limit of cumulative take (direct + indirect) ≥ 133 bats prior to year 2031, initiate consultation with USFWS and DOFAW.

1. Each tier represents the total take requested (i.e., take is not additive among tiers).
2. 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.

Based on the best available science and agency guidance, mitigation for Tiers 5 and 6 will prioritize land-based mitigation, with a focus on restoration and management of lands with bat foraging, roosting, and/or breeding habitat. Land-based mitigation will build on the Tier 4 Mitigation and may include improvements to available foraging habitat, which includes a variety of landscapes that have suitable insect prey or roosting habitat (native and non-invasive trees that have suitable physical characteristics).

Although there are limitations to the knowledge available for the Hawaiian hoary bat, Auwahi Wind will use the best scientific data available. By adopting the "best scientific data available" standard in the ESA, Congress indicated it expected that the USFWS will make decisions based on "available" information. The adaptive management provisions of the HCP (Section 7.4.2.2) provide a mechanism for the USFWS, DOFAW, and Auwahi Wind to adjust the HCP's conservation strategy to incorporate new scientific information as it becomes available.

The following subsections describe the parameters for land-based mitigation should Tier 5 or 6 be triggered and the parameters associated with land restoration/management including biological objectives, prioritization and selection criteria, take offset/net benefit, measures of success and monitoring, and adaptive management (Section 7.4.2.2).

6.2.5.1 Land Restoration/Management

Components of a land restoration/management mitigation plan are described below.

Biological Objectives

The biological objective of habitat restoration or land management mitigation is to restore habitat that is considered of low value for the Hawaiian hoary bat to a condition that would promote survival of the species, or to prevent the degradation of habitat that would otherwise decline to the point that it would no longer provide bat habitat. This objective is in line with the overarching biological goals of the approved HCP (2011) and the HCP Amendment (see Section 4.0), as well as the bat recovery plan (USFWS 1998).

Prioritization and Selection Criteria

The following discusses Auwahi Wind's priorities when evaluating land-based mitigation actions for Tier 5 and Tier 6 mitigation. Auwahi Wind will prioritize building upon the mitigation measures implemented as part of the Tier 4 Mitigation on the Ranch and adjacent parcels, which focus on land protection and land management. The timing when the mitigation is triggered may also impact the selection of management actions, management actions with long lead times would not be preferred late in the permit term as the benefit of these actions may not be realized until after the permit term.

The selection criteria and additional considerations for identifying the mitigation parcel(s) appear below. Criteria are those elements that must apply to the mitigation parcel. Selection considerations are those factors that are evaluated as part of the criteria and help compare the applicability of one parcel with another.

Selection Criteria:

- The land must be capable of being restored to habitat types that are suitable for bat foraging and/or roosting.
- Hawaiian hoary bats are documented to be using (or expected to use) the parcel or adjacent parcels.

Selection Considerations:

The objective of a land restoration/management action will be to manage land to improve its suitability for bat foraging, roosting, or reproduction. Selection considerations for a land restoration or land management mitigation action are as follows:

- Mitigation actions will occur on Maui, the same island where the Project is located;
- Mitigation projects will avoid close proximity to the Project;
- Restoration efforts will focus on restoring native habitats to provide net environmental benefits;
- Habitat improvement for bats will be measured over an established baseline condition and result in an increase of bat habitat or habitat quality;

- Land management or population monitoring projects will also serve as research projects to document whether the management results in an increase in bat activity/occupancy; and
- Restoration/management actions within parcels that are protected by a previous tier of mitigation or another project's mitigation will be in addition to that mitigation action/plan so that the mitigation actions and offset provided can be recognized as distinct.

Auwahi Wind will need to identify appropriate parcel(s) for such mitigation. Land will be preferred if it has existing protection through a conservation easement or other instrument, but the habitat suitability for the Hawaiian hoary bat is lacking in one or more essential components such as those outlined in Section 3.8.1 and Section 6.2.4. The restoration mitigation work will be additive, and will be distinct from existing work that is planned to occur under the approved HCP or Tier 4 Mitigation. The site-specific implementation plan that will be submitted to the agencies will include information on how Auwahi Wind will address the deficiencies of the parcel(s) and increase its suitability for bats, thus increasing the parcel's carrying capacity for the Hawaiian hoary bat to provide a net benefit for the species and fully offset the take for the tier.

Examples of restoration/management activities include:

- Actions to promote the regeneration of forest for foraging or roosting :
    - Fencing to exclude ungulates;
    - Removal of ungulates;
    - Removal of invasive species that are detrimental for bat foraging or roosting habitat;
    - Planting of native or non-invasive trees; and
    - Increasing host species for insect prey;
- Actions to improve habitat suitability for the basic physiology and breeding:
    - Installation or improvement of water features,
- Other actions as deemed appropriate for the land based on past land uses or site characteristics.

Take Offset/Net Benefit

Auwahi Wind will minimize and avoid impacts to the Hawaiian hoary bat to the maximum extent practicable and provide mitigation to fully offset take. Should Tier 5 or Tier 6 be reached, Auwahi Wind will provide a net benefit by implementing a land-based 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 foundation for the mitigation is based on the life-span of the Hawaiian hoary bat and a median CUA size of 20.3 acres (DOFAW 2015). The selection criteria and considerations ensure that the parcel selected would be suitable for bats.

The restoration/management of 20.3 to 40 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). The acreage may be adjusted based on the suitability of the habitat and life cycle of the bat. For Tier 5 a minimum of 690.2 acres, and for Tier 6 a minimum of 487.2 acres will be restored. If habitat is improved for the benefit of bats as determined through monitoring, the habitat will be considered to offset bat take. The offset credit assumes that the lifespan of the bat will be considered in the benefit from this CUA over the life of the mitigation project and the habitat value of any enhancements. The essential habitat needs of the bat are considered to include foraging substrate, water, roost trees with sufficient canopy cover, and/or pupping habitat. Bats can travel over 7 miles per night (Bonaccorso et al. 2015), have foraging ranges much larger than a CUA, and use individual roost trees even in residential or urban habitats (Kawailoa Wind Power 2014),. Therefore, providing for the essential needs of the Hawaiian hoary bat within each CUA would be sufficient to ensure a net benefit for the species. The benefit assessed for the restoration actions will be calculated as the difference from the baseline conditions to the modified conditions after management actions have occurred. For example, if water features are added to a parcel where none were present previously, it would be assumed that the density of bats would increase up to seven-fold as documented from Ukoa Pond or other nearby ponds. Thus, the land restoration/management plan will offset the Tier 5 take of 34 bats and Tier 6 take of 25 bats, should these tiers be reached.

Measures of Success and Monitoring

The Tiers 5 and 6 mitigation will expand the Tier 4 Mitigation to encompass additional lands; the success criteria will match the criteria outlined in Tier 4. The success of the mitigation efforts for Tiers 5 and 6 will be determined generally as follows (specific measures of success will be identified in each tier's mitigation plan):

The Hawaiian hoary bat will be monitored to evaluate the effectiveness of the mitigation and whether the objectives of the mitigation are met. The success of land restoration and management actions are dependent on the land selected for mitigation; the management actions selected for mitigation; the intensity, frequency, and scale of the actions; as well as adaptive management responses. Therefore, the success criteria for a management action must be built into the plan at the time it is developed. In developing success criteria for land management actions, Auwahi Wind will create management actions that are specific, measurable, achievable, relevant, and time-bound. If land restoration/management is conducted for mitigation, it will include the following provisions as success criteria in addition to specific measurements developed at the time the mitigation plan is developed:

- The restoration/management occurs in an area protected by a conservation easement or other similar type measure;
- A USFWS and DOFAW-approved site-specific implementation plan is developed and implemented;
- A mitigation monitoring program is established and implemented for the duration of the mitigation project to evaluate the progress of achieving the success criteria; and

- Acoustic or other monitoring types for bat activity is successfully implemented at the mitigation site, or monitoring of other surrogate measures is successfully implemented. The data are analyzed and reported, and the results show that the success criteria (as identified in the mitigation plan) have been achieved. Surrogate measures of success could include measures such as the verification of ungulate removal or fence installation, verification of the percent cover of invasive plant species or forested area, or verification of installation of water features.

Monitoring is important to demonstrating success. As previously described, current technology does not provide for measuring the number of bats, so surrogate measures of success such as those identified above are appropriate. Should new information or technology become available to better monitor bats, measures of success may be revised through adaptive management.

Adaptive Management

The mitigation actions for Tiers 5 and 6 will be adaptively managed, if needed, at the time the mitigation tier is triggered to incorporate the best available science, new technological advances, and agency guidance. Additional adaptive management considerations are identified in Section 7.4. This approach will allow Auwahi Wind to leverage the results from Hawaiian hoary bat research projects currently underway or that are being initiated in Hawai'i under other HCPs to address existing information gaps based on the ESRC-identified research priorities and are expected to identify new approaches to mitigation that will directly improve the survival and/or productivity of the Hawaiian hoary bat. This may result in refinements to the parcel selection criteria, the way that suitable bat habitat is defined, the mitigation acreage ratio, and management actions deemed appropriate to maximize the benefit to bats. Additional adaptive management provisions are provided below.

Adaptive management for land restoration/management must consider several elements, including parcel selection, restoration/management actions and monitoring, monitoring protocols, and other mitigation options as described below.

- New information may influence the selection considerations for parcel selection, as well as the management actions selected to improve the suitability of the habitat for bats.
- Should the selected parcel for restoration/management action in the vicinity of the Tier 4 Mitigation not be available or determined in coordination with USFWS and DOFAW to not be the best site, an alternative site or another mitigation option will be identified.
- 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.
    - If restoration/land-management efforts fail to meet the success criteria set forth above, adaptive management will be implemented to take corrective actions, based on recommendations from USFWS and DOFAW and the best available science and technological advances at that time.

- Monitoring to assess success criteria
    - New methods for monitoring or assessment of monitoring data may become available that improve the ability to determine the impact of management actions. These new methods may be incorporated or replace existing tools for monitoring and will be built into the plan at the time it is developed.
    - Interim success criteria will be developed to ensure that the long-term success criteria are met; and
    - If the interim or long-term success criteria for the mitigation are not met, the mitigation will be evaluated to identify additional actions that are necessary to achieve interim and overall success criteria. Any new information derived from ongoing Hawaiian hoary bat research projects will be considered if deemed appropriate when implementing associated management recommendations. Restoration efforts and success criteria may require revision to ensure the mitigation objectives are obtained.
- At the time Tier 5 or 6 is triggered, if the best available science at that time or technological advances identify that monitoring of bats or surrogate measures be modified to better assess the benefit to bats, Auwahi Wind will coordinate with USFWS and DOFAW on alternative actions.

6.2.5.2 Adaptive Management – Other Mitigation Options

Additional adaptive management options could also apply to land-based restoration/management as described below.

- *Land Protection*: Land and suitable habitat shown to support Hawaiian hoary bats may be threatened with imminent degradation, such as development, or deforestation. This threat would decrease the suitability of the lands to support the current population of Hawaiian hoary bats. Preservation of these lands would prevent the anticipated degradation and thereby increase the population over a potential future scenario. Should land protection be selected for future tiers of mitigation Auwahi Wind will work with USFWS and DOFAW to develop a site-specific mitigation implementation plan 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 USFWS and DOFAW to identify the most appropriate mitigation measures. As identified above, the on-going research may indicate that other mitigation measures may be more effective in off-setting bat take than the land-based option and this could include future research. Although 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 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 (Table 6-5; 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. Table 6-5 provide 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 unaltered 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 6-5, 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 6.5, within 5 months of reaching the tier trigger.
5. USFWS and DOFAW will review, revise if needed, and approve the mitigation plan within 3 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.

6. If the mitigation plan is approved 3 months before the subsequent tier has been reached, Auwahi Wind may begin implementation of mitigation actions immediately, but not later than 1 month before the tier is reached as estimated by EoA.[10]

A description of each mitigation tier and the timing of triggering is provided in Table 6-5.

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. A contingency fund is being established that is 5 percent of the total mitigation cost for Tier 4. An additional $10,000 per year will be set aside for DLNR administration of the ITL associated with the mitigation. The total funding assurance for Tier 4 will be $3.7 million. Funding assurances to support the mitigation measures will be in the form of a bond, 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 6.2.5. A detailed estimate of funding

[10] 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.

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

This section requires no edits for the HCP Amendment.

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

To ensure that the minimization measures are effective, Auwahi Wind has developed an adaptive management strategy. The effectiveness of the minimization measures in achieving reductions in bat take will be quantified using the Baseline Fatality Rate as estimated in EoA (Dalthorp et al. 2017) using the Project post-construction mortality monitoring data. The Baseline Fatality Rate is the average annual fatality rate calculated using all prior years of post-construction mortality monitoring data in EoA. Given the Project's observed take stochasticity over time, the Baseline Fatality Rate will provide a better measure of the effectiveness of minimization measures than a calculation of take independent of time.

In response to the higher than anticipated take of bats, Auwahi Wind implemented voluntary adaptive management measures to reduce the risk of bat take as described in Section 4.2.7, and incorporated canine searching into the downed wildlife monitoring protocol (January 2018) to increase the detection of downed wildlife. As described in Section 4.2.7, the 2018 baseline 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 from 30 minutes before sunset to 30 minutes after sunrise for the months of August to October.

7.4.1.1 Monitoring

Monitoring is an important element of the adaptive management program for evaluating the minimization measures as well as the mitigation program. The purpose of the monitoring is to 1) evaluate the efficacy of the minimization measures, 2) evaluate the progress of the mitigation success criteria, and 3) determine the need to implement adaptive management actions to ensure minimization and mitigation goals and objectives are being met.

7.4.1.2 Risk Analysis

Auwahi Wind is using 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 (dawn to dusk). Auwahi will implement a baseline minimization strategy consisting of 728 continuous curtailment nights (8 turbines curtailed to 6.9 m/s from August through September). The application of curtailment nights using adaptive management allows for specificity in curtailment implementation, while maintaining flexibility to implement the curtailment in the highest risk periods. Alternative methods for applying curtailment exist; for example:

- Two turbines curtailed for half of the night would equal 1 curtailment night.
- One turbine curtailed for the entire night, with a cut-in speed of 6.9 year-round, would equal 365 curtailment nights.
- Four turbines curtailed for the entire night with a cut-in speed of 6.9 m/s for 6 months, would equal approximately 720 curtailment nights.

