Auwahi Wind Farm Habitat Conservation Plan FY2014 Annual Report
Incidental Take Permit TE64153A-0/ Incidental Take License ITL-17

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1.0 Introduction

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

This report provides a summary of monitoring and mitigation activities that have occurred since Fiscal Year (FY) 2013 report (from July 1, 2013 to June 30, 2014). The following subsections provide an overview of post -construction mortality monitoring (PCMM) and mitigation activities and address other required annual reporting items, an annual work plan for the upcoming year, and annual cost expenditures as required under the ITP/ITL. Auwahi Wind successfully met all permit conditions in FY 2014 (Table 1-1). Auwahi Wind provided a one-time payment of $25,000 to the Haleakala National Park on April 17, 2012, to cover mitigation expenses for the Hawaiian Goose. Auwahi Wind developed a MOU and a made a one-time payment of $14,000 to the Leeward Haleakala Restoration Partnership (LHWRP) on April 17, 2012 to cover mitigation expenses for the Blackburn's sphinx moth. Detailed reports providing updates on Hawaiian petrel and Blackburn's sphinx moth mitigation, as well as the finalized Hawaiian hoary bat research plan, are included as attachments to this report.

Table 4-1. Summary of Compliance Status July 1, 2013-June 30, 2014.

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
PCMM at the Project				
Project biologist	HCP, Section 4.2.1 and 7.1.1	To be on-staff during project operations	In compliance; ongoing	Sempra Project Biologist has been on staff since June 2013, prior Tetra Tech acted as project biologist.
PCMM	HCP, Section 7.1.1 & PCMM Plan	Intensive monitoring will occur years 1, 2, 7, 12, 17, and 22 (total of 6 years, includes carcass removal and searcher efficiency trials)	In compliance; ongoing	Monitoring commenced in December 2012 and is ongoing through year 2 of operation. PCMM results for FY14 are provided in section 2 of this report.
Wildlife education and incidental reporting program	HCP, Section 7.11	Prior to and throughout operations	In compliance; ongoing	A wildlife education and incidental reporting program was initiated during construction and is ongoing. Eight fatalities have been reported via this program in FY14.
Notification of DLNR and the USFWS whenever a species protected by the Migratory Bird Treaty Act (MBTA), or a listed species, is found dead or injured, and observations of seabirds attracted to construction lighting	ITP Conditions L(i)	Via telephone within 24 hours and in a written report within five calendar days	In compliance; ongoing	Incident reports for 2 fatalities in FY13 and 19 fatalities (8 incidental and 11 during systematic searches) in FY 14 were submitted. One fatality was a T&E species (Hawaiian Hoary Bat), reported on October 9, 2013.
Reporting to DLNR of any mortalities, injuries, or disease related to the Covered Species	ITP Condition L(iv)	Within 3 days		
Table summarizing fatalities documented during PCMM	ITP Condition L(iv)	Semi-annually	In compliance; ongoing	Semi-annual table submitted to USFWS and DOFAW January 15, 2014. Fatalities documented during FY 14; provided in section 2 of this report, table 2-3.
Semi-annual progress report	ITP Condition L(ii)	Annually in February	In compliance; ongoing	Semi-annual progress report submitted to USFWS and DOFAW January 15, 2014. The next semi-annual progress report will be submitted in February, 2015.

Table 5-1. Summary of Compliance Status July 1, 2013-June 30, 2014.

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
Hawaiian Hoary Bat Mitigation				
Conservation easement for the Waihou Mitigation Area (Tier 1 mitigation)	HCP, Section 6.2.1	Within 210 days of ITP/ITL issuance or the initiation of vertical construction of the turbines, whichever comes sooner; easement extension granted by DOFAW	In compliance; completed	Recorded conservation easement with the Hawaiian Islands Land Trust to preserve the Waihou Mitigation Area in perpetuity on December 18, 2012.
Install new ungulate-proof fencing or retrofit cattle fencing around the Waihou Mitigation Area (Tier 1 mitigation)	HCP, Section 6.2.1	Initiate within first year of permit issuance and shall be completed within two years of permit issuance (February 9, 2014)	In compliance; completed	Installation complete September 2013.
Remove ungulates from within fence line (Tier 1 mitigation)	HCP, Section 6.2.1	Initiate after ungulate proof fence is completed	In compliance; completed	Ungulates removed in March of 2014. Quarterly inspections of fence to ensure fence stability and area remains ungulate free.
Conduct vegetative restoration activities, including removal of invasive species and native reforestation (Tier 1 mitigation)	HCP, Section 6.2.1, Table 6-3	Initiate after ungulate proof fence is completed	In compliance; ongoing	Semi-annual removal of target invasive species conducted in March 2014. Native plants being propagated at local nursery, to be planted FY15.
Acoustic monitoring at the wind farm (Tier 1 mitigation)	HCP, Table 6-2	Years 1 and 2 of operation	In compliance; ongoing	Initiated July 2013, results of first year provided in section 3.2 of this report.
Hawaiian hoary bat research plan (Tier 2 mitigation)	HCP, Section 6.2.2	Draft research plan to USFWS/DOFAW within 1 year of issuance of ITP; finalize within 2 years of ITP issuance and before the start of the study	In compliance; completed	Final plan submitted to USFWS and DOFAW in February 2014; in cooperation with USGS. Plan approved by agencies March 2014. See Attachment 2.

Table 6-1. Summary of Compliance Status July 1, 2013-June 30, 2014.

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
Hawaiian Petrel Mitigation				
Petrel burrow surveys (Tier 1 mitigation)	HCP, Section 6.3.6, Table 6-6	Burrow monitoring will occur annually for first 3 years, an additional 5 years of monitoring will occur at certain points during the life of the mitigation	In compliance; ongoing	Conducted petrel burrow surveys in 2012 and 2013; 2014 burrow surveys started in March and will continue through November 2014. 2013 results provided in Attachment 1.
Predator control at the Kahikinui Petrel Management Area (Tier 1 mitigation)	HCP, Section 6.3.5; Petrel Management Plan	Auwahi Wind will begin predator control within the first year of operation	In compliance; ongoing	Phased deployment of predator control traps in September 2013. Full implementation of predator control in February 2014. 2013 results provided in Attachment 1.
Blackburn's Sphinx Moth Mitigation				
Funding to the Leeward Haleakala Watershed Restoration Partnership (LHWRP) to restore 6 acres of dryland forest in the Auwahi Forest Restoration Project	HCP, Sections 4.2.3 & 6.5.1, Table 6-2	First payment to LHWRP within 30 days of obtaining permit and remainder of funds paid within 3 months	In compliance; complete	Full payment to LHWRP on April 17, 2012. A letter from LHWRP summarizing status of restoration is provided in Attachment 3.
Nene Mitigation				
Research or management funding ($25K) provided to Haleakala National Park	HCP, Section 6.4, Table 6-2	Within 60 days of obtaining permit	In compliance; complete	Full payment to NPS April 17, 2012. A letter from the NPS summarizing the status and use of funds is provided in FY13 reporting.
Abutilon menziesii **(red ilima)**				
Ulupalakua Ranch will plant 10 red ilima from its on-going conservation efforts. Report plant survival (3yrs)	HCP, Section 4.2.3	After construction/site restoration is complete	In compliance; complete	Plants propagated at the Ulupalakua Ranch nursery in 2013. They are successfully planted and thriving.
Fire Management Plan				
Invasive species surveys for fire prone grass	HCP, Section 4.2.4; Fire Management Plan	Annually; additional semi-annual surveys for 2 years where invasive species are found	In compliance; ongoing	Invasive fire prone grass survey conducted annually. Buffel grass (*Cenchrus ciliaris)* established Project wide prior to construction.

2.0 Post-construction Mortality Monitoring

Auwahi Wind's HCP lays out a long term monitoring approach consisting of two years of intensive monitoring followed by interim years of less intensive but systematic monitoring. PCMM was initiated in December of 2012. During the commissioning period (December through mid-January) heavy construction equipment and operations in the near vicinity of the turbines limited the searching to pads and roads. Beginning January 25th, 2013, standardized carcass searches beneath all eight turbines and the met tower, carcass persistence trials, and searcher efficiency trials began following the schedule and methods outlined in detail in the FY13 report in Attachment 1 (summary in Table 2-1). PCMM has continually been in effect since the commissioning of the project.

A Migratory Bird Special Purposes-Utility Permit (Permit No. MB92518A-0) for handling migratory bird carcasses was issued by USFWS on December 10, 2012. A State Protected Wildlife Permit (Permit No. WL14-03) for handling native bird and bat carcasses was issued by DOFAW on April 11, 2013. Permits are valid through March 31, 2015 and September 24, 2015, respectively.

Twenty-one fatalities have been documented at the Auwahi Wind site since the start of operations; nineteen of these fatalities were documented in FY 14. One fatality in FY 14 was a covered species, the Hawaiian hoary bat (Table 2-3). No fatalities have been observed at the met tower.

Table 2-1. Post-construction Mortality Monitoring Summary, FY 14.

