Kaheawa Wind Power II
Habitat Conservation Plan
Annual Report: FY 2016

Kaheawa Wind Power, LLC
3000 Honoapiilani Highway
Wailuku, Hawaii 96768

August, 2016

ITL-15 and ITP E27260A-0

I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate and complete.

Mitchell Craig

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SunEdison, LLC

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Executive Summary

Kaheawa Wind Power II, LLC (KWPII) has been implementing a Habitat Conservation Plan (HCP) since December 2011. KWPII is currently owned by Terraform Power, LLC and operated by SunEdison, LLC. The HCP supports the federal Incidental Take Permit TE-27260A- 0 and Hawaii Incidental Take License ITL-15, both issued in January 2012. KWPII was commissioned to begin operating on July 2, 2012. Species covered under the HCP include the Hawaiian petrel (HAPE), Newell's shearwater (NESH), Hawaiian goose (HAGO or nēnē), and the Hawaiian hoary bat (LACI). This report is for the fourth year of operations State of Hawaii Fiscal Year (FY) 2016, July 1, 2015 through June 30, 2016. KWPII has previously submitted annual HCP progress reports for FY 2013, 2014, and 2015 to U.S. Fish and Wildlife Service (FWS) and the Division of Forestry and Wildlife (DOFAW).

Beginning in FY 2016 the downed wildlife search area is reduced relative to the previous three years and now consists of graded roads and WTG pads found within a 70m radius circle centered on each turbine. Teresa Gajate was contracted beginning October 2015 to conduct canine-assisted searching, with visual searching as a secondary method. During FY 2016, the search interval mean and standard deviation (SD) in days for KWPII was 7.04 (SD = 0.75).

Of the HCP covered species only one nēnē fatality was observed during FY 2016. The total estimated direct take at the 80% credibility level for KWPII HCP covered species is eight and 18 adults for nēnē and LACI, respectively (Huso *et al.* 2015). Indirect take (IDT) for LACI is one and IDT including lost future productivity for nēnē would be three juveniles. No take of HAPE or NESH has been observed.

Independent contractor Kristin Mack was chosen to conduct searcher efficiency (SEEF) trials for KWPII throughout the fiscal year. The mean SEEF for large, medium, and small carcasses was 100% (N = 11), 100% (N = 10), and 81.4% (N = 43), respectively.

In four carcass retention (CARE) trials a total of four chickens, four wedge-tailed shearwaters (WTSH), and 21 rats were used. Considering the first 14 days of the 28-day long trials the CARE mean and SD for each size class in days were 14.0 for chicken (SD = 0), 11.3 for WTSH (SD = 5.5) and 7.0 for rats (SD = 6.1).

Wildlife Acoustics SM2BAT+™ bat detectors with one SM3BAT™ microphone each recorded detections at all eight WTG associated ground locations at KWPII during 7.5% (152 of 2038) of the total detector nights. Wildlife Acoustics SM2BAT+™ and SM3BAT™ bat detectors recorded detections at each of the seven nacelle WTG locations at KWPII during 11.3% (214 of 1901) of the total detector nights.

A total of 40 site personnel received Wildlife Education and Observation Program (WEOP) trainings in FY 2016 including a refresher for all regular staff.

Vegetation management of the search plots for FY 2016 treated 20.8 acres of total plot area using hand-held weed whackers and herbicide.

A mitigation obligation for KWPII was to re-introduce native plant species at discrete locations on-site in the first three years. To date 5,263 plants have been planted at a designated site north of KWPI WTG-17, exceeding our goal of 5,000. Survival counts were conducted in June 2016. Survival rate for a sample of these outplanted species is 86.2% (N = 508), which satisfies our mitigation requirement.

Seabird mitigation for KWPII is carried out at the Makamaka'ole Seabird Enclosures and currently focuses on trapping and monitoring for potential predators, maintenance of enclosure fences, erosion control and monitoring seabird activity within the Makamaka'ole Stream drainage area and near artificial burrows within the enclosures. Alternative seabird mitigation site surveys began in East Maui in FY 2015 and were completed in FY 2016. An application to amend the HCP and state and federal take license and permit to increase LACI and nēnē take was sent to the FWS and DLNR-DOFAW on May 8, 2015. The amendment and mitigation proposals for LACI and nēnē are in review. LACI Tier 1 and Tier 2 mitigation has been funded and is ongoing at Kahikinui Forest Reserve. Tier 3 LACI mitigation is being planned. Tier 1 nēnē mitigation has been partially funded and is ongoing as predator control on Maui.

Regular agency and Endangered Species recovery Committee (ESRC) meetings occurred in FY 2016. KWPII also provided quarterly summary reports for FY 2016 Q1, Q2 and Q3.

Definitions

CARE	Carcass Retention Trial
DLNR	Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
ESRC	Endangered Species Recovery Committee
FWS	United States Fish and Wildlife Service
FY	Fiscal Year
HAGO	Hawaiian Goose (*Branta sandvicensis)*
HAPE	Hawaiian Petrel (*Pterodroma sandwichensis*)
HCP	Habitat Conservation Plan
ITL	Incidental Take License
ITP	Incidental Take Permit
KWP	Kaheawa Wind Power
LACI	Hawaiian Hoary Bat (*Lasiurus cinereus semotus)*
Met tower	Meteorological tower
NESH	Newell's Shearwater (*Puffinus newelli*)
NFWF	National Fish and Wildlife Foundation
SEEF	Searcher Efficiency Trial
SEOW	Hawaiian Short Eared Owl (*Asio flammeus sandwichensis*)
WTG	Wind Turbine Generator

Introduction

In July 2012 Kaheawa Wind Power Phase II, LLC (KWPII) began commercial operation to meet the growing need for renewable energy across the island of Maui. The State Board of Land and Natural Resources approved a Conservation District Use Permit (CDUP) for the facility, which is situated on state conservation lands, in August 2010.

In fulfillment of the Endangered Species Act and Chapter 195-D, Hawai`i Revised Statutes, KWPII developed a project-specific Habitat Conservation Plan (HCP) in cooperation with the U.S Fish and Wildlife Service (FWS), the Department of Land and Natural Resources- Division of Forestry and Wildlife (DLNR-DOFAW) and the Hawai`i Endangered Species Recovery Committee (ESRC). Upon final approval of the HCP, the federal ITP (TE-27260A-0) and state ITL (ITL-15) were issued in January 2012, each with a duration of twenty years. The ITP and ITL cover four federally-listed and endangered species: the Hawaiian petrel or 'Ua'u (*Pterodroma sandwichensis*), Newell's shearwater or 'a'o (*Puffinus newelli*), Hawaiian goose or nēnē (*Branta sandvicensis*), and the Hawaiian hoary bat or 'ope'ape'a (*Lasiurus cinereus semotus*).

This report summarizes HCP related activities for KWPII during the fourth year of project operations (July 1, 2015 through June 30, 2016).

Downed Wildlife Monitoring

KWPII biologists have been implementing a year-round intensive monitoring program to document downed (i.e., injured or dead) wildlife incidents involving HCP-listed and non-listed species on the project site and its vicinity since operations began in July 2012. Systematic searches were conducted on foot by human only or by canine-assisted searchers. Beginning in July 2015, after the ESRC gave its approval at the March 31, 2015 public meeting, the search plot areas were reduced in size relative to the size of plot searched prior to July 2015. The reduced search area includes only roads and graded WTG pads found within a circle of radius 70m radius centered on each WTG (Figure 1, Appendix 1). This reduced search area makes up approximately 26.9%, and 36.5% of the hypothesized total fall distribution of nēnē and LACI (Appendix 1).

Teresa Gajate and her canine Makalani provided canine searching in FY 2016 beginning October 2015. Canine-assisted searching was the primary search method, with visual searching secondary. In FY 2016 56.1% (N = 409) of searches were canine-assisted and 43.9% (N = 320) were visual (Appendix 2). Canine searches were postponed or skipped in favor of visual searches if nēnē were present at the turbine or if turbine repairs necessitated a delay. The presence of nēnē halted three WTG searches.

In FY 2016, the search interval mean and standard deviation (SD) in days for KWPII monitoring was 7.04 (SD = 0.75) (Table 1 and Appendix 3). For the safety of the KWPI technical staff, monitoring is halted during periods when wind speeds are reported higher than 15 meters per second (m/s). During FY 2016 no monitoring schedule interruptions occurred.

Table 1. Search interval mean and standard deviation in days per WTG plot on KWPII FY 2016.

WTG	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Mean	7.04	7.04	7.04	7.04	7.04	7.04	7.04
SD	0.75	0.75	0.75	0.75	0.75	0.75	0.75
WTG	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mean	7.04	7.04	7.04	7.04	7.04	7.04	7.04
SD	0.77	0.77	0.77	0.75	0.75	0.75	0.75
Mean TOTAL		**7.04**		**SD TOTAL**		**0.75**	

Fatalities

Downed wildlife incidents documented at KWPII during FY 2016 are summarized in Table 2. Locations of fatalities found with reference to WTGs and site facilities are described in Figure 1. One of these incidents involved HCP-covered species or species of concern – one Hawaiian goose was reported to DOFAW and USFWS within 24 hours. Details of all HCP-covered species fatalities are provided in Downed Wildlife Incident Reports submitted to DOFAW and USFWS within three days of each discovery.

Table 2. Documented wildlife fatalities at KWPII in FY 2016.

Common Name	Discovery Date	Turbine	Distance to nearest structure (m)
Endangered and MBTA			
Hawaiian Goose	10/13/2015	7	9
Barn Owl	4/11/2016	Other	1000
Eurasian Skylark	3/16/2016	6	30
White-tailed Tropicbird	7/10/2015	9	14
White-tailed Tropicbird	6/9/2016	13	54
Non-listed			
African Silverbill	8/18/2015	11	1
Black Francolin	7/2/2015	13	1
Black Francolin	7/2/2015	13	1
Black Francolin	7/28/2015	1	2
Black Francolin	11/10/2015	4	79
Common Myna	4/27/2016	9	20
Common Myna	6/1/2016	1	36
Gray Francolin	8/11/2015	1	1
Gray Francolin	11/18/2015	12	61
Gray Francolin	5/20/2016	5	89
Gray Francolin	5/25/2016	2	43
Nutmeg Mannikin	12/9/2015	10	63
Nutmeg Mannikin	3/2/2016	5	6
Unknown	12/30/2015	14	26

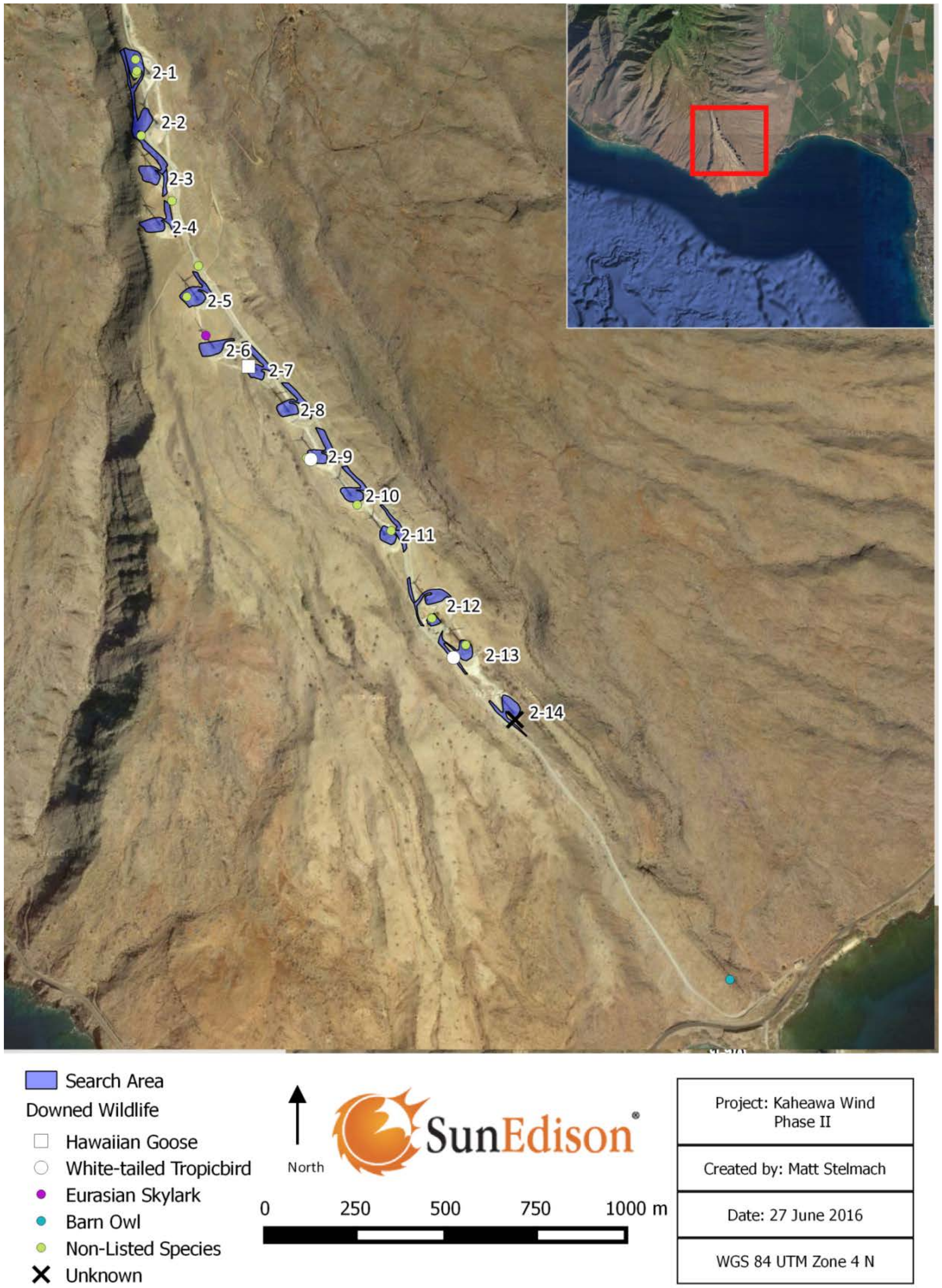

Figure 1. All downed wildlife observed over FY 2016 throughout KWPII in reference to WTGs.

SEEF and CARE Study

Searcher Efficiency Trials (SEEF)

In FY 2016, independent contractor Kristin Mack (SEEF proctor) was chosen to proctor SEEF trials. The SEEF proctor used randomly selected points within the reduced search area for SEEF locations. The schedule was pre-determined by week and unavailable to on-site staff. On-site staff would coordinate the search schedule with the SEEF proctor to ensure SEEFs were put out on scheduled search days. At the end of each search day on-site staff would communicate what was found to the SEEF proctor. If any SEEF carcasses were missed a different on-site staff member who did not participate in the searches for the day (typically the HCP manager) would attempt to recover the carcass and report the results to the SEEF proctor.

For the KWPII searcher efficiency trials a total of 70 carcasses were placed; 49 rat, 10 WTSH, and 11 chickens (Appendix 4). The mean SEEF for large, medium, and small carcasses was 100% (N = 11), 100% (N = 10), and 81.4% (N = 43), respectively (Table 3 and 4). Six of 49 rats were not recovered after searches and are not included in the SEEF result.

Table 3. Overall searcher efficiency results for FY 2016.

SEEF Results FY 2016				
Carcass type	**Count**	**Avg**	**Included**	**Notes**
Large Bird	11	100%	True	
Med Bird	10	100%	True	
Rat	6	0.0 %	False	Assumed Scavenged
Rat	43	81.4%	True	

Table 4. Searcher efficiency by search method and carcass size.

SEEF Results FY 2016			
Search Type	**Carcass type**	**Count**	**Avg**
Canine	Large Bird	10	100%
Canine	Med Bird	7	100%
Canine	Rat	29	89.7%
Visual	Large Bird	1	100%
Visual	Med Bird	3	100%
Visual	Rat	14	64.3%

Carcass Retention Trials (CARE)

CARE trials are used to estimate how long a carcass remains detectable to searchers before complete removal or obscuring by scavengers. Trials proctored were conducted using Rhode Island crossed chickens as surrogates for nēnē, Wedge-tailed shearwaters for HAPE and NESH, and commercially produced rats for LACI. The chickens were from Maui farmers. WTSH carcasses are generally fledglings and adults found dead by the public and delivered to Sea Life Park on Oahu or collected by DOFAW on Maui. Our state and federal wildlife collection permits for KWPII are numbers WL 15-05 and MB24151B-0, respectively. Rat carcasses were purchased from Layne Laboratories, Inc. in California, a pet food company. These rats are brown and/or black and are the Layne Laboratory “Small Colored” size category (approximately 11.3 cm in body length) and were chosen to mimic body size of LACI (Figure 2).

During FY 2016, CARE trials used four chickens, four WTSH, and 21 rats (Appendix 5). All trials were for 28 days. Fatality estimates use the data as it has been collected (28 day trials). Considering the first 14 days of the trials to compare current CARE trials to trials in the past the CARE mean and SD for each surrogate in days were 14.0 for chicken (SD = 0), 11.3 for WTSH (SD = 5.5) and 7.0 for rats (SD = 6.1) (Table 5).

Table 5. Carcass retention trial results for FY 2016, considering only the first 14 days.

CARE Statistics FY 2016			
Carcass Type	**Count**	**Average Maximum Days**	**SD Days**
Wedge-tailed Shearwater	4	11.3	5.5
Rat	21	7.0	6.1
Chicken	4	14	0

Figure 2. Hawaiian hoary bat and rat surrogate for CARE and SEEF trials.

Canine Interactions with Wildlife

Special precautions are taken to limit canine interaction with wildlife. The handler is directed to immediately call back Makalani if nēnē were observed and to skip turbines if nēnē were present within the turbine search area or vicinity. Skipped turbines were preferentially searched later the same day or next day with the canine search team or alternatively visually searched. Throughout the searches no canine wildlife interactions were observed. An example of the search pattern and effort is shown in Figure 3.

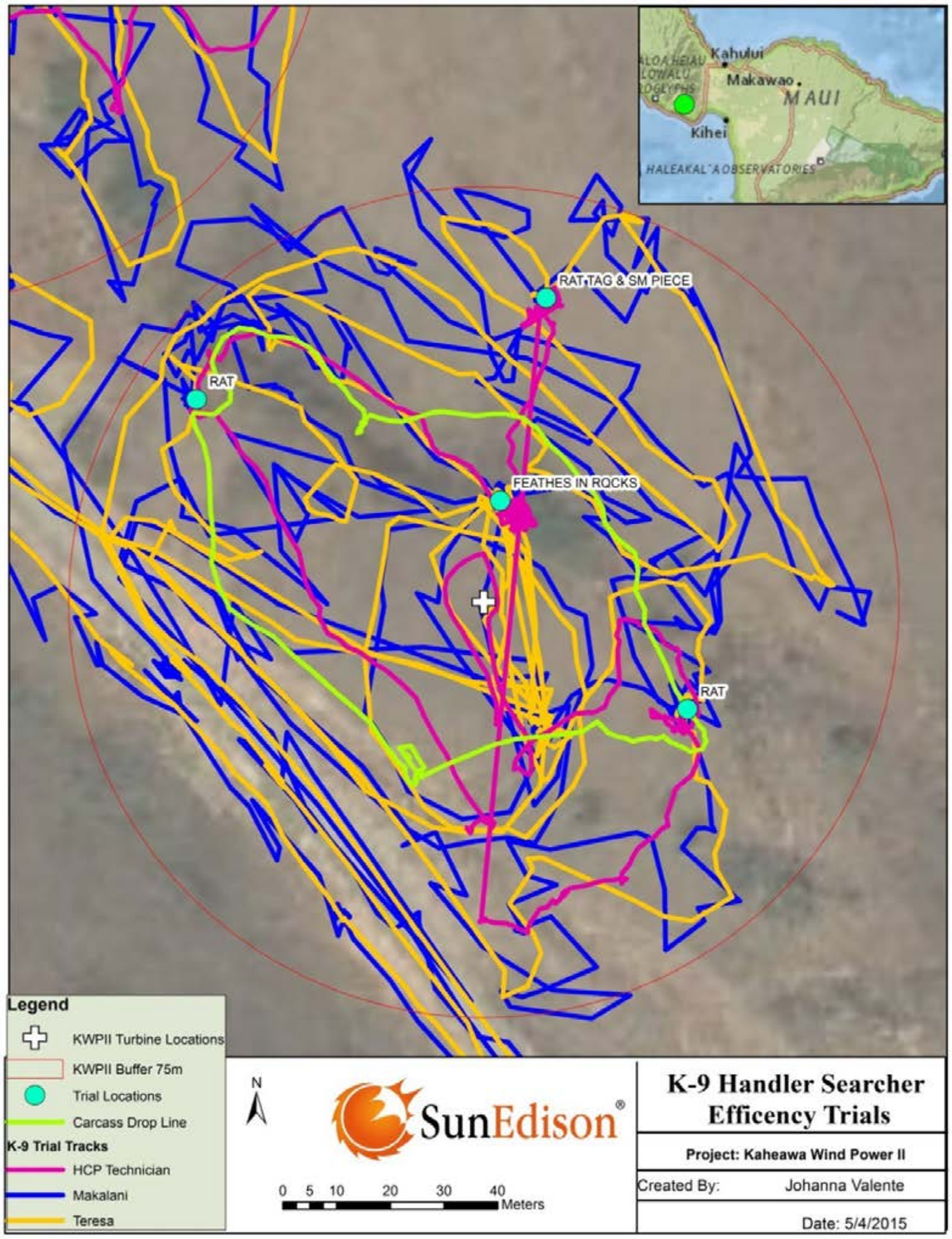

Figure 3. Makalani's tracks associated with his SEEF detections and the locating a Eurasian Skylark carcass on February 10, 2015 found at KWPII WTG-13.

Scavenger Trapping

A predator trapping program was re-initiated in August 2015. Trapping included; eight DOC250™ body grip traps, and seven cage traps (Figure 4). During FY 2016, 18 mongoose, four rats and nine cats were caught using the approved trapping protocol and monitoring frequency (Table 6).

Trapping is intended to decrease scavenging of carcasses used in CARE trials and also any downed wildlife, and should have the added benefit of improving nēnē fledgling survival and nesting success. All traps were designed to minimize inadvertent interaction with nesting birds. In FY 2016, two common mynas were inadvertently killed in DOC250 traps. In an effort to further reduce the likelihood of non-target take, trap entrances were reduced in size.

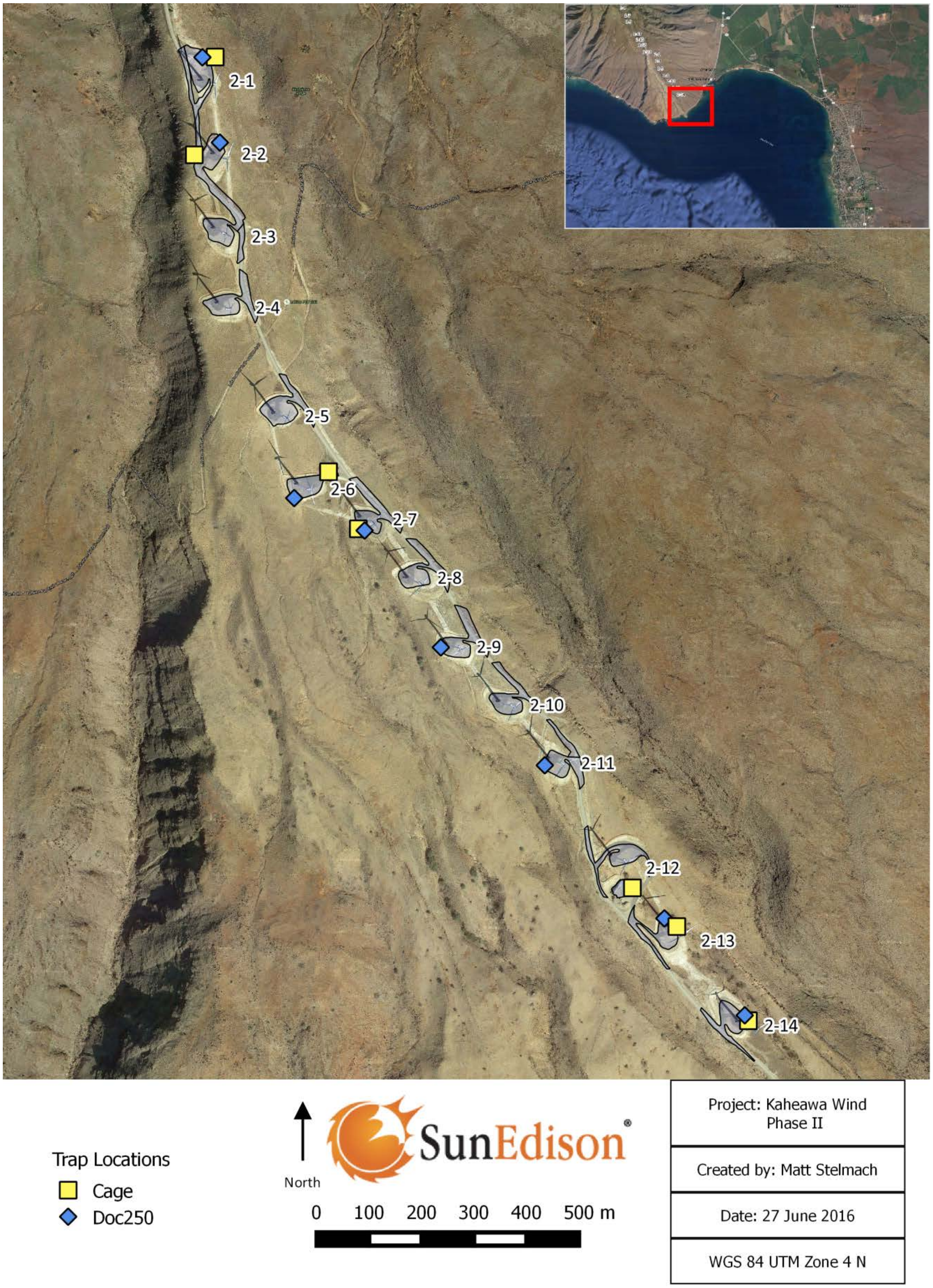

Figure 4. Location of KWPII predator traps.

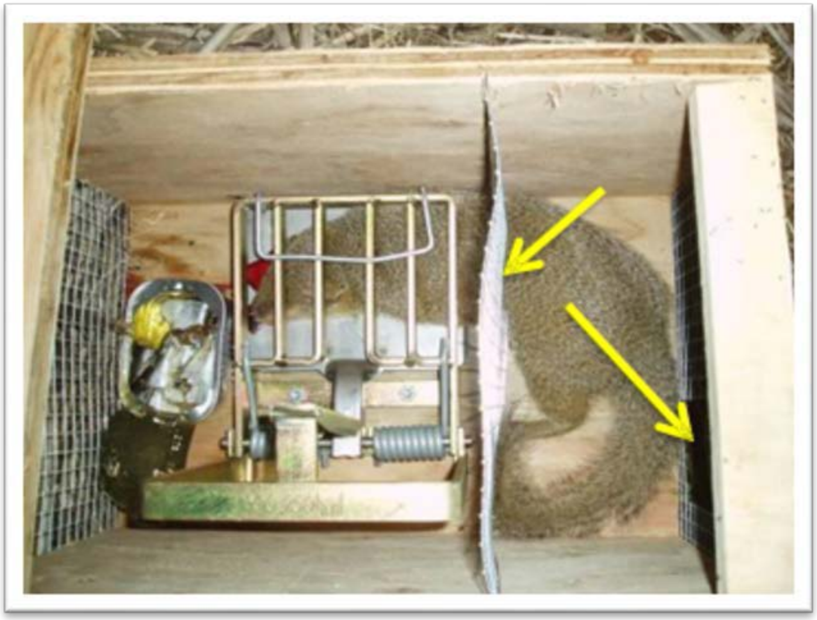

Figure 5. DOC-250 trap encased in a "bird-safe" box with arrows pointing to the 2 separate entrances that must be negotiated to access and trigger the trap mechanism itself.

Table 6. KWPII trapping and monitoring protocol.

Trap Type	Species Targeted	Monitoring Frequency	Frequency of Baiting/Re-setting	Frequency of Cleaning and Re-locating
DOC 250	Mongoose, Rat	Weekly	Weekly	Minimum 1x per 3 months
Cage Trap	Cat, Mongoose	24 Hours	2-7 Days	Minimum 1x per 3 months

Estimating Adjusted Take

Of the HCP covered species only one nēnē was observed during FY 2016. The total observed take for each species at KWPII since operations began is four nēnē and three LACI. The estimators used in this report were developed by USGS (Huso *et al.* 2015) and have been recommended by DOFAW and FWS. The estimator's output is a value that represents the number of fatalities that has not likely been exceeded during the survey period. Values can be generated for varying levels of "credibility" (confidence), expressed as a percentage (e.g., 50%, 80%, etc.) - the higher the desired level of credibility, the more conservative (higher) the estimated value. At the request of FWS the more conservative 80% credibility level is reported.

The total estimated take at the 80% credibility level for KWPII HCP species is eight and 18 adults for nēnē and LACI, respectively (Appendix 6). At the request of FWS the more conservative 80% credibility level is reported. Observed take is the only take that has been documented and confirmed at the site. However, for the purposes of estimating potential take for permitting and mitigation, statistical methods have been developed for estimating additional take that may have occurred but that was not observed. This "unobserved take" attempts to account for fatalities that may have fallen outside of search plots, were missed by searchers, or were removed by scavengers or environmental factors such as high winds.