Furthermore, Auwahi Wind will conduct acoustic and thermal imagery studies in 2018 using two technologies to determine bat exposure rates and identify factors correlated with risk to bats that are associated with the Project. The study will look at general trends in timing of bat observations, patterns of behavior, and other factors that may allow Auwahi to optimize minimization measures or turbine operations that could reduce the risk to bats. The studies are described below:

1) Four turbine nacelles will be instrumented with acoustic monitoring devices for 12 months (July 2018 – June 2019). Simultaneously, meteorological data will be collected at these turbine nacelles.
2) A thermal video system will be installed with support from USGS. This system will be operational in combination with the acoustic monitoring devices for 3 months (August – October 2018).
3) Data will be analyzed 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) investigate the behaviors bats are exhibiting while interacting with the turbine; and 3) determine the range and upper thresholds of wind speeds at which bats are observed.

The results of these Project studies, as well as from other research being conducted specific to Hawaiian hoary bats, will be used to determine the periods of higher risk. The results of the risk analysis will be used to inform the implementation of adaptive management measures associated with Auwahi Wind's LWSC program and the application of curtailment nights, if appropriate. This information is important to correlate, if possible, bat behavior and activity around turbines and shed light on how to minimize bat impacts. It is expected that the results of these studies will provide data to support modifying the application of curtailment nights in one or more of the following ways:

- Distribution of curtailment nights to turbines or groups of turbines with higher risk;
- Hours of the night associated with higher risk;
- Further refinement of the seasonality of risk; and
- Environmental conditions that are indicators for risk.

Other information may also be gained through these, or other ongoing studies that allows refinement in the application of curtailment nights to reduce the risk to bats. The results of these studies may also be used to inform the potential future use of other viable technologies as they become commercially available to optimize minimizing risk to bats.

7.4.1.3 Implementation

Several terms are introduced in this section and are defined for clarity as follows:

- **Baseline Fatality Rate** – EoA will use prior years of data in the multiple years module to calculate the current average annual direct fatality rate referred to as the Baseline Fatality Rate. This fatality rate takes into account all prior years (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.

- **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 (129 direct take estimated by EoA / 20 years of operation). The Threshold Value for the amendment is based on a reduction in take rate from the current levels by 30 percent for years 2018-2032 and represents a take rate that would meet the Tier 6 maximum take at the end of the permit term. Therefore, a Baseline Fatality Rate that exceeds the Threshold Value triggers a need for additional minimization measures.

- **Reversion Trigger** – The EoA reversion trigger module will be used to determine if the Baseline Fatality Rate falls below 60 percent of the Threshold Value (at the 80 percent credible level). If reversion is indicated, it is a signal that relaxation of the operational minimization measures may be warranted. The Reversion Trigger is the signal that would allow for testing different LWSC cut-in speeds below 6.9 to see if a lower cut-in speed would have an equivalent benefit or insignificant difference, as is suggested by the LWSC analysis summarized in Figure 4-1.

The adaptive management framework consists of:

1) Regular comparison of the Baseline Fatality Rate to the threshold value based on monitoring data in years 2020, 2025, and 2030, to determine if adaptive management provisions are triggered. 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.

2) Responsive actions in the event the Baseline Fatality Rate is below, greatly below, or above the specified Threshold Value. Table 7-1 provides details for actions to be taken given each potential future scenario.

This framework will ensure the Project remains in compliance with its ITP/ITL in the event that the actual take differs from what is predicted in the HCP Amendment. The timing of evaluation will provide sufficient data to evaluate the effect of the minimization measures. If an evaluation is scheduled, the evaluation will occur between January 1 and January 31, and include data through December 31 of the preceding year, in conjunction with the semi-annual reporting (evaluation milestone). The end of the calendar year is concurrent with the complete year of take estimation used by Auwahi Wind. The evaluation of the results will be completed within 1 month of the evaluation milestone, between February 1 and February 28. If revised minimization measures are required, they will be implemented as soon as possible, and within 1 month of the evaluation, before March 31.

The expected future scenarios are:

- Should the Baseline Fatality Rate exceed the Threshold Value at a given evaluation milestone, adjustments to the LWSC program or additional risk minimization measures will be implemented. Potential measures will be evaluated based on the best available science and site-specific data including the results of the 2018-2019 risk analysis studies described above. If the Threshold Value was exceeded at a previous milestone, the newly-triggered actions may include the use of new technology that may not have been previously available. 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 fall below the Threshold Value, no action will be necessary.
- Should the Baseline Fatality Rate fall significantly below the Threshold Value, changes to the LWSC program or other ongoing risk minimization measures may be implemented at Auwahi Wind's discretion per the Reversion Trigger, and after verification with USFWS and DOFAW that the project is in compliance,. In this scenario, evaluation of the Baseline Fatality Rate will occur again 2 years following changes to risk minimization measures to assess effectiveness. The first evaluation of possible reversion trigger would be in year 13 (2025).

Any change to minimization measures as the result of a response will be assessed for its effect on the subsequent 2 year's Baseline Fatality Rate using post-construction mortality monitoring data. After 2 years, the Baseline Fatality Rate will be compared to the threshold value to determine if adaptive management is triggered. Should the Baseline Fatality Rate exceed the Threshold Value at that time adaptive management actions will be taken and the program will be re-evaluated again at each 2-year interval until the Baseline Fatality Rate is equal to or less than the Threshold Value. Should adaptive management trigger an alteration to minimization less than 2 years from a scheduled trigger, as outlined in Table 7-1, the next evaluation will occur 2 years after the alteration instead of at the scheduled evaluation. Auwahi Wind has adopted this assessment approach given that observed fatalities are relatively rare events, and there may be insufficient statistical power to detect the effect of an action after a single year of implementation. Responses may include modifications to the LWSC program and other actions based on the best available science. Auwahi Wind will evaluate the data available from post-construction mortality monitoring as well as bat activity monitoring, if available, to determine the most appropriate application of alterations to curtailment, if determined to be the best response. Factors considered in the analysis will include:

- The spatial distribution of fatalities at the wind farm. For example, the distribution of observed bat fatalities at the Project is not evenly distributed, with turbines 1-4 accounting for a combined 78 percent of observed fatalities after correcting for variation in searchable area during the first 5 years of Project operations.
- The timing of fatalities in terms of season and/or months of the year.
- The available data provided from bat activity monitoring (2018 thermal and acoustic study) to impact time of night of implementing curtailment or other appropriate operational changes.
- The availability of new technologies that may further reduce risk to bats.
- Other available literature or data which may become available.

Given the current information and assuming no changes to known minimization strategies, the Project will prioritize temporal and spatial adjustments of the curtailment nights if the Baseline Fatality Rate exceeds the Threshold Value. As defined above, a curtailment night is the equivalent of one turbine curtailed to the highest LWSC cut-in speed (6.9 m/s) for one night (dawn to dusk or similar). Auwahi Wind will implement 728 Curtailment Nights (8 turbines * 91 days=728 turbine curtailment nights) for the baseline LWSC regime. There is currently a higher proportional risk of fatalities at turbines 1-4. Should the spatial distribution of fatalities continue to indicate a higher risk at turbines 1-4, those turbines may be selected for additional curtailment nights while reducing turbine curtailment nights at the remaining turbines. Some general Hawaiian hoary bat surveys have shown that activity was higher in the hour or hours after sunset or preceding sunrise (Menard 2001). Should the acoustic and thermal monitoring in Section 7.4.1.2 confirm this period of risk at Auwahi Wind, Auwahi Wind will be able to target curtailment to hours when risk is increased, thereby potentially allotting curtailment nights to dates outside of the August to October timeframe. In addition to these patterns, other studies may indicate patterns of risk that are targeted to redistribute curtailment nights. These alterations allow Auwahi to shift curtailment from times of low risk to periods of higher risk. Should redistribution of curtailment nights not provide the necessary effectiveness, alternative adaptive management measures will be pursued. Alternative adaptive management measures are discussed below in Section 7.4.1.4. Auwahi Wind may also implement additional minimization measures, beyond those outlined in this section in consultation with the USFWS and DLNR.

Table 7-1. Adaptive Management Framework

Evaluation Milestone	Potential Outcomes and Associated Responses		
	Baseline Fatality Rate Less Than or Equal to the Threshold Value	Baseline Fatality Rate Significantly Less Than the Threshold Value (Reversion Trigger)	Baseline Fatality Rate Greater Than the Threshold Value
Year 8 of the Permit Term, Year 2 of the HCP Amendment 2020	**Response:** • No action needed. • Or, based on current best available science or development of viable and commercially available technology, Auwahi Wind can elect to implement other minimization measures that are equal to or greater in effectiveness as LWSC.	**Response:** • No reversion trigger is possible in year 8. • No action taken	**Response** • Implement an incremental adjustment of the current LWSC program. This could include o adjust dates of curtailment nights or, o adjust time of night of curtailment o redistribute curtailment nights based on turbine risk AND/OR • Implement a commercially-ready deterrent system that has been verified to reduce direct take of bats to an equal or greater extent than the LWSC changes noted above. This may include dim ultra-violet light, ultrasonic devices mounted on the nacelle or blades, or other technology. AND/OR Implement smart curtailment[11] or an impact detection technology or other technology shown to contribute to a reduction in risk for bats, or for identifying when fatalities may occur. AND • Reevaluate the effectiveness of the adjustments after two years to determine if minimization measures have resulted in sufficient take reduction

[11] Smart curtailment is real time monitoring of the site for conditions associated with risk, and may include bat calls, radar, or other means of detecting risk to determine when to curtail operations.

Evaluation Milestone	Potential Outcomes and Associated Responses		
	Baseline Fatality Rate Less Than or Equal to the Threshold Value	**Baseline Fatality Rate Significantly Less Than the Threshold Value (Reversion Trigger)**	**Baseline Fatality Rate Greater Than the Threshold Value**

Year 13 of the Permit Term, Year 7 of the HCP Amendment
2025
	Response:
	• No action needed.
	• Or, based on current best available science or development of viable and commercially available technology, Auwahi Wind can elect to implement other minimization measures that are equal to or greater in effectiveness as LWSC.
		Discretionary Response:
		• At Auwahi's discretion, implement an incremental change in the current LWSC program. This could include reducing cut-in speed, or curtailing fewer turbines, nights or hours of the night.
		• At Auwahi's discretion, remove technology previously used to reduce risk for bats.
			Response:
			• Implement an incremental adjustment of the current LWSC program. This could include
			  ○ adjust dates of curtailment nights or,
			  ○ adjust time of night of curtailment
			  ○ redistribute curtailment nights based on turbine risk
			AND/OR
			• Implement a commercially-ready deterrent system that has been verified to reduce direct take of bats. This may include dim ultra-violet light, ultrasonic devices mounted on the nacelle or blades, or some other technology.
			AND/OR
			• Implement smart curtailment or an impact detection technology or other technology shown to contribute to a reduction in risk for bats, or for identifying when fatalities may occur.
			AND
			• Reevaluate the effectiveness of the adjustments after two years to determine if minimization measures have resulted in sufficient take reduction

Evaluation Milestone	Potential Outcomes and Associated Responses		
	Baseline Fatality Rate Less Than or Equal to the Threshold Value	**Baseline Fatality Rate Significantly Less Than the Threshold Value (Reversion Trigger)**	**Baseline Fatality Rate Greater Than the Threshold Value**
Year 18 of the Permit Term 2030, Year 12 of the HCP Amendment	**Response:** • No action needed. • Or, based on current best available science or development of viable and commercially available technology, Auwahi Wind can elect to implement other minimization measures that are equal to or greater in effectiveness as LWSC.	**Discretionary Response:** • At Auwahi's discretion, implement an incremental change in the current LWSC program. This could include reducing cut-in speed, or curtailing fewer turbines, nights or hours of the night. • At Auwahi's discretion, remove technology previously used to reduce risk for bats. • If the reversion trigger was reached at a previous milestone, an additional reduction of risk minimization measures could occur.	**Response:** • Implement an incremental adjustment of the current LWSC program. This could include ○ adjust dates of curtailment nights or, ○ adjust time of night of curtailment ○ redistribute curtailment nights based on turbine risk AND/OR • Implement a commercially-ready deterrent system that has been verified to reduce direct take of bats. This may include dim ultra-violet light, ultrasonic devices mounted on the nacelle or blades, or some other technology. AND/OR • Implement smart curtailment or an impact detection technology or other technology shown to contribute to a reduction in risk for bats, or for identifying when fatalities may occur.

7.4.1.4 Future Technologies

This Amendment anticipates the potential future development of an effective, economical, and commercially-viable bat deterrent. However, such technology is still in the testing phase and although it shows promise for reducing bat take (RNRG 2017, pers. comm.), there are no proven commercially available systems at this time. 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). Such a development could be used independently or in coordination with LWSC to further reduce the risk of Hawaiian hoary bat take. If an effective, economical, and commercially-viable bat deterrent technology becomes available during the Project's permit term, Auwahi Wind will consult with USFWS and DOFAW to determine if implementation of the technology is appropriate. Should the benefit of bat deterrents be equivalent to LWSC or the effect of LWSC effectiveness is insignificant after the implementation of bat deterrents, Auwahi Wind may forgo the use of LWSC for the use of bat deterrents.

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 1 hour before sunset to 1 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 for consideration because ceasing operations at night year-round would trigger a clause in the Power Purchase Agreement (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 5 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.

