Auwahi **Wind**

August 31, 2016

Jodi Charrier
United States Fish and Wildlife Service
Pacific Islands Office
300 Ala Moana Boulevard
Room 3-122, Box 50088
Honolulu, HI 96850
Jodi_Charrier@fws.gov

Katherine Cullison
Hawaii Department of Land and Natural Resources
Division of Forestry and Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813
Katherine.cullison@hawaii.gov

**Via Email SUBJECT: Auwahi Wind Farm Project Habitat Conservation Plan FY 2016 (Year 5) Annual Report**

Dear Ms. Charrier 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, 2015 through June 30, 2016.

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, 2015 – June 30, 2016. 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. Nene mitigation has been completed.

Should you have any questions on this annual report, please feel free to contact me at (808) 495-5234 or via email at mvanzandt@AuwahiWind.com.

Sincerely,

Marie VanZandt
Project Biologist/Auwahi Wind Farm

This page intentionally left blank

# Auwahi Wind Farm Habitat Conservation Plan FY 2016 Annual Report

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


Prepared By:

Sempra Energy

Auwahi Wind Energy LLC
PO Box 901364
Kula, HI 96790

August 2016

This page intentionally left blank

# Table of Contents

## List of Tables



## List of Figures

This page intentionally left blank

## 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 2012). 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 semotu*), 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) 2016 (from July 1, 2015 to June 30, 2016). 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 2016 (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 Haleakala Watershed Restoration Partnership (LHWRP) are included as attachments to this report. Completion of the Nene mitigation was documented in the FY 2013 annual report (Tetra Tech 2013).

**Table 1-1.** Summary of compliance status July 1, 2015 – June 30, 2016.

| 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 | Sempra Project biologist has been on staff since June 2013, previously Tetra Tech acted as Project biologist. |
| 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 2016 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 2016. |
| 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 | Two fatalities were listed species (Hawaiian hoary bats) and two fatalities were MBTA in FY 2016. |
| 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, 2016. Fatalities documented during FY 2016; 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 15, 2016. The next semi-annual progress report will be submitted in February 2017. |

**Table 1-1.** Summary of Compliance Status July 1, 2014 – June 30, 2015.

| 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 September 2015/February 2016. Total of thirty-eight acres of native trees and shrubs out-planted. Ongoing maintenance. |
| Acoustic monitoring at the wind farm (Tier 1 mitigation) | HCP, Table 6-2 | Years 1 and 2 of operation | In compliance; completed | Initiated July 2013, completed in December 2015. Results of two years and a half years provided in Section 3.2 of this report. |
| 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 |

**Table 1-1.** Summary of Compliance Status July 1, 2015 – June 30, 2016.

| 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 2016. Results from 2015 provided in Attachment 2. |
| 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 2015 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 5. |
| **Nene Mitigation** | | | | |
| Research or management funding ($25K) provided to Haleakala 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 reporting. |
| ***Abutilon menziesii*** **(red ilima)** | | | | |
| 'Ulupalakua Ranch will plant 10 red ilima (*Abutilon menziesii*) 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. |
| **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. |

# 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 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 three-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. WL14-03) for handling native bird and bat carcasses was issued by DOFAW on April 11, 2013. Permits are valid through March 31, 2018 and September 24, 2017, respectively.

**Table 2-1.** Post-construction mortality monitoring summary, FY 2016.

| Variable | Systematic July 2015 - June 2016 |
|---|---|
| **Study Metrics for Fatality Estimates** | |
| Total number of Project turbines | 8 |
| Number of turbines searched | 8 |
| Search plot size | Pads and Roads within 100 meter (328 feet) radius of turbine |
| Met tower search plot size | 10 meters (33 feet) around the base of the met tower |
| Search interval | 3 days |
| **Fatalities of Covered Species** | |
| **Hawaiian Petrel** | |
| Number of fatalities documented | 0 |
| Adjusted take | 0 |
| **Hawaiian Goose** | |
| Number of fatalities documented | 0 |
| **Hawaiian Hoary Bat Fatalities** | |
| Number of fatalities documented | 2 |
| Adjusted take | 0 (sex of fatalities to be determined) |
| **Fatalities of Other Species[1]** | |
| Fatalities found during searches | 5 |
| Fatalities found incidentally | 3 |

[1]Includes two MBTA species.

## 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, 2015 – June 30, 2016. 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. The search area size and configuration varied among turbine pads. Based on carcass distributions compiled by Tetra Tech from 25 publically 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 are currently searched for the Project, which are consistent with recent carcass distribution modeling efforts (Hull and Muir 2010).

**Table 2-2.** Average search interval between standardized carcass searches at the Auwahi Wind Project, FY 2016.

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

[1] Includes all turbines and meteorological tower

Ten fatalities were documented in FY 2016; seven of these fatalities were documented during systematic carcass searches (Table 2-3). Two fatalities recorded were covered under the MBTA, both being great frigatebirds (*Fregata minor*). Two fatalities were Covered Species, both 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 2016.

| Species | Legal Status | Found Date | Location (Turbine) | Type of Detection |
|---|---|---|---|---|
| Great Frigatebird *(Fregata minor)* | MBTA | 8/25/2015 | 4 | Systematic Search |
| Hawaiian Hoary Bat *(Lasiurus cinereus semotus)* | T&E | 9/28/2015 | 4 | Systematic Search |
| Gray Francolin *(Francolinus pondicerianus)* | None | 12/14/2015 | 1 | Incidental |
| Gray Francolin *(Francolinus pondicerianus)* | None | 12/15/2015 | 7 | Systematic Search |
| Great Frigatebird *(Fregata minor)* | MBTA | 2/8/2016 | 6 | Incidental |
| Gray Francolin *(Francolinus pondicerianus)* | None | 3/27/2016 | 7 | Systematic Search |
| Gray Francolin *(Francolinus pondicerianus)* | None | 4/14/2016 | 4 | Systematic Search |
| Common Myna *(Acridotheres Tristis)* | None | 5/18/2016 | 6 | Incidental |
| Hawaiian Hoary Bat *(Lasiurus cinereus semotus)* | T&E | 6/10/2016 | 6 | Systematic Search |
| Common Myna *(Acridotheres Tristis)* | None | 6/10/2016 | 6 | Systematic Search |

## 2.2 Carcass Persistence Trials

Four carcass persistence trials were conducted during FY 2016, and are summarized together for each carcass size class in Table 2-4. Each trial had a minimum of six carcasses per size class. Wedge-tailed shearwaters (*Ardenna pacificus*) and Gray Francolins (*Francolinus pondicerianus*) were used as surrogates for large birds, and medium sized black rats (*Rattus rattus*) were used as surrogates for bats. In FY 2015 carcass persistence trials were discontinued for large birds due to consistency in persistence times far exceeding the search interval, across the initial two years of PCMM. Trials continued for bats throughout FY 2016 and were reinitiated for large birds in January 2016.

Carcasses were placed at randomly generated points on turbine pads and roads. 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 and analytical methods are included in Attachment 1 of the 2013 HCP annual report (Tetra Tech 2013). Bootstrap estimates of carcass persistence time and 95 percent confidence intervals for each carcass category were calculated using 1,000 replicates.

The average probability of persistence is defined by Huso (2011) as:

$$\hat{r} = \frac{\hat{\bar{t}}\,(1 - e^{-I/\hat{\bar{t}}})}{min\,(\hat{\tilde{I}}, I).}$$

where $\hat{\bar{t}}$ is the average carcass persistence time, $I$ is the actual search interval and $\hat{\tilde{I}}$ is the effective search interval (the length of time when 99 percent of the carcasses can be expected to be removed; $\hat{\tilde{I}}$ = - log (0.01) * ($\hat{\bar{t}}$).

Auwahi Wind has implemented continual predator control on site since the fall of 2013. The average carcass persistence time for bats remained relatively constant throughout systematic search periods in FY 2016 (Table 2-4). The probability of persistence increased slightly for bats from FY 2015, due to a decrease in the amount of time between fatality searches. Similar to trials conducted in the first two years of operation, most large birds persisted through the entire 21-day trial period resulting in a modeled probability of persistence greater than 100 days in FY 2016.

**Table 2-4.** Carcass persistence estimates for systematic searches at the Auwahi Wind Project, FY 2016.

| Search | Carcass Size Class | N | Average Carcass Persistence Time (days) | 95% CI | $\hat{r}$ value |
|---|---|---|---|---|---|
| Systematic | Bats | 67 | 3.96 | 2.97-5.08 | 0.68 |
| Systematic | Large birds | 15 | >100 | n/a[1] | 0.90 |

[1]no meaningful CI can be estimated, almost all carcasses persist for the entire trial

## 2.3 Searcher Efficiency

Searcher efficiency trials were conducted during FY 2016. 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. Thirty-four searcher efficiency trial days occurred during FY 2016, consisting of 67 individual trials. Wedge-tailed shearwaters 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. 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.

Bootstrap estimates of searcher efficiency and 95 percent confidence intervals (CI) were calculated, using 1,000 replicates for each carcass category (large bird and bat). The estimated searched efficiency is defined by Huso (2011) as:

$$\hat{p} = \frac{n_i}{k_i}$$

Where $\hat{p}$ is the proportion of trial carcasses available to be found and detected by searchers, $n_i$ is the number of trial carcasses found for the *i*th carcass category, $k_i$ is the number of trial carcasses found for the *i*th carcass category.

In FY 2015 searcher efficiency trials for large birds was discontinued due to consistency in searching across the initial two years of PCMM. Trials continued for bats throughout FY 2016 and were restarted for large birds in January 2016. Searcher efficiency for large birds increased from 2014 (77 percent) to above 90 percent. Searcher efficiency remained at or above 70 percent for bats. Throughout FY 2016 fatality searches were restricted to pads and roads, where regularly scheduled vegetation management most likely increased detectability of trial carcasses.

**Table 2-5.** Searcher efficiency estimates for systematic searches at the Auwahi Wind Project, FY 2016.

| Search | Carcass Size Class | No. Placed[1] | No. Found | Average Searcher Efficiency (%) | 95% CI |
|---|---|---|---|---|---|
| Systematic | Bats | 53 | 37 | 70 | 57-81 |
| Systematic | Large birds | 14 | 13 | 93 | 79-100 |

[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 three and a half years of monitoring at the Project, there were eight fatalities of Covered Species (seven 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 Evidence of Absence software (EoA; Dalthorp et al. 2014) 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. 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 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 3.5 years for bats, and 2.5 years for large birds (Table 2-6). 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 2016.

| Year | Curtailment (5m/s) | Carcass Size Class | No. Fatalities Detected | Proportion of carcass distribution searched | Average Search Interval (days) | Probability of persistence- r | Average Searcher Efficiency (%) | Detection bias- g[a] |
|---|---|---|---|---|---|---|---|---|
| 1 | No | Bats | 1 | 0.97 | 9 | 0.44 | 0.57 | 0.26 |
| 2 | No | Bats | 4 | 0.94 | 5 | 0.75 | 0.52 | 0.55 |
| 3 | Yes | Bats | 1 | 0.76 | 3 | 0.73 | 0.68 | 0.44 |
| 4 | Yes | Bats | 1 | 0.76 | 3 | 0.76 | 0.76 | 0.50 |
| 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 | 0.76 | 3 | 0.99[b] | 0.89[b] | 0.55[b] |
| 4 | Yes | Large birds | 0 | 0.76 | 3 | 0.90 | 0.93 | 0.50 |

[a] Detection bias calculated using Evidence of Absence Software (Dalthorp et al. 2014)

[b] Derived from FY 2014 bias correction trials, conducted within year 3 search area

Based on the seven bat fatalities detected during 3.5 years of surveys, the "maximum likelihood value" is sixteen fatalities, although the probability that the total fatalities are exactly equal to sixteen is only 8 percent (Figure 1). It can be asserted with 80 percent certainty that the number of fatalities ranged from 7 to 23 over this survey period (Attachment 1). Auwahi Wind is 80 percent certain that no more than 23 fatalities have occurred.

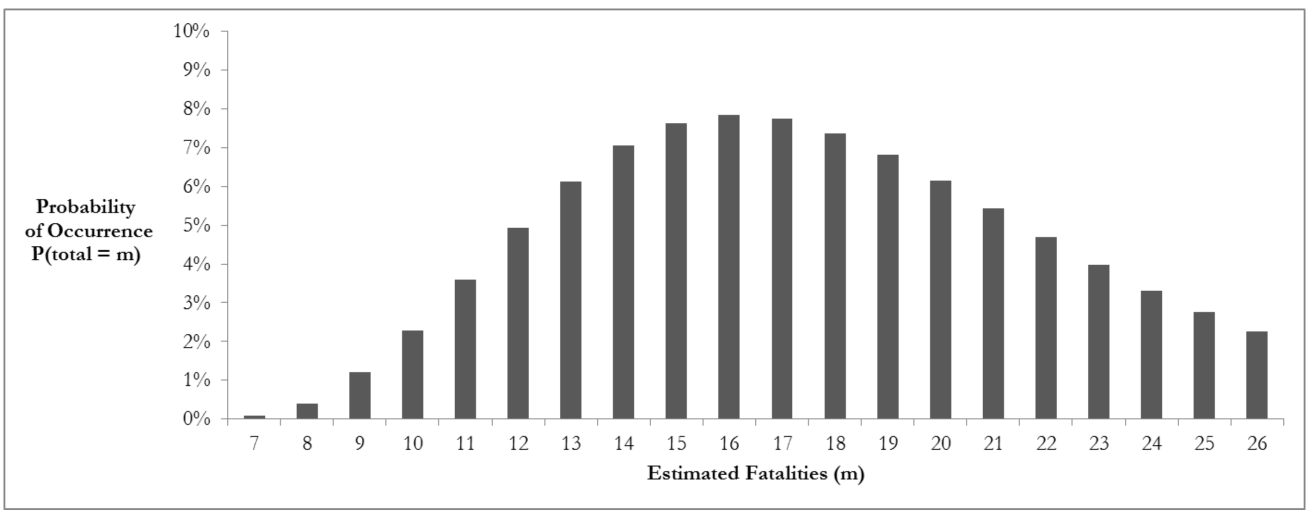



**Figure 1.** Posterior probability distribution for Hawaiian hoary bats using the Evidence of Absence software (Dalthorp et al. 2014).

Based on the one Hawaiian petrel fatality detected during 3.5 years of surveys, it is most likely that one fatality 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 fatalities have occurred. Examining the posterior distribution we see the "maximum likelihood value" is equal to 1, and the chance that total fatalities are exactly equal to 1 is 42 percent (Figure 2).