Variable	Value
Study Metrics for Fatality Estimates	
Total number of Project turbines	8
Number of turbines searched	8
Turbine specifications	Siemens 3.0 Megawatts Hub height: 80 meters (263 feet) Rotor diameter: 101 meters (331 feet) Maximum blade tip height (MBTH): 131 meters (428 feet)
Turbine search plot size	200 meters x 200 meters (656 feet x 656 feet)
Met tower search plot size	10 meters (33 feet) around the base of the met tower
Study period	Annual (July 1st 2013-June 30th 2014 in this report)
Search interval	3.5 days July-November, 7 days December -June
Fatalities of Covered Species	
Hawaiian Petrel	
Number of fatalities documented	0
Adjusted take	0
Hawaiian Goose	
Number of fatalities documented	0
Adjusted take	0
Hawaiian Hoary Bat Fatalities	
Number of fatalities documented	1
Adjusted take	0 (take occurred outside of breeding season)
Fatalities of Other Species[1]	
Number of fatalities during searches	10
Number of fatalities incidental	8

[1]Includes five MBTA species and one Blackburn's Sphinx Moth died of natural causes (not incidental take).

2.1 Standardized Carcass Searches

Standardized carcass searches were conducted at all eight turbines and the met tower. The turbine search plots extend 100 meters (328 feet) from the turbine on each side to create a square plot of 200 meters x 200 meters (656 feet x 656 feet) centered on the turbine. Linear transects are spaced approximately 6 meters (19.7 feet) apart are established within the search plot, with searchers scanning out to 3 meters (9.8 feet) on each side of the transects. The actual search area is smaller than the entire plots due to some areas considered non-searchable for safety reasons. Searchers used a handheld Trimble Juno GPS unit to log searching efforts; all data collected was downloaded at the end of the day. Based on the amount of searchable area within each plot, the proportion of the bird and bat carcass distributions actually searched was calculated for each turbine and for the Project (based on 25 publically available studies compiled by Tetra Tech). Based on the current search plot size and configuration, a total of 97.1 percent of the bat distribution and 90.7 percent of the large-bird distribution was searched for the Project during standardized carcass searches in FY 14.

The following search intervals are followed:

- Weekly surveys from December through June, when petrel and bat activity is expected to be low.
- Twice weekly surveys from July through November, which includes petrel fledging period (October through November) and peak bat activity.

Table 2-2 Average Search Interval between Standardized Carcass Searches at the Auwahi Wind Project, FY 14.

Month	Average Search Interval (days) [1]
July	3.5[2]
August	3.1
September	3.1
October	3.0
November	3.5
December	6.1
January	6.1
February	6.2
Bat March	6.2
April	6.0
May	5.9
June	6.3

[1] Includes all turbines and meteorological tower

[2] Tropical Storm Flossie interrupted regular search interval in late July

Nineteen fatalities were documented in FY 14 at the Project; eleven of these fatalities were documented during standardized carcass searches (Table 2-3). Five fatalities recorded were covered under the Migratory Bird Treaty Act. One fatality was a HCP covered species, the Hawaiian hoary bat. No fatalities have been observed at the met tower.

Table 2-3. Documented Fatalities at Auwahi Wind Project, FY 14.

Species	Legal Status	Found Date	Location (Turbine)	Type of Detection
Hawaiian Hoary Bat *(Lasiurus cinereus semotus)*	T&E	10/9/2013	2	Standardized Search
Great Frigatebird *(Fregata minor)*	MBTA	10/21/2013	5	Standardized Search
Zebra Dove *(Geopelia striata)*	None	11/27/2013	Site Road	Incidental
African Silverbill *(Lonchura cantanas)*	None	12/2/2013	2	Incidental
Common House Sparrow *(Passer domesticus)*	None	1/10/2014	1	Incidental
Gray Francolin *(Francolinus pondicerianus)*	None	2/3/2014	8	Standardized Search
Blackburn's Sphinx Moth *(Manduca blackburni)*	T&E	2/3/2014	5	Incidental [1]
Common Myna *(Acridotheres tristis)*	None	2/12/2014	2	Incidental
African Silverbill *(Lonchura cantanas)*	None	2/13/2014	3	Standardized Search
African Silverbill *(Lonchura cantanas)*	None	2/21/2014	2	Standardized Search
African Silverbill *(Lonchura cantanas)*	None	2/21/2014	2	Standardized Search
Common House Sparrow *(Passer domesticus)*	None	2/27/2014	Site Road	Incidental
Common House Sparrow *(Passer domesticus)*	None	3/21/2014	2	Standardized Search
Cattle Egret *(Bubucus ibis)*	MBTA	4/22/2014	O&M	Incidental
Common Chukar *(Alectoris chuckar)*	None	4/29/2014	4	Standardized Search
Gray Francolin *(Francolinus pondicerianus)*	None	5/23/2014	6	Standardized Search
Bulwer's Petrel *(Bulweria bulwerii)*	MBTA	6/24/2014	7	Standardized Search
Wedge-tailed Shearwater *(Ardenna pacificus)*	MBTA	6/25/2014	5	Standardized Search
Bulwer's Petrel *(Bulweria bulwerii)*	MBTA	6/27/2014	5	Incidental

[1] DOFAW determined female Blackburn's Sphinx Moth died of natural causes associated with life cycle; this was not the result of project operations.

2.2 Carcass Persistence Trials

The survey year is divided into the wet season (November through April) and dry season (May through October). Carcass persistence trials were conducted during the wet and dry season of FY 14 and are summarized for each carcass size class in Table 2-2. Two carcass persistence trials were conducted during the dry season and three carcass persistence trials were conducted during the wet season of FY14. Each season had a minimum of thirty carcasses per size class. Wedge-tailed shearwaters (*Ardenna pacificus*) and chukars (*Alectoris chucker*) were used as surrogates for large birds and a combination of mice, small birds and medium – sized rats were used as surrogates for bats.

Carcasses were placed at randomly generated points within the turbine search plots, stratified by cover type to ensure that different types of terrain and vegetation, indicative of differing levels of visibility, were represented in proportion to their presence in the search plots. Carcasses were checked daily until they were no longer detectible or the 21-day trial period was complete. Changes in carcass condition were tracked and documented with photos. Detailed description of field and analytical methods are included in Attachment 1 of the 2013 HCP annual report. Bootstrap estimates of carcass persistence time and 95 percent confidence intervals were calculated, using 1,000 replicates, by carcass category.

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

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

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

Both large bird and bat surrogates persisted much longer during the wet season as opposed to the dry season (Table 2-4). Although, bats overall average probability of persistence was greater in the dry season due to increased search efforts July – November. When Auwahi Wind documented low carcass persistence times during the dry season of FY 13, they proactively put measures in place to reduce predator abundance. Predator control for mongoose and cats is implemented year round at the Project. It is difficult to determine if increased carcass persistence time in the wet season was the result of implemented predator control or of changes to predator prey interactions in what was considered an “unusually” wet year on the leeward side of Maui. The island of Maui was subjected to an island wide field mouse (*Apodemus sylvaticus*) explosions beginning in December 2013. Abundance of prey (field mice) for predators (feral cats and mongoose) at the Project may have reduced the attractiveness of trial carcasses to predators, resulting in an increase in carcass persistence.

Table 7-4. Carcass Persistence Estimates for the Wet Season (November-April) and Dry Season (May-October) at the Auwahi Wind Project, FY 14.

Season	Carcass Size Class	N	Average Carcass Persistence Time (days)	95% CI	$\hat{r}$ value[2]
Wet	Bats[1]	46	14.3	7.6-26.2	0.49
Dry	Bats[1]	60	5.8	4.2-7.8	0.65
Wet	Large birds	21	>100 days[3]	>100 days[3]	0.98
Dry	Large birds	30	19.9	9.3-44.5	0.83

[1]Mice, small birds, and medium-sized rats used as surrogates

[2] Average probability of persistence, value weighted to reflect changes in the fatality search interval throughout the season

[3]Carcasses lasted the duration of study period, using Huso 2011 they could theoretically last 3,000+ days

2.3 Searcher Efficiency

Searcher efficiency trials were conducted during the wet and dry season during FY14. These trials incorporated the assessment of each member of the field staff and were conducted by the Project Biologist (tester) on site. All trials were conducted so that the searchers being assessed had no prior knowledge of the trial; every fatality search day was treated as if it had the potential to be a searcher efficiency trial day. Nineteen searcher efficiency trial days occurred during the dry season and twenty-seven trial days occurred during the wet season of FY14. Each season had a minimum of thirty carcasses per size class placed. Wedge-tailed shearwaters and chukars were used as surrogates for large birds and small mice and medium sized rats were used as surrogates for bats.

Turbines were randomly selected for trials. On each trial day, one to five carcasses from each size category were placed in the field. Carcasses were placed at randomly generated points within the selected turbines' search plots, with points stratified by cover type to ensure that they were represented in proportion to their presence within the study area. All trial carcasses were retrieved by the end of each trial day; if a trial carcass was not found by searchers the tester would go out to the location and attempt to retrieve the trial carcass. If not found by the searcher or the tester, the carcass was assumed to have been scavenged and thus unavailable to be found by searchers. Subsequently, these carcasses were not included in the analysis.

Bootstrap estimates of searcher efficiency and 95 percent confidence intervals (CI) were calculated, using 1,000 replicates for each carcass category (large bird and bat).

The estimated searched efficiency is defined by Huso (2011) as:

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

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

Searcher efficiency for large birds remained above 70% in both the wet and dry season. Searcher efficiency did decrease for large birds and bats during the wet season of FY 14. This was most likely due to an unusually wet year on the leeward side of Maui, resulting in increased vegetation heights, temporarily impairing visibility of searchers. Auwahi Wind worked within the constraints of Ulupalakua Ranch scheduling to move cattle from neighboring pastures onto the Project vicinity as soon as possible. Once cattle were moved within the Project vicinity (March 2014) they were able to significantly reduce vegetation, as a result searcher efficiency increased.

