Auwahi **Wind**

August 31, 2017

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Via Email SUBJECT: Auwahi Wind Farm Project Habitat Conservation Plan FY 2017 (Year 5) Annual Report

Dear Dr. Sether and Ms. Cullison:

Please find the attached annual report for the Auwahi Wind Farm Project Habitat Conservation Plan (HCP), prepared in compliance with the conditions of U.S. Fish and Wildlife Service Incidental Take Permit (ITP) TE64153A-0 and Department of Land and Natural Resources Incidental Take License (ITL) ITL-17. This annual report covers monitoring and mitigation activities conducted from July 1, 2016 through June 30, 2017.

The report identifies each HCP requirement and ITP/ITL condition completed, ongoing requirements and conditions, compliance status, and basis for determining compliance. Also, in compliance with HCP monitoring requirements, a post-construction mortality monitoring update is included. This update summarizes the results of monitoring conducted July 1, 2016 – June 30, 2017. Detailed reports providing updates on Hawaiian petrel mitigation, Hawaiian hoary bat research, and Blackburn's sphinx moth mitigation are included as attachments to this report. Hawaiian goose mitigation has been completed.

Should you have any questions on this annual report, please feel free to contact me at (808) 876-4100 or via email at gakau@sempraglobal.com.

Sincerely,

George Akau
Project Biologist/Auwahi Wind Farm

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Auwahi Wind Farm Habitat Conservation Plan FY 2017 Annual Report

Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17

Submitted To:

Sempra Renewables Auwahi Wind

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August 2017

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1.0 Introduction

In January 2012, Auwahi Wind Energy, LLC (Auwahi Wind) finalized a Habitat Conservation Plan (HCP) for the construction and operation of the 21-megawatt Auwahi Wind Farm Project (Project) in east Maui, Hawaii (Tetra Tech 2012a). The HCP was developed to obtain incidental take permit (ITP) number TE64153A-0 from the U.S. Fish and Wildlife Service (USFWS), and incidental take license (ITL) number ITL-17 from the Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), both of which authorize incidental take for the Hawaiian petrel (*Pterodroma sandwichensis*), Hawaiian goose (*Branta sandvicensis*), Hawaiian hoary bat (*Lasiurus cinereus semotus*), and Blackburn's sphinx moth (*Manduca blackburni*), collectively Covered Species. DOFAW issued the ITL on February 9, 2012, and USFWS issued the ITP on February 24, 2012, each with a term of 25 years.

This report provides a summary of monitoring and mitigation activities that have occurred during Fiscal Year (FY) 2017 (from July 1, 2016 to June 30, 2017). The following subsections provide an overview of post-construction mortality monitoring (PCMM) and mitigation activities and address other required annual reporting items as identified in the HCP, an annual work plan for the upcoming year, and annual cost expenditures as required under the ITP/ITL. Auwahi Wind successfully met all permit conditions in FY 2017 (Table 1-1). Detailed reports providing updates on Hawaiian petrel mitigation, Hawaiian hoary bat research being conducted by the U.S. Geological Survey (USGS), and Blackburn's sphinx moth mitigation efforts continued by Leeward Haleakalā Watershed Restoration Partnership are included as attachments to this report. Completion of the Hawaiian goose mitigation was documented in the FY 2013 HCP annual report (Tetra Tech 2013).

Table 1-1. Summary of compliance status FY 2017.

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
PCMM at the Project				
Project biologist	HCP, Section 4.2.1 and 7.1.1	To be on-staff during Project operations	In compliance; ongoing	Project biologist has been on staff since project began operations in December 2012.
PCMM	HCP, Section 7.1.1 & PCMM Plan	Intensive monitoring will occur years 1, 2, 7, 12, 17, and 22 (total of 6 years, includes carcass removal and searcher efficiency trials)	In compliance; ongoing	Monitoring commenced in December 2012 and is ongoing. PCMM results for FY 2017 are provided in Section 2 of this report.
Wildlife education and incidental reporting program	HCP, Section 7.11	Prior to and throughout operations	In compliance; ongoing	A wildlife education and incidental reporting program was initiated during construction and is ongoing. Three fatalities were reported via this program in FY 2017. Wildlife education and reporting protocol training was provided to 99 contractors in FY 2017.
Notify DLNR and the USFWS whenever a species protected by the Migratory Bird Treaty Act (MBTA) or a listed species is found dead or injured, or if there are observations of seabirds attracted to construction lighting	ITP Conditions L(i)	Via telephone within 24 hours and in a written report within five calendar days	In compliance; ongoing	Six fatalities were listed species (Hawaiian hoary bats) and three fatalities were MBTA in FY 2017.
Report to DLNR of any mortalities, injuries, or disease related to the Covered Species	ITP Condition L(iv)	Within 3 days		
Table summarizing fatalities documented during PCMM	ITP Condition L(iv)	Semi-annually	In compliance; ongoing	Semi-annual table submitted to USFWS/DOFAW January 15, 2017 Fatalities documented during FY 2017; provided in Section 2 of this report, Table 2-3.
Semi-annual progress report	ITP Condition L(ii)	Annually in February	In compliance; ongoing	Semi-annual progress report submitted to USFWS/DOFAW April 5, 2017. The next semi-annual progress report will be submitted in February 2018.

Table 1-1. Summary of Compliance Status FY 2017.

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
Hawaiian Hoary Bat Mitigation				
Conservation easement for the Waihou Mitigation Area (Tier 1 mitigation)	HCP, Section 6.2.1	Within 210 days of ITP/ITL issuance or the initiation of vertical construction of the turbines, whichever comes sooner; easement extension granted by DOFAW	In compliance; completed	Recorded conservation easement with the Hawaiian Islands Land Trust to preserve the Waihou Mitigation Area in perpetuity on December 18, 2012.
Install new ungulate-proof fencing or retrofit cattle fencing around the Waihou Mitigation Area (Tier 1 mitigation)	HCP, Section 6.2.1	Initiate within first year of permit issuance and complete within two years of permit issuance (February 9, 2014)	In compliance; completed	Installation complete September 2013.
Remove ungulates from within Waihou Mitigation Area fence line (Tier 1 mitigation)	HCP, Section 6.2.1	Initiate after ungulate proof fence is completed	In compliance; completed	Ungulates removed in March of 2014. Quarterly fence inspections continue to ensure fence stability and area remains ungulate free.
Conduct vegetative restoration activities, including removal of invasive species and native reforestation (Tier 1 mitigation)	HCP, Section 6.2.1, Table 6-3	Initiate after ungulate proof fence is completed	In compliance; ongoing	Semi-annual removal of target invasive species conducted in October 2016/February 2017 Total of 41 acres of native trees and shrubs out-planted. Ongoing maintenance
Acoustic monitoring at the wind farm (Tier 1mitigation)	HCP, Table 6-2	Years 1 and 2 of operation	In compliance; completed	Initiated July 2013, completed in December 2015. Results provided in FY 2016 HCP annual report (Sempra Energy 2016).
Hawaiian hoary bat research plan (Tier 2 mitigation)	HCP, Section 6.2.2	Draft research plan submitted to USFWS/DOFAW within 1 year of issuance of ITP; finalize within 2 years of ITP issuance and before the start of the study.	In compliance; ongoing	Final plan submitted in cooperation with USGS to USFWS/DOFAW in February 2014. Plan approved by USFWS/DOFAW in March 2014. Plan implemented March 2015.
Hawaiian hoary bat research continued (Tier 3 mitigation)	HCP, Section 6.2.3	Use research in Tier 2 to evaluate appropriate mitigation – additional area for bat habitat restoration or conduct additional research.	In compliance, ongoing	Final Tier 2 & 3 research plan submitted in cooperation with USGS and USFWS/DOFAW and approved May 2016. Funding allocated, implemented first quarter FY 2017.
Predator control at the Kahikinui Petrel Management Area (Tier 1 mitigation)	HCP, Section 6.3.5; Petrel Management Plan	Auwahi Wind will begin predator control within the first year of operation	In compliance; ongoing	Full implementation of predator control in February 2014. Results from 2016 provided in Attachment 2.

Table 1-1. Summary of Compliance Status FY 2017.

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
Hawaiian Petrel Mitigation				
Petrel burrow surveys (Tier 1 mitigation)	HCP, Section 6.3.6, Table 6-6	Burrow monitoring will occur annually for first 3 years; an additional 5 years of monitoring will occur at certain points during the life of the mitigation	In compliance; ongoing	Conducted petrel burrow surveys 2012 –2015; 2016 burrow surveys started in March and will continue through November 2017. Results from 2016 provided in Attachment 2.
Blackburn's Sphinx Moth Mitigation				
Funding to LHWRP to restore 6 acres of dryland forest in the Auwahi Forest Restoration Project	HCP, Sections 4.2.3 & 6.5.1, Table 6-2	First payment to LHWRP within 30 days of obtaining permit and remainder of funds paid within 3 months	In compliance; ongoing	Full payment to LHWRP on April 17, 2012. A letter from LHWRP summarizing status of restoration is provided in Attachment 4.
Hawaiian Goose Mitigation				
Research or management funding ($25K) provided to Haleakalā National Park Service (NPS)	HCP, Section 6.4, Table 6-2	Within 60 days of obtaining permit	In compliance; completed	Full payment to NPS April 17, 2012. A letter from the NPS summarizing the status and use of funds is provided in FY 2013 HCP annual report (Tetra Tech 2013).
Red 'Ilima (*Abutilon menziesii*) Mitigation				
'Ulupalakua Ranch will plant 10 red 'ilima from its on-going conservation efforts. Report plant survival (3 years)	HCP, Section 4.2.3	After construction/site restoration is complete	In compliance; completed	Plants propagated at the 'Ulupalakua Ranch nursery in 2013. They were successfully out-planted and are thriving. Plant survival reported in Section 3.4.
Fire Management Plan (FMP)				
Implementation of FMP associated with lands owned by 'Ulupalakua Ranch	HCP, Section 4.2.4; Fire Management Plan	Education of employees, fuel reduction in high priority areas via grazing, firebreaks in high priority areas, and construction/availability of a water source to fire department	In compliance; ongoing	Annual review and management of FMP with 'Ulupalakua Ranch, ongoing employee, training, water source (site well) available to fire department. Irrigation system installed in FY 2017. Vegetation control for fuel reduction conducted monthly through contracted landscape company, Pono Pacific. Landing zone and staging area for firefighting efforts maintained in FY 2017.

2.0 Post-construction Mortality Monitoring

Auwahi Wind's HCP lays out a long term monitoring approach consisting of two years of intensive monitoring followed by interim years of less intensive but systematic monitoring. PCMM was initiated in December 2012. During the commissioning period (December through mid-January) heavy construction equipment and operations in the near vicinity of the turbines limited the searching to pads and roads. Beginning January 25, 2013, standardized carcass searches beneath all eight turbines and the met tower, carcass persistence trials, and searcher efficiency trials began following the schedule and methods outlined in detail in the FY 2013 HCP annual report (Tetra Tech 2013). December 2014 marked the end of intensive monitoring across the entire plot. Beginning January 2015, systematic searches have continued across pads and roads at a 3- to 4-day interval.

A Migratory Bird Special Purpose Utility permit (Permit No. MB92518A-0) for handling migratory bird carcasses was issued by USFWS on December 10, 2012. A State Protected Wildlife Permit (Permit No. WL17-08) for handling native bird and bat carcasses was reissued by DOFAW on May 12, 2017. Both permits are valid through March 31, 2018.

Table 2-1. Post-construction mortality monitoring summary, FY 2017.

Variable	Systematic (July 2016 – June 2017)
Study Metrics for Fatality Estimates	
Total number of Project turbines	8[1]
Number of turbines searched	8[1]
Sample plot size	Pads and roads within 100-meter (328-foot) radius of turbine
Met tower search plot size	10 meters (33 feet) around the base of the met tower
Search interval	3 days (July 2016 – February 2017); 4 days (March – June 2017)
Fatalities of Covered Species	
Hawaiian Petrel	
Number of fatalities documented	0
Indirect take	0
Hawaiian Goose	
Number of fatalities documented	0
Indirect take	0
Hawaiian Hoary Bat	
Number of fatalities documented	6
Indirect take	~3 (indirect take will be officially calculated when genetic testing results become available)
Fatalities of Other Species[2]	
Fatalities found during searches	9
Fatalities found incidentally	3

[1]One turbine was not operational and not searched, as it poses no risk to wildlife, from October 2, 2016 through June 30, 2017
[2]Includes three MBTA species fatalities

2.1 Systematic Carcass Searches

It was agreed by USFWS/DOFAW (December 12, 2014) that Auwahi Wind could begin systematic searches in January 2015. Systematic searches were conducted along all pads and roads within a 100-meter (328-foot) radius of turbines July 1, 2016 – June 30, 2017. Linear transects, spaced approximately 6 meters (20 feet) apart, were established within each search area, with searchers scanning out to 3 meters (10 feet) on each side of the transects. Searches were conducted at 3 day intervals from July 2016 - February 2017 and at 4-day intervals from March – June 2017. The search interval was lengthened in response to improved carcass persistence times associated with adjustments to the scavenger control program. The search area size and configuration varied among turbine pads. Based on carcass distributions compiled by Tetra Tech from 25 publicly available studies, the areas searched at the Project represented a total of 56 percent of the large-bird distribution and 76 percent of the bat distribution, which are consistent with results based on a theoretical carcass distribution model (Hull and Muir 2010).

Table 2-2. Average search interval between standardized carcass searches at the Auwahi Wind Project, FY 2017.

Month	Average Search Interval (days)[1]
July	3
August	3
September	3
October	3[2]
November	3
December	3
January	3
March	4
April	4
May	4
June	4

[1]Includes all operational turbines and meteorological tower
[2]Turbines were deenergized during part of the month of October and not searched during this time; upon being reenergized the 3-day search interval was reinitiated.

Eighteen fatalities were documented in FY 2017; fifteen of these fatalities were documented during systematic carcass searches (Table 2-3). Three fatalities recorded were species covered under the MBTA, two great frigatebirds (*Fregata minor*) and one white-tailed tropicbird (*Phaethon lepturus*). Six fatalities were Covered Species, all being Hawaiian hoary bats. No fatalities have been observed at the met tower.

Table 2-3. Documented fatalities at the Auwahi Wind Project, including threatened and endangered (T&E) FY 2017.

Species	Legal Status[1]	Found Date	Location (Turbine)	Type of Detection
Hawaiian Hoary Bat	T&E	07/07/2016	2	Systematic
Hawaiian Hoary Bat	T&E	08/15/2016	2	Systematic
Gray Francolin	None	08/21/2016	7	Systematic
Hawaiian Hoary Bat	T&E	08/30/2016	8	Systematic
Hawaiian Hoary Bat	T&E	09/02/2016	1	Systematic
Great Frigatebird	MBTA	09/05/2016	5	Systematic
Spotted Dove	None	09/11/2016	6	Systematic
Great Frigatebird	MBTA	09/14/2016	4	Systematic
White-tailed Tropicbird	MBTA	09/17/2016	3	Systematic
Hawaiian Hoary Bat	T&E	09/26/2016	3	Systematic
Hawaiian Hoary Bat	T&E	09/29/2016	2	Systematic
Common Myna	None	10/26/2016	1	Systematic
Black Francolin	None	11/10/2016	8	Systematic
House Sparrow	None	11/16/2016	3	Systematic
Common Myna	None	03/09/2017	4	Incidental
Zebra Dove	None	04/10/2017	1	Incidental
Common Myna	None	05/08/2017	6	Systematic
Zebra Dove	None	05/12/2017	1	Incidental

[1]T&E = Protected under the Endangered Species Act as threatened or endangered species; MBTA = Protected under the Migratory Bird Treaty Act; None = Introduced species without legal protection.

2.2 Carcass Persistence Trials

Three carcass persistence trials were conducted during FY 2017, and are summarized together for each carcass size class in Table 2-4. Each trial had a minimum of five carcasses per size class. Wedge-tailed shearwaters (*Ardenna pacificus*) and cattle egrets (*Bubulcus ibis*), were used as surrogates for large birds, and medium sized black rats (*Rattus rattus*) were used as surrogates for bats.

Carcasses were placed at randomly generated points on turbine pads and roads within active search plots. Carcasses were checked daily until they were no longer detectible or the 21-day trial period was complete. Changes in carcass condition were tracked and documented with photos. Detailed description of field methods are included in Attachment 1 of the 2013 HCP annual report (Tetra Tech 2013). Estimates of carcass probability and 95 percent confidence intervals for each carcass category were calculated using the single class module of Evidence of Absence software (EoA; Dalthorp et al. 2017).

Auwahi Wind has implemented continual predator control on site since the fall of 2013. The probability that a carcass would persist until the next search remained high in FY 2016 (Table 2-4). The probability of persistence increased for bats from FY 2016. Similar to trials conducted in the other years of operation, most large birds persisted through the entire 21-day trial period resulting in a very high probability of persistence until the next search in FY 2017.

Table 2-4. Carcass persistence estimates for systematic searches at the Auwahi Wind Project, FY 2017.

Carcass Size Class	N	Probability of Carcass Persistence until Next Search	95 Percent Confidence Interval	Search Interval
Bats	33	0.94	0.87 – 0.98	3 – 4
Large birds	26	1.00	1.00 – 1.00	3 – 4

2.3 Searcher Efficiency

Searcher efficiency trials were conducted during FY 2017. These trials incorporated the assessment of each member of the field staff and were conducted by the Project biologist (tester) on site. All trials were conducted so that the searchers being assessed had no prior knowledge of the trial; every fatality search day was treated as if it had the potential to be a searcher efficiency trial day. Twenty-eight searcher efficiency trial days occurred during FY 2017, consisting of 53 individual trials. Wedge-tailed shearwaters and cattle egrets were used as surrogates for large birds, and medium sized black rats and bat decoys were used as surrogates for bats.

For all trials, turbines were randomly selected for trials (turbine 4 was removed from trials in October, as it has not operated since then). On each trial day, one to five carcasses were placed in the field. Carcasses were placed at randomly generated points within the selected turbines' search plots. All trial carcasses were retrieved by the end of each trial day. If a trial carcass was not found by searchers, the tester would go out to the location and attempt to retrieve the trial carcass. If not found by the searcher or the tester, the carcass was assumed to have been scavenged and thus unavailable to be found by searchers and omitted from the analysis. Estimates of searcher efficiency and 95 percent confidence intervals for each carcass category were calculated using the single class module of EoA (Dalthorp et al. 2017).

Searcher efficiency for large birds remained high (above 90 percent), and searcher efficiency for bats was estimated at 61 percent. Throughout FY 2017 fatality searches were restricted to pads and roads, where regularly scheduled vegetation management improves the detectability of trial carcasses.

Table 2-5. Searcher efficiency estimates for systematic searches at the Auwahi Wind Project, FY 2017.

Carcass Size Class	Number Placed[1]	Number Found	Average Searcher Efficiency	95 Percent Confidence Interval
Bats	33	20	0.61	0.44 – 0.76
Large birds	20	19	0.95	0.79 – 1.0

[1]Excludes carcasses that were placed in the field but removed by scavengers prior to the survey (i.e., were not available to be found by searchers or tester).

2.4 Take

2.4.1 Direct Take

To ensure an accurate measurement of take and verify compliance under the ITL/ITP, fatality rates are adjusted based on the PCMM results. During the four and a half years of monitoring at the Project, there were 14 fatalities of Covered Species (13 Hawaiian hoary bats and one Hawaiian petrel). To account for unobserved fatalities, statistical models or estimators are used for calculating fatality rates. Given the limitations of the available statistical tools when dealing with small sample sizes, Auwahi Wind and USFWS/DOFAW agreed to use the EoA software in a meeting on April 17, 2015. EoA software was developed to provide an estimate of the probability, with a user-defined level of credibility, that the number of fatalities has not exceeded a given threshold. An updated version was released in July 2017 (Dalthorp et al. 2017). Interpretation of model output presents a regulatory challenge with respect to determining whether or not a take limit has been reached or exceeded because the EoA does not produce an exact estimated number of fatalities (i.e., a point estimate of take).

The agreed upon approach uses two pieces of information produced by the EoA to evaluate the likelihood that the number of fatalities has reached or exceeded the take limit: 1) The "maximum likelihood value" or where the probability of number of fatalities is greatest; and (2) The one-sided confidence interval surrounding the "most likely value," based on a credibility level of 80 percent.

Auwahi Wind used the EoA software and ran the model with PCMM data collected over the past 4.5 years for bats and large birds (Table 2-6). Because the fiscal year does not coincide with Project's operational year, the observed fatalities, carcass persistence, searcher efficiency, and detection bias values in Table 2-6 represent values for operational years, with the period from January 1, 2017 through June 30, 2017 representing year 5. Therefore values differ from those reported for the full FY 2017 in the sections above. We estimated an upper limit for potential Project direct take using an 80 percent credibility level for bats and large birds (Attachment 1).

Table 2-6. Summary of PCMM data at the Auwahi Wind Project, FY 2013 – FY 2017.

Year	Curtailment (5m/s)	Carcass Size Class	Number of Fatalities Detected	Proportion of Carcass Distribution Searched	Average Search Interval (days)	Probability of Persistence	Average Searcher Efficiency (%)	Detection bias[1]
1	No	Bats	1	0.97	9	0.44	0.57	0.28
2	No	Bats	4	0.94	5	0.75	0.52	0.55
3	Yes	Bats	1	0.76	3	0.73	0.68	0.45
4	Yes	Bats	7	0.76	3	0.76	0.76	0.55
5	Yes	Bats	0	0.76	3-4[2]	0.93[2]	0.64[2]	0.59[2]
1	No	Large birds	1	0.91	9	0.79	0.74	0.67
2	No	Large birds	0	0.91	5	0.98	0.75	0.84
3	Yes	Large birds	0	0.56	3	0.99[3]	0.89	0.55[3]
4	Yes	Large birds	0	0.56	3	0.96	0.96	0.48
5	Yes	Large birds	0	0.56	3-4	1.0	0.92	0.39

[1]Detection bias calculated using Evidence of Absence software (Dalthorp et al. 2017)
[2]Detection bias calculated using pooled data with custom search interval in single class module from Evidence of Absence software.
[3]Derived from year 2 (FY 2014) bias correction trials conducted within year 3 (FY 2015) search area.