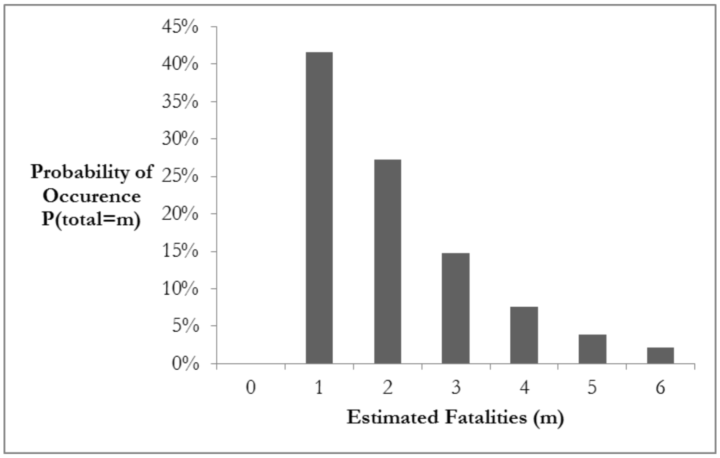



**Figure 2.** Posterior probability distribution for Hawaiian petrels using the Evidence of Absence software (Dalthorp et al. 2014).

### 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).

There have been no confirmed female bat fatalities during the breeding period at Auwahi Wind, although two fatalities were observed during the breeding season (found August 30, 2013 and June 10, 2016). The sex is unknown for both of these fatalities, but tissue samples have been submitted for genetic testing. Should genetic testing indicate either of these fatalities was a female, Auwahi Wind will reevaluate the potential for the collision-related fatalities to have resulted in indirect take.

## 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 take appropriate steps for documenting and reporting any species encountered during the operation of the Project. Forty-seven contractors and new staff participated in this training in FY 2016, 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. Feral cat and mongoose traps are deployed across all turbine plots 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.
- 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 2012). Each tier represents a level of take and is associated with outlined mitigation measures. Reaching Tier 1 take levels for a species triggers initiation of Tier 2 associated mitigation. There is a high probability that the number of bat fatalities has exceeded the Tier 2 take level of 11 bats, approximately 92 percent (Attachment 1). There is a moderate probability, approximately 25 percent, that the number of fatalities has exceeded the Tier 3 take level of 21 bats. To ensure that mitigation efforts precede the occurrence of take, Auwahi Wind has initiated Tier 3 mitigation and implemented an approved Tier 2 & 3 bat research plan. Funding for this Tier 2 & 3 bat research plan has been secured and is expected to begin in the first quarter of FY 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 (BSM). Monthly surveys continue to be conducted for BSM and manual removal of tree tobacco (*Nicotiana glauca*) has been completed, in addition to translocating any BSM 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. More than 97 plants were removed from the Project in FY 2016, with most plants less than three feet tall. Prior to plant removal, two larvae, at fifth instar, were detected during visual surveys of tree tobacco in FY 2016. Larvae found were relocated following USFWS/DOFAW protocols.

# 3.0 Mitigation

## 3.1 Hawaiian Petrel Mitigation

Results from the 2015 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 feral cat or other predator activity. Results of the 2016 breeding season and predator control will be included and summarized in the 2017 annual report.

### 3.1.1 Petrel Burrow Monitoring

Petrel burrows within Kahikinui PMA continued to be monitored during the 2015 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. One new burrow located in 2015 was marked, mapped, and added to the monitoring dataset. In the 2015 breeding season 64 petrel burrows were monitored, 33 showed signs of activity some time during the breeding season. Consistent activity through the breeding season was seen at 31 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 26 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 26 – 80 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 ten burrows: eight successfully fledged and two failed during the egg laying stage.

### 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 & 2014 Petrel Monitoring Report summarizes in detail the results of predator control in the breeding season. In the 2015 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 3, 2015 and ran through December 14, 2015. A total of 122 traps were deployed across Kahikinui PMA, resulting in 27,152 trap nights. Trap types included: 10 Belisle body grip, 35 Doc250, 18 KaMate snap, 37 Goodnature self-loader, and 22 Victor foothold traps (equipped with 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 53 predators, including mongoose, Polynesian rat (*Rattus exulans*), black rat, and house mouse (*Mus musculus*). An additional five traps were donated to the Maui Nui Seabird Recovery Project, which conducted seabird management in the adjacent Kahikinui Natural Area Reserve. These traps removed an additional 8 predators.

### 3.1.3 Benefits

Auwahi Wind has measured reproductive success of Hawaiian petrels within Kahikinui PMA for the past four years as well as baseline predator activity for the past two years. Auwahi Wind is committed to predator control for the life of the Project. This should have a positive effect on the reproductive success of Hawaiian petrels within Kahikinui PMA, and may also reduce predation in adjacent areas managed by NPS and the National Science Foundation - Daniel K. Inouye Solar Telescope. 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 three years, nine 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.

## 3.2 Hawaiian Hoary Bat Mitigation and Monitoring

Implementation of Tier 1 and Tier 2 bat mitigation is on-going at the Waihou Mitigation Area, located on Uluplalakua Ranch. Tier 1 mitigation consists of the restoration of native forest on approximately 130 acres of pastureland in the Waihou Mitigation Area, specifically the Puu 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. Funding has been allocated to this research and is expected to begin quarter one of FY 2017.

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.

### 3.2.1 Tier 1 Mitigation

The Puu Makua site is in its third year of restoration efforts. The installed 2.4-meter (8-foot) tall fence surrounding the 53-hectare (130 acre) parcel, continues to be inspected and maintained ungulate-free. Fence checks are conducted quarterly to ensure the integrity of the fence and detect any possible incursion. Hawaii Vegetation Control continues sweeps of the entire site twice a year for the removal of invasive species including tropical ash (*Fraxinus uhdei*), bocconia (*Bocconia frutescens*), black wattle (*Acacia mearnsii*), and Monterey pine (*Pinus radiata*). Invasive species sweeps took place over the course of one week in September 2015 and February 2016; the next scheduled sweep is in October 2016.

Auwahi Wind completed its second phase of native tree out-planting in December 2015, with an additional planting of 19 acres. Spring and fall efforts resulted in over 38 acres out-planted in open pasture within the Puu Makua site. Over 12,000 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 in the fall were predominately koa (*Acacia koa*), 'ohia lehua (*Metrosideros polymorpha*), a'ali'i (*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 ʻŌlapa (*Cheirodendron trigynum*), kōlea (*Myrsine lessertiana*), naio (*Myoporum sandwicense*) and 'iliahi (*Santalum haleakalae*).

Follow-up management within the planted plots over the past year has included non-native grass and blackberry (*Rubus argutus*) control. The expectation is that grasses will need to be treated every 6 – 9 months after planting, for 2 – 3 years, to ensure slow-growing trees are established above grasses. After one year survival rates varied between types of plant, overall plot survival rates ranged between 85 – 97 percent.

In February 2017, Auwahi Wind will conduct a follow-up vegetation monitoring study, with the objectives of assessing conditions post-planting and carrying out invasive species management activities. The follow up survey will use the same approach as the original baseline monitoring, using line-intercept and plot-based sampling along with permanent photo points (Tetra Tech 2014). Results will be used to track progress towards achieving long-term HCP success criteria.

### 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 research plan in March of 2015. The first phase of implementation 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 Puu Makua parcel and surrounding areas since March of 2015. Acoustic data cards are collected every 3 – 6 months. Research objectives completed in FY 2016 are summarized by USGS in Attachment 3.

### 3.2.3 Acoustic Monitoring

In July of 2013, two ground-based, solar powered, acoustic monitors (Wildlife Acoustics SM2Bat+) were placed within the Project area at WTG 1 and WTG 6. Units were placed on water containment units, 2 – 2.5 meters (6 – 8 feet) above the ground. Settings for the units followed the recommendations of the USGS bat research team from the Kilauea Field Station, Hawaii (Sempra Energy 2014). Acoustic monitors were operational for two and a half years and decommissioned in December 2015. Tetra Tech was contracted to review files collected and process vocalization data. A summary of acoustic data collected across the entire sampling period is summarized in Attachment 4.

### 3.2.4 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.

### 3.3 Blackburn's Sphinx Moth

As stated in the 2012 annual report (Tetra Tech 2013), Auwahi Wind developed a Memorandum of Understanding (MOU) and made a one-time payment of $144,000 to the LHWRP on April 17, 2012, to restore 6 acres of dryland forest at the Auwahi Forest Restoration Project. A letter from the LHWRP providing an update on use of funding during FY 2016 is provided in Attachment 5. A total of 929 of the proposed 1500 ‘aiea (*Nothocestrum latifolium*) have been out-planted into 4.5 hectares (11 acres). LHWRP is committed to fulfilling their MOU obligations over the next year, although they have expressed concern over ‘aiea seed production in the last year.

## 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 3.5 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 2017.

## 5.0 Annual Workplan and Schedule

A work plan for FY 2017 is provided in Attachment 6. 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 2016 is provided in Attachment 7. This summary lists costs (including staff labor) that Auwahi Wind has expended toward fulfilling the terms of the HCP in FY 2016, as well as cumulatively, and compares them against the budgeted amounts specified in Appendix 8 of the HCP.

## 7.0 References

Dalthorp, D., M. Huso., D. Dail., and J. Kenyon. 2014. Evidence of Absence Software User Guide: U.S. Geological Survey USGS Data Series 881, pp. 34.

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

Huso, M. 2011. An estimator of wildlife fatality from observed carcasses. Environmetrics 22:318 – 329.

Hull, C. L. and S Muir. 2010. Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. Australasian Journal of Environmental Management 17.2: 77 – 87.

NPS (National Park Service). 2012. Hawaiian Petrel Monitoring Protocol — Pacific Island Network Natural Resource Report NPS/PWR/PACN/NRR—2012/DRAFT. National Park Service, Fort Collins, CO.

Sempra Energy. 2014. Auwahi Wind Farm Project Habitat Conservation Plan FY 2014 Annual Report. Prepared for Auwahi Wind Energy, LLC. Maui, Maui County, HI.

Sempra Energy. 2015. Auwahi Wind Farm Project Habitat Conservation Plan FY 2015 Annual Report. Prepared for Auwahi Wind Energy, LLC. Maui, Maui County, HI.

Simons, T. R. 1985. Biology and behavior of the endangered Hawaiian Dark-rumped Petrel. Condor 87:229 – 245.

Simons, T. R. and C. N. Hodges. 1998. Dark-rumped Petrel (*Pterodroma phaeopygia*). In The Birds of North America, No. 345 (A. Poole and F. Gill, Eds.). Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC.

Tetra Tech. 2012. Auwahi Wind Farm Project Habitat Conservation Plan. Prepared for Auwahi Wind Energy, LLC. Maui, Maui County, HI.

Tetra Tech. 2013. Auwahi Wind Farm Project Habitat Conservation Plan FY 2013 Annual Report. Prepared for Auwahi Wind Energy, LLC. Maui, Maui County, HI.

Tetra Tech. 2014. Waihou Mitigation Area Vegetation Monitoring Plan. Prepared for Auwahi Wind Energy, LLC. Maui, Maui County, HI.

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

This page intentionally left blank

# Attachment 1
# Evidence of Absence Software Outputs – Fatality Estimation

# Attachment 1- Evidence of Absence Software Outputs – Fatality Estimation

**Settings**

Credibility level (1 - α)

0.8

| Yr | X | g | $g_{lwr}$ | $g_{upr}$ | rel_wt |
|---|---|---|---|---|---|
| 1 | 1 | 0.262 | 0.197 | 0.329 | 12 |
| 2 | 4 | 0.509 | 0.414 | 0.601 | 13 |
| 3 | 1 | 0.436 | 0.368 | 0.497 | 11 |
| 4 | 1 | 0.5 | 0.395 | 0.587 | 6 |

**Actions**

New Data From

Edit Data By Hand

Save to .csv

Estimate Total Number of Fatalities

Return to Main Page

**Results**

**Posterior distribution for total fatality for 4 years.**

g = P(observe|arrive): 0.418 95% CI: 0.3526 0.4849

80% credible maximum: 23

| m | P(total = m) | P(total > m) |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 2 | 0 | 1 |
| 3 | 0 | 1 |
| 4 | 0 | 1 |
| 5 | 0 | 1 |
| 6 | 0 | 1 |
| 7 | 0.001059 | 0.9989 |
| 8 | 0.004775 | 0.9942 |
| 9 | 0.01215 | 0.982 |
| 10 | 0.02297 | 0.959 |
| 11 | 0.03596 | 0.9231 |
| 12 | 0.0493 | 0.8738 |
| 13 | 0.06122 | 0.8126 |
| 14 | 0.0704 | 0.7422 |
| 15 | 0.07615 | 0.666 |
| 16 | 0.07836 | 0.5877 |
| 17 | 0.07734 | 0.5103 |
| 18 | 0.07371 | 0.4366 |
| 19 | 0.06819 | 0.3684 |
| 20 | 0.06148 | 0.3069 |
| 21 | 0.05421 | 0.2527 |
| 22 | 0.04688 | 0.2058 |
| 23 | 0.03985 | 0.166 |
| 24 | 0.03337 | 0.1326 |
| 25 | 0.02757 | 0.105 |
| 26 | 0.0225 | 0.08254 |

**Figure 1.** Evidence of Absence software output for Hawaiian Hoary Bats(EoA; Dalthorp et al. 2014).

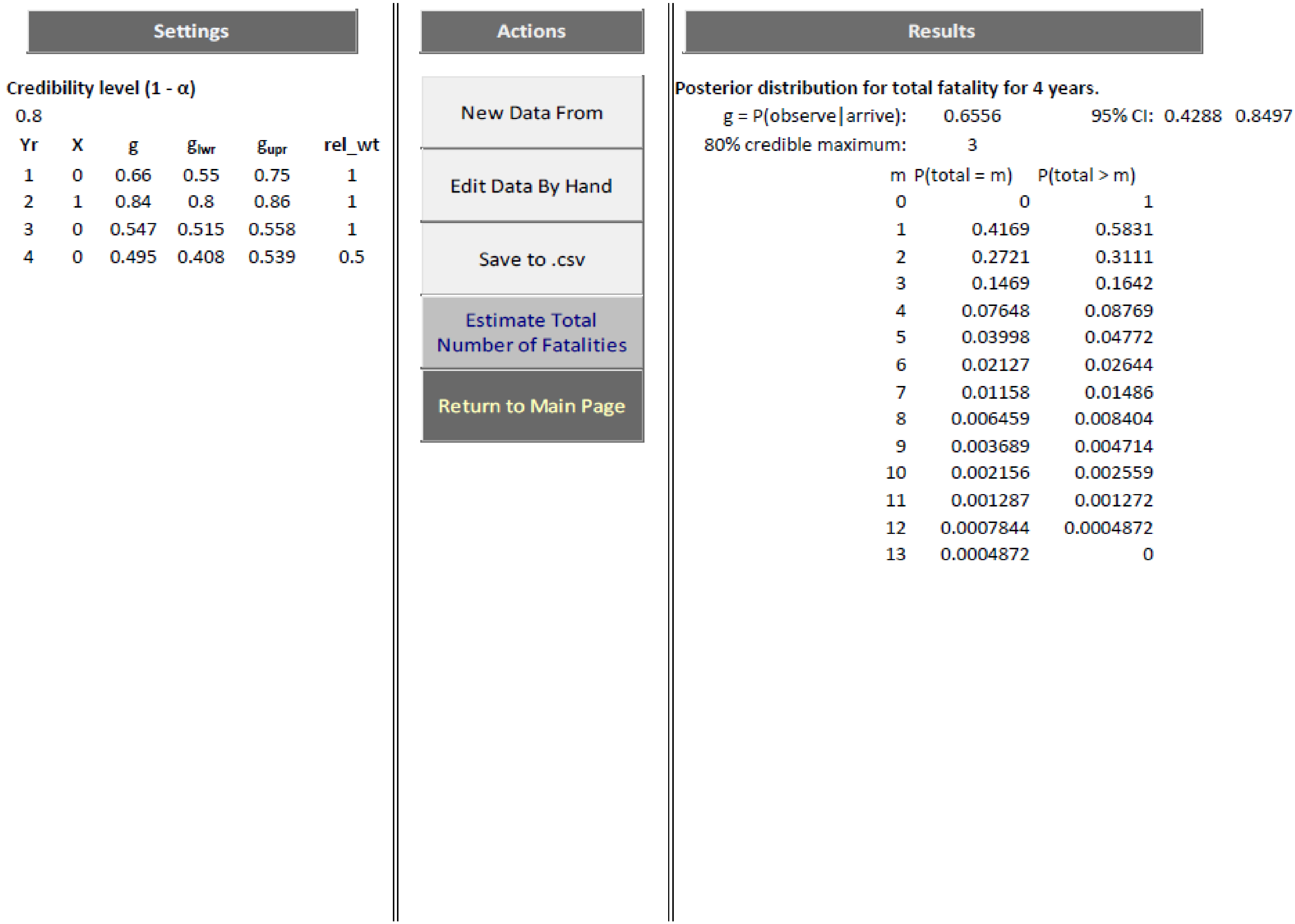



**Figure 2.** Evidence of Absence software output for Hawaiian Petrels(EoA; Dalthorp et al. 2014).

# Attachment 2

# Kahikinui Management Area Hawaiian Petrel Monitoring Report

Auwahi Wind Energy Project

# 2015 Auwahi Wind Energy Hawaiian Petrel Report

Kahikinui Petrel Management Area

Prepared by:

Sempra U.S. Gas & Power

Auwahi Wind Energy, LLC
101 Ash Street, HQ 08B
San Diego, CA 92101-3017

August 2016

## 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 2015 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 2015 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);

4) Implement predator control throughout the nesting season;

A total of 64 burrows were monitored within Kahikinui PMA in 2015 (63 initially located prior to the 2015 season and 1 burrow located during 2015 surveys), March through November. Thirty-three (52 percent) of the burrows showed signs of activity at some point during the breeding season and 31 burrows (48 percent) were inactive in 2015. Eggs were confirmed at 10 of the active burrows based on observations of egg shell, an abandoned egg, or chick down. Reproductive success was between 26 and 80 percent. Nineteen game cameras were rotated among 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 10.3 percent in February and decreased to 4.1 percent in August/September. The three-day mongoose tracking index was calculated at 4.5 percent in February and decreased to 0 percent in August/September. These results point to a decrease in both rodent and 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.

Auwahi Wind continued to implement the predator control strategy developed in 2013. Between March and mid-December 2015, 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 40 weeks for a total of 27,152 trap nights. Predator control efforts implemented by Auwahi directly removed 53 predators from Kahikinui PMA. The catch per unit of effort (CPUE) for the season for all trap types combined was 0.20 percent. Auwahi Wind also made a contribution to the trapping efforts led by the Maui Nui Seabird Recovery Project in the adjacent Kahikinui Natural Area Reserve; and this trapping effort removed an additional eight predators.

# Table of Contents

## LIST OF TABLES



## LIST OF FIGURES

# 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 2015 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 predator control is implemented and 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 and 2015 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 Mount Haleakala. 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 2015

The objectives of the 2015 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. 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 19 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 122 traps, while continuing to evaluate trap effectiveness and placement.

5. Pilot the use of foothold traps and remote alert technology within Kahikinui PMA.

# 2. METHODS

## 2.1 BURROW ACTIVITY AND REPRODUCTIVE SUCCESS

Burrow checks were conducted monthly from March to July 2015 (the petrel prospecting, laying, and incubating period) and then twice a month during August – November 2015 (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 2015 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 four years of monitoring (2012 – 2015) 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 – 2015 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 thoughout 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. Nineteen of these cameras were used as an additional method for measuring reproductive success during the 2013 – 2015 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 2015. 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

All traps were placed within a 200-meter buffer of the petrel burrows using gridded spacing (Island Conservation and Tetra Tech 2013). Ten Belisle SuperX kill traps were placed along the perimeter of the area where active petrel burrows were located. In addition, 37 Goodnature A24 kill traps and 35 DOC250 kill traps were deployed to control mongooses across all units; although designed to control mongooses, these traps also have the ability to trap rodents. The Goodnature traps and DOC250 traps were each spaced at 150-meter intervals. Eighteen Kamate traps, designed to kill rats, were deployed in the northern management unit, each spaced 50 meters apart. All trap types were housed in wooden boxes or plastic coverings to reduce the risk of seabird bycatch.

The trapping grid was operational by March 6, 2015 (Figure 4). All traps were visually checked by Auwahi Wind technicians, every two weeks from March to mid-December. Bait types within DOC250 traps were rotated every check between tuna/sardines and peanut butter base. Belisle SuperX traps were baited with beef hotdogs; KaMate traps were baited with macadamia nuts; and Goodnature traps were baited with peanut butter.

In addition to the trapping grid, targeted (cats and mongoose) foothold trapping occurred within five locations of the management area. Each location contained 3–5 Victor foothold traps, with a total of 22 foothold traps deployed. Each trap was outfitted with a sensor device that utilized radio frequency and cell phone (OMNI M2M) technology to alert technicians if the trap was triggered. Trapping sensor technology was tested September to mid-December.

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 2015 breeding season, burrow monitoring commenced on March 20 and ended on November 10, 2015, at which time all of the burrows had ceased to be active. A total of 64 burrows were monitored within Kahikinui PMA (63 initially located prior to the 2015 season and 1 burrow located during 2015 surveys).

Thirty three (52 percent) of the 64 burrows showed signs of activity at some point during the 2015 breeding season, and 31 burrows (48 percent) were seasonally inactive. Of the 33 active burrows, 31 were consistently active (burrows visited more than once). The 31 active burrows that showed consistent signs of activity throughout the breeding season were used to calculate reproductive success for Kahikinui PMA in 2015. Eight burrows successfully produced a fledgling; two burrows showed clear signs of reproduction, but the nests failed (a cracked egg was observed outside both nests); and 21 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 21 burrows, either by the biologist monitoring the burrows or captured on game cameras stationed at the burrows.

Reproductive success in 2015 was between 26 and 80 percent. Based on the survey findings, eggs were assumed to have been laid in 10 to 31 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 26 percent (Figure 5). The percentage of chicks fledged per egg laid was between 26 and 80 percent.

There was no significant difference in reproductive success in the four years of monitoring ($\chi^2$=2.31, *df* =3 *P*=0.89). There was also no significant difference in the reproductive success after two years of predator control ($\chi^2$=1.17, *df* =12, *P*=0.74).

### 3.2 GAME CAMERA MONITORING

Game cameras were deployed at 21 burrows in 2015. Game cameras confirmed activity at all 21 burrows and documented the successful fledging of eight chicks; although the exact fledge date of one chick was not determined. The percentage of chicks fledged per active burrow based on game camera monitoring was 38 percent. Successful fledging was recorded between October 8 and November 4, 2015 (Table 2). Game cameras recorded two separate instances of a feral cat investigating a burrow (Figure 2). The cat was recorded investigating burrow 55 on August 8 and again on October 3. There were no clear signs of depredation at the burrow, and this nest was never confirmed to have a fledged chick. Two adults were seen outside the burrow on October 8. 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 seven 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 (<2700 meters). The 1-day tracking index was 10.3 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 only three transects. There was a decrease from 10.3 to 4.1 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 (2700–2800 meters). The three day tracking index was 4.5 percent for mongoose in February.

Halfway through the trapping season, in September, mongooses were not detected along any of the transects (0 percent).

Investigating trends in the activity index across the entire management period (Fall of 2013 – Fall of 2015), 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.

### 3.4 PREDATOR CONTROL

The predator control strategy was initiated in March 2015, following the tracking tunnel study. The predator control grid was operational for 40 weeks between March and mid-December, with a total of 27,152 trap nights (Table 3). Predator control efforts removed 53 targeted mammalian predators from Kahikinui PMA, including 35 mice, 17 rats, and 1 mongoose. No feral cats were successfully trapped in 2015, within the Kahikinui PMA.

Between March and August the number of predators removed monthly ranged between 3 and 5 individuals. Between September and November, the monthly average removal rate spiked to 6 to14 individuals per month before dropping again in December (Figure 7). The combined CPUE for the season was 0.19 percent (0.01 – 0.36 percent, depending on target species and trap used). Incidental captures were documented while conducting predator trapping and included two chukars.

Goodnature traps removed the highest number of predators and had the highest CPUE (Table 3). DOC250 traps were the most effective at removing rats and the one mongoose. The Belisle Bucket appeared to be the least effective, with no targeted predators removed. This trap incidentally killed one chukar chick. Auwahi Wind also made a contribution to the trapping efforts led by the Maui Nui Seabird Recovery Project in the nearby Kahikinui NARS parcel. These traps were able to remove an additional eight predators, including one cat, two mongooses and five black rats.

# 4. DISCUSSION

### 4.1 REPRODUCTIVE SUCCESS

Throughout 2015, 33 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 - 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 2015. The increase in active nests within the colony has not resulted in a significant increase in reproductive success however. 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 four years of monitoring (29 –33 active nests).

We have not seen a significant increase in the reproductive success within the management area since predator control implementation. This season will be the second 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%) and no change in success after two years of implementation of predator control (Chen et al. 2015, pers. comm Chen August 2016). Auwahi Wind will continue to measure reproductive success and determine how effective predator control is at increasing reproductive success in subsequent years.

Previous annual reports have discussed alternative explanations for low reproductive success in both sites compared with the nearby Haleakala National Park (42 - 61 percent, 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). Goodnature traps have proven successful at removing rodents when this occurs, with up to four carcasses found underneath one trap at one check.

Although there were no predators caught during the pilot foothold trapping, the OMNI M2M sensor technology 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. Inconsistency in messages being received throughout the site warrants further testing, to ensure confidence. We will also continue to test the product at the Project facility, where traps are more accessible and can be visited more frequently.

This season, one cat was detected, twice on camera, at a monitored burrow. This is in contrast to the 2013 and 2014 monitoring seasons when 3+ separate cat detections were recorded. We have never captured a predation event on camera nor found a petrel carcass or signs of predation (torn feathers) following cat detections. Cat detections have been at burrows that were already confirmed inactive or that successfully fledged a chick after the cat was observed. In 2016, we plan to implement a more systematic camera assessment of cats within the management area. This assessment will also guide targeted foothold trapping.

### 4.3 SUMMARY AND RECOMMENDATIONS FOR 2016

- 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 three 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 – 2015 point toward a fluctuations in rodent and mongoose activity within the site. These assessments are also helpful in interpreting predator trapping results. Predator assessments will continue in the 2016 trappings season; with the addition of an assessment specific to feline activity.
- Goodnature Traps continue to be able to remove the highest number of predators within Kahikinui PMA. In 2016, traps will be spaced closer (25 meters) and clustered around active burrows.

- Victor Foothold trap trials did not result in any targeted predator catches. Without the assistance of remote sensor technology, staffing effort needed for this trapping method is demanding in remote areas. Foothold trapping efforts in 2016 will target the chick hatching and fledging period.

# 5. LITERATURE CITED


Blackwell, G.L., Potter M.A., McLennan J.A. 2002. Rodent density indices from tracking tunnels, snap-traps and Fenn traps: do they tell the same story? New Zealand Journal of Ecology 26:43–51.

Brown, K.P., Moller, H., Innes, J., and Alterio, N. 1996. Calibration of tunnel tracking rates to estimate relative abundance of ship rats (*Rattus rattus*) and mice (*Mus musculus*) in a New Zealand forest. New Zealand Journal of Ecology 20:271–275

Brown, C.R., Stutchbury, B.J., and Walsh, P. D.. 1990. Choice of colony size in birds. Trends in Ecology & Evolution 5.12: 398-403.

Chen, H., C. Ganter and J. Panglao. 2015. ATST 2014 Hawaiian Petrel Monitoring Report. DKIST

Danchin, E., and R. H. Wagner. 1997. The evolution of coloniality: the emergence of new perspectives. Trends in Ecology and Evolution **12**:342–347.

Gillies, C. and Williams, D. 2007: Using tracking tunnels to monitor rodents and mustelids. V2.5.1. OLDDM-118330, Department of Conservation Intranet, Department of Conservation, Research, Development & Improvement Division, Hamilton, New Zealand.

Island Conservation and Tetra Tech Inc, 2013. Predator Control Strategy for the Auwhai Wind Kahikinui Petrel Management Area. Prepared for Auwahi Wind Energy, Maui, Maui County, HI.

NPS (National Park Service). 2012. Hawaiian Petrel Monitoring Protocol — Pacific Island Network. Natural Resource Report NPS/PWR/PACN/NRR—2012/DRAFT. National Park Service, Fort Collins, CO.

Natividad Hodges, C. S. 1994. Effects of introduced predators on the survival and fledging success of the endangered Hawaiian Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*). Thesis. Department of Forest Resources, University of Washington, Seattle, WA. 49 pp.

Schreiber, E.A., and J. Burger, eds. Biology of marine birds. CRC Press, 2001.

Sempra Energy, VanZandt, M. 2014. Auwahi Wind HCP Annual Report FY14. Prepared for Auwahi Wind Energy, Maui, Maui County, HI.

Simons, T. R. 1985. Biology and behavior of the endangered Hawaiian Dark-rumped Petrel. Condor 87:229-245.

Speedy, C., Day, T., and Innes, J. 2007. Pest eradication technology- the critical partner to pest exclusion technology: the Maungatautari experience. USDA National Wildlife Research Center Symposia - Managing Vertebrate Invasive species, University of Nebraska, Lincoln, USA.

Stokes D.L., and P.D. Boersma, 2000. Nesting Density and Reproductive Success in a Colonial Seabird, The Magellanic Penguin. Ecology 81:278-2891

Tetra Tech Inc. 2012a. Final Auwahi Wind Farm Project Habitat Conservation Plan. Prepared for Auwahi Wind Energy. Maui, Maui County, HI.