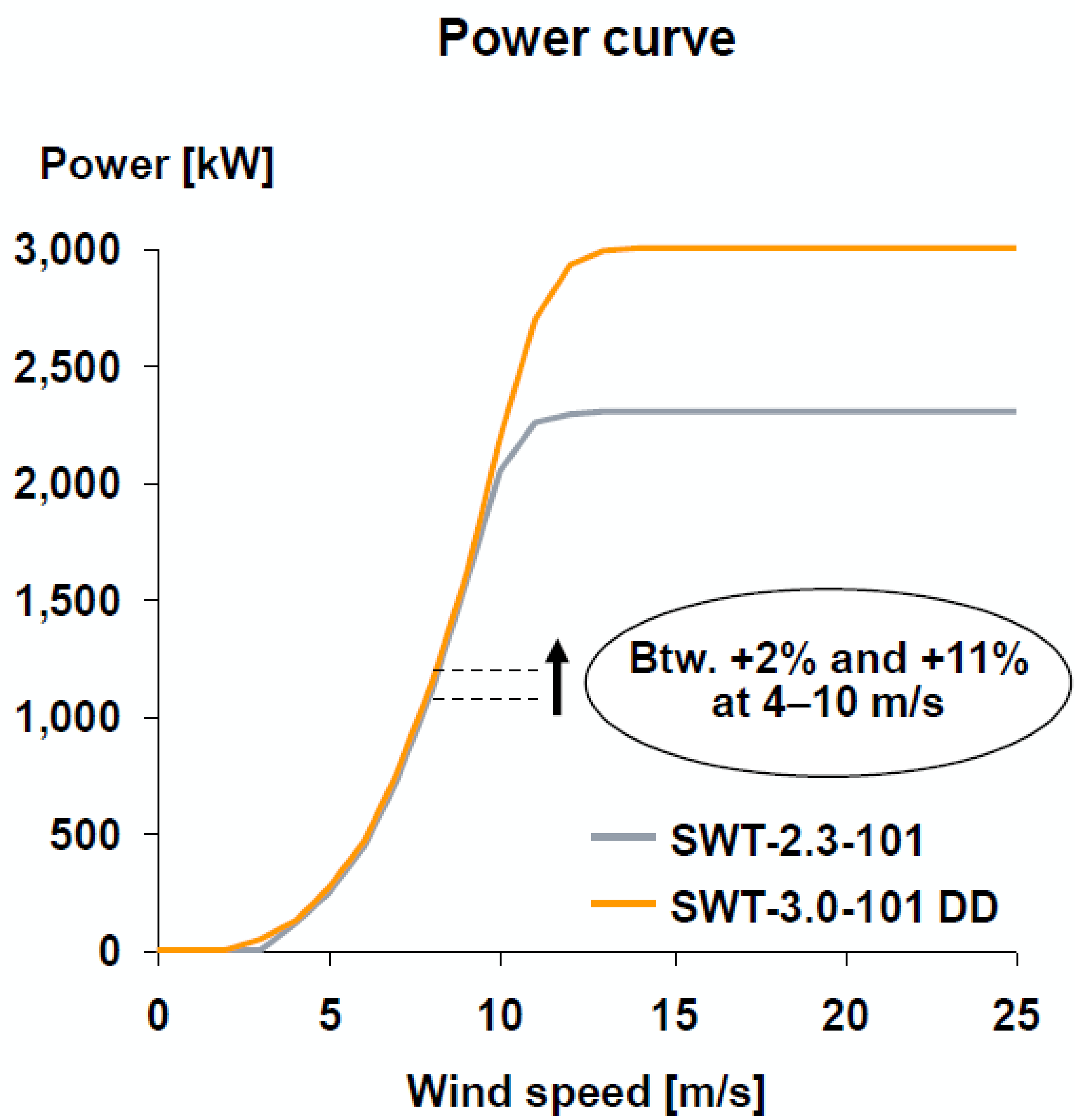


Figure 8-1. Power Curve for a Siemens SWT-2.3 and SWT-3.0 (NREL 2010)

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 10 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 5 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), 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 $3,762,648 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). DLNR compliance costs are estimated at $10,000 annually and will be paid out of Project funds each year. Auwahi Wind will add $10,000 to the LOC to be used by DLNR should annual costs not be paid. This fund is to be renewed annually and adjusted for inflation to cover continuing costs for the remainder of the permit term (total estimated cost $140,000 before adjusting for inflation). 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 6.2.5. A detailed estimate of funding assurances is provided in Appendix I.

The funding assurance amounts for Tiers 5 and 6 would be approximately $1,974,346 and $1,451,724, 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.

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 Hawai‘i DLNR;
- The expiration date will not be less than 1 year from the effective date of the LOC and will contain a provision for automatic renewal for periods of not less than 1 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

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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

AUWAHI WIND FARM PROJECT
POST-CONSTRUCTION MONITORING PLAN

Prepared for

Auwahi Wind Energy, LLC

Prepared by

TETRA TECH

Original: December 2011

Revised for Amendment: August 2018

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ATTACHMENTS

ABBREVIATIONS AND ACRONYMS

xagl	above ground level
Auwahi Wind	Auwahi Wind Energy LLC
xDLNR	Hawaiʻi Department of Land and Natural Resources
xDOFAW	Hawaiʻi Department of Land and Natural Resources/Division of Forestry and Wildlife
xESA	Endangered Species Act
xGPS	global positioning system
xHCP	Habitat Conservation Plan
xHNP	Haleakala National Park
xITL	Incidental Take License
xITP	Incidental Take Permit
KWP	Kaheawa Wind Power
xPCMP	Post-Construction Monitoring Plan
Plan	post-construction mortality monitoring plan
Project	Auwahi Wind Farm Project
TBD	To be determined
xUSFWS	U.S. Fish and Wildlife Service
xWTG	wind turbine generator

ORIGINAL HCP POST CONSTRUCTION MONITORING PLAN

The original Auwahi Wind HCP included a Post-Construction Monitoring Plan (PCMP; Appendix E) that is provided below in Sections 1 through 8. This original PCMP included an initial period of intensive monitoring. Based on the results of the intensive monitoring and with agency approval, the monitoring protocols and search area were adaptively modified as provided for in the PCMP. The Long-term Monitoring Plan prepared for this HCP amendment was developed based on the results of the intensive monitoring period, the best available science, and the other adaptations to improve safety and efficiencies. The Long-term Monitoring Plan that guides the monitoring moving forward associated with this amendment is described in Section 9 through 14 as a supplement to the original PCMP. Auwahi Wind did not revise the original HCP PCMP because it is the plan that guides the Project the HCP amendment is granted.

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND AND PURPOSE OF THE POST-CONSTRUCTION MONITORING PLAN

Species listed under the federal Endangered Species Act (ESA) of 1973, as amended, and the State of Hawaii endangered species statutes, have the potential to occur in the vicinity of the Auwahi Wind Farm Project (Project), including the Hawaiian petrel, nēnē, and Hawaiian hoary bat. Individuals of these species could be killed or injured if they collide with wind turbine generators (WTG), or when bats fly close enough to experience barotrauma. In bats, barotrauma is tissue damage to the lungs caused by rupture of small blood vessels that results from the rapid air-pressure reduction near moving WTG blades (Baerwald et al. 2008).

Due to the potential for incidental take of these species, Auwahi Wind Energy LLC (Auwahi Wind) has consulted with the U.S. Fish and Wildlife Service (USFWS) and the Hawaii Department of Land and Natural Resources (DLNR) to acquire an Incidental Take Permit (ITP) and an Incidental Take License (ITL) issued by these agencies, respectively. These permits issued in accordance with Section 10(a) (1) (B) of the ESA and Section 195 D of the Hawaii Revised Statues, respectively, require the preparation of a Habitat Conservation Plan (HCP).

This Post-Construction Monitoring Plan (PCMP) has been developed as a means to document impacts, or lack thereof, 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. Based on the results of post-construction monitoring, avoidance and minimization measures as outlined in the HCP adaptive management strategy could be modified, or additional measures identified and implemented, as necessary, should Project effects differ substantially from what was anticipated.

Although the PCMP is implemented to document any potential incidental take of threatened or endangered species, impacts to non-listed species will be recorded for informational purposes. Additionally, although survey efforts will focus on documenting mortality through standardized searches, all injuries and mortality associated with the project (e.g., vehicle strikes) will be documented.

1.2 COMPONENTS OF THE PCMP

Wind farm-related fatality estimation is based on the number of carcasses found during carcass searches conducted under operating WTGs. Both the length of time carcasses remain on site before being removed by scavengers (carcass removal rate) and the ability of searchers to locate carcasses (searcher efficiency) can bias the number of carcasses located during standardized searches. Therefore, this PCMP includes 1) methods for conducting standardized carcass searches to monitor potential injuries or fatalities associated with Project operation, 2) carcass removal trials to assess seasonal, site-specific carcass removal rates by scavengers or other means, and 3) searcher efficiency trials to assess observer efficiency in finding carcasses. Vegetation conditions also will be assessed and documented as part of the monitoring protocol when conducting carcass searches and carcass removal and searcher efficiency trials. The proposed field and analytical methods are consistent with post-construction monitoring being conducted, or proposed, for other wind projects in Hawaii and other U.S. locations (Johnson et al. 2000; Kerns and Kerlinger 2004; Fiedler et al. 2007; NWC and West 2007; Tetra Tech 2008; KWP 2006, 2011; Erickson 2009; Arnett et al. 2009a; SWCA 2010; Poulton and Erikson 2010; Strickland et al. 2011), but have been adapted to the specific characteristics of the Project.

The PCMP protocol outlines the surveys and trials to be conducted and provides an adaptive management approach to post-construction monitoring. Methods and timing outlined in this protocol may be modified over time as project-specific information is obtained to maximize the effectiveness and efficiency of the monitoring program (e.g., search interval, the number of WTGs searched, plot size). Additionally, recent advancements in the science of post-construction monitoring have resulted in variations in the standard monitoring protocol based on site-specific conditions at individual wind farms, species of interest, study objectives, and statistical developments in the quantification of bias correction factors and mortality rates (Shoenfeld 2004; Jain et al. 2007, Arnett et al. 2009a; Huso 2010). It can be assumed that post-construction monitoring techniques will continue to be refined over the 25-year life of the ITP and ITL. Therefore, the intent of this protocol is to provide a sound framework that can apply the best available science over the long term. Any recommended changes to the protocol from the baseline provided herein would require review and approval by USFWS and DLNR/Division of Forestry and Wildlife (DOFAW).

1.3 OTHER NECESSARY PERMITS

Prior to initiating surveys, permits required to implement the monitoring program will be obtained, including the USFWS Special Purpose Permit and the DOFAW Protected Wildlife Permit. These permits grant permission and include provisions for handling wildlife and carcasses. They will be required for handling any native wildlife carcasses used in the searcher efficiency and carcass removal trials described below, unless other legal species, such as chickens are used.

2.0 STANDARDIZED CARCASS SEARCHES

The objective of the standardized carcass searches is to systematically search WTG locations for avian and bat casualties that are attributable to collision with Project facilities or barotrauma. Although all fatalities will be recorded, the PCMP focuses on listed species. For purposes of this PCMP, the casualties will be referred to as collision-related fatalities.

2.1 SAMPLING DURATION AND INTENSITY

The PCMP carcass searches to document avian and bat fatalities will begin once all WTGs are constructed and commissioning activities are complete.

Year 1 – Avian species: During the first year of operation, post-construction monitoring for potential avian fatalities focusing on seabirds will consist of systematic searches beneath each of the Project's 8 WTG (Table 2-1). Weekly searches will be conducted from March through June. Surveys will be conducted twice per week from July through November that includes the petrel fledgling period (October to the end of November). This timeframe will encompass movements of the Hawaiian petrel between nesting areas in Haleakala National Park (HNP) and the ocean during pre-nesting, nesting, and fledging (March through November; Simons and Hodges 1998). Monthly surveys will be conducted from December through late February when seabirds are not present on Maui..

Year 1 – Bats: Unless otherwise dictated by the results of carcass removal trials (Section 3.0), bi-weekly (two times per week) searches for potential bat fatalities will be conducted during the potential high activity period of Hawaiian hoary bats (Table 2-1). Hawaiian hoary bats are thought to breed in Hawai'i during April through August, although this has not been verified on Maui. The peak bat activity period at KWP 1 and 2 and the Auwahi Projects is July – November so those periods would have the highest potential for bats to be present in the Project area (Menard 2001, SWCA 2011, Auwahi unpublished data). Therefore, more intensive monitoring is proposed for this period. The purpose of the bi-weekly search interval for bats is to minimize the influence of searcher efficiency. The average carcass persistence time at KWP I is approximately 7 days; therefore, bi-weekly searches should give searchers two opportunities to detect a given carcass. The effect of this approach can be a significant improvement in search efficiency. For example, if searcher efficiency is 60 percent, the probability of missing the same carcass twice is only 14 percent (0.40 * 0.40).

Year 2 – During Year 2 of the PCMP, search frequency from January to March and from October to December will remain unchanged (Table 2-1) unless dictated otherwise by the results of Year 1 bias trials. The frequency of searches during the bat activity period (July-September) will be based on the results of bias trials conducted in Year 1, in coordination with and following approval from the USFWS and DOFAW.

Beyond Year 2 – Some level of monitoring may be required throughout the operational period of the Project; the scope and frequency of this additional monitoring will be determined by the rate of take documented at the Project and will be subject to the approval of USFWS and DOFAW (Section 7.0).