Based on the 13 bat fatalities detected during 4.5 years of surveys, the "maximum likelihood value" is 26 direct take although the probability that the total direct take is exactly equal to 26 is only 7.2 percent (Figure 1). It can be asserted with 80 percent certainty that the number of direct take ranged from 13 to 33 over this survey period (Attachment 1). Auwahi Wind is 80 percent certain that no more than 33 direct take have occurred.

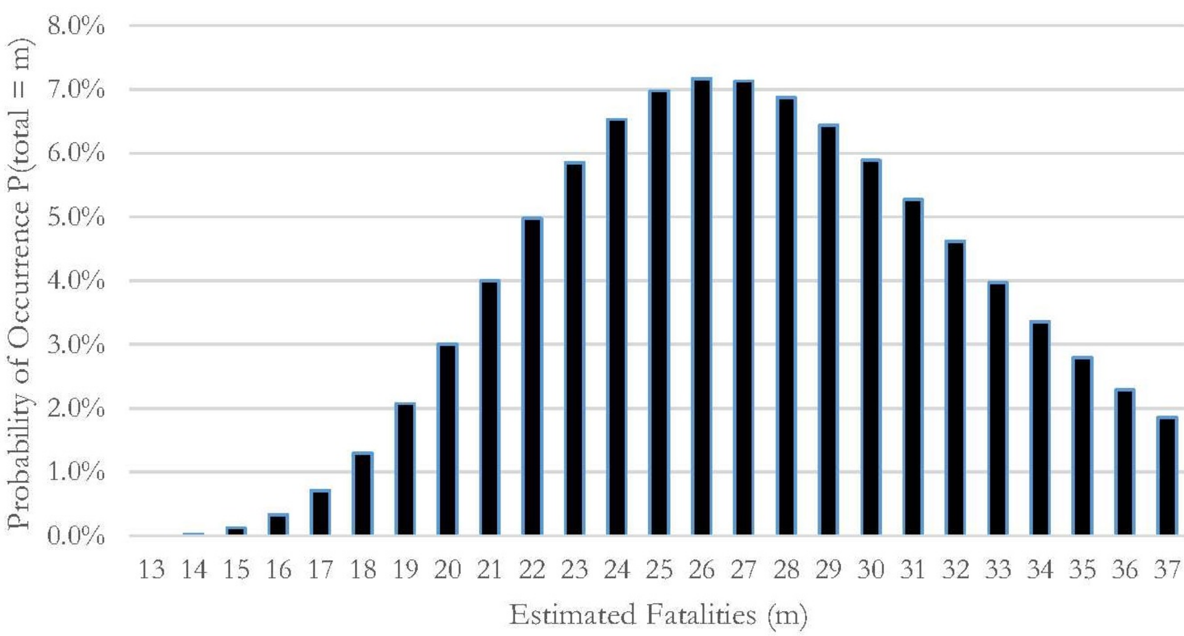

Figure 1. Posterior probability distribution for Hawaiian hoary bats using the Evidence of Absence software (Dalthorp et al. 2017).

Based on the one Hawaiian petrel fatality detected during 4.5 years of surveys, it is most likely that one direct take occurred. Bias correction trials from year 3 were derived from year 2 trials conducted in the year 3 search areas (pads and roads). It can be asserted with 80 percent certainty that the number of fatalities ranged from 1 to 3 over this survey period (Attachment 1). Auwahi Wind is 80 percent certain that no more than three direct take have occurred. Examining the posterior distribution, we see the "maximum likelihood value" is equal to 1, and the chance that total direct take is exactly equal to 1 is 46.3 percent (Figure 2).

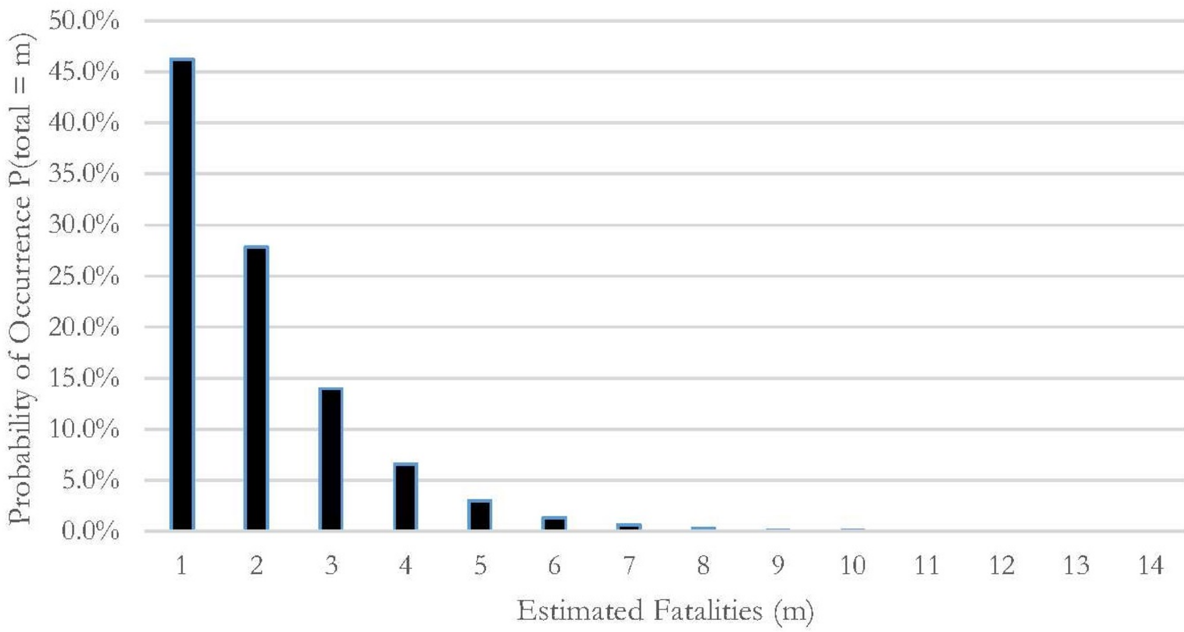

Figure 2. Posterior probability distribution for Hawaiian petrels using the Evidence of Absence software (Dalthorp et al. 2017).

2.4.2 Indirect Take

It is assumed that take of an adult bird or bat during the breeding season may result in the indirect loss of a dependent young. Thus, for every seabird or bat carcass detected during the breeding season, modifiers are applied to estimate indirect take to account for the likelihood that a given adult is reproductively active, the likelihood that the loss of a reproductively active adult results in the loss of its young, and average reproductive success (Auwahi Wind HCP, Section 5.2).

Section 7.1.2 of the approved HCP outlines the reporting process for accounting for indirect take of bat carcasses detected during the breeding season. There have been no confirmed female bat fatalities during the breeding period at Auwahi Wind, although six fatalities were observed during the period when females may be pregnant or supporting dependent young (April 1 – September 15). The sex is unknown for each of these fatalities, but tissue samples have been submitted for genetic testing. Should genetic testing indicate any of these fatalities was a female, Auwahi Wind will reevaluate the potential for the collision-related fatalities to have resulted in indirect take and immediately report results following Section 7.1.2.

The USFWS provided guidance (October 1, 2016) proposing a new standardized process for estimating direct and indirect observed take in the absence of verified gender information in new HCP's and HCP Amendments. At the request of USFWS and DOFAW, this report has utilized the proposed (October 2016)

USFWS methodology as an exercise to provide an interim indication of indirect take pending the results of genetic testing. The indirect take exercise for the Project is calculated as the sum of indirect take resulting from the following components of direct take:

- Observed adult female take occurring during the pup dependency period (April 1 – September 15);
- Observed [adult?] take of unknown sex expected to be female during the pup dependency period; and
- Unobserved take expected to be female and occurring during the pup dependency period.

This exercise in calculating an interim value of indirect take was based on the October 2016 USFWS guidance as follows:

- The average number of pups attributed to a female that survive to weaning is assumed to be 1.8.
- The sex ratio of bats taken through unobserved direct take is assumed to be 50 percent female, unless there is substantial evidence (10 or more bats) to indicate a different sex ratio.
- The assessment of indirect take to a modeled unobserved direct take accounts for the fact that it is not known when the unobserved fatality may have occurred. The period of time from pregnancy to end of pup dependency for any individual bat is estimated to be 3 months. Thus, the probability of taking a female bat that is pregnant or has dependent young is 25 percent.
- The conversion of juveniles to adults is 1 juvenile to 0.3 adults.

Based on the above methodology, the exercise resulted in an interim estimate of indirect take for FY 2017 calculated as:

Total observed female take assumed to have dependent young (April 1 – September 15)

0 (none observed)

Total observed take of unknown sex assumed to have dependent young (April 1 – September 15) [1]

6 (take during breeding season) * 0.5 (assumed sex ratio) * 1.8 (pups per female) = 5.4 juveniles based on observed take.

Total unobserved take of unknown sex assumed to have dependent young (April 1 – September 15)

(33 [80 percent upper credible limit] – 13 [observed direct take]) * 0.5 (assumed sex ratio) * 0.25 (proportion of calendar year females could be pregnant or have dependent pups) * 1.8 (pups per female) = 4.5 juveniles based on unobserved direct take.

Total Interim Estimate of Juvenile Indirect Take = 9.9 (0+ 5.4 + 4.5)

2.5 Wildlife Education and Incidental Reporting

Auwahi Wind implemented a wildlife education and incidental reporting program for contractors, Project staff members, and other ʻUlupalakua Ranch staff who are on site regularly. This annual training enables staff to identify the Covered Species that may occur in the Project area, record observations of these species, and

[1] Auwahi Wind is awaiting genetic testing results to identify the sex of bat carcasses that were too decomposed to determine sex based on morphology. Indirect take will be adjusted when this information becomes available.

take appropriate steps for documenting and reporting any species encountered during the operation of the Project. Auwahi Wind trained 99 contractors and new staff in FY 2017, and three incidental fatalities were reported (Table 2-3).

2.6 Adaptive Management

2.6.1 Minimization Measures and Post-construction Mortality Monitoring Adaptive Management

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

- In an effort to minimize negative hazards associated with operating turbines at low wind speeds, Auwahi Wind voluntarily implemented low wind speed curtailment. On February 5, 2015, Auwahi Wind began feathering turbine blades below a cut-in speed of 5 meters/second, from one hour before sunset until one hour after sunrise, year round.
- 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 as it has not been operational since then) 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 50 – 100 mm (2 – 4 inches) 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.
  Auwahi Wind continues to work with USFWS/DOFAW on interpreting EoA outputs, given the limitations of using probability distributions to interpret an exact estimated number of fatalities (i.e., a point estimate of take).

2.6.2 Tier 2 & 3 Hawaiian Hoary Bat Mitigation

A three-tiered approach to take and mitigation is described in the approved Project HCP for the Hawaiian hoary bat (Tetra Tech 2012a). As a result of significant electromagnetic interference from radio towers, the Tier 3 bat mitigation study was adaptively managed in consultation with USFWS and DOFAW to focus on insect prey base and food habitat assessment objectives that do not rely on telemetry information (Attachment 3). As part of this adaptive management, additional acoustic monitoring is being performed and the level of effort and periods of performance for other elements have been extended. Within FY 2017 this adaptive management included the expansion of acoustic monitoring efforts. One acoustic detector was deployed at the ponds within the mitigation area (April 2017), one acoustic detector was placed at an anchaline pond along the shoreline of the Project area (June 2017), and two detectors were setup in Wiliwili (*Erythrina sandwicensis*) mixed native dryland forest grazing pastures at Auwahi Wind Farm site (June 2017).

2.6.3 Blackburn's Sphinx Moth Avoidance and Minimization

Auwahi Wind continues to implement avoidance and minimization measures for the Blackburn's sphinx moth. Monthly surveys continue to be conducted for Blackburn's Sphinx moth and manual removal of tree tobacco (*Nicotiana glauca*) has been completed, in addition to translocating any Blackburn's sphinx moth larvae and eggs found on tree tobacco at the Project (USFWS/DOFAW email instructions February 7, 2014). Areas within 33 feet of roadsides and edges of turbine pads are targeted because they may present a hazard for the moth, due to exposure to dust, possible trampling, and increased chance of collisions with vehicles. Through continued maintenance on-site there has been a decrease in plants within hazard areas. During FY 2017 319 plants were removed from the Project with most plants less than three feet tall. In FY 2017, no eggs or larvae were detected during visual surveys of tree tobacco.

3.0 Mitigation

3.1 Hawaiian Petrel Mitigation

Results from the 2016 petrel breeding season are summarized below and fully described in Attachment 2. Beginning August 2013, implementation of the predator control strategy was applied within Kahikinui Petrel Management Area (Kahikinui PMA). This includes predator assessments using tracking tunnels, grid spaced traps targeting areas within a 200-meter (656-foot) buffer of Hawaiian petrel nesting burrows, and deployment of game cameras to monitor for Hawaiian petrel and predator activity. Results of the 2017 breeding season and predator control will be included and summarized in the FY 2018 HCP annual report.

3.1.1 Petrel Burrow Monitoring

Petrel burrows within Kahikinui PMA continued to be monitored during the 2016 breeding season to obtain an estimate of the number of active petrel burrows and reproductive (fledging) success. As in previous years, monitoring protocol followed methods used by the NPS (NPS 2012) and was supplemented with game cameras. Burrows were checked a minimum of once a month March –June, and every other week during the chick rearing and fledgling period, July –mid-November. All burrows were monitored during each check March – July; after July only active burrows were monitored. Four new burrows located in 2016 were marked, mapped, and added to the monitoring dataset. In the 2016 breeding season 68 petrel burrows were monitored, 28 showed signs of activity sometime during the breeding season. Consistent activity through the breeding season was seen at 25 burrows. By the end of the breeding season 8 burrows had successfully fledged a chick. The number of burrows known to have fledged a chick/number of active burrows within the management area was 32 percent. We cannot confirm that all active nests were occupied by breeding birds, according to Simons (1985) 66 – 75 percent of the Hawaiian petrel burrows determined to be active contained eggs. The percentage of chicks fledged per egg laid within the management area was 32 – 67 percent. The range represents the difference between using only those nests known to have eggs laid and assuming all active nest had eggs laid (i.e., burrows classified as failed or occupied by a non-breeder). We were able to determine the known fates of 12 burrows: eight successfully fledged and four failed (three during the egg laying stage, and one predated chick).

3.1.2 Predator Control

Auwahi Wind worked with Island Conservation and Tetra Tech to develop a predator control strategy for Kahikinui PMA based on site-specific conditions and Island Conservation's expertise. The 2013 & 2015 Petrel Monitoring Report summarizes in detail the results of predator control in the breeding season. In the 2016 breeding season, Auwahi Wind continued to deploy tracking tunnels to assess rat and mongoose activity across the entire 324-hectare (801-acre) Kahikinui PMA at the start and halfway through the breeding season. Results of the activity index point to seasonal and annual fluctuations in both rodent and mongoose activity throughout Kahikinui PMA. Trapping for the season commenced on March 14, 2016 and ran through November 23, 2016. A total of 119 traps were deployed across Kahikinui PMA, resulting in 26,740 trap nights. Trap types included: 11 Belisle body grip, 33 Doc250, 47 Goodnature self-loader, and 28 Victor foothold traps (equipped with OMNI M2M remote sensor technology). All traps were checked and baited every two weeks. Baits were alternated between trap checks. Trapping efforts over this time resulted in removal of 65 predators, including cats, Polynesian rat (*Rattus exulans*), black rat, and house mouse (*Mus musculus*). An additional five traps were donated to the Maui Nui Seabird Recovery Project, and two traps to the Maui Forest Bird Recovery Project and Haleakalā National Park Service, which conducted predator control in the adjacent Kahikinui Natural Area Reserve and Haleakalā National Park. These traps removed an additional 5 predators.

3.1.3 Benefits

Auwahi Wind has measured reproductive success of Hawaiian petrels within Kahikinui PMA for the past five years as well as baseline predator activity for the past three years. In accordance with assumptions in the HCP, predator control conducted by Auwahi Wind is anticipated to have had a positive effect on the reproductive success of Hawaiian petrels within Kahikinui PMA, and may also have reduced predation in adjacent areas managed by NPS (Haleakalā National Park), Maui Nui Seabird Recovery Project (State of Hawaii Kahikinui Natual Area Reserve), Leeward Haleakalā Watershed Partnership (State of Hawaii Department of Hawaiian Homelands) and the National Science Foundation - Daniel K. Inouye Solar Telescope (DKIST). Ongoing monitoring continues to benefit the petrel colony by providing new information on the extent of the colony, reproductive success, and fledging activity, which were previously unknown. Over the course of four years, 16 new burrows have been located, adding to the originally 54 burrows located with extensive surveys in 2012. Deployment of Reconyx cameras have also given the scientific community unique insight into the activity and exact fledging dates of Hawaiian petrels within the East Maui population.

The number of burrows existing within the Kahikinui PMA colony is not consistently at the level needed to ensure that the success criteria for Tier 1 mitigation under the HCP are met. The original HCP included a demographic model which assumed an average of 33 active burrows and a reproductive success rate of 60 percent with predator trapping (see Table 6-4 in the original HCP); however, on average there have been 28 active burrows monitored each year between 2013–2016 (ranging from 25 to 33) and an average reproductive success rate of approximately 35 percent (see Attachment 2). Therefore, the assumed benefit of predator control based on the available number of active burrows in the Kahikinui PMA is not sufficient to produce enough adult petrels, based on estimated population growth, to offset the amount of authorized petrel take under the ITP. Therefore, Auwahi Wind proposes to continue petrel mitigation efforts at the Kahikinui PMA in the 2017 and 2018 breeding season, and then transition mitigation efforts (monitoring and predator control) to the adjacent DKIST site in 2019 to overtake the management of 80 active burrows at that site. Such a transition was identified as a potential adaptive management option within the Auwahi Wind's approved HCP if the mitigation efforts at the Kahikinui PMA colony were insufficient to provide the necessary benefit (Tetra Tech 2012a). Given the reported reproductive success at the DKIST site, predator control is expected to produce enough petrels to meet Tier 1 mitigation success criteria by the end of the permit term. See Attachment 2 for additional detail.

3.2 Hawaiian Hoary Bat Mitigation and Monitoring

Implementation of Tier 1 – 3 bat mitigation is on-going at the Waihou Mitigation Area, located on ʻUluplalakua Ranch. Tier 1 mitigation consists of the restoration of native forest on approximately 130 acres of pastureland in the Waihou Mitigation Area, specifically the Puʻu Makua parcel (including installation of an ungulate proof fence, ungulate removal and native reforestation). This parcel was placed into a conservation easement held by the Hawaiian Islands Land Trust on December 18, 2012 and will be protected in perpetuity. Tier 2 mitigation consists of funding Hawaiian hoary bat research to contribute to the overall knowledge of the Hawaiian hoary bat on Maui. Tier 3 mitigation expands on the bat research approved for Tier 2. All tiers of mitigation have been funded and are being implemented in accordance with mitigation plans approved by USFWS and DOFAW.

Auwahi Wind also installed two ground-based detectors (Wildlife Acoustics SM2-XBat) at the Project site and collected acoustic data for the first two years and a half years of operations. Methods and results of this study are presented in the FY 2016 HCP annual report (Sempra Energy 2016).

3.2.1 Tier 1 Mitigation

The Waihou mitigation area was identified for Tier 1 bat mitigation (Auwahi Wind HCP, 2012) and an ungulate fence was built around the Puʻu Makua parcel. Three other parcels were identified for bat mitigation as part of the Waihou mitigation area including Duck Ponds, Cornwell, and Kaumea Loko. The goal of constructing an ungulate proof fence and establishing native plant reforestation areas for Tier 1 mitigation is to provide protection for Hawaiian hoary bat foraging and roosting habitat (Tetra Tech 2012a). Measures of success for bat mitigation are identified as:

- After 6 years, mitigation fencing is completed and ungulates have been removed from within the fenced area, and over the 25-year permit term the fence is maintained and the area is kept free of ungulates.
- After 25 years, the cover of invasive species (excluding kikuyu grass [*Pennisetum clandestinum*]) in the managed areas is less than 50 percent.
- After 25 years, reforested areas within the Waihou mitigation area have greater than 50 percent cover dominated by native woody species (particularly koa [*Acacia koa*] and ʻōhiʻa [*Metrosideros polymorpha*]). According to Wagner et al. (1999), mature koa/ʻōhiʻa montane mesic forests "consist of open-to-closed uneven canopy of 35 m tall koa emergent above 25 m tall ʻōhiʻa (Tetra Tech 2012a).

Target invasive species have been removed and biannual vegetation management activities will continue to maintain target invasive species coverages well below the 50 percent required. Tree poppy (*Bocconia frutecens*) has been removed from the management area but is found in high numbers throughout the ʻUlupalakua ranch property. It sprouts readily where vegetation management activities create cleared areas (e.g., areas that are cleared of pasture grasses to the barren soil in preparation for out-planting native species). Management for this species consists primarily of hand pulling seedlings. Another target invasive species that poses a risk due to its ability to quickly propagate as a result of the surrounding seed bank and its biology is black wattle (*Acacia mearnsii*). Mature black wattle forests are found along the northern and eastern boundary of the Puʻu Makua fence boundary. Quarterly fenceline checks performed to monitor fence integrity have incorporated the creation and maintenance of a 10-15 foot buffer of target invasive species. The majority of black wattle removal is performed along the fenceline in conjunction with quarterly fenceline checks. Other identified target invasive species including tropical Ash (*Fraxinus uhdei*) and Monterey pine (*Pinus radiata*) have been observed to be slower at recovering from initial targeted sweeps, and maintenance of these species require less effort than tree poppy and black wattle.