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, 2015

| Burrow # | Camera Deployment Date | Last Date of Activity | Successfully Fledged |
|---|---|---|---|
| 3 | 2/10/2015 | 8/27/2015 | No |
| 6 | 2/10/2015 | 11/4/2015 | 10/21/2015 |
| 9 | 2/10/2015 | 8/15/2015 | No |
| 15 | 7/7/2015 | 11/4/2015 | 11/4/2015 |
| 25 | 2/10/2015 | 11/4/2015 | 11/4/2015 |
| 29 | 2/10/2015 | 4/29/2015 | No |
| 31 | 2/10/2015 | 7/28/2015 | No |
| 32 | 2/10/2015 | 8/15/2015 | No |
| 33 | 2/10/2015 | 11/4/2015 | 10/21/2015 |
| 34 | 2/10/2015 | 11/4/2015 | 10/21/2015 |
| 39 | 2/10/2015 | 8/27/2015 | No |
| 42 | 2/10/2015 | 8/15/2015 | No |
| 51 | 2/10/2015 | 8/15/2015 | No |
| 52 | 2/10/2015 | 11/4/2015 | 9/11/2015* |
| 54 | 2/10/2015 | 10/21/2015 | 10/8/2015 |
| 55 | 2/10/2015 | 11/4/2015 | No |
| 56 | 2/10/2015 | 4/29/2015 | No |
| 58 | 2/10/2015 | 10/21/2015 | 10/8/2015 |
| 63 | 7/7/2015 | 8/27/2015 | No |
| 66 | 2/10/2015 | 5/28/2015 | No |
| 67 | 7/7/2015 | 7/28/2015 | No |

*Camera malfunctioned, unable to determine exact fledge date, chick down seen at burrow on 9/11/2015

**Table 3:** Summary of trapping results and catch per unit effort (CPUE), 2015

| Trap Type | Total Traps | Trap Nights | Mongoose | | Rats | | Mice | | Cats | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | # | CPUE | # | CPUE | # | CPUE | # | CPUE |
| Belisle Body Grip | 10 | 1,569 | 0 | 0 | 0 | NA | 0 | NA | 0 | 0 |
| GoodNature | 37 | 9,533 | 0 | 0 | 6 | 0.06% | 34 | 0.36% | NA | NA |
| DOC250 | 35 | 8,876 | 1 | 0.01% | 7 | 0.08% | 1 | 0.01% | NA | NA |
| KaMate | 18 | 5,110 | 0 | NA | 4 | 0.08% | 0 | 0 | NA | NA |
| Foothold | 22 | 2,064 | 0 | 0 | NA | NA | NA | NA | 0 | 0 |
| Total | 122 | 27,152 | | | | | | | | |