Table 2-5. Searcher Efficiency Estimates for the Wet Season (November-April) and Dry Season (May-October) at the Auwahi Wind Project, FY 14.

Season	Carcass Size Class	No. Placed[1]	No. Found	Average Searcher Efficiency (%)	95% CI
Wet	Bats	27	11	41	22-59
Dry	Bats	27	16	59	41-74
Wet	Large birds	31	22	71	52-87
Dry	Large birds	25	22	88	72-100

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

2.4 Take

2.4.1 Direct Take

During the first year and a half of intensive monitoring at Auwahi Wind Farm, there was one covered species fatality documented (Hawaiian hoary bat). The Huso estimator (Huso 2011; Huso et al. 2012) is currently the least biased method for estimating the adjusted number of fatalities given a sufficient sample size. However, the Huso and other fatality estimators should only be used to calculate adjusted fatality estimates for sample sizes of more than five and accuracy in the estimated number of fatalities may still be questionable with sample sizes of less than 10 or 15 carcasses (H. Huso, personal comm., 2013 Bat and Wind Energy Workshop, Honolulu, HI). Currently, there are no accurate methods available for calculating adjusted fatality estimates with small sample sizes (e.g., less than 5 carcasses). Therefore, it is not possible to calculate an adjusted fatality estimate with the current sample size.

DOFAW determined the female Blackburn's Sphinx Moth found by Environmental technicians died of natural causes associated with life cycle; this was not the result of project operations. Auwahi Wind has already mitigated for any potential impact operations may incur and is taking proactive measures to ensure avoidance and minimizations measures are in place.

2.4.2 Indirect Take

The Hawaiian hoary bat was taken on October 9, 2013, outside of the breeding season (Menard 2001, cited in Cooper and Day 2009); therefore, no indirect take occurred.

2.5 Wildlife Education and Incidental Reporting

Auwahi Wind implemented a Wildlife Education and Incidental Reporting program for contractors, Project staff members, and other 'Ulupalakua Ranch staff who are on site regularly. This annual training enables staff to identify the Covered Species that may occur in the Project area, record observations of these species, and take appropriate steps for documenting and reporting any species encountered during the construction and operation of the Project. Fourteen individuals have gone through this training in FY14 and eight incidental fatalities were reported (Table 2-3).

2.6 Adaptive Management

2.6.1 Post-construction Mortality Monitoring Adaptive Management

Within the PCMM protocol, monthly fatality searches between December and February, when Hawaiian Petrels are not accessing the Haleakala colony, is currently approved. Auwahi Wind voluntarily increased its fatality search interval to once per week to reduce the bias associated with carcass persistence duration.

In order to be consistent across wind farm projects in the Hawaiian Islands, USFWS/DOFAW (agencies) made recommendations for carcass surrogates to be used for Hawaiian petrels and bats. They recommended wedge-tailed shearwaters to be used as surrogates for petrels and medium sized rats to be used for bats (via a coordination meeting on January 31, 2014). In December of 2013, Auwahi Wind already had moved to using only wedge-tailed shearwaters in searcher efficiency and carcass persistence trials. In March of 2014, Auwahi Wind moved to using only medium sized rats as bat surrogates.

Carcass persistence trials conducted in the FY 13 wet season documented a high number of carcasses scavenged early in the 21 day trial period. In order to decrease the scavenging rate and potentially increase carcass persistence at the site, Auwahi Wind implemented full predator control in December of 2013. Feral cat and mongoose traps were deployed across all turbine plots and were actived year round. Mongoose traps consisted of two types of kill traps, DOC 250's and Goodnature A24's. Feral cat trapping was limited to Belisle Body Grip traps, when cattle were not present. All traps were checked on average biweekly during the wet season and weekly during the dry season. All trap types were successful at removing predators, 42 mongoose and 3 feral cats were removed from the site during FY 14. Carcass persistence duration has increased across the site, most likely a result of trapping efforts. Predator control will continue at the Project in FY 15.

In June 2014, during the quarterly coordination meeting, the agencies concurred with Auwahi Wind that the fatality search plot for bats could be reduced to a 50 meter radius of the turbine without significantly impacting the bat carcass distribution searched. The proportion of the bird and bat carcass distributions was calculated for each turbine within the Project. The carcass distribution calculation is based on 25 publically available studies compiled by Tetra Tech and confirmed in a peer reviewed study comparing observed distributions with modeled distributions for bats and other bird class sizes (Hull and Muir 2010). Based on this compiled data, it is calculated that approximately 90% of bat carcasses fall within the first 50 meters of the turbine base. Accounting for areas that are unsearchable, the new search plot size will encompass 91 percent of the bat distribution at the Project. Moving forward in FY 15, searcher efficiency and carcass persistence trials will now be restricted to within the new plot size.

2.6.2 Blackburn's Sphinx Moth Avoidance and Minimization

In February of 2014, Auwahi Wind field technicians found a Blackburn's sphinx moth dead on the pad of turbine 5. It was confirmed by DOFAW that the female moth died of natural causes and therefore was not an incidental take resulting from project operations. Although the risk of effects to the moth, in association with project operation, has been determine to be very low, due to the increased presence of tree tobacco (*Nicotiana glauca*) at the Project, Auwahi Wind consulted with the agencies to identify any additional measure that could be implemented to avoid and minimize potential impacts to moths (via a conference call on February 6, 2014). It was decided that, although the likelihood was low, areas within 33 feet of roadsides and edges of turbine pads may present a hazard for the moth, due to exposure to dust, possible trampling and increased chance of collisions with vehicles. Avoidance and minimization measures include manual removal of tree tobacco and translocation of any moth larvae and eggs found on host plants within a 33 foot roadside buffer (via email instructions February 7, 2014).

In March, 2014 Auwahi Wind technicians visually surveyed all tree tobacco within a 33-foot buffer around the roads, turbine pads and any other disturbed areas within the Project. They approached each plant and visually surveyed for signs of pupating larvae (such as frass, chewed stems or other browsing characteristics). If no larva/eggs were detected, the plant was removed. Sixty-eight Blackburn's sphinx moth larva and two eggs were detected during visual surveys of tree tobacco in FY 14. All eggs and larvae found were relocated following instructions by USFWS/DOFAW (email instructions Feb 7, 2014). Over 270 plants were removed from the Project. The Project is now visually inspected once a month for tree tobacco, any plant detected is fully inspected and removed.

3.0 Mitigation

3.1 Hawaiian Petrel Mitigation

Results from the 2013 petrel breeding season are summarized below. The 2013 Petrel Monitoring Report provides additional detail for the 2013 results and is included as Attachment 1. In February 2014, full implementation of the predator control strategy was applied across Kahikinui Petrel Management Area. This included a predator assessment using tracking tunnels, grid spaced traps targeting areas within a 200 meter buffer of Hawaiian petrel nesting burrows, and game cameras to monitor for cat detections. Results of the 2014 breeding season and predator control will be included in the 2014 Petrel Monitoring Report and will be summarized in the 2015 annual report.

3.1.1 Petrel Burrow Monitoring

Petrel burrows within the Kahikinui Petrel Management Area (Kahikinui) continued to be monitored during the 2013 breeding season to obtain an estimate of the number of active petrel burrows and reproductive (fledging) success. As in previous years, monitoring protocol follows methods used by the National Park Service (NPS; NPS 2012). Burrows were checked a minimum of once a month from March through August, and every other week during the chick rearing and fledgling period, from September to mid-November. All burrows were monitored during each check March- July; after July only active burrows were monitored. New burrows located in 2013 were marked, mapped, and added to the monitoring dataset. In the 2013 breeding season 59 petrel burrows were monitored, including five newly discovered burrows in 2013. By August 2013, 26 burrows still showed signs of activity. By the end of the breeding season 7 burrows had successfully fledged a chick. The percentage of known chick's fledged/active burrow within the management area was 27%. We cannot confirm that all active nests were occupied by breeding birds. The percentage of chicks fledged/eggs laid within the management area was 27 – 64%. The range represents the difference between using only those nests with known fates versus including all potentially active nests (i.e., burrows classified as failed or occupied by a non-breeder).

In May 2013, 10 Reconyx game cameras were deployed at active petrel burrows to document burrow activity and the presence of predators at burrows. An additional 7 Reconyx game cameras were deployed at active burrows in August 2013, for a total of 17 cameras. The cameras were rotated between active burrows throughout the breeding season to confirm reproductive success of nests and document predation events. Cameras were rotated between nineteen burrows and captured successful fledging of five chicks (Attachment

1). Three separate instances of a feral cat investigating an active burrow were recorded by the game cameras. There were no clear documented signs of depredation at any of the monitored burrows.

3.1.2 Predator Control

Auwahi Wind worked with Island Conservation and Tetra Tech to develop a predator control strategy for Kahikinui based on site-specific conditions and Island Conservation's expertise. The strategy allows predator control to be adaptively managed over time. The effectiveness of the initial phase of efforts informed how the strategy needed to be refined in order to best control predators in the petrel colony

Given the scale, remoteness, ruggedness and uncertainties related to the effectiveness of different trap types within Kahikinui, Auwahi Wind implemented a phased approach to predator control. The initial phase was started in September, 2013 and involved the deployment of tracking tunnels to assess rat and mongoose activity across the entire management area and a variety of kill traps paired with cameras within the northern section Kahikinui to evaluate trap effectiveness. A total of 59 traps were deployed within the northern section of the management area (above 9,000 feet elevation) from September – November 2013. Four different traps were evaluated, DOC250 traps (targeting mongoose and rats), Belisle Body Grip traps (targeting feral cats), GoodNature A24 traps (targeting mongoose and rats) and KaMate traps (targeting rats). All traps were checked and baited once a week with a variety of baits to attempt to determine bait preferences and longevity. This initial phase of deployment removed a total of ten predators, including Polynesian Rats, Black Rats and Mice. This initial testing phase allowed Auwahi Wind to collect site- and trap-specific data on predator presence, activity and other logistic factors to determine the most effective and efficient methods of predator control to be used at Kahikinui. The 2013 Petrel Monitoring Report, summarizing in detail the results for 2013 predator control, is included in Attachment 1.