Table 2-1. Search Frequency by Month in Relation to Seasonality of Petrel and Bat Biology

Topic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Petrel Biology	Petrels not present		Petrel breeding periods							Petrel fledging period		Petrels not present
Bat Biology	Low bat use			Bat breeding season			Peak bat activity at KWP II and Auwahi*					Low bat use
Year 1	1X month	1X month	1X week	1X week	1X week	1X week	2X week	2X week	2X week	2X week	2X week	1X month
Year 2	1X month	1X month	1X week	1X week	1X week	1X week	TBD*	TBD	TBD	2X week	2X week	1X month

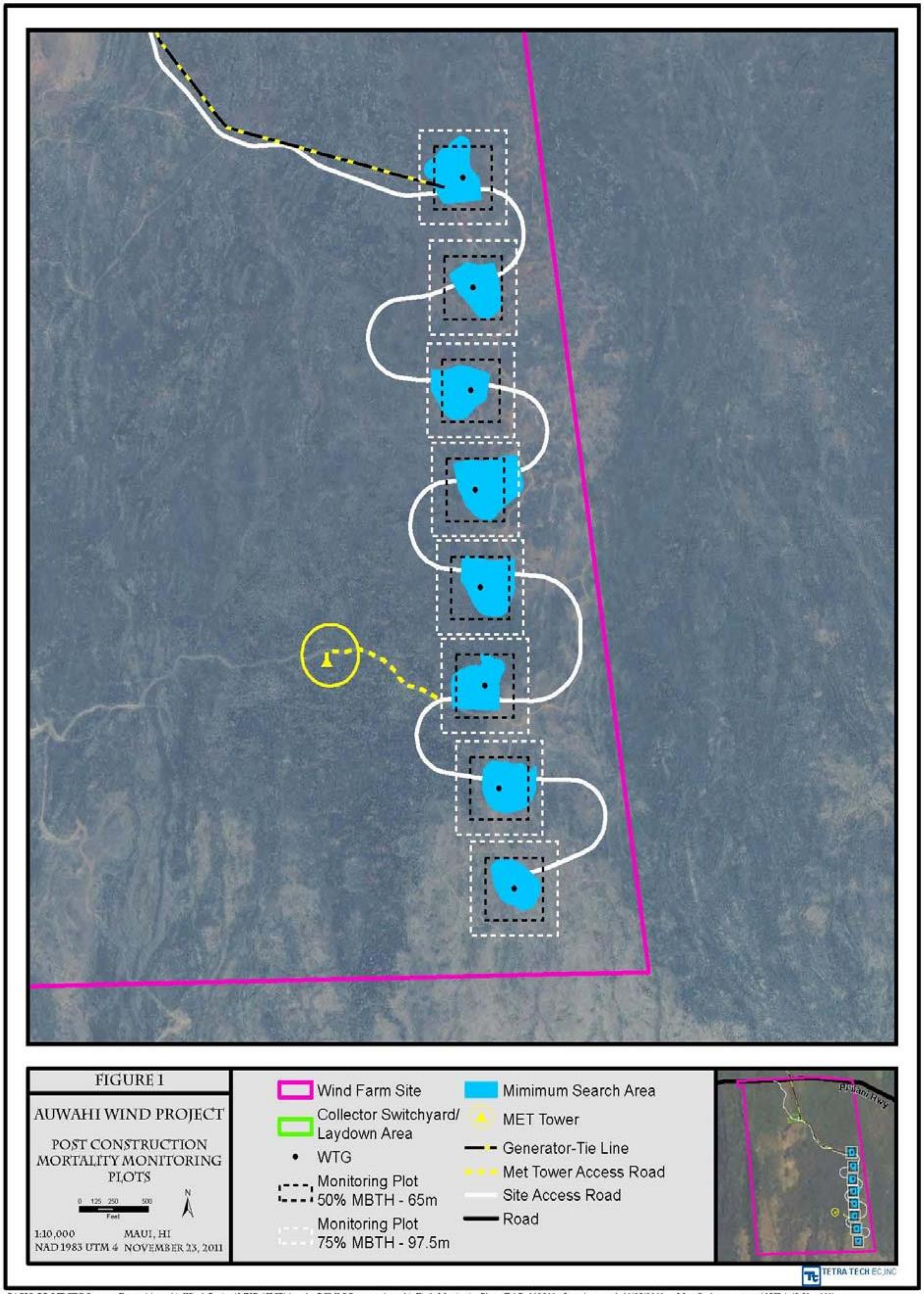
*Year 2 sampling frequency during bat activity period to be determined based on Year 1 data.
TBD – to be determined

2.2 SAMPLING DESIGN

Search Plot Size and Configuration

Based on publicly available results from other post-construction monitoring programs at wind farms in Hawaii and the mainland, the majority of carcasses found during standardized carcass searches around individual WTGs have been found within a distance equal to 50 to 67 percent of WTG height. At the operating Kaheawa I project, 75 percent of carcasses attributed to WTG collisions found to date (including nine carcasses of listed species: three Hawaiian petrel, four nēnē, and two Hawaiian hoary bat) were found within a distance less than 50 percent of the maximum time height of the WTGs where the area searched was 100 percent of WTG height (Hufana, S. pers. com. 2010). At the High Winds Wind Power Project, 96 percent of carcasses were found within two-thirds (67 percent) of WTG height (Kerlinger et al. 2005). Studies conducted at other wind energy facilities indicate that nearly all fatalities are found well within the WTG maximum tip height with over 80 percent of bat carcasses within a distance equal to 50 percent of the maximum distance from the tip height to the ground (Johnson et al. 2003; Young et al. 2003; Erickson et al. 2004; Arnett 2005; Kerns et al. 2005; Jain et al. 2007; Strickland et al. 2011).

The ideal search area for petrel fatalities (i.e., approximately 75 percent of WTG height) would have a radius of 97.5 meter (Figure 1). The WTG has a hub height of approximately 262.5 feet (80 meters) and blade lengths of 165.6 feet (50.5 meters), resulting in a maximum tip height of 428.2 feet (130.5 meters) above ground level (agl). The cleared and maintained turbine pad areas are not uniform among turbines, but are primarily rectangular in shape with sides between 295 and 492 feet (90 and 150 meters) in length (Figure 1). Therefore, portions of each search area not cleared by construction activity remain as rugged terrain. If the full area within the plot is determined not to be searchable based on low searcher efficiency or impassible terrain (depending on existing vegetation), the plot size will be reduced to the searchable area. Search areas will encompass maintained turbine pads and access roads, as well as adjacent unmaintained searchable areas. The actual area searched will be dependent on the configuration of the maintained areas, as well as the portion of the unmaintained area that can be realistically searched as determined during initial surveys (see Search Plot Mapping section below). Prior to conducting the first survey, a sweep survey will be completed within all search plots to clear all pre-existing carcasses from the search area. Ultimately, the monitoring plot sizes may not be consistent across WTGs or uniform in size in order to maximize search area and searcher efficiency. Density-weighted averaging will be used to estimate the number of carcasses that may have fallen in the non-search areas (Strickland et al. 2011; Section 5.0).



P:\GIS_PROJECTS\Sempra_Energy\Auwahi_Wind_Project\MXDs\HCP\Apndx_PCMM\Sempra_Auwahi_Fig1_MonitoringPlots_TabP_112311 - Last Accessed: 11/23/2011 - Map Scale correct at: ANSI A (8.5" x 11")

The ideal search area for bat fatalities (i.e., approximately 50 percent of WTG height) would have a radius of 65 m, and is a subset of the petrel search area. To maximize searcher efficiency, Auwahi Wind proposes to search all cleared areas within this ideal search area. On average, 58 percent of the ideal search area for each WTG consists of cleared area. Density-weighted averaging will be used to estimate the number of carcasses that may have fallen in the non-search areas (Strickland et al. 2011; Section 5.0).

Some of the terrain where WTGs are proposed is rugged and densely vegetated, which may in some instances make locating carcasses very difficult. Much effort would be spent searching these areas with an anticipated low searcher efficiency rate. Vegetation management would not be cost effective for this site; however, once the WTGs are operational and if it is determined that some vegetation can be managed for a reasonable cost, Auwahi Wind will consider this in order to increase the searchable area and searcher efficiency. Therefore, to maximize the potential for locating carcasses and use of resources, areas will be deemed realistically searchable if they consist of terrain that is safe for searchers to traverse and/or have a searcher efficiency rate of at least 70 percent for seabirds. The total search area for each WTG will be measured post-construction.

Transects will be established within search plots approximately 20 feet (6 meters) apart, adjusted as necessary for vegetation type and visibility, and the searcher will walk along each transect searching both sides out to 10 feet (3 meters) for fatalities. Personnel trained in proper search techniques will conduct the carcass searches. Protocol for documenting any fatalities or injuries is provided in Section 2.3.

The likelihood of collisions with a met tower on site is low. However, standardized searches will be conducted at the same search interval under the met tower within a plot extending 33 feet (10 meters) from the base of the guy wires. Transects will be spaced approximately 20 feet (6 meters) apart, but will be adjusted for vegetation type and visibility.

Search Plot Mapping

The Project site is topographically diverse with some proposed WTG locations in areas where safety issues may render portions of search plots unsearchable and vegetation management not feasible. This search area restriction influences the proportion of the actual fatalities that can possibly be detected (Huso 2010). To better estimate this potential influence, a global positioning system (GPS) will be used to map the boundaries of the actual area searched at each WTG. A density-weighted correction factor, based on this percentage of area searched and on the distribution of found carcasses, will be applied to the fatality estimate (e.g., Arnett 2005; Strickland et al. 2011). The proposed mortality estimator accounts for unequal searchable area across searched WTGs (Section 5.0).

Once the plot size is determined, vegetation types outside the maintained WTG pad within search plots will be mapped and classified according to varying levels of visibility (e.g., Arnett et al. 2009a,b). However, as previously discussed, search plot size and visibility may differ between WTGs. Therefore, it may be appropriate to group WTGs according to plot size and visibility and calculate fatality rates accordingly.

2.3 FATALITY DOCUMENTATION

2.3.1 Documentation of Turbine-related Fatalities

All carcasses found during standardized carcass searches will be labeled with a unique number, and searchers will record: species, sex, and age when possible; date and time collected; location (GPS coordinate and distance/direction from the WTG); condition (intact, scavenged, feather spot); and any comments that may indicate cause of death. If a carcass of a listed species is found, searchers will follow the project Downed Wildlife Protocol (Attachment 1) and complete a Downed Wildlife Incident Report (Attachment 3).

The condition of each carcass found will be recorded using the following categories:

Intact/Complete—a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.

Scavenged/Dismembered—an entire carcass or most of a carcass which shows signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that has been heavily infested by insects.

Feather Spot—ten or more feathers at one location indicating predation or scavenging.

All casualties located will be photographed as found and plotted on a detailed map of the study area showing the location of the WTGs and associated facilities such as overhead power lines and met towers. A copy of the field forms for each carcass will be kept with the carcass at all times in a separate bag, if the carcass is removed from the field (examples provided as Attachments 2 and 3).

Carcasses will be double-bagged and frozen for future reference and possible necropsy or as otherwise directed by USFWS or DOFAW. Carcasses of non-listed species will be left in place or kept for searcher efficiency and/or carcass removal trials, or disposed of at an approved location as appropriate.

Searchers may discover carcasses incidental to formal carcass searches (e.g., while driving within the Project site). For each incidentally discovered carcass, the searcher will identify, photograph, and record data for the carcass as would be done for carcasses found during formal scheduled searches, but will code these carcasses as incidental discoveries.

Any injured native birds or bats found on the Project site will be carefully captured by a trained project biologist or technician and transported to a local USFWS- and DOFAW-approved wildlife rehabilitator (e.g., Maui Animal Rescue and Sanctuary located approximately 30 miles [48 kilometers] from the Project). Auwahi Wind staff conducting the surveys will be trained on how to handle any downed wildlife or carcasses found anywhere within the project area. Furthermore, a Downed Wildlife Incident Report (Attachment 3) will be completed for any injured animal or fatality.

2.3.2 Reporting Procedures

If a carcass of a listed species is found, searchers will follow the project Downed Wildlife Protocol (Attachment 1). This protocol includes agency contact information for reporting project-related incidental takes and from standardized surveys. Searchers will either provide the carcasses to the appropriate entity or store the carcass in the freezer for possible necropsy or take other action as directed by the USFWS and DOFAW. During the first 2 years of monitoring, all carcasses found attributed to incidental or during standardized surveys will be reported to USFWS and DOFAW.

3.0 CARCASS REMOVAL TRIALS

Carcass removal is the disappearance of a carcass from the search area due to scavenging, predation, or other means (e.g., wind, rain, decomposition beyond recognition). As previously discussed, the intensity of fatality searches should be conducted at a frequency that minimizes the amount of extrapolation that would be required in estimating mortality. Seasonal differences in carcass removal rates (e.g., changes in scavenger population density or type) and possible differences in the size of the animal being scavenged are typically taken into account when evaluating carcass removal rates.

The objective of the carcass removal trials is to document the length of time carcasses remain in the search area, and thus are available to be found by searchers, and, subsequently, to determine the frequency of carcass searches within the search plots. Carcass removal trials will be conducted during each season the first 2 years and will be used to adjust carcass surveys for removal bias.

Carcasses used in the trials will be selected to best represent the size, mass, coloration, and will have similar proportions to the Covered Species. For petrels and nene, carcasses may include legally obtained wedge-tailed shearwaters, a close taxonomic relative to Hawaiian petrels, if available; otherwise, commercially available adult game birds or cryptically colored chickens will be used to simulate seabirds. Auwahi Wind will coordinate with DOFAW and USFWS on availability of carcasses to be used during carcass removal trials. Bat carcasses will most likely not be available for scavenging trials, so a surrogate will be used. Carcasses of dark-colored mammals (e.g., small rats or mice) may be used to simulate bats. Legally obtained small passerines (e.g., house sparrows) or commercially available game bird chicks may be considered to simulate bats, although they are not ideal because of their differences in appearance and decomposition rates. Non-listed bird carcasses found during the surveys may be used for these trials.

3.1 SAMPLING INTENSITY

Given that carcass persistence times are currently unknown in the Project site, an initial carcass removal trial will be conducted for seabirds and bats after the Project is operational and just prior to the initiation of the PCMP to determine an initial carcass persistence rate. The search interval during the potential high bat activity period (July – November) will be established as the shorter of two time periods: two times per week or the interval after which at least 90 percent of trial carcasses remain. The resulting carcass removal data will be used during estimation of Project-wide avian and bat mortality. Should the desired search frequency not be met at any time due to reasons other than weather, health, or safety, Auwahi Wind will inform the agencies to discuss a course of action. These occurrences will be documented in annual monitoring reports. At the conclusion of Year 1 monitoring, the search frequency for Year 2 will be determined in consultation with USFWS and DOFAW.