Auwahi Wind completed native tree out-planting in FY 2016, with over 40 acres out-planted in open pasture within the Puʻu Makua site (Sempra Energy 2016). Over 13,000 plants, spaced 2 – 4 m apart, were planted in plots 0.25 – 2 hectares (0.5 – 4.5 acres) in size. Plots were prepared with a weed trimmer and treated with herbicide prior to planting to reduce competition with non-native grasses. Plants out-planted were predominately koa, ʻōhiʻa, aʻaliʻi (*Dodonea viscosa*) and māmane (*Sophora chrysophylla*). Some specialty native plants were mixed into out-planting efforts to create more diversity within plots. These specialty plants included māmaki (*Pipturus albidus*), kāwaʻu (*Ilex anomala*), halapepe (*Chrysodracon auwahiensis*), ʻōhelo (*Vaccinium reticulatum*), and ʻōhe mauka (*Polyscias hawaiensis*).

Follow-up management within the planted plots continued in FY 2017 and has included suppression of non-native grass and blackberry (*Rubus argutus*). The expectation is that grasses will need to be treated once a year after initial planting, for 2 – 3 years, to ensure slow-growing trees are established above grasses. Additionally, plots will be revisited after 1-2 years and unsuccessful plants will need to be replaced with new plants. Wilt resistant koa seedlings were purchased from the Hawaii Agriculture Research Center in FY 2017. These koas will be used to replace unsuccessful out-plantings within established restoration units in FY 2018.

Puʻu Makua reforestation and vegetation management efforts were monitored in FY 2017 by plant species coverage surveys (line-intercept), out-planting plot survivorship surveys, and established photo points. For FY 2017, recorded native woody species coverage was 26.8 percent. Auwahi Wind is in year 3 of monitoring with baseline conditions established in 2014. Auwahi Wind has exceeded the identified interim measures of success of 75 percent of out-plantings surviving with an average plot survival rate of 87 percent (range of survival by plot 23-100 percent) and invasive species cover of less than 65 percent (observed 0.01 percent). .

3.2.2 Tier 2 and 3 Mitigation

Auwahi Wind worked with Tetra Tech and Dr. Frank Bonaccorso from the U.S. Geological Survey (USGS) to develop a research project combining radio telemetry and acoustic monitoring. The goal of this study is to contribute to the knowledge of the Hawaiian hoary bat on Maui and also to track the success of restoration efforts in the Waihou Mitigation Area. The Tier 2 research plan was approved by USFWS/DOFAW in March 2014 (Sempra Energy 2014). 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 in May 2016. This combined 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).

Auwahi Wind began implementing the approved Tier 2 research plan in March of 2015. The Tier 2 research plan study includes acoustic monitoring, used to establish a baseline of seasonal occupancy for bats within the mitigation area and to focus subsequent mist-netting and radio-telemetry efforts. Six acoustic detectors have been operational within the Puʻu Makua parcel (four within fence) and surrounding areas (two outside fence) since March of 2015. Acoustic data cards are collected every 3 – 6 months.

Auwahi Wind began implementing the approved Tier 3 research plan in October of 2016 however, telemetry efforts were thwarted by electromagnetic interference of the transmitter signals by nearby radio transmission towers. The Tier 3 research plan was then adaptively managed in consultation with USFWS and DOFAW with a focus on other components of the study including the insect prey base study and a food habitat assessment. Research objectives for Tier 2 and 3 mitigation completed in FY 2017 are summarized by USGS in Attachment 3.

3.2.3 Benefits

Completion of the fence, removal of ungulates, and habitat restoration will benefit the Hawaiian hoary bat through the creation and protection of roosting and foraging habitat. Acoustic monitoring at the Project provides site-specific information on activity patterns and could be used in conjunction with other monitoring projects to acquire an island-wide understanding of Hawaiian hoary bat activity on Maui. Research has been identified as an important recovery action under the Hawaiian hoary bat recovery plan (USFWS 1998), and as an HCP mitigation action in the ESRC Bat Guidance (DOFAW 2015). Tier 2 and 3 mitigation research plan funds bat research whose results will contribute to closing important gaps in the understanding of the species. Specifically, Auwahi Wind's research will fill in gaps in our knowledge of Hawaiian hoary bat diet, prey availability, and plant/prey associations. The results of this data should improve our understanding of how to manage habitat to benefit the Hawaiian hoary bat. Initial research has already identified pasture and water features that are being used for foraging by the Hawaiian hoary bat, and developing a nuanced understanding of how such features support the bat's life history requirements will be an important step in improving Hawaiian hoary bat mitigation efforts.

3.3 Blackburn's Sphinx Moth

As stated in the 2012 HCP annual report (Tetra Tech 2012b), Auwahi Wind developed a Memorandum of Understanding (MOU) and made a one-time payment of $144,000 to the Leeward Haleakalā Watershed Restoration Project on April 17, 2012, to restore 6 acres of dryland forest at the Auwahi Forest Restoration Project. A letter from the Auwahi Forest Restoration Project providing an update on use of funding during FY 2017 is provided in Attachment 4. A total of 970 of the proposed 1500 'aiea (*Nothocestrum latifolium*) have been out-planted into 4.5 hectares (11 acres). Auwahi Forest Restoration Project is committed to fulfilling their MOU obligations over the next year, although they have continued to express concern over 'aiea seed production.

3.4 Red 'Ilima

Auwahi Wind has fulfilled its HCP requirement to out-plant 10 Red 'ilima on 'Ulupalakua Ranch to offset potential Project impacts. Plants were propagated at the 'Ulupalakua Ranch nursery in 2013. They were successfully out-planted and are thriving with 98 percent of the original 46 out-plantings surviving. In addition, Auwahi has assisted the ranch in maintaining a 1-acre habitat restoration project initiated for out-plantings, and three more fenced out-plantings have been established on ranch property. Flowering adult plants have been recorded from all 4 locations.

4.0 Changed or Unforseen Circumstances

The Project has seen higher than expected take of the Hawaiian hoary bat at its facility in the first 4.5 years of operations. On February 25, 2015, Auwahi Wind met with USFWS/ DOFAW to discuss its pursuit of a major amendment to their joint ITL/ITP. The proposed major amendment will be limited exclusively to address take of the federally listed Hawaiian hoary bat, incidental to activities associated with the operation, maintenance, and decommissioning of the Project. The amendment process is currently under way and several drafts have been circulated between USFWS and DOFAW field offices. The amendment is expected to be approved in FY 2018.

5.0 Annual Workplan and Schedule

A work plan for FY 2018 is provided in Attachment 5. This work plan identifies major monitoring and mitigation activities and their associated timelines.

6.0 Cost Expenditures and Budget

A summary of HCP-related expenditures for FY 2017 is provided in Attachment 6. This summary lists costs (including staff labor) that Auwahi Wind has expended toward fulfilling the terms of the HCP in FY 2017, as well as cumulatively, and compares them against the budgeted amounts specified in Appendix 8 of the HCP.

7.0 References

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Attachment 1

Evidence of Absence Software Inputs and Outputs – Fatality Estimation

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Attachment 1 -Evidence of Absence Software Inputs and Outputs – Fatality Estimation

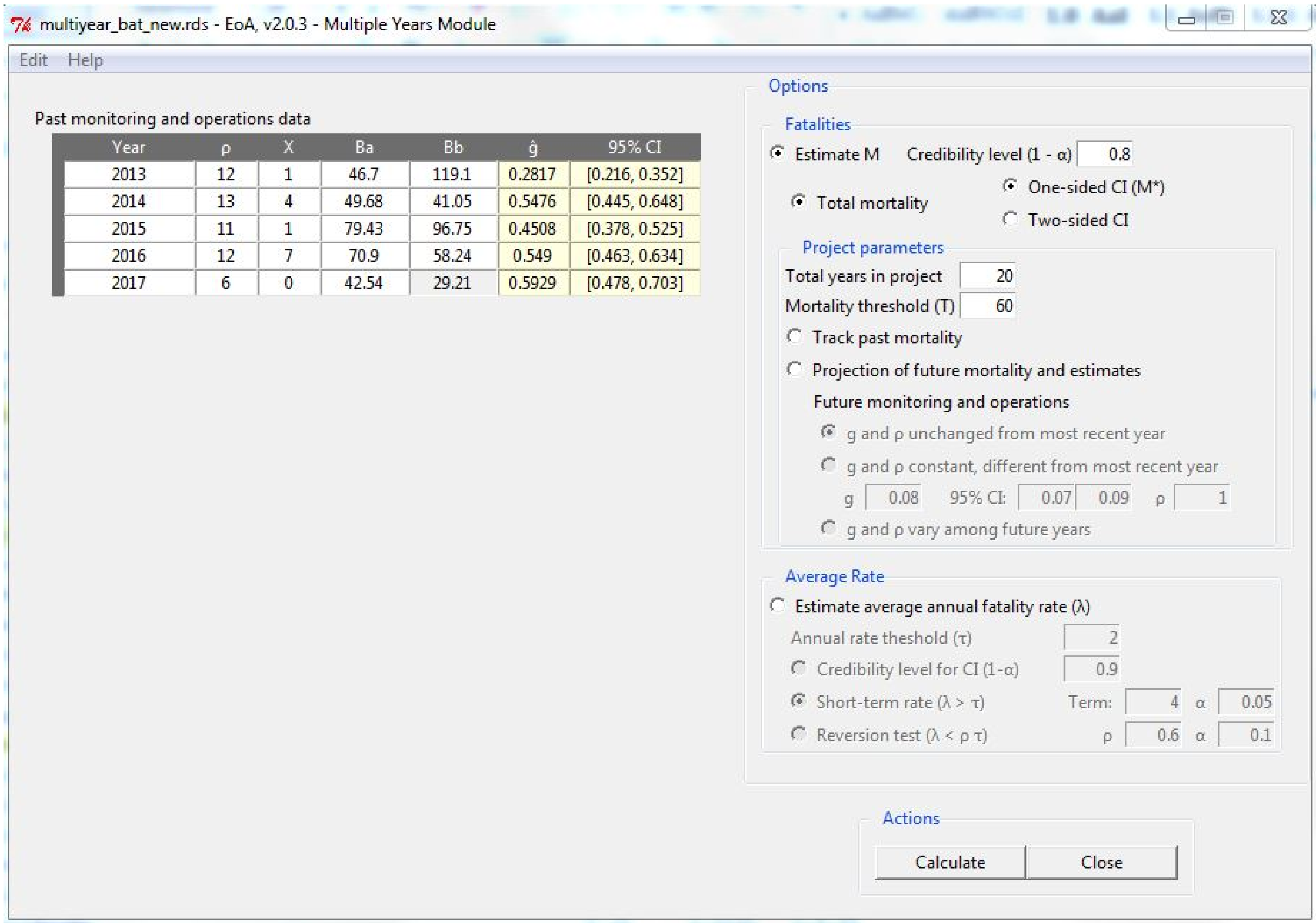

Figure 1. Evidence of Absence software input for Hawiian hoary bats multi-year analysis (Dalthorp et al. 2017).

```
Summary statistics for total mortality through 5 years
------------------------------------
Results
M* = 33 for 1 - a = 0.8, i.e., P(M <= 33) >= 80%

Estimated overall detection probability: g = 0.474, 95% CI = [0.435, 0.514]
   Ba = 288.33, Bb = 319.8

Estimated baseline fatality rate: lambda = 0.5287, 95% CI = [0.284, 0.851]


Test of assumed relative weights (rho) and potential bias             Fitted rho
Assumed rho     95% CI
     12      [0.694, 24.514]
     13      [4.524, 26.936]
     11      [0.423, 17.710]
     12      [10.077, 37.452]
      6      [0.008, 7.203]

p = 0.08859 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 1.027

Posterior distribution of M
m      p(M = m) p(M > m)
0       0.0000   1.0000
.
.
.
13      0.0000   1.0000
14      0.0003   0.9996
15      0.0013   0.9984
16      0.0033   0.9950
17      0.0071   0.9879
18      0.0130   0.9749
19      0.0207   0.9542
20      0.0300   0.9242
21      0.0400   0.8842
22      0.0498   0.8344
23      0.0585   0.7759
24      0.0653   0.7106
25      0.0698   0.6408
26      0.0717   0.5691
27      0.0713   0.4978
28      0.0687   0.4291
29      0.0644   0.3647
30      0.0589   0.3058
31      0.0527   0.2531
32      0.0462   0.2069
33      0.0397   0.1672
34      0.0336   0.1336
35      0.0280   0.1057
36      0.0229   0.0827
37      0.0186   0.0642
.
.
.
==============================================================================
Input
Year (or period) rel_wt  X    Ba     Bb    ghat     95% CI
2013             12.000  1   46.7  119.1 0.282 [0.216, 0.352]
2014             13.000  4  49.68  41.05 0.548 [0.445, 0.648]
2015             11.000  1  79.43  96.75 0.451 [0.378, 0.525]
2016             12.000  7   70.9  58.24 0.549 [0.463, 0.634]
2017             6.000   0  42.54  29.21 0.593 [0.478, 0.703]
```

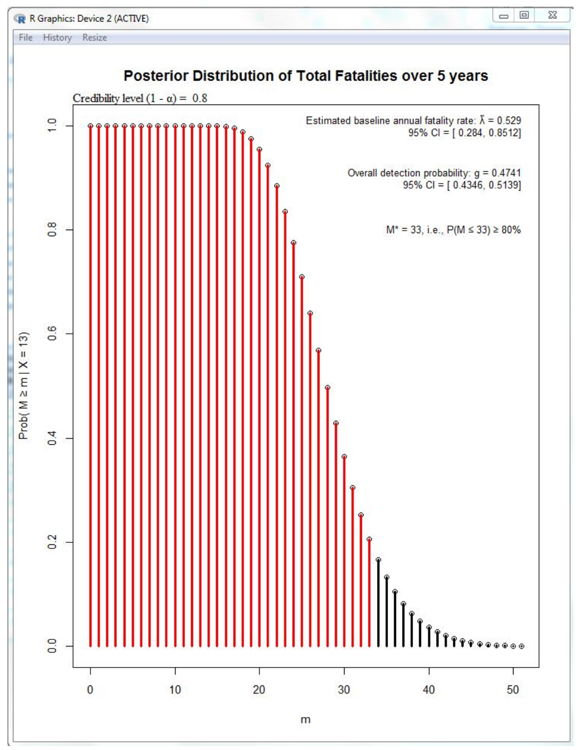

Figure 2. Evidence of Absence software output for Hawiian hoary bats multi-year analysis (Dalthorp et al. 2017).

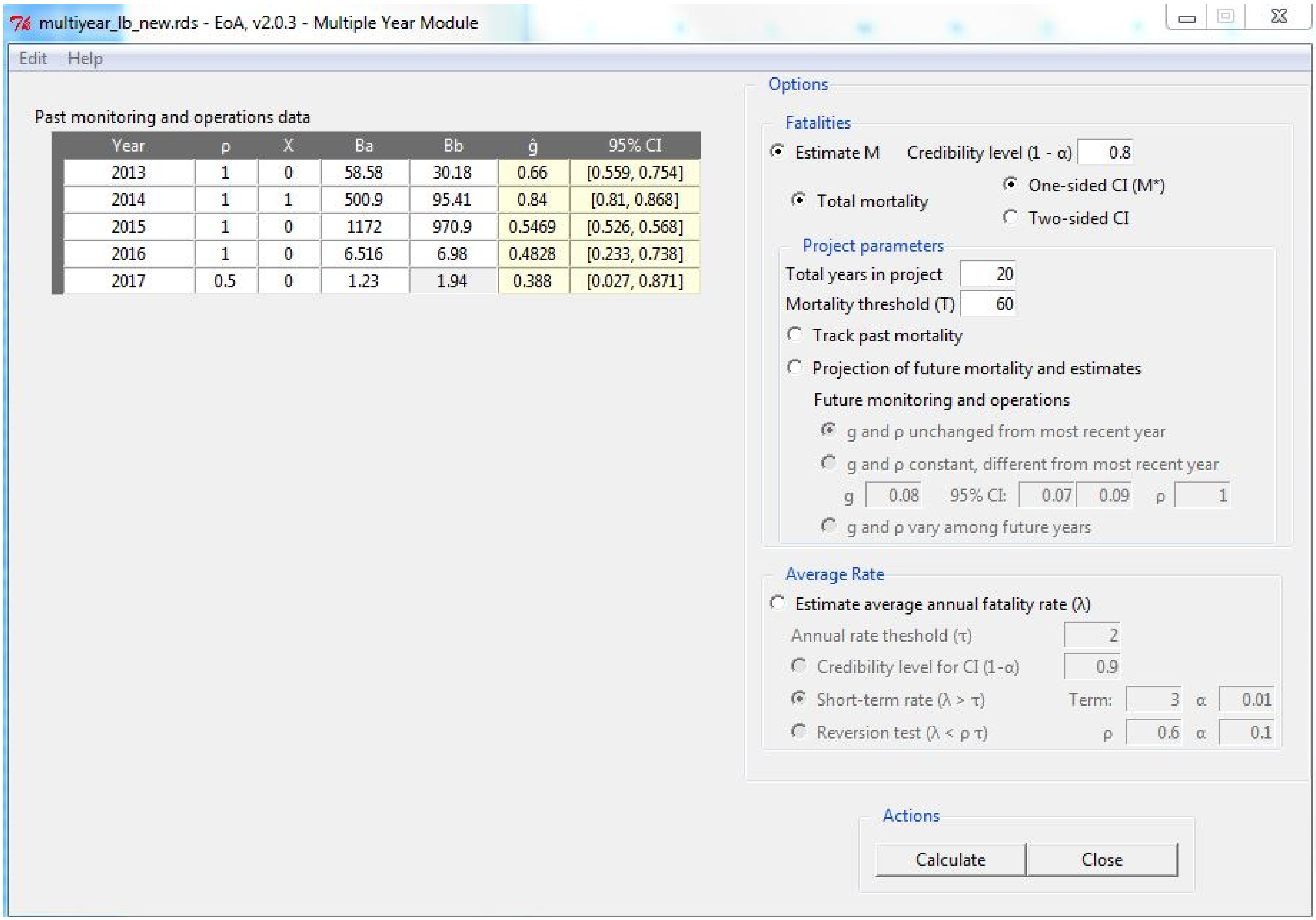

Figure 3. Evidence of Absence software output for Hawiian petrels multi-year analysis (Dalthorp et al. 2017).

```
Summary statistics for total mortality through 5 years
------------------------------------
Results
M* = 3 for 1 - a = 0.8, i.e., P(M <= 3) >= 80%

Estimated overall detection probability: g = 0.605, 95% CI = [0.523, 0.684]
   Ba = 84.763, Bb = 55.279

Estimated baseline fatality rate: lambda = 0.5546, 95% CI = [0.0397, 1.74]


Test of assumed relative weights (rho) and potential bias            Fitted rho
Assumed rho     95% CI
      1      [0.001, 1.980]
      1      [0.032, 3.031]
      1      [0.002, 2.376]
      1      [0.002, 2.592]
    0.5      [0.102, 4.345]

p = 0.67205 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 0.82

Posterior distribution of M
m      p(M = m) p(M > m)
0       0.0000   1.0000
1       0.4625   0.5375
2       0.2782   0.2594
3       0.1394   0.1200
4       0.0656   0.0545
5       0.0300   0.0245
6       0.0135   0.0110
7       0.0061   0.0049
8       0.0027   0.0022
9       0.0012   0.0010
10      0.0005   0.0004
11      0.0002   0.0002
12      0.0001   0.0001
13      0.0001   0.0000
14      0.0000   0.0000
15      0.0000   0.0000
================================================================================
Input
Year (or period) rel_wt  X    Ba     Bb   ghat    95% CI
2013              1.000  0  58.58  30.18 0.660 [0.559, 0.754]
2014              1.000  1  500.9  95.41 0.840 [0.810, 0.868]
2015              1.000  0   1172  970.9 0.547 [0.526, 0.568]
2016              1.000  0  6.516   6.98 0.483 [0.233, 0.738]
2017              0.500  0   1.23   1.94 0.388 [0.027, 0.871]
```

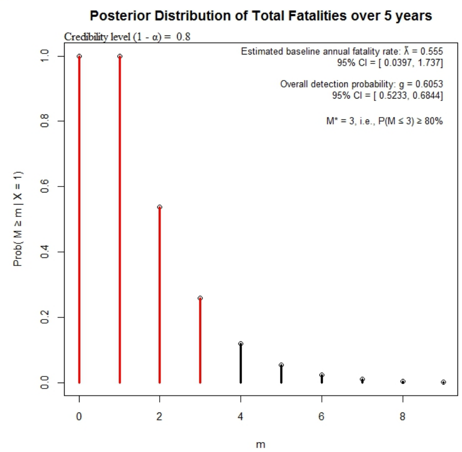

Figure 4. Evidence of Absence software output for Hawiian petrels multi-year analysis (Dalthorp et al. 2017).

Attachment 2

Kahikinui Management Area Hawaiian Petrel Monitoring Report

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Auwahi Wind Energy Project

2016 Auwahi Wind Energy Hawaiian Petrel Report

Kahikinui Petrel Management Area

Prepared for:

Auwahi Wind Energy, LLC

101 Ash Street, HQ 08B

San Diego, CA 92101-3017

Prepared By:

August 2017

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EXECUTIVE SUMMARY

In December 2012, Auwahi Wind Energy, LLC (Auwahi Wind) constructed and began commercial operations of the 8-turbine, 21-megawatt Auwahi Wind Farm (the Project) in east Maui, Hawaii. To address potential endangered species impacts associated with the Project, Auwahi Wind developed a Habitat Conservation Plan (HCP), which was finalized in January 2012. To address the requirements under the HCP for Hawaiian petrels (Pterodroma sandwichensis), this report summarizes the 2016 Hawaiian petrel management activities executed in the Auwahi Wind Kahikinui petrel management area (Kahikinui PMA).