Indirect take is the possible or known take of offspring that have been negatively affected by the direct take of their parents. Indirect take can be from observed or unobserved direct take. Both parents of nēnē and the two seabirds exhibit equal responsibility for care of young until fledging while only the female LACI cares for their offspring. All four covered species have seasonal breeding periods as described in the KWPII HCP and the point during the breeding season when an adult is taken determines to what extent the offspring is affected (i.e. the chance of survival of an offspring without one or both parents may vary).

Indirect take caused by observed take is calculated for take of female LACI or LACI of unknown sex, observed between April 1 and September 15. Indirect take estimated from unobserved LACI take is calculated assuming half of the unobserved take would be female and that for each female there is an average probability that she would be pregnant or lactating for three months in a year. Bats fly through the project area throughout the year and the probability of an individual female bat having dependent young during a 12 month period is assumed to be 25% (three out of 12 months). The average period of dependence is based on the information that Hawaiian hoary bats have one brood a year, and that hoary bats in North America have an average 56 day gestation period followed by parental care to weaning averaging 34 days or approximately three months in total (Hayssen *et al* 1993, Hayes and Wiles 2013, and NatureServe 2015 for *Lasiuris cinereus*). There is not enough information for hoary bats from Hawaii to determine the gestation and pre-weaning dependent period. Consequently, indirect take is assessed to bats lost through "unobserved direct take" at the rate of 0.225 juveniles/bat (0.5 x 0.25 x 1.8 = 0.225). For KWPII no female LACI and no LACI whose sex has not yet been determined were observed during the breeding period since 2012. The sex of all LACI found during the breeding period, if any, will be determined in FY 2017 and indirect take may be recalculated.

Indirect take calculation depends on when the adult take was observed. Indirect take and accrued lost future productivity for nēnē is 0.72 and 1.46, respectively (Appendix 7). Indirect take from observed and unobserved take of LACI is one adult LACI (from juvenile indirect take estimated to survive to adult)(Appendix 8). The Tier 2 amended take limit of 11 adult LACI is exceeded.

Hawaiian Hoary Bat Monitoring

In order to better understand variations in LACI activity specifically near the WTGs, we have operated eight Wildlife Acoustics SM2BAT+ ™ detectors with one microphone (mic) each since October 2013 throughout KWPII. Prior to October 2013 Titley Anabat™ acoustic detectors had been deployed. All of the SM2BAT+ ™ mics were replaced with SM3BAT ™ mics mounted at 6.5 meters height. Six were placed near the WTGs while two were placed near a gulch edge; each mic was positioned horizontally, pointing SW (away from the prevailing NE trade winds). In addition to the ground units and as an adaptive management measure, a total of five SM3BATs ™ and two SM2BAT+ ™ were also deployed in nacelles equipped with one mic pointing backwards and parallel to the top of the nacelle at 72m height.

In FY 2016 detectors recorded LACI activity at all ground and nacelle locations. Ground detectors recorded activity during 7.5% (152 of 2038) of total detector nights and nacelle detectors recorded activity during 11.3% (214 of 1901) of total detector nights (Table 7). LACI presence by month, turbine and hour are shown in Figures 6, 7, and 8. Activity distinctly peaks before 2300 hours and gradually declines towards morning for both ground and nacelle units (Figure 8).

A portion of the data from 1 July – 4 August was lost due to storage media failure. Therefore this data and time period is excluded from analysis. Data for June was collected on June 16 and reflects data up to that date.

Table 7. Hawaiian Hoary bat nights with detections and total detection nights at KWPII in FY 2015.

Detector Location (WTG)	Total Detector Nights	Total Detector Nights with Activity	% Detector Nights with Activity/Total Detector Nights
		Ground Detectors	
1	283	28	**9. 9%**
2	233	14	**6.0%**
3 (Gulch)	283	22	**7.8%**
5	283	22	**7.8%**
9	173	4	**2.3%**
11	276	12	**4.4%**
13	255	31	**12.2%**
14 (Gulch)	252	19	**7.5%**
Totals	**2038**	**152**	**7.5%**
		Nacelle Detectors	
1	283	51	**18.0%**
3	283	33	**11.7%**
5	278	43	**15.5%**
7	247	10	**4.1%**
9	284	33	**11.6%**
11	243	24	**9.9%**
14	283	20	**7.1%**
Totals	**1901**	**214**	**11.3%**

LACI Nightly Presence by Month in FY 2016

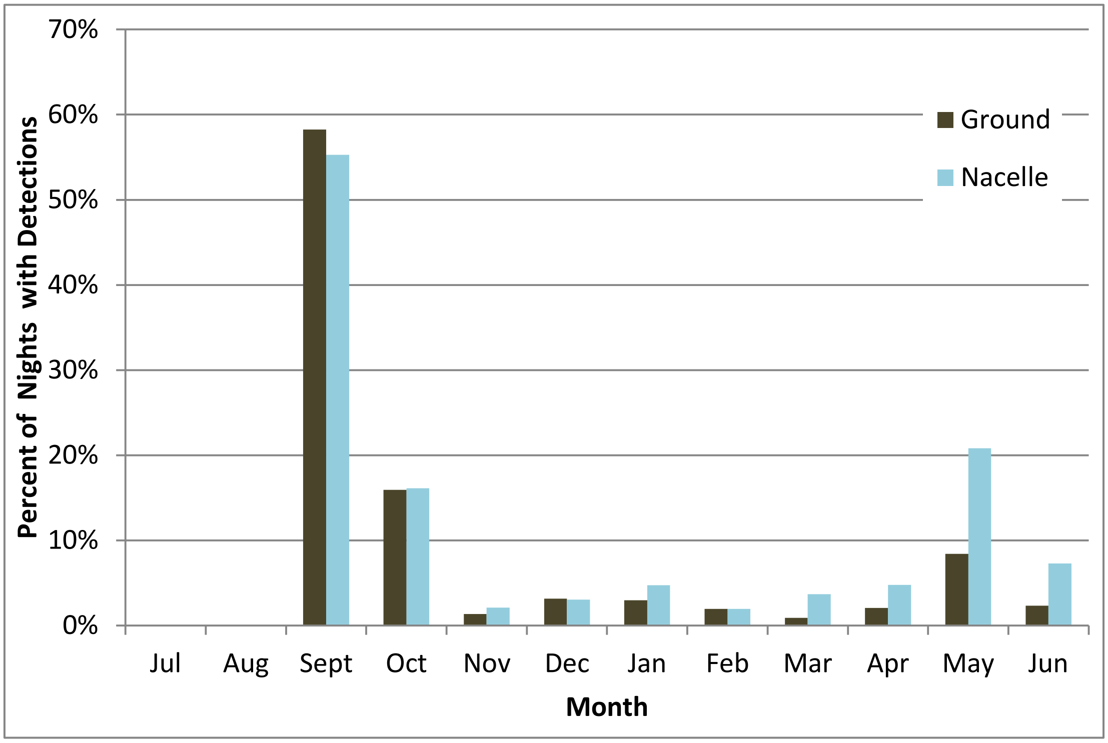

Figure 6. LACI nightly presence at KWPII by month in FY 2016.

LACI Nightly Presence by WTG in FY 2016

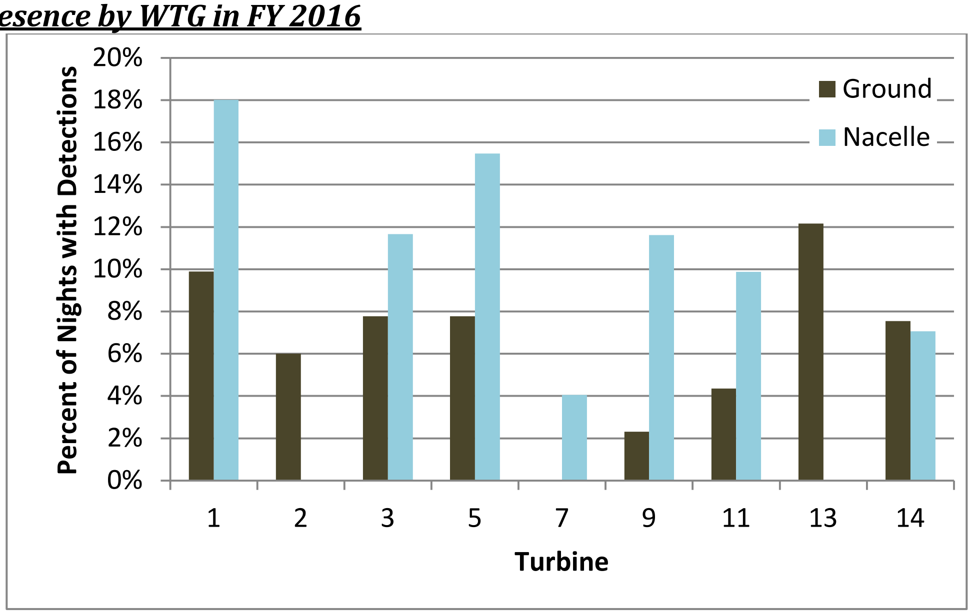

Figure 7. LACI nightly presence at KWPII by turbine (WTG) during FY 2016 (these locations range from the highest elevation on the left (WTG-1) and lowest on the right (WTG-14G)).

LACI Nightly Presence by Night Hour in FY 2016

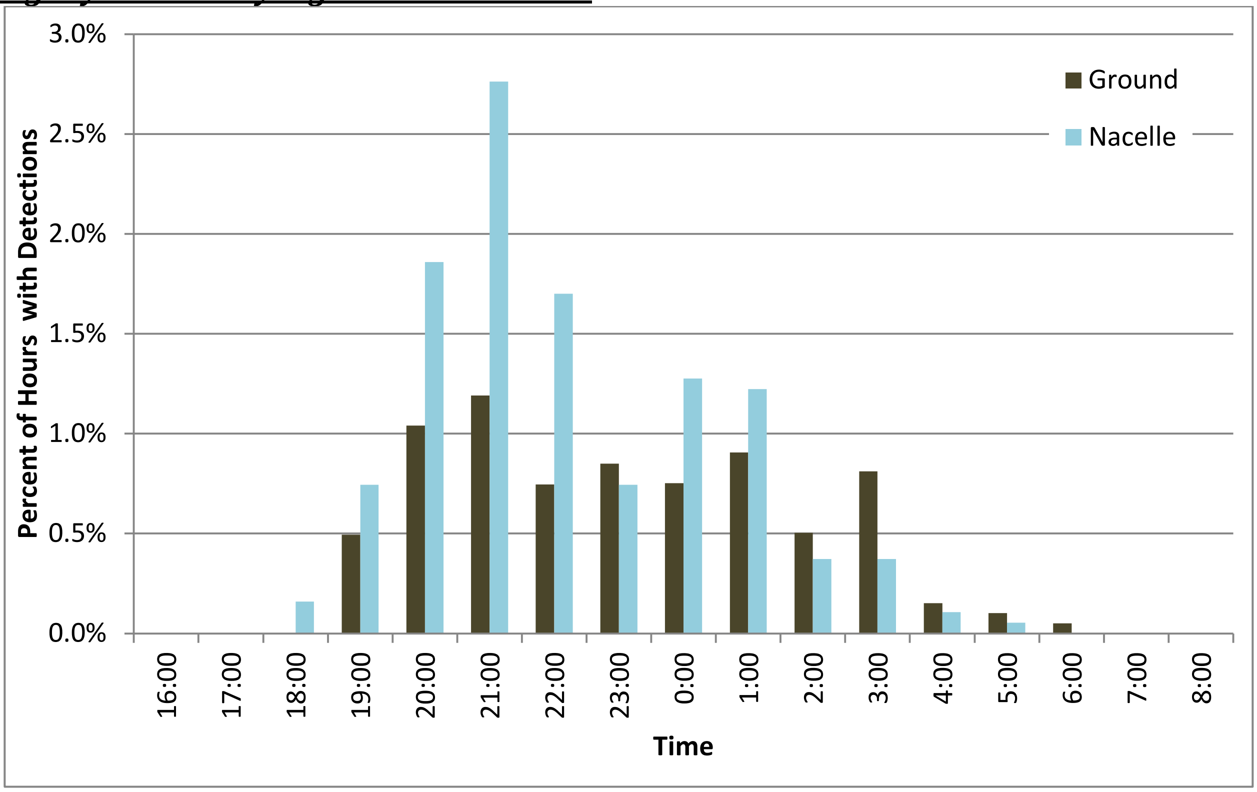

Figure 8. LACI detection by night hour in FY 2016.

Wildlife Education and Observation Program

The WEOP helps to ensure the safety and well-being of native wildlife in work areas and along site access roadways. The training provides useful information to assist staff, contractors, and visitors to be able to conduct their business in a manner consistent with the requirements of the HCP, CDUP, land use agreements and applicable laws. Records of wildlife observations by WEOP-trained staff are also used by the HCP program to identify patterns of wildlife use of the site.

WEOP trainings were given to 40 personnel who were on-site regularly for two days or more (Appendix 9). The personnel were trained to identify covered and non-covered species of wildlife that may be found on-site and what protocol to follow, as determined in the HCP, when a downed wildlife is found. The trainees were also made aware of driving conditions and received instruction on how to drive and act around wildlife.

A total of 288 observations have been reported to date during this fiscal year on KWPII, including 265 Hawaiian Geese, 20 Hawaiian short-eared owls, one rabbit, and two deer (Figures 9 and 10). Data collected was used to better protect and understand HCP species and their habitat use.

WEOP Summary of Species and Locations FY 2016

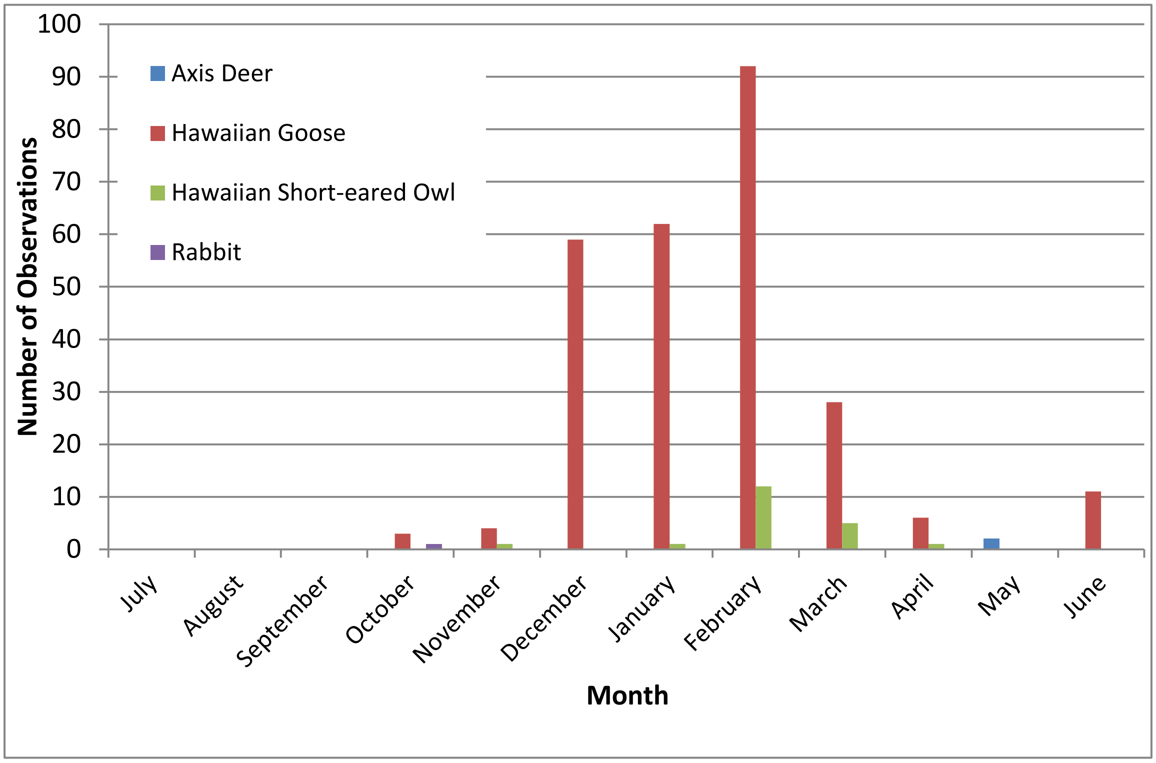

Figure 9. Wildlife observed and recorded as part of WEOP at KWPII by species and month.

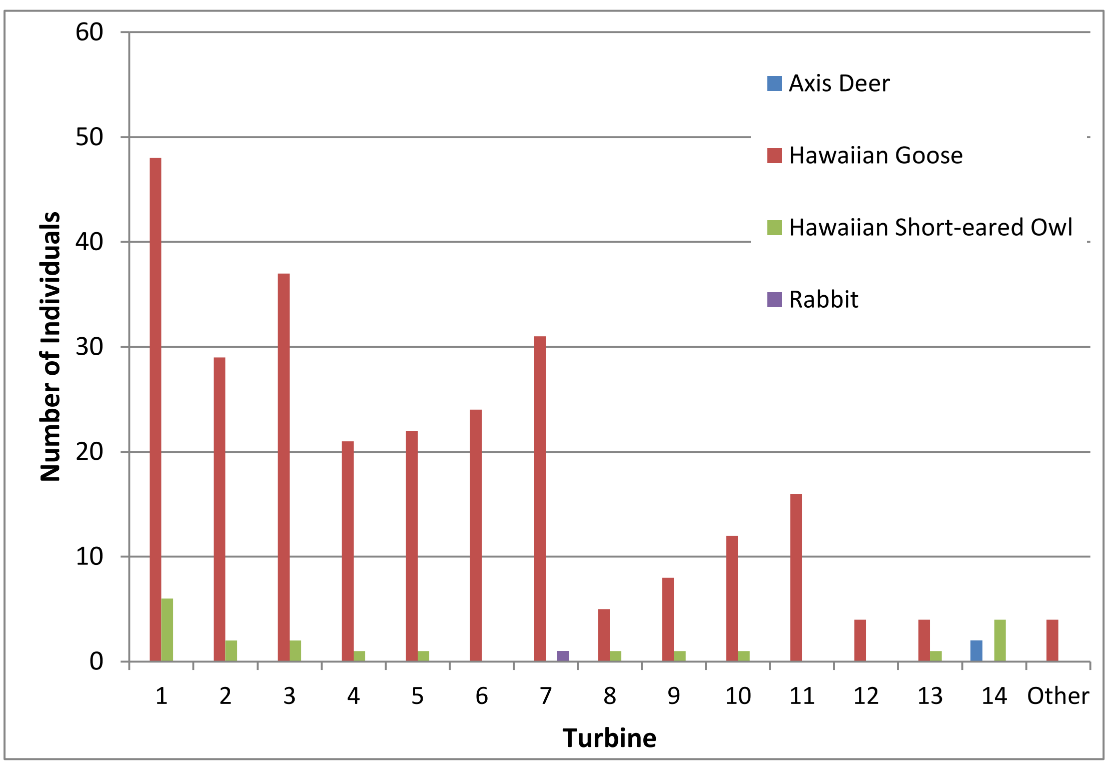

Figure 10. Wildlife observed and recorded as part of WEOP at KWPII by species and turbine location.

Vegetation Management

The HCP team manages ground cover at a stature that will improve monitoring efficiency and minimize impacts to native plants without compromising soil stability. Due to nēnē nesting season vegetation management activities are currently managed between April 1 and October 31st, while areas associated with the WTG pads are managed as permitted by DOFAW Wildlife staff.

Treatment for plot areas was conducted in April 2016. In total, 16 hours of labor by the HCP team managed 20.76 acres. Tall grasses were reduced to 8cm in height, and non-native shrubs and trees were cut out and removed from the plots.

KWPII Revegetation

Revegetation goals for KWPII are specified in Section 6.7 and Appendix 8 of the KWPII HCP, as summarized below:

1) Address the immediate need to stabilize exposed soils following construction activities at KWPII, in accordance with erosion and sedimentation control BMPs and NPDES storm water discharge permitting requirements.
2) Re-introduce native plant species in selected areas throughout the site over the next several years, to re-establish native plant species in areas that have been overgrown with non-native species for a century or more.

Goal 1 was accomplished with hydroseeding and hardscraping potential erosion areas as prescribed in Appendix 8 of the HCP, completed shortly after construction, and ended with watering intervals that continued into Year 1. In FY 2014 a plan was submitted and approved by DOFAW and FWS proposing to meet the prescribed standards of Goal 2 by selecting a singular “restoration site” in the vicinity of the adjacent KWPI project, outside of KWPI search plots.

The plan proposed installing a minimum of 5,000 individual plants during the first three years following construction with a 75% success survival rate after one year, in accordance with Appendix 8. In addition to the planting goal, the HCP specifies that the location of plantings will be determined in consultation with the DOFAW and FWS. KWPII identified several prospective areas adjacent to KWPI, and “Site 1” was accepted as the preferred location. Onsite native seed collection commenced in June 2013. Propagation of native seedlings was contracted to Maui Native Nursery.

By the end of FY 2014, an irrigation system had been installed over approximately 2500 square meters using drip irrigation attached to a 5,000 gallon tank and a total of 2,472 native planted had been introduced to the restoration site. Photos of the revegetation site can be found in Figure 11. In FY 2015, 2,761 additional plants were installed with the help of KWPII personnel and volunteer groups. In June 2015, native plant species totaled 5,263 ‘Ohi’a (*Metrosideros polymorpha*), ‘Akia (*Wilkstroemea oahuensis*), Ko’Oko’Olau (*Bidens micrantha*),‘Iliahi (*Santalum freycinetianum*), Naupaka kuahiwi (*Scaevola gaudichaudiana*), ‘Ulei (*Osteomeles anthyllidifolia*), and ‘A‘ali‘i (*Dodonaea viscosa*), and completed Goal 2 of KWPII revegetation efforts (Figure 12).

Survival success was measured by counting a randomized sampling of 10% of the plants (N = 508). Irrigation lines were used as transects and drip nozzles were used as survey points. Each nozzle was counted either as the species present, dead if a plant was present and had not survived, or no plant present (but assumed to have been present and subsequently died). The final survival count found 86.2% (N = 509) of plants in the sample surviving (Table 8). A complete dataset for the survey can be found in Appendix 10.

Table 8. Species count for survival at the KWPII revegetation site.

Condition	Species	Count	Total
Alive	*Wikstroemia oahuensis*	119	438
Alive	*Metrosideros polymorpha*	46	
Alive	*Santalum freycinetianum*	6	
Alive	*Scaveola gaudichaudii*	4	
Alive	*Bidens micrantha*	55	
Alive	*Dodonaea viscosa*	146	
Alive	Unknown	1	
Alive	*Osteomeles anthyllidifolia*	61	
Dead	Unknown	62	36
None		34	34

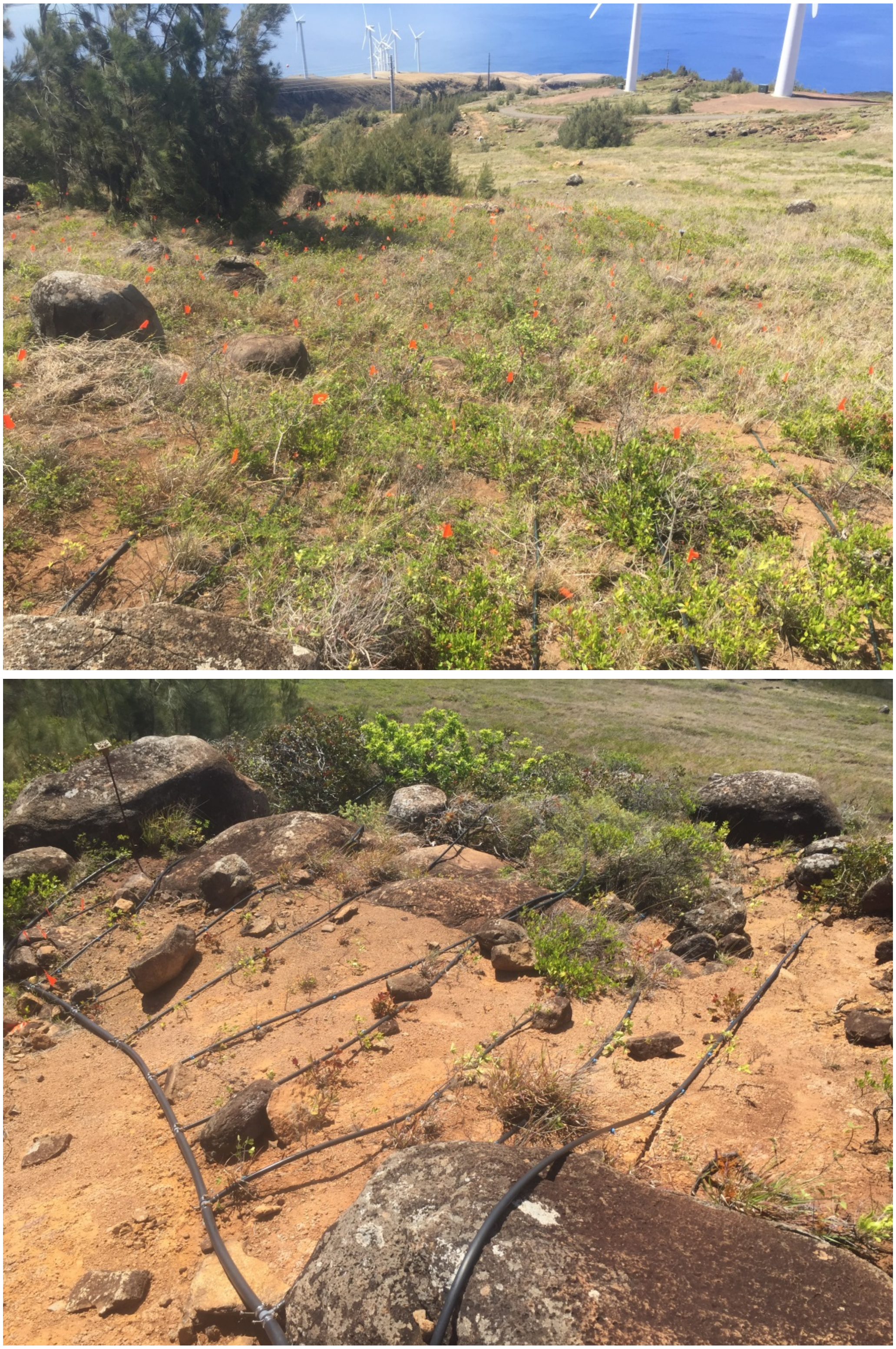

Figure 11. KWPII revegetation site for reference. Flagged monitoring areas shown above. Plants distinguishable at nozzles shown below.

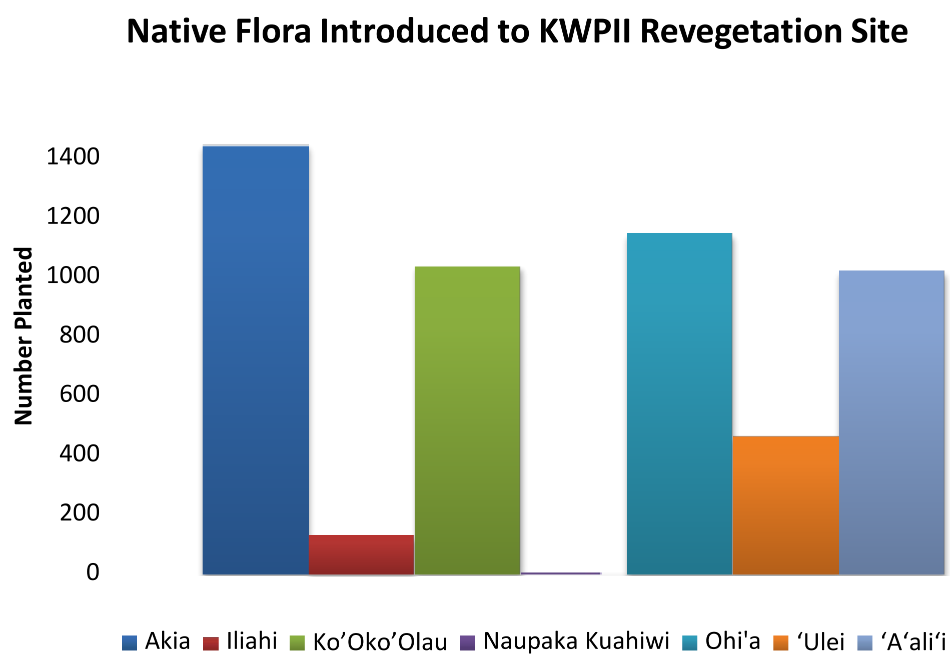

Figure 12. Native plant restoration by species number.

Mitigation

Hawaiian Hoary Bat

Complete funding obligations for Tier 1 and Tier 2 LACI mitigation ($375,000) have been provided in FY 2014 Q4, by KWPII for habitat restoration at Kahikinui Forest Reserve on Maui (Appendix 11). The Tier 1 and 2 LACI permitted take of 11 adults as amended has been exceeded. An application to amend the HCP and state and federal take license and permit to increase take for LACI and nēnē was made May 8, 2015 to the USFWS and DLNR-DOFAW. The amendment application and additional mitigation proposals for KWPII are in review.

East Maui Seabird Survey

In the unlikely event the initial five year mitigation targets at Makamaka'ole for the NESH are not met, East Maui has been surveyed for potential additional mitigation sites. The Maui Nui Seabird Recovery Project was funded with $56,062 to provide equipment and support survey costs, completed this survey in September 2015, and reported the results (Appendix 12). The survey assessed areas adjacent to Haleakala National Park, Maui in the area below Ko'olau Gap and above Keanae by deploying Wildlife Acoustics SM2™ and SM3™ acoustic detectors at 60 locations in approximately 8,000 hectares between 3,000-8,000 ft. altitudes (Figure 13).