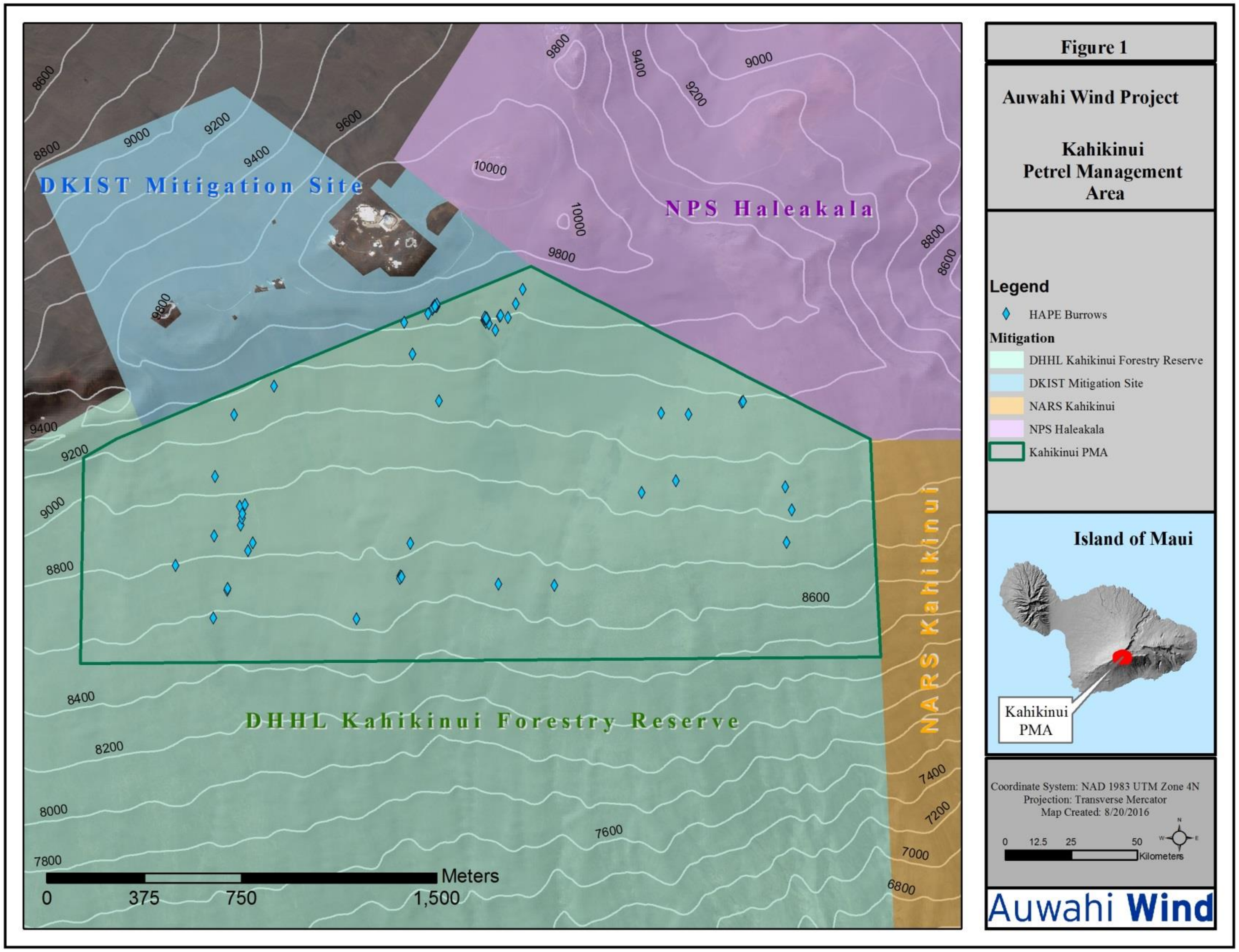



**Figure 1:** Auwahi Wind Kahikinui PMA.

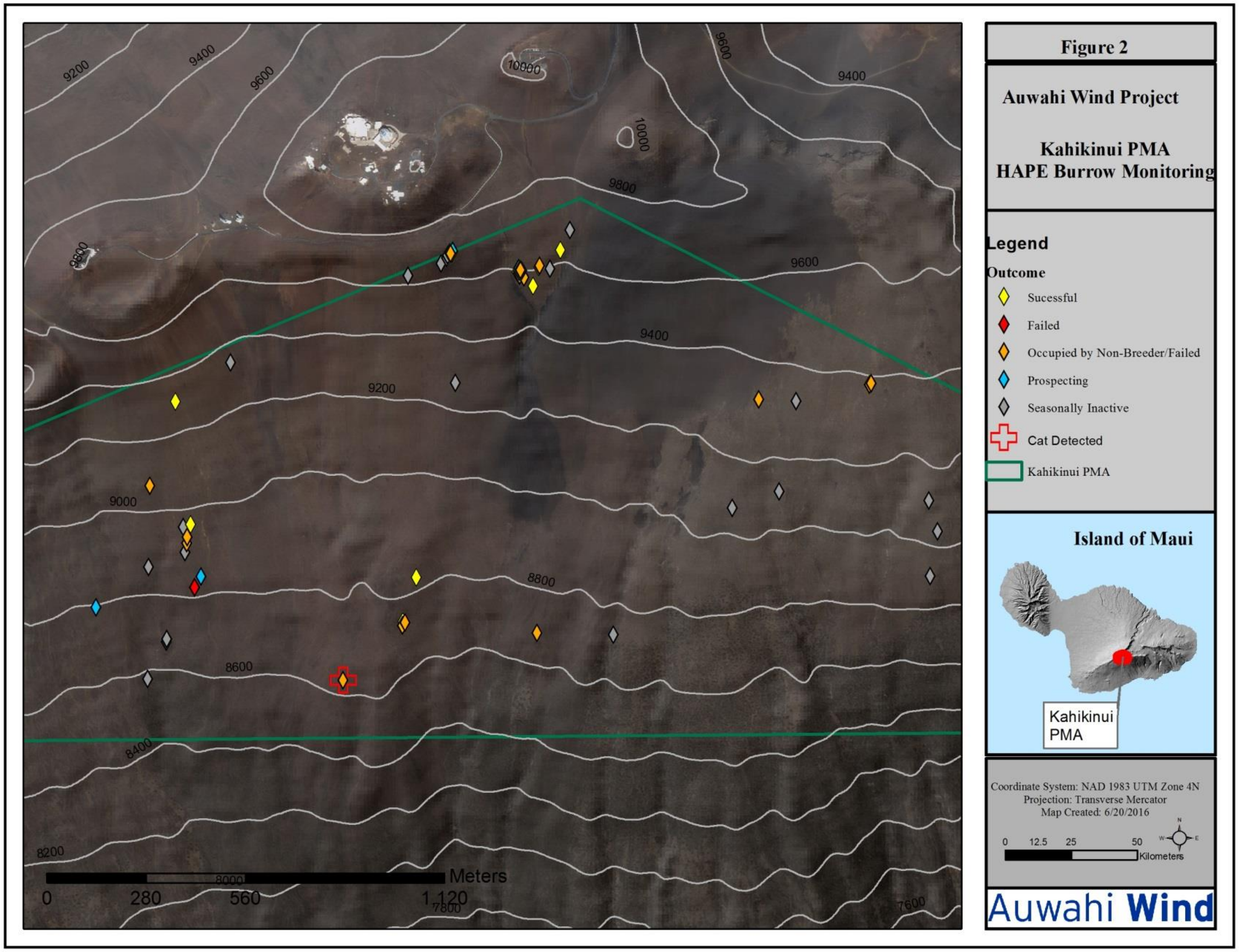



**Figure 2:** Petrel monitoring results at Kahikinui PMA, 2015

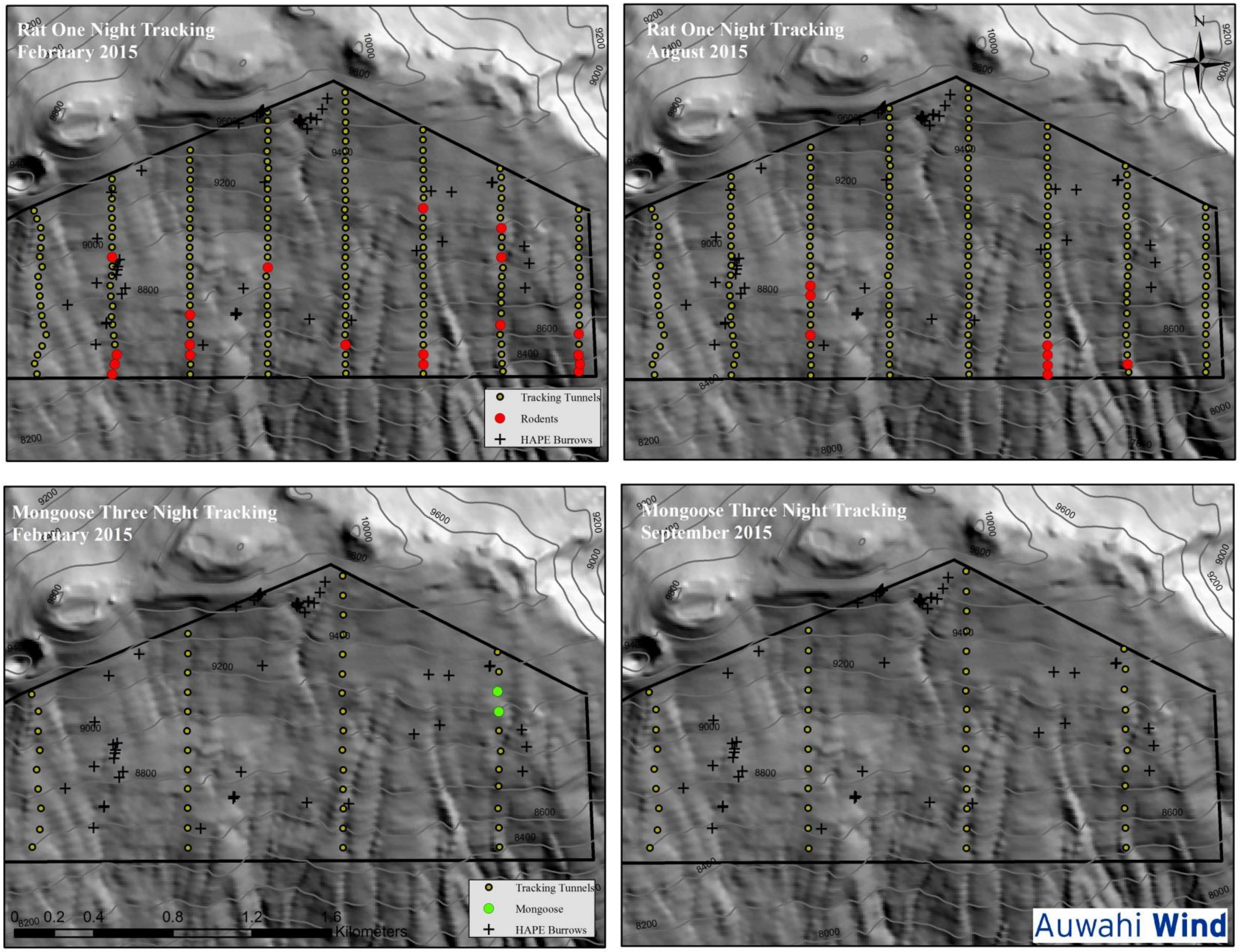



**Figure 3:** One/Three day tracking tunnel results Kahikinui PMA, February and August/September 2015

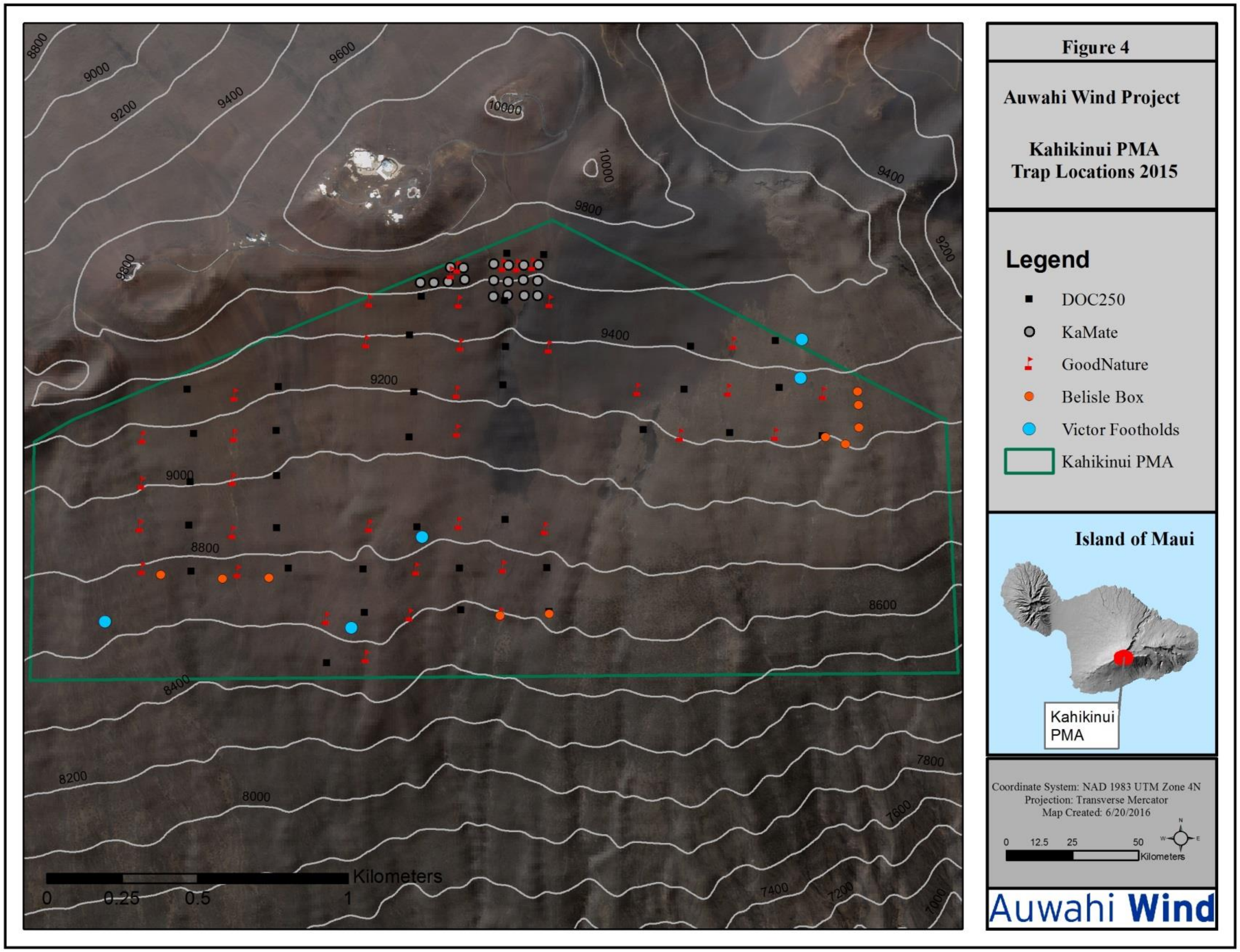



**Figure 4:** Operational predator control grid within Kahikinui PMA, 2015

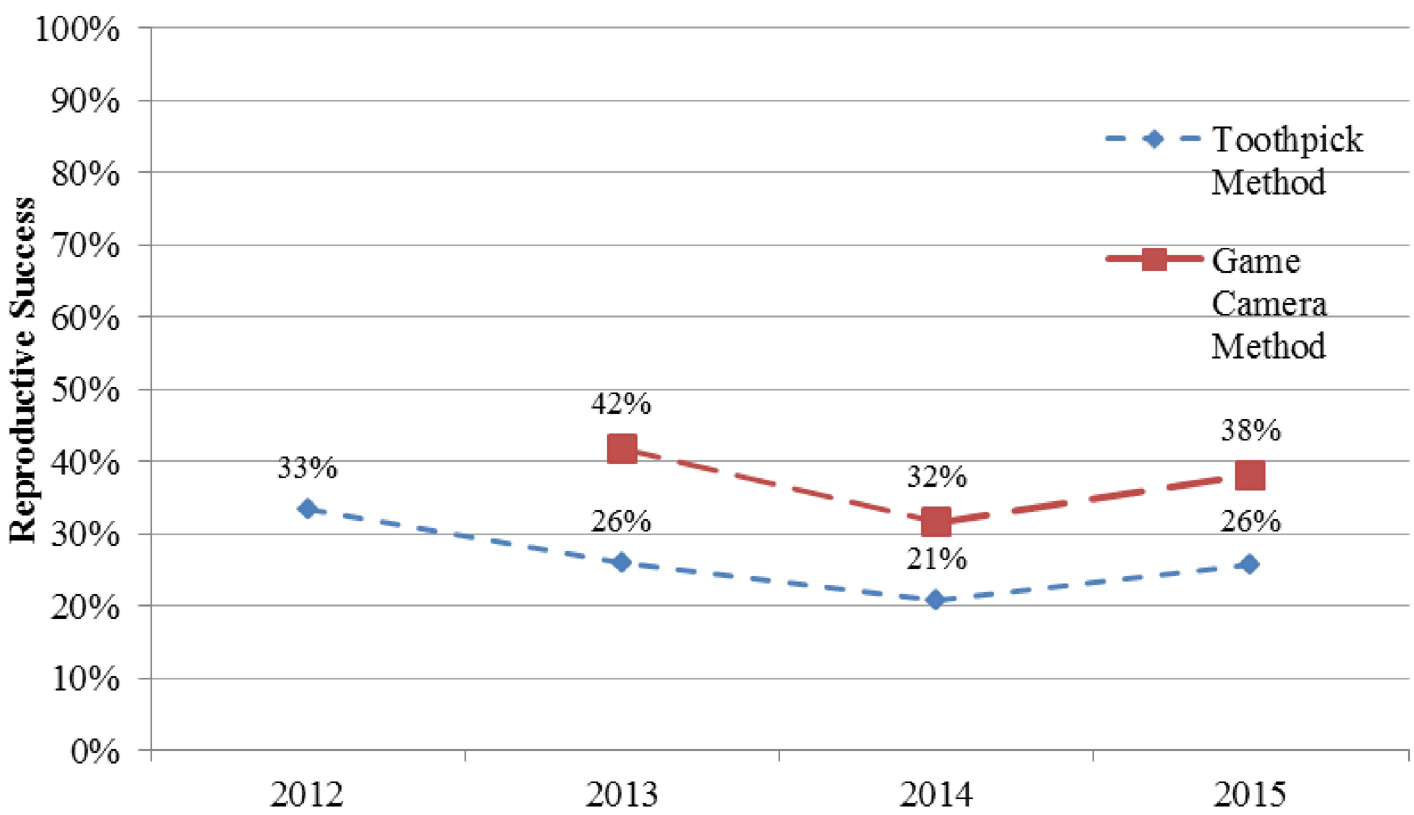



**Figure 5:** Reproductive success within Kahikinui PMA, 2012 - 2015

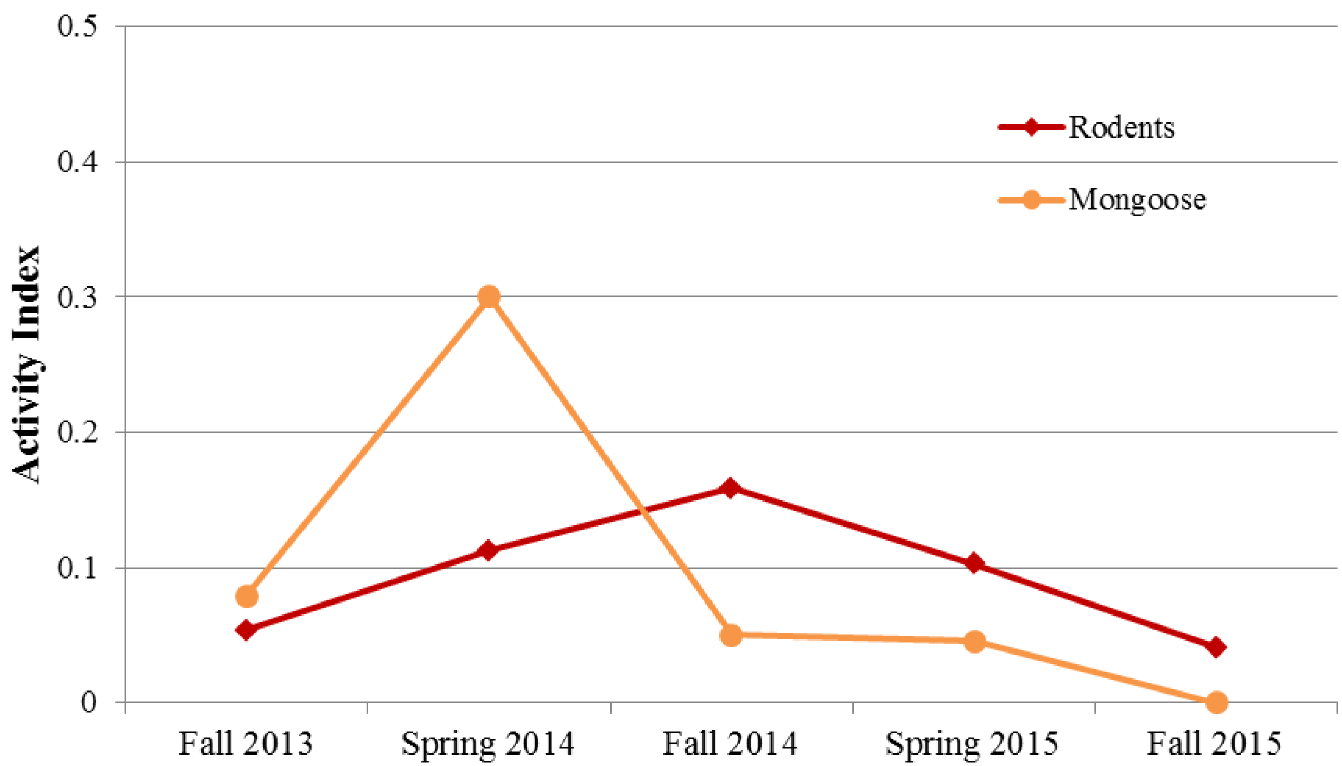



**Figure 6:** Summary of rodent and mongoose tracking tunnel results, 2013 - 2015

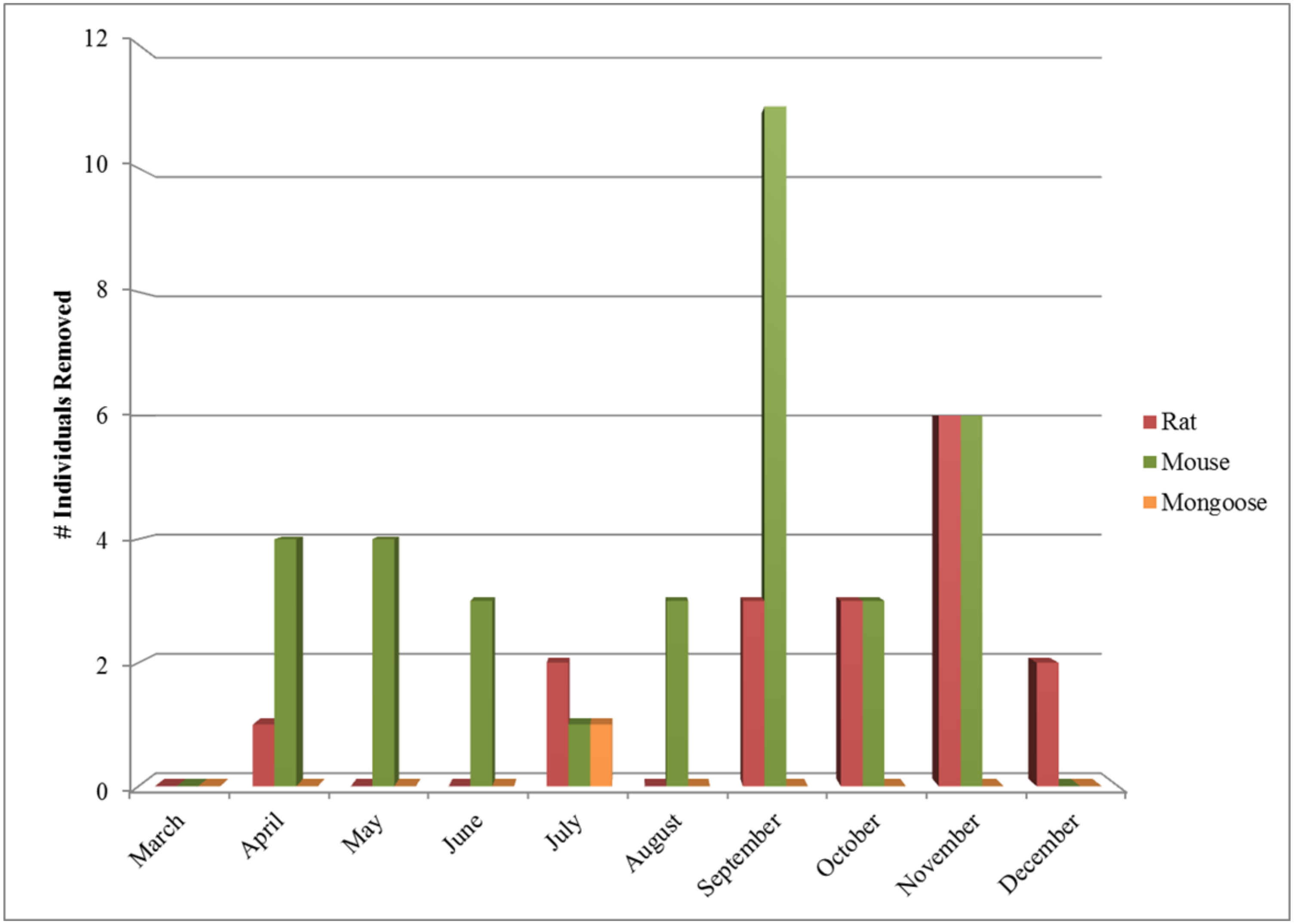



**Figure 7:** Monthly summary of predator trapping results, 2015

# Attachment 3

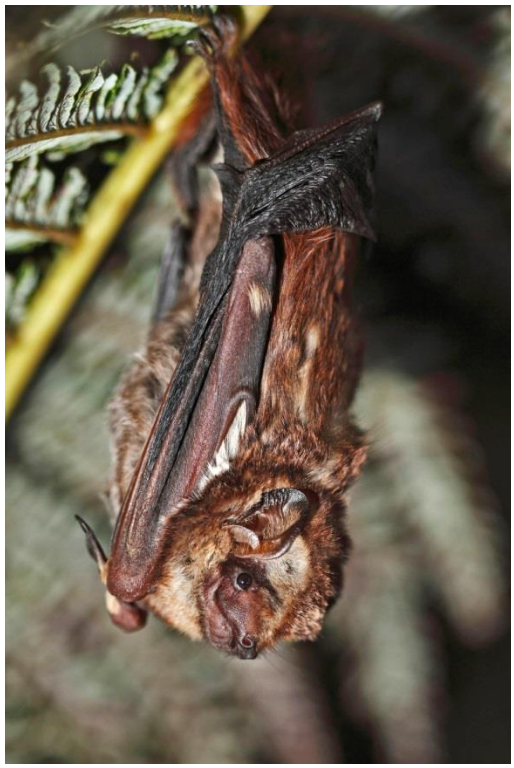
# Hawaiian Hoary Bat Tier 2 & 3 Research Summary