Assuming adequate carcass availability, at least two trials will be conducted per season with up to eight carcasses of each size class (bat and bird) placed per trial, resulting in a total of up to 64 trial carcasses used in carcass removal studies for the entire year for the Project. Seasons will be defined based on the following annual dry and wet seasons experienced in Hawaii: dry season (May through October) and wet season (November through April). The trials will be spread throughout sampling period to incorporate the effects of varying weather, climatic conditions, and scavenger densities. The first trial will be conducted prior to initiating the monitoring program to establish the initial appropriate search interval.

3.2 CONDUCTING THE TRIAL

Each carcass used for the carcass removal trial will be placed at stratified random locations within the Project site near or within the search plots. Prior to initiating the trial, a set of random locations will be generated to determine the location of trial carcasses. These locations will subsequently be loaded into a GPS as waypoints to allow the accurate placement of the carcasses by field personnel. Carcasses will be dropped from waist high and allowed to land in a random posture. Each trial carcass will be discreetly marked (e.g., small tag or wire wrapped around one leg) prior to dropping so that it can be identified as a study carcass if it is found by other searchers or Project personnel.

Personnel conducting carcass searches will monitor the trial birds every day over a 21-day period during the first year of post-construction monitoring. By doing daily checks, Auwahi Wind will know the exact 24-hour period when the carcass is removed. Experimental carcasses will be left at the location until the end of the carcass removal trial.

When checking the carcass, searchers will record the condition as intact (normal stages of decomposition), scavenged (feathers pulled out, chewed on, or parts missing), feather spot (only feathers left), or completely gone. Changes in carcasses condition will be cataloged with pictures and detailed notes; photographs will be taken at placement and any time major changes have occurred. At the end of the 21-day period any evidence of the carcasses that remain will be removed.

3.3 CARCASS REMOVAL RATE ESTIMATION

Estimates of carcass removal rates or the time (measured in days) that carcasses remain on site and are available to be found by searchers are used to adjust carcass counts for removal bias. Mean carcass removal time ($\bar{t}$) is the average length of time a carcass remains in the study area before it is removed:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c}$$

where t_i is the time (in days) a carcass remains in the study area before it is removed, s is the number of carcasses used in the trial, and s_c is the number of carcasses in removal trials that remain in the study area at the end of the trial period.

4.0 SEARCHER EFFICIENCY TRIALS

The ability of searchers to detect carcasses is influenced by a number of factors including the skill of an individual searcher in finding the carcasses, the vegetation composition within the search area, and the characteristics of individual carcasses (e.g., body size, color). The objective of searcher efficiency trials is to estimate the percentage of bird and bat fatalities that searchers are able to find. Estimates of searcher efficiency are then used to adjust carcass counts for detection bias. Searcher efficiency trials will be conducted during each season of the survey period during the first 2 years of monitoring to account for seasonal differences in searcher efficiency. Carcass acquisition for searcher efficiency trials will be the same as that described for carcass removal trials.

4.1 SAMPLING INTENSITY

Searcher efficiency trials will begin when WTGs are placed into operation and standardized carcass searches start. Personnel conducting the searches will not know when trials are conducted or the location of the detection carcasses. Trials will be conducted at least two times for each of the two seasons and will incorporate testing of each member of the field crew. Carcasses from both size classes (seabird and bat) will be included in the trials. A minimum of five carcasses per size class will be used in each trial. The number of trials conducted per season will be dependent upon carcass availability.

4.2 CONDUCTING THE TRIAL

All carcasses will be placed at stratified random locations within areas being searched prior to the carcass search on the same day so that searchers are not aware they are being tested. Carcasses will be dropped from waist high or higher and allowed to land in a random posture. Each trial carcass will be discreetly marked (e.g., small tag or wire wrapped around one leg) prior to dropping so that it can be identified as a study carcass after it is found. The number and location of the detection carcasses found during the carcass search will be recorded. The number of carcasses available for detection during each trial will be verified immediately after the trial by the person responsible for distributing the carcasses.

4.3 SEARCHER EFFICIENCY RATE ESTIMATION

Searcher efficiency rates will be estimated by searcher, carcass size and types, WTG, and season. These rates are expressed as p, the proportion of trial carcasses that are detected by searchers in the searcher efficiency trials, as provided in the fatality rate calculation discussion in Section 5.0.

5.0 FATALITY RATE CALCULATION

The estimate of total direct take will incorporate observed mortality, documented during standardized carcass searches, as well as unobserved mortality, or individuals that may have been killed by interactions with Project components but are not found by searchers for various reasons.

Specifically, fatality estimates will be calculated for seabirds and will take into account:

- Search interval;
- Searchable area around each searched turbine;
- Observed number of carcasses found during standardized searches during the monitoring year for which the cause of death can be attributed to facility operation;
- Carcass removal rates, expressed as the estimated average number of days a carcass is expected to remain in the study area and be available for detection by the searchers during removal trials; and
- Searcher efficiency, expressed as the weighted average proportion of planted carcasses found by searchers during searcher efficiency trials.

There have been many recent advances in post-construction monitoring techniques and fatality rate estimates, and there are a number of estimators available for calculating fatality rates. These estimators provide different methods to account for unobserved mortality, with some estimators treating searcher efficiency and carcass removal as separate factors and others treating them as interrelated (e.g., Shoenfeld 2004; Jain et al. 2007; Huso 2010). However, the most recent estimator developed by Huso (2010) is expected to be used until improvements to estimating fatality rates are available. Huso's estimator will improve the potential for reducing the inherent biases in the data and provide the ability to account for variable search ability (e.g., based on vegetation types or unsearchable areas) within the search plot. Take can also be calculated per turbine and per interval while adjusting for variables such as actual area searched or visibility class. The Huso (2010) estimator can be expressed as:

$$\hat{M} \frac{c}{\hat{a}\ \hat{r}\ \hat{p}\ \hat{e}}$$

Where:

M = estimated total direct mortality
c = observed number of carcasses
a = the estimated density-weighted proportion of the plot searched
r = estimate of proportion of carcasses remaining after scavenging (scavenger efficiency)
p = estimated searcher efficiency (proportion of carcasses found)
e = effective search interval (days) calculated as the ratio of (days before 99 percent of carcasses can be expected to be removed/search interval) or 1, whichever is less.

6.0 WILDLIFE EDUCATION AND INCIDENTAL REPORTING PROGRAM

Auwahi Wind will implement a Wildlife Education and Incidental Reporting program for contractors, Project staff members, and other ʻUlupalakua Ranch staff who are on site on a regular basis. This training enables staff to identify the Covered Species that may occur in the Project area, record observations of these species, and take appropriate steps for documentation and reporting when any Covered Species is encountered during construction or operation of the Project including when downed birds or bats are found. The Wildlife Education and Incidental Reporting program will facilitate incidental reporting of observations within the Project site, as well as within the generator-tie line corridor where Auwahi Wind staff and ʻUlupalakua Ranch are regularly present during the course of normal Project and ranch operations. Incidental reporting will inform the Project post-construction monitoring program of any wildlife fatalities that occur outside of standardized fatality surveys within the Project, as well as providing supplementary information on impacts associated with the generator-tie line where standardized post-construction monitoring will not occur. The program will be prepared by a qualified biologist and will be approved in advance by the USFWS and DOFAW. Over the term of this HCP, the program will be updated as necessary.

The program will include wildlife education briefings to be attended by new Project staff and other contractors or ranch staff as appropriate. Staff members will be provided with printed reference materials that include photographs of each of the Covered Species and information on their biology and habitat requirements; threats to the species on site; and measures being taken for their protection under this HCP. The Project Biologist, who will coordinate the post-construction monitoring on site, will coordinate with the Construction Foreman and the Project Operations Manager to ensure that personnel receive the appropriate written material.

Staff members will be responsible for responding to and treating wildlife appropriately under all circumstances, including avoiding approaching any wildlife other than downed wildlife and avoiding any behavior that would harm or harass wildlife (including feeding). In conjunction with regular assigned duties, personnel will be responsible for:

- Recording any project-related wildlife incidents;
- Adhering to Project area road speed limits;
- Identifying Covered Species when possible (Hawaiian petrel, nēnē, Hawaiian hoary bat, and Blackburn's sphinx moth) and documenting observations by filing a Wildlife Observation Form; and
- Identifying, reporting, and handling any downed wildlife in accordance with the Downed Wildlife Protocol, including filing a Downed Wildlife Incidence Report form (Attachment 3).

7.0 SAMPLING BEYOND THE INITIAL TWO-YEAR PERIOD

Sampling duration, plot size, and survey intensity may be modified upon completion of the initial 2 years of monitoring or sooner, subject to approval by USFWS and DOFAW. It is anticipated that surveys conducted during the first 2-year period will provide sufficient data on take to adequately describe carcass distribution and spatial and temporal trends in fatalities within the Project area. The PCMP data may provide justification for modifying search plot size, search frequency, or the number of WTGs searched, or for concentrating sampling efforts at specific WTGs or during certain times of year during subsequent years of monitoring. These data will also illustrate trends in searcher efficiency and carcass removal over time.

Should the documented searcher efficiency drop below an average of 50 percent, Auwahi Wind will collaborate with the USFWS and DOFAW to develop alternative search strategies (e.g., intensive vegetation management, trained search dogs). A searcher efficiency of 25 percent is considered to be the minimum required for statistical validity (Strickland et al. 2011).

Auwahi Wind proposes a long-term monitoring approach consisting of periodic intensive monitoring followed by interim years of less intensive but systematic monitoring. Intensive monitoring would occur every 5 years after the initial 2-year intensive sampling period (i.e., years 7, 12, 17, and 22), resulting in a total of 6 years of intensive monitoring during the life of the Project (Table 7-1). During intensive monitoring years, searcher efficiency trials and carcass removal trials would be conducted to determine if any variables have changed over time and if any modifications to search frequency are required (Table 7-1). During interim years, assuming trends in the monitoring data provide confidence in the estimate of take, the monitoring effort would be reduced to conducting systematic carcass surveys on a monthly or other less frequent basis. The frequency at which the surveys take place during interim years will be determined at the conclusion of the carcass removal trials for that 5-year period. It is assumed that searcher efficiency trials may have to be conducted more frequently depending on changes in staff. All adjustments to direct take during interim years would use the most recent estimates from the searcher efficiency and carcass removal trials. Revised methods will be evaluated in cooperation with USFWS and DOFAW.

Table 7-1. Schedule of Post-Construction Monitoring over the ITP/ITL Term

Year of Permit Term	Standardized Carcass Searches	Searcher Efficiency and Carcass Removal Trials
1	Intensive Monitoring	X
2	Intensive Monitoring	X
3-6	Systematic Monitoring	--
7	Intensive Monitoring	X
8-11	Systematic Monitoring	--
12	Intensive Monitoring	X
13-16	Systematic Monitoring	--
17	Intensive Monitoring	X
18-21	Systematic Monitoring	---
22	Intensive Monitoring	X
23-25	Systematic Monitoring	--

This approach is designed to inform Auwahi Wind where take levels are in relation to the established tiers outlined in the HCP and to provide a mechanism for continually assessing and adjusting the sampling scheme to ensure data accuracy. Continuous standardized monitoring will provide shorter-term benchmarks for evaluating whether take is higher or lower than anticipated over a several-year period, recognizing that take may fluctuate during years of operation. Thus, Auwahi Wind will be able to gauge easily when a given tier of take is being approached, signaling the need to engage the USFWS and DOFAW in additional discussions regarding Project status and to begin preparation for implementation of additional mitigation. This information will be used to inform any other decisions related to adaptive management as described in the HCP.

8.0 REPORTING

An annual report for the Project will be submitted to USFWS and DOFAW. The report will include the following:

- A summary of the results of the post-construction monitoring surveys including a list of detected carcasses;
- Results of the carcass removal trials and searcher efficiency trials;
- Documented take, if any, of each covered listed species;
- The identification of any recommended changes to the monitoring protocols, and
- Any proposed protocol modifications.

The reporting schedule is outlined in the Monitoring section of the HCP.

A Downed Wildlife Incident Report will be filed with the USFWS and DOFAW within 3 business days (Attachment 3) of the discovery of a federally and state-listed species and cumulative adjusted take will be reported to the agencies within 3 weeks. Auwahi Wind will consult with the USFWS and DOFAW to review take limits and will discuss changed circumstances or adaptive management measures as necessary. Carcasses of non-listed species will be reported to DOFAW and USFWS on a monthly basis.

SUPPLEMENT: THE AUWAHI HCP AMENDMENT LONG-TERM POST CONSTRUCTION MORTALITY MONITORING PLAN

Auwahi Wind has completed the initial intensive period of monitoring as described above in the original PCMP. The PCMP was developed with the best science available at the time. Information gained from the initial 5 years of morning at the Project as well as the current best available science has been used to revise the protocol as described below in the long-term post-construction mortality monitoring plan.

9.0 INTRODUCTION

This supplement to the original PCMP describes the long-term post-construction mortality monitoring plan (Plan) to be implemented at the Auwahi Wind Farm Project (Project). Under the approved Project Habitat Conservation Plan (HCP; Tetra Tech 2012), Auwahi Wind Energy, LLC (Auwahi Wind) committed to conducting Intensive Monitoring during the first 2 years of Project operations, after which time initial post-construction mortality monitoring data and other site-specific considerations would be used to adaptively manage the monitoring program. This appendix outlines the approach to post-construction mortality monitoring over the remainder of the 20 year operating term of the Project's 25-year Incidental Take Permit (ITP)/Incidental Take License (ITL) term (permit term) while the turbines are operational. It serves as a supplement to the Project's Post-Construction Monitoring Plan. Recent advancements in the science of wind farm post-construction mortality monitoring since 2012 have been incorporated as appropriate.