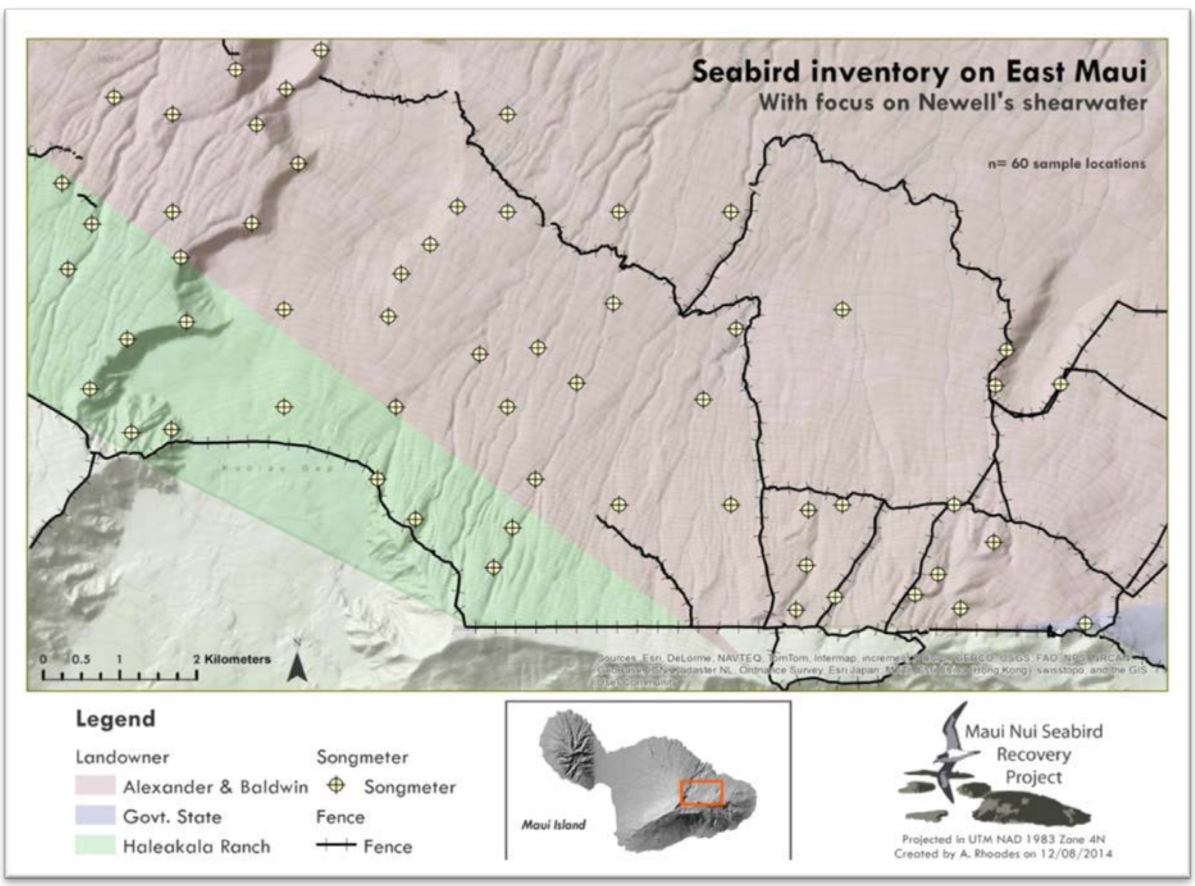

Figure 13. 60 selected survey sites in areas adjacent to Haleakala National Park in the area below Ko'olau Gap and above Keanae.

The surveys will help evaluate potential colony locations, estimate the numbers of birds, assess predator activity, and develop a management feasibility assessment.

Hawaiian Petrel and Newell's Shearwater- Makamaka'ole

Figure 14. Two completed enclosures on the Makamaka'ole Seabird Mitigation site (Enclosure B is left and Enclosure A is right).

Weekly site visits to Makamaka'ole continue and focus on predator trapping and tracking and ongoing maintenance of both enclosures, burrow checks , and game camera operation (Figure 14). Monitoring checklists have been created to ensure consistent oversight. These checklists include sound system battery checks, game camera operation and download, burrow checks for erosion damage, signs of bird activity and ongoing perimeter checks of fences and culverts. The Victor™ rat snap traps, DOC 200™ body grip traps (all encased in bird-safe boxes), and cage traps are routinely maintained (Figure 15 and Table 9). Experimentation with bait and trap types have been ongoing. Game cameras also have been deployed to monitor small mammal activity near culverts where heavy rain may create fence breaches.

The enclosures continue to be an effective but not impermeable barrier to rats. This year we saw an average rate of 3.5 rats per enclosure per year (N = 7). This translates to an ingress rate of 1 rat per 102 days, which is less than half the rate found at the predator proof fence at Ka'ena Point on Oahu (Young *et al.* 2013). The ingress rates are not uniform throughout the year. Ingress occurrences tend to be clustered, and can be associated with breeches in the enclosure associated with high rain events and fence degradation. Tracking tunnel trials show toxicant and trapping efforts within the enclosures have been an effective 3rd line of defense (after exterior trapping and the fence barrier).

Figure 15. New victor snap trap bird safe box design

Table 9. Makamaka'ole trapping data by species and location for FY 2016.

Trap Location	Trap Type	Quantity Deployed	Number Caught
Outside A	Cage	1	0
	Victor Rat Snap	13	32 rats, 3 mice
	Doc 200 Body Grip	13	28 mongoose
Inside A	Victor Rat Snap	10	5 rats, 12 mice
	Cage	1	0
	Doc 200 Body Grip	4	0
Outside B	Cage	1	1 mongoose
	Victor Rat Snap	10	19 rats, 6 mice
	Doc 200 Body Grip	5	21 mongoose, 1 rat
Inside B	Victor Rat Snap	10	2 rats, 22 mice
	Cage	1	0
	Doc 200 Body Grip	5	0

Ten tracking tunnels inside Enclosure A and 10 inside Enclosure B have been inked and baited every other month to assess small mammal activity (Table 10). Since January 24, 2014 no mongoose have been detected or trapped inside either enclosure. On January 7, 2015 we received our approved protocol to continue using Diphacinone bait blocks. Twenty-five and 22 bait stations using Diphacinone bait blocks are currently deployed inside Enclosure A and Enclosure B, respectively. Bait stations within both enclosures continue to be checked biweekly, and re-baited as needed.

Table 10. Makamaka'ole rodent relative abundance summary, as the number of tunnels with paw prints out of 10 total tunnels deployed.

	July 2015 Totals		September 2015 Totals		November 2015 Totals	
	% A	% B	% A	% B	% A	% B
Mouse	0	0	0	0	0	0
Rat	0	0	0	0	0	0
Mongoose	0	0	0	0	0	0
	January 2016 Totals		March 2016 Totals		May 2016 Totals	
	% A	% B	% A	% B	% A	% B
Mouse	6	0	0	0	0	0
Rat	0	0	0	0	0	0
Mongoose	0	0	0	0	0	0

Erosion inside and outside of enclosures continues to be monitored closely. Specially fabricated hydrologic flumes are still attached to the outflow sections of two culverts at Enclosure A. These flumes direct water away from the enclosure, preventing erosion directly outside of the culvert tube and limiting the amount of displaced sediment entering neighboring streams. ` Uki (*Machaerina augustifolia*), `Ohi`a Lehua (*Metrosideros polymorpha*), Naupaka Kuahiwi (*Scaveola gaudichaudii*), `Akia (*Wikistroemia uva-ursi*), Hame (*Antidesma pulvinatum*), and Kupu Kupu (*Nephrolepis cordifolia*) were propagated by Maui Native Nursery and continue to be out-planted in and around both enclosures to stabilize soil in disturbed areas and to add to native flora within the mitigation area. We planted 278 `Uki, 100 `Ohi`a, five Naupaka, five Hame, five `Akia, and 85 Kupukupu during FY 2016 with more variety of out-plantings scheduled for FY 2017.

Acoustic attraction systems ran throughout the entire year and will continue broadcasting calls throughout FY 2017. Sound Files for the acoustic attraction system were updated in July 2016 with a mixture of both HAPE and NESH calls provided by Maui Nui Seabird Recovery Project. HAPE calls were recorded from Waikamoi, Maui in 2015, and NESH calls were recorded on Kaua`i from Pohakea in Hono O Na Pali as well as from Upper Limahuli. KWP Biologists have been conducting monthly night surveys, beginning on March 2nd, to ensure the sound systems work correctly and to monitor bird activity in the area (Appendix 13).

In the 2016 Makamaka'ole Natural Area Reserve Special Use Permit, the NARS staff requested that temperature fluctuation be monitored and if possible reduced. Pacific Rim conservation provided guidance on acceptable tolerance and insight gained at Kilauea Point National Wildlife Refuge. In an effort to determine an effective means to maintain burrow temperatures within tolerance limits we began a temperature monitoring and insulation trial. Results of the trial can be found in Appendix 14.

Seabird activity inside enclosure B has been increasing since our first sighting during the 2015 calendar year breeding season on June 22nd, 2015. Throughout the 2015 breeding season, three species of seabird including Hawaiian petrel, Newell's shearwater, and Bulwer's petrel (*Bulweria Bulwerii*) frequented two burrows within enclosure B between the months of June and October. On July 25th, 2015 game cameras caught the first footage of a Bulwer's petrel entering an artificial burrow, followed by a Hawaiian petrel burrow entrance on August 12th, 2015 (Figure 16), and a Newell's Shearwater entrance on September 21st, 2015. The first sighting of bird activity for the 2016 calendar year breeding season was witnessed on April 26th , 2016, of a Bulwer's petrel, making this season's first sighting two months earlier than the breeding season prior (Figure 17). Since then, there has been continuous activity throughout May and June at three burrow sites within enclosure B of both Newell's shearwater and Bulwer's petrel (Figure 18). On June 23rd, 2016 a game camera caught the first images of two Newell's shearwaters sharing a single burrow (Figure 19). No HAPE have been observed so far on burrow associated game cameras in calendar year 2016.

Figure 16. Hawaiian petrel in front of burrow entrance with decoy in background inside enclosure B on August 12, 2015.

Figure 17. Bulwer's petrel In front of burrow entrance 42B inside enclosure B on June 22nd, 2016.

Figure 18. A Bulwer's petrel (left) and Newell's shearwater (right) in front of burrow entrance 50B inside enclosure B on June 25th, 2016.

Figure 19. Two Newell's shearwaters in front of burrow entrance 22B inside enclosure B on June 23rd, 2016 (HAPE decoy in the background).

Nēnē

After consultation with the FWS and DOFAW Tier 1 nēnē mitigation has been decided to consist of predator control around nēnē nesting and feeding areas on Maui (Appendix 15). The state DLNR has been funded $162,750 on December 30, 2015 and nēnē assessment and predator control have yet to begin.

Adaptive Management

In accordance with the KWPII HCP, low wind speed curtailment (LWSC) at 5 m/s was initially in effect for the months of April through November since operations began. This period was extended to begin mid-February and continue through December 15, 2014 in response to fatalities documented at KWPII on March 13, 2013 and February 26, 2014, and at KWPI on December 14, 2013. Curtailment includes blades feathered to minimize rotation. Prior to May 2014, 50% of observed fatalities at KWPI and KWPII had occurred in April and September, suggesting that collision risk was higher during these months. LWSC was therefore increased from 5 m/s to 6 m/s on April 10 through April 30, 2014.

On June 6, 2014 SunEdison offered an adaptive management proposal to the FWS and DOFAW for LACI and on July 29, 2014 the LWSC was raised to 5.5 m/s between February 15th and December 15th from sunset to sunrise annually. KWPII currently operates with one weather station at ground level, eight ground bat detectors, and seven bat detectors at nacelle height. KWP continues to investigate ultrasonic bat deterrent but the technology has not yet proven to be effective or feasible at nacelle height.

Agency Visits and Reporting

KWP attended and hosted several meetings with the USFWS and DOFAW to discuss a variety of topics during FY 2016 on September 21, 2015; January 30, 2016; and June 14, 2016. Three ESRC meetings in FY 2016 involved KWP projects on September 8, 2015; October 21-22, 2015; and December 17, 2015.

KWP continues to notify agencies of fatalities via email within 24 hours and sends out a downed wildlife report within three calendar days.

A quarterly abbreviated summary report for FY 2016 Q1, Q2 and Q3 was provided.

Expenditures

The total HCP related expenditures in FY 2016 is $337,241 (Appendix 16).

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Appendices

Appendix 1. Estimating Proportion of Total Fall Distribution Actually Searched during Reduced Monitoring for Nēnē and the Hawaiian Hoary Bat at Kaheawa Wind Power II.

Nēnē Fatality Distribution

Kaheawa Wind Power II (KWPII) estimated total fatalities for nēnē to date using the first four years of fatality monitoring data (Appendix 5, this report).

Intensive monitoring at KWPII (and KWPI since 2010) searched the areas around all turbines in circles centered on the WTG and with a radius extending to 70 m. Based on ballistics modeling Hull and Muir (2010) calculated that approximately 20% of the total fall distribution of large birds (nēnē) around "small" turbines may fall beyond 70 m. They considered turbines with a hub height of 65 m to be a "small" turbine in their model; 75 m and 97 m was considered the distance 80% and 99%, respectively, of all large birds might fall around a "small" turbine.

The long-term monitoring is assumed to continue to the end of the permit period at the same reduced search area effort as began in July 2015. The reduced effort at KWPII consists of searching only the roads and graded pads that occur within the 70 m radius circle centered on each turbine (Figure 1a and 1b). The portion of all nēnē carcasses that could fall from turbine strikes that fall only within the 70 m circle is calculated based on the known fall distribution of all observed nēnē at KWPI and KWPII (Figure 2) and an assumption that 20% of nēnē may have fallen beyond 70 m and not observed. To create a total fall distribution we added five more nēnē beyond those actually observed within 70 m: two at 71-80 m, two at 81-90 m, and one at 91-100 m or 20% more than the actual observed nēnē (N = 26) used in creating the fall distribution. The KWPI and KWPII hub heights (68 and 72 m, respectively) and maximum height of the rotor swept zone (90 and 100 m, respectively) are similar and so we include all of the observed nēnē take from both sites in creating the fall distribution. The fall distribution is assumed to be uniform around the turbine.

A 70 m circle centered on each WTG is modeled to include approximately 84% of all nēnē carcasses expected to fall from turbine strikes (Figure 2). The 70 m circle is divided into six circular adjacent bands around the WTG. The first, closest band is 20 m radius and each band farther from the WTG is 10 m radius (Table 1). The area in acres is calculated for each band. Since more birds are expected to and do fall closer to the WTG there are fewer fatalities per acre as the distance increases (each band is density weighted, the area closer to the WTG will have a higher density of fatalities per acre so the area in each band is weighted according to the observed density of fatalities). The portion of the total area that will actually be searched (roads and pads) in each band is determined using ARCGIS (Table 1). The proportion of the total area in each band actually searched per band and the fatality density per band are multiplied for each band and the results summed for all six bands to determine the portion of the entire fall distribution that is actually searched (Table 1). The reduced search area is estimated to encompass 26.9% of all nēnē fatalities that could occur (Table 1).

Table 1. Proportion of nēnē Expected to Fall within the 70 m Search Area

Distance Band (m)	Search Area Within Distance Band (ac)*	Total Area Of Distance Band (ac)	Proportion Of Distance Band Searched (A)	Portion Birds Found Within Distance Band (B)	DWA of Distance Band (A x B)
20	3.30	4.33	0.76	0.162	0.123
30	1.92	5.41	0.35	0.194	0.068
40	1.44	7.59	0.19	0.323	0.061
50	1.16	9.77	0.12	0.065	0.008
60	1.38	11.94	0.12	0.032	0.004
70	1.13	14.11	0.08	0.065	0.005
			Total	**0.839**	**0.269**

*determined using GPS of area searched and ARCGIS for acreage determination

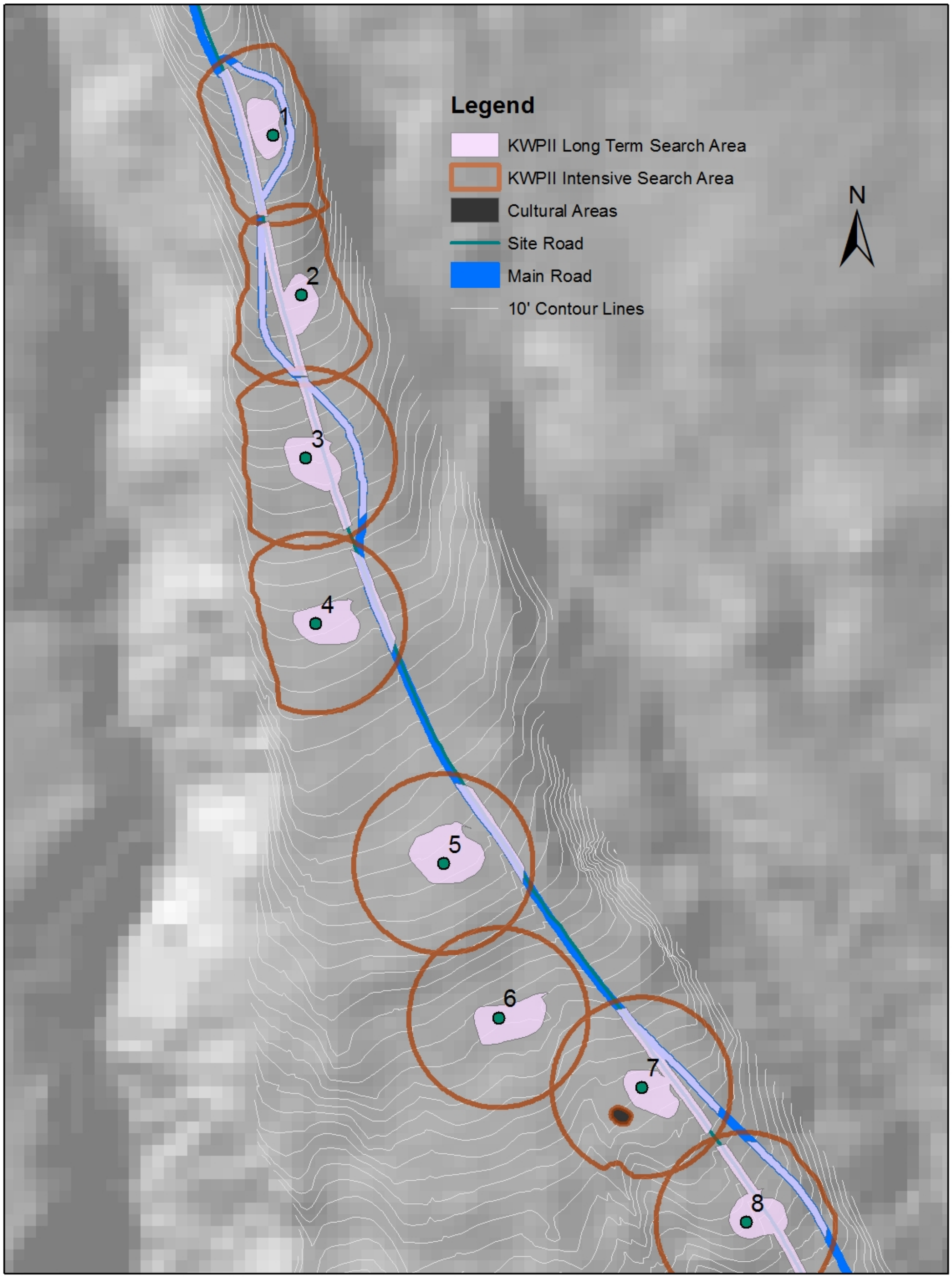

Figure 1a. Proposed Long Term Monitoring Search Area for KWPII (Turbines 1-7) with Roads and Pads Out to 70 m. Complete circles are 70 m radius.

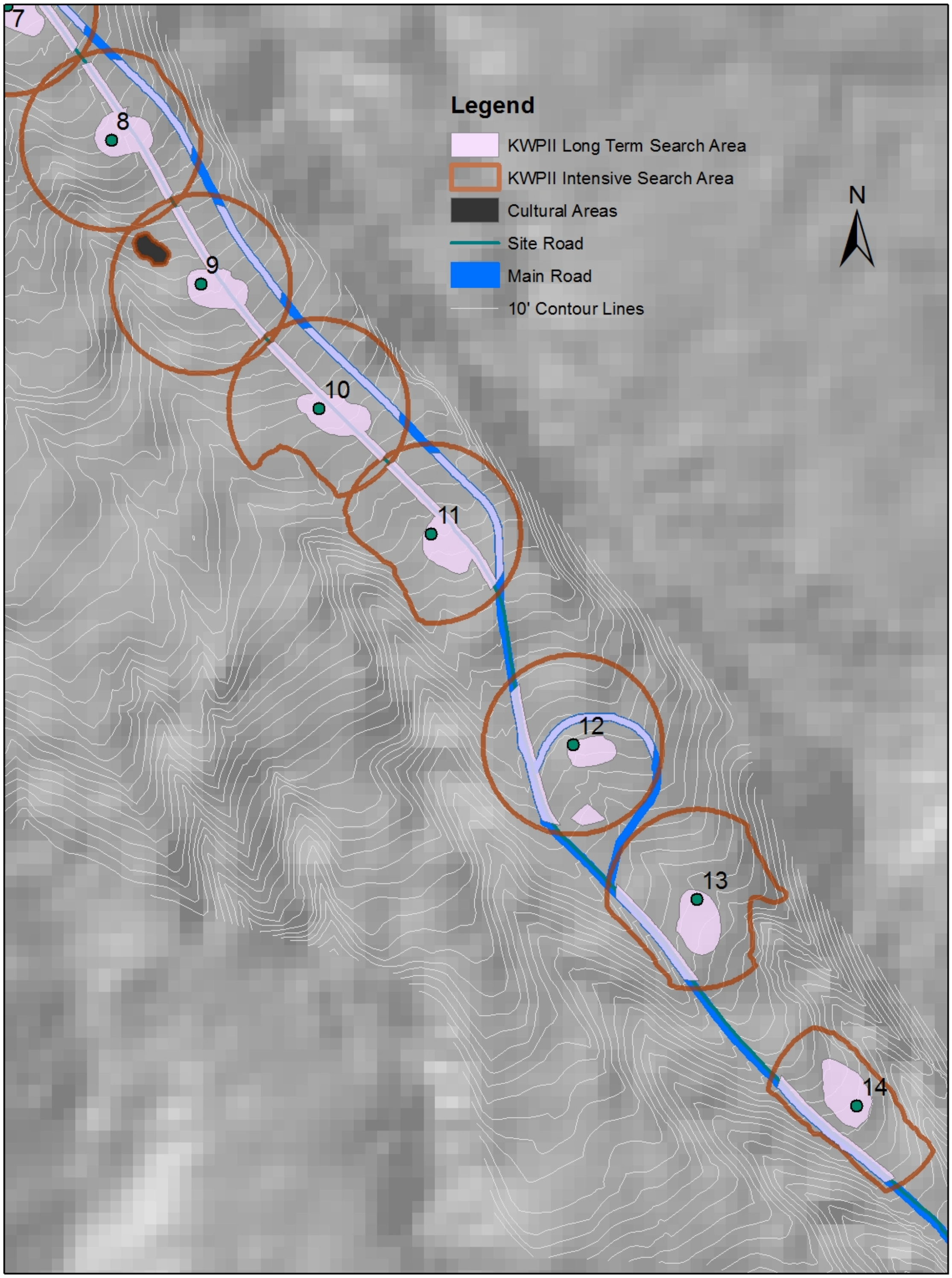

Figure 1b. Proposed Long Term Monitoring Search Area for KWPII (Turbines 8-14) with Roads and Pads Out to 70 m.

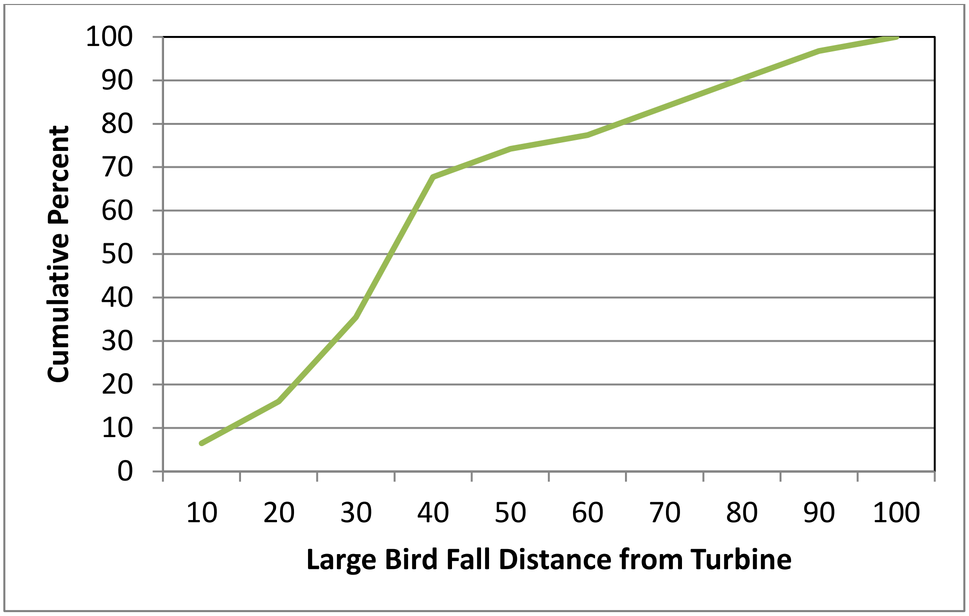

Figure 2. Cumulative Percent Distribution of Large Birds Found with Distance from Turbine at KWPI and KWPII (N = 26 observed and N = 5 hypothesized).

Hawaiian Hoary Bat Fall Distribution

Total expected fatality for the Hawaiian hoary bat for KWPII was estimated using the first four years of fatality monitoring data. The long-term monitoring is assumed to continue at the same reduced search area effort as began in July 2015. The reduced effort consists of searching only the roads and graded pads that occur within a 70 m radius circle centered on each turbine (Figure 1a and 1b). The portion of all carcasses that fall from turbine strikes that fall only within the 70 m circle is calculated based on the known fall distribution of all bats observed at KWPI and KWPII (Figure 3). The fall distribution is derived from a sample of only 11 bats but there are no other data available in Hawaii for the relatively short height of the KWP WTGs. The fall distribution is assumed to be uniform around the turbine. The KWPI and KWPII maximum height of the rotor swept zone are similar (90 and 100 m, respectively).

A 70 m circle centered on each WTG is modeled to include 100% of all carcasses expected to fall from turbine strikes (Figure 3). Nonetheless, to be conservative, we assume only 95% of all possible fatalities fall within 70 m. The 70 m circle is divided into six bands expanding from the WTG. The first, closest band is 20 m radius and each band farther from the WTG is 10 m radius (Table 2). The total area is calculated for each band. Since more bats fall closer to the WTG each band expanding from the center will be larger in area than the next closer band but is expected to have fewer fatalities per m^2 as the distance increases (also called the density weighted area, DWA; the area closer to the WTG will have a higher density of fatalities per m^2). The portion of the total area that makes up each band that will actually be searched (roads and pads) is determined using ARCGIS (Table 2). The area searched per band and the observed fatality density per m^2 per band are multiplied for each band and the results summed for all six bands to determine the portion of the entire bat fall distribution that is actually searched (Table 2).

The reduced search plot size encompasses 36.5% of the fall distribution of bats (Table 2).

Table 2. Proportion of Hawaiian Hoary Bats Expected to Fall Within the Search Area

Distance Band	Search Area Within Distance Band (ac)*	Area Of Distance Band (ac)	Proportion Of Distance Band Searched (A)	Percent Bats Found Within Distance Band (B)	DWA of Distance Band (A x B)
20	3.30	4.33	0.76	0.27	0.205
30	1.92	5.41	0.35	0.18	0.063
40	1.44	7.59	0.19	0.45	0.086
50	1.16	9.77	0.12	0.09	0.011
60	1.38	11.94	0.12	0.00	0.00
70	1.13	14.11	0.08	0.00	0.00
			Total	**0.99**	**0.365**

*determined using GPS of area searched and ARCGIS for acreage determination

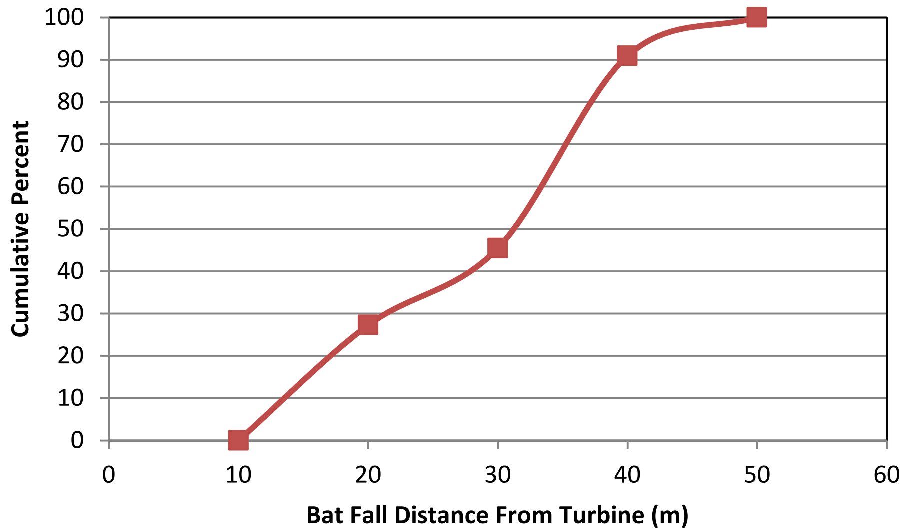

Figure 3. Cumulative Percent of Bats Found With Distance from Turbine at KWPI and KWPII (N = 11)

References:

Manuela M. P. Huso, Daniel H. Dalthorp, David A. Dail, and Lisa J. Madsen. 2015. Estimating wind-turbine caused bird and bat fatality when zero carcasses are observed. Ecological Applications. http://dx.doi.org/10.1890/14-0764.1

Appendix 2. Canine – Visual search ratio.