# AUWAHI WIND ENERGY PROJECT

## HAWAIIAN HOARY BAT PROGRESS REPORT

*Prepared for*

**Auwahi Wind Energy LLC**



**Prepared by Frank Bonaccorso[1], Corinna Pinzari[2], and Kristina Montoya-Aiona[1]**

[1]US Geological Survey and [2]Hawaii Cooperative Studies Unit

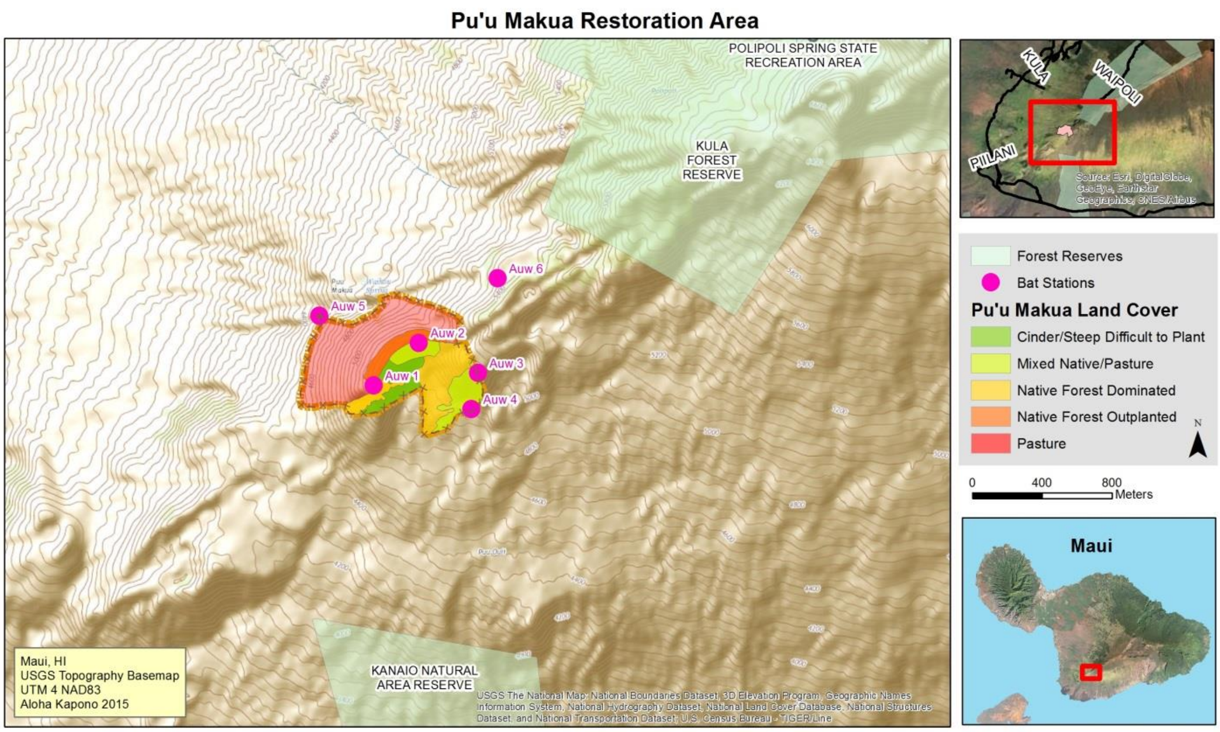
9 May 2016

USGS science for a changing world

## Introduction

This report offers a summary of bat acoustic detections at the Pu'u Makua Restoration Area through the first annual cycle, March 2015 through March 2016, of recording by USGS. It then discusses suggested timing and strategy for bat live capture and radio-tagging for study of bat movements and local spatial use patterns based on what has been learned thus far about Hawaiian hoary bats at Pu'u Makua and elsewhere in Hawaii.

## Study Area




Map of the Pu'u Makua Restoration Area and Vicinity showing Six Acoustic Recording Stations (pink dots labeled Auw 1 through Auw 6).

**Methods**

Six Song Meter SM2BAT+ Ultrasonic Recorders (Wildlife Acoustics, Inc., Concord, MA) with high frequency microphones (SMX-US) were deployed across the mitigation area (AUW 1 through 6 on the Map) to record bat echolocation calls and associated date and time data. These full spectrum, direct recorders were designed for long term passive monitoring to record continuously onto memory cards for up to several months before downloading and maintenance checks. Acoustic monitoring locations were chosen based on accessibility, safety, and potential suitability of habitat for bat foraging and/or roosting. Locations were spaced to provide widespread coverage of the mitigation area and one additional site (AUW 6) in a nearby area deemed potentially good for mist-net capture of bats. Detectors switch on and off automatically 1 hour prior to sunset and 1 hour after sunrise. The detectors were powered by batteries charged with solar energy. Four high capacity SD memory cards were placed in each detector to insure adequate memory for data logging. Detectors were checked approximately on a bimonthly schedule during the first year of monitoring.

The collected call files were processed with the latest version of Kaleidoscope (Wildlife Acoustics 2015) to filter ambient noise, then audibly and visually inspected by an acoustics technician for quality assurance. Acoustic detections were further be categorized as “search calls” (single or multiple low repetition clicks) or “feeding buzzes” (rapidly repeating clicks characteristic of a prey attack by a bat). These data (not fully processed at present) will be used to calculate activity level metrics to identify high-use areas within the mitigation area in a forthcoming and more complete annual report.

**Results**

Acoustic sampling information collected from each bat detector site over the first annual cycle appears below in Table 1. All but one bat detector (Auw 3) recorded continuously without technical faults. Bats were present throughout the year of sampling although the number of files containing bat activity varied considerably between stations on a monthly basis. Auw 6 had the highest number of nights with bat calls recorded and an extremely large number of total call files having confirmation of bat echolocation activity. We note that Auw 3, although operating effectively only part of the year, and Auw 6 detected bats over 70% of the nights sampled.

**Year One Totals (April 1st, 2015 through March 31st, 2016)**

| Bat Detector Site | Elevation (m) | Recording Nights | Nights Bats Present | Files with Bat Activity | % Nights with Bat Calls |
|---|---|---|---|---|---|
| Auw 1 | 1611 | 366 | 103 | 1350 | 28% |
| Auw 2 | 1606 | 366 | 38 | 52 | 10% |
| Auw 3* | 1607 | 77* | 55* | 153* | 71%* |
| Auw 4 | 1515 | 366 | 73 | 199 | 20% |
| Auw 5 | 1396 | 366 | 20 | 29 | 5% |
| Auw 6 | 1644 | 366 | 284 | 36653 | 78% |

Table 1. Bat presence and sampling information for each detector site at Pu'u Makua during the annual recording cycle from April 2016 through March 2016. *Equipment at Auw 3 encountered malfunctions causing some loss of data.

Mean monthly bat detectability (p) over an annual cycle from April 2015 through March 2016 for six pooled bat detection stations is shown in Figure 1. Although sampling was conducted in the latter portion of March 2016, that month is excluded from this analysis because of incomplete sampling in that time period and because some evidence from other studies suggests that the novelty of a new elevated object in the habitat such as a pole and microphone may create a behavioral artifact with increased investigation and echolocation calling by bats (the authors, personal observations). To provide reference from an additional study nearby on Maui, annual mean detectability for the current study at Pu'u Makua and from comparable elevation at Kahikinui, Maui, are represented by red (mean = 0.38) and blue lines (mean = 0.37) respectively in Figure 1.

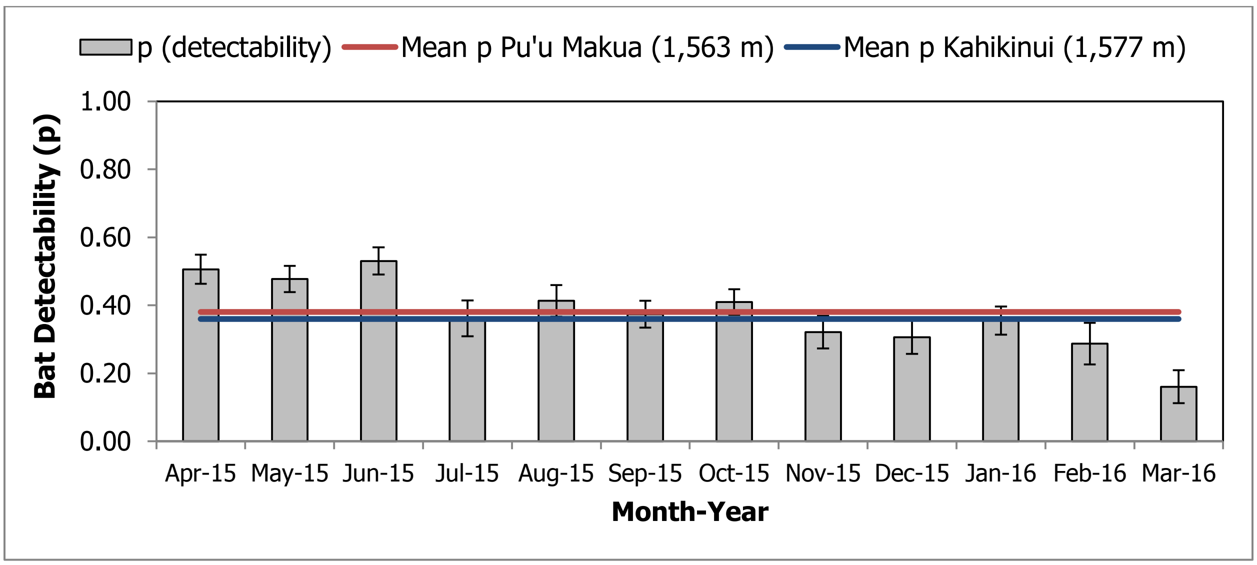



Figure 1. Mean monthly bat detectability (p) over an annual cycle pooled for six bat detection stations at Pu'u Makua. Vertical lines atop each bar are standard errors.

The variation in bat detectability through the April 2015-March 2016 annual cycle is depicted in Figure 2. Due to software failures, the Auw 3 detector station only collected accurate data during March, April, June, September and October 2015, thus results from that particular station are incomplete. The locations of the individual recording stations are shown on Map 1.

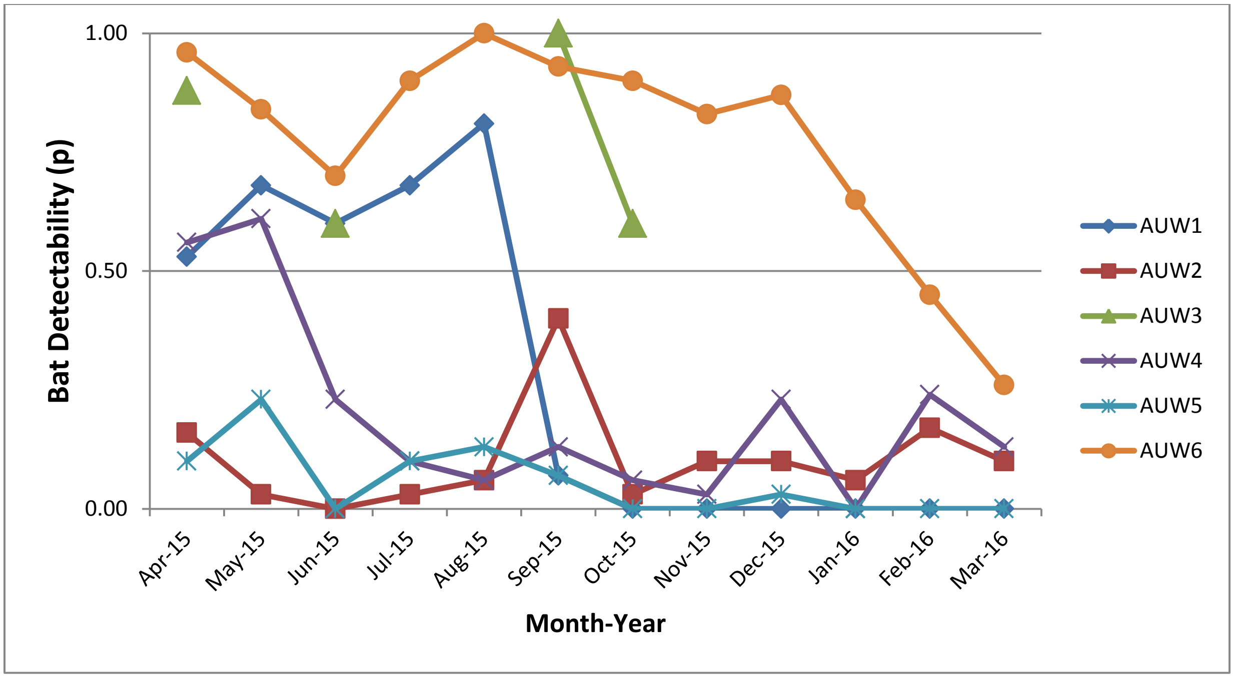



Figure 2. Mean monthly bat detectability (p) over an annual cycle for six individual bat detection stations.

**Conclusions**

Bats were actively present at Pu'u Makua throughout the annual cycle sampled in our study of 2015-2016. At least 4 of 6 detector stations recorded bat echolocation in every month of the first year of study. There was relatively little seasonal variation in the pooled samples of detectability from all the Pu'u Makua sampling stations and many of the standard error bars overlap. No strong peak in bat activity appeared in any month or season with the 2015-216 annual cycle. Monthly variation at individual sampling stations was most noticeable at detector stations 1, 3, 4, and 6 (Figure 1).

Given that there is no strong seasonality in bat detection at Pu'u Makua, we suggest that the following are the time periods (1. ranked best and 2. second best) representing best likelihood of success in bat capture and radio-telemetry:

1. September-October-November 2016 – although only approximating mean values in Figure 1, this time of year represents the season of highest population numbers in the annual cycle of Hawaiian hoary bats when young of the year have fledged and grown sufficiently to allow radio-tagging. This autumn season maximizes the opportunity to combine radio-tagging of both adults and subadults. Previous USGS studies have indicated a higher proportion of bat captures in Hawaii during the fall season when adults are breeding and thus very active in flight and post-fledging young are abundant and relatively unskilled at flight and prey capture (authors, personal observations).
2. April-May-June 2017 – the season of highest bat detectability at Pu'u Maku based on the acoustic sampling to date. However, by this time in the annual reproductive season, the

fledgling from the previous year are more accomplished fliers and the island population theoretically should be at its lowest point in the annual cycle given loss from mortality and before reproductive input from the current breeding year.