3.1.3 Benefits

To date, Auwahi Wind has measured baseline reproductive success of Hawaiian petrels within Kahikinui as well as baseline predator activity levels. Auwahi Wind is committed to predator control for the life of the project, this should have a positive effect on the reproductive success of Hawaiian Petrels not only within Kahikinui but possible have spillover effects in areas managed by NPS and ATST. Ongoing monitoring continues to benefit the petrel colony by providing new information on the extent of the colony, reproductive success, and fledging activity which was previously unknown. Deployment of Reconyx cameras have given the scientific community unique insight into the activity and exact fledging dates of Hawaiian petrels within the East Maui population (see Attachment 1).

3.2 Hawaiian Hoary Bat Mitigation

Implementation of Tier 1 and Tier 2 bat mitigation is underway at the Waihou Mitigation Area, located on Uluplalakua Ranch. The key elements of Tier 1 mitigation consist of the restoration of native forest on approximately 130 acres of pastureland in the Waihou Mitigation Area (including installation of an ungulate proof fence, ungulate removal and native reforestation). This parcel was placed into a conservation easement held by the Hawaiian Islands Land Trust on December 18, 2012, and will be protected in perpetuity. Tier 2 mitigation consists of funding Hawaiian hoary bat research to contribute to the overall knowledge of the Hawaiian Hoary Bat on Maui.

Auwahi Wind has also installed two ground-based detectors (Wildlife Acoustics SM2-XBat) at the Project site to collect acoustic data for the first two years of operation.

3.2.1 Ungulate Proof Fence Installation

Auwahi Wind contracted Pacific Fencing to install an ungulate proof fence around the 130-acre Puu Makua parcel. The fence was completed in September 2013. The 8 feet (2.4 meter) tall fence is approximately 11,475 linear feet, made of hog wire with no barbed wire strands with a mesh size of less than 6 inches (15.2 cm). In January 2014, F.A.R.E ungulate control was contracted to conduct extensive sweeps of the enclosed area and remove all ungulates found. F.A.R.E. used a combination of hunters on foot, dogs and thermal imaging cameras to remove all ungulates. The site is now certified by F.A.R.E as ungulate free, as of January 2014. Fence checks are conducted quarterly to ensure the integrity of the fence and detect any possible incursion.

3.2.2 Site Restoration and Management

Following the Waihou Mitigation Area Management Plan (Tetra Tech 2012), Auwahi Wind has begun site restoration and management efforts within the fenced Puu Makua parcel. In March 2014, Auwahi Wind conducted baseline vegetation monitoring, with the objective of establishing conditions prior to planting and other management activities. Baseline monitoring was conducted using line-intercept and plot based sampling along with permanent photo points (Tetra Tech 2014). Results of baseline monitoring will be compared to interim success criteria periodically after plantings are installed to track progress towards achieving long-term HCP success criteria.

Hawaii Vegetation Control is contracted to conduct biannual sweeps of the entire 130 acres, for the removal of the primary invasive species including tropical ash (*Fraxinus uhdei*), bocconia (*Bocconia frutescens*), black wattle (*Acacia mearnsii*), and Monterey pine (*Pinus radiata*) within the fenced area. The first invasive species sweep and removal took place over the course of two weeks in April 2014, the next sweep is scheduled for August 2014.

Auwahi Wind is preparing for its first native tree out planting efforts in March of 2015. Species chosen for plantings include those naturally occurring in the area, and will predominately be koa (*Acacia koa*), 'ohia lehua (*Metrosideros polymorpha*), 'a'ali'i (*Dodonea viscosa*), and kōlea lau nui (*Myrsine lessertiana*), along with additional native trees and understory plantings. Seeds stock is continually being identified and collected from the Puu Makua parcel and surrounding areas. Seedlings have been purchased and are currently being grown by a local grower, Native Nursery.

3.2.3 Hawaiian Hoary Bat Research

Auwahi Wind worked with Tetra Tech and Dr. Frank Bonaccorso from the U.S. Geological Survey (USGS) to develop a research project combining radio telemetry and acoustic monitoring. The goal of this study is to contribute to the knowledge of the Hawaiian hoary bat on Maui and also to track the success of restoration efforts in the Waihou Mitigation Area. The final research plan was approved by USFWS and DOFAW in March of 2014. It is anticipated that the study will be initiated in the second quarter of 2015 (Attachment 2).

3.2.4 Acoustic Monitoring

In July of 2013, two ground-based, solar powered, acoustic monitors (Wildlife Acoustics SM2Bat+) were placed within the Project area (Figure 1). Units were placed on water containment units, 6-8 feet above the ground. Settings for the units followed the recommendations of the USGS bat research team from the Kilauea Field Station, Hawaii (Table 3-1). Tetra Tech was contracted to review files collected and process vocalization data.

Table 8-1. Configurations settings for the Wildlife Acoustic SM2Bat+ units at the Auwahi Wind Project.

Configuration Options	Setting
Sampling Rate	192 kHz
High Pass Filter	1000 Hz
Gain	36 dB
No Bias	ON
Recording Start	1 hour before local Sunset
Recording End	1 hour after local Sunrise
Files Stored	.WAV
Dig HPF	fs/24
Dig LPF	OFF
Trigger Level	18 SNR
Trigger Window	2.0 sec

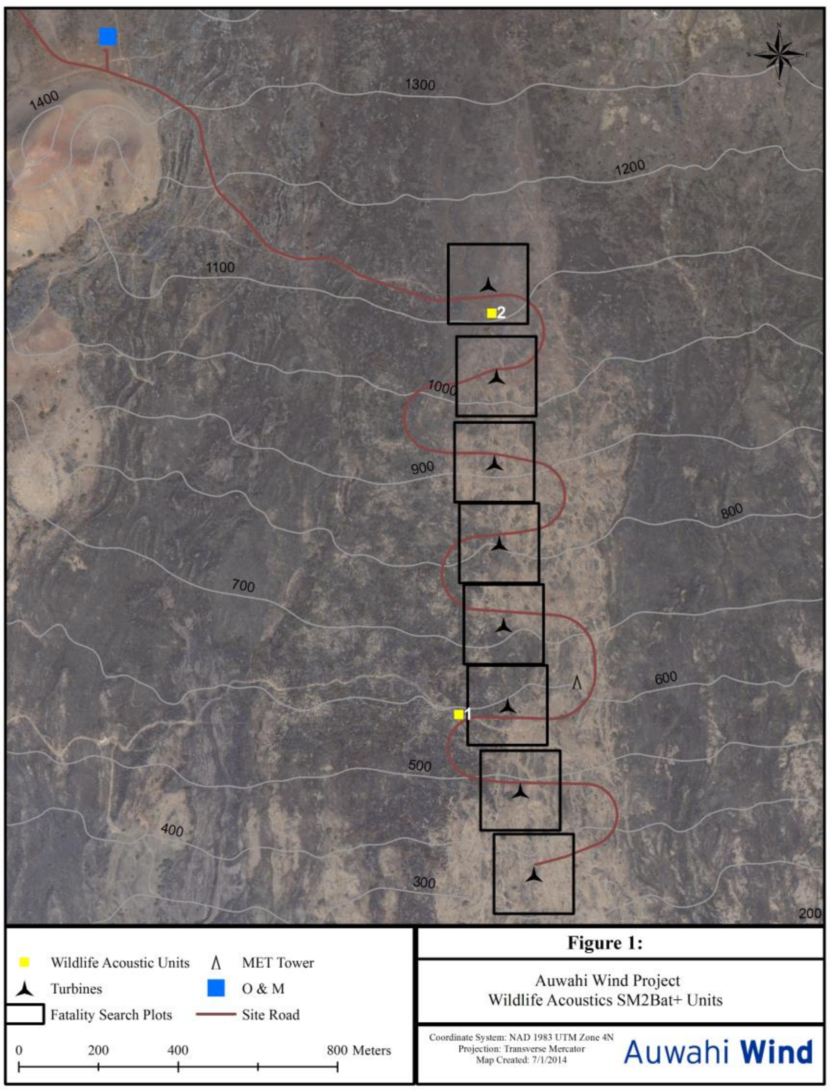

Figure 1. Location of the two Wildlife Acoustics SM2Bat+ Units at Auwahi Wind Project.

The original raw recordings made during the survey period were converted from .wac format to .wav and zero-crossing format using Kaleidoscope 1.1.22 software (Wildlife Acoustics, Inc., Cambridge, MA). Recordings were then processed with Sonobat Attributor 6.2 (Sonobat, Inc., Humboldt, CA), which attributed each file with survey location information and removed noise signals. Both Sonobat 3.2.0 NNE (Sonobat, Inc.) and BCID 2.6a (Ryan Allen, Bat Call Identification, Inc., Kansas City, MO) software programs were used to analyze potential bat calls recorded during the surveys. All potential call files were then manually reviewed for bat calls. Manual analysis involved visually inspecting spectrograms of each call and comparing them to a call library.