	WTG														
Search Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Canine	29	29	28	29	29	28	30	29	29	29	30	30	30	30	**409**
Visual	23	23	24	23	23	24	23	23	23	23	22	22	22	22	**320**
Total	**52**	**52**	**52**	**52**	**52**	**52**	**53**	**52**	**52**	**52**	**52**	**52**	**52**	**52**	**729**
Canine %	*55.8%*	*55.8%*	*53.9%*	*55.8%*	*55.8%*	*53.9%*	*56.6%*	*55.8%*	*55.8%*	*55.8%*	*57.7%*	*57.7%*	*57.7%*	*57.7%*	***56.1%***
Visual %	*44.2%*	*44.2%*	*46.2%*	*44.2%*	*44.2%*	*46.2%*	*43.4%*	*44.2%*	*44.2%*	*44.2%*	*42.3%*	*42.3%*	*42.3%*	*42.3%*	***43.9%***

Appendix 3. KWPII monitoring interval data.

	Turbine													
Search Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6	7/6
	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14	7/14
	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21	7/21
	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28	7/28
	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4
	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10	8/10
	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18	8/18
	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25	8/25
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	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9	9/9
	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16	9/16
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	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2	12/2
	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9	12/9
	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16	12/16
	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22	12/22
	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30	12/30
	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6	1/6
	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13	1/13
	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20	1/20
	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27	1/27
	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3	2/3
	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10	2/10
	2/18	2/18	2/18	2/18	2/18	2/18	2/18	2/18	2/18	2/18	2/17	2/17	2/17	2/17
	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24	2/24
	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2	3/2
	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9	3/9
	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23	3/23
	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30	3/30
	4/6	4/6	4/6	4/6	4/6	4/6	4/6	4/7	4/7	4/7	4/7	4/7	4/7	4/7
	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13	4/13
	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20	4/20
	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27	4/27
	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4	5/4
	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11	5/11
	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20	5/20
	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25	5/25
	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1	6/1
	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8	6/8
	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15	6/15
	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22	6/22
	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29	6/29

Appendix 4. KWPII SEEF trials.

Trial date	Carcass type	WTG	Found	Not Recovered	Human Searcher	Canine Searcher
8/10/2015	Rat	9	No	True	SE	
8/10/2015	Rat	5	No	False	JV	
8/10/2015	Rat	5	No	False	JV	
8/10/2015	Rat	12	No	True	SE	
8/17/2015	Rat	1	No	True	SE	
8/25/2015	Med Bird	1	Yes	False	SE	
8/25/2015	Rat	8	No	True	SE	
8/31/2015	Rat	8	Yes	False	JV	
9/16/2015	Rat	3	Yes	False	SE	
9/16/2015	Large Bird	5	Yes	False	SE	
9/22/2015	Rat	9	No	True	SE	
10/1/2015	Rat	1	Yes	False	SE	
10/13/2015	Rat	3	No	False	SE	
10/13/2015	Rat	8	No	True	SE	
10/20/2015	Rat	1	Yes	False	TG	Makalani
10/20/2015	Rat	11	Yes	False	TG	Makalani
11/10/2015	Med Bird	7	Yes	False	TG	Makalani
11/10/2015	Rat	14	Yes	False	TG	Makalani
11/24/2015	Rat	3	Yes	False	TG	Makalani
11/24/2015	Rat	5	Yes	False	TG	Makalani
11/24/2015	Rat	11	Yes	False	TG	Makalani
12/2/2015	Large Bird	7	Yes	False	TG	Makalani
12/9/2015	Rat	8	Yes	False	TG	Makalani
1/13/2016	Rat	6	No	False	SE	
1/13/2016	Rat	2	Yes	False	SE	
1/20/2016	Med Bird	8	Yes	False	TG	Makalani
2/3/2016	Rat	13	Yes	False	SE	
2/3/2016	Rat	1	Yes	False	SE	
2/10/2016	Rat	10	Yes	False	TG	Makalani
2/17/2016	Rat	11	No	False	TG	Makalani
3/2/2016	Rat	1	Yes	False	TG	Makalani
3/2/2016	Large Bird	5	Yes	False	TG	Makalani
3/9/2016	Rat	4	Yes	False	TG	Makalani
3/16/2016	Rat	13	Yes	False	TG	Makalani
3/23/2016	Rat	12	Yes	False	TG	Makalani
3/30/2016	Rat	6	Yes	False	TG	Makalani
3/30/2016	Rat	7	Yes	False	TG	Makalani
3/30/2016	Rat	1	Yes	False	TG	Makalani
4/13/2016	Rat	2	Yes	False	SE	
4/20/2016	Rat	4	Yes	False	SE	

Trial date	Carcass type	WTG	Found	Not Recovered	Human Searcher	Canine Searcher
4/20/2016	Rat	9	Yes	False	SE	
5/4/2016	Large Bird	9	Yes	False	TG	Makalani
5/4/2016	Med Bird	6	Yes	False	TG	Makalani
5/4/2016	Med Bird	11	Yes	False	TG	Makalani
5/11/2016	Med Bird	9	Yes	False	SE	
5/11/2016	Rat	10	No	False	SE	
5/11/2016	Med Bird	2	Yes	False	SE	
5/20/2016	Large Bird	11	Yes	False	TG	Makalani
5/20/2016	Rat	14	No	False	TG	Makalani
5/20/2016	Rat	4	Yes	False	TG	Makalani
5/20/2016	Rat	5	Yes	False	TG	Makalani
5/20/2016	Med Bird	7	Yes	False	TG	Makalani
5/25/2016	Rat	1	Yes	False	TG	Makalani
5/25/2016	Rat	6	Yes	False	TG	Makalani
5/25/2016	Med Bird	6	Yes	False	TG	Makalani
5/25/2016	Rat	10	Yes	False	TG	Makalani
5/25/2016	Rat	10	No	False	TG	Makalani
5/25/2016	Rat	1	Yes	False	TG	Makalani
6/8/2016	Large Bird	11	Yes	False	TG	Makalani
6/8/2016	Rat	4	Yes	False	TG	Makalani
6/8/2016	Large Bird	8	Yes	False	TG	Makalani
6/8/2016	Rat	11	Yes	False	TG	Makalani
6/8/2016	Rat	12	Yes	False	TG	Makalani
6/8/2016	Med Bird	7	Yes	False	TG	Makalani
6/22/2016	Large Bird	4	Yes	False	TG	Makalani
6/22/2016	Large Bird	10	Yes	False	TG	Makalani
6/22/2016	Large Bird	14	Yes	False	TG	Makalani
7/6/2016	Large Bird	9	Yes	False	TG	Makalani
7/6/2016	Rat	14	Yes	False	TG	Makalani
7/6/2016	Rat	12	Yes	False	TG	Makalani

Appendix 5. CARE trials.

					Carcass Day	0	1	2	3	7
Trial ID	Turbine	Distance (m)	ID	CARE Start Date	Carcass Type	7/20/2015	7/21/2015	7/22/2015	7/23/2015	7/27/2015
98	8	39	74	7/20/2015	Rat	TRUE	FALSE			
98	9	66	75	7/20/2015	WTSH	TRUE	TRUE	TRUE	TRUE	FALSE
98	6	80	76	7/20/2015	Rat	TRUE	FALSE			

					Carcass Day	1	2	3	4
Trial ID	Turbine	Distance (m)	ID	CARE Start Date	Common Name	9/2/2015	9/3/2015	9/4/2015	9/5/2015
99	3	40	77	9/1/2015	Rat	FALSE			
99	2	46	78	9/1/2015	Rat	FALSE			
99	3	50	79	9/1/2015	Rat	TRUE	TRUE	TRUE	FALSE
99	12	65	80	9/1/2015	Rat	TRUE	FALSE		

					Carcass Day	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	24	31
Trial ID	Turbine	Distance (m)	ID	CARE Start Date	Common Name	12/4/2015	12/5/2015	12/6/2015	12/7/2015	12/8/2015	12/9/2015	12/10/2015	12/11/2015	12/12/2015	12/13/2015	12/14/2015	12/15/2015	12/16/2015	12/17/2015	12/18/2015	12/28/2015	1/4/2016
AA	5	4	52	12/4/2015	Chicken		TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
					Carcass Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	25	32
Trial ID	Turbine	Distance (m)	ID	CARE Start Date	Common Name	12/4/2015	12/5/2015	12/6/2015	12/7/2015	12/8/2015	12/9/2015	12/10/2015	12/11/2015	12/12/2015	12/13/2015	12/14/2015	12/15/2015	12/16/2015	12/17/2015	12/18/2015	12/28/2015	1/4/2016
AA	2	19	60	12/3/2015	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE									
AA	2	35	61	12/3/2015	WTSH	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AA	3	50	62	12/3/2015	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AA	3	76	63	12/3/2015	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AA	6	41	64	12/3/2015	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AA	12	16	65	12/3/2015	Rat	TRUE	FALSE															

					Carcass Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	21	28
Trial ID	Turbine	Distance (m)	ID	CARE Start Date	Common Name	2/16/2016	2/17/2016	2/18/2016	2/19/2016	2/20/2016	2/21/2016	2/22/2016	2/23/2016	2/24/2016	2/25/2016	2/26/2016	2/27/2016	2/28/2016	2/29/2016	3/7/2016	3/14/2016
AB	4	30	90	2/15/2016	WTSH	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AB	4	40	91	2/15/2016	Rat	TRUE	TRUE	TRUE	TRUE	FALSE											
AB	8	15	92	2/15/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AB	12	50	93	2/15/2016	Chicken	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AB	12	70	94	2/15/2016	Rat	TRUE	TRUE	FALSE													
AB	14	10	95	2/15/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE						
AB	4	55	96	2/15/2016	Rat	TRUE	FALSE														

					Carcass Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	21	28
Trial ID	WTG	Distance (m)	ID	CARE Start Date	Common Name	4/20/2016	4/21/2016	4/22/2016	4/23/2016	4/24/2016	4/25/2016	4/26/2016	4/27/2016	4/28/2016	4/29/2016	4/30/2016	5/1/2016	5/2/2016	5/3/2016	5/10/2016	5/17/2016
AC	2	28	104	4/19/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE									
AC	4	9	105	4/19/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AC	4	28	106	4/19/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AC	5	41	107	4/19/2016	Chicken	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AC	5	17	108	4/19/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AC	6	15	109	4/19/2016	WTSH	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AC	7	8	110	4/19/2016	Rat	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE

Appendix 6. Take Estimation Inputs for nēnē and LACI at KWPII.

Hawaiian hoary bat						Hawaiian goose					
				ghat 95% CI						*ghat* 95% CI	
Year	rho	Observed Fatality	*ghat*	lower	upper	Year	rho	Observed Fatality	*ghat*	lower	upper
1	1	1	0.286	0.162	0.43	1	1	1	0.806	0.736	0.868
2	1	2	0.334	0.229	0.448	2-3	2	2	0.826	0.799	0.852
3	0.85	0	0.263	0.167	0.371	4	1	1	0.315	0.303	0.327
4	0.85	0	0.176	0.131	0.226						
Overall		**3**	**0.269**	**0.201**	**0.342**			**4**	**0.693**	**0.500**	**0.857**
M* (estimated mortality, 80% Credibility)	**18**					**8**					

Appendix 7. Nēnē Indirect Take and Lost Productivity at KWPII.

Year	*2013*	*2014*	*2015*	*2016*	Total	
Observed Fatality	***1***	***2***	***0***	***1***	4	
Estimated Fatality Multiplier	2.00	2.00		2.00		
Estimated Fatality	2.00	4.00		2.00	**8**	**Direct Take**
Indirect Take Multiplier	0.09	0.09		0.09		
Indirect Take	0.18	0.36		0.18	**0.72**	**Indirect Take**
Accrued Adult Take		2.00	6.00	6.00		
Adult Lost Productivity Accrued (0.1 multiplier)		0.20	0.60	0.60	**1.40**	
Indirect Take to Adult (0.9 annual survival rate)			0.15	0.29		
Fledgling to Adult Lost Productivity (0.1 multiplier)			0.01	0.04	**0.06**	
					1.46	**Lost Productivity**

Appendix 8. Indirect Take Calculations for Hawaiian Hoary Bat at KWPII.

Component	Input	Value
A	Total Estimated Direct take	18
B	Observed direct take (ODT)	3
C	Unobserved direct take (UDT) (**A - B**)	15
D	ODT female or unknown during Apr 1- Sep 15 (0 female, 0 unknown)	0
E	Proportion of UDT that could be female and probability a female is pregnant or lactating (0.5 x 3/12)	0.125
F	Survival of twin pups to weaning (0.9 x 2 pups)	1.80
G	ODT IDT (**D x F**)	0
H	UDT IDT (**C x E x F**)	3.38
I	IDT total (**G + H**)	3.38
J	Survival of juvenile to adult	0.3
	IDT as adults (I x J)	1

Appendix 9. WEOP training log for FY 2016.

WEOP Training			
Name	**Date**	**Employer**	**Trainer**
Steven Rymsha	8/17/2015	First Wind	JV
Matt Tores	9/23/2015	ACTR	MS
Justin Berry	9/23/2015	GE	MS
Mark Stewart	9/23/2015	GE	MS
Roberto Hernandez	9/23/2015	GE	MS
Manny Maddela	9/23/2015	GE	MS
Ollie Colifer	9/23/2015	GE	MS
Derwin Haysshida	9/23/2015	ACTR	MS
William Cair	9/23/2015	PPC	MS
Jeffery Kuniling	9/23/2015	GE	MS
James Akery	10/26/2015	GE	MS
Leram Rangel	10/26/2015	Granite	MS
Jason Snediol	10/26/2015	GE	MS
Richard Jenkins	10/26/2015	GE	MS
Dennis Ball	10/26/2015	EVM	MS
Spencer Gassett	10/26/2015	Omne	MS
Joe Rhodes	10/26/2015	Omne	MS
Juan Avila	10/26/2015	GE	MS
Chris Ng	10/26/2015	SunEdison	MS
Dave Doyle	10/26/2015	SunEdison	MS
Mercer East	10/26/2015	SunEdison	MS
Casey Cohan	10/26/2015	SunEdison	MS
Spencer Engler	10/26/2015	SunEdison	MS
Steven Rymsha	10/26/2015	SunEdison	MS
Jesse Johnson	10/26/2015	SunEdison	MS
Matthew Pratt	10/26/2015	SunEdison	MS
Jason Welsh	11/3/2015	GE	MS
Chris Hanel	11/4/2015	GE	MS
Patrick Hannon	1/8/2016	Rope Partner	MS
Mike Dugan	1/22/2016	Rope Partner	MS
Kevin Anderson	2/8/2016	Granite	MS
Ryan Westenhaver	2/8/2016	Granite	MS
Fawzi Khedahe	2/8/2016	Granite	MS
Brian Schiemer	5/20/2016	GE	MS
Chris Robinson	5/20/2016	GE	MS
Isacc Snell	5/20/2016	GE	MS
John Smith	5/20/2016	GE	MS
Ron Scott Broncolillo	5/20/2016	GE	MS
Deborah Pittman	5/20/2016	GE	MS
Oskar Villalobos	6/1/2016	GE	MS

Appendix 10. KWPII revegetation site survival survey.

	Transect											
	7	8	12	17	19	24	34	37	42	43	72	74
1	*Metrosideros polymorpha*	*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
2	*Metrosideros polymorpha*	*Metrosideros polymorpha*	*Scaveola gaudichaudii*	*Scaveola gaudichaudii*	*Dead*	*Bidens micrantha*	*Metrosideros polymorpha*	*Metrosideros polymorpha*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
3	*Metrosideros polymorpha*	*Metrosideros polymorpha*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*
4	*Metrosideros polymorpha*	*Metrosideros polymorpha*	*Bidens micrantha*	*Dead*	*Santalum paniculatum*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*	*Bidens micrantha*
5	*Metrosideros polymorpha*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dead*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Bidens micrantha*	*Bidens micrantha*
6	*Metrosideros polymorpha*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
7	*Metrosideros polymorpha*	*Dead*	*Wikstroemia uva-ursi*	*None*	*Dead*	*Dead*	*Wikstroemia uva-ursi*	*Dead*	*Machaerina angustifolia*	*Dead*	*Dead*	*Dodonaea viscosa*
8	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Metrosideros polymorpha*	*Dead*	*Metrosideros polymorpha*	*Dead*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Bidens micrantha*	*Dodonaea viscosa*
9	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Dead*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Santalum paniculatum*	*Dodonaea viscosa*	*Bidens micrantha*	*Osteomeles anthyllidifolia*
10	*Dead*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*	*Dead*	*Dodonaea viscosa*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
11	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Bidens micrantha*	*Dead*	*Dodonaea viscosa*	*Bidens micrantha*	*Dodonaea viscosa*
12	*Bidens micrantha*	*Dead*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Dead*	*Bidens micrantha*
13	*Dead*	*Osteomeles anthyllidifolia*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dead*	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
14	*Metrosideros polymorpha*	*Dead*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*	*Dead*
15	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Osteomeles anthyllidifolia*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*	*Bidens micrantha*
16	*Dead*	*Dead*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Bidens micrantha*	*Bidens micrantha*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*	*Dead*
17	*Bidens micrantha*	*Dead*	*Santalum paniculatum*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*
18	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dead*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*	*Santalum paniculatum*
19	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Osteomeles anthyllidifolia*	*Dead*	*Dodonaea viscosa*	*Dead*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
20	*Bidens micrantha*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Bidens micrantha*	*Dead*
21	*Dodonaea viscosa*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dead*
22	*Osteomeles anthyllidifolia*	*Wikstroemia uva-ursi*	*Dead*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dead*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Bidens micrantha*	*Santalum paniculatum*
23	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dead*	*Bidens micrantha*	*Bidens micrantha*
24	*Osteomeles anthyllidifolia*	*Dead*	*Wikstroemia uva-ursi*	*Metrosideros polymorpha*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Bidens micrantha*	*Bidens micrantha*

25	*Dodonaea viscosa*	*Dead*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Dead*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Wikstroemia uva-ursi*
26	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Wikstroemia uva-ursi*
27	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Unknown*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Dodonaea viscosa*	*Bidens micrantha*	*Dodonaea viscosa*
28	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*		*Wikstroemia uva-ursi*	*Dead*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Bidens micrantha*	*Bidens micrantha*
29	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*		*Santalum paniculatum*		*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Bidens micrantha*	
30	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dead*		*Dodonaea viscosa*		*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Bidens micrantha*	
31	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*	*Dead*				*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Bidens micrantha*	
32	*Bidens micrantha*	*Wikstroemia uva-ursi*	*Dodonaea viscosa*	*Wikstroemia uva-ursi*				*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Bidens micrantha*	
33	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*		*Wikstroemia uva-ursi*				*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*	*Dead*	
34	*Bidens micrantha*	*Wikstroemia uva-ursi*						*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*	*Bidens micrantha*	
35	*Wikstroemia uva-ursi*	*Dodonaea viscosa*						*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*	*Dead*	
36	*Wikstroemia uva-ursi*	*Dead*						*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*	*Bidens micrantha*	
37	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*						*Dodonaea viscosa*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Bidens micrantha*	
38	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*						*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Dead*	*Dead*	
39	*Wikstroemia uva-ursi*	*Osteomeles anthyllidifolia*						*Dodonaea viscosa*	*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Bidens micrantha*	
40	*Dodonaea viscosa*	*Wikstroemia uva-ursi*						*Dodonaea viscosa*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*	*Wikstroemia uva-ursi*	
41	*Wikstroemia uva-ursi*	*Dodonaea viscosa*						*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*	
42	*Wikstroemia uva-ursi*	*Dead*						*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Osteomeles anthyllidifolia*		
43	*Wikstroemia uva-ursi*	*Wikstroemia uva-ursi*						*Metrosideros polymorpha*	*Osteomeles anthyllidifolia*	*Dead*		
44	*Wikstroemia uva-ursi*							*Dead*	*Osteomeles anthyllidifolia*	*Dodonaea viscosa*		
45	*Wikstroemia uva-ursi*								*Osteomeles anthyllidifolia*	*Dead*		
46	*Wikstroemia uva-ursi*								*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*		
47	*Wikstroemia uva-ursi*								*Dodonaea viscosa*	*Metrosideros polymorpha*		
48	*Osteomeles anthyllidifolia*								*Dodonaea viscosa*	*Dead*		
49	*Osteomeles anthyllidifolia*								*Dodonaea viscosa*	*Metrosideros polymorpha*		
50	*Osteomeles anthyllidifolia*								*Dodonaea viscosa*	*Dead*		

51	*Dead*								*Dodonaea viscosa*	*Scaveola gaudichaudii*		
52	*Dead*								*Dodonaea viscosa*	*Scaveola gaudichaudii*		
53	*Wikstroemia uva-ursi*								*Dodonaea viscosa*	*Bidens micrantha*		
54	*Dodonaea viscosa*								*Dodonaea viscosa*	*Wikstroemia uva-ursi*		
55	*Osteomeles anthyllidifolia*								*Dodonaea viscosa*	*Dodonaea viscosa*		
56	*Osteomeles anthyllidifolia*								*Dodonaea viscosa*	*Dead*		
57									*Dodonaea viscosa*	*Dead*		
58									*Dodonaea viscosa*	*Bidens micrantha*		
59									*Dodonaea viscosa*	*Dodonaea viscosa*		
60									*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*		
61									*Dodonaea viscosa*	*Wikstroemia uva-ursi*		
62									*Osteomeles anthyllidifolia*	*Metrosideros polymorpha*		
63									*Dodonaea viscosa*	*Metrosideros polymorpha*		
64									*Osteomeles anthyllidifolia*	*Dodonaea viscosa*		
65									*Osteomeles anthyllidifolia*	*Dodonaea viscosa*		
66									*Dodonaea viscosa*	*Dodonaea viscosa*		
67									*Dodonaea viscosa*	*Dead*		
68									*Dodonaea viscosa*	*Metrosideros polymorpha*		
69									*Dodonaea viscosa*	*Metrosideros polymorpha*		
70									*Dodonaea viscosa*			
71									*Dodonaea viscosa*			

Appendix 11.

FY 2016 – HAWAIIAN HOARY BAT MITIGATION FOR KAHEAWA WIND POWER II, ISLAND OF MAUI

Prepared by: Lance De Silva, Forest Management Supervisor
Division of Forestry and Wildlife, Maui Branch

INTRODUCTION

Since June 4, 2014, the Division of Forestry and Wildlife (DOFAW), funded as per the requirements described in the Kaheawa Wind Power II Habitat Conservation Plan (HCP) continues to actively manage 340 acres within the Kahikinui State Forest Reserve (SFR), as well as sections of the larger surrounding units of the Nakula Natural Area Reserve (NAR) and Kahikinui SFR. Activities including controlling ungulates, and restoring and creating native habitat have been identified as key needs for maintaining and increasing hoary bat productivity.

Management of the 340 acres project area, as well as the larger surrounding units of the Nakula Natural Area Reserve (NAR) and Kahikinui SFR has increased since last calendar year, largely in part due to the continued funding support of Kaheawa Wind Power II. Controlling ungulates, restoring and creating native habitat, and increasing native bird and bat populations are some of the multiple management efforts geared for this area. These management efforts continue to be conducted and managed primarily by Maui DOFAW staff.

OVERVIEW

All helicopter services have continued to be procured with Windward Aviation, a Maui based company. The pilots' familiarities with the area, weather and flying conditions, and type of contract operations required for this type of work continue to be beneficial to the efficiency of the project and overall continued success. The construction and maintenance of temporary landing zones and campsites near the project area has also provided work crews with better accessibility. During the past year, the area has seen more average seasonal weather patterns as compared to last year's above normal precipitation accumulations.

Since the initial efforts to remove the feral ungulates in October 2014, staff members have continued to notice significant changes within the project area, as well as the surrounding Nakula NAR and Kahikinui SFR. There continues to be an increase in grass and native shrub growth and, more noticeably, a steady increase of bracken fern *(Pteridium aquilinum)* recruitment in the hardpan and gulch areas. Large sections of rock surface areas are being populated with these bracken ferns. The most impressive change has been the increase in natural generation of native flora, specifically koa *(Acacia koa)* and pukiawe *(Styphelia tameiameiae)*; largely in part due to a viable seed bank and ungulate free environment. We continue to see an increase in game bird species presence and activity, as well as an increase in sightings of nene, all of which are positive improvements. However, with the absence of feral ungulates, there are new issues that have risen and continue to threaten the restoration and reforestation efforts; most significantly, the threats of increased fuel loading and weed infestation. These issues are being addressed through various control and mitigation efforts, and continuous collaborations and discussions between agencies are on-going. In

May 2016, DOFAW was awarded a USDA Forest Service State & Private Forestry (S&PF) grant that will help address some of the challenges identified in last fiscal year's end of year report.

ACTIVITIES & RESULTS

Fencing

Approximately 2.8 miles of fence apron was installed in July 2014 by DOFAW Forestry Program field crews. This fence section is part of the 7.3 miles of ungulate proof fence that has been installed to protect the entire Nakula NAR and sections of the Kahikinui SFR from encroaching ungulates. This protected larger unit encompasses approximately 2,700 acres. Eight inspections, including one inspection immediately following the onset of Tropical Storm Darby (July 2016) have been conducted by DOFAW staff while conducting aerial control missions for feral ungulates within the reserves.

DOFAW personnel continue to maintain approximately 2.8 miles of white poly tape along the fenceline to prevent bird strikes.

Funding Source: Partially funded by DOFAW Forestry operating and watershed grant funds and Kaheawa WindPower II HCP funds.

Ungulate Control

During the reporting period for fiscal year 2016, a total of eight aerial control missions (approximately 11 hours total flight time) were conducted by DOFAW staff resulting in 39 feral goats dispatched from within the entire Nakula NAR and Kahikinui SFR unit. Total number of ungulates dispatched since the initial mission conducted in October 2014 is 688 feral goats and 18 feral pigs. Currently, ungulate presence within the 2,700 acres unit is 'zero'. To ensure 'zero' tolerance, a collared goat also referred to as a 'Judas' goat was placed within the unit to 'round up' any remaining goats, taking advantage of its natural instinct to socialize and congregate.

Quarterly scheduled aerial control missions to monitor ungulate presence within the unit will continue in fiscal year 2017. Ungulates detected during subsequent monitoring flights will be dispatched accordingly in a timely manner through scheduled aerial control missions. New detections or ungulate ingress into this protected unit may, at any time, occur because of a fence break that may be caused by inclement weather, vandalism, normal wear and tear, etc. Per our DOFAW Forestry Program's fence maintenance protocol, personnel will continue to conduct regular scheduled fence checks throughout the year, as well as immediately following the onset of any strong weather disturbances that may pose a threat to the integrity of the fence.

Funding Source: Partially funded by DOFAW Forestry operating and watershed grant funds and Kaheawa WindPower II HCP funds.

Plant Quality and Procurement

The out-planting work for this reporting period covered approximately 74 acres of the 340 total acres of the project area. During this period, 31,990 native plant seedlings were out-planted, making the total number of native plant seedlings out-planted within the unit at approximately 42,000 since the initial reforestation efforts began. An additional 15,000 seedlings are projected to be out-planted by spring 2017. Another 20,000 seedlings will be procured and planted in fiscal years 2017-19 to supplement and account for anticipated plant mortality due to various causes.

A new experimental product utilizing a self-condensing 'planter's' box will be installed on an experimental basis in several hard pan areas where success and survivorship of recently out-planted seedlings have been mildly low.

Funding Source: Funded by Kaheawa Wind Power II HCP funds.

Site Preparation – Soil Testing/Conditioning

Several soil collections from various areas within the unit were conducted in July 2015 and samples were sent for analysis in August 2015. In general, majority of the sites contain sufficient to high levels of pH and calcium, while showing deficiencies in potassium, phosphate, and magnesium. Recommendations on how to improve soil conditions have been noted for future field application use. Collecting and analyzing soil samples to determine deficiencies remain a priority and will aid in future reforestation and restoration efforts.

In fiscal year 2016, no additional grass control treatments were scheduled due to unforeseen inclement weather and lack of helicopter availability. Grass control treatments for site prep work is scheduled for approximately 50 acres in fiscal year 2017.

Funding Source: Partially funded by DOFAW Forestry operating funds and Kaheawa Wind Power II HCP funds.

Weed Monitoring and Suppression

Two aerial weed surveys were conducted in fiscal year 2016 covering the entire Nakula NAR and Kahikinui SFR unit. Of the two surveys, one focused primarily on Rapid Ohia Death (R.O.D). Fortunately, there were no visual signs or symptoms of the disease. Forestry personnel who are conducting aerial control missions within the unit continue to survey for weed species during their missions. Fireweed *(Senecio madagascariensis),* bull thistle *(Cirsium vulgare)* and balloon plant *(Asclepias physocarpa)* were sighted and documented across the lower elevations of the Nakula NAR and Kahikinui SFR.