As proposed in the HCP, take and mitigation are accounted for in tiers such that each tier has a higher take level and a correspondingly higher level of mitigation. For the initial tier (Tier 1), Auwahi Wind is mitigating potential impacts to petrels by implementing predator control within Kahikinui PMA to increase their survival and reproductive success. Tier 1 mitigation requires predator control at 33 active burrows (see the HCP for additional details).

Several objectives were identified for the 2016 petrel management season. These objectives included:

1) Conduct routine petrel burrow monitoring to assess the number of active petrel burrows; and
2) Determine reproductive success of petrel burrows within management area.
3) Continue with comprehensive predator assessments across Kahikinui PMA prior to initiation of predator control (February) and halfway through the nesting season (August/September); and
4) Implement predator control throughout the nesting season.

A total of 68 burrows were monitored within Kahikinui PMA in 2016 (64 initially located prior to the 2016 season and 4 burrows located during 2016 surveys), March through November. Twenty-eight (41 percent) of the burrows showed signs of activity at some point during the breeding season and 40 burrows (59 percent) were inactive in 2016. Eggs were confirmed at 12 of the active burrows based on observations of egg shell, an abandoned egg, or chick down. Reproductive success was between 32 and 67 percent. Twenty-three game cameras were rotated among 26 active burrows throughout the season to collect supplemental information on burrow activity and to use as an additional method to measure reproductive success.

Tracking tunnels were used to monitor the presence and distribution of small mammals (rodents and mongooses) within Kahikinui PMA in February, prior to implementing predator control, and again in August/September, halfway through the trapping season. A

one-day index was used for rodents and a three-day index for mongooses. The one-day tracking index for rodents was calculated at 5.3 percent in February and increased to 17.5 percent in August/September. The three-day mongoose tracking index was calculated at 1.7 percent in February and decreased to 0 percent in August/September. These results point to an increase in rodent activity and a decrease in mongoose activity as the trapping season progressed. Overall, there has been a decrease in both rodent and mongoose activity indices since measurements began in August of 2013, which the exception of rodent activity in the August/September 2016.

Auwahi Wind continued to implement the predator control strategy developed in 2013. Between March and mid-December 2016, Auwahi Wind deployed traps targeting feral cats, mongoose and rats within a 200-meter buffer of the known active petrel burrows. The predator control grid was operational for 37 weeks for a total of 26,740 trap nights. Predator control efforts implemented by Auwahi directly removed 65 predators from Kahikinui PMA. The catch per unit of effort (CPUE) for the season for all trap types combined was 0.24 percent. Auwahi Wind also made a contribution to the trapping efforts led by the Maui Nui Seabird Recovery Project, the Maui Forest Bird Recovery Project, and Haleakala National Park Service, which conducted predator control in the adjacent Kahikinui Natural Area Reserve and Haleakala National Park; this trapping effort removed an additional five predators.

The number of burrows existing within the Kahikinui PMA colony is not consistently at the level needed to ensure that the success criteria for Tier 1 mitigation under the HCP, as currently written, are met despite benefiting the petrel colony. Therefore, Auwahi Wind proposes to continue petrel mitigation efforts at the Kahikinui PMA in the 2017 and 2018 breeding season, and then transition mitigation efforts (monitoring and predator control) to the adjacent DKIST site in 2019 to overtake the management of active burrows at that site.

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1. INTRODUCTION

1.1 BACKGROUND

In December 2012, Auwahi Wind Energy, LLC (Auwahi Wind) began commercial operations of the 8-turbine, 21-megawatt Auwahi Wind Farm (Project) in east Maui, Hawaii. To address potential endangered species impacts associated with the Project, Auwahi Wind developed a Habitat Conservation Plan (HCP), which was finalized in January 2012 (Tetra Tech 2012a). Based on the anticipated take levels provided in the HCP, Auwahi Wind obtained an incidental take license (ITL) from the Hawaii Department of Land and Natural Resources (DLNR) on February 9, 2012, and an incidental take permit (ITP) from the U.S. Fish and Wildlife Service (USFWS) on February 24, 2012. To address the reporting requirements under the HCP for Hawaiian petrels (*Pterodroma sandwichensis*; petrels), this report summarizes the 2016 petrel management activities executed in the Auwahi Wind Kahikinui Petrel Management Area (Kahikinui PMA).

As proposed in the Auwahi Wind HCP, take and mitigation are accounted for in tiers such that each subsequent tier has a higher take level and a correspondingly higher level of mitigation. For the initial tier (Tier 1), Auwahi Wind committed to mitigating potential impacts to petrels by implementing predator control within Kahikinui PMA to increase the survival and reproductive success of Hawaiian petrels. Tier 1 mitigation requires predator control at 33 active burrows (see the HCP for additional details). Petrel management activities will be considered successful if (1) predator control is successfully implemented and (2) mitigation efforts result in an increase in reproduction that offsets authorized take, as outlined in the Hawaiian Petrel Management Plan (Management Plan; Tetra Tech 2012b), approved by USFWS and the DLNR/Division of Fish and Wildlife (DOFAW).

A full predator control strategy was developed in partnership with Tetra Tech, Inc. and Island Conservation for Kahikinui PMA (Island Conservation and Tetra Tech, Inc 2013). In September 2013 Auwahi Wind initiated a pilot predator control program within the upper portion of Kahikinui PMA, where the densest proportions of petrel burrows are located. The pilot predator control in the first year targeted mammalian predators including feral cats (*Felis catus*), mongoose (*Herpestes javanicus*), and rodents (predominantly black rats [*Rattus rattus*], Polynesian rats [*Rattus exulans*] and the common mouse [*Mus musculus*]). Lessons learned in the 2013 pilot predator control program guided future placement of traps and types of baits used in the 2014, 2015, and 2016 trapping seasons. This strategy continues to focus predator control on feral cats, mongooses and rats and expands trapping efforts into the entire Kahikinui PMA.

1.2 KAHIKINUI PMA

Kahikinui PMA is located on the Department of Hawaiian Homelands (DHHL) portion of the Kahikinui Forest Reserve (Figure 1). The management area consists of approximately 356 hectares (ha) with petrel burrows scattered throughout. A 25-year License Agreement (License No. 772) was approved by the DHHL Commission on April 23, 2012, identifying Auwahi Wind as the responsible party for the management of petrels within Kahikinui Forest Reserve. Petrel surveys were conducted in 2011 and 2012 by Tetra Tech, Inc. (Tetra Tech), to locate active burrows within the Kahikinui PMA. Survey methods and results were outlined in the 2012 Hawaiian Petrel Report (HCP Annual Report FY13).

Kahikinui PMA is located on a south facing slope along the southwestern flank of Haleakala crater. The elevation within Kahikinui PMA ranges from 2,560 – 2,972 meters above sea level. The area is subject to rapidly changing weather conditions and fluctuating temperatures. There are no roads or trails, the terrain is rocky, and the substrate varies from volcanic cinder to large rock outcrops, including numerous gullies. The slopes are very rugged and steep in some sections and often consist of loose, sharp rock. A large cinder field occurs in the center of Kahikinui PMA. Vegetation is denser at the lower elevations than the higher elevations and consists mostly of native shrubs, primarily pukiawe (*Styphelia tameiameiae)* and ohelo (*Vaccinium reticulatum*).

1.3 OBJECTIVES OF 2016

As in previous years, the objectives of the 2016 management season were to continue petrel burrow monitoring to assess the number of active burrows in Kahikinui PMA, determine petrel reproductive success, and continue implementation of a full predator control strategy. An additional objective in 2016 was to conduct an overarching evaluation of whether or not the Kahikunui PMA continues to be a suitable mitigation area, based on the results of 5 years of petrel monitoring and mitigation efforts, or if additional adaptive management is warranted to ensure compliance with HCP mitigation requirements. These objectives were met using five main tactics:

1. Burrow checks conducted at known burrows to obtain an estimate of the number of active burrows and their reproductive success.

2. Deployment of 23 game cameras at active burrows to further document activity of petrels and any predation events.

3. A comprehensive predator assessment conducted across Kahikinui PMA prior to implementation of predator control (February) and in August/September (halfway through the year), using 1-day and 3-day tracking tunnel indices for rodents and mongooses, respectively.

4. Continuation of full predator control strategy that included the deployment of 119 traps, while continuing to evaluate trap effectiveness and placement.

2. METHODS

2.1 BURROW ACTIVITY AND REPRODUCTIVE SUCCESS

Burrow checks were conducted monthly from March to July 2016 (the petrel prospecting, laying, and incubating period) and then twice a month during August – November 2016 (the chick rearing and fledgling period). During each survey, trained surveyors checked the status of known petrel burrows and opportunistically searched nearby suitable habitat for additional burrows. Any new burrows located in 2016 were marked, mapped, and added to the monitoring dataset. All known burrows were monitored during each check through July, after which only active burrows were monitored (Figure 2). Burrows were monitored following methods used by the Haleakala National Park Service (NPS 2012 and HCP Annual Report FY13), also known as the "toothpick method". At the end of the breeding season, burrows were classified into one of five categories of seasonal status based on of the activity pattern observed during the burrow checks (Table 1). The seasonal status of each burrow determined if it was included in the reproductive success calculations; seasonally inactive burrows were omitted from the calculations.

Two metrics of reproductive success were utilized to allow for direct comparisons between previous monitoring years at Kahikinui PMA and other local petrel studies:

1. **Percent Chicks Fledged per Active Burrow—**The sum of the Successful burrows and the Probably Successful burrows, divided by the number of burrows consistently active during the egg-laying season (showed signs of activity during more than one check), converted to a percentage. This estimate assumes that each Successful and Probably Successful burrows fledged one young.

2. **Percent Chicks Fledged per Egg Laid—**This metric is represented by two values, one derived with assumptions providing a minimum value and a second derived with assumptions providing a maximum value. The numerator in each case is the sum of the Successful and the Probably Successful burrows, and assumes a maximum of one egg or fledgling per burrow. The denominator for the calculation is the number of burrows with eggs laid. Because the nest chambers could not be seen, low and high values of the denominator were estimated. The low estimate of the range for eggs laid included only those burrows where egg laying was confirmed (e.g., Failed, Probably Successful, and Successful burrows). The high estimate of the range for eggs laid included all burrows consistently active during the egg-laying season, including those burrows that may have been Occupied by a Non-Breeder later in the season. The overall proportions for these values were then converted to percentages that represented the minimum and maximum value.

The trend in the total number of active burrows and reproductive success between the five years of monitoring (2012 – 2016) was investigated using a chi-square test. Using the minimum percentage of chicks fledged to eggs laid (assuming all active burrows during the egg laying season have an egg) was used to compare reproductive success across the four monitoring seasons. Beginning in 2013 Auwahi was able to monitor reproductive success for the entire season (the 2012 monitoring season began in June). For the 2013 – 2016 seasons, burrows that showed consistent activity throughout the start of the season (March – July) were included in calculations of reproductive success. Burrows that were visited only one time throughout the start of the season (March – July) were excluded from the reproductive success calculations, as they were assumed to be indicative of prospecting (i.e., non-nesting) behavior. A chi-square test was used to investigate if there was a relationship between reproductive success and the implementation of predator control.

2.2 GAME CAMERA MONITORING

Beginning 2012, Reconyx Hyperfire™ cameras were used to provide supplemental information on burrow activity. Twenty-three of these cameras were used as an additional method for measuring reproductive success during the 2013 – 2016 breeding seasons. Cameras were installed at active burrows, simultaneously being monitored with the toothpick method. The cameras were maintained until petrel activity ceased, and then moved to other burrows with indications of recent petrel activity. Reproductive success was also calculated using the sub-sample of burrows monitored by cameras and compared with the full sample of burrows monitored with the traditional toothpick methodology. Reproductive success was calculated using the percentage of chicks fledged per active burrow observed on the camera, under the assumption that all active burrows had an egg.

2.3 TRACKING TUNNELS

Tracking tunnels were used to monitor the presence and distribution of small mammals (rodents and mongooses) within Kahikinui PMA (Brown et al. 1996, Blackwell et al. 2002, Gillies and Williams 2007, Speedy et al. 2007) in February and August/September 2016. This method provided an indicator of relative abundance of small mammals prior to implementing predator control and halfway through the season under active predator control. Tracking tunnel and transect spacing methodology are described in the Auwahi Wind Energy 2013 Hawaiian Petrel Report (HCP Annual Report FY14). The tracking tunnel grid consisted of 187 permanent tracking tunnel stations (Figure 3). Small mammal relative abundance was calculated as the mean percentage of tunnels with tracks per line (Gillies and Williams 2007).

2.4 PREDATOR CONTROL

A total of 119 traps were deployed across Kahikinui PMA, resulting in 26,740 trap nights. Trap types included 11 Belisle body grip traps, 33 DOC250 kill traps, 47 Goodnature A24 self-loader kill traps, 28 Victor foothold traps (equipped with OMNI M2M remote sensor technology). All traps were placed within a 200-meter buffer of the petrel burrows using gridded spacing (Island Conservation and Tetra Tech 2013). Although designed to control mongooses, the Goodnature and DOC250 traps also have the ability to trap rodents. The Goodnature traps and DOC250 traps were each spaced at 150-meter intervals. All trap types, excluding footholds, were housed in wooden boxes or plastic coverings to reduce the risk of seabird bycatch. Foothold traps were placed seasonally, approximately 3-5 meters apart, and clustered in areas where cat activity was documented or believed to occur (fence lines, pathways, etc). OMNI M2M sensors, attached to footholds, were tested for a second year.

The trapping grid was operational by March 14, 2016 (Figure 4). All traps were visually checked by Auwahi Wind technicians, every two weeks from March to late-November. Bait types within DOC250 traps were rotated every check between tuna/sardines, peanut butter, beef hotdogs, and a variety of other items such as catnip, baby food, and wax bait. Belisle body grip traps were baited primarily with beef hotdogs; Goodnature traps were baited with cinnamon or peanut butter; foothold traps were baited primarily with tuna/sardines and fish oils.

Trap nights for each trap type were calculated as the number of traps multiplied by the number of nights. The CPUE was calculated for each species and trap type as the total number of individuals captured with a trap device/total trap nights for that trap device. CPUE was used to compare the success of different traps types and to provide a measure of overall trapping success that is comparable to other trapping projects in the Hawaiian Islands.

3. RESULTS

3.1 BURROW ACTIVITY AND REPRODUCTIVE SUCCESS

During the 2016 breeding season, burrow monitoring commenced on March 14, 2016 and ended on November 23, 2016, at which time all of the burrows had ceased to be active. A total of 68 burrows were monitored within Kahikinui PMA (64 initially located prior to the 2016 season and 4 burrows located during 2016 surveys).

Twenty-eight (41 percent) of the 68 burrows showed signs of activity at some point during the 2016 breeding season, and 40 burrows (59 percent) were seasonally inactive. Of the 28 active burrows, 25 were consistently active (burrows visited more than once). The 25 active burrows that showed consistent signs of activity throughout the breeding season were used to calculate reproductive success for Kahikinui PMA in 2016. Eight burrows successfully produced a fledgling; four burrows showed clear signs of reproduction, but the nests failed (three eggs rolled out of nests and one chick was predated); and 13 either failed or were occupied by a non-breeder. The cause of nest failures/abandonment is unclear. There were no clear documented signs of depredation observed at these 13 burrows, either by the biologist monitoring the burrows or captured on game cameras stationed at the burrows.

Reproductive success in 2016 was between 32 and 67 percent. Based on the survey findings, eggs were assumed to have been laid in 12 to 25 of the active burrows; the range represents the difference between using only those nests where egg-laying was confirmed versus assuming all consistently active nests had eggs laid. The percentage of chicks fledged per active burrow within the Kahikinui PMA was 32 percent (Figure 5). The percentage of chicks fledged per egg laid was between 32 and 67 percent. There was no significant difference in reproductive success in the five years of monitoring (χ^2=1.706, df =4 P=0.79).

3.2 GAME CAMERA MONITORING

Game cameras were deployed at 26 burrows in 2016. Game cameras confirmed activity at 21 burrows and documented the successful fledging of seven chicks. The percentage of chicks fledged per active burrow based on game camera monitoring was 33 percent. Successful fledging was recorded between October 1 and October 23, 2016 (Table 2). Game cameras recorded four separate instances of a feral cat investigating a burrow (Figure 2). The cat was recorded investigating burrow 55 on February 23, 2016, and again on October 13, 2016. There were no clear signs of depredation at the burrow, and this nest was never confirmed to have a fledged chick. Cat activity was also recorded on October 27, 2016, at burrow 58, where a chick was predated, and at burrow 39, where a chick later successfully fledged. Game cameras also captured visitation by goats, chukars, rats, and mice at the entrances of both successful and unsuccessful burrows.

3.3 TRACKING TUNNELS

In February, rodents were detected along four of the eight transects (Figure 3), using the 1-day rodent index. Rodent detections occurred throughout the site but were concentrated in the lower elevations of Kahikinui PMA (<2,700 meters). The 1-day tracking index was 5.3 percent (mean percentage of tunnels with tracks per line) for rodents in February. Halfway through the trapping season in August/September, rodents were detected along seven transects. There was an increase from 5.3 to 17.5 percent in the tracking index for rodents.

Mongooses were initially detected in February along one of the four transects, with the three day index. Detections were on the eastern portion of the management area (2,700–2,800 meters). The three day tracking index was 1.7 percent for mongoose in February. Halfway through the trapping season, in September, mongooses were not detected along any transect (0 percent).

Investigating trends in the activity index across the entire management period (Fall of 2013 – Fall of 2016), there does not appear to be any significant trends. Overall activity for both rodents and mongoose is low across the site, across all monitoring periods. Mongoose activity has stayed below Fall 2013 levels since the Fall of 2015 (Figure 6).

3.4 PREDATOR CONTROL

The predator control strategy was initiated in March 2016, following the tracking tunnel study. The predator control grid was operational for 37 weeks between March and late-

November, with a total of 26,740 trap nights (Table 3). Predator control efforts removed 65 targeted mammalian predators from Kahikinui PMA, including 49 mice, 14 rats, two feral cats. There were fluctuations in the number of predators removed (1 – 22 predators) with a spike in September (22 predators; Figure 7). The combined CPUE for the season was 0.24 percent (0.00 – 0.51 percent, depending on target species and trap used). Incidental captures were documented while conducting predator trapping and included one goat and six chukars.

Goodnature traps removed the highest number of predators and had the highest CPUE, followed by the DOC250 traps (Table 3). DOC250 traps were the most effective at removing rats and removed one of the cats. A foothold trap caught the second cat. The Belisle body grip trap appeared to be the least effective, with no targeted predators removed. This trap incidentally killed one chukar chick. An additional five traps were donated to the Maui Nui Seabird Recovery Project, and two traps to the Maui Forest Bird Recovery Project and Haleakala National Park Service, which conducted predator control in the adjacent Kahikinui Natural Area Reserve and Haleakala National Park. These traps removed an additional 5 predators.

4. DISCUSSION

4.1 REPRODUCTIVE SUCCESS

Throughout 2016, 28 burrows showed signs of activity at some point during the breeding season. Since monitoring began in 2012, we have seen a regular seasonal decline in active burrows in the month of September. The number of active burrows drops between 9 and 13 burrows, depending on the year, despite higher levels of active burrows earlier in the season. According to Simons et al. (1985), both failed breeders and non-breeders typically leave the colony in September. Without confirmation of an egg in the burrow, it is challenging to determine what percentage of the burrows failed or simply contained juvenile non-breeders. This results in large confidence intervals surrounding reported reproductive success percentages.

We have seen a net increase in the total number of nests reported in the management area from 2012 to 2016. However, the increase in nests within the colony has not resulted in an increase in the number of active nests in each year or a significant increase in reproductive success. This may be a result of an increase in younger/non-breeding birds investigating the site, which can increase the denominator in the calculation of reproductive success where actually breeding status is uncertain. The number of active nests has remained relatively similar throughout the five years of monitoring (28 – 33 active nests).

We have not seen a significant increase in the reproductive success within the management area since predator control implementation. The 2016 season will be the third year that predator control has been fully implemented at Kahikinui PMA. Similarly, the adjacent Daniel

K. Inouye Solar Telescope (DKIST) mitigation site has reported low reproductive success (10 – 26 percent) and no change in success was observed after two years of implementation of predator control (Chen et al. 2015, pers. comm Chen August 2016).

Previous annual reports have discussed alternative explanations for low reproductive success in both sites compared with the nearby Haleakala National Park (42 – 61 percent chicks fledged per active burrow; Natividad 1994). These have included:

1. Individual fitness may be correlated with population density (Brown et al. 1990, Danchin and Wagner 1997, Stokes and Boersma 2000, Schreiber and Burger 2001), and Kahikinui PMA has a lower density of burrows across the management area than does Haleakala;

2. Kahikinui PMA may be an example of a population of younger/non-breeding birds predominantly investigating the site, as seen with the mass exodus of potentially non-breeding birds every September. The increase in non-breeders during the first few years will keep the reproductive success low until the first generation reaches breeding age;

3. Pressures occurring away from the colony (i.e., at-sea), where changes in climate and fisheries may have an impact on prey abundance and foraging efficiency; and

4. Changes in reproductive rates in the park during the last 20 years, since reproductive success was last measured.

4.2 PREDATOR CONTROL AND INTERPETING PREDATOR ASSESSMENTS

The overall decrease in rodent and mongoose activity, using tracking tunnels, has corresponded with a decrease in rodent and mongooses removed with trapping efforts. In the spring of 2014, we saw a spike in mongoose activity (Figure 6). Over the next year and a half of targeted predator control, eight mongooses were removed from the management area and surrounding area, with efforts either directly or indirectly supported by Auwahi Wind. By the fall of 2015, we did not detect any mongooses on the tracking tunnels.

Rodent activity appears to have seasonal pulses, based on the tracking tunnel and trapping results. We typically see pulses in rodent activity within the management area in the fall (September – November). The spike in rodent activity documented in the August/September 2016 1-day index corresponded with an increase in trapping of mice over that same time period. Goodnature traps have proven successful at removing rodents when this occurs, with up to four carcasses found underneath one trap at one check.