A bat pass was defined as a call file containing one or more call pulses. Bat passes provide an index of activity and the number of bat passes is generally indicative of the level of bat activity near the detector location; however, it is not possible to determine if multiple bat passes represent multiple bats or a single bat making multiple passes. When Tetra Tech detected multiple call files recorded in close, temporal succession, they were combined into a single bat pass for analysis. Survey effort was presented as detector nights, which was defined as one detector unit operating for one complete night.

Summary data provided in Table 3-2 includes the total number of bat passes, per unit, in the first year of data collection. A total of 40 bat passes, contained within 31 nights, were detected at the Project in FY 14. Detector two had double the detection rate of detector one. One possible reason for this may be detector two's closer proximity to clusters of woody vegetation, taller than 15 feet, possibly used for roosting by bats. Detector one is located more than 500 feet lower in elevation, where vegetation is not as tall and mostly limited to shrub brush.

Table 9-2. Summary data for the two Wildlife Acoustic SM2Bat+ units at the Auwahi Wind Project.

Detector ID	Deployment Dates	Detector Nights	Bat Pass	Total Detection Rate (Bat Pass/Detector Night)
1	7/15/2013 - 6/30/14	350	14	0.0400
2	7/15/2013 - 6/30/14	350	26	0.0743

Monthly detection rates, combining both detectors indicate the highest rates of detection occurring May-September (Figure 2), peaking in September. This trend of peak activity in August and September has been documented in numerous projects across the Hawaiian Islands, including a five year study conducted on the island of Hawaii (Gorressen et al. 2013). This island wide study observed consistent seasonal patterns in occupancy and detection probability throughout the five years of the study, with highest detection peaking in September. The peak August/September activity is composed of the bat fledging period, considered the annual maximum of the population (F. Bonaccorso personal observation).

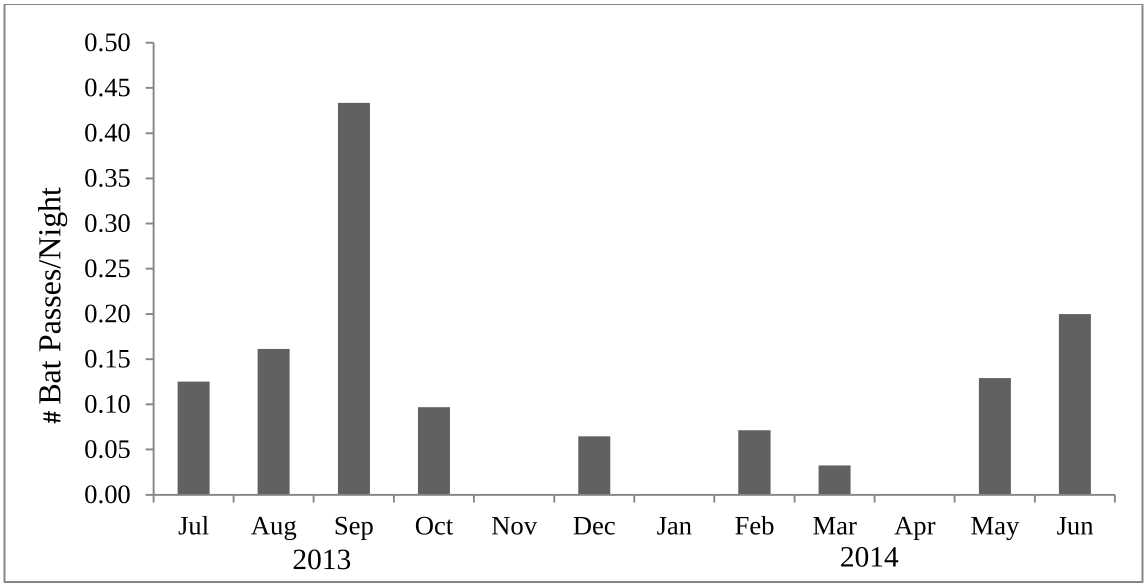

Figure 2. Monthly detection rates, combining both Wildlife Acoustic SM2Bat+ units at the Auwahi Wind Project.

3.2.5 Benefits

Completion of the fence, removal of ungulates, and habitat restoration will benefit the Hawaiian hoary bat through the creation and protection of roosting and foraging habitat. Acoustic monitoring at the Project provides site specific information on activity patterns and could be used in conjunction with other monitoring projects to acquire an island wide understanding of Hawaiian hoary bat activity on Maui.

3.3 Blackburn's Sphinx Moth

As stated in the 2012 annual report, Auwahi Wind developed an MOU and made a one-time payment of $144,000 to the Leeward Haleakala Watershed Restoration Partnership (LHWRP) on April 17, 2012, to restore 6 acres of dryland forest at the Auwahi Forest Restoration Project. A letter from the LHWRP providing an update on use of funding during FY14 is provided in Attachment 3.

4.0 Changed or Unforseen Circumstances

There were no events or circumstances that would be considered changed or unforeseen circumstances during the FY 14 reporting period at the Project.

5.0 Annual Workplan and Schedule

An annual work plan for FY 15 identifying major monitoring and mitigation activities and their associated timelines is provided in Attachment 4.

6.0 Cost Expenditures and Budget

A summary of HCP-related expenditures for FY 14 is provided in Attachment 5. This summary lists costs (including staff labor) that Auwahi Wind has expended toward fulfilling the terms of the HCP in in FY14, as well as cumulatively, and compares them against the budgeted amounts specified in Appendix 8 of the HCP.

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Attachment 1

Kahikinui Management Area Hawaiian Petrel Monitoring Report

Auwahi Wind Energy Project

2013 Auwahi Wind Energy Hawaiian Petrel Report

Kahikinui Management Area

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August 2014

EXECUTIVE SUMMARY

In December 2012, Auwahi Wind Energy, LLC (Auwahi Wind) constructed and began commercial operations of the 8-turbine, 21-megawatt Auwahi Wind Farm (the Project) in east Maui, Hawaii. To address potential endangered species impacts associated with the Project, Auwahi Wind developed a Habitat Conservation Plan (HCP), which was finalized in January 2012. Based on the anticipated take levels provided in the HCP, Auwahi Wind obtained an incidental take license (ITL) from the Hawaii Department of Land and Natural Resources (DLNR) on February 9, 2012 and an incidental take permit (ITP) from U.S. Fish and Wildlife Service (USFWS) on February 24, 2012. To address the requirements under the HCP for Hawaiian Petrels (*Pterodroma sandwichensis*), this report summarizes the 2013 Hawaiian Petrel management activities executed in the Auwahi Wind Kahikinui petrel management area (Kahikinui).

As proposed in the HCP, take and mitigation are accounted for in tiers such that each tier has a higher take level and a correspondingly higher level of mitigation. For the initial tier (Tier 1), Auwahi Wind will mitigate potential impacts to petrels by implementing predator control within Kahikinui to increase the survival and reproductive success of Hawaiian Petrels. Over a 20-year management period, Tier 1 mitigation requires predator control at 33 active burrows (see the HCP for additional details).

The objectives of the 2013 petrel surveys were to: assess the number of active burrows in Kahikinui; determine petrel reproductive success prior to implementation of full predator control (i.e., baseline conditions); and begin a phased approach to predator control within the site (collect site, species and trap specific data on predator presence, activity, and bait preferences).

A total of 59 burrows were monitored within Kahikinui in 2013 (40 initially located during the 2011 surveys, 14 additional burrows found during 2012 and 5 burrows located during 2013 surveys). Burrow checks were conducted monthly from March to August 2013 and then bi-monthly during the chick rearing and fledgling period, from September to November 2013. During each survey, surveyors checked the status of known petrel burrows and opportunistically searched nearby suitable habitat for additional burrows. Any new burrows located in 2013 were marked, mapped, and added to the monitoring dataset. All known burrows were monitored during each check through July, after which only active burrows were monitored.

Twenty-seven (46 percent) of the burrows showed signs of activity at some point during the breeding season and 32 burrows (54 percent) were inactive within Kahikinuiin 2013. Twenty-six burrows were consistently active throughout the breeding season (the one burrow that was only active once during the season was removed from the analyzed dataset). Of the 26 active burrows, 5 (19 percent) successfully produced a fledgling, two (8 percent) probably successfully produced a fledgling, and 19 (73 percent) either failed or were occupied by a non-breeder. The cause of nest failures/abandonment is unclear. There were no clear documented signs of depredation observed at any of the monitored burrows, either by the biologist monitoring the burrows or captured on game cameras stationed at the burrows.

Tracking tunnels were used to monitor the presence and distribution of small mammals (rodents and mongooses) within Kahikinuiin September 2013. To determine the relative abundance across Kahikinui, we used a one-day index for rodents and a three-day index for mongooses. We placed individual tracking tunnel stations along four to eight north-to-south transects, totaling 187 tracking stations for our one-day rodent index and 47 tracking tunnels for the three day mongoose index. Rodents were detected along five of the eight transects, for our one-day rodent index. All detections occurred in the lower elevations of Kahikinui (>2650 m); these areas offer denser vegetation then the upper elevations (<2650 m)of Kahikinui. The one-day tracking index was calculated at 5.3 % for rodents, relatively low across the landscape.

Mongooses were detected along two of the four transects, for the three-day mongoose index. Detections occurred in the eastern section of Kahikinui and covered a range of elevations (2865– 2560 m). The three-day tracking index was calculated at 7.9 % for mongooses, again relatively low across the landscape.