One ground survey was also conducted in fiscal year 2016 covering the areas around a number of temporary landing zones and camp sites. As a result, forestry program personnel detected and removed one bocconia plant *(Bocconia frutescens)* near the Pahihi Gulch area located within the forest reserve. To date, this is the furthest east along the slopes of Leeward Haleakala that this plant has been detected.

Efforts by partnering agencies continue to work on controlling populations of bocconia that are sighted outside of the project area to prevent further spread into this unit. The four pine trees

(Pinus radiata) that were detected last fiscal year have since been cut down and treated. Subsequent weed surveys are scheduled for this area to ensure early detection and rapid response.

Funding Source: Partially funded by DOFAW Forestry operating funds and Kaheawa Wind Power II HCP funds.

Table 1. Schedule of Mitigation Activities

Implementation Activities	Fiscal Year 2016				Entity Responsible	Total Cost
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr		
Fence Inspection		XX	XX	XX	DOFAW Maui Nui Branch	*included into aerial control missions
Aerial Control Eradication and Tagging of Animals (ACETA) Activities		XX	XX	XX	DOFAW Maui Nui Branch	**$13,200** *$8,755 paid by DOFAW; $4,445 paid w/ KWP II funds
Soil Sampling and Conditioning	XX				*DOFAW Maui Nui Branch collected and submitted to CTAHR for analysis	**$1500***flight time paid with KWP II funds
Plant Procurement		XX	XX	XX	Obtained from Native Nursery, LLC by DOFAW	**$133,315** *procured approximately 48k seedlings
Planting of Overstory/Understory Species	XX	XX	XX	XX	DOFAW Maui Nui Branch	*costs included overstory/under story cost paid by KWP II
Weed Surveys					DOFAW Maui Nui	*included into aerial control missions paid by KWP II
Total						**$148,015.00**

MEASURES OF SUCCESS

According to the HCP, prior to the start of management measures, the following must be achieved:

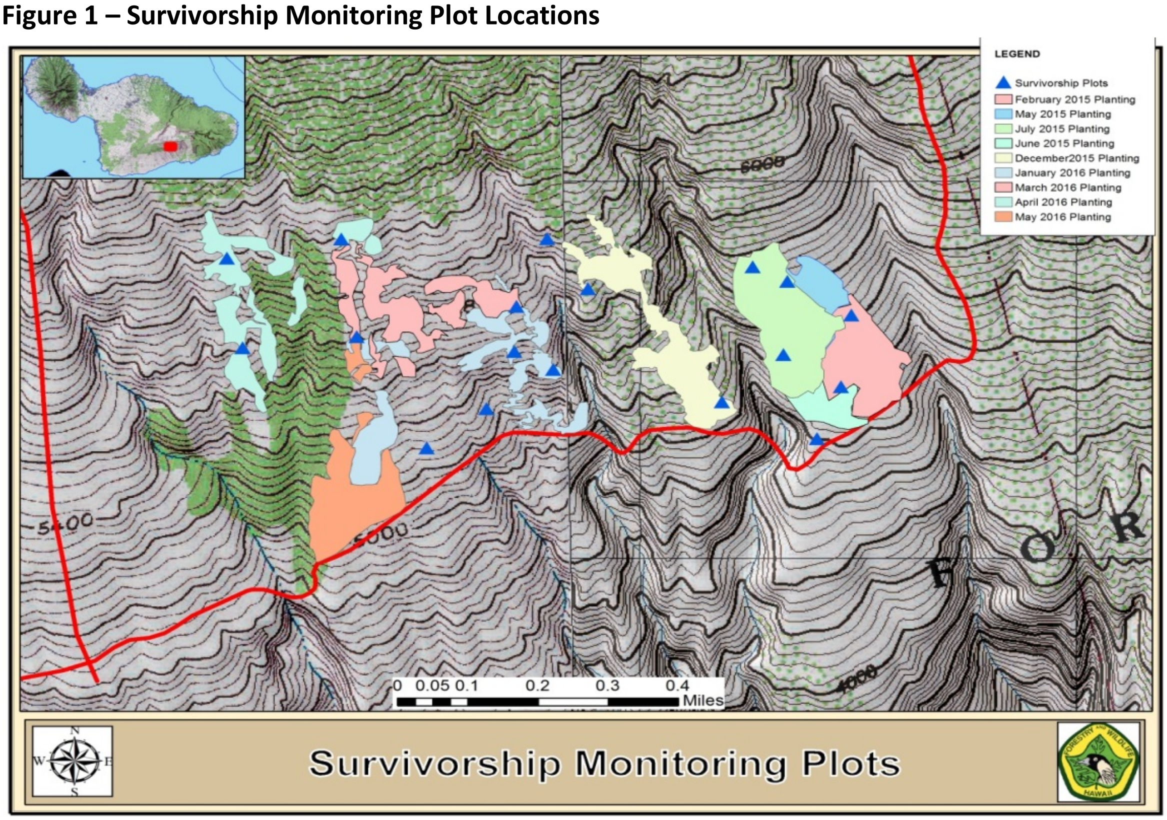
a. **Survivorship monitoring of out-planted seedlings.** Survivorship plots are randomly established throughout the planting area. Plot size is 1/10 acre with a radius of 37.2 feet from plot center. The vigor of the plot is noted on a scale from 1-3, where 1 is poor health and 3 is excellent health. A general survey of the top 3 dominant flora besides the planted trees within the plot is also recorded. Plots are scheduled to be revisited every six months. Forestry personnel have installed 20 plots (9 grass, 3 rock/grass, 2 rock, 4 hardpan, and 2 herbicide treated) to date, covering all substrate and ground cover types (Figure 1). The results of these monitoring plots represent the average % of plants surviving per plot per ground type since initial out-planting. The monitoring trips were completed on January 12, 2016, February 26, 2016, April 22, 2016, and August 4, 2016 and the results are as follows:

Grass average = 94.4%
Grass/Rock average = 79.9%
Rock average = 43.2%
Dirt/Hardpan average = 53.1325%
Herbicide pretreated average = 77.45%

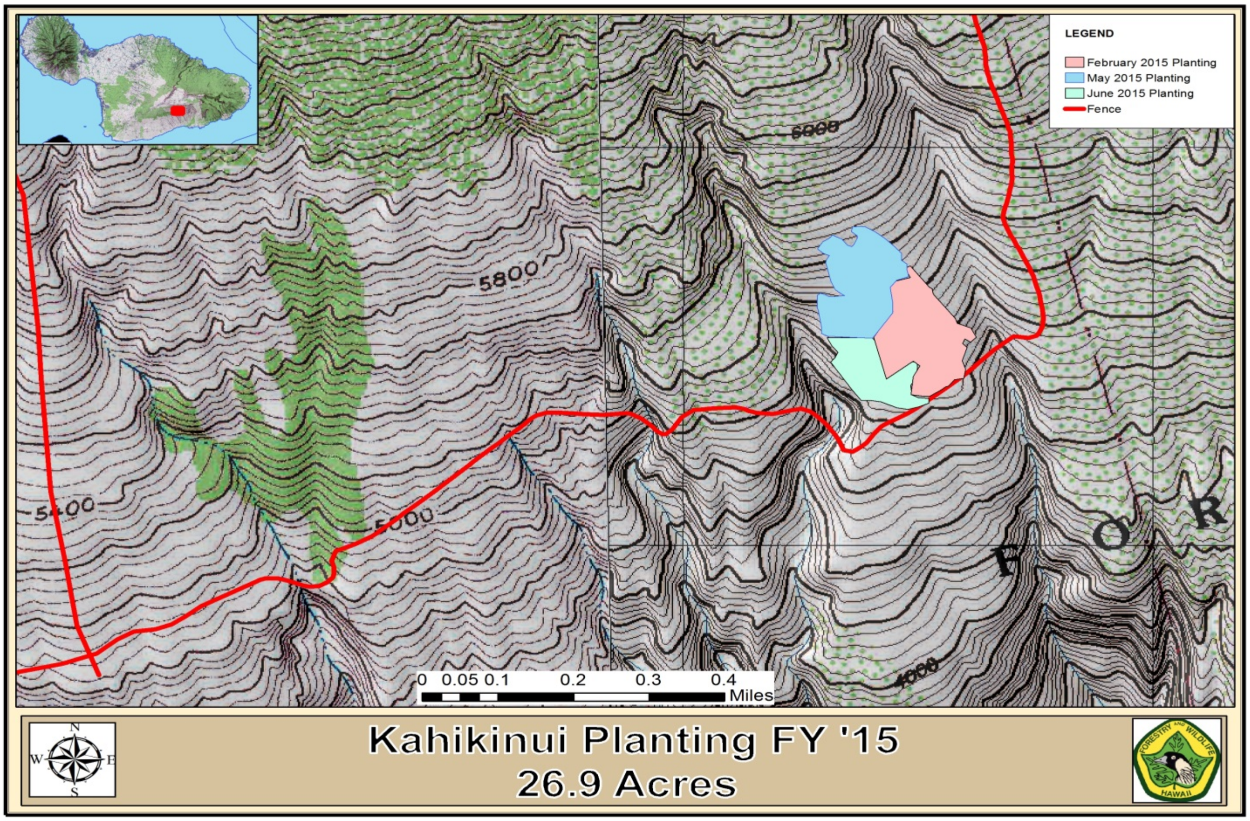
By Species*:
Koa *(Acacia koa)* - 348/454, overall yielding a 76.6% survival rate
Aalii *(Dodonaea viscosa)* - 182/214, overall yielding a 85.0% survival rate
Pilo *(Cosprosma spp.)* **-** 40/42, overall yielding a 95% survival rate
Ohia *(Metrosideros polymorpha)* – 58/58, overall yielding a 100% survival rate
Mamane *(Sophora chrysophylla)* – 125/125, overall yielding a 100% survival rate

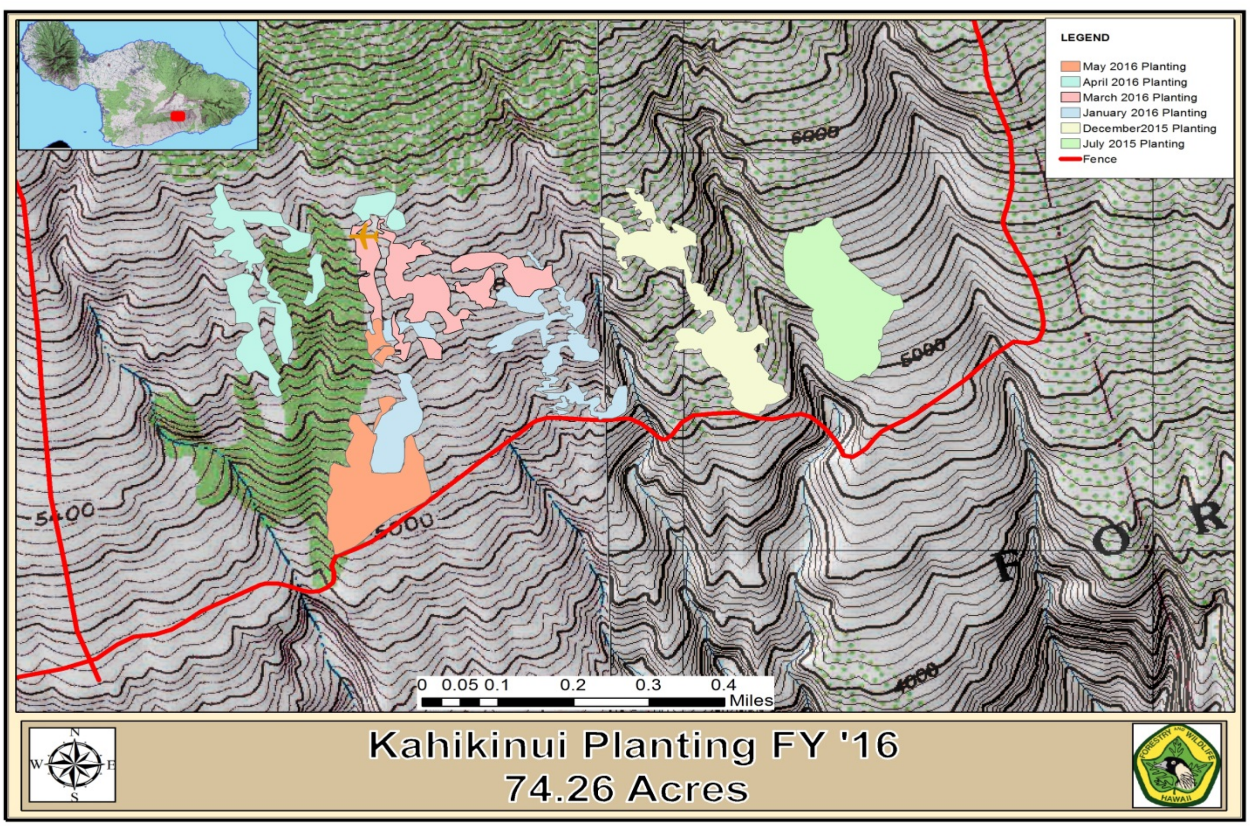
**other plant species such as Osteomeles anthyllidifolia, Santalum freycinetianum, and Cheirodendron trigynum were not present in the random sample plots taken so far.*

Figure 1 – Survivorship Monitoring Plot Locations



APPENDIX 1 – MAPS, LISTS & PHOTOS





Outplanting Taxon By Subunit

Subunits = <All>

From 7/1/2015 to 6/30/2016

Kahikinui-Nakula Units-Ka

Action = Plant

Taxon:	*Quantity:*
Acacia koa	17473
Cheirodendron trigynum sub	91
Coprosma ochracea	32
Dodonaea viscosa	6609
Metrosideros polymorpha	3048
Osteomeles anthyllidifolia	161
Sophora chrysophylla	4576
Action Total Plants	31990
Polygon Total Plants	31990
Total all subunits	31990

Species List for FY'16 out-planting

Outplanting Taxon By Subunit

Subunits = <All>

From 7/1/2014 to 6/30/2016

Kahikinui-Nakula Units-Ka

Action = Plant

Taxon:	*Quantity:*
Acacia koa	25412
Cheirodendron trigynum sub	91
Coprosma ochracea	32
Coprosma waimeae	270
Dodonaea viscosa	7092
Metrosideros polymorpha	3783
Osteomeles anthyllidifolia	161
Santalum freycinetianum	15
Sophora chrysophylla	4576
Action Total Plants	41432
Polygon Total Plants	41432
Total all subunits	41432

Species List for FY'15 and FY'16 out-planting

Temporary campsite located in the Kahikinui State Forest Reserve. View from project area looking makai with (Nu'u) shoreline in the background.

Forestry staff member planting koa (Acacia koa) seedlings in 340 unit.

Healthy koa (Acacia koa) seedling 6 months after planting.

Natural regeneration of pukiawe seedlings (Styphelia tameiameiae).

Appendix 12.

Exploratory Acoustic Surveys for Hawaiian Petrel, Newell's Shearwater, and Barn Owl in East Maui, Hawaii

Report
November 17, 2015

For: **Jay Penniman, Maui Nui Seabird Recovery Project**

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Summary

This report contains results and analysis of exploratory acoustic monitoring efforts undertaken by the Maui Nui Seabird Recovery Project on the eastern slopes of Haleakalā on the island of Maui. Specifically, the survey was designed to detect the presence of three species: Hawaiian Petrel, Newell's Shearwater, and Barn Owl. Sensors were deployed at 41 sites throughout 4 main regions over the course of 2015 survey effort. Hawaiian Petrel were detected at 25 of these sites, Newell's Shearwater at 2, and Barn Owl at 20.

Introduction

Two threatened seabird species have been pushed to upland refuge sites on the Main Hawaiian islands; ʻuaʻu (Hawaiian Petrel, *Pterodroma sandwichensis*), ʻaʻo (Newell's Shearwater, *Puffinus newelli*). Once common, these species are now at risk of extirpation from breeding colonies throughout the archipelago, due to habitat loss and introduced predators, such as mongoose, rats and Barn Owls (*Tyto alba*). The largest breeding aggregation of Hawaiian Petrels is thought to be within the boundaries of the Haleakalā National Park (Simons & Hodges 1998). Work is currently underway to reduce threats and increase the availability of habitat for these threatened seabirds in and around the Park, including an ungulate-proof fence is being constructed around the Kahikinui Forest Reserve on the leeward slope of Haleakalā (abutting Haleakalā National Park), an ungulate proof fence around a to be determined section of the Haleakalā National Park, and ungulate/predator removal projects in both restoration areas.

The Maui Nui Seabird Recovery Project and the Park have undertaken surveys to collect baseline data on seabird populations in these restoration areas in order to measure the effectiveness of these management actions through time. Reliable data on the status and distribution of these seabirds is extremely challenging because both return to breeding colonies at night, nest in cryptic underground burrows, and generally breed in isolated, delicate, and treacherous terrain. This makes traditional surveys expensive, labor intensive, logistically complicated and potentially damaging to fragile habitat (particularly when related to long-term colony monitoring). New technology, such as automated acoustic monitoring techniques, have proven effective for monitoring these elusive species.

Here we report the results of continued acoustic monitoring surveys by the Maui Nui Seabird Recovery Project (MNSRP) designed to search for seabird activity on the eastern slope of Haleakalā, in Ko'olau Forest Reserve and Haleakalā National Park. Specifically the surveys were designed to:

1) Document presence and nightly patterns of acoustic activity by *ʻuaʻu*, *ʻaʻo*, and Common Barn Owl at specified locations across the landscape of East Maui, adjacent to and within Haleakalā National Park;
2) Establish an inventory (base line) of acoustic activity by each of the three target species at selected sites on East Maui, adjacent to Haleakalā National Park;

3) Search for *ʻuaʻu*, *ʻaʻo*, and common barn owl acoustic activity at exploratory sites; and
4) Continue the development of automated acoustic monitoring as a tool for a) detecting seabird population dynamics and changes and b) assisting with development of appropriate management actions.

Automated acoustic sensors for ecological monitoring

Acoustic cues have long been an important part of bird monitoring projects (Sauer et al. 1994). Recent technological innovations now make it possible to deploy weatherproof acoustic sensors that can reliably sample the acoustic environment for months at a time without maintenance. Hundreds of hours of field recordings can then be processed with pattern recognition software using deep learning and artificial neural network techniques to derive measures of acoustic activity rates for species of interest. This combination of passive acoustic sensors and automated call detection is especially powerful for monitoring rare/elusive species and species in remote locations (Acevedo & Villanueva-Rivera 2006; Agranat 2007; Brandes 2008a, 2008b).

Passive acoustic sensors and automated classification techniques have increasingly been employed to search for rare bird species including many seabirds (McKown 2008; Buxton & Jones 2012; Buxton et al. 2013; Borker et al. 2014; Oppel et al. 2014). Conservation Metrics has partnered with local biologists to conduct acoustic surveys for Newell's Shearwater, Hawaiian Petrel, and Band-rumped Storm-petrel across the Hawaiian Islands, including four years of intensive surveys on the island of Kaua'i.

Methods

Acoustic sensor hardware

A mixture of Wildlife Acoustics SM2, SM2+, and SM3 automated recorders were used for this project. Each of these sensors is a single-board computer in a weatherproof housing containing, four D cell batteries. SM2 and SM2+ sensors used SMX-II and SMX-US microphones, and SM3 sensors use their own integrated microphones.

Recording schedule

Song Meter 3s were programmed to record 1 out of every 5 minutes, for 5 hours starting at sunset, then record 1 out of every 10 minutes for the 5 hours preceding sunrise. They were set to record in UTC -10, using sunrise and sunset information for 20.71 N, 156.26 W. Recordings were made in stereo WAC format at a 24KHz polling rate, with +24dB of gain and a High Pass filter at 220Hz and Zero Crossing off. A program file (Seabirds_WestMaui_2015_SM3_24dB_stereoWac.PGM) has been provided to MNSRP.

Song Meter 2(+) sensors were programmed to record on the same schedule and with +48dB gain. CMI tests have indicated that this gain level is comparable to +24 dB gain on a SM3. A program file (Seabirds_Maui_stro24k_2015.SET) has been provided.

Survey Sites

A total of 18 sensors were placed at 44survey points in East Maui: 26 in Ko'olau, 19 in Waikamoi, 2 in Nuu Mauka, and 2 in Puu Pahu (Figure 1). Five of these sensors (KAW115, KAW125, NAK3, HAL1, and MNSRP18) were only deployed at one location, while the rest were moved between locations throughout duration of survey effort. For 5 days in June, 9 sensors were placed together at one area in Ainaho, and continued recording during this period. For purposes of analysis, this was treated as a single site, 'LZ—Ainaho'.

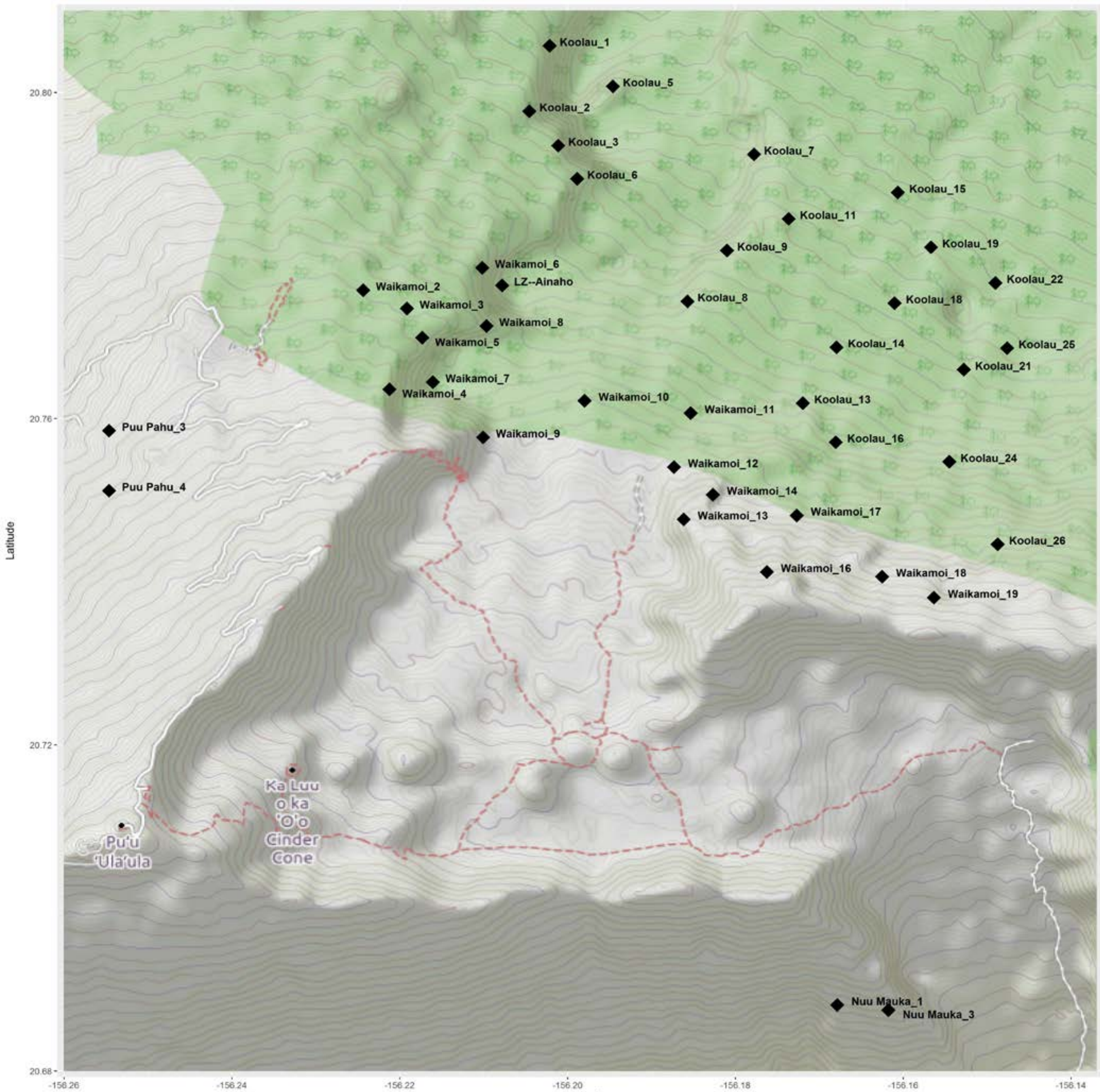

Figure 1: Acoustic survey points in East Maui.

Automated call detection

Automated acoustic analysis of all field recordings was carried out with custom detection and classification software created by Conservation Metrics. This approach uses machine learning algorithms known as Deep Neural Networks to detect sounds on field recordings with spectro-temporal properties that are similar to signals produced by target species. Deep Neural Networks (DNNs) are a powerful classification tool used in speech recognition(Deng et al. 2013) for image recognition (Krizhevsky et al. 2012; Ciresan et al. 2012) and computer vision (Deng et al. 2013) problems.

CMI's approach splits field recordings into 2-second clips and extracts measurements of 10 spectro-temporal features typically found in animal sounds. A DNN classification model is then trained for each species of interest using training and cross-validation datasets containing examples of positive sounds (vocalizations from target species) and a representative example of negative sounds from the soundscape at all survey sites. The DNNs learn which spectro-temporal features best differentiate target sounds from other sounds in the environment, and each model can then be applied to raw acoustic data. The models return a probability that a given 2-second window contains a sound produced by the target species. This method has proven better (more sensitive and more accurate) at detecting target sounds than other widely available bioacoustics analysis software.

Results

Survey Effort

This report presents data of an analysis of 2,134 hours of survey effort in 2015. Eighteen sensors were placed at a total of 44 survey points over the course of a combined 1,515 sensor-nights (Table 1, Figure 2, Figure 3).

Table 1: Survey Effort at all sites. Sites with 0 Total Nights and Total Hours are sites that were deployed but for which CMI did not receive data—some units were lost in the field.