The approach to long-term mortality monitoring consists of Systematic Monitoring throughout the remainder of the permit term while turbines are operational, with the potential to adaptively manage the Plan in consultation with the USFWS and DOFAW. The primary purpose of Systematic Monitoring (as well as previous Intensive Monitoring efforts) is to collect standardized mortality data that can be used to develop an estimate of adjusted take (estimated take) of the Hawaiian hoary bat attributable to Project operations) and enable the comparison of estimated take relative to authorized take limits under the ITP/ITL. Estimated take accounts for observed direct take, unobserved direct take, and indirect take. These terms are defined as follows and described in detail in Section 2:

> **Intensive Monitoring—**Standardized carcass searches conducted in full-sized search plots designed to include the majority of large bird and bat fatalities. Search plots centered on Project wind turbines. Bias correction trials conducted (searcher efficiency and carcass persistence). Data used to estimate take for Intensive Monitoring periods.
>
> **Systematic Monitoring—**Standardized carcass searches conducted within refined search plots excluding hazardous areas to traverse (roads and pads within 328 feet [100 meters] of turbines). Bias correction trials conducted (searcher efficiency and carcass persistence; see Section 3 for additional detail). Data used to estimate take for Systematic Monitoring periods.

Intensive Monitoring at the Project began in January 2013 and was completed in January 2015. Implementation of Systematic Monitoring was approved by USFWS and DOFAW and implemented in January 2015 to increase the efficiency of the monitoring effort and address site-specific safety concerns (see the December 12, 2014 meeting minutes [Auwahi Wind 2014a] and FY 2015 annual report [Auwahi Wind 2015] for details). The following sections describe the long-term mortality monitoring timeline, Systematic Monitoring, adaptive management, and updated reporting requirements.

10.0 LONG-TERM MONITORING SCHEDULE

This section describes the schedule for long-term mortality monitoring over the remainder of the Project's permit term. As noted above, beginning in January 2015 Systematic Monitoring (described in Section 3) was initiated which incorporated standardized searches of roads and turbine pads to establish a baseline estimate of take following implementation of turbine low wind speed curtailment. A spike in observed bat fatalities in the summer of 2016 under low wind speed curtailment suggested that inter-annual variability in fatality rates at the site may require a relatively long monitoring period to understand patterns of bat fatalities at the Project. Prior to February 2015, low wind speed curtailment had not been implemented. Systematic Monitoring provides opportunities to document temporal changes in annual fatality rates. Systematic Monitoring will continue until results reveal predictable patterns of fatalities, at which point this Plan may be adapted in consultation with USFWS and DOFAW.

The following provides an overview of the long-term mortality monitoring schedule by year of commercial operation:

Years 1 and 2 – Intensive Monitoring was conducted as described in Appendix E of the approved Project HCP with results reported in FY 2013, 2014, and 2015 annual compliance reports (Tetra Tech 2013; Auwahi Wind 2014b, 2015). The estimated take from these years is assumed to be representative of take without implementation of low wind speed curtailment.

Years 3 through 20 – Routine Systematic Monitoring will be conducted during all months of the year as appropriate for the search type. Alterations to the search routine may be determined to be necessary based on the results of carcass persistence trials or the Plan may be adjusted in consultation with USFWS and DOFAW.

Years 21 through 25 – No monitoring is scheduled during the final 5 years of the permit term. Turbines are anticipated to be inactive because the power purchase agreement expires after 20 years of commercial operation. If the Project continues to operate during this period, Systematic Monitoring will be implemented while the Project is operating, unless a modification to the Plan is developed in consultation with USFWS and DOFAW.

11.0 SYSTEMATIC MONITORING

11.1 SEARCH AREA AND PROTOCOL

The search areas for Systematic Monitoring consist of roads and graded pads that occur within a 328-foot (100-meter) radius of each of the Project turbines. Although the search plot size and configuration varies among turbines, an analysis of the expected carcass distribution around each turbine indicates that the total search area encompasses approximately 76 percent of the overall distribution of bat carcasses and approximately 56 percent of the carcass distribution for large birds (Strickland et al. 2011).

Procedures for conducting Systematic Monitoring follow those used for Intensive Monitoring and include weekly searches. Canine search teams will be used primarily. No search transects are established. An expert canine handler and canine team is used to survey the search area. The search area is delineated by the HCP Manager and provided to the canine team. The searcher uses experience and environmental conditions to cover the search area. In the event the canine search team is unavailable, human searchers will be used. When human searchers are used, they will be using transects. Within each search plot, transects are established approximately 20 feet (6 meters) apart. Vegetation control will be maintained within the search plots during years of Systematic Monitoring to maximize visibility. Personnel trained in proper search techniques conduct the carcass searches by walking along each transect and scanning both sides out to 10 feet (3 meters) for fatalities.

11.2 FATALITY DOCUMENTATION

Procedures for documenting observed fatalities largely follow those described in the PCMP of the approved Project HCP; however, a subsequent release by DOFAW of a standardized protocol for response to downed birds and bats (Attachment 1) has resulted in revised procedures that supersede those previously described.

11.3 CARCASS REMOVAL AND SEARCHER EFFICIENCY TRIALS

Carcass removal and searcher efficiency trials estimate biases in carcass detectability. These trials will be conducted during the periods of Systematic Monitoring and results will be used to derive adjusted take estimates as described in the PCMP of the approved Project HCP (see Section 5) and as clarified here (Section 4).

Carcass removal trials will be conducted at least twice per season (twice during the wet season and twice during the dry season) and will include a minimum of 10 large birds and 10 medium-sized rats per trial (or appropriate surrogate species). This seasonal sample size results in a goal of 80 trial carcasses (40 per size class) for an entire year, should sufficient carcasses be available. Trials will last a minimum of 21 days and will consist of daily checks for the first 7 days followed by checks every other day until then end of the trial to document the presence or absence of each carcass throughout the trial period or until carcasses are no longer detected. Because of low carcass persistence documented during the Intensive Monitoring period, predator control measures (trapping) were initiated in November 2013 and is anticipated to continue during periods of Systematic Monitoring.

Searcher efficiency trials will be conducted a minimum of three times during each of the two seasons and spaced out within each survey season to capture the potential effects of varying weather and vegetation growth. Carcasses from two size classes (large birds and rats) will be included in the trials resulting in a goal of 60 trial carcasses (30 per size class) for an entire year, should sufficient carcasses be available.

12.0 ANALYSIS AND INTERPRETATION

Auwahi Wind will use an appropriate USFWS- and DOFAW-approved analytical tool to estimate take of Covered Species. As described in the approved Project HCP, direct take of Covered Species will be estimated by using statistical models that adjust the number of observed fatalities for detection bias inherent in mortality monitoring. Model inputs (searcher efficiency, carcass persistence, etc.) will be based on data collected during each monitoring period. Estimates of indirect take, based on the seasonal patterns of fatalities and assumptions about Covered Species' life history data, are added to estimated direct take to develop the estimated take for the Project (see approved Project HCP and Section 5.1.2 of the HCP Amendment). The approach to estimating take for Nene and Hawaiian petrel is described in the approved Project HCP and the Project Post-Construction Monitoring Plan.

This section summarizes the analysis and interpretation of bat fatalities and supersedes the approach described in the approved Project HCP and the Post-Construction Monitoring Plan. A more comprehensive explanation of the approach, statistical parameters, interpretation, and justification are provided in Appendix H of the HCP Amendment. At this time, based on small numbers of bat fatalities observed during the two years of Intensive Monitoring and three years of Systematic Monitoring, Auwahi Wind anticipates that the statistical model used to account for direct take would be the Dalthorp et al. (2017) Evidence of Absence statistical tool. However, if a minimum sample size of 5 to 10 fatalities are observed during a monitoring period, the estimated direct take instead would be derived using the Huso estimator (Huso 2010; Huso et al. 2012). Finally, should new suitable and peer-reviewed approaches to estimating direct take or fatality rates become available, Auwahi Wind will work with USFWS and DOFAW to assess whether an alternate approach should be considered

The Evidence of Absence tool creates a probability distribution of the number of potential direct fatalities. Information from previous years "inform" the current probability distribution, allowing for the development of more accurate probability distributions through on-going monitoring. The output provides the user with the levels of confidence that take estimates at a defined credibility level would not be exceeded over the permit term. Results are a function of the credibility level, observed fatalities, and past and projected future monitoring efforts. An 80 percent credibility level has been required by USWS and DOFAW to assess compliance with an ITP/ITL and provides a high level of confidence that actual take would not exceed the estimated take. Comparison of estimated direct take plus indirect take with ITP/ITL authorized take limits or tier limits enables the assessment of compliance with the ITP/ITL.

Indirect take will be accounted for generally using the approach as outlined in Section 5.1.2 of the HCP Amendment, but accounting for the actual status of known fatalities. Specifically, parameters recommended in USFWS and DOFAW guidance (USFWS 2016) will be used to estimate indirect take for bat fatalities. Specifically, indirect take for unobserved direct take is the product of the estimate of unobserved take, the proportion of this take that is assumed to be female (0.5), the proportion of these fatalities that are assumed to occur during the pup dependency period (3/12), and the average number of pups produced (1.8). Genetic samples from all observed fatalities will be collected and results used to determine the sex of observed fatalities during the period when females could have dependent young (April 1 – September 15). Prior to the determination of the sex of a fatality during the dependency period, the probability of it being a female will be estimated to be 50 percent. Following the results of genetic testing or other information identifying the sex of an individual bat fatality, indirect take estimates will be updated to reflect the most current information, with confirmed female fatalities found between April 1 and September 15 assumed to have had dependent young. No indirect take will be ascribed to males or any female taken between April 1 and September 15 that were determined to not have dependent young. Total take will be calculated by adding indirect take in terms of adult equivalents (based on an assumed survival rate of juveniles to adulthood of 0.3) to the estimate of direct take (described above).

Fatalities found incidentally to standardized searches are those found outside the search plots. These fatalities will be reported but not included in the calculation of estimated take, as the statistical models include adjustments (i.e., proportion of the carcass distribution searched) that account for carcasses that fall outside of the search plots. The most appropriate method for including incidental fatalities found within the search plots but outside of standardized searches is to include them as a probability function based on study parameters. If such a carcass was not found incidentally, it would have been subject to loss described by carcass persistence parameters (alpha and beta), and detected with the searcher efficiency probability of detection (p) multiplied by the decrease in efficiency per subsequent search (k), and accounted for in the a priori distribution used to model future takes. The USFWS has provided guidance on the incorporation of fatalities found incidentally within the search area. This guidance, subsequent guidance, or other methods mutually agreed upon by Auwahi Wind, USFWS and DOFAW will be used by Auwahi in assessing indirect take:

> If a carcass is found incidentally, then it must be determined if the carcass would have been found on the next routine search day and therefore counted as Observed, or if the carcass would have been missed or be gone on the next routine search and accounted for in the Unobserved portion of fatalities." The Hawaiian hoary bat carcasses are important to ongoing genetic research, so leaving the listed carcass in place is not in the best interest for the species. If a carcass is found incidentally, in the designated search area the Downed Wildlife Protocol and reporting should be followed. The report should clearly indicate who found the carcass, and under what circumstances (turbine maintenance, weeding, mowing, etc.). The report should also indicate the method of determining how to categorize the carcass. The three methods are:
>
> **1)** Permittee chooses to include the carcass as Observed in the model, regardless of searcher efficiency.
>
> **2)** Wildlife agencies will include the carcass as Observed in the model when the documented detection probability is sufficiently high so as to reasonably assume the carcass would have been found on a subsequent scheduled search. Specifically, this method makes the assumption that the search efficiency and *k* value are such that there is a high probability that the carcass would have been found on a subsequent search. This method will be used for all large and medium carcasses found. This method will also be used for smaller carcasses when it is reasonable to assume the carcass or carcass trace would have been found on a subsequent search. The wildlife agencies will assume a carcass would have been found when the documented searcher efficiency ≥75 percent and *k* value ≥ 0.7.
>
> In the case of small carcasses where the searcher efficiency is less than 75 percent (based on permittee's documented efficacy), a double-blind search with a replacement surrogate should be conducted to determine how the recovered carcass shall be categorized: Observed or Unobserved. That trial shall include the following criteria:
>
> **a.** The surrogate (typically a rat) should be identical to that used for search efficacy trials and similar in size to the carcass found.
> **b.** The surrogate carcass should be labeled as a surrogate for the specific carcass it is representing, and placed by a third party in the proximity of where the carcass that was recovered was found with label hidden.
> **c.** The placement of this carcass should be conducted by the same party responsible for placing carcasses for efficiency trials, whenever possible.
> **d.** Under no circumstances should the searcher conducting the routine search, be the one placing the surrogate or have knowledge of the surrogate's location or the timing of the placement.

e. Routine fatality searches should be carried out following standard search procedures.

f. The outcome of the trial should be reported in the compliance report and include the date the surrogate was placed and the date the carcass was found. If the carcass was never found, the third party should check on the status of the carcass. If the carcass is still present, leave it in place for subsequent searches. Include this information in the compliance report.

g. If the surrogate was found, the original carcass should be reported as Observed. If the surrogate was not found, the original carcass should be reported as Unobserved.

The post-construction mortality monitoring data will provide the information necessary to assess compliance with authorized levels of incidental take and to determine when additional mitigation should be initiated.

13.0 ADAPTIVE MANAGEMENT

This Plan provides an adaptive management approach to the long-term mortality monitoring program. The monitoring approach outlined above may be modified over the permit term, as Project-specific information is obtained, to maximize the effectiveness and efficiency of the monitoring program and to apply the best available science. Project-specific post-construction mortality monitoring results may provide justification for modifying the mortality monitoring protocol including adjustments to survey intensity and/or the long-term mortality monitoring schedule.

Advancements continue to be made in the science of post-construction mortality monitoring particularly with statistical tools to assess bias correction factors and fatality rates (Shoenfeld 2004; Jain et al. 2007; Arnett et al. 2009; Huso 2010; Huso et al. 2012, 2015; Dalthorp and Huso 2017). Additionally, monitoring protocols and technologies for fatality detection, as well as measures for avoidance and minimization of fatalities, will continue to evolve during the course of the permit term and may warrant adjustments to the Plan. In order to maintain a scientifically reliable and cost-effective approach to post-construction mortality monitoring, the Plan may be modified by Auwahi Wind with review and approval from USFWS and DOFAW.

Additionally, Project-specific post-construction mortality results may indicate the need for wind farm operational changes. The following sections outline specific triggers and associated adaptive management measures.