One cat was caught during the foothold trapping. The OMNI M2M sensor technology, initially tested in 2015, continued to showed promise as an alternative to daily checks of live traps. The sensor devices rely on cell phone technology to alert technicians of trap triggering. Traps were purposefully triggered during biweekly trap checks to confirm that trigger messages were being sent and received. Through these tests, we were able to confirm cell phone signal throughout the site. After better waterproofing and a change in housing design, the sensors consistently sent messages. We plan to use the product in the 2017 breeding season and continue to test the product at the Project facility, where traps are more accessible and can be visited more frequently.

This season, four separate cat detections were captured by game cameras, including two at an individual burrow (burrow 55) early and late in the breeding season, and at two other burrows. This is in similar to the 2013 and 2014 monitoring seasons when 3+ separate cat detections were recorded. A petrel carcass or signs of predation (torn feathers) has never been documented on camera following cat detections; however, in 2016 predation of a chick was observed on camera at burrow 58 and the carcass was later found 50+ meters away from the burrow. Cat detections have also been at burrows that were already confirmed inactive or that successfully fledged a chick after the cat was observed.

4.3 PROPOSED TRANSITION TO DKIST SITE

The number of known burrows within the Kahikinui PMA has not been consistently at the level needed to ensure that the current success criteria for Tier 1 mitigation under the HCP will be met as currently written. Tier 1 mitigation is intended to compensate for the incidental take of 19 adults petrels and 7 chicks over 25 years. Under the HCP, Tier 1 mitigation at the Kahikinui PMA will be deemed successful if (1) predator control is implemented and methods are successful in capturing predators, and (2) mitigation efforts result in one more fledgling or adult than that required to compensate for the requested amount of take under that tier. To demonstrate the anticipated mitigation benefit of predator control, the original HCP included a demographic model[1] which compared vital rates and population growth under moderate predation (no predator control) and mild predation (with predator control) scenarios. The assumption was that the implementation of predator control in addition to the area being completely fenced and ungulate free, by the Department of Forestry and Wildlife (DOFAW), would reduce predation from moderate to mild levels, resulting in an increase in adult survival and reproductive rates (Table 4).

This original modelling analysis assumed an average of 33 active burrows within the Kahikinui PMA and a reproductive success rate of 60 percent with predator trapping (see Table 6-4 in the HCP and Table 4 below). However, on average there have been 28 active burrows monitored each year within the Kahikinui PMA, from 2013 – 2016 (ranging from 25 to 33), and an average reproductive success rate of approximately 35 percent. Therefore

[1] The Project HCP used a deterministic matrix model to model how the changes in petrel vital rates due to predator control impact the population growth rate (lambda). This model, commonly used in population ecology, uses stage-specific information on survival and reproduction to calculate the population growth rate. Demographic values used in this model (and presented in Table 4) were provided by the USFWS, based on Simons (1984).

reproductive success rate of the active burrows in the Kahikinui PMA is not sufficient to produce enough adult petrels, based on the current assumptions of estimated population growth, to offset the amount of authorized petrel take under the ITP (Table 4). In addition, DOFAW has had unforeseen delays in completing the fence and removing the ungulates from the area. However, many unanticipated benefits of the mitigation efforts at the Kahikinui PMA have occurred. Since predator control at the Kahikinui PMA has been implemented, reductions in predators have been observed at the other nearby petrel management areas, including Haleakala National Park and the DKIST site. Although this information is anecdotal, the target predators are capable of traveling distances that would allow them to transit through the multiple petrel colonies on Haleakala such that the removal of predators from one management area has the potential to benefit nearby management areas. Predator control efforts have also provided an opportunity to test new technologies, such as the OMNI remote sensors, as well as for Auwahi Wind to collaborate with similar conservation projects through the sharing of traps and trapping information.

The Project HCP noted that in the event that mitigation benefits at the Kahikinui PMA were less than anticipated such that management of additional petrel burrows was needed to achieve the necessary mitigation benefit, Auwahi Wind would assume management of the petrel colony at the adjacent DKIST site, after mitigation under their HCP (ATST 2010) had been met. As of the 2015 breeding season, the DKIST site included 168 active petrel burrows surrounded by a predator exclusion fence (Chen at al. 2015, 2016). Given the reported reproductive success at the DKIST site (Chen et al. 2016), predator control at 80 of these burrows would be expected to produce enough petrels to meet the Auwahi Wind Tier 1 mitigation success criteria, as currently written, by the end of the permit term (Tables 4 and 5). Additionally, the petrel burrows at the DKIST site are densely clustered within approximately 130 acres, enabling predator control efforts and the associated benefits to focus on a smaller area (i.e., be more intensive with the same level of effort), compared to the Kahikinui PMA where burrows are sparsely distributed within approximately 800 acres. Therefore, Auwahi Wind proposes to continue petrel mitigation efforts at the Kahikinui PMA in the 2017 and 2018 breeding seasons, and then transition mitigation efforts to the adjacent DKIST site in 2019 to overtake the management of the 168 active burrows.

As shown in Table 5, implementing predator control at the Kahikinui PMA through 2018 is anticipated to produce a total of approximately 5 adult petrels. Initiating predator control at the DKIST site in 2019 and continuing its implementation through 2033 (Year 20 of the permit term), is expected to produce a total of approximately 18 adult petrels. Therefore, collectively the management of the Kahikinui PMA (2012 – 2018) and the DKIST site (2019 – 2033) would produce a total of 23 adult petrels, exceeding the Tier 1 authorized take level (Table 5).

4.4 SUMMARY AND RECOMMENDATIONS FOR 2017

- Since completion of comprehensive surveys in 2012, there has been a net increase of ten burrows within the breeding colony.
- The use of game cameras for four consecutive years has allowed Auwahi Wind to have a more definitive understanding of activity and breeding success within Kahikinui PMA.
- Predator assessments (tracking tunnels) 2013 – 2016 point toward a fluctuation in rodent and mongoose activity within the site. These assessments are also helpful in interpreting predator trapping results.
- Goodnature traps continue to be able to remove the highest number of predators within Kahikinui PMA. Trap spacing implemented in 2016 will be continued in 2017.
- Targeted use of foothold traps when cat activity is highest (October – November) was effective in removing one cat from the site. Targeted use of these traps will continue in 2017.
- Sempra continues to investigate the effectiveness of OMNI M2M sensors for monitoring foothold traps within the management area.

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Tetra Tech Inc. 2012b. Final Hawaiian Petrel Management Plan. Prepared for Auwahi Wind Energy. Maui, Maui County, HI.

6. TABLES AND FIGURES

Table 1. Seasonal status of Hawaiian petrel burrows at the end of the breeding season, based on visit data.

Seasonal Status	Definition
Seasonally Inactive	No toothpick disturbance or activity sign[1] during any burrow checks.
Successful	Chick fledged, indicated on a game camera, no signs of predation.
Probably Successful	Toothpick disturbance and reproductive sign[2] present at active burrow entrance in October and no sign of depredation.
Failed	Observed depredation, or reproductive sign observed but ceased before fledging period in October.
Failed/Occupied by Non-breeder	Initially signs of activity, no reproductive sign observed and activity ceased before the before October fledging.

[1] Activity sign includes; droppings, tracks, feathers, and odor

[2] Reproductive sign includes; egg, eggshell, chick down, chick

Table 2: Game camera Hawaiian petrel burrow monitoring summary, 2016

Burrow #	Camera Deployment Date	Last Date of Activity	Successfully Fledged Date
3	3/8/2016	8/30/2016	
4	6/8/2016	7/23/2016	
6	3/8/2016	10/16/2016	10/16/2016
9	3/8/2016	10/16/2016	10/1/2016
13	6/23/2016	8/5/2016	
15	3/8/2016	7/26/2016	
22	3/8/2016	6/10/2016	
23	9/13/2016	8/16/2016	
25	3/8/2016	8/23/2016	
29	3/8/2016	4/28/2016	
31	3/8/2016	7/17/2016	
32	3/8/2016	10/22/2016	10/21/2016
33	3/8/2016	10/18/2016	10/15/2016
34	3/8/2016	10/23/2016	10/23/2016
39	3/8/2016	10/22/2016	10/22/2016
42	3/8/2016	10/13/2016	10/13/2016
50	6/8/2016	6/23/2016	
51	3/8/2016	8/19/2016	
52	3/8/2016	7/23/2016	
54	3/8/2016	9/5/2016	
55	3/8/2016	8/14/2016	
58	3/8/2016	10/15/2016	
59	6/8/2016	7/9/2016	
62	6/8/2016	8/3/2016	
67	3/8/2016	7/20/2016	
68	9/27/2016	never	

Table 3: Summary of trapping results and catch per unit effort (CPUE), 2016

Trap Type	Total Traps	Trap Nights	Mongoose		Rats		Mice		Cats	
			#	CPUE	#	CPUE	#	CPUE	#	CPUE
DOC250	33	8,216	0	0.00%	11	0.13%	0	0.00%	1	0.01%
Belisle Body Grip	11	1,976	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Foothold	34	4,108	0	0.00%	NA	NA	NA	NA	1	0.02%
Goodnature	47	12,440	0	0.00%	3	0.02%	49	0.39%	0	0.00%

Table 4. Vital Rates used to model the petrel population for comparison of baseline and conditions under predator control at the Kahikinui PMA and DKIST petrel colony

Scenario	Survival – Breeding Adults[1]	Survival – Juvenile[1]	Fledglings per Female[2]	Female Fledgling per female[2]	Lambda[1]
Kahikinui Baseline - No Predator Control (Moderate Predation)					
HCP Assumption	0.85	0.8034	0.55	0.245	0.933
Actual Rates at Kahikinui PMA	0.85	0.8034	0.33	0.16	0.912
Kahikinui PMA with Predator Control (Mild Predation)					
HCP Assumption	0.9	0.8034	0.6	0.3	0.978
Actual Rates at Kahikinui PMA	0.9	0.8034	0.35	0.18	0.954
DKIST Site – Baseline and with Predator Control					
Assumed baseline DKIST Rates in 2019 –Existing Predator Exclusion Fencing Only (Moderate Predation)	0.88	0.8034	0.33	0.16	0.934
Assumed DKIST Rates with Management by Auwahi Wind – Predator Exclusion Fencing and Predator Control (Mild Predation)	0.93	0.8034	0.35	0.18	0.978

[1] Vital rates based on input from USFWS and Simons (1984).

[2] Assumed vital rates based on input from USFWS and Simons (1984); actual vital rates based on field data.

Table 5. Projection of predator control benefits at the Kahikinui PMA and DKIST site

KAHIKINUI PMA		
Metric	**Baseline – No Predator Control (Moderate Predation)**	**With Predator Control (Mild Predation)**
Number of Active Burrows	28	28
Percent of Active Burrows with Breeding Pairs	0.75	0.75
Lambda	0.91	0.95
Number of Breeding Females	10.5	10.5
Year 1 - 2013	9.58	10.02
Year 2 - 2014	8.73	9.56
Year 3 - 2015	7.96	9.12
Year 4 - 2016	7.26	8.70
Year 5 - 2017	6.62	8.30
Year 6 - 2018	6.04	7.92
Number of Breeding Adults	12.08	15.83
Total Number of Adults After 6 Years	16.11	21.11
Estimated Benefit from 2012 to 2018 (Number Adult Petrels Produced)		**5.00**
DKIST SITE		
Metric	**Baseline –Predator Exclusion Fencing Only (Moderate Predation)**	**With Predator Control (Mild Predation)**
Number of Active Burrows	80	80
Percent of Active Burrows with Breeding Pairs	0.75	0.75
Lambda	0.93	0.98
Number of Breeding Females	30	30
Year 7 - 2019	28.03	28.62
Year 8 - 2020	25.56	27.30
Year 9 - 2021	23.31	26.05
Year 10 - 2022	21.26	24.85
Year 11 - 2023	19.39	23.71
Year 12 - 2024	17.69	22.62
Year 13 - 2025	16.13	21.58
Year 14 - 2026	14.71	20.58
Year 15 - 2027	13.42	19.64
Year 16 - 2028	12.23	18.73
Year 17 - 2029	11.16	17.87
Year 18 - 2030	10.18	17.05
Year 19 - 2031	9.28	16.26
Year 20 - 2033	8.46	15.52
Number of Breeding Adults	16.93	31.03
Total number of Adults after 14 years	22.57	41.38
Estimated Benefit from 2019 to 2033 (Number of Adult Petrels Produced)		**18.81**

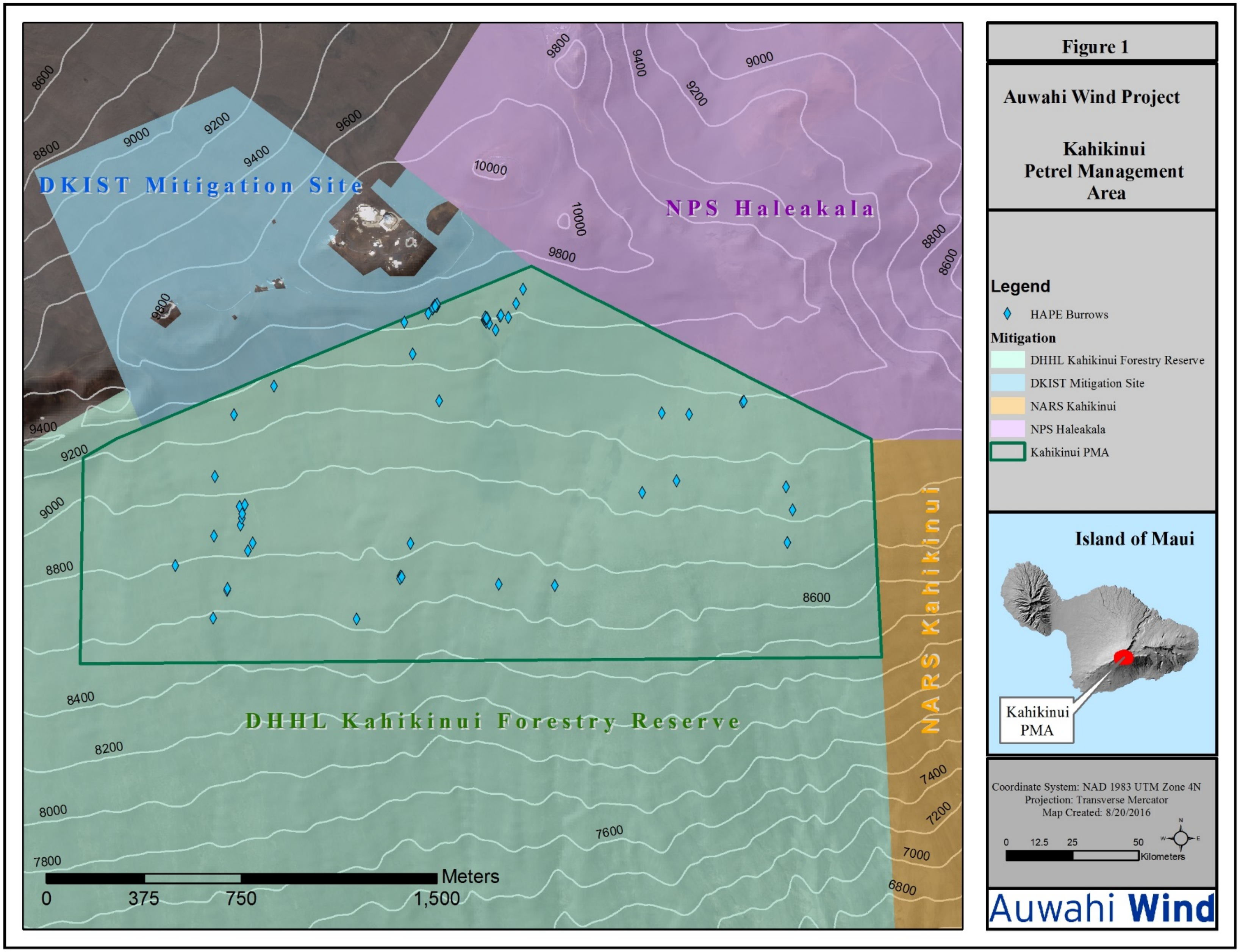
Figure 1
Auwahi Wind Project
Kahikinui
Petrel Management
Area
Legend
HAPE Burrows
Mitigation
DHHL Kahikinui Forestry Reserve
DKIST Mitigation Site
NARS Kahikinui
NPS Haleakala
Kahikinui PMA
Island of Maui
Kahikinui
PMA
Coordinate System: NAD 1983 UTM Zone 4N
Projection: Transverse Mercator
Map Created: 8/20/2016
0 12.5 25 50
Kilometers
Auwahi Wind
DKIST Mitigation Site
NPS Haleakala
NARS Kahikinui
DHHL Kahikinui Forestry Reserve
Meters
0 375 750 1,500

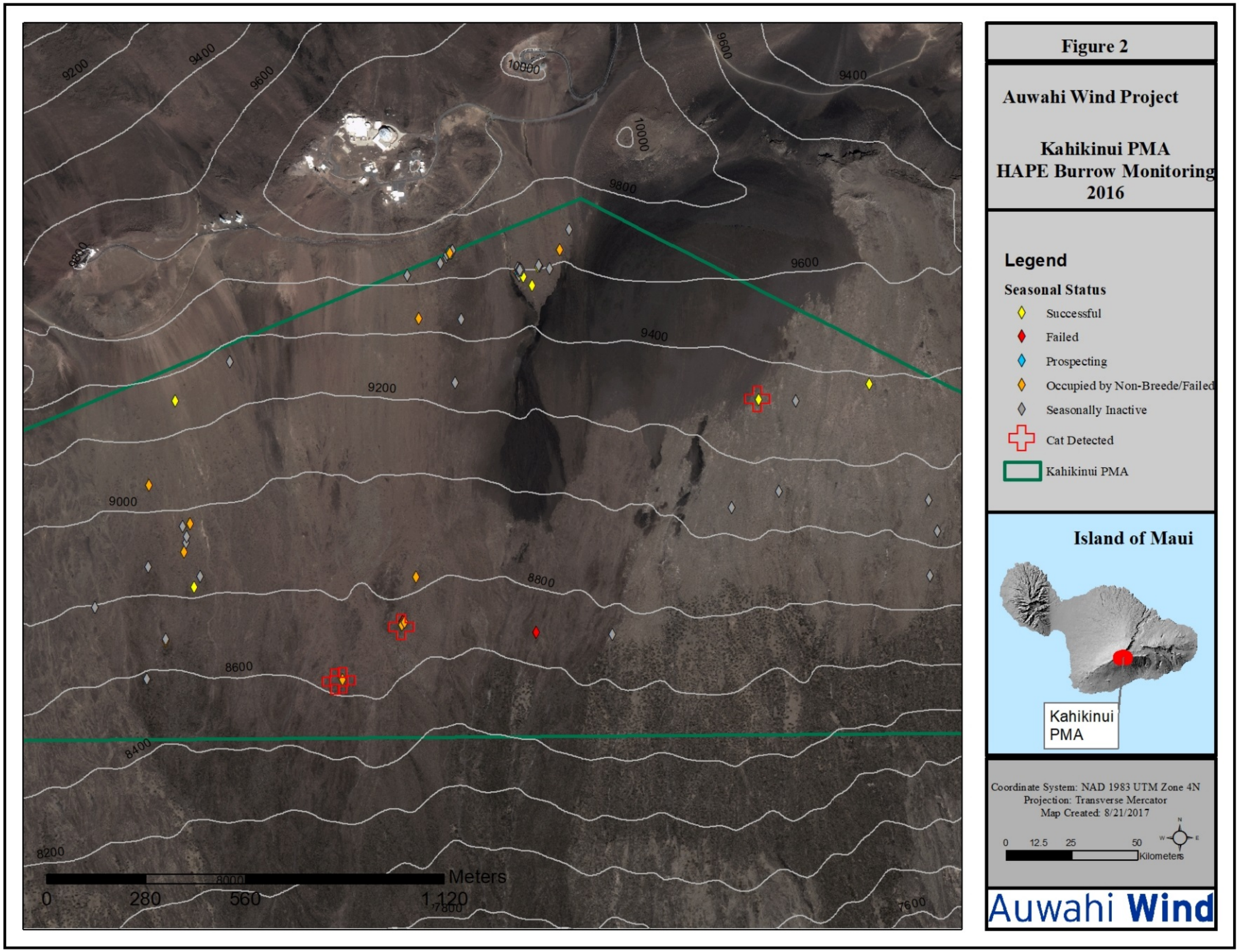
Figure 2
Auwahi Wind Project
Kahikinui PMA
HAPE Burrow Monitoring
2016
Legend
Seasonal Status
Successful
Failed
Prospecting
Occupied by Non-Breede/Failed
Seasonally Inactive
Cat Detected
Kahikinui PMA
Island of Maui
Kahikinui
PMA
Coordinate System: NAD 1983 UTM Zone 4N
Projection: Transverse Mercator
Map Created: 8/21/2017
0 12.5 25 50
Kilometers
Auwahi Wind
Meters
0 280 560 1,120
9200
9400
9600
9800
10000
9000
8800
8600
8400
8200
8000
7800
7600