Recording Unit	SPID	Longitude	Latitude	Deployment Date	Retrieval Date	Total Nights	Total Hours
MNSRP01	Koolau_1	-156.202151	20.80573	5/16/2015	6/18/2015	34	48.1
MNSRP18	Koolau_10	-156.178673	20.783284	6/18/2015	7/20/2015	33	44.82
MNSRP04	Koolau_11	-156.173659	20.784506	6/18/2015	7/20/2015	33	46.24
MNSRP17	Koolau_13	-156.171969	20.761903	6/24/2015	7/20/2015	27	36.33
MNSRP09	Koolau_14	-156.167956	20.768747	6/24/2015	7/20/2015	27	37.27
MNSRP02	Koolau_15	-156.160647	20.787738	6/18/2015	7/20/2015	33	46.23
MNSRP09	Koolau_16	-156.168044	20.757118	7/21/2015	9/4/2015	46	68.84
MNSRP04	Koolau_18	-156.161042	20.774163	7/21/2015	9/4/2015	46	68.84
MNSRP02	Koolau_19	-156.156698	20.78102	7/21/2015	9/4/2015	46	68.84
MNSRP04	Koolau_2	-156.20457	20.797711	5/16/2015	6/18/2015	34	47.76

Recording Unit	SPID	Longitude	Latitude	Deployment Date	Retrieval Date	Total Nights	Total Hours
MNSRP17	Koolau_20	-156.162497	20.752078	7/21/2015	9/4/2015	0	0
MNSRP06	Koolau_21	-156.152784	20.766022	7/21/2015	9/4/2015	46	68.84
MNSRP18	Koolau_22	-156.149021	20.776646	7/21/2015	9/4/2015	35	51.7
MNSRP01	Koolau_23	-156.146277	20.782958	7/21/2015	9/4/2015	0	0
MNSRP10	Koolau_24	-156.154518	20.754719	7/21/2015	9/4/2015	46	68.84
MNSRP05	Koolau_25	-156.147624	20.768651	7/21/2015	9/4/2015	46	68.84
MNSRP12	Koolau_26	-156.148747	20.744598	7/21/2015	9/4/2015	46	67.5
MNSRP05	Koolau_3	-156.20113	20.793482	5/16/2015	6/18/2015	28	39.98
MNSRP18	Koolau_4	-156.19758	20.798079	5/16/2015	6/18/2015	34	46.09
MNSRP02	Koolau_5	-156.194611	20.800748	5/16/2015	6/18/2015	34	47.52
MNSRP06	Koolau_6	-156.19886	20.789427	5/16/2015	6/18/2015	34	47.78
MNSRP01	Koolau_7	-156.177784	20.792411	6/18/2015	7/20/2015	33	46.22
MNSRP06	Koolau_8	-156.185717	20.774384	6/18/2015	7/20/2015	33	46.29
MNSRP05	Koolau_9	-156.181005	20.780625	6/24/2015	7/20/2015	4	1.69
MNSRP05	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	3	2.9
MNSRP10	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	7	8.92
MNSRP11	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	7	8.88
MNSRP13	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	6	5.81
MNSRP12	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	7	8.46
MNSRP09	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	7	8.46
MNSRP14	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	7	8.48
MNSRP17	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	3	2.82
MNSRP15	LZ--Ainaho	-156.207806	20.7763387	6/18/2015	6/24/2015	7	6.73
HAL1	Nuu Mauka_1	-156.1678695	20.68810755	6/15/2015	7/13/2015	29	40.47
HAL1	Nuu Mauka_2	-156.1644935	20.68869455	7/13/2015	NA	0	0
NAK3	Nuu Mauka_3	-156.1617715	20.68748254	6/15/2015	7/14/2015	30	42.19
NAK3	Nuu Mauka_4	-156.1600775	20.68536855	7/14/2015	NA	0	0
KAW115	Puu Pahu_1	-156.2516997	20.75638499	6/23/2015	NA	0	0
KAW125	Puu Pahu_2	-156.257231	20.74675386	6/23/2015	NA	0	0
KAW115	Puu Pahu_3	-156.2546482	20.75852913	7/22/2015	8/27/2015	37	55.16
KAW125	Puu Pahu_4	-156.2546578	20.75116777	7/22/2015	7/30/2015	9	12.19
MNSRP07	Waikamoi_1	-156.2211284	20.78295385	5/16/2015	NA	0	0
MNSRP12	Waikamoi_10	-156.197984	20.762208	6/24/2015	7/20/2015	27	36.39
MNSRP10	Waikamoi_11	-156.185343	20.760696	6/24/2015	7/20/2015	27	37.46
MNSRP13	Waikamoi_12	-156.187328	20.754067	6/24/2015	7/20/2015	27	36.43
MNSRP15	Waikamoi_13	-156.186168	20.74766	6/24/2015	7/20/2015	27	36.34
MNSRP14	Waikamoi_14	-156.182698	20.750679	6/24/2015	7/20/2015	27	36.39
MNSRP11	Waikamoi_15	-156.179189	20.755763	6/24/2015	7/20/2015	0	0
MNSRP13	Waikamoi_16	-156.176255	20.741211	7/21/2015	9/4/2015	46	67.5
MNSRP11	Waikamoi_17	-156.172692	20.74813	7/21/2015	9/4/2015	46	68.84
MNSRP14	Waikamoi_18	-156.162519	20.740623	7/21/2015	9/4/2015	46	67.5

Recording Unit	SPID	Longitude	Latitude	Deployment Date	Retrieval Date	Total Nights	Total Hours
MNSRP15	Waikamoi_19	-156.156351	20.738053	7/21/2015	9/4/2015	46	67.5
MNSRP10	Waikamoi_2	-156.224365	20.775763	5/16/2015	6/18/2015	34	47.82
MNSRP11	Waikamoi_3	-156.21915	20.773526	5/16/2015	6/18/2015	34	47.51
MNSRP13	Waikamoi_4	-156.22124	20.7636	5/16/2015	6/18/2015	34	44.88
MNSRP12	Waikamoi_5	-156.217327	20.769924	5/16/2015	6/18/2015	34	46.1
MNSRP09	Waikamoi_6	-156.210171	20.778509	5/16/2015	6/18/2015	34	47.49
MNSRP14	Waikamoi_7	-156.216063	20.76447	5/16/2015	6/18/2015	34	46.07
MNSRP17	Waikamoi_8	-156.209663	20.771364	5/16/2015	6/18/2015	34	46.09
MNSRP15	Waikamoi_9	-156.210076	20.75771	5/16/2015	6/18/2015	21	27.84
Totals						**1515**	**2134.18**

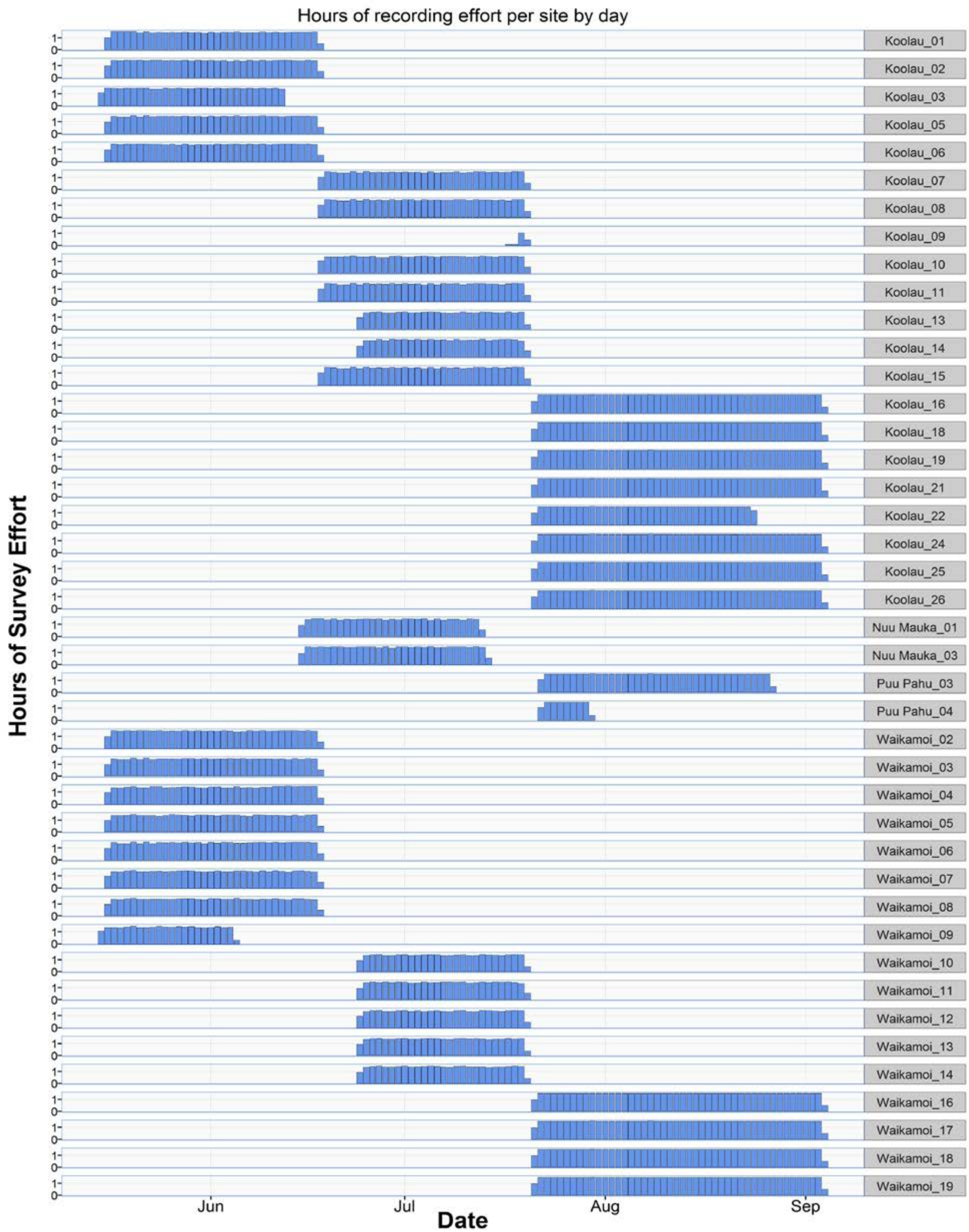

Figure 2: Hours of survey effort per survey site over time, excluding recordings from the staging area in Ainaho.

Hawaiian Petrel

Hawaiian Petrel activity peaked between 20 and 80 minutes after sunset (Figure 3). Seasonally, activity exhibited distinct peaks in mid-late May and early July (Figure 7, Figure 8), though seasonal trends would likely be more apparent if more sites had been surveyed continuously through the entire nesting season. Overall, petrel activity was detected at 13 sites in Ko'olau, 16 sites in Waikamoi, both sites in Nuu Mauka, and the staging area at Ainaho (Figure 4, Figure 5, Figure 6, Figure 9). The highest call rates during Round 1 were at Waikamoi_9 (3.208 +/- 3.121 s.d. Calls/Min) (Figure 4). The highest call rates during Round 2 were at Waikamoi_13 (1.681 +/- 2.088 s.d. Calls/Min) (Figure 5). The highest call rates during Round 3 were at Koolau_25 (0.00741 +/- 0.0497 s.d. Calls/Min.) (Figure 6).

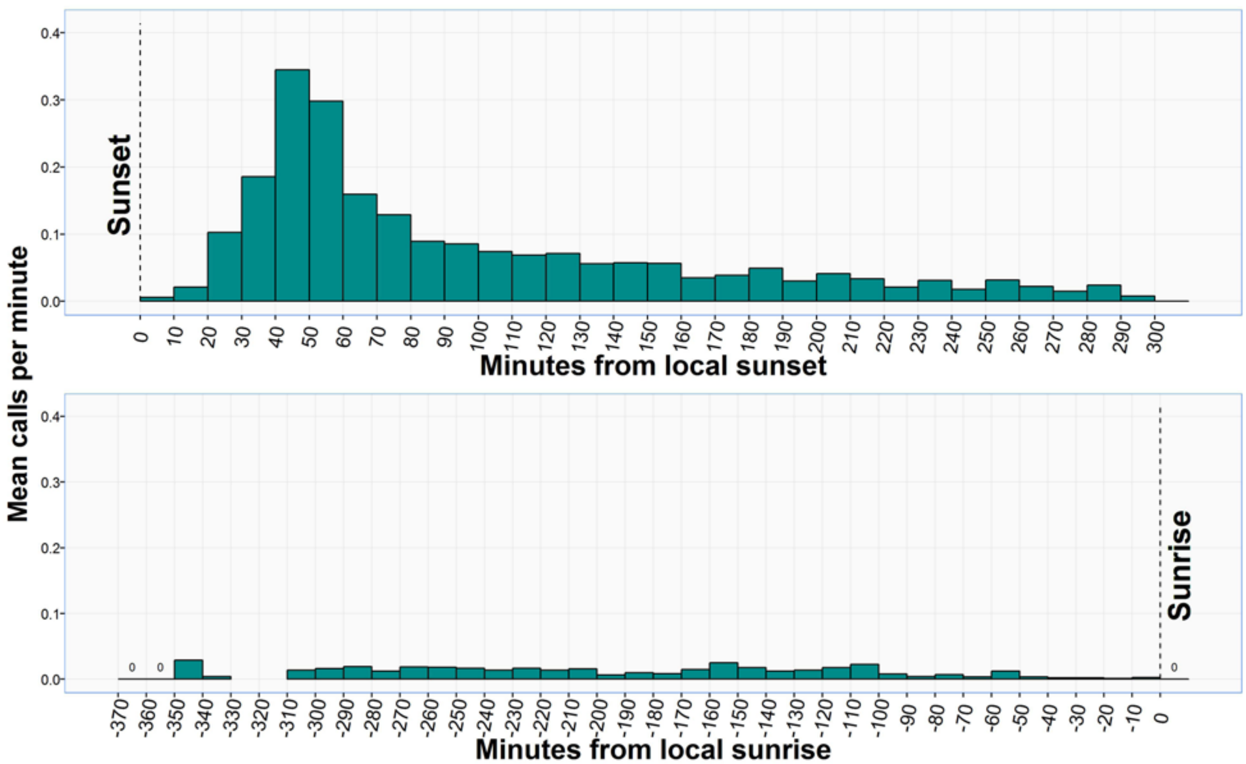

Figure 3: Hawaiian Petrel activity as a function of time from sunset and sunrise, aggregating all sites and the complete survey duration.

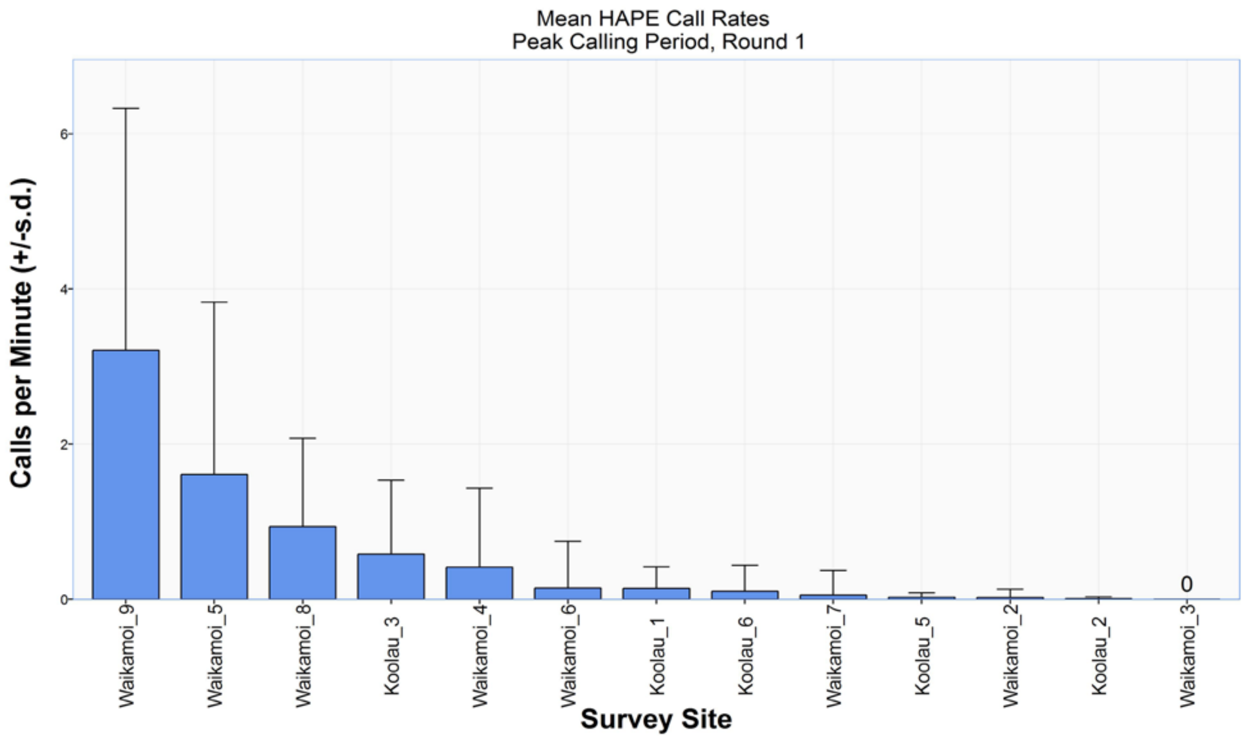

Figure 4: Hawaiian Petrel mean call rates at each site during peak calling hour (20-80 minutes after sunset), comparing sites from Round 1 (05/15/2015 to 06/18/2015).

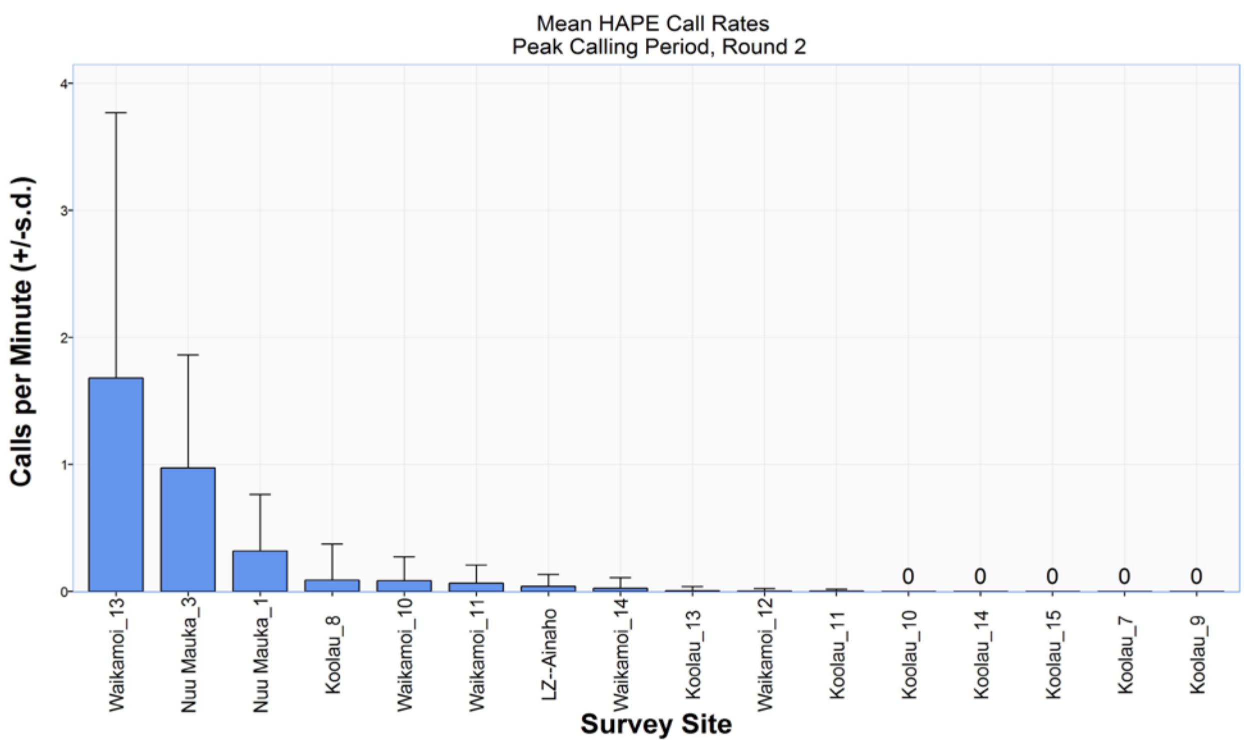

Figure 5: Hawaiian Petrel call rates at each site during peak calling period (20-80 minutes after sunset), comparing sites from Round 2 (6/18/2015 to 7/20/2015).

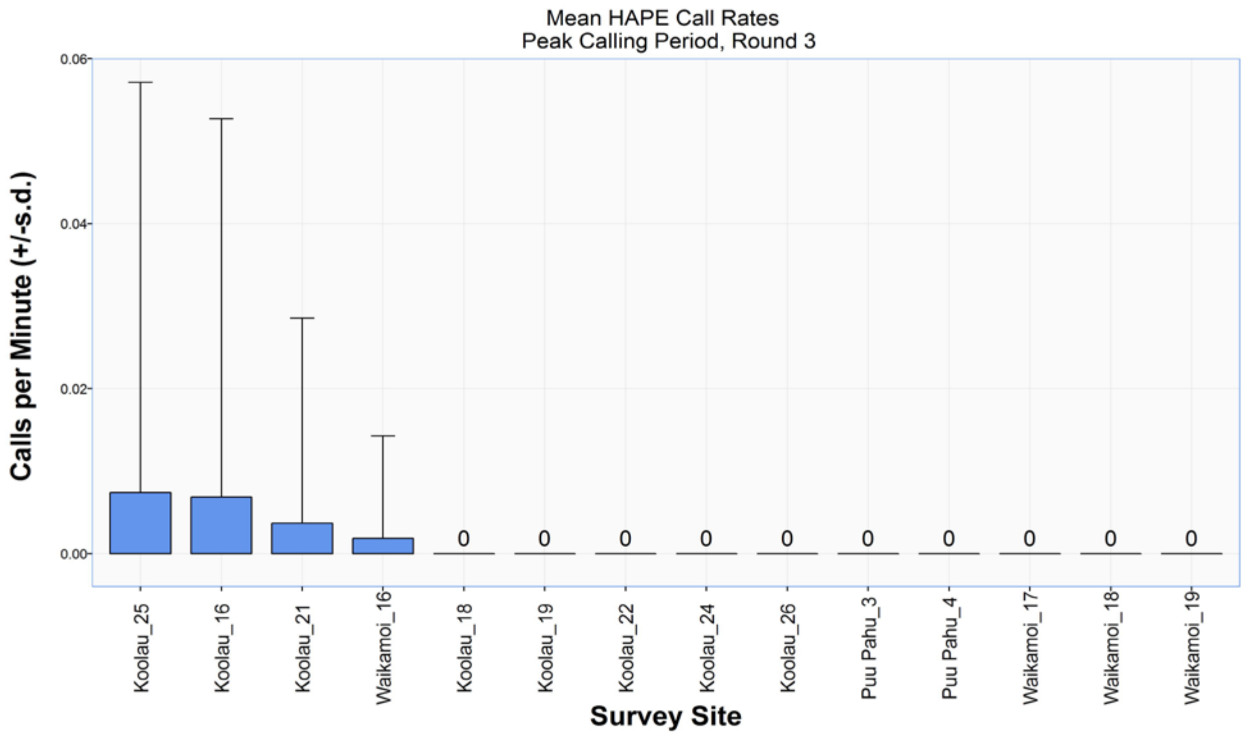

Figure 6: Hawaiian Petrel call rates at each site during peak calling hour (20-80 minutes after sunset), comparing sites from Round 3 (7/21/2015 to 09/04/2015).

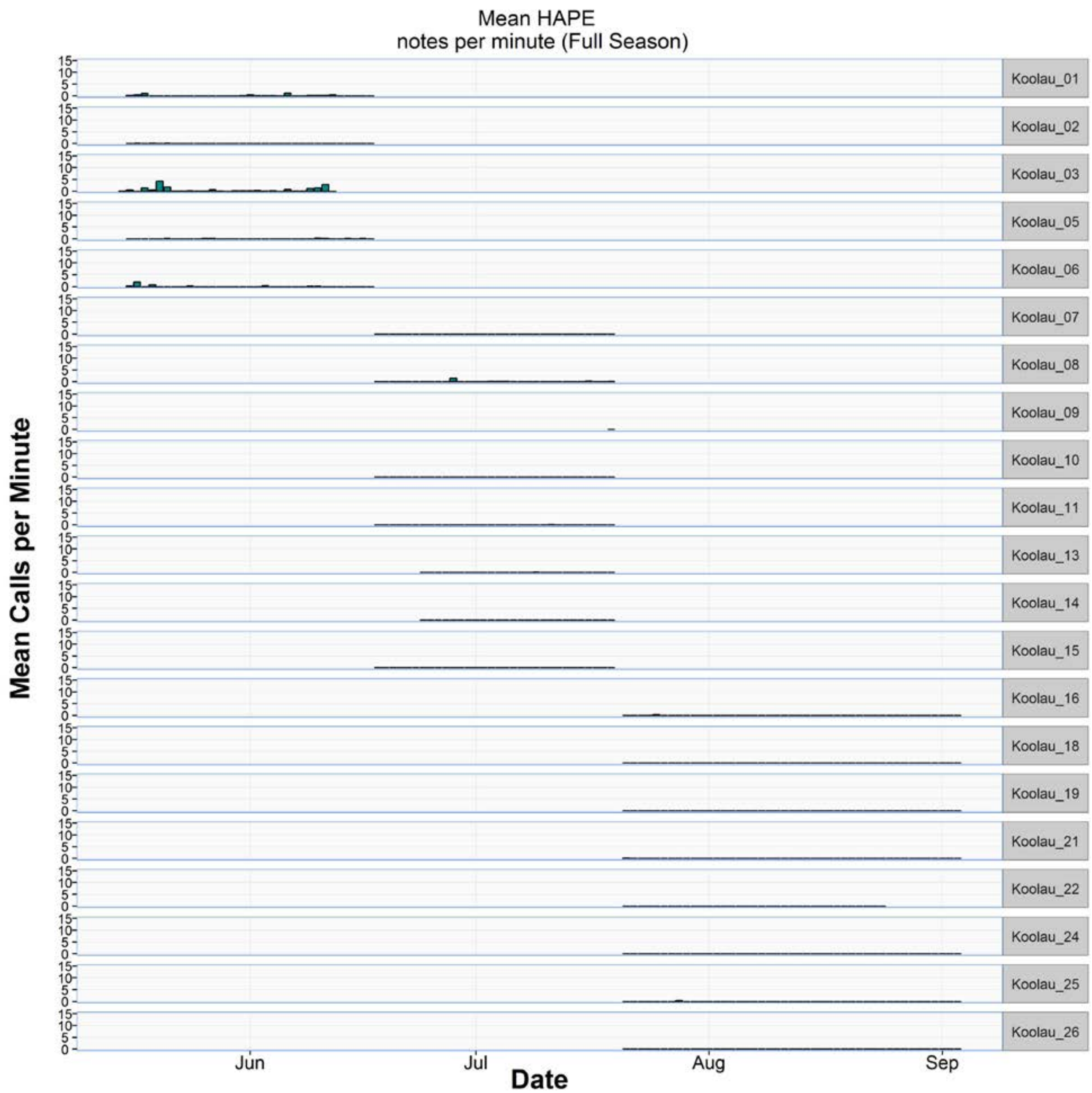

Figure 7: Hawaiian Petrel call rates over time at Ko'olau sites. Call rates were calculated during peak calling hour (20-80 minutes after sunset).

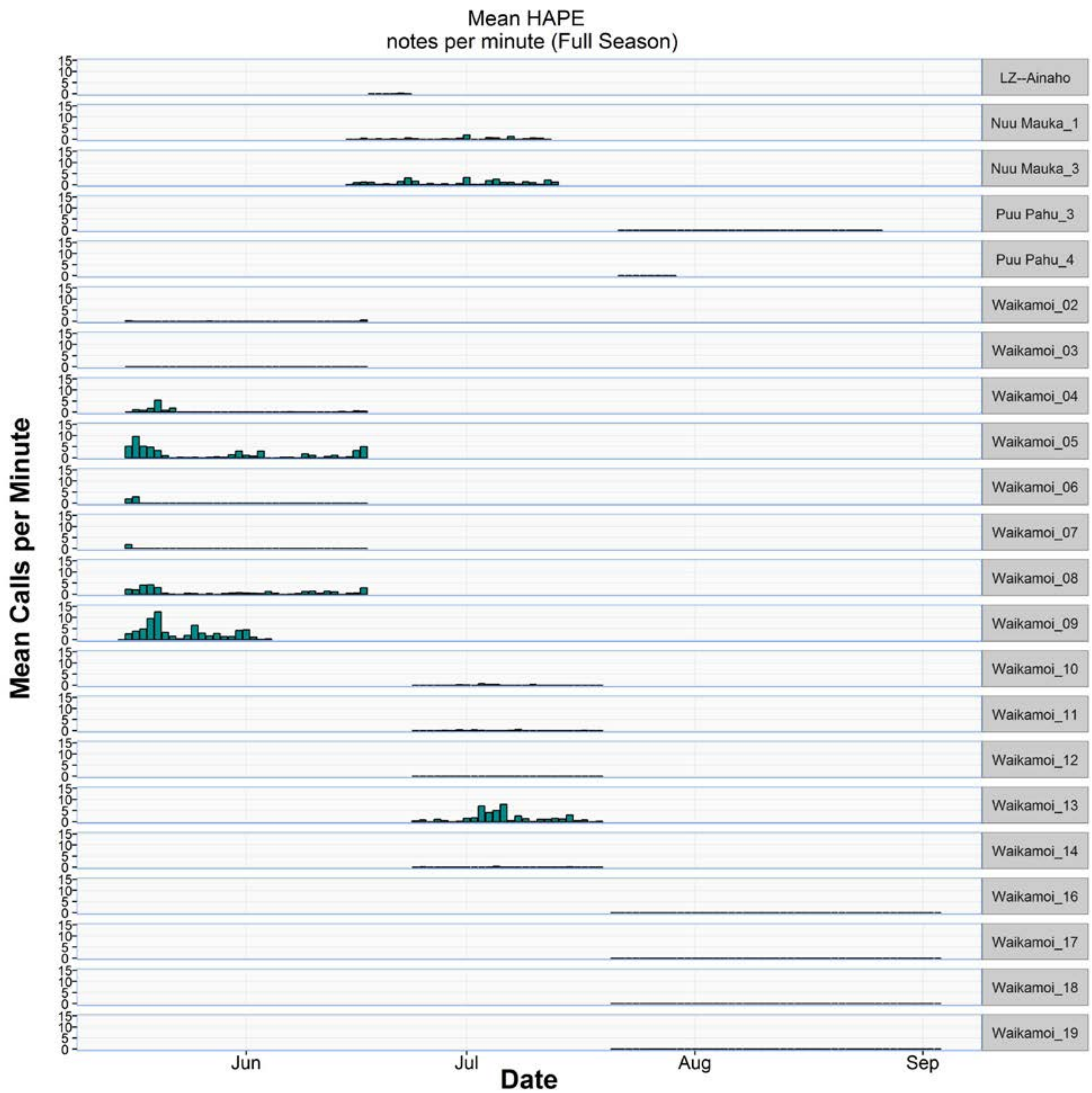

Figure 8: Hawaiian Petrel call rates over time at non-Ko'olau sites. Call rates were calculated during peak calling hour (20-80 minutes after sunset).