Because AUW6 has the heaviest tree cover with narrow open corridors such as roads and forest edges (Figure 3) necessary for increased probability of live capture of bats from mist-netting and also has the high bat detectability and call file counts, AUW6  offers the best possibilities for capturing bats to be radio-tagged for telemetry studies at Pu'u Makua.  Other potential netting sites within the mitigation area or immediate surroundings are offered by the high ridgeline and road with more scattered vegetation mosaics at AUW 3 and 1.  Some of the gullies near the latter recording areas may also offer potential for bat capture with mist-nets. A possible mist-net capture effort also might try placing nets over the canopy of young regrowth where recent plantings of native vegetation for habitat restoration offers workable canopy heights of not more than 5-6 meters, although this type of "habitat" net placement has not been tried before in Hawaii.  All of the above mist-netting placements by habitat can be coupled with broadcasting bat calls placed behind mist nets if initial attempts to capture bats in given locations fail.  However, netting without broadcasting should be attempted first because broadcasting sends mixed age/sex specific signals.  Most likely there will be attraction to the broadcast by bats that hold a resident feeding territory in order to chase off the supposed intruding bats as well as attraction of breeding individuals investigating potential mates.  At the same time broadcast may be repelling non-territorial transient bats and non-breeding age bats.

Figure 3.  a) Left photo showing a narrow open corridor in a pine forest near Pu'u Makua highly suitable for bat capture with mist-nets, adjacent to station Auw 6; and b) Right photo showing black wattle forest edge that offers secondary suitability for bat capture, adjacent to station Auw 3.

Additional data that will be compiled from the first year of acoustic data will include the following: total sound pulse counts, ratio of search calls to feeding buzzes, occurrence of multiple bats recorded in one file, social calls, and timing of echolocation activity during the night.  Finally we note that the second year of acoustic monitoring beyond what is called for in the original study plan (Tier 2) already is underway and quarterly downloads of data will be made through this second annual cycle of recording as part of the planned Tier 3 effort.

# Attachment 4

# Auwahi Wind Acoustic Monitoring Site Summary

| | |
|---|---|
| **TO:** | Marie Van Zandt, Auwahi Wind Energy, LLC |
| **FROM:** | Susan Hurley and Nathan Schwab, Tetra Tech, Inc. |
| **DATE:** | May 27, 2016 |
| **SUBJECT:** | Auwahi Wind Project Hawaiian Hoary Bat Acoustic Survey Memo, 2013 – 2016 |

Auwahi Wind Energy, LLC (Auwahi Wind) constructed the 21 megawatt Auwahi Wind Project (Project) in 2012. The Project Habitat Conservation Plan (HCP) required two years of acoustic monitoring for the Hawaiian hoary bat (*Lasiurus cinereus semotus*), a federal and state endangered species. Auwahi Wind contracted Tetra Tech, Inc. (Tetra Tech) to conduct the acoustic survey. This technical memorandum summarizes the results of the acoustic survey conducted for the period July 2013 to January 2016.

# METHODS

To assess Hawaiian hoary bat activity at the Project area, Tetra Tech deployed two SM2BAT+ detectors (Wildlife Acoustics, Massachusetts, USA) to record the echolocation calls of bats from July 2013 – January 2016. Surveyors placed one detector in the southern region (AW1) of the Project Area, while the other detector was placed in the northern part of the Project Area (AW2). Tetra Tech used ground-based detectors with microphones mounted at a height of approximately 3 meters to increase the sampling volume and to minimize the effects of clutter and temperature changes on echolocation sequences. Tetra Tech programmed the detectors to record from approximately sunset until sunrise each night. Acoustic files were downloaded from the units approximately once per month.

Once collected, Tetra Tech filtered the raw data using Kaleidoscope Pro (version 3.1; Wildlife Acoustics) with a signal filter of:

- 18-45 kilohertz;
- Duration of 2 – 500 milliseconds;
- Minimum of two pulses; and
- Hoary bat selected as the only species classifier.

Tetra Tech manually vetted all bat passes auto-classified as bat-like, as well as those passes auto-classified as hoary bat with only two matching pulses. Bat passes provide an index of activity; however, it is not possible to determine if multiple bat passes represent multiple bats or a single bat passing a microphone multiple times. The survey effort is presented as detector-nights, which represents one detector unit operating for one night.

# RESULTS AND DISCUSSION

Tetra Tech recorded data from July 17, 2013 – January 1, 2016 at AW1, and from July 22, 2013 – January 6, 2016 at AW2. During this period, detectors were operational for a total of 1,632 detector-nights out of a possible 1,798 detector-nights (91% of all detector-nights). The AW1 detector was operational for 833 nights out of a possible 899 nights, and the AW2 detector was operational for 799 nights out of a possible 899 nights (Table 1). At least one detector was operational during every night of the study period.

Over the approximately 2.5-year survey period, the detectors recorded a total of 371 bat passes, resulting in 0.23 mean bat passes/detector-night (Table 2). Overall mean bat activity was nearly two times greater at the AW1 detector (0.29 bat passes/detector-night) than the AW2 detector (0.17 bat passes/detector-night). Most bat activity occurred during August, September, and October (Figure 1). At AW1, the greatest mean bat activity was in September 2014 (2.2 bat passes/detector-night; Table 1) and 2015 (1.2 bat passes/detector-night). Thirty of the 66 bat passes recorded at AW1 in September 2014 occurred on a single night (September 14). At AW2, the greatest mean bat activity occurred in September 2013 (0.90 bat passes/detector-night), and in August and September of 2015 (0.81 and 0.80, respectively; Table 2). Of the full months available for sampling, the detectors did not record a bat pass during 4 monthly periods at AW1 (mostly during winter). There were 8 monthly periods that failed to record a bat pass at AW2 (also mostly during winter; Table 2). Temporally, most bat activity at these two detectors occurred between sunset and midnight, however, the detectors did document bat activity during the remaining crepuscular and nocturnal hours of the night (Figure 2).

Increased bat activity levels occurred during the late summer and fall (August, September, and October) during all years at both detectors. Bat activity during these three months accounted for nearly 80% of all bat passes during the study period. The observed increase in bat activity during late summer and early fall, as well as the nightly increase in bat activity occurring shortly after dusk, is consistent with previous studies in Hawaii (Bonaccorso 2008, Kepler and Scott 1990, Menard 2001). Post-construction data available from the Maui-based Kaheawa Pastures Wind Energy Facility documented a similar increase in bat activity during August – November in 2008, however, no hoary bats were detected during the fall in 2009 (Kaheawa Wind Power 2009). The Kaheawa project monitored bat activity with Anabat units, and detected 5 total bat passes using two detectors in the fall 2008. During the fall at Auwahi, the two detectors recorded 44 – 128 bat passes, highlighting dramatic variation in bat activity among years. Although the Kaheawa monitoring was conducted in different years with different equipment, it does provide some context for the results at Auwahi.

# LITERATURE CITED

Bonaccorso, F. 2008. Annual Summary Report: Hawaiian Hoary Bat Occupancy in Hakalau Forest National Wildlife Refuge. Special Use Permit: 12516-07008.

Kaheawa Wind Power, LLC. 2009. Kaheawa Pastures Wind Energy Generation Facility; Habitat Conservation Plan FY09 Annual Report: Year 3 HCP Implementation. 146 pp. Available online: http://dlnr.hawaii.gov/wildlife/files/2013/10/KWPI_Year3_FY2009_Annual_Report_red.pdf. Accessed May 2016.

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

Menard, T. 2001. Activity patterns of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) in relation to reproductive time periods. MS Thesis. University of Hawaii, Honolulu.

**Table 1. Dates of Operation for Each Detector by Year at Auwahi Wind, 2013 – 2016**

| Detector | Dates of Operation | | Total Detector-Nights Functioning | Total Detector-Nights Possible | Percentage of Detector-Nights Functioning |
|---|---|---|---|---|---|
| | Year | Dates | | | |
| AW1 | 2013 | July 17 – December 31 | 833 | 899 | 93 |
| | 2014 | January 1 – January 9 | | | |
| | | January 20 – December 8 | | | |
| | 2015 | January 3 – September 6 | | | |
| | | September 8 – September 9 | | | |
| | | September 18 – October 17 | | | |
| | | October 19 – October 28 | | | |
| | | October 30 – November 4 | | | |
| | | November 16 – December 5 | | | |
| | | December 14 – December 31 | | | |
| | 2016 | January 1 | | | |
| AW2 | 2013 | July 22 – October 9 | 799 | 899 | 89 |
| | | October 27 – December 31 | | | |
| | 2014 | January 1 – February 8 | | | |
| | | February 26 – December 31 | | | |
| | 2015 | January 1 – March 30 | | | |
| | | June 3 – December 18 | | | |
| | | December 21 – December 31 | | | |
| | 2016 | January 1 – January 6 | | | |

**Table 2. Mean Bat Passes per Detector-Night by Date and Detector, 2013 – 2016**

| Month-Year | AW1 | | | AW2 | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bat Passes | Detector-Nights | Mean Bat Passes per Detector-Night | Bat Passes | Detector-Nights | Mean Bat Passes per Detector-Night | Bat Passes | Detector-Nights | Mean Bat Passes per Detector-Night | Standard Error |
| Jul-13 | 1 | 15 | 0.07 | 2 | 10 | 0.20 | 3 | 25 | 0.12 | 0.09 |
| Aug-13 | 2 | 31 | 0.06 | 5 | 31 | 0.16 | 7 | 62 | 0.11 | 0.05 |
| Sep-13 | 3 | 30 | 0.10 | 27 | 30 | 0.90 | 30 | 60 | 0.50 | 0.10 |
| Oct-13 | 4 | 31 | 0.13 | 3 | 13 | 0.23 | 7 | 44 | 0.16 | 0.08 |
| Nov-13 | 0 | 30 | 0.00 | 2 | 30 | 0.07 | 2 | 60 | 0.03 | 0.02 |
| Dec-13 | 0 | 31 | 0.00 | 2 | 31 | 0.06 | 2 | 62 | 0.03 | 0.03 |
| Jan-14 | 0 | 21 | 0.00 | 0 | 31 | 0.00 | 0 | 52 | 0.00 | - |
| Feb-14 | 5 | 28 | 0.18 | 0 | 11 | 0.00 | 5 | 39 | 0.13 | 0.07 |
| Mar-14 | 2 | 31 | 0.06 | 2 | 31 | 0.06 | 4 | 62 | 0.06 | 0.03 |
| Apr-14 | 7 | 30 | 0.23 | 0 | 30 | 0.00 | 7 | 60 | 0.12 | 0.04 |
| May-14 | 7 | 31 | 0.23 | 2 | 31 | 0.06 | 9 | 62 | 0.15 | 0.06 |
| Jun-14 | 3 | 30 | 0.10 | 4 | 30 | 0.13 | 7 | 60 | 0.12 | 0.05 |
| Jul-14 | 3 | 31 | 0.10 | 3 | 31 | 0.10 | 6 | 62 | 0.10 | 0.04 |
| Aug-14 | 14 | 31 | 0.45 | 12 | 31 | 0.39 | 26 | 62 | 0.42 | 0.10 |
| Sep-14 | 66 | 30 | 2.20 | 4 | 30 | 0.13 | 70 | 60 | 1.17 | 0.67 |
| Oct-14 | 29 | 31 | 0.94 | 3 | 31 | 0.10 | 32 | 62 | 0.52 | 0.13 |
| Nov-14 | 4 | 30 | 0.13 | 0 | 30 | 0.00 | 4 | 60 | 0.07 | 0.05 |
| Dec-14 | 4 | 7 | 0.57 | 0 | 31 | 0.00 | 4 | 38 | 0.11 | 0.06 |
| Jan-15 | 2 | 29 | 0.07 | 0 | 31 | 0.00 | 2 | 60 | 0.03 | 0.02 |
| Feb-15 | 2 | 28 | 0.07 | 0 | 28 | 0.00 | 2 | 56 | 0.04 | 0.03 |
| Mar-15 | 0 | 31 | 0.00 | 0 | 31 | 0.00 | 0 | 62 | 0.00 | - |
| Apr-15 | 3 | 30 | 0.10 | - | 0 | - | 3 | 30 | 0.10 | 0.07 |
| May-15 | 1 | 31 | 0.03 | - | 0 | - | 1 | 31 | 0.03 | 0.03 |
| Jun-15 | 3 | 30 | 0.10 | 1 | 28 | 0.04 | 4 | 58 | 0.07 | 0.03 |

| Month-Year | AW1 | | | AW2 | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Bat Passes | Detector-Nights | Mean Bat Passes per Detector-Night | Bat Passes | Detector-Nights | Mean Bat Passes per Detector-Night | Bat Passes | Detector-Nights | Mean Bat Passes per Detector-Night | Standard Error |
| Jul-15 | 1 | 31 | 0.03 | 5 | 31 | 0.16 | 6 | 62 | 0.10 | 0.04 |
| Aug-15 | 30 | 31 | 0.97 | 25 | 31 | 0.81 | 55 | 62 | 0.89 | 0.22 |
| Sep-15 | 25 | 21 | 1.19 | 24 | 30 | 0.80 | 49 | 51 | 0.96 | 0.18 |
| Oct-15 | 12 | 29 | 0.41 | 4 | 31 | 0.13 | 16 | 60 | 0.27 | 0.08 |
| Nov-15 | 5 | 19 | 0.26 | 1 | 30 | 0.03 | 6 | 49 | 0.12 | 0.06 |
| Dec-15 | 1 | 23 | 0.04 | 1 | 29 | 0.03 | 2 | 52 | 0.04 | 0.03 |
| Jan-16 | 0 | 1 | 0.00 | 0 | 6 | 0.00 | 0 | 7 | 0.00 | - |
| **Total** | **239** | **833** | **0.29** | **132** | **799** | **0.17** | **371** | **1632** | **0.23** | **0.03** |