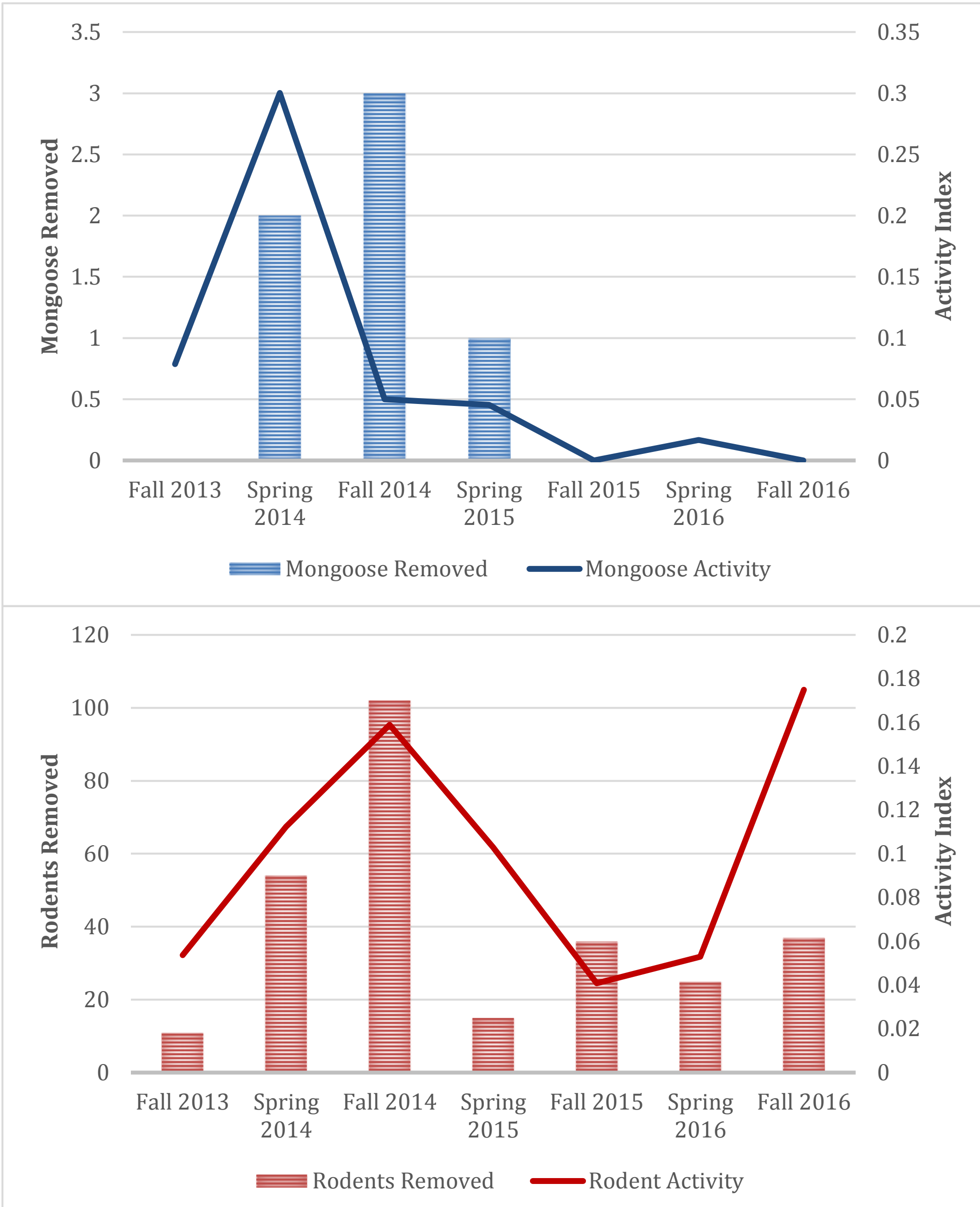

Figure 3. One/Three-day tracking tunnel results Kahikinui PMA, February and August/September 2016 (preliminary Spring 2017 data shown for reference)

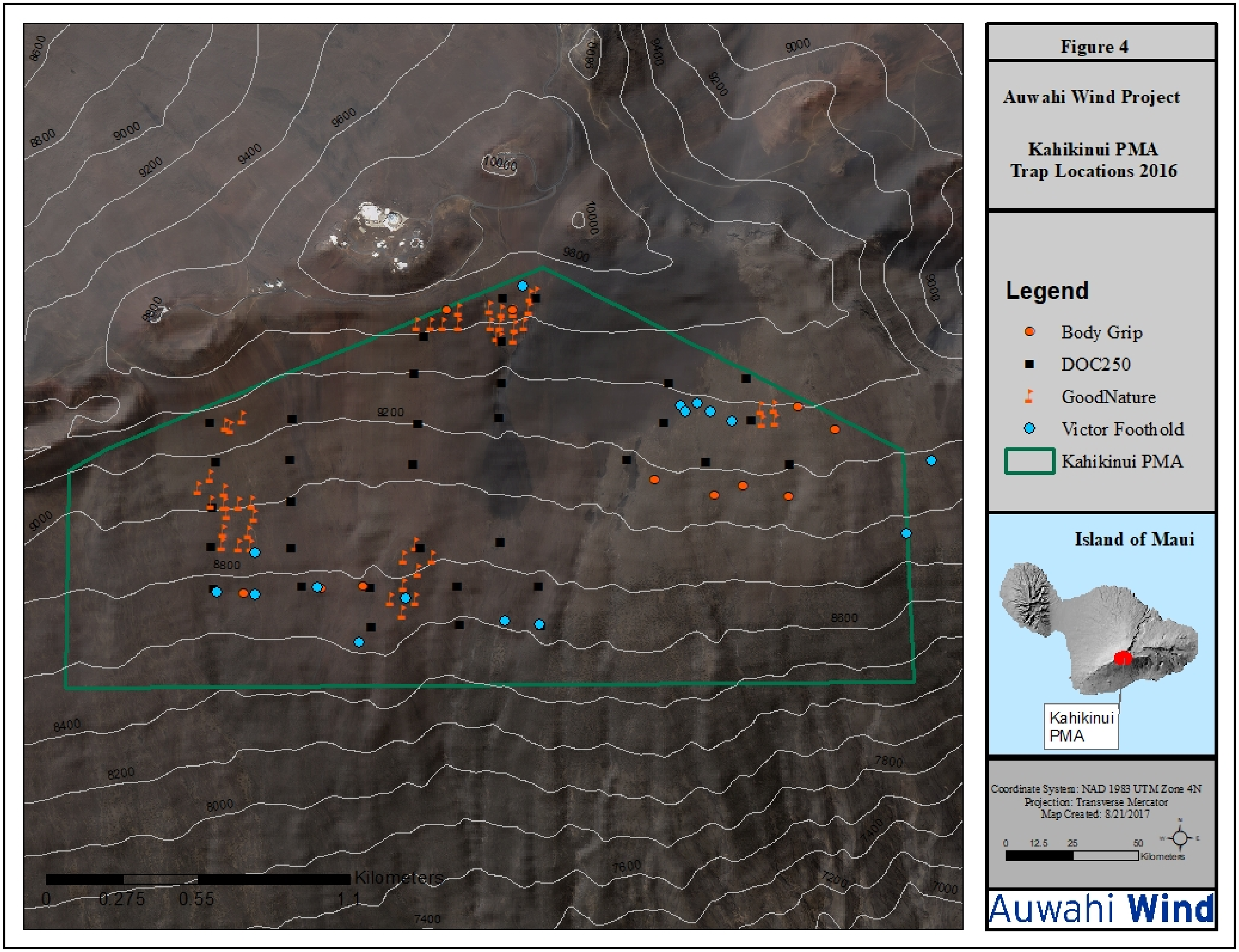
Figure 4
Auwahi Wind Project
Kahikinui PMA
Trap Locations 2016
Legend
Body Grip
DOC250
GoodNature
Victor Foothold
Kahikinui PMA
Island of Maui
Kahikinui PMA
Coordinate System: NAD 1983 UTM Zone 4N
Projection: Transverse Mercator
Map Created: 8/21/2017
0 12.5 25 50 Kilometers
0 0.275 0.55 1.1 Kilometers
Auwahi Wind

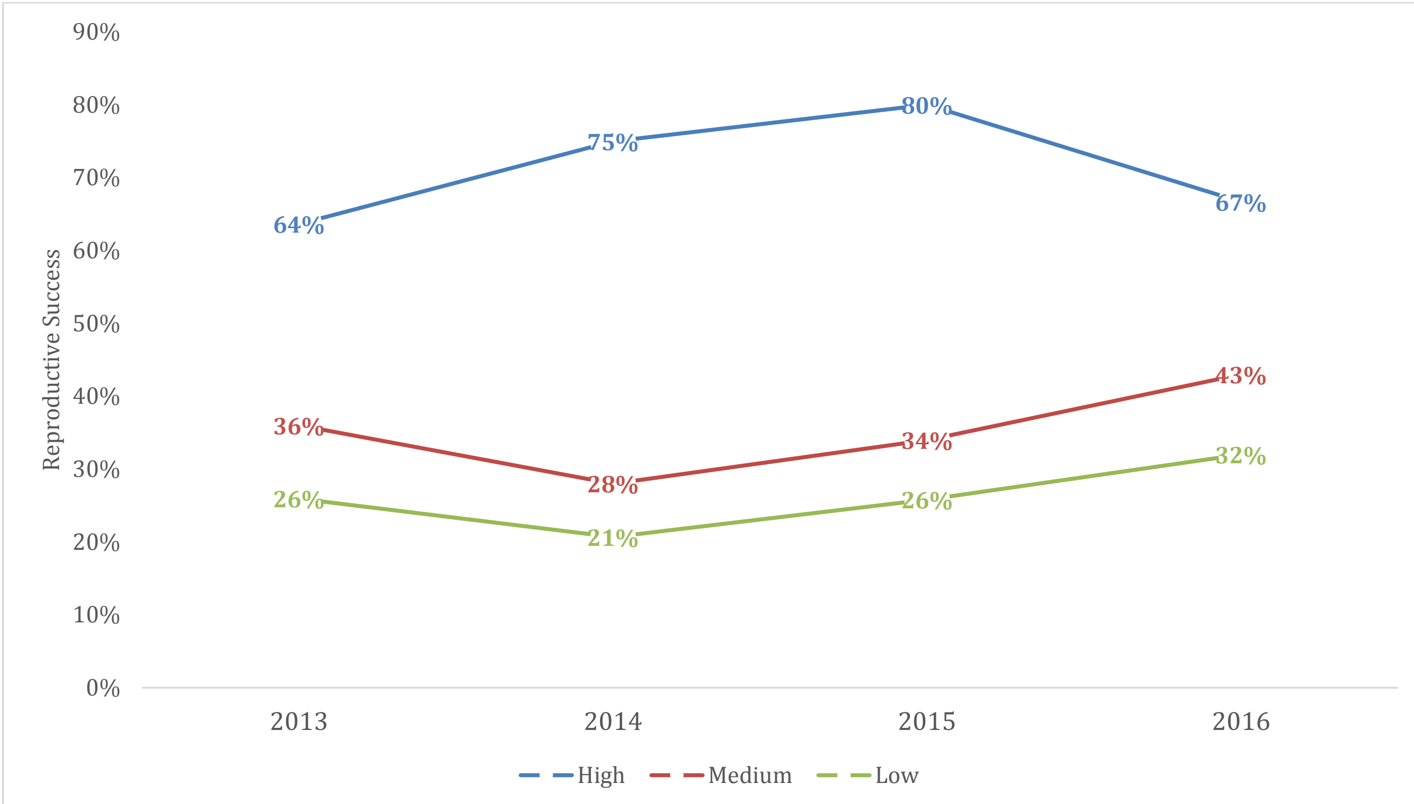

Figure 5. Reproductive success within Kahikinui PMA, 2013 – 2016, (toothpick method). High assumes only those burrows that had direct evidence of breeding had breeding adults; medium assumes 75 percent of the burrows that showed signs of activity had breeding adults; and low assumes all burrows that showed signs of activity had breeding adults.

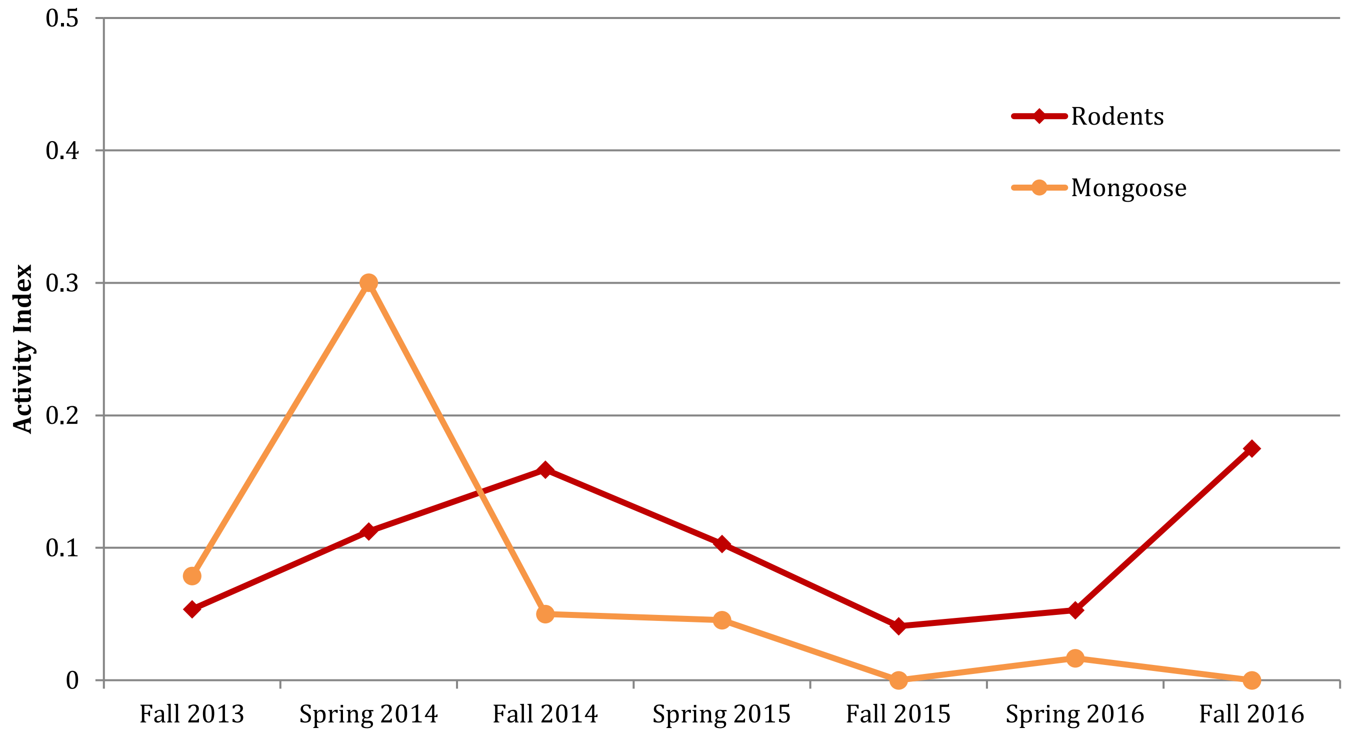

Figure 6. Summary of rodent and mongoose tracking tunnel results, 2013 - 2016

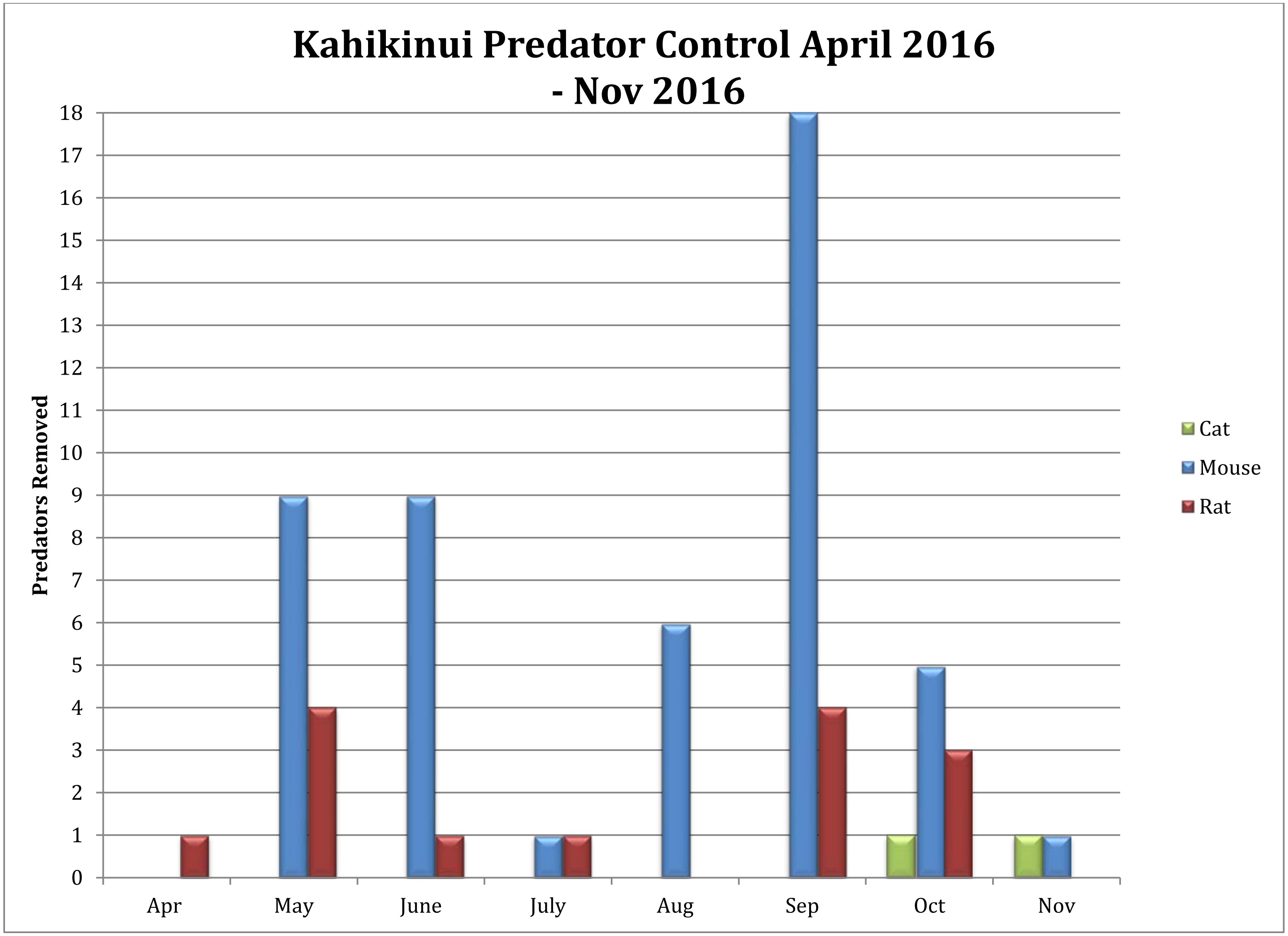

Figure 7. Monthly summary of predator trapping results, 2016

Attachment 3

Hawaiian Hoary Bat Tier 2 & 3 Research Summary

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United States Department of the Interior
U.S. GEOLOGICAL SURVEY
Pacific Island Ecosystems Research Center
Kilauea Field Station
PO Box 44, Building 344
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TAKE PRIDE® IN AMERICA

April 5, 2017

Auwahi Wind Energy
20100 Piilani Highway
Kula, Hawaii 96790

Dear Ms. VanZandt,

This letter summarizes the USGS/HCSU bat research efforts at the Pu'u Makua Restoration Area through 12 December 2016. Contained herein is a brief description of the study methods as well as preliminary and currently-available data available from acoustic monitoring, radio telemetry efforts and evaluation of the insect prey base. These data have not been peer-reviewed and should be considered provisional and subject to revision. A map, figures, and tables are attached.

The USGS looks forward to discussions with you and other stakeholders regarding the next phase of this research.

Very respectfully,

Gordon Tribble
Director

Summary of field research on the Hawaiian hoary bat at Pu'u Makua Restoration Area, Maui

Acoustic Monitoring

Six full spectrum Song Meter SM2BAT+ Ultrasonic Recorders with high frequency microphones (Wildlife Acoustics, Inc., Concord, MA) powered by solar panels were deployed in late March 2016 and fully operational (collecting data provided in this letter) commencing on 1 April 2016 (Figures 1 and 2). Station locations were chosen based on accessibility, safety, potential suitability of habitat for bat activity, and to provide widespread coverage. Five recorders were located in the mitigation area and one was located at a nearby site (AUW 6) deemed potentially good for mist-net capture of bats. The SM2BAT+ units recorded bat echolocation calls with associated date and time onto SD memory cards. The units operated continuously from one hour prior to sunset through one hour after sunrise. Data downloads and operational evaluation of the devices took place at approximately two month intervals.

Echolocation call files were processed with Kaleidoscope Pro4 (Wildlife Acoustics) to filter ambient noise, and checked for quality assurance. Acoustic detections were categorized as "search calls" (single or multiple low repetition clicks) or "feeding buzzes" (rapidly repeating clicks characteristic of a prey attack by a bat). The program Presence (Hines, 2006 USGS) was used to calculate monthly "detectability" of bats at each monitoring location. Detectability (p) represents the frequency of bat presence on a scale of 0 to 1, with 0 describing no bat activity and 1 representing acoustic activity by every night within a survey period.

On 13- 15 October 2016, SMX-US microphones were replaced with newer-model SMX-U1 microphones. We operated side by side comparisons of both microphone types over several weeks to standardize reporting of the number of echolocation pulses recorded from the two models. Initial results suggest that the SMX-U1 microphones have improved sensitivity.

Bat activity was recorded at all six detection stations from the onset of the study in April 2015 through the September 2016 (Table 1, attached). Limited monthly data was collected from station Auw 3 due to software issues until after July 11th, 2016 (47% of the sampling period did not produce full nights of data). Insufficient solar charging affected Auw 2 during August (14% of sampling period not recorded) and Auw 5 during September (8 % of sampling period not recorded).

The number of files recorded containing bat vocalizations varied considerably between stations. Station Auw 6 had the highest values for nights in which bats were present, echolocation pulses, feeding buzzes, and files where multiple bats were simultaneously present. The next highest counts came from AUW 1 and AUW 3; with AUW 1 having greater pulses and files with multiple bats, while AUW 3 showed more nights with bat presence and more feeding buzzes.

Pooled mean monthly bat detectability (p) was 0.38 +/- 0.001 SE over 18 months of sampling (red line in Figure 3). Except for a spike during the fledgling season in August 2017, mean monthly detectability for the six pooled stations showed small variance about the cumulative study mean. Great variation in bat detectability did occur over the reported study period at individual recording stations, perhaps in response to localized microclimate and insect availability in Figure 4.