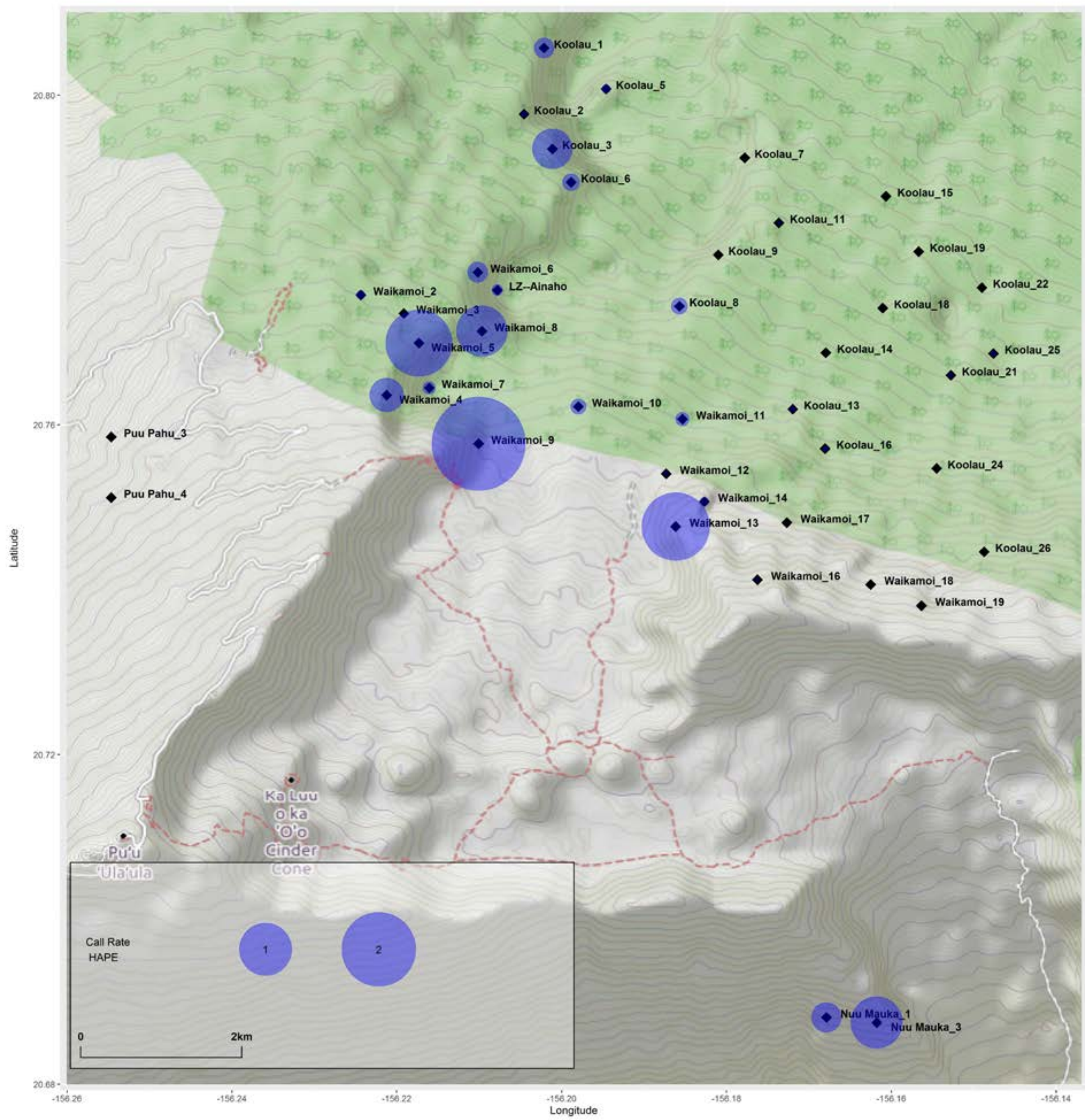

Figure 9: Map showing Hawaiian Petrel call rates during peak calling hour (20-80 minutes after sunset).

Newell’s Shearwater

Newell’s Shearwater calls were detected in low numbers at 5 sites: 4 in Ko’olau and 1 in Nuu Mauka (Figure 9). Only Ko’olau_3 (Figure 9) had regular activity and so seasonal or nightly phenology for Newell’s Shearwater populations on East Maui is difficult to characterize beyond a minor peak in activity at Ko’olau_3 during the beginning of survey effort (Figure 10).

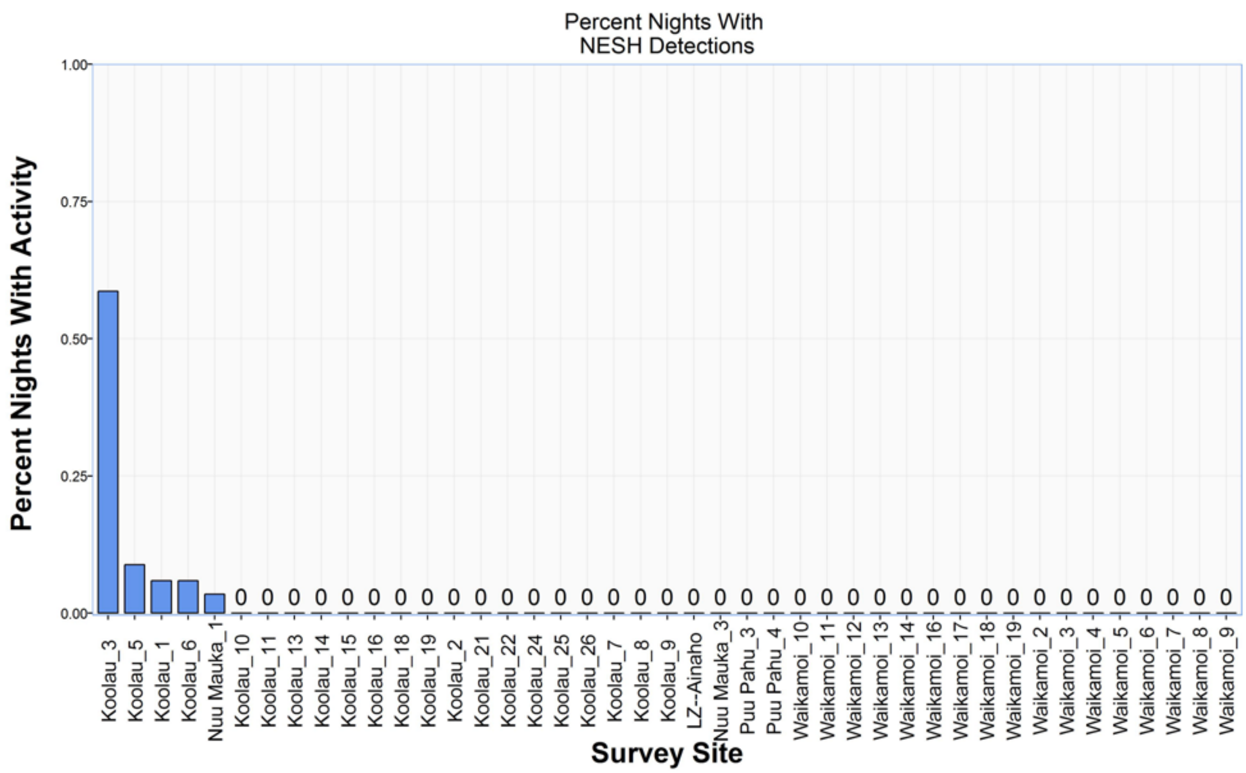

Figure 10: Percentage of survey nights at each site that have one or more Newell’s Shearwater detections

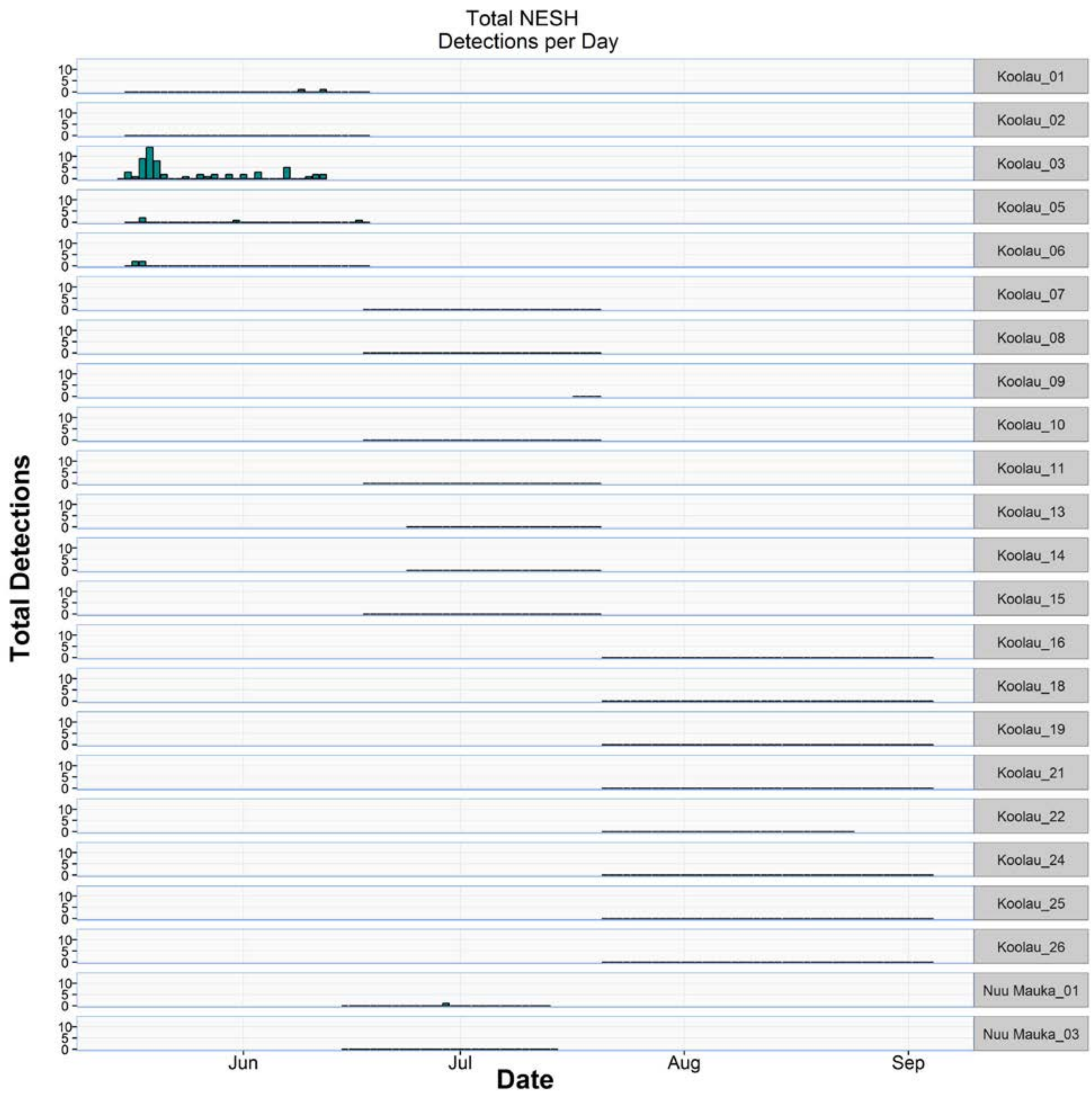

Figure 11: Total Newell's Shearwater detections by day at Ko'olau and Nuu Mauka sites

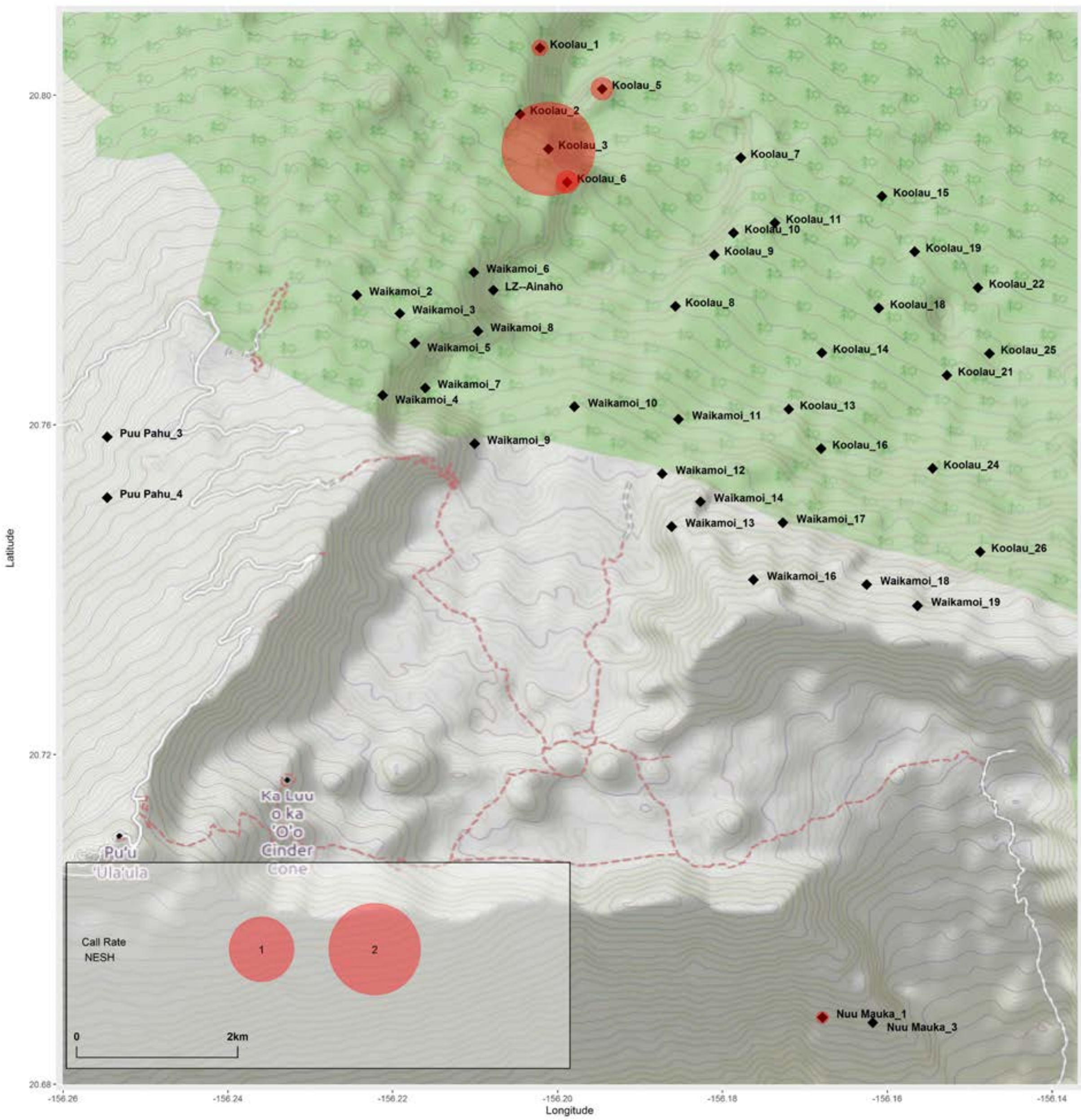

Figure 12: Map showing average Newell's Shearwater detections per survey night.

Barn Owl

Barn Owl calls were detected at 12 sites in Waikamoi, 7 sites in Ko'olau, and one site in Puu Pahu (Figure 12, Figure 16), with the highest call rates at Waikamoi_5 and Waikamoi_9 (Figure 12). Owls exhibited no temporal trends in activity, whether over the course of a night (Figure 12) or over the course of the survey season (Figure 13, Figure 14).

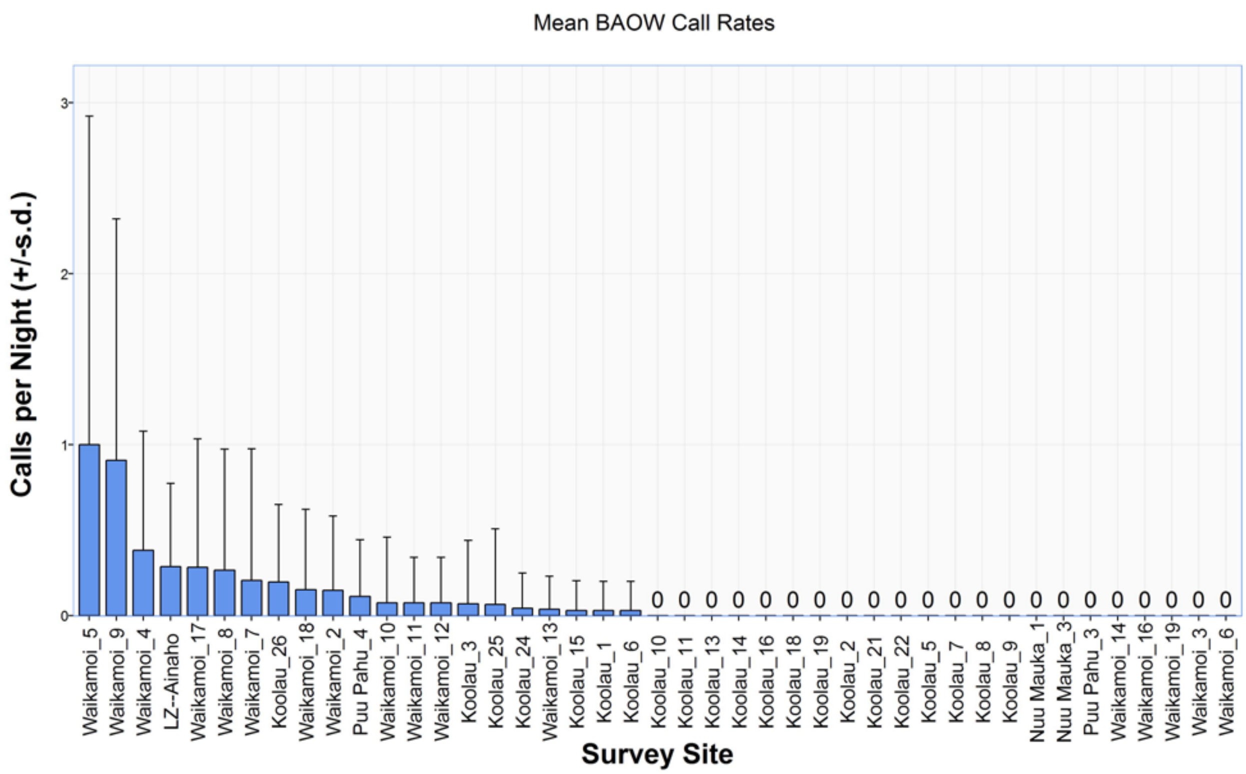

Figure 13: Mean Barn Owl calls per night at all sites across entire survey duration

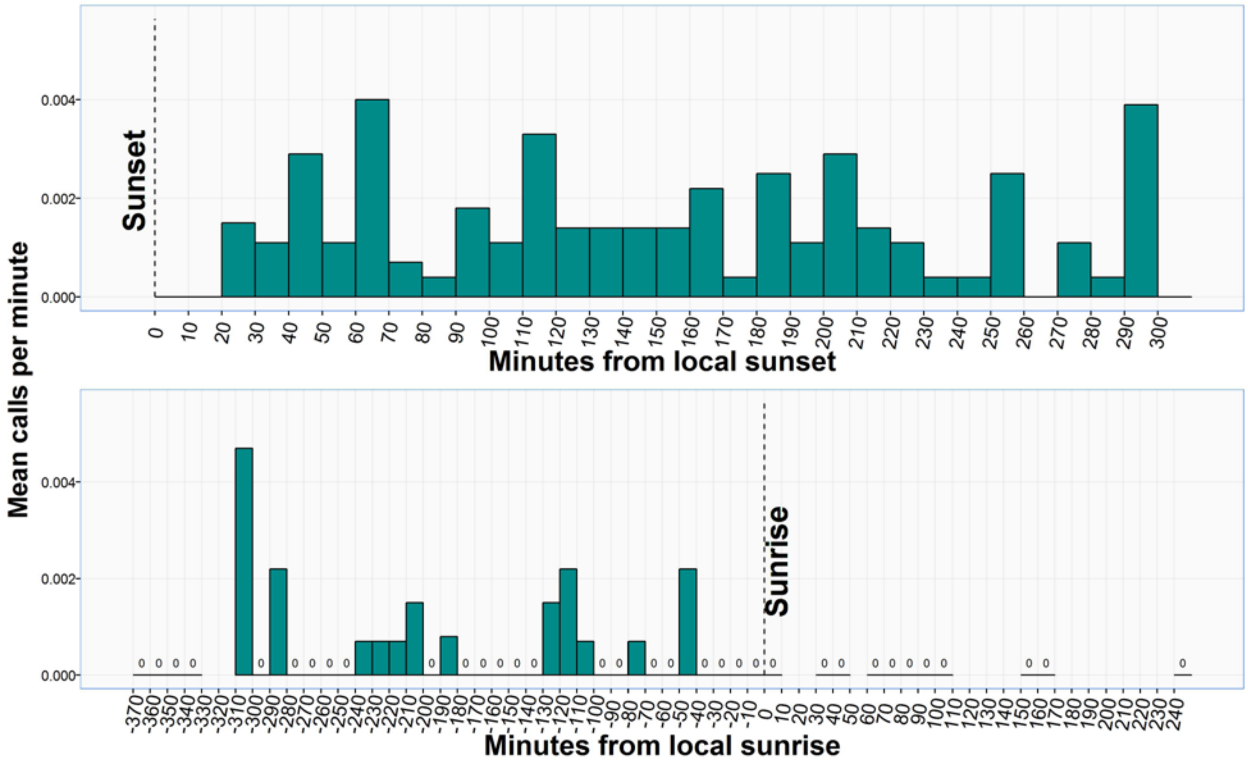

Figure 14: Barn Owl call rates as a function of time from sunset and sunrise, across all sites during the entire survey duration.

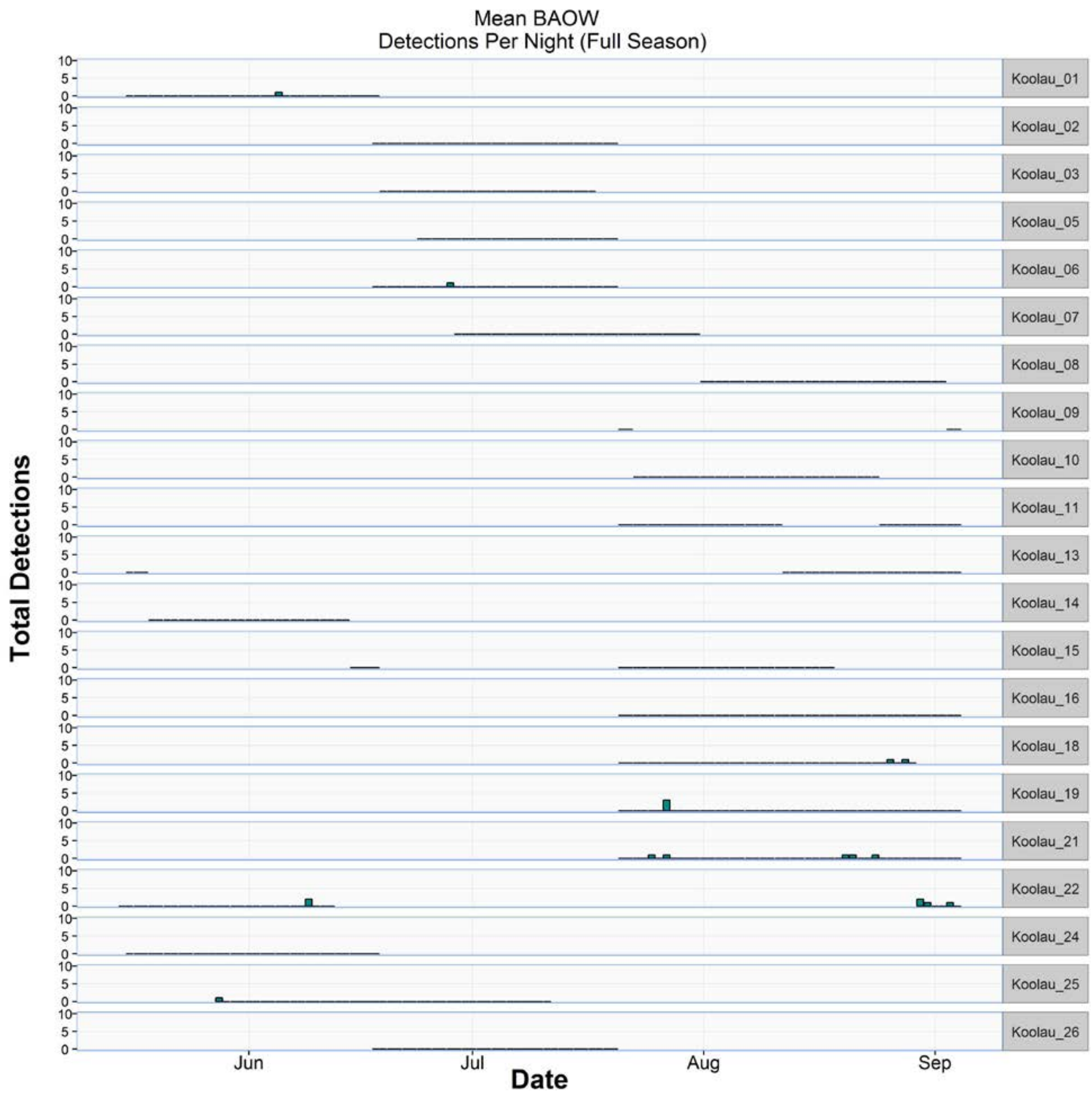

Figure 15: Total Barn Owl detections by day at Ko'olau sites.

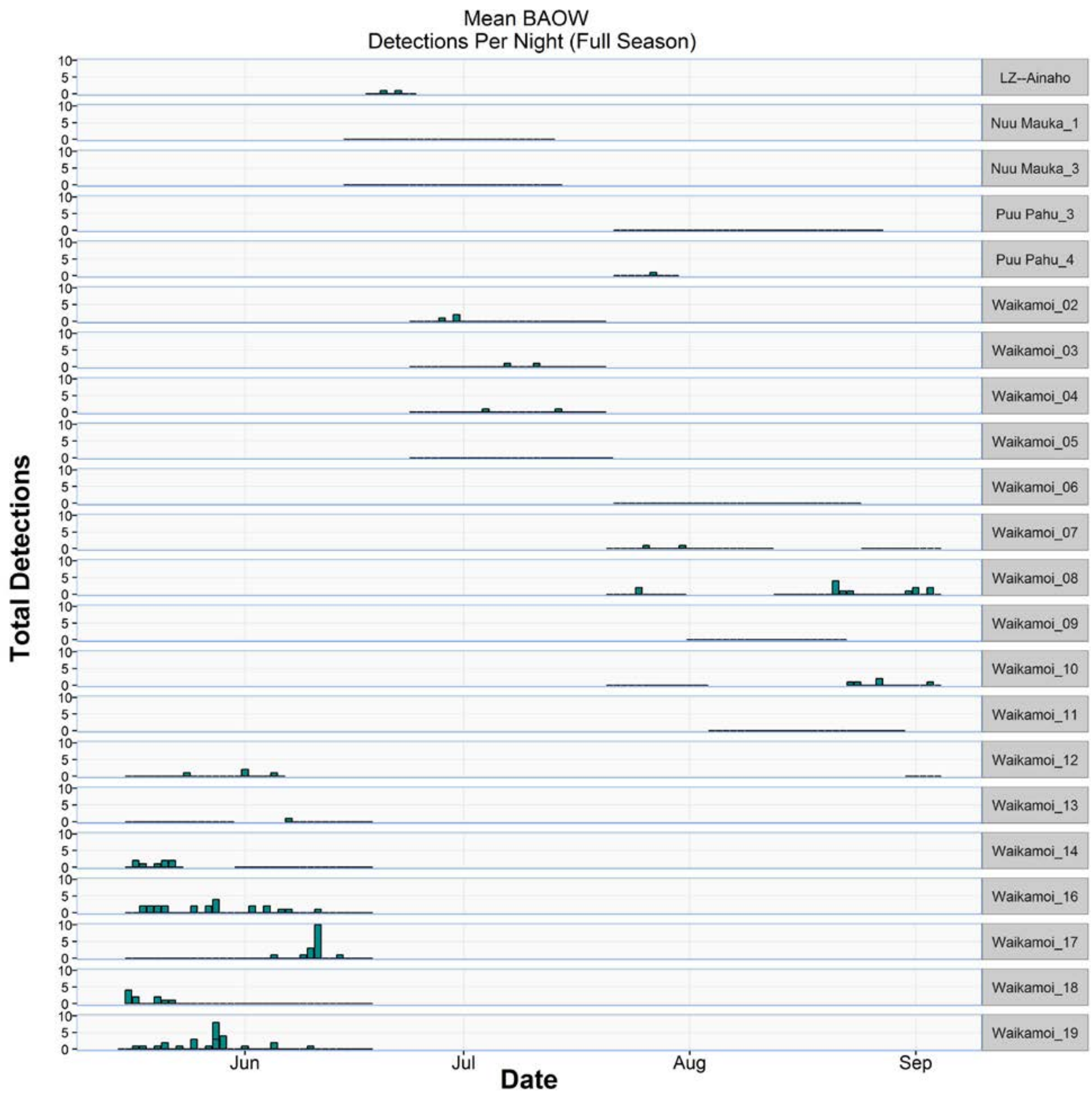

Figure 16: Total Barn Owl detections by day at non-Ko'olau sites.