A full predator control strategy was developed in partnership with Tetra Tech, Inc. and Island Conservation for Kahikinui. The predator control strategy targets feral cats, mongooses and rodents. This strategy focuses control efforts within a 200 meter buffer of the known petrel burrows, dividing Kahikinui into four main management units. In September 2013 a pilot of the predator control strategy was implemented in the northern management unit, where the densest populations of petrel burrows are located (29 burrows in 2013). The grid of traps was operational September 13, 2013. Traps were checked once a week from September 13, 2013 – November 13, 2013.

Pilot predator control in the northern management unit resulted in a low number of predators (11 rodents) removed from Kahikinui. The low number of predators removed reflects the low activity index found with tracking tunnels for both rodents and mongooses. In February of 2014 Auwahi Wind expanded predator control into all management units. A full summary of the results will be included in the 2014 report.

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1. INTRODUCTION

1.1 BACKGROUND

In December 2012, Auwahi Wind Energy, LLC (Auwahi Wind) began commercial operations of the 8-turbine, 21-megawatt Auwahi Wind Farm (the Project) in east Maui, Hawaii. To address potential endangered species impacts associated with the Project, Auwahi Wind developed a Habitat Conservation Plan (HCP), which was finalized in January 2012 (Tetra Tech 2012a). Based on the anticipated take levels provided in the HCP, Auwahi Wind obtained an incidental take license (ITL) from the Hawaii Department of Land and Natural Resources (DLNR) on February 9, 2012 and an incidental take permit (ITP) from the U.S. Fish and Wildlife Service (USFWS) on February 24, 2012. To address the requirements under the HCP for Hawaiian petrels (*Pterodroma sandwichensis*), hear after "petrels", this report summarizes the 2013 petrel management activities executed in the Auwahi Wind Kahikinui Petrel Management Area (Kahikinui).

As part of the HCP process, Auwahi Wind estimated take of petrels, both direct (adults) and indirect (nestlings/eggs), using risk assessment models and then designed compensatory mitigation to offset the estimated take (Tetra Tech 2012a). As proposed in the HCP, take and mitigation are accounted for in tiers such that each tier has a higher take level and a correspondingly higher level of mitigation (Table 1). Auwahi Wind agreed to implement Tier 1 mitigation and add higher tiers of mitigation only if required based on the estimated levels of take. For Tier 1, Auwahi Wind will mitigate potential impacts to petrels by implementing predator control within Kahikinui beginning in 2013 to increase the survival and reproductive success of petrels. Over a 20-year management period, Tier 1 mitigation requires predator control at 33 active burrows in order to achieve the desired net benefit resulting from management activities. Petrel management activities will be considered successful if predator control is implemented and mitigation efforts result in an increase in reproduction that offsets authorized take, as outlined in the Hawaiian Petrel Management Plan (Management Plan; Tetra Tech 2012b), approved by USFWS and the DLNR/Division of Fish and Wildlife (DOFAW).

Table 1. Auwahi Wind Project ITP/ITL Authorized Take by Tier.

Tier	Approved Take Over the 25-year HCP Period
Tier 1	19 adults/fledgling; 7 nestlings/eggs
Tier 2	32 adults/fledgling;12 nestlings/eggs
Tier 3	64 adults/fledgling; 23 nestlings/eggs

1.2 MANAGEMENT AREA AND PREVIOUS SURVEYS

The management area is located on the Department of Hawaiian Homelands (DHHL) portion of the Kahikinui Forest Reserve (Figure 1). The management area consists of approximately 356 hectares (ha) with petrel burrows scattered throughout. A 25-year License Agreement (License No. 772) was approved by the DHHL Commission on April 23, 2012, identifying Auwahi Wind as the responsible party for the management area within Kahikinui Forest Reserve.

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

PETREL SURVEYS 2011 -2012

Petrel surveys were conducted in 2011 and 2012 to locate active burrows within the management. A crew of biologists, each spaced approximately 5-10 meters apart systematically searched for petrel burrows by walking transects perpendicular to the slope of the mountain. Survey areas in 2011 focused in the northern and eastern sections of Kahikinui. The 2012 searches were conducted in previously surveyed areas to ensure all burrows were located and in previously unsurveyed areas to maximize the number of burrows available to be managed. Searches in previously unsurveyed areas were limited to suitable nesting habitat; cinder fields were not searched because the loose soils in these areas are not utilized by nesting petrels. The 2012 surveys included the use of trained conservation dogs at the request of the USFWS because these dogs can locate petrel burrows based on the strong and distinctive musty scent associated with petrel burrows. The crew of biologists conducted searches in areas not surveyed by the dog teams. Forty-four petrel burrows were located in 2011 and 14 additional burrows were located in 2102 (Tetra Tech 2013).

1.3 HAWAIIAN PETREL BIOLOGY

The federal and state endangered Hawaiian petrel is a pelagic seabird that spends most of its life on the open ocean but nests on the Hawaiian Islands. Petrels nest in burrows which are often more than 2 m long, from entrance to nest chamber (Simons and Hodges 1998). Petrel burrows near Haleakala typically occur at the base of large rock outcrops or within lava tubes (Simons 1983, Tetra Tech 2013). The petrels show a high degree of nest-site and mate fidelity (Simons 1985), with pairs returning to the same nesting burrow year after year.

Petrels are present on Maui from late February to early November. Beginning in late February, petrels spend several weeks at the colony performing burrow maintenance and engaging in social activity. Petrels then return to sea for approximately one month. Egg-laying commences once the petrels return (April-May). A single egg is laid within the nest chamber, and the male and female take turns incubating the egg (May-July). Once the egg hatches (July), parents briefly brood the chick before beginning extended foraging trips at sea (August- November). The chick remains unattended at the burrow except for periodic visits by the parents to deliver food. The fledging period for most petrels at Mount Haleakala is from early October to early November (Simons and Hodges 1998, Chen et al. 2011, Tetra Tech 2013).

One of the most serious threats to Hawaiian petrels is depredation by introduced predators because petrels have not developed behavioral defenses against introduced mammals. Feral cats (*Felis silvestris*) and Indian mongooses (*Herpestes auropunctatus*) are the primary predators of petrels at Haleakala National Park; in some years more than 60 percent of all egg and chick mortality was caused by cats and mongooses (Simons 1983). Nestlings are particularly susceptible to predation, as they cannot fly for several weeks after hatching (Hess and Banko 2006). In addition, rats and mice are known to prey upon seabird chicks and eggs (Jones et al. 2008). Haleakala National Park has captured the black rat (*Rattus rattus*), Norway rat (*R. norvegicus*), Polynesian rat (*R. exulans*), and house mouse (*Mus musculus)* during predator control efforts, with black rats being the most prevalent species documented (NPS unpublished data).

1.4 OBJECTIVES OF 2013

The objectives of the 2013 petrel surveys were to: assess the number of active burrows in the Tier 1 management area (Tetra Tech 2013), determine petrel reproductive success prior to full implementation of predator control (i.e., baseline conditions); and begin a phased approach to predator control within the site (collect site, species and trap specific data on predator presence, activity, and bait preferences). These objectives were met using four main components:

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

2. Deployment of 17 game cameras at active burrows to further document activity of petrels and any predation events.

3. A comprehensive predator assessment conducted across Kahikinui using 1-day and 3-day tracking tunnel indexes for rodents and mongooses, respectively.

4. Initiation of a pilot predator control strategy that included the deployment of 59 traps in the northern management unit to collect site, species and trap specific data.

2. METHODS

2.1 BURROW ACTIVITY AND REPRODUCTIVE SUCCESS

All burrows found within the management area in 2011 and 2012 were monitored to obtain an estimate of the number of active petrel burrows and reproductive (fledging) success before full implementation of predator control. In the 2013 breeding season 59 petrel burrows were monitored, including five newly discovered burrows that were opportunistically discovered during the 2013 burrow checks. New burrows located in 2013 were marked, mapped, and added to the monitoring dataset. Burrows were monitored following methods used by the NPS (NPS 2012). All burrows were checked a minimum of once a month from March through August. Beginning in August, only active burrows were monitored bi-monthly through November.

Without access to the nest chamber within the burrow, it is difficult to know with certainty the status and reproductive success of burrows. As such, indirect monitoring methods based on presence of petrel sign and game cameras were used. Each time a burrow was visited it was categorized as active, inactive, or unknown (see definitions in Table 2). At the end of the breeding season the activity pattern of each burrow was evaluated for annual reproductive success (see definitions in Table 3).

Burrows were categorized as active, inactive, or unknown during each visit based on toothpick status (standing or knocked over) and the presence of petrel sign. Each time a burrow was visited by biologists, the burrow was visually inspected with a flashlight to search for evidence of petrel activity within the burrow. The nest chambers of all the burrows were located too far back within the burrow to be viewed to determine the fate of eggs; therefore, a barrier of toothpicks spaced approximately 1 inch apart was placed at the burrow entrances (NPS 2012). Petrels entering or exiting the burrow knock down several adjacent toothpicks, providing evidence of petrel use of the burrow. Burrows were considered to be active (entered by a petrel) if at least three consecutive toothpicks were knocked over. During each visit, any toothpicks that had been knocked over were reset and evidence of petrel activity at the burrow was removed so that it was not recorded in future surveys.

Table 2. Hawaiian petrel burrow activity categories.