Acoustic monitoring for bat echolocation activity at the six recording stations at Pu'u Makua continues through the present. Recording units were last inspected on 6 December 2016 and 7 February 2017 (data analysis for this period is not completed as yet). The next maintenance visit is scheduled for April 2017.

Bat Captures

Mist netting was conducted at two locations between 6 PM and 1 AM near AUW 6 on 13 nights between 14 October and 7 December 2016 representing a cumulative 1,630 net-meter-hours of effort. Our bat capture efficiency rate was 0.0024 bats/net-meter-hr. We used acoustic data collected at AUW 6 to determine times when bats were most frequently detected within the night. An acoustic lure was deployed for two nights, but social calls broadcast did not attract locally flying bats to nets. The acoustic lure was discontinued because such broadcasts can deter non-territorial or non-breeding age bats from the capture area.

Three bats, all adult males, were captured in mist nets adjacent to a game pond (Figure 5 and Table 2). Each bat was handled following the guidelines of the American Society of Mammologists and the University of Hawaii IACUC. Each bat received uniquely colored plastic bands on the right forearm. We recorded the sex, weight, and sampled wing tissue (3 mm biopsy punch) and hair from each individual. The male captured on 3 November was recaptured on 25 November, over the same pond where it was previously caught indicating foraging site fidelity for this individual. Fecal pellets were collected from two of the individuals for dietary analysis (one bat had an empty stomach and did not provide fecal material).

Radio-telemetry

To test the efficacy of an automated network of fixed receivers, three antennas were mounted on 20 foot masts (Figure 6). Sigma Eight Orion receiving systems with data loggers and powered by solar energy were installed by 25 October 2016 (see locations of Towers 1, 2, 3 in Figure 1). Receivers were programmed to record positions of all tagged bats when in line of sight range every 15 seconds. Subsequent review of the data showed considerable electromagnetic interference was prevalent at Pu'u Makua, likely from nearby radio and television communication towers. The electromagnetic interference was especially strong at Tower 2. The Orion receivers were replaced by Sparrow Systems receivers on 7 December in hopes they would perform better than the Sigma Eight Orion system. However, the Sparrow Systems receivers also were subject to electromagnetic interference (Figure 7) as well as lines of sight that were limited to areas much smaller than the outlying areas used by the two tagged bats described below.

Two adult male bats fitted with Sparrow tags, and released at their capture sites respectively on 3 November (Bat M47, radio .736) and 28 November (Bat M49, radio .537). A third bat we captured was too small for radio attachment according to ASM guidelines and was released after taking standard measurements, genetics biopsy, and fecal samples.

Following the release of Bat M47 on 3 November, the chase team searched for 36 hours over 6 nights until 14 November. Soon after release Bat M47 was observed briefly as it moved northeast of the capture site into heavily forested and inaccessible area until signal was lost. M47 was again weakly detected by the chase team on 4 November again to the northeast of the study area where access was not possible.

Bat M49 was tagged and released on 28 November. A signal from this bat was received only briefly on the night of release and again briefly four nights later with a single weak signal on a bearing towards inaccessible forest in Polipoli State Recreation Area.

No additional radio signals to those described above were received on either tagged bat despite nightly drives around Pu'u Makua, Ulapalakua Ranch, Polipoli State Recreation Area and Kula Forest Reserve with effort totaling 42 hours over 7 nights through 8 December. The automated Sparrow Systems tracking network (locations shown in Figure 1) was operational for a total of 40 days in which we attempted to track tagged bats. Additionally, tracking effort was conducted using hand held antennas operated by a mobile ground team which attempted find signals of tagged bats both on foot and from vehicles that deployed between 6 pm and midnight on 13 nights. The mobile team drove all accessible roads within the Waihou restoration area and surrounding ranch lands up to 1.5 kilometers southwest from the capture site each search night. Despite considerable effort, little informative tracking data were collected either from the automated antennas or by the chase team.

In general, Pu'u Makua offers very poor terrain for radio-tracking highly mobile flight animals which may have foraging ranges of many miles around roosting sites. At Pu'u Makua our ground tracking was hindered by few steep dirt ranch roads that severely limited movements and prohibited searching in many inaccessible areas. Frequent poor weather conditions not suitable to either bat flight or movement of the chase team also impacted the nights available for ground tracking; we had to suspend chase team efforts for reasons of safety on 5 nights due to high winds and rain. Furthermore, the automated tower array of receivers/antennae were hampered by poor lines of site due to mountainous terrain, electro-magnetic noise from area transmission towers, and the long distance movements of bats which could only be netted at the edge of the study area. In a more favorable environment with better lines of site, a test of Sigma Eight Orion and Sparrow receivers was conducted on Hawaii Island on 14 December 14, 2016, and showed that when free from strong electromagnetic interference, Sparrow receivers were capable of detecting radio transmitters used on hoary bats at a range of at least 2 km in partially forest terrain, compared to about 1 km for the Sigma Eight Orion receivers. Given all the site-specific difficulties at Pu'u Makua, USGS does not recommend further efforts at radio-telemetry of hoary bats at this locality.

Insect Prey Base Collections

The insect prey base for the Hawaiian hoary bat at the Pu'u Makua Restoration Area was assessed using several methods. Based on knowledge of Hawaiian hoary bat diet from other locations (C. Todd, 2012, University of Hawaii at Hilo, Master's Thesis), we focused on surveying Lepidoptera (moths) and Coleoptera (beetles). Methods used to collect insects included malaise and light trapping, and shaking vegetation to dislodge arthropods onto a sheet (locations shown in Figure 8). Lepidoptera and Coleoptera collected from vegetation will help identify host plant associations. Eight malaise traps, four placed near bat acoustic monitoring stations, were run continuously from 25 October through 7 December, 2016. Traps were emptied of their contents at approximately weekly intervals. Two light traps were run from 7 to 10 pm for 2–3 nights at each site during the new moon (October 25- 27 and November 27-29, 2016). Insects associated with restoration plantings and pasture grasses were sampled from the dominant plant species within each area by gently shaking foliage for approximately one person-hour during October 25-28 and November 27-30, 2016. The plant species searched include aalii (*Dodonaea viscosa*), grass (species not identified), koa (*Acacia koa*), mamaki (*Pipterus albidus*), mamane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), ohia (*Metrosideros polymorpha*), and pukiawe (*Leptocophylla tameiameiae*). A subset of caterpillars collected on these plants was reared to the adult stage to facilitate identification. Representative insects collected using these methods were identified to finest taxonomic level possible from comparison to museum species and are held as a voucher collection at Kilauea Field Station.

Overall, 3,702 Lepidoptera were collected in malaise traps and 469 Lepidoptera were collected in light traps. Lepidoptera identifications are not yet complete, but more than 30 species and morpho-species have been identified from the samples; 24 species have been identified to the genus or species level (Table 3, attached). All Lepidoptera collected were moths except for *Udara blackburni* (Blackburn's blue butterfly) which was occasionally collected in the caterpillar stage on aalii and koa. Small (generally <1 cm in body length) undetermined Lepidoptera comprised about 40% of the total, but several larger taxa were also common. No endangered Blackburn's sphinx moths (*Manduca blackburni*) were collected.

Lepidoptera and Coleoptera relative abundance and species composition differed between collecting methods and among sites (Figure 9). Undetermined Lepidoptera were most common at the Cabin and MAM sites, where they comprised between 43% of the assemblage in light traps at the Cabin site to 64% in malaise traps at the MAM site. Lepidoptera within the families Geometridae, Noctuidae and Tortricidae were also relatively common. Differences in species composition between trap types is most evident at the REST site where Tortricidae comprised 70% of the assemblage in malaise traps and

Noctuidae comprised 74% of the fauna in light traps. Forthcoming analyses will quantify faunal patterns among sites. Coleoptera comprised <1% of the fauna in both malaise and light traps.

The relative abundance of Coleoptera and Lepidoptera collected by beating vegetation varied among plant species sampled (Table 4). Coleoptera were more abundant than Lepidoptera on aalii, grass, koa, mamane, naio and ohia while Lepidoptera were more numerous on mamaki and pukiawe. Among Coleoptera, Coccinelidae were most common, comprising >40% of the total on all plants except pukiawe. Curulionidae and an undetermined species were next most abundant but never comprised more than 10% of the fauna on any plant species. For Lepidoptera, mamaki and pukiawe produced the greatest proportion of individuals (100 and 76.9%, respectively). Aalii supported four identified Lepidoptera families while three were collected on koa; all other plants supported one or two families.

For woody plants, koa produced the greatest number of individuals per unit of sample effort, followed by aalii (1.4 and 0.8 individuals/person-minute, respectively). The number of individuals per unit sample effort was ≤0.3 for the other five woody plants

Overall, more Coleoptera and Lepidoptera were collected on aalii than the other plant species, but the total counts have not yet been standardized for search effort (i.e., more time was spent collecting off the common aalii than off of the less common mamaki). Therefore, those values should be interpreted with caution.

Of 32 caterpillars reared from host plants, 25 became moths, 6 remain in the pupal stage and one is still a caterpillar (Table 5). *Scotorythra* spp. were most common (72% of the total) but *Amorbia emarginata*, *Udara blackburni* and *Uresiphita* sp. were also collected. Those individuals not yet mature are unknown species of *Scotorythra*. *Scotorythra* spp. were found on aalii, koa and naio, *A. emarginata* and *U. blackburni* were found on aalii and koa, and *Uresiphita* sp. was found on mamane. Numerous caterpillars were collected on other host plants, including mamaki, mamane and pukiawe, but they died before reaching the pupal stage and could not be identified.

Food Habit Assessment

Fecal samples were collected during mist netting captures from two adult male bats. Insects from the voucher collection will be used to develop the genetic barcode database from which bat diet will be determined.

Summary of Progress towards research objectives

Both bat presence and foraging activity was documented at Pu'u Makua at all six acoustic monitoring stations. There was slight seasonal variation in the pooled samples of detectability from all the Pu'u Makua sampling stations.

Station Auw 6 offered the best location for capturing bats at Pu'u Makua because it had both a high level of flight activity and the tallest and densest tree cover with roads and forest edges creating narrow open flight corridors conduce to netting success.

Ground tracking radio tagged bats with hand held and automated tracking technologies to gather data on core area proved to be extremely difficult because 1) the low capture rate of bats in the area, 2) local weather patterns and unpredictable storm events, 3) a limited regional road network with restricted access to heavily forested and mountainous terrain 4) electromagnetic interference at the automated receiving towers. For these reason, we were not successful in achieving the goal of documenting core use areas for Hawaiian hoary bats at Pu'u Makua.

From initial evaluation of the insect community, a Lepidopteran and Coleopteran it appears that a prey base to support foraging bats currently exists in the Waihou region, and within the Pu'u Makua Restoration Area.

Proposed research for 2017

Pending discussion with all stakeholders and based on the results and experience gained to this date, the following outline is suggested as a proposed work plan for 2017 with the remaining available funding amounting to $83,623.

Field Work: USGS proposes to conduct additional field research at Pu'u Makua with a focus on enhancing the following data sets/objectives:

- Continue acoustic monitoring through 3 full years of sampling at the six monitoring stations. Analysis of bat recordings will include monthly and annual detectability, number of search and feeding buzz pulses, and activity with nights over a three year period (2015-2018 concluding in March 2018)
- Strong mist-netting effort in May/June 2017 to capture bats for increasing demographic information through wing biopsy for genetics analysis, collection of fecal samples for dietary study.
- Assess insect prey base for a second season in May/June 2017; using both malaise and light traps as well as repeated vegetation sampling of restoration area plantings.
- Comparison of trends in bat activity and foraging attacks with patterns in insect prey availability, taxon, and habitat.
- Genetic analysis of fecal pellets and insect prey barcoding. This will begin in July 2017 after the final mist-netting and insect collection have been completed so that processing samples together is cost effective for staff laboratory time, supply purchases, and sequencing fees.

USGS recommends that radio-tracking bats at Pu'u Makua should be dropped from the research plan due to the impractical terrain and logistics in this area. In place of radio-telemetry, USGS will shift time and funds in 2017 in order to add greater effort on the following:

1) Increase the staff effort (20 nights as weather permits) devoted to nights of mist-netting to capture bats for genetic sampling and fecal collection (staff as budgeted could not simultaneously net and radio-track, thus more time will be implemented for netting to boost bat captures).
2) Add a second season of insect prey base sampling 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 dietary study to the extent that funds are available once field work is completed.

Attached Figures

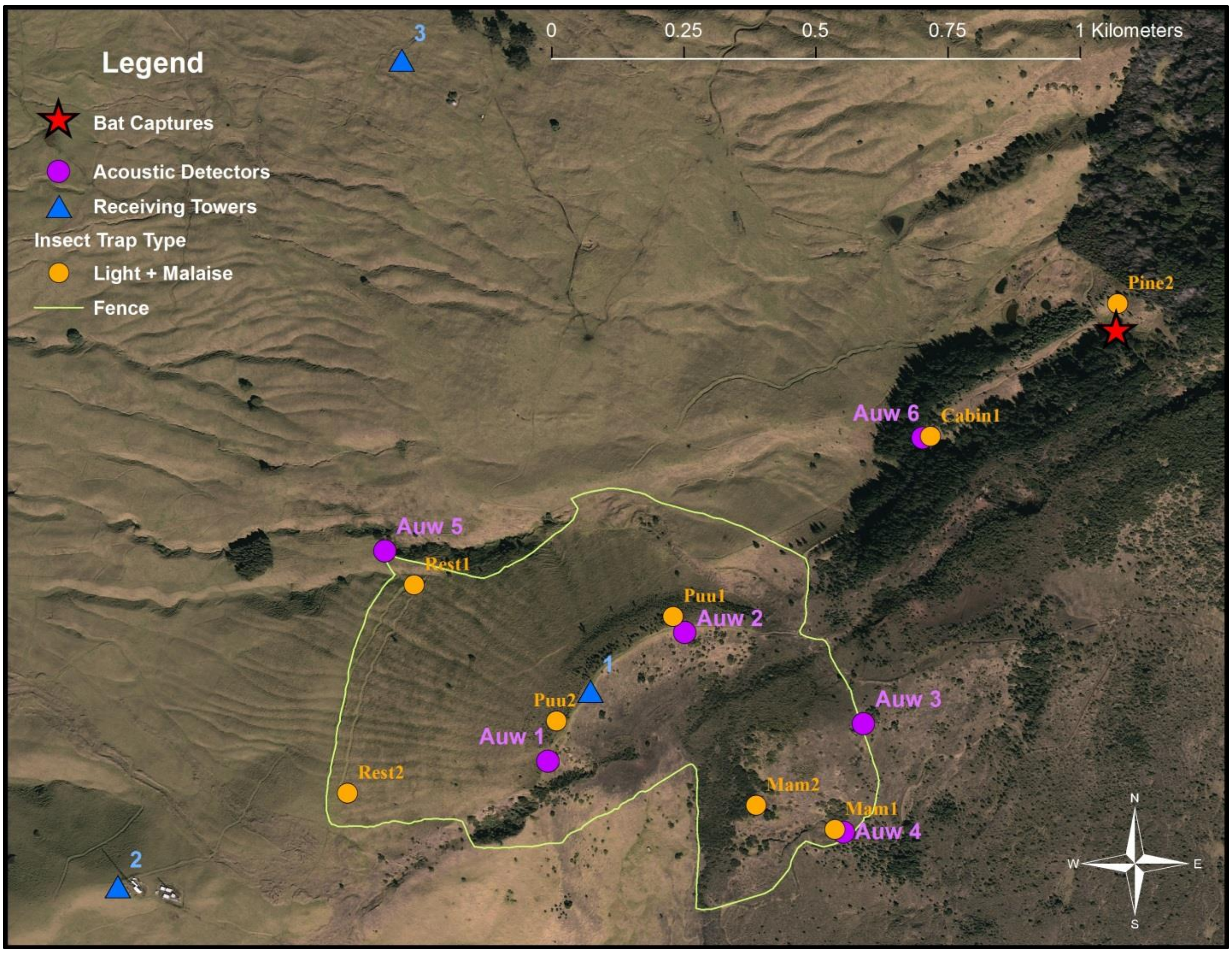

Figure 1. Map of the fenced Pu'u Makua Restoration Area and vicinity showing six acoustic recording stations (purple dots AUW 1 through AUW 6), eight paired light and malaise traps (orange dots labeled with site code), three radio-telemetry receiving towers (blue triangles with tower number), and the single location of live bat captures from mist netting (red star).

Figure 2. Bat monitoring station AUW5, within restoration habitat (left). Collecting data and servicing bat station AUW4 (right).

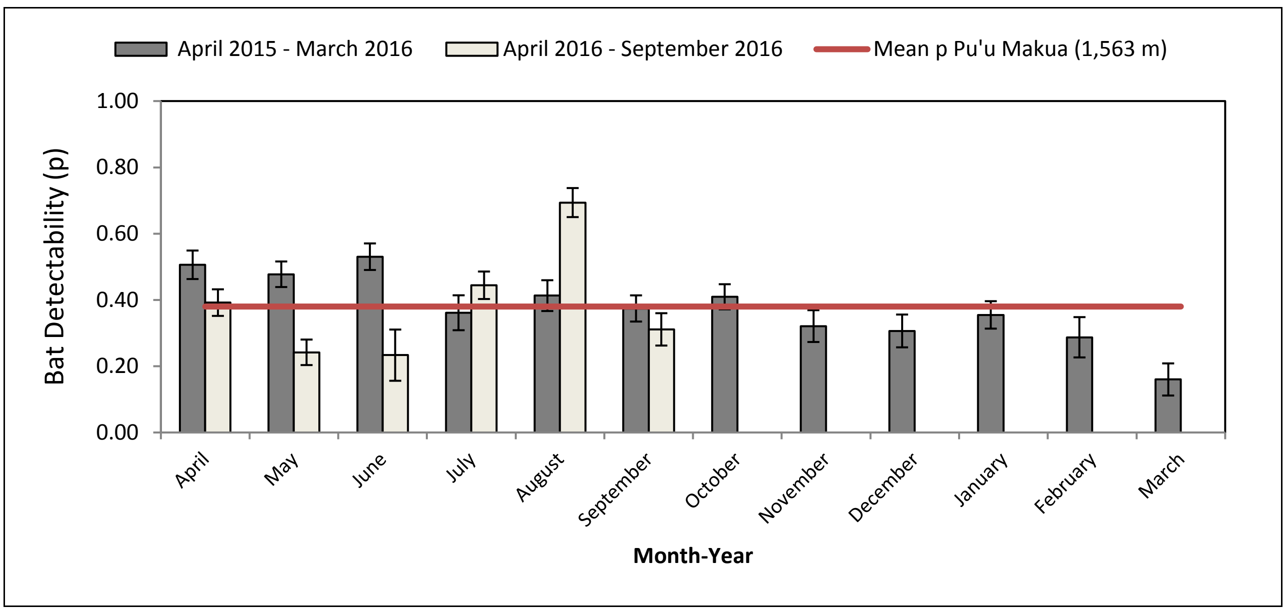

Figure 3. Mean monthly bat detectability (p) over 18 months from six bat detection stations at Pu’u Makua. Solid red line indicates mean detectability (0.38 ± 0.001 SE) across the entire survey period. Vertical bars above columns represent standard errors.

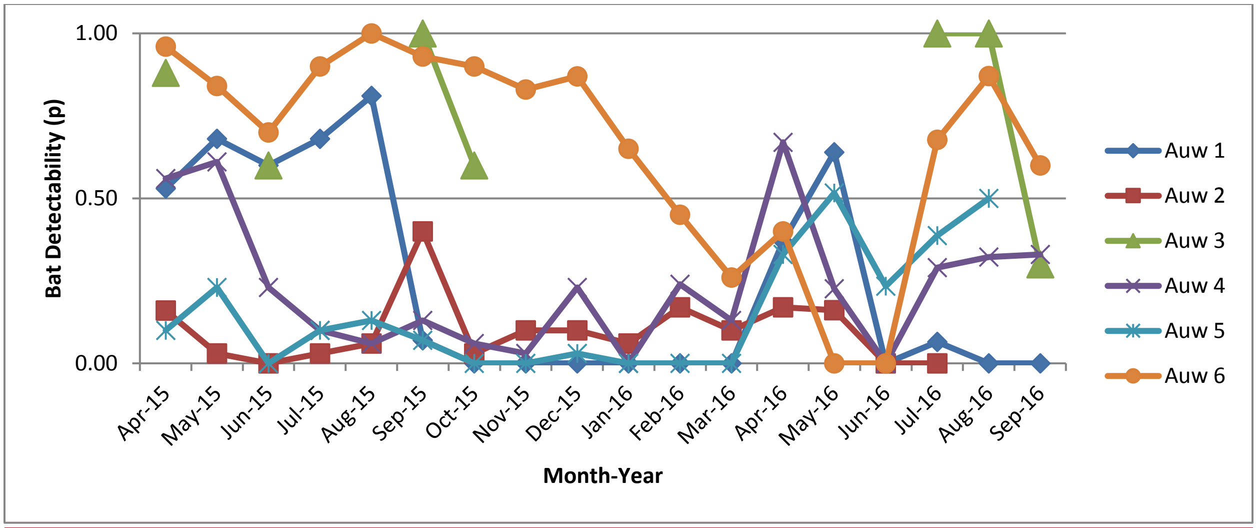

Figure 4. Mean monthly bat detectability (p) from April 2015 through September 2016 for six individual bat detection stations at Pu’u Makua.