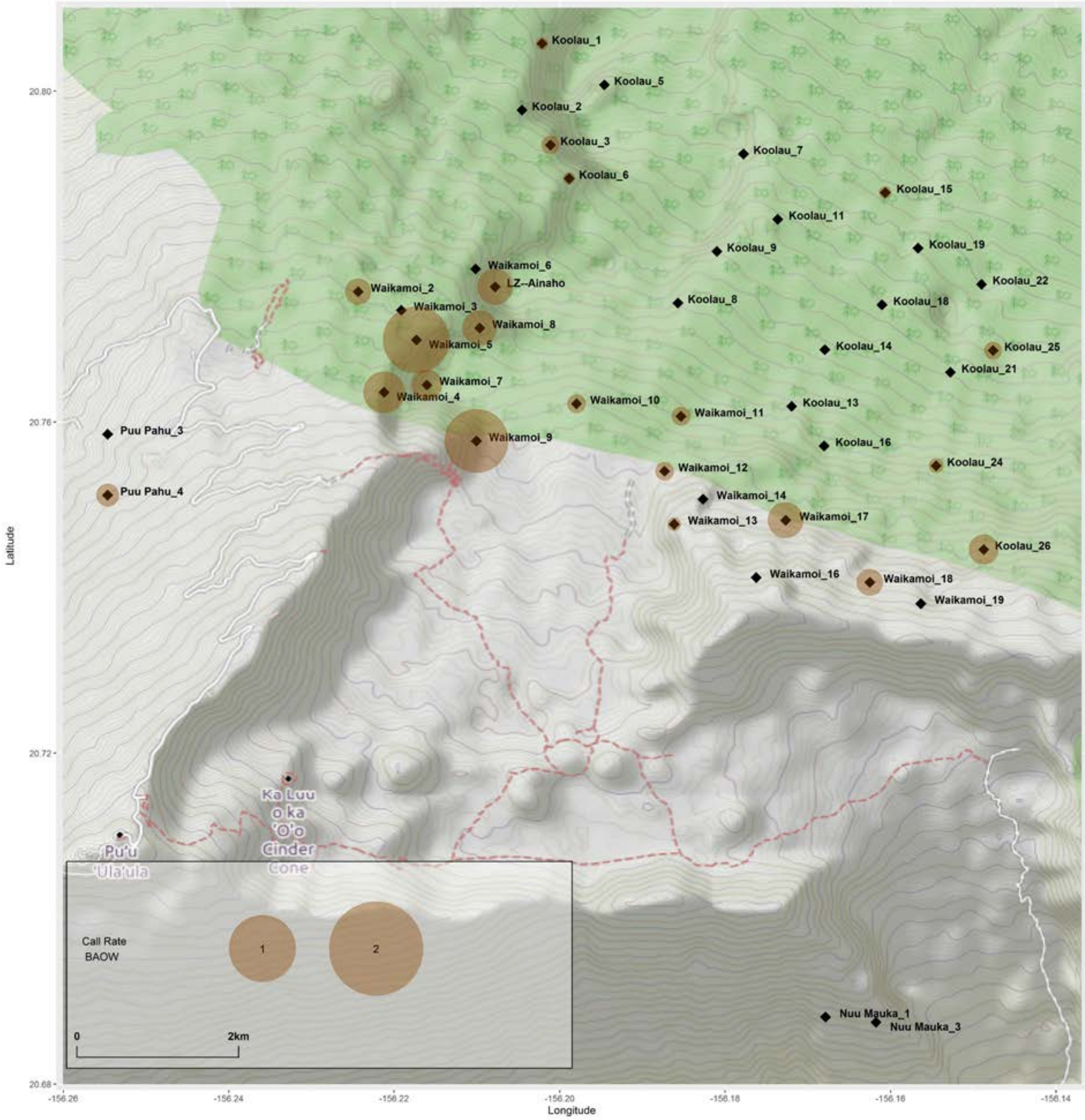

Figure 17: Map of average Barn Owl detections per night, across entire survey duration

Discussion

The 2015 helicopter deployed acoustic surveys in East Maui detected the vocalizations of target species at a number of exploratory sites. Specifically, Hawaiian Petrel vocal activity was detected at many points across the survey area. Newell's Shearwater activity was limited to 4 or fewer detections at all but one site - Koolau_3.

Barn Owl detections were widespread but intermittent, which matches with the results of previous Barn Owl acoustic surveys at other locations in the Hawaiian Islands (McKown unpublished reports).

Whether the activity detected is related to new breeding aggregations, or to birds flying up to the large Hawaiian Petrel breeding colony on Haleakalā remains to be determined.

Future acoustic surveys should duplicate previously-successful survey designs, combining some season-long deployments at single locations with helicopter deployment of shorter-survey 'Rover' units to detect novel sites. This approach would allow for improved observation of phenology and better establishment of baseline activity for long-term trend monitoring.

Finally, it is interesting to note that the observed Hawaiian Petrel peak activity period was 30 minutes earlier than the peak of activity in survey effort from 2014 in Kahikinui Forest Reserve on the western side of Haleakalā, just under 10km away. Whether this is related to flight paths or some other explanation remains to be seen.

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Appendix 13. Makamaka'ole night survey summary data.

Date	Time	Species	Count	Flight Direction	Notes
30-Mar-16	18:15	BANO	1		
30-Mar-16	18:20	BANO	1		
30-Mar-16	19:40	HAPE	1		Maybe two
20-Apr-16	19:20	HAPE	1	S	
20-Apr-16	19:25	HAPE	1	S	
20-Apr-16	19:30	HAPE	1	S	
20-Apr-16	19:35	HAPE	1	S	
20-Apr-16	19:40	HAPE	1	S	
20-Apr-16	19:45	HAPE	1	S	
20-Apr-16	19:50	HAPE	1	S	
20-Apr-16	19:55	NESH	1	S	
16-May-16	19:20	NESH	1	S	
16-May-16	19:27	NESH	2	NE	Clear view
16-May-16	19:30	NESH	2		Hear calls, cloud cover low
16-May-16	19:38	NESH	2		Calls overhead
16-May-16	19:41	NESH	4		Circling in Makamaka'ole
16-May-16	19:46	NESH	1	N	Flies directly above burrows
16-May-16	19:49	NESH	3		Observed directly overhead
16-May-16	19:52	HAPE	2		Fly within 5m of observation point
16-May-16	19:52	NESH	1		Fly within 5m of observation point
16-May-16	19:54	NESH	1		Calls from Stream
16-May-16	20:05	NESH	1	S	
20-Jun-16	19:41	NESH	1	SW	
20-Jun-16	19:46	NESH	1		
20-Jun-16	19:50	NESH	1		
20-Jun-16	19:53	NESH	2		
20-Jun-16	19:55	NESH	2		
20-Jun-16	19:56	NESH	1		
20-Jun-16	19:59	NESH	2		1953-2030 NESH Calling back to sound system and circling burrow area agressivly
20-Jun-16	20:30	BANO	1	NW	Barn owl flushed from roost on fence post inside of enclosure B as we were packing out.

Appendix 14.

Burrow Temperature Monitoring

Maintaining burrow temperatures within specified tolerances by experimenting with burrowing box insulation concepts was done during the non-breeding months within both enclosures. Studies conducted by Lyons (1979), Simons (1985, Figure 1), and Howell and Bartholomew (1961) suggest that high temperatures, exceeding 30 C and high variation in temperature, exceeding 5 C could discourage HAPE and NESH from the use of artificial burrows and that long term exposure to high temperatures could be detrimental. Six different designs were drawn up and constructed to insulate the exposed burrow boxes from direct sun and high temperatures (Figure 2). The 6 designs included 2 sizes of plywood covers, with and without insulation material (for a total of 4), one with a shade cloth cover, and one with burlap and sandbags. Each experimental method was measured with a LogTag Temperature Data Logger. Temperature loggers were set inside the burrow box, on the ground adjacent to the entrance for each burrow. Temperatures were recorded every 30 minutes from Dec 4, 2015 to Jan 8, 2016 (Figure 3).

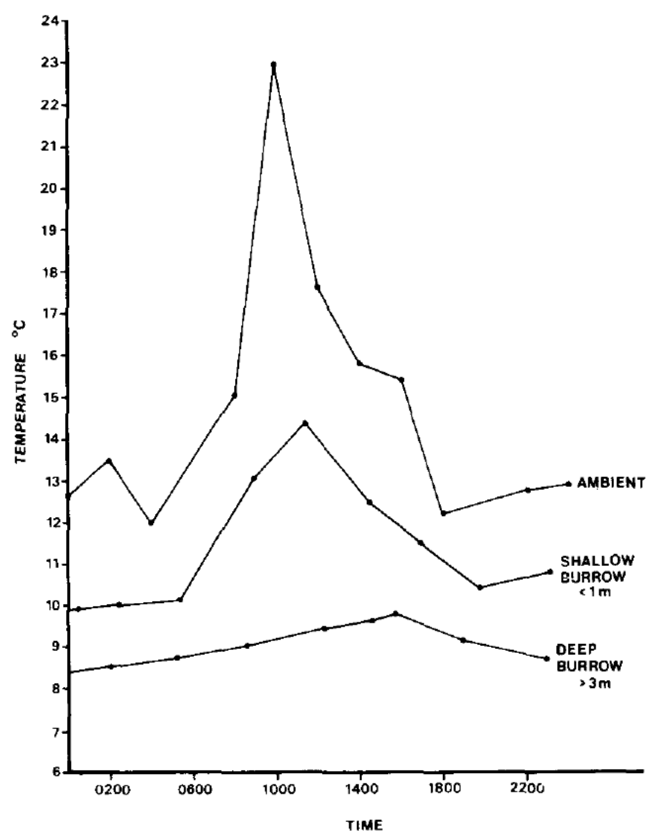

Figure 1. Simons (1985) Burrow temperatures from the summit of Haleakala

Figure 2. Each of the experimental insulation designs tested. Left top: Small unvented. Right top: Shade cloth. Mid left: Small vented. Mid right: Large insulated. Bottom: sand bag and burlap burrow covered left and exposed right.

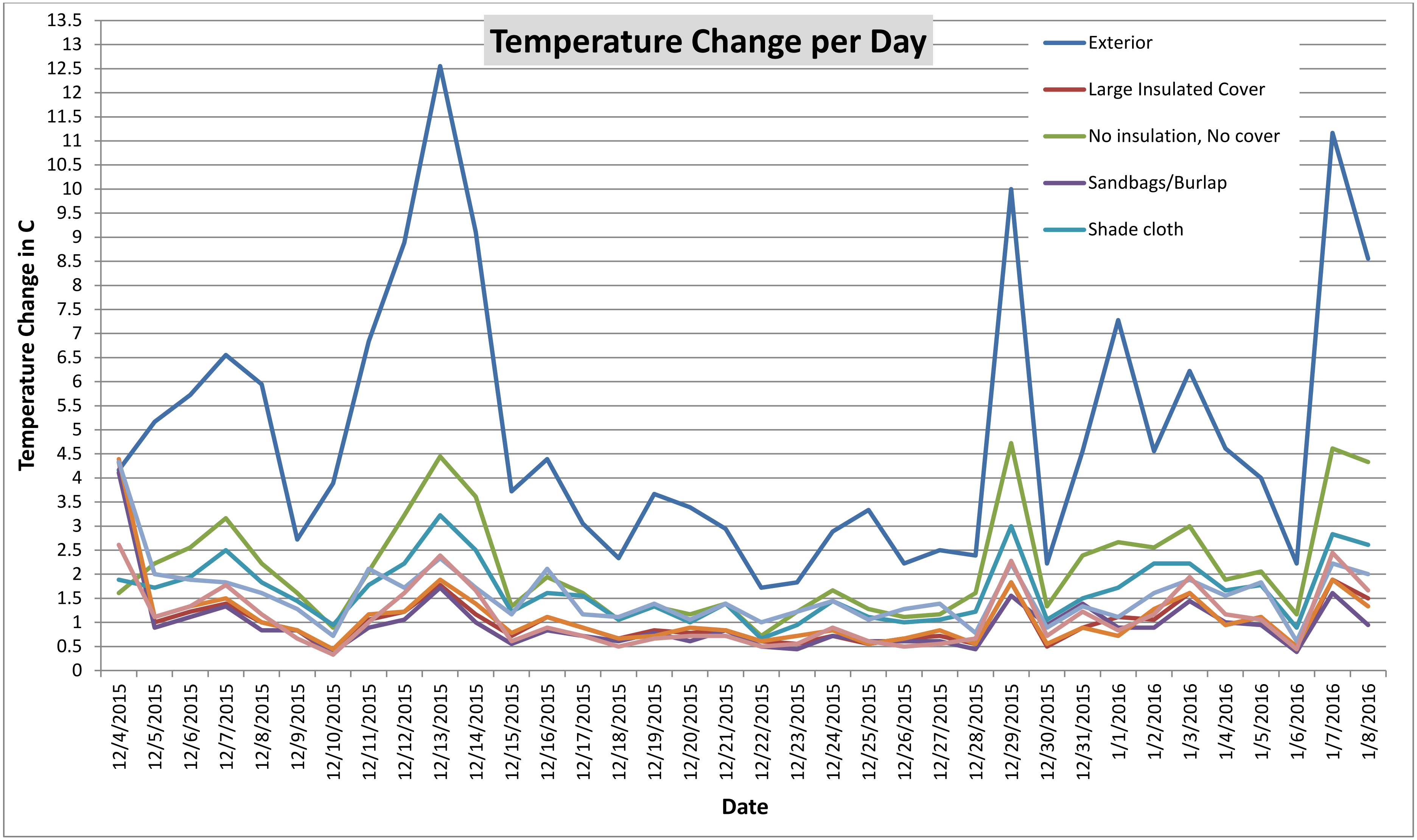

Figure 3. This graph shows the difference between the maximum and minimum daily temperatures.

All of the experimental methods reduced the mean and range of internal burrow temperature well below the 30° C threshold. It appears that the sandbag/burlap has the highest mitigating impact in terms of temperature regulation. Each of the "insulated" boxes maintained the maximum temperature swing below 2.5° C and none of the temperatures approached 30° C. With these results in mind, as well as the DLNR NARs staff concerns of maintaining minimal visual impact, minimal site disturbance, and ease of access to nest boxes, a final insulation design was created (Figure 4). It is a slightly modified version of the small uninsulated box which provides more airflow/airspace between the insulating box and the burrow box (Figure 5). It has no added insulation, requires no excavation, and provides easy access to check inside the burrows. A wooden cover with an air insulation buffer also provides added protection to the burrow boxes, which should increase the longevity of the boxes and decrease the frequency which disturbance would be necessary to replace decaying boxes.

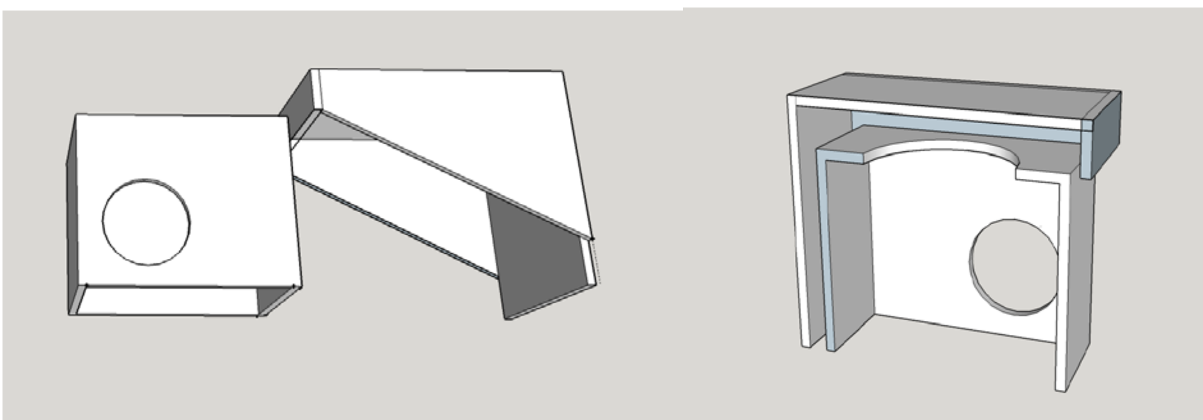

Figure 4. Detailed plan view of the final design, relative to the burrow boxes.

Figure 5. An insulation box prior to assembly

Figure 6. Final insulation box design in place over a burrow.

Additional temperature readings were collected inside 8 burrow boxes with the final insulations design installed within enclosure B using the same methods as the previous trials (Figure 6). Temperatures were collected between the dates of March 3rd 2016 through June 26th 2016 (Figure 7). Ambient temperature was collected at 10 minute intervals by a weather nearby weather station.

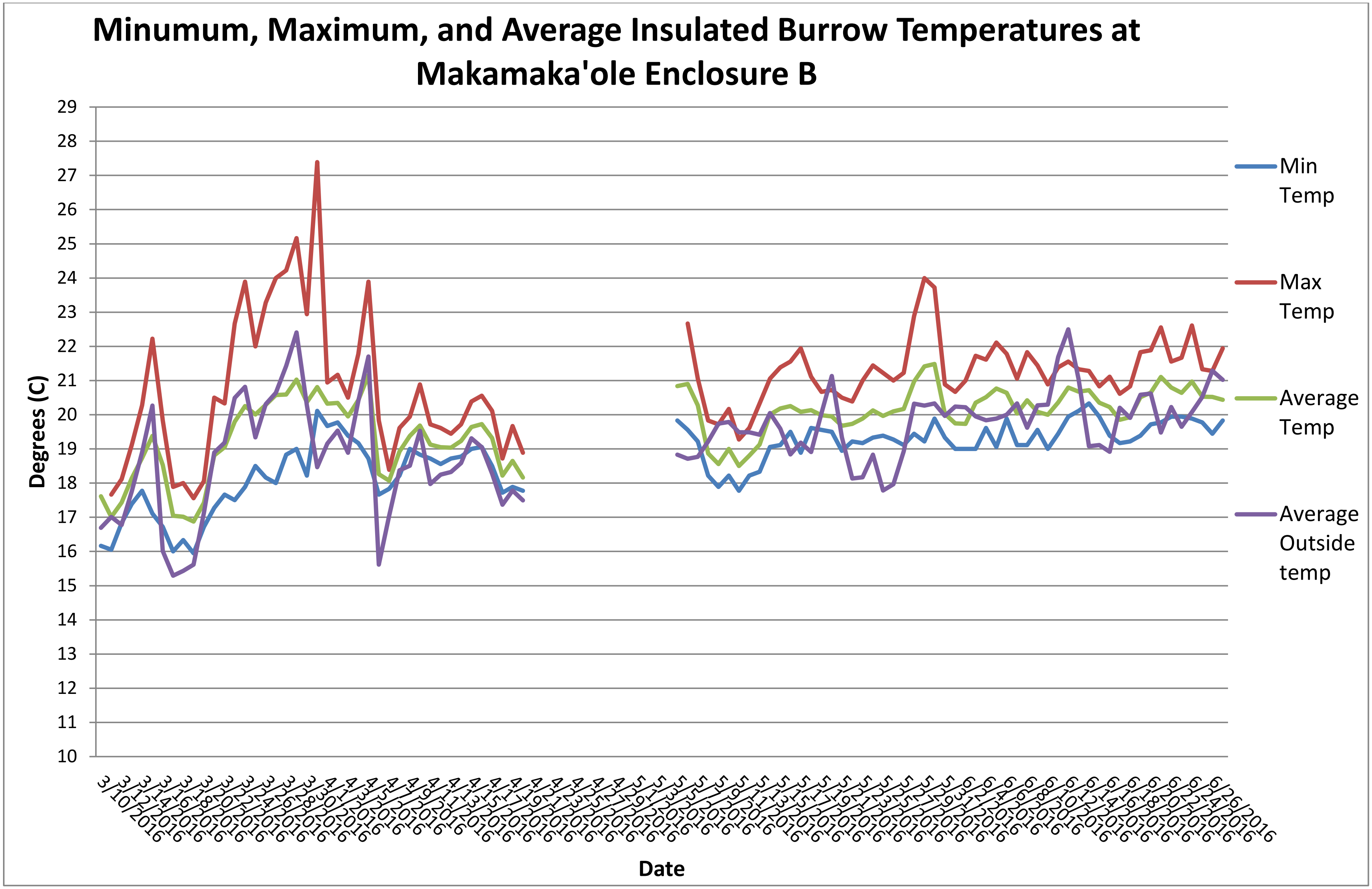

Figure 7. Graph showing minimum, maximum, and average burrow temperatures Inside enclosure B burrows with the final insulation design.

Appendix 15.

MEMORANDUM OF UNDERSTANDING

BETWEEN

KAHEAWA WIND POWER II, LLC

AND

THE STATE OF HAWAIʻI
Department of Land and Natural Resources
Division of Forestry and Wildlife

(Monitoring of Nene and Predator Control Management on the Island of Maui – Tier 1 Nene Mitigation Obligations under the Kaheawa Wind Power II Habitat Conservation Plan)

1. Preface.

This Memorandum of Understanding ("MOU") is made on May 30, 2016 between Kaheawa Wind Power II, LLC (hereinafter referred to as "KWP II") and The State of Hawaiʻi, Department of Land and Natural Resources, Division of Forestry and Wildlife ("DOFAW").

WHEREAS, on January 5, 2012 the Board of Land and Natural Resources ("BLNR") approved KWP II's Final Habitat Conservation Plan and issued to KWP II a State Incidental Take License ("ITL") pursuant to Hawaiʻi Revised Statutes Chapter 195D, authorizing the incidental take of the following Covered Species: Nene (*Branta sandvicensis*), Newell's Shearwater (*Puffinus auricularis newelli*), Hawaiian petrel (*Pterodroma sandwichensis*), and Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) on property owned or otherwise controlled by KWP II on the island of Maui;

WHEREAS, the Habitat Conservation Plan ("HCP") and State ITL provide that certain mitigation and monitoring tasks be implemented, and provide that DOFAW or another qualified entity may implement certain of those mitigation and monitoring tasks using funds to be provided by KWP II in partial fulfillment of the requirements of the HCP;

WHEREAS, DOFAW and KWP II have identified Nene nesting and release sites on the island of Maui that will benefit from predator control, monitoring, and vegetation management actions;

WHEREAS, KWP II and DOFAW, by mutual agreement, desire to establish a MOU pursuant to which KWP II and DOFAW will collaborate from April 1, 2016 to June 30, 2017 on efforts to protect and mitigate take for endangered Nene on Maui, and DOFAW will provide staff directly and all necessary equipment deemed appropriate to conduct Nene predator control, monitoring, and vegetation management;

NOW, THEREFORE, KWP II and DOFAW mutually agree to the following:

2. Purpose.

The purpose of this Agreement is to establish a MOU whereby:

- KWP II accepts the proposal by DOFAW titled *Scope of Work for Maui Nui Nene Monitoring and Predator Control Management* (hereinafter referred to as the "Scope of Work");
- DOFAW will implement the Scope of Work for the purpose of providing Tier 1 mitigation for the incidental take of Nene during construction and operation of the KWP II project; and
- KWP II will provide funds to DOFAW necessary to implement the Scope of Work indicated not to exceed $162,750, the "Amount Requested" in the Scope of Work .

This MOU does not negate or affect any other agreements in effect between KWP II and DOFAW. The attached Scope of Work may be updated by agreement from both parties in order to maintain the purpose and intent of this MOU, in concurrence with the U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office (USFWS PIFWO).

3. Responsibilities.

DOFAW:

- Will implement the Scope of Work (Attachment 1). This Scope of Work covers activities from April 1, 2016 to June 30, 2017. This Scope of Work has been reviewed by DOFAW, KWP II, and the USFWS PIFWO.
- Will report to KWP II and USFWS PIFWO as specified in the Scope of Work attached to this Agreement.
- Will deposit checks from KWP II, described below, in the State of Hawaiʻi Endangered Species Trust Fund, and ensure that such deposits are specifically designated for use by DOFAW to implement the attached Scope of Work.
- Will maintain an ongoing accounting of the funds spent implementing the monitoring portion of the attached Scope of Work including any expenditure reports and will provide them to KWP II upon request.

KWP II:

- Will, within 60 days of the execution of this MOU, deliver a check to DOFAW in the amounts agreed upon for the attached Scope of Work.

4. Implementation

The parties agree that this MOU constitutes a commitment by KWP II and DOFAW to collaborate on the projects described in the Scope of Work (Attachment 1), a commitment by KWP II to provide DOFAW with funds to be used to benefit and provide mitigation for the incidental take of Nene as described in the HCP, and a commitment by DOFAW to utilize such funds to implement the attached Scope of Work. The parties further agree that completion of the projects described in the attached Scope of Work will satisfy Tier 1 mitigation requirements for Nene as set forth in the HCP. Performance by DOFAW of the mitigation actions depends upon the timely receipt of funds from KWP II.

5. Termination

For any reason whatsoever, either party may terminate involvement in this MOU by providing 90 days prior written notice to the other party. Any unused funds will be returned to KWP II.

6. Counterparts

This MOU may be executed in several counterparts, each of which shall be an original and all of which shall constitute one and the same document. By signing below, each indicates that they have the requisite authority to enter into this Memorandum of Understanding.

IN WITNESS WHEREOF the **PARTIES** hereto have executed this, **MEMORANDUM OF UNDERSTANDING** by way of signature and date below.

KAWEAWA WIND POWER II, LLC

By: Hawaii Holdings, LLC,

Its sole member and manager

By: Hawaiian Island Holdings, LLC,

Its sole member and manager

By: First Wind Operating Company, LLC,

Its sole member and manager

By: TerraForm First Wind Operating Company, LLC

Its sole member and manager

By: TerraForm First Wind ACQ, LLC,
Its sole member and manager

By: TerraForm First Wind ACQ Master Holdco, LLC

Its sole member and manager

By: TerraForm Power Operating, LLC,
Its sole member and manager

By: ______________________

Name: Rebecca Cranna
Title: Executive Vice President and Chief Financial Officer

Department of Land and Natural Resources
Division of Forestry and Wildlife:

____

Suzanne Case, Chairperson
Board of Land and Natural Resources

Date: 7/1/16

APPROVED AS TO FORM:

____

Deputy Attorney General
State of Hawaii

Attachment 1

Scope of Work for Maui Nui Nene Monitoring and Predator Control Management

PROPOSAL

to

KAHEAWA WIND POWER II, LLC

PROJECT TITLE:	Maui Nui Nene Monitoring and Predator Control Management
DEPARTMENT:	Land and Natural Resources
DIVISION:	Forestry & Wildlife
DISTRICT:	Maui
PROJECT PERIOD:	April 1, 2016 to July 15, 2017
AMOUNT REQUESTED:	$162,750.00

Project Description

On January 5, 2012 the Board of Land and Natural Resources approved SunEdison's (formerly First Wind) Kaheawa Wind Power II Habitat Conservation Plan (HCP) and Incidental Take License (ITL). The ITL authorizes the incidental take of the Nene (*Branta sandvicensis*). Mitigation described under the HCP consists of providing funding to the Division of Forestry and Wildlife (DOFAW) to build an additional release pen and five years of funding for conducting predator control, vegetation management and monitoring at the additional pen beginning in 2016 and monitoring will include an annual census, banding of adults and fledglings, identifying nests and quantifying reproductive success at the release pen area. In addition, predator control measures to reduce populations of mammalian predators are to be conducted in and around the release pen and are expected to increase the survival of fledglings and adults in and around the vicinity of the pen and also increase the productivity of breeding pairs.

At this time DOFAW does not plan to build an additional release pen but other Nene management actions as described in the HCP will be conducted under this project. The project objective for Maui Nui Nene Monitoring and Predator Control Management is to assist in the recovery of the Nene (*Branta sandvicensis*). The primary objectives are to establish predator trap lines in known nesting areas, removal of invasive vegetation in and around an open-top release pen, and to monitor movements and nesting activities throughout Maui County.

Project Objectives

- Establish and maintain trap lines in known nesting areas throughout Maui County. These trap line will be instituted to control rats, mongoose, cattle egrets, feral cats and dogs that may pose a threat to Nene and nesting sites. Areas where trap lines may be established include the following areas; West Maui, South Maui, Central and UpCountry (Makawao, Kula). Sites will be determined during the breeding season and as landowner agreements are established. No rodenticides will be used.
- Habitat Management – controlling alien plant invasions using chemical and mechanical means, mowing grass areas, and assist in restoring native vegetation at the open-top release pen site at Piiholo Ranch.
- General maintenance of the open-top release pen which includes maintenance of storage buildings, fence lines and water units.
- Monitoring movements, nest success, distribution and survival of Nene at the open-top release sight and established managed areas with trap lines. Records will be kept of individual birds sighted, GPS nest locations, and monitoring of nesting activities and success. Additionally, assistance with examinations, measurement and banding of unidentified birds will be conducted. All birds will be banded if possible.

- Identify areas of human conflict with agriculture, transportation, and other human activities that may be hazardous to Nene or humans. Assist in outreach with the public regarding conflicts or concerns with Nene.
- Evaluation of mitigation success and documentation of productivity will be based on comparisons with previous monitoring data (the baseline) for the Lahainaluna and Olowalu sites for 2012-2015 as shown in the table below. The baseline number of fledglings produced for the period 2012-2015 is 3.0 for Lahainaluna and 5.25 for Olowalu. At Piiholo, the baseline number of fledglings is considered zero since all fledglings produced in the period covered by this proposal will be from actions funded under this proposal.

NENE NESTS AND FLEDGLINGS – BASELINE FROM MONITORING

Date	Location	Number of Nests	Number of Fledglings	Baseline as Mean Number of Fledglings
2012	Lahainaluna	6	4	3.0
2013	Lahainaluna	10	6	
2014	Lahainaluna	12	2	
2015	Lahainaluna	5	0	
2012	Olowalu	4	9	5.25
2013	Olowalu	7	1	
2014	Olowalu	7	11	
2015	Olowalu	4	0	

Reporting

- Detailed records of sightings, nesting success, predator removal, and banding will be required and submitted in an annual report by July 15, 2017.

Coordination

1. Operations coordinated by the Maui Branch Nongame Biologist.
2. Conduct public outreach and educate the public on Nene awareness.
3. Coordinate with other agencies and community on human conflicts and concerns.

Operations

1. Coordinate and plan field operations under the guidance of Nongame Wildlife Biologist.
2. Conduct field observations of movements and nest success.

3. Establish, manage and monitor trap lines.
4. Conduct habitat management and maintenance in open-top release pen areas.
5. Band and mark wildlife for distribution and life studies which include examines wildlife for sex, age and weight.
6. Gather and organize data for analysis by the Nongame biologist.

Budget

Service Period:	April 1, 2016 to July 15, 2017	
Funding Source:	Mitigation Funds (SunEdison)	$162,750.00
Positions Request:	Biologist	$82,000.00
	Wildlife Field Assistant	$60,000.00
Equipment / Supplies	Traps, binoculars, GPS units, Rain gear, computers, game cameras, office Supplies	$13,000.00
Administrative Fee		$7,750.00

Appendix 16. KWPII expenditures for FY 2016.

KWPII	Cost
Permit Compliance	$182,088
Seabird Management	$25,275
Vegetative Management	$20,416
Fatality Monitoring	$32,164
Equipment and Supplies	$5,722
First Wind Labor	$71,576
Total Cost for FY 2015	**$337,241**