13.1 ADAPTIVE MANAGEMENT OF THE LONG-TERM MONITORING PROGRAM

Systematic Monitoring data will be evaluated on an annual basis to determine if changes to the protocol are necessary. Auwahi Wind would reevaluate the monitoring protocol if a combination of search parameters (Interval, Area, SEEF, and CPT) cause the overall detection probability (Ghat) value to fall below 0.30. In response Auwahi Wind may increase search frequency, intensify predator control measures, and/or increase vegetation management efforts within the search plots to better assess causes and patterns of mortality of the Covered Species.

Under adaptive management Auwahi Wind has made the following changes to minimize impacts and improve post-construction mortality monitoring:

> Under the recommendation of USFWS/DOFAW, Auwahi Wind continues to implement scavenger control at the site. Predator traps are deployed across all turbine search plots (turbine 4 was removed in October 2016 and returned to service February 2018) and used year-round to remove scavengers and increase carcass persistence. Carcass persistence has increased across the site as a result.
>
> Beginning in January 2015, Auwahi Wind implemented quarterly vegetation management on pads and roads to increase visibility during fatality searches. Vegetation is cut back and maintained at 2 to 4 inches (50 to 100 millimeters) along pads and roads year-round. These efforts have increased the detectability of carcass surrogates during searcher efficiency trials. Monthly vegetation management efforts were initiated in March of 2017.
>
> Beginning in January 2015, Auwahi Wind switched to systematic searching of pads and roads within a 100-meter buffer of the turbine. Searcher efficiency and carcass persistence trials continue within this area to better refine fatality estimations for the life of the Project.
>
> Beginning in January 2018, Auwahi wind began to use a canine team to conduct fatality searches once time per week and plans to continue the use of canines for regular searches.

In addition, the development of an effective commercially-available and economical technology to detect turbine collisions, higher than anticipated levels of searcher efficiency or carcass persistence, or new information on the spatial distribution of carcasses could suggest reductions in search area or frequency of searches, or other modifications to the Plan.

14.0 ANNUAL REPORT

An annual report for the Project will be submitted to USFWS and DOFAW following the schedule outlined in the Monitoring section of the HCP Amendment. Auwahi Wind will consult with the USFWS and DOFAW to review take limits and will discuss changed circumstances or adaptive management measures as necessary (Section 5).

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ATTACHMENT 1

DOWNED WILDLIFE PROTOCOL

DOWNED WILDLIFE PROTOCOL

STANDARD PROTOCOL FOR HOLDERS of a State of Hawai`i INCIDENTAL TAKE LICENSE and U.S. Fish and Wildlife Service INCIDENTAL TAKE PERMIT RESPONDING TO DEAD OR INJURED BIRDS AND BATS THAT ARE THREATENED AND ENDANGERED SPECIES OR MBTA SPECIES

[For species not listed as endangered or threatened or MBTA use the downed wildlife form at the end of this document]

Do not move wildlife unless in imminent danger.
Call DOFAW immediately for your island using the phone numbers in Attachment 1

Fill out information on the downed wildlife form using the version with the same date as this protocol and send as directed later in this protocol

OVERVIEW

The islands of Hawai`i contain numerous native and endemic species of wildlife that are protected by strict state and federal laws. This protocol is geared towards downed (injured or deceased) wildlife and focused on the endangered Hawaiian hoary bat and avian species protected by the Endangered Species and Migratory Bird Treaty Acts. The likelihood of encountering injured or dead wildlife that are protected by state and federal endangered species laws should be considered equal to encountering non-listed species. Therefore, all downed wildlife should be treated with the same safeguards and care to ensure adequate response and documentation according to the following set of guidelines.

Always be prepared for discovery of downed birds and bats. Please ensure that all staff and personnel are trained in this protocol, and that contact information, written protocols, and supplies are ready for response.

The first response for downed birds and bats is to call the local Hawai`i Division of Forestry and Wildlife (DOFAW) Office. The DOFAW staff is generally able to respond by sending someone to the scene to retrieve the injured or deceased wildlife. If DOFAW staff cannot be reached, you must leave a message and call-back number. In the event that DOFAW personnel are reached but not able to respond right away, they may instruct those reporting the incident to provide necessary response. Follow their directions carefully.

If DOFAW staff cannot be contacted, especially if the downed animal is in imminent danger, you should be prepared to handle the animal yourself, following the protocol, and transport them to DOFAW or a permitted wildlife rehabilitator. Again, you should only handle injured wildlife if DOFAW staff cannot be contacted or if the animal is in imminent danger.

DOWNED WILDLIFE PROTOCOL

PREPARING TO RESPOND FOR DOWNED OR INJURED BIRDS AND BATS

In all cases, ensure that all field staff are trained in the response protocol for injured birds and bats. Ensure they have read and understand the protocol, and have the protocol posted (including highlighted contact information) in a prominent location. Make sure that all staff know who to contact, and where supplies for handling injured wildlife are located. Staff should be regularly briefed on protocols, especially at the beginning of each distinct season that might correspond with a heightened likelihood of encountering downed wildlife.

Non-governmental parties should make prior arrangements, including procedures and payments with the rehabilitation or veterinary care facilities that will be used to treat injured animals.

At a minimum, for vehicles or foot patrols where maintaining a wildlife response kit (carrier) may be impractical, keep a copy of the protocol handy and accessible along with a large clean towel, soft cloth such as a t-shirt or flannel, several flags or tent stakes, and a pair of gloves, all of which are to be specifically designated for use in injured wildlife response.

For facilities and dedicated vehicles, please prepare and maintain one or more carriers designated for handling and transporting injured wildlife. This response kit should contain: a large clean towel; soft cloth such as a t-shirt or flannel; several flags or tent stakes; several pairs of gloves (plastic/latex disposable gloves and also heavy duty gloves such as leather or heavy rubber that can be sanitized); eye protection; a ventilated cardboard box, pet carrier, or other non-airtight container; and a copy of the protocol. For larger facilities (managed areas such as wildlife refuges, preserves, wetlands, or conservation areas), or areas where downed birds and bats are likely, please maintain several containers of various sizes. The container must provide enough room for the animal to comfortably move around, but also be sturdy enough to hold active birds or bats.

For small birds or bats, cardboard pet carriers or 'living world' plastic carriers work well as they have many ventilation holes and handles for easy carrying. Waxed pet carriers are preferred because they are sturdier, hold up longer, and can be thoroughly cleaned between uses. Sturdy cardboard boxes with holes punched in them to allow cross ventilation are also good. For birds, holes no wider than one inch in diameter should be punched on all four sides of the box. For bats, holes must be no larger than one-half inch diameter. A minimum of eight holes per side is sufficient. The carrier should be padded inside, well-ventilated and covered (to provide a sense of security).

Plastic dog kennels are recommended for handling larger birds, such as petrels, shearwaters, owls, hawks, ducks, stilts, and geese. All cages must have towels or rags placed in the bottom to help prevent slipping and protect bird feet and keels. The towel or other cushioning material should be sufficient to cover the bottom of the container effectively

Cardboard boxes that are used for transporting injured wildlife should only be used once then discarded to avoid cross-contamination and/or disease or pathogen transfer. If plastic kennels or waxed pet carriers are used, be sure that they are adequately cleaned or sterilized between uses. Never put two animals in the same container.

Always wear personal protective equipment when handling downed wildlife. Disease and contamination exposure can work in both directions (bird or bat to person, and vice versa); always use protection against direct contact. If it becomes necessary to handle a bird, always wear disposable gloves. If multiple animals are being handled ensure that a new pair of gloves is used between each bird or bat.

Never put birds or bats near your face. When handing a bird or bat to someone else, make sure that the head, neck, and wings are secure and in control first to avoid serious injury to handlers and to minimize injury to the animal. Never allow an alert bird with injuries to move its head freely while being handled – many birds will target eyes and can cause serious injury if not handled properly. Communicate with the person you are working with.

Never feed an injured bird or bat. The dietary needs of most species are more delicately balanced than many people realize. Most injured animals are suffering from dehydration, and attempting to feed or water the animal may kill it, as it is probably not yet able to digest solid food or even plain water. Often, when an injured animal arrives at a veterinary or rehabilitation facility, it is given a special fluid therapy for several days before attempts to feed the animal begin.

Handle wild birds and bats only if it is absolutely necessary. The less contact you have with the animal, the more likely it will survive.

NOTE: For remote sites with spotty coverage, ground staff may need to have a planned communication system with radios, or a cell carrier known to provide adequate coverage, that will allow communication with a designated contact able to relay information to DOFAW island biologist at the appropriate numbers listed in Attachment 1.

IF YOU FIND A LISTED OR MBTA BIRD OR BAT WHICH IS INJURED AND IN IMMINENT DANGER:

1. Do not put yourself in danger. Always wear personal protective equipment and clothing, including gloves and eye protection, to protect yourself when handling injured wildlife.
2. Mark the location with a flag or tent stake. **Record the time and location of the observation including the animal species and its condition, and call the DOFAW island biologist immediately at the number in Attachment 1**. Contact information is in prioritized order; if you don't reach the first person on the list, you must call the next. If possible, have someone stay with the animal while someone else calls. If there is no response from either party the animal may be picked up and transported to a qualified care facility after documenting key information and taking photos. If the animal is in imminent danger and you are able to protect it from further harm, mark the location where it was found with a flag or tent stake.
3. Pick up the bird or bat as safely as possible. Always bear in mind your safety first, and then the injured animal. If picking up a bird, approach and pick up the bird from behind as soon as possible, using a towel, t-shirt, or cloth by gently wrapping it around its back and wings. Gently covering the head (like a tent) and keeping voices down will help the animal remain calm and greatly reduce stress. If picking up a bat, use only a soft light-weight cloth such as a t-shirt or towel (toes can get caught in towel terry loops). Place the cloth completely over the bat and gather up the bat in both hands. You can also use a kitty litter scooper (never used in a litter box before) to gently "scoop" up the bat into a container.
4. Record the date, time, location, condition of the animal, and circumstances concerning the incident as precisely as possible. Place the bird or bat in a ventilated box (as described above) for transport. Never put two animals in the same container. Provide the animal with a calm, quiet environment, but do not keep the animal any longer than is necessary. It is critical to safely transport it to a wildlife official or veterinary professional trained to treat wildlife as soon as possible. While coordinating transport to a facility, keep the injured animal secure in the rescue container in a warm, dark, quiet place. Darkness has a calming effect on birds, and low noise levels are particularly important to help the animal remain calm. Extra care should be taken to keep wildlife away from children and pets.

DOWNED WILDLIFE PROTOCOL

5. Transportation of the animal to DOFAW per coordination with DOFAW staff may be required as soon as possible.
6. Notify HCP staff of DOFAW at the Honolulu office and USFWS within 24 hours via email.
7. Fill out a Downed Wildlife Form (us the version with the same date as this protocol) and report to the appropriate official(s) including DOFAW and USFWS HCP staff within 3 days.
    a. For DOFAW send to the following email addresses: dofaw.hcp@hawaii.gov; glenn.m.metzler@hawaii.gov
    b. For USFWS send to the following email addresses:
        i. For O`ahu and Kaua`i: jiny_kim@fws.gov, and cc: diane_sether@fws.gov, jenny_hoskins@fws.gov, Victoria_owens@fws.gov, and keith_swindle@fws.gov
        ii. For Maui, Moloka`i, Lana`i, and Hawai`i: diane_sether@fws.gov and cc: jenny_hoskins@fws.gov, Victoria_owens@fws.gov, and keith_swindle@fws.gov
8. If you must keep the bird or bat overnight, keep it in a ventilated box with a secure lid. Please keep the animal in a quiet, dark area and do not attempt to feed, handle, or release it. Continue to try to contact DOFAW staff and veterinary care facilities.

IF YOU FIND A LISTED OR MBTA BIRD OR BAT WHICH IS INJURED BUT NOT IN IMMINENT DANGER:

9. Do not put yourself in danger. Always wear personal protective equipment and clothing, including gloves and eye protection, to protect yourself when handling injured wildlife.
10. Mark the location with a flag or tent stake. **Record the time and location of the observation including the animal species and its condition, and call the DOFAW island biologist immediately at the number in Attachment 1.** Contact information is in prioritized order; if you don't reach the first person on the list, you must call the next. If possible, have someone stay with the animal while someone else calls. If there is no response from either party the animal may be picked up and transported to a qualified care facility after thoroughly documenting the situation in the downed wildlife form and taking appropriate photos.
11. Usually DOFAW staff will have you leave the animal in place while they come and get the animal, but dependent on the situation they may provide other instructions. Please follow their directions.
12. While waiting for DOFAW staff to arrive, minimize noise and movement in the area around the wildlife. Watch the animal so that its location is not lost if it moves away. If possible, keep sources of additional harassment or harm, such as pets, vehicles, and loud noises, away from the animal. Note any changes in the condition of the animal.
13. Notify HCP staff of DOFAW at the Honolulu office and USFWS within 24 hours of discovery via email.
14. Fill out a Downed Wildlife Form (use the version with the same date as this protocol) and report to the appropriate official(s) including DOFAW and USFWS HCP staff within 3 days.
    a. For DOFAW send to the following email addresses: dofaw.hcp@hawaii.gov; glenn.m.metzler@hawaii.gov
    b. For USFWS send to the following email addresses:
        i. For Oahu and Kauai wildlife: jiny_kim@fws.gov, and cc: diane_sether@fws.gov, jenny_hoskins@fws.gov, Victoria_owens@fws.gov, and keith_swindle@fws.gov
        ii. For Maui, Molokai, Lanai, and Hawaii wildlife: diane_sether@fws.gov and cc: jenny_hoskins@fws.gov, victoria_owens@fws.gov, and keith_swindle@fws.gov

Do not attempt to release the bird or bat yourself. Do not move injured wildlife unless explicitly instructed by DOFAW. DOFAW will need to document circumstances associated with the incident. The animal may also have internal injuries or be too tired or weak to survive. Never throw the bird or bat into the air as this could cause more injury or result in death. Let trained staff or veterinary personnel familiar with wildlife rehabilitation and care examine the animal and decide when, where, and how to proceed.