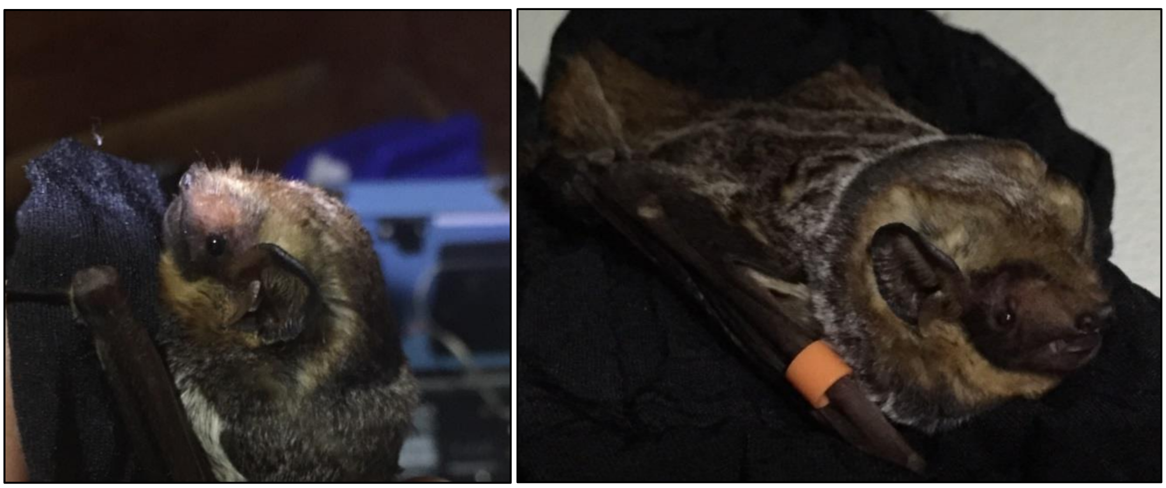

Figure 5. Captured adult male Hawaiian hoary bats: Bat M47 (left) and M48 (right).

Figure 6. SigmaEight Orion automated radio receiving tower set up at site T1.

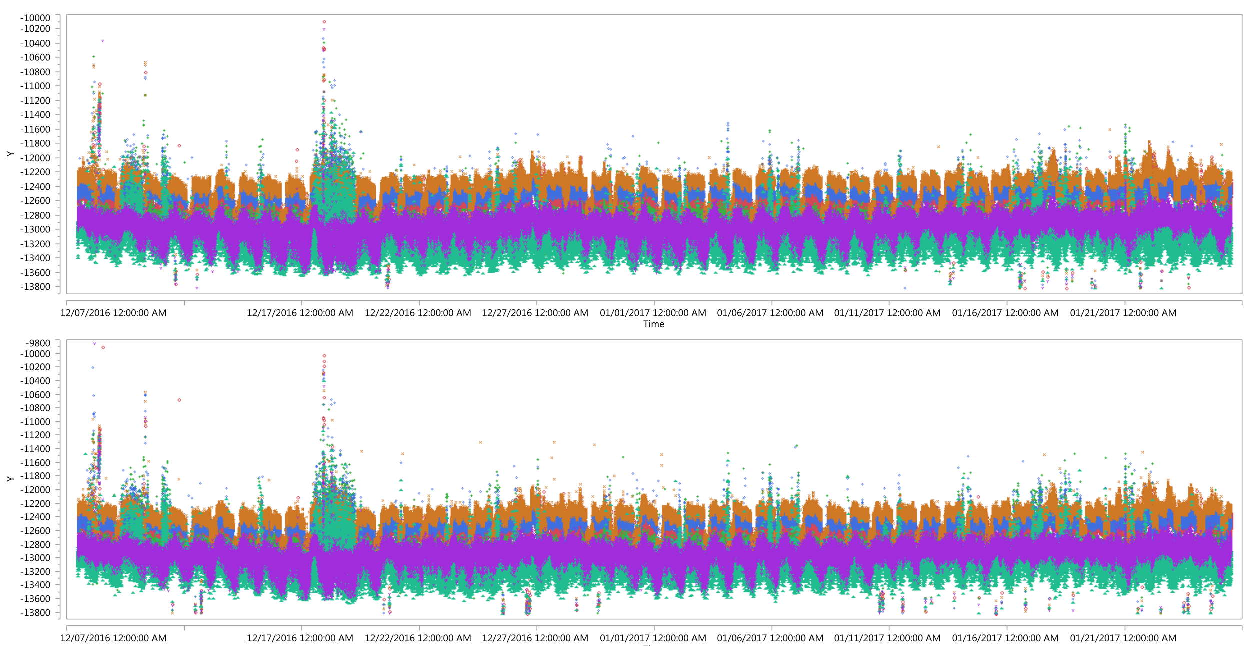

Figure 7. Samples of recordings at telemetry station 1 (T1) between December 7th, 2016 and January 25th, 2017. The time series of detections are for two pre-programmed transmitter frequencies (upper and lower panels) with signal strength on the y-axis. The upper panel in Figure 9 shows detections at a

frequency used on a tagged bat. The lower panel is a separate reference frequency used to indicate background "noise" and to which the bat's transmitter frequency is compared. The near identical pattern in both panels indicates that the detections are entirely due to electromagnetic noise received at both frequencies.

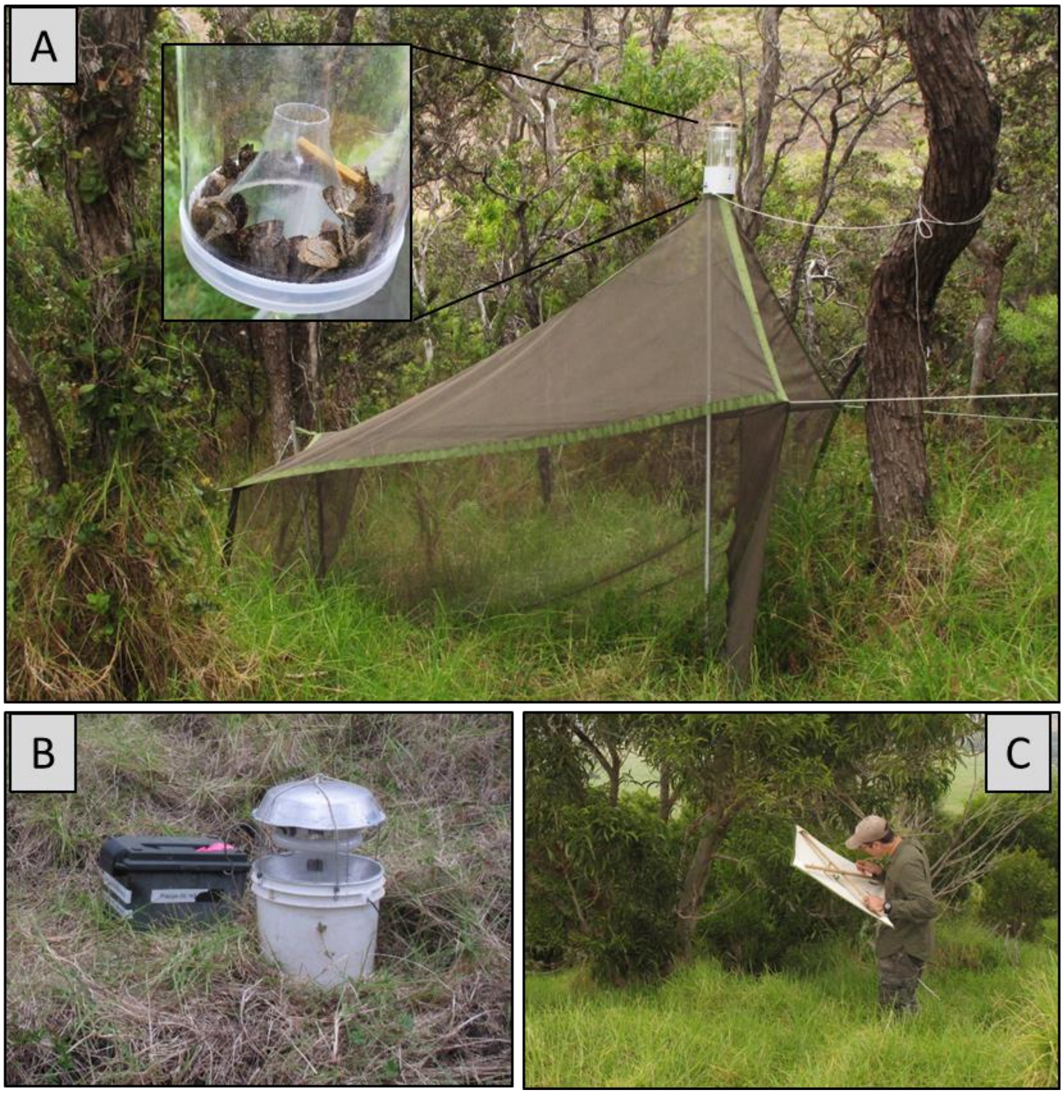

Figure 8. Methods used to collect Lepidoptera and Coleoptera at the Auwahi bat restoration area include malaise traps (A; inset shows numerous geometrid moths within the collection chamber), battery operated light traps (B), and shaking vegetation to dislodge arthropods (C).

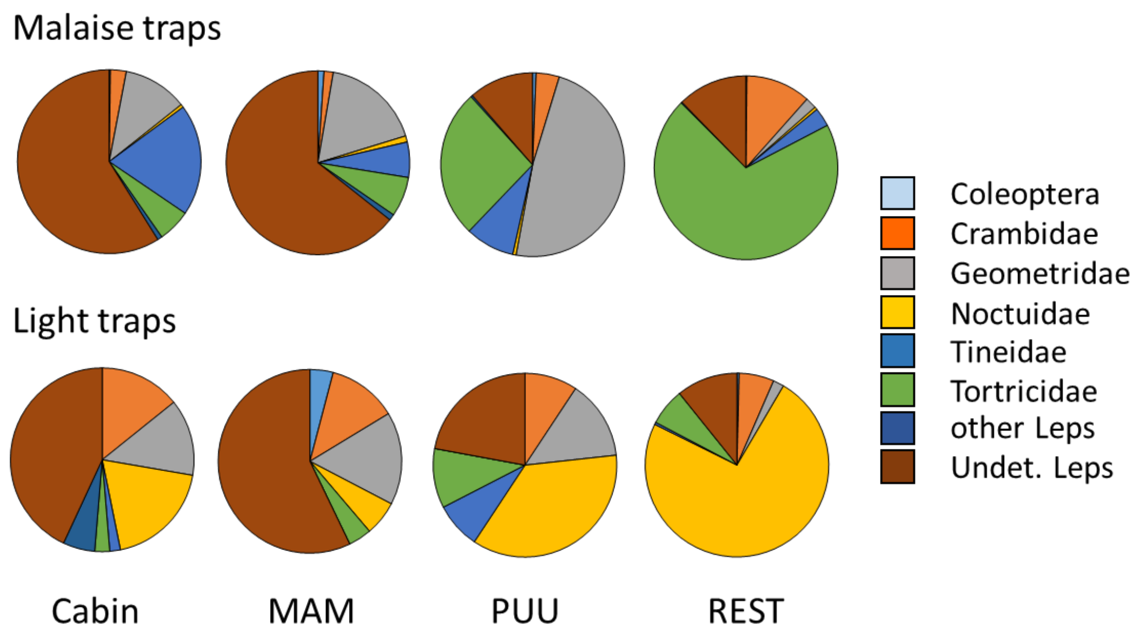

Figure 9. Relative abundance of Coleoptera and Lepidoptera collected in malaise traps (top) and light traps (bottom) at the four study sites.

Table 1. Summary of bat presence and acoustic information recorded for each detector site at Pu'u Makua during April 2015 through September 2016.

Detector Site	Elevation (m)	Recording Nights	Nights Bats Present	Echolocation Pulses	% Nights with Bat Calls	Feeding Buzzes	Files with Multiple Bats
Auw 1	1,611	549	118	20,764	21%	84	58
Auw 2	1,606	468	49	1,141	10%	12	6
Auw 3	1,607	288	115	11,064	40%	135	4
Auw 4	1,515	549	121	5,840	22%	62	6
Auw 5	1,396	506	74	2,234	15%	15	0
Auw 6	1,644	549	361	17,8986	66%	1,632	946

Table 2. Capture and marking information for bats captured in the Waihou vicinity, November 2016.

Bat ID	Radio	Date	Time	Sex	Weight (g)	Forearm (mm)	Band	Hair & Tissue	Fecal	Recapture Date
M47	.736	11/3/16	18:50	M	14	47.8	Green/ white	yes	yes	11/15/16
M48	none	11/15/16	19:36	M	16.5	49	Orange	yes	yes	
M49	.537	11/28/16	21:00	M	15.75	48.5	Blue	yes	no	

Table 3. Lepidoptera collected from the Auwahi bat restoration area during October 25th to December 7th, 2016. Host plant associations are tentative and were obtained from the literature or web-based sources.

Family	**Genus**	**Species**	**Host plant**
Crambidae	*Maruca*	*vitrata*	legumes
Crambidae	*Udea*	*pyranthes*	*Vaccinium* sp.
Crambidae	*Nomophila*	*noctuella*	grasses
Crambidae	*Omiodes*	*localis*	monocots
Crambidae	*Omiodes*	sp. A	monocots
Crambidae	*Omiodes*	sp. B	monocots
Crambidae	*Omiodes*	sp. C	monocots
Crambidae	*Uresiphita*	*polygonalis*	mamane
Erebidae	*Ascalapha*	*odorata*	legumes
Geometridae	*Eupithecia*	sp.	various
Geometridae	*Scotorythra*	*paludicola*	koa
Geometridae	*Scotorythra*	*rara*	various
Geometridae	*Scotorythra*	sp. A	unknown
Geometridae	*Scotorythra*	sp. B	unknown
Lycaenidae	*Udara*	*blackburni*	koa, aalii
Noctuidae	*Chrysodeixis*	*eriosoma*	various
Noctuidae	*Agrotis*	*ipsilon*	various
Noctuidae	*Athetis*	*thoracica*	unknown
Noctuidae	*Haliophyle*	*flavistigma*	unknown
Noctuidae	*Pseudoletia*	*unipunctata*	grasses
Sphingidae	*Hyles*	*lineata*	various
Tineidae	*Epiphyas*	*postvittana*	various fruit
Tortricidae	*Amorbia*	*emigratella*	legumes
Xyloryctidae	*Thyrocopa*	sp.	various

Table 4. Percent abundance of Coleoptera and Lepidoptera collected from foliage of nine common plant species in the Auwahi bat restoration area. Totals for each order are indicated in bold. The bottom three lines summarize the total abundance, sample effort, and the standardized abundance, respectively.

Order	Family	aalii	koa	mamake	mamane	naio	ohia	pukiawe	grass
Coleoptera		**52.0**	**35.7**		**36.7**	**60.0**	**45.0**	**17.6**	**72.7**
	Aglycyderidae		0.7		2.0				
	Coccinelidae	48.6	28.6		28.6	60.0	45.0	5.9	59.1
	Curculionidae	2.9	2.1		6.1			5.9	9.1
	Elateridae		0.7						
	Nitidulidae								
	Scolytidae		0.7						
	undetermined	0.6	2.9					5.9	4.5
Lepidoptera		**48.0**	**64.3**	**100.0**	**63.3**	**40.0**	**55.0**	**82.4**	**27.3**
	Geometridae	35.3	56.4	16.7	6.1	40.0	20.0	58.8	4.5
	Lycaenidae	4.6							
	Tineidae	0.6	2.9	66.7	4.1				
	Tortricidae	2.3	2.1		2.0		5.0		9.1
	Undetermined	5.2	2.9	16.7	51.0		30.0	23.5	13.6
Total number of individuals		173	140	6	49	10	20	17	22
Effort (person-min or no. of sweeps for grass)		220	100	30	150	30	120	120	500
Number/unit effort		0.8	1.4	0.2	0.3	0.3	0.2	0.1	0.04

Table 5. Lepidoptera reared from caterpillars collected on host plants at the Auwahi bat restoration area.

	host plant			
Lepidoptera species	**aalii**	**koa**	**mamane**	**naio**
Amorbia emarginata	2	1		
Udara blackburni	3	1		
Scotorythra spp.	13	5		5
Uresiphita sp.			2	
Total	18	7	2	5

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Attachment 4

Status Update from the Leeward Haleakalā Watershed Restoration Partnership on Use of Funds for Blackburn's Sphinx Moth Mitigation

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Auwahi FOREST RESTORATION PROJECT

Auwahi Forest Restoration Project quarterly report to Sempra
For forest restoration at Auwahi, 'Ulupalakua Ranch, Maui
Progress from May 18, 2017 through August 1, 2017

We are contacting you to update you on the progress of the goals outlined for the Auwahi Forest Restoration Project to conduct primary restoration in six acres and plant 1500 *'aiea* (*Nothocestrum latifolium)* and 10 *'iliahi* (*Santalum haleakalae var. lanaiense*). We have successfully conducted primary restoration in six acres of Auwahi, planted 970 *'aiea*, and 20 *'iliahi* in Auwahi exclosures.

We are pleased to report that the seeds gathered in May have successfully germinated (photo bottom left) and will require roughly 9-12 months to reach the required vigor to outplant in Auwahi forest. In addition, on one of our recent Auwahi volunteer trips (July 15th) we outplanted ten healthy *'aiea* saplings in to the forest (photo bottom right).

RECEIVED
AUG 01 2017
Tri-Isle RC&D Council, Inc.

Ancient 'Ohi'a Tree
@ Auwahi

Attachment 5

FY 2018 Annual Work Plan and Timeline

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FY 2018 Annual Work Plan and Timeline

Task		2017						2018					
		July	August	September	October	November	December	January	February	March	April	May	June
Post Construction Mortality Monitoring	Fatality Searches	Four Day Interval Searches Utilizing Environmental Technicians			Continue Four Day Search Intervals Utilizing Environmental Technicians Searching Or Implement Weekly Searches Utilizing Search Dog								
	Searcher Efficiency Trials	Monthly Trials											
	Carcass Persistence Trials	Quarterly Trials											
	Scavenger Control	Traps Operational Year-Round											
Petrel Mitigation	HAPE Monitoring	Burrow Monitoring								Burrow Monitoring			
	Predator Control	Traps Operational All Units		Predator Activity Assessment	Traps Operational All Units				Predator Activity Assessment	Traps Operational All Units			
Bat Mitigation	Ungulate Control	Quarterly Fence Inspection			Quarterly Fence Inspection			Quarterly Fence Inspection			Quarterly Fence Inspection		
	Vegetation Monitoring and Invasive Species Control				Semi-Annual Invasive Vegetation Management				Annual Vegetation Monitoring	Semi-Annual Invasive Vegetation Management			
	Reforestation	Out-planting Replacements for Plants that Died in Established Planting Units			Re-Treat Grasses Around Out-Plantings		Volunteer Group Trips					Re-Treat Grasses Around Out-Planting	
	Tier 2 & 3 (Acoustic Monitoring)	Acoustic Monitoring Year 3											
	Tier 2 & 3 (Expanded Research)	Acoustic Monitoring and Insect Prey Study Expanded Year 1											Year 2 Summary Report
	Tier 2 & 3 (Insect Prey-Based Study)	Identifying Insects and Genetic Barcoding Insect Prey Based Study/Food Habitat Assessment											Year 2 Summary Report
Reporting	ITP & ITL Conditions		Annual HCP Report Submitted					Incidental Take Summary Tables Submitted	Semiannual Progress Report Submitted				

Attachment 6
FY 2017 Expenditures for HCP Implementation

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	Tier, Ongoing, or One-time	Event	Proposed Cost	Total Costs Incurred to Date (up to July 2017)	Costs Incurred FY 13 (July 1, 2012 - June 30, 2013)	Costs Incurred FY 14 (July 1, 2013 -June 30, 2014)	Costs Incurred FY 15 (July 1, 2014 -June 30, 2015)	Costs Incurred FY 16 (July 1, 2015 -June 30, 2016)	Costs Incurred FY 17 (July 1, 2016 -June 30, 2017)
General Measures	Ongoing	Wildlife Education and Incidental Reporting Program	$5,000	$4,667	$3,000	$1,500	$167	N/A	N/A
	Ongoing	Downed Wildlife Post-Construction Monitoring and Reporting and Mitigation Monitoring	$1,810,000	$643,473	$100,000	$185,145	$152,901	$108,727	$96,700
	Ongoing	*DOFAW Compliance Monitoring (only if needed)	$200,000	$7,023	N/A	N/A	$2,423	N/A	$4,600
		Subtotal General Measures	*$1,815,000*	*$655,163*	*$103,000*	*$186,645*	*$155,324*	*$108,727*	*$101,300*
Hawaiian Hoary Bat	Tier 1	Retrofit fencing and restoration measures at the Waihou Mitigation Project	$522,000	$782,779	$314,900	$63,173	$128,410	$149,833	$126,463
	Tier 1	Acoustic Monitoring onsite	$40,000	$39,827	$5,000	$8,691	$14,663	$11,473	N/A
	Tier2	Telemetry Research	$250,000	$250,000	N/A	$32,726	$8,308	$142,819	$66,146
	Tier 3	Expanded Research	$320,000	$234,360	N/A	N/A	N/A	N/A	$234,360
Hawaiian Petrel		Subtotal Bats	*$812,000*	*$1,072,606*	*$319,900*	*$104,591*	*$151,381*	*$304,125*	*$426,969*
	Tier 1	Burrow Monitoring and Predator Control	$550,000	$515,457	$214,000	$74,572	$107,743	$56,410	$62,731
		Subtotal Petrels	*$550,000*	*$515,457*	*$214,000*	*$74,572*	*$107,743*	*$56,410*	*$62,731*
Nene	One-Time	Research and Management Funding	$25,000	$25,000	$25,000	N/A	N/A	N/A	N/A
		Subtotal Nene	*$25,000*	*$25,000*	*$25,000*	*N/A*	*N/A*	*N/A*	*N/A*
Backburn's Sphinx Moth	One-Time	Restoration of 6 acres of Dryland Forest	$144,000	$144,000	$144,000	N/A	N/A	N/A	N/A
		Subtotal Moth	*$144,000*	*$144,000*	*$144,000*	*N/A*	*N/A*	*N/A*	*N/A*
		Total HCP-related Expenditures	**$3,346,000**	**$2,412,225**	**$805,900**	**$365,808**	**$414,448**	**$469,263**	**$591,000**

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