Category	Description
Active	Three or more toothpicks knocked down in burrow and clear signs* of recent activity.
Inactive	Toothpicks still standing in burrow and no sign of recent activity.
Undetermined	Toothpicks knocked down in burrow but no clear sign of recent activity (prior placement of toothpicks, at the time of first check or discovery)

*Sign includes; droppings, tracks, feathers, and odor

2.1.1 ANNUAL REPRODUCTIVE SUCCESS ASSIGNMENTS

At the end of the breeding season, burrows were classified into one of five categories (Table 3) of reproductive success based on of the activity pattern observed during the monthly and bi-monthly burrow checks.

Table 3. Reproductive seasonal status assigned to Hawaiian petrel burrows at the end of the breeding season based on visit data.

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

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

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

2.1.2 METRICS OF REPRODUCTIVE SUCCESS

Two metrics of reproductive success were utilized to allow for direct comparisons with the other local petrel studies and provide baseline values prior to predator control: chicks fledged per active burrow and chicks fledged per egg laid. Reproductive metrics that include the use of eggs laid are complicated because eggs are rarely seen due to burrow characteristics. Therefore, it is not possible to distinguish between failed burrows and those occupied by non-breeders. In order to account for this pattern, estimates of chicks fledged per eggs laid used are presented as ranges to include the maximum and minimum possible values (maximum value if we assumed all active burrows that discontinued activity prior to fledge were were occupied by non-breeders, minimum value if we assumed all burrows that discontinued activity prior to fledge failed).

Chicks Fledged/Active Burrow—The percent of chicks fledged was the sum of the Successful Burrows and the Probably Successful Burrows divided by the number of Active Burrows. This estimate assumes that each Successful and Probably Successful Burrow fledged one young.

Chicks Fledged /Egg Laid—The percent of chicks fledged was the sum of the Successful Burrows and the Probably Successful Burrows, as defined above, divided by the number of burrows with eggs laid. This estimate assumes a maximum of one egg or fledgling per burrow. For eggs laid, a range in values was used because the nest chambers could not be seen. The low end of the range for eggs laid included only those burrows where egg laying was confirmed (e.g., Failed, Probably Successful, and Successful burrows). The high end of the range for eggs laid included the all burrows still active during the egg-laying season (July), which could possibly include those burrows Occupied by a Non-Breeder later in the season.

2.2 GAME CAMERA MONITORING

Seventeen Reconyx Hyperfire™ High Performance cameras were used to supplement the evaluation of burrow activity and breeding success during the 2013 breeding season. In May 2013, 10 game cameras were deployed at active petrel burrows to document burrow activity and the presence of predators at burrows. An additional 7 game cameras were deployed in September 2013. Cameras were left at burrows until petrel activity ceased, after which, the camera was moved to another burrow with petrel sign or removed for the season (Figure 2). The percentage of chicks fledged/active burrow was observed on camera and calculated within Kahikinui.

2.3 TRACKING TUNNELS

Tracking tunnels were used to monitor the presence and distribution of small mammals (rodents and mongooses) within the management area (Brown et al. 1996, Blackwell et al. 2002, Gillies and Williams 2007, Speedy et al. 2007). Black Trakka tracking tunnels were utilized, which consist of a lightweight polypropylene tunnel, a pre-inked tracking card, and two U-shaped pins to secure the tunnel. Peanut butter was placed on a small piece of paper in the center of the inked section of the tracking card and then placed in the tunnel. Animals reaching the peanut butter tracked ink from their feet to the absorbent ink-free portion of either end of the card, leaving their tracks as they left the tunnel.

In September 2013, we placed 187 individual tracking tunnel stations along eight north-to-south oriented transects, using methods outlined in Gilles and Williams (2007; Figure 3). All eight transects were established in close proximity to petrel burrows. These transects were spaced approximately 400 meter apart. Within each transect, the tracking tunnel stations were set at 50 m intervals. Where available, tracking tunnel stations were placed alongside boulders or next to vegetation because such features provide more cover and may therefore have higher levels of rodent activity than placing the tunnels out in the open. The location of each tracking tunnel station was recorded with a GPS unit. The baited tracking tunnel stations were deployed for approximately 24-hours. Once the tracking cards were collected, each card was examined for the presence of small mammal footprints (Gillies and Williams 2002). The cards were scored as tracked or untracked, and tracks were identified as belonging to rodent species or mongoose. In order to calculate activity, we used a tracking index of relative abundance for rodents expressed as the mean percentage of tunnels tracked by rodents per line (Gillies and Williams 2007).

A subset of the rat tunnels were used to calculate mongoose abundance using a 3 day relative abundance scale, starting the following day after the 24-hour index was calculated. We placed 47 individual tracking tunnels along 4 north to south transects. These transects were spaced approximately 800 meter apart. Within each transect, the tracking tunnel stations were set at 100 m intervals. Tracking cards were baited with peanut butter and were collected after three nights.

2.4 PREDATOR CONTROL

A predator control strategy (strategy) was developed in partnership with Tetra Tech, Inc. and Island Conservation for the entire Auwahi Wind Kahikinui petrel management area (Island Conservation and Tetra Tech 2013). The strategy divides the management area into four management units (Figure 2) and focuses on predator control of feral cats, mongooses and rats. Traps were placed within a 200 meter buffer of the petrel burrows on grid lines. In September of 2013 a pilot phased approach (Phase one; Figure 4) to the predator control strategy was initiated in the northern management unit, where the densest population of petrel burrows are located (29 burrows in 2013). Two wooden boxes each containing two Belisle SuperX kill traps were spaced 250 meters apart for the control of feral cats. In addition, nine Goodnature A24 kill traps and eight DOC250 kill traps were deployed to control mongooses; although designed to control mongooses, these traps also have the ability to trap rodents. The Goodnature traps and DOC250's were each spaced at 150 meter intervals. All trap types were housed in wooden boxes or plastic coverings to reduce the threat of seabird bicatch.

Rodent control, using KaMate traps, was set out in the upper portion of the northern management unit in this pilot year to reduce negative impacts caused by rodents, assess initial trapping success, and gauge the amount of effort needed to regularly bait and check these traps. The need to initiate rodent trapping within additional colony units will be assessed as additional information is gained, but full deployment of rodent traps encompassing all units is not anticipated in the initial years of full predator control. Forty KaMate kill traps were used for the control of rodents. The KaMate kill traps were spaced every 50 meters on transects 100 meters apart. The KaMate traps were housed in a white plastic station and field tested for keeping non-targets out.

The northern management unit trapping grid was operational by September 13, 2013 (Figure 4). All traps within the northern management unit were checked once a week from September 13, 2013 to November 13, 2013. To determine bait preferences, several types of bait including tuna, sardines, fish oil, beef hotdogs, rodundo peanut butter, and macadamia nuts were used to attract predators. Baits within DOC250, Belisile Super X, and KaMate traps were rotated on a weekly basis. Trap nights for each species were calculated based on the number of traps multiplied by the number of traps set in a given night.

3. RESULTS

3.1 BURROW ACTIVITY AND REPRODUCTIVE SUCCESS

Twenty-seven (46 percent) of the burrows were active at some point during 2013 breeding season and 32 (54 percent) were seasonally inactive (saw no activity during any of the burrow checks). Of the 27 active burrows, 26 were consistently active throughout the breeding season (the one burrow that was only active once during the season was removed from the analyzed dataset). Of the 26 active burrows, five (19 percent) successfully produced a fledgling, two (7 percent) probably successfully produced a fledgling, four (15 percent) showed signs of reproduction but failed, and fifteen (57 percent) stopped visiting the nests sometime between August –September, these burrows either failed or were occupied by a non-breeder. The cause of nest abandonment/failure is unclear. There were no documented depredation events observed during burrow checks or when reviewing game camera data; however, not all burrows had cameras monitoring them and cats, mongooses and rodents were documented within the vicinity of active burrows.

Burrow activity remained relatively constant April through August and sharply declined at the beginning of September (Figure 5). The highest number of burrows where the status was unknown occurred during the initial burrow check in March; these burrows were recorded as unknown because monitoring had just begun and toothpicks were only initially being placed for surveying. The highest number of active burrows observed during any one month of monitoring occurred in July, with 27 active burrows. There was a sharp decrease in the number of active burrows between August 29, 2013 and September 5, 2013 surveys, with 12 burrows discontinuing activity. These burrows did not have any reproductive sign, suggesting that they may have been occupied by non-breeders. Surveys ended on November 11 because all of the burrows had ceased to be active.

Reproductive success for the 2013 Hawaiian petrel colony within the management area is calculated to be between 27 – 64%. Based on the survey findings, eggs were assumed to be laid in 11 to 26 of the active burrows; the range represents the difference between using only those nests with known fates versus including all potentially active nests (i.e., burrows classified as failed or occupied by a non-breeder). The percentage of chick's fledged/active burrow within the management area was 27%. The percentage of chicks fledged/eggs laid within the management area was 27 – 64%.

3.2 GAME CAMERA MONITORING

Game cameras were rotated between 19 burrows. Using these cameras we were able to confirm activity at 12 of these burrows and capture successful fledging of five chicks. Successful fledging was recorded between October 16 – October 29, 2013 – (Table 4). Game Cameras captured visitation by goats and chukars at several of the nest entrances, both active and inactive burrows. Game cameras recorded three separate instances of a feral cat investigating a burrow (Figure 2). Cat activity was recorded on September 23, 2013at inactive burrow #58. Petrel activity had already ceased on July 6, 2013for burrow #58. A feral cat was also documented two separate times investigating burrow #32, on October 19, 2013 and October 24, 2013; the chick successfully fledged on camera from this burrowOctober 22, 2013. There were no clear signs of depredation at any of the burrows monitored with game cameras although rat and field mice were observed at all burrows. The percentage of chicks fledged/active burrow observed on camera within the management area was 42%.