IF YOU FIND A LISTED OR MBTA DECEASED BIRD OR BAT:

All listed (MBTA and T&E species) wildlife found deceased must be reported ASAP upon detection to DOFAW and USFWS.

1. Mark the location with a flag or tent stake. **Record the time and location of the observation including the animal species and its condition, include photo documentation**.
2. **Call the DOFAW island biologist immediately at the number in Attachment 1**. Contact information is in prioritized order; if you don't reach the first person on the list, you must call the next. **Do not** move or collect the wildlife unless directed to do so by DOFAW. If necessary place a cover over the wildlife carcass or pieces of carcass *in-situ* (a box or other protecting item) to prevent wind or scavenger access from affecting its (their) position(s). Usually DOFAW staff will have you leave the animal in place while they come and get the animal, but dependent on the situation they may provide other instructions. Please follow their directions carefully.
3. If the DOFAW island biologist primary and secondary contacts (at the numbers in Attachment 1) cannot be reached within 1 hour, the carcass should be double bagged and placed in the refrigerator, not the freezer, until appropriate disposition is determined by the wildlife agencies. However, if the carcass is clearly from a wind energy turbine collision it can be placed directly in the freezer. The island biologist must still be contacted and when reached their instructions followed.
4. Also notify HCP staff of DOFAW at the Honolulu office and USFWS within 24 hours of discovery via email.
5. DOFAW island biologists will determine if the carcass should be submitted to the National Wildlife Health Center Honolulu Field Station (Dr. Thierry Work) for necropsy. The general considerations are as follows: if the fatality appears atypical for the species and situation the carcass may be a candidate for necropsy. If cause of fatality is questionable DOFAW or USFWS HCP biologists should provide instructions on how to proceed.
6. Fill out a Downed Wildlife Form (use the version with the same date as this protocol) and send to the appropriate official(s) including DOFAW and USFWS HCP staff within 3 days.
    a. For DOFAW send to the following email addresses: dofaw.hcp@hawaii.gov; glenn.m.metzler@hawaii.gov
    b. For USFWS send to the following email addresses:
        i. For O`ahu and Kaua`i wildlife: jiny_kim@fws.gov cc: diane_sether@fws.gov, jenny_hoskins@fws.gov, victoria_owens@fws.gov, and keith_swindle@fws.gov
        ii. Maui, Moloka`i, Lana`i, and Hawai`i wildlife: diane_sether@fws.gov, and cc: jenny_hoskins@fws.gov, victoria_owens@fws.gov, and keith_swindle@fws.gov

Attachment 1. Contact List for Downed Wildlife Protocol for DOFAW Island Biologists

Island	Primary Contact	After business hours/weekends
Maui	(808) 984-8100 (First Primary Contact) [Secondary: (808) 268-5087, (808) 870-6344, (808) 280-4114 (seabirds)]	(808) 870-6344, (808) 268-5087, (808) 280-4114 (seabirds)
Moloka`i	(808) 553-1745, (808) 870-7598	(808) 870-7598
Lana`i	(808) 565-7916, (808) 357-5090	(808) 357-5090
East Hawai`i	(808) 974-4221	(808) 640-3829
West Hawai`i	(808) 887-6063	(808) 339-0983
O`ahu	(808) 973-9786, (808) 295-5896	(808) 295-5896, (808) 226-6050
Kaua`i	(808) 274-3433 (808) 632-0610, (808) 635-5117 [Secondary: (808) 212-5551 for Kaua`i Seabirds HCP and KIUC Short-term HCP]	(808) 645-1576, (808) 635-5117

Downed Wildlife Forms on the following pages:

Downed Wildlife Incident Documentation and Reporting Form for LISTED and MBTA SPECIES
Downed Wildlife Form for Species NOT LISTED or MBTA

ATTACHMENT 2

CARCASS SURVEY FIELD FORMS

Auwahi Wind Farm Project Post-construction Monitoring Field Form

Date (MM/DD/YYYY) ____________ **Surveyors** _________________

Precipitation ______ (L) light rain (R) rain (D) dry (F) fog **Cloud Cover** _____ (C) clear (P) partly cloudy-25% (L) light-50% (M) moderate-75% (H) high-100%

Wind _____ (0) <0 mph (1) leaves barely move (2) leaves rustle/sm. twigs move (3) sm. twigs move (4) sm. branches move (5) lg. branches move/trees sway (6) variable

Standardized Carcass Searches

Tower No./Met tower[1]	Search Plot (50 or 75 %)	Start Time	End Time	Total Minutes	Fatalities Detected[2]	Other Observations (other wildlife, tracks, sign)
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			
		___:___	___:___			

[1] If a scheduled carcass search cannot be conducted due to weather or other safety concerns note the tower number and provide justification.

[2] List unique identifying number to correspond with casualty mmddyyyy_ turbine#_species code_ # (optional if more than one carcass of the same species is found)

ATTACHMENT 3

DOWNED WILDLIFE INCIDENT REPORT

Downed Wildlife Incident Documentation and Reporting Form
LISTED and MBTA SPECIES

Facility Name:
Species Common Name:
Species Scientific Name:
Four Letter Code: [common name, e.g. HOBA for the Hawaiian Hoary Bat; contact DOFAW unsure]:
File Name: [naming convention: SPECIESCODE_YEAR_MM-DD_FACILITY ABBREVIATION]

Observer Name:	
Report Prepared by:	
Date of Incident:	
Date of report:	
Fatality or Injury:	
Age (Adult/Juvenile), if known:	
Sex (if known):	
Incidental or Routine Search:	
Date Last Surveyed:	
Official Search Dist. and Whether In or Out	
Time Observed (HST):	
Time Initially Reported to DOFAW (HST):	
Time Picked Up and By Who:	
Deceased Animal Sent for Necropsy (Y/N)	
General Location:	
GPS Coordinates units and datum; prefer: GCS WGS84 or NAD83 UTM Zone 4N (specify):	
Closest Turbine #, distance from and bearing:	
Closest structure and distance (non-turbine):	
Ground Cover Type and Height (cm):	
Cloud Cover (%):	
Cloud Deck (m above ground level):	
Precipitation:	
Temperature (°F)	
Wind Direction&Speed for Wind Projects (m/s):	

Details:

Condition of Specimen [include a description of the animal's general condition, as well as any visible injuries, be specific (*e.g.*, large cut on right wing tip)]:

Probable Cause of Injuries and Supportive Evidence [be descriptive, *e.g.*,'teeth marks visible on upper back', or 'found adjacent to tire marks in mud']:

Action Taken [include names, dates, and times, whether sent for necropsy]:

Additional Comments:

Include the following:
-photos up close and photo with nearest structures or turbines in the background; include a ruler or measuring device to provide scale
-map showing aerial imagery with location of found animal, search area polygon, turbine numbers, and nearby features, roads, and structures labeled where applicable

Additional Information Required for Covered Species at HCP Wind Energy Sites
-For the turbine associated with the fatality, include a figure showing rotor speed, wind-speed, and all weather variables for the time period spanning the last two search periods up to the time the fatality or injury was found.
-Moon phase
-Presence and description of grazing cattle within 1 mile of the turbines (bats only)
-Presence of any standing or flowing water within 1 mile of the turbines (including watering troughs)(bats only)

Downed Wildlife Incident Documentation and Reporting Form

SPECIES NOT LISTED OR MBTA

Facility Name:
Species Common Name:
Species Scientific Name:
Four Letter Code: [common name, e.g. HOBA for the Hawaiian Hoary Bat; contact DOFAW unsure]:
File Name: [naming convention: SPECIESCODE_YEAR_MM-DD_FACILITY ABBREVIATION]

Observer Name:	
Date of Incident:	
Species (common name):	
Age (Adult/Juvenile), if known:	
Sex (if known):	
Incidental or Routine Search:	
Time Observed (HST):	
General Location:	
GPS Coordinates; GCS WGS84 or NAD83 UTM Zone 4N) (specify):	
Closest Turbine #, distance from and bearing:	
Closest structure (*e.g.*, Turbine # or Bldg):	
Distance to Base of closest structure:	
Bearing from Base of closest structure:	
Condition of specimen:	
Action Taken:	
Temperature:	
Precipitation within the past 24 hours	
Wind Direction&Speed for Wind Projects (m/s):	

Probable Cause of Injuries and Supportive Evidence:

Additional Information:

[Photos]

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

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APPENDIX H

EVIDENCE OF ABSENCE ANALYSIS

New Appendix associated with HCP Amendment

1 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, pers. comm., 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 are 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.

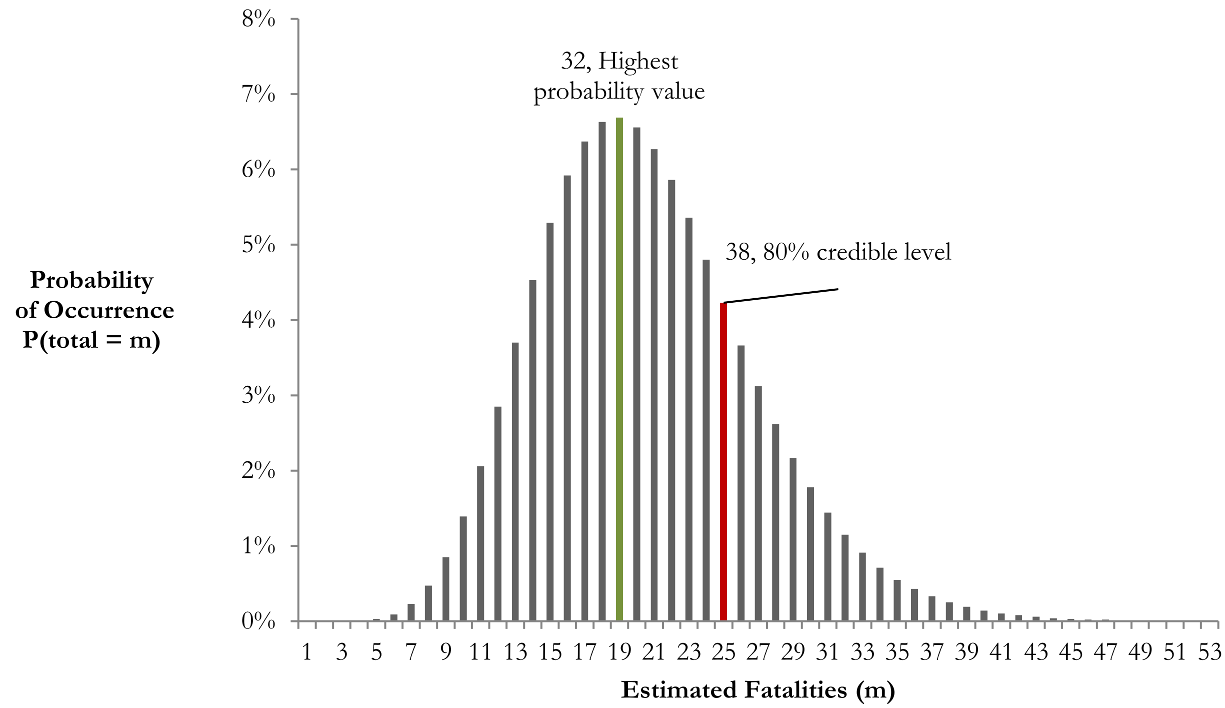
2 DIRECT TAKE

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. 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, 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 actual mortality exceeds the predicted 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.

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



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. This results in a higher take estimate with a greater likelihood that actual mortality will be less than predicted mortality. 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.[12] 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 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

[12] In the EoA output in figure 2a, 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).

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.

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 2b, 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 2a, 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 2a, Item 1).

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

```
================================================================================
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
                                          1
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 M	M*	quantiles of M 0.05	0.10	0.25	0.50	0.75	0.90	0.95	quantiles of M* 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 (2)	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 2b. Output of the EoA Used for Prediction of Future Years Given the 30% Reduction in Take Rate Scenario (Page 2 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

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]
```

3 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 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, Rows 2-5).

4 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 REFERENCES

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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	‘Ulupalakua Ranch	195000	975,000
Pond installation	1	Per gallon	Ulupalakua Ranch	100000	100,000
Person Hours (maintenance, monitoring)	25	Per hour	Tier 1 mitigation costs	8736	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	2,881,460
Adaptive management					
Koa Planting	1,965	Per acre	Forestry Solutions	197.5	463,740
Pond installation	1	Per gallon	‘Ulupalakua Ranch	200,000	200,000
Person Hours (maintenance, monitoring)	25	Per hour	Tier 1 mitigation costs	1150	28,750
				Sub-Total	692,490
				Sub-Total	$3,573,950
				DOFAW Contingency	$178,698
				Total	$3,752,648

Table 2. Funding Assurances

Tier	Category[1/]	One-time Cost[2/]	Cost per year	Year's Effort	Total	Notes
Tier 4	Protection, and restoration	$3,573,950	---	---	$3,573,950	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	Contingency/Adaptive Management	$178,698			$178,698	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		**$3,752,648**			**$3,752,648**	
Other	DLNR compliance	-	$10,000	1	$10,000	Compliance monitoring, cost estimated per year. Auwahi Wind pays annually for costs associated with compliance, The LOC provides insurance for annual costs. The LOC is to be renewed annually and adjusted for inflation.
Total Funding assurance to be provided with the HCP Amendment					**$3,762,648**	
Future Tiers						
Tier 5[2]	Additional mitigation	$1,880,330	---	---	$1,880,330	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]	Contingency/Adaptive Management	$94,016			$94,016	Estimated at 5 percent of mitigation
Total Tier 5		**$1,974,346**			**$1,974,346**	

Tier	Category[1/]	One-time Cost[2/]	Cost per year	Year's Effort	Total	Notes
Tier 6[2]	Additional mitigation	$1,382,595	---	---	$1,382,595	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]	Contingency/Adaptive Management	$69,129			$69,129	Estimated at 5 percent of mitigation
	Total Tier 6	**$1,451,724**			**$1,451,724**	

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.