**Figure 1. Mean Bat Passes per Detector-Night by Month, 2013 – 2016**

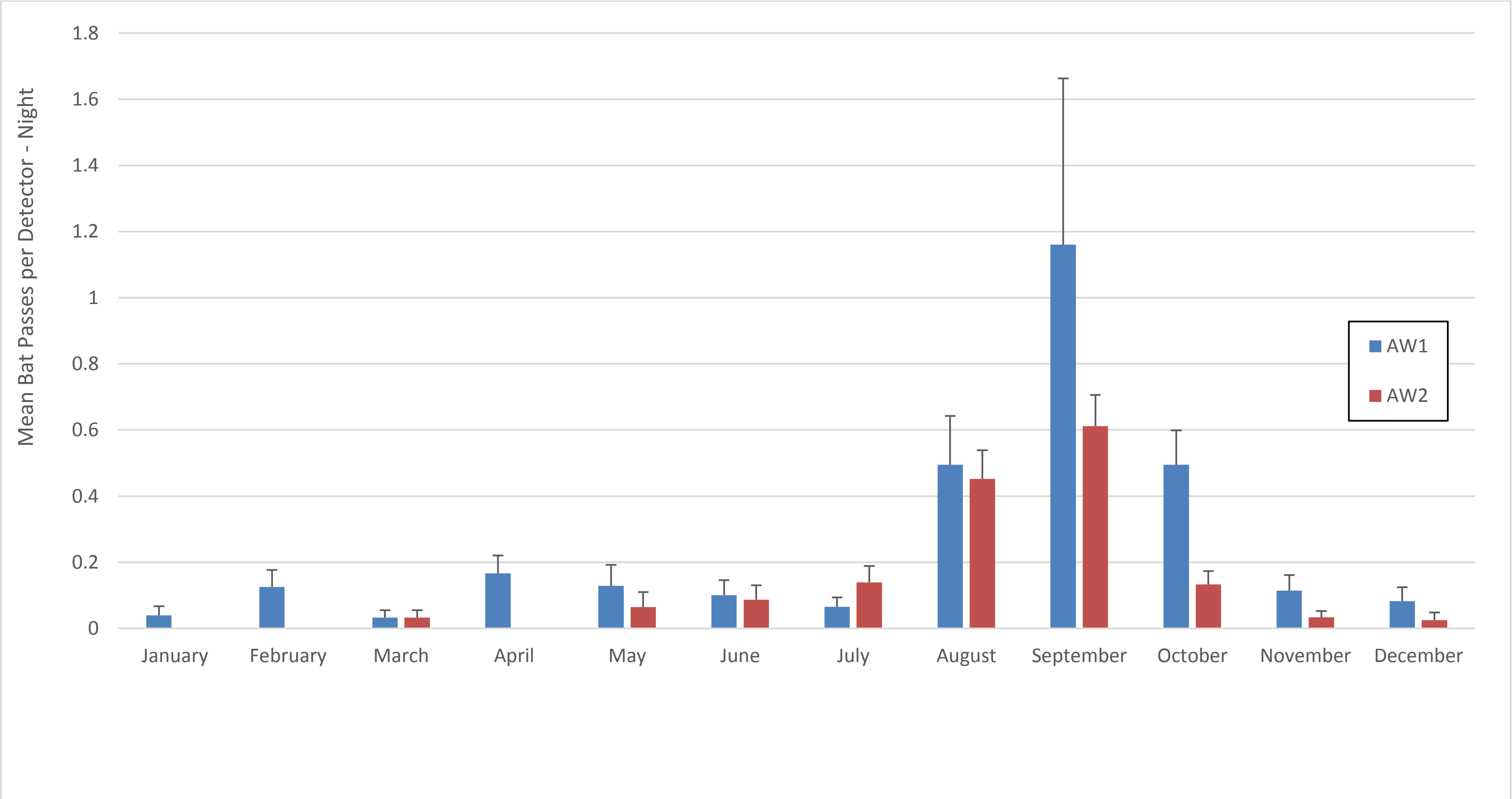
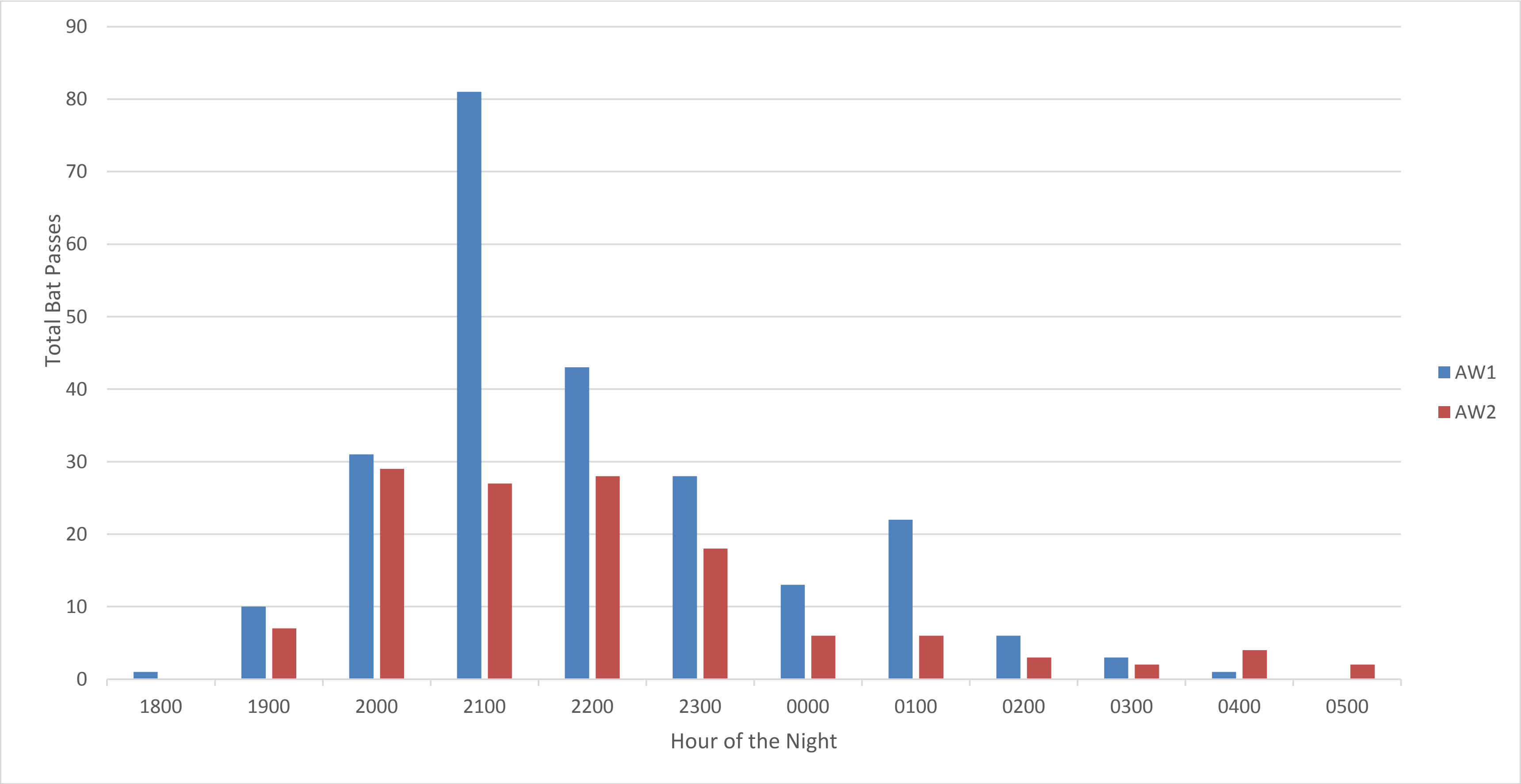


**Figure 2. Total Bat Passes per Hour, 2013 – 2016**



# Attachment 5

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

*Auwahi Forest Restoration Project annual report to Sempra*
*For forest restoration at Auwahi, 'Ulupalakua Ranch, Maui*
*Progress from June 16, 2015 through June 15, 2016*

We are writing you with an annual update on progress of the goals outlined for the Auwahi Forest Restoration Project to conduct primary restoration in 6 acres and plant 1500 'aiea (*Nothocestrum latifolium*) and 10 'iliahi (*Santalum haleakalae var. lanaiense*). Since last June the Auwahi Project has conducted eight volunteer trips with 137 volunteers planting over 1,400 native plants, 141 of which being *`aiea*. Since receiving funds, we have conducted primary restoration in more than 6 acres, planted a total of 929 *`aiea* and 20 *`iliahi*.

Unfortunately, the uncharacteristic warm summer rains of 2015 were not ideal conditions for native species seed production. Perhaps due to prolonged periods of soil moisture, despite good flower set throughout much of last year, there was no evidence of *`aiea* seed production in Auwahi. However, the last six months of cooler winter/spring rains, typical of this dry forest, should offer more familiar conditions for native Hawaiian dry forest species reproduction. We continue to monitor the phenology of all native trees at Auwahi, with special focus on *`aiea*. Currently, many species at Auwahi are flowering and have immature seeds. Remarkably, *`iliahi* is currently among the most productive trees in Auwahi with hundred of seeds near ripe. We collected roughly 30 *`iliahi* seeds in May for future out-planting. We are hopeful that the favorable environmental conditions will also yield a healthy *`aiea* seed set. This summer, we are focusing our efforts, both through volunteer trips and crew field days, on gathering seed with a special emphasis on *`aiea* seed collection. It is not clear if we will be able to collect seeds and outplant the remaining 571 *`aiea* seedlings by next April. If this season's flowers produce fruit, few fruits can lead to many seedlings. The jury is still out as to whether we will see a fruit crop from *'aiea* this year. If we do, it may be possible to out plant the remaining seedlings. If there is no fruit crop we will have to work towards completing the project in the following year.

Likely due to the warm summer rains in 2015 there was a significant increase in invasive plant species cover in Auwahi forest, primarily *Bocconia frutescens, Glycine wightii,* and *Rubus argutus.* These three species are priority invaders and of utmost concern for the long-term trajectories of Auwahi forest as they each have the potential to disrupt the native forest function. *Bocconia* and *Rubus* are both shade-tolerant, produce prolific seeds and are bird dispersed and recruit in the darkest native understory canopies at Auwahi. *Glycine*, a very productive legume, has the potential to increase the nitrogen content in the soil, shifting soil chemistry to further favor invasive species. At this stage of restoration controlling these priority invasive weed species is critical to the long-term success and sustainability of forest restoration at Auwahi. Last fall, in addition to monitoring native trees for seeds, we prioritized forest management to controlling mature individuals and preventing these species from establishing further seed banks. We are monitoring established priority invader population areas where individuals have historically reproduced. Our efforts this past fall were pivotal in the preventing the establishment of problematic invasive weed populations and the sustainability of our restoration efforts. Since the beginning of the 2016, we have been able to shift focus to planting and seed gathering trips.

Figure 1: Tray of `*aiea* seedlings planted into Auwahi forest habitat on July 25, 2015.

Figure 2: Volunteers gathering `*iliahi* seeds on May 2016.

# Attachment 6

# FY 2017 Annual Work Plan and Timeline

# FY 2017 Annual Work Plan and Timeline

<table>
<tr><th></th><th></th><th colspan="6">2016</th><th colspan="6">2017</th></tr>
<tr><th></th><th></th><th>July</th><th>Aug</th><th>Sept</th><th>October</th><th>November</th><th>December</th><th>January</th><th>February</th><th>March</th><th>April</th><th>May</th><th>June</th></tr>
<tr><td rowspan="3">Post Construction Mortality Monitoring</td><td>Fatality Searches</td><td colspan="6">Three Day Interval Searches</td><td colspan="6">Search Interval (to be determined by carcass persistence trials)</td></tr>
<tr><td>Searcher Efficiency Trials</td><td colspan="12">Monthly Trials</td></tr>
<tr><td>Carcass Persistence Trials</td><td colspan="12">Quarterly Trials</td></tr>
<tr><td rowspan="2">Petrel Mitigation</td><td>HAPE Monitoring</td><td colspan="5">Burrow Monitoring</td><td colspan="3"></td><td colspan="4">Burrow Monitoring</td></tr>
<tr><td>Predator Control</td><td colspan="2">Traps Operational All Units</td><td>Predator Activity Assessment</td><td colspan="2">Traps Operational All Units</td><td colspan="2"></td><td>Predator Activity Assessment</td><td colspan="4">Traps Operational All Units</td></tr>
<tr><td rowspan="6">Bat Mitigation</td><td>Ungulate Control</td><td>Quarterly Fence Inspection</td><td colspan="2"></td><td>Quarterly Fence Inspection</td><td colspan="2"></td><td>Quarterly Fence Inspection</td><td colspan="2"></td><td>Quarterly Fence Inspection</td><td colspan="2"></td></tr>
<tr><td>Vegetation Monitoring and Invasive Species Control</td><td colspan="3"></td><td>Semi-Annual Invasive Vegetation Management</td><td colspan="3"></td><td>Annual Vegetation Monitoring</td><td>Semi-Annual Invasive Vegetation Management</td><td colspan="3"></td></tr>
<tr><td>Reforestation</td><td colspan="3"></td><td colspan="2">Re-treat grasses around out planting</td><td colspan="5"></td><td colspan="2">Re-treat grasses around out planting</td></tr>
<tr><td>Tier 2 & 3 (Acoustic monitoring)</td><td colspan="12">Acoustic Monitoring Year 2</td></tr>
<tr><td>Tier 2 & 3 (Radio- telemetry)</td><td colspan="3">Study Prep</td><td>Tower set up</td><td colspan="3">Radio telemetry</td><td colspan="4"></td><td>Year 1 Summary Report</td></tr>
<tr><td>Tier 2 & 3 (Insect Prey Based Study)</td><td colspan="4">Study Prep</td><td colspan="3">Insect Prey Based Study/Food Habitat Assessment</td><td colspan="4"></td><td>Year 1 Summary Report</td></tr>
<tr><td>Reporting</td><td>ITP & ITL Conditions</td><td></td><td>Annual HCP Report Submitted</td><td colspan="4"></td><td>Incidental Take Summary Tables Submitted</td><td>Semiannual Progress Report Submitted</td><td colspan="4"></td></tr>
</table>

# Attachment 7

# FY 2016 Expenditures for HCP Implementation

| | Tier, Ongoing, or One-time | Event | Proposed Cost | Total Costs Incurred to Date (up to July 2016) | 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) |
|---|---|---|---|---|---|---|---|---|
| **General Measures** | Ongoing | Wildlife Education and Incidental Reporting Program | $5,000 | $4,667 | $3,000 | $1,500 | $167 | N/A |
| | Ongoing | Downed Wildlife Post-Construction Monitoring and Reporting and Mitigation Monitoring | $1,810,000 | $546,773 | $100,000 | $185,145 | $152,901 | $108,727 |
| | Ongoing | *DOFAW Compliance Monitoring (only if needed) | $200,000 | $2,423 | N/A | N/A | $2,423 | N/A |
| | | Subtotal General Measures | *$1,815,000* | *$553,863* | *$103,000* | *$186,645* | *$155,324* | *$108,727* |
| **Hawaiian Hoary Bat** | Tier 1 | Retrofit fencing and restoration measures at the Waihou Mitigation Project | $522,000 | $656,316 | $314,900 | $63,173 | $128,410 | $149,833 |
| | Tier 1 | Acoustic Monitoring onsite | $40,000 | $39,827 | $5,000 | $8,691 | $14,663 | $11,473 |
| | Tier2 | Telemetry Research | $250,000 | $183,854 | N/A | $32,726 | $8,308 | $142,819 |
| **Hawaiian Petrel** | | Subtotal Bats | *$812,000* | *$879,997* | *$319,900* | *$104,591* | *$151,381* | *$304,125* |
| | Tier 1 | Burrow Monitoring and Predator Control | $550,000 | $452,726 | $214,000 | $74,572 | $107,743 | $56,410 |
| | | Subtotal Petrels | *$550,000* | *$452,726* | *$214,000* | *$74,572* | *$107,743* | *$56,410* |
| **Nene** | One-Time | Research and Management Funding | $25,000 | $25,000 | $25,000 | N/A | N/A | N/A |
| | | Subtotal Nene | *$25,000* | *$25,000* | *$25,000* | *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 |
| | | Subtotal Moth | *$144,000* | *$144,000* | *$144,000* | *N/A* | *N/A* | *N/A* |
| | | **Total HCP-related Expenditures** | **$3,346,000** | **$2,055,586** | **$805,900** | **$365,808** | **$414,448** | **$469,263** |