3.3 TRACKING TUNNELS

There was an overall low detection rate for both rodents and mongooses in the September assessment. Rodents were detected along five of the eight transects (Figure 3), using the one day rodent index. All rodent detections occurred in the lower elevations of the management area (>2700 m), these areas offer denser vegetation then the northern sections of management area. The one day tracking index was calculated at 5.3 % for rodents, considerably low across the entire landscape.

Mongooses were detected along two of the four transects, for the three day mongoose index. Detections occurred in the eastern section of the management area and covered a range of elevations (2865 – 2560 m). The three day tracking index was calculated at 7.9 % for mongoose, again relatively low across the landscape.

3.4 PREDATOR CONTROL

In this pilot deployment of four trap types, predator removal was low across the northern management unit. No feral cats were removed with the Beslisle Super X kill traps during an estimated 240 trap nights. No mongooses were removed with the Doc250 or Goodnature A24 kill traps during an estimated 1020 trap nights. However, two rodents were removed using the Doc250 traps (Figure 4). Nine rodents were removed using the KaMate traps during an estimated 2107 trap nights (Figure 4). Rodents removed during predator control efforts included black rat, Polynesian rat, and house mouse. Given the low catch success, it was not possible to determine bait preferences at the site. Tuna and macadamia nuts were the two baits that successfully trapped rodents during the bait rotation.

4. DISCUSSION

4.1 DELINEATION OF MANAGEMENT AREA

In 2013, the entirety of the management area contained 26 active petrel burrows, indicating that all the active burrows found will need to be managed for predator control to meet the requirements of the HCP for Tier 1 mitigation. Only five additional burrows were found opportunistically in the areas previously covered in 2011 and 2012 during the 2013 burrow checks, suggesting that surveys were effective in locating burrows and that new burrows found after predator control is fully implemented in 2014 should be recognized as a net increase in the breeding colony.

4.2 REPRODUCTIVE SUCCESS

As stated in previous Hawaiian petrel reports from the Haleakala colony (Chen et al. 2011, Tetra Tech 2012b, and Tetra Tech 2013), direct comparisons of petrel reproductive success among projects is challenging due to the variation in survey techniques, reproductive success criteria and differences in the level and duration of management activity. The percentage of chicks fledged per active burrow is presented in most studies and provides the potential for a common metric. Two items will need to be clearly defined in order for proper comparisons to be made; what constitutes an active burrow and when to consider a chick fledged.

Various interpretations of what defines an active burrow will cause difficulties in comparison between projects. Activity considered solely based on the toothpick method may cause inflated numbers of active burrows. In this study we monitored 19 active burrows with both the toothpick method and game cameras. Only 63 percent (12) of these burrows had actual petrel activity. Estimates of active burrows without the use of game cameras have the potential to be higher than actual numbers. Game cameras revealed toothpicks were being knocked down by rats, feral goats and chukar. Combining the toothpick method with requiring at least one type of petrel sign present provides a more accurate representation of the number of active burrows.

The number of active burrows may also be affected by the duration a burrow is monitored. We monitored throughout the season (March – November) and saw a fluctuation in the number of active burrows (Figure 5). This fluctuation was in part the result of non-breeders occupying colonies for only a portion of the breeding season. If burrows are only monitored late in the season (August/September), one may have a lower numbers of active burrows because many of these nests may have already failed or because non-breeding adults or young prospecting petrels have already left for the season. Burrows should be monitored continually throughout the breeding season to accurately assess the number of active burrows. Burrows consistently active in this duration should be considered the active burrow sample.

Whether a burrow is recorded as successfully fledging a chick is often dependent on available resources of the management project, survey techniques, and personal interpretation. Research conducted by Simons (1985), using cameras and excavated burrows, reported petrels at the Haleakala colony fledging between October 8 - 30 - (n=40). In the 2011 petrel report from ATST, petrels fledged on camera between October 19- 25, 2011(n=8). Auwahi Wind has captured seven chicks successfully fledging on game cameras October 8 - 31(2012-2013). Game cameras provide more conclusive information on the reproductive success outcome. It is not economically feasible to have a camera located at every active burrow to confirm a fledged chick. These confirmed fledge dates, from multiple projects on Haleakala give a solid indication of successful burrows maintaining activity until the October fledging period. This game camera data could be pooled together and be used as a standard for interpreting reproductive sign, monitoring data and ultimately reproductive success.

4.3 PRELIMINARY PREDATOR ASSESSMENT AND CONTROL- LESSONS LEARNED -

Predator control in the northern management unit resulted in a 11 rodents being removed from the management area. The number of predators removed reflects the low activity index found with tracking tunnels for both rodents and mongoose. Rodents were not even detected in the tracking tunnels in the northern management unit. The northerly adjacent ATST management site, actively manages for rodents using Diphacinone toxicant. Minimal rodent activity in upper elevations may be the result of spillover management effects from the ATST site.

We quickly learned that trap placement can impact efficacy. The upper Kahikinui habitat is sparsely vegetated, some areas with higher habitat complexity (rock fields and low shrubs). These areas seem to be important habitat for predators as they have a high preference for cover. All effective traps were located in rock fields and low shrubs. We saw no activity in traps laid out in the scree slope perimeters. For this reason a strict grid seems to be less important than finding suitable habitat at each approximate trap location. The increased habitat complexity also assisted in approximating travel routes as tracks and trails are very difficult to find in the open habitat of the scree slopes. Future trapping deployments will rely less on a strict grid and focus more on predator microhabitats and maintaining a safe distance from petrel burrows.

After initial weekly rotation of baits in DOC250, Belisile Super X and KaMate traps, we soon based bait selection on persistence of bait and availability. Meat products have been reported as highly favorable food baits for mongoose (USDA-Hilo per communication) and are necessary for cats which are obligate predators. Tuna was selected as our primary bait for cost and availability. However; we learned that tuna left out at high altitude (3000 m) desiccated quickly and thus became ineffective after 24 hours due to a combination of low pressure, high winds and high daytime temperatures. We experimented with a "slow drip" bait station using tuna slurry in a bag; however this tended to dry out and inhibit fresh bait from being released. We found the best solution was to use a tuna can with bait left inside; during occasional rains the tuna would tend to be rehydrated and continued to give off a noticeable odor. The type of peanut butter used in the all the Goodnature traps apparently has a low volatility, which seems to limit the distance by which it can attract predators but increases the longevity of the bait. We will continue to use this longer lasting peanut butter in future trapping efforts with Goodnature traps.

Both rats and mice were caught in Doc250 and KaMate traps. The macadamia nuts used in the KaMate traps had the benefits of clearly showing any rodent activity via bite marks, and having a high longevity. Baking nuts were used and were usually ½ or ¼ of a whole nut and could thus be set on their long axis making them less stable and easier to trigger. No predators were trapped in the Goodnature traps which may have been due to the mounting mechanism. Traps were mounted to a section of pvc pipe that was hammered into the ground. This pvc pipe may have been difficult for rodents to climb up into the traps. Future trapping with Goodnature traps will use wooden stakes, a material more conducive to rodents for climbing (OANRP per communication).

The three feral cat detections on the game cameras were in the far eastern and southern sections of the management area, roughly 2 km apart. Feral cats on Mauna Kea, Hawaii, studied in similar subalpine conditions, were documented having a home range between 772 – 1418 ha and traveling a mean daily distance of upward of 4 km (Goltz et al. 2008). Both cats had a similar calico coat although with the lower resolution camera photos we were unable to determine whether this cat was the same at both sites.

Despite both cats and mongooses being detected on site (either by cameras or tracking tunnels), no individuals were caught in traps during the 2013 breeding seasons. There are a variety of suspected causes: neophobia (fear of anything new), limited lifetime of baits, limited attractiveness of selected baits, and the overall low density of cats and mongooses. To this end we plan to try adding olfactory/visual lures (such as bobcat glands and hanging feathers), increasing the number of traps, altering the distribution of traps to areas with more habitat complexity, and pre-bait traps to increase efficacy. Concealed foot-hold traps are a proven effective method for capturing cats that hunt in remote areas, as opposed to feral cats scavenging around human settlements (Short et al. 2002). We are planning on testing out the effectiveness of foot-holds in the 2014 breeding season.

In February of 2014 Auwahi Wind will expand predator control into all management units. We will take the lessons learned in the 2013 pilot study to guide future placement of traps and types of baits used (with the addition of olfactory/visual lures), and add new traps types (leg holds).

4.4 IMPLICATIONS AND RECOMMENDATIONS FOR 2014

- The low number of opportunistically discovered active burrows during the 2013 breeding season, after comprehensive surveys in 2011&2012, indicate that new burrows found after predator control is fully implemented should be recognized as a net increase in the breeding colony.

- Reproductive success within the management area in 2013 was consistent with what was reported in most petrel studies conducted on Mount Haleakala. However, comparing reproductive success to other studies is difficult because survey techniques, reproductive criteria, management activities, and differences in intensity and duration of management activities

- The use of game cameras allows Auwahi Wind to have a more definitive understanding of activity and breeding success within the management area; however, game cameras still cannot separate the non-breeding birds from early season failures.

- The increased use of game cameras will likely provide more conclusive information on the reproductive success outcome of nests within the management area; however, this game camera information may not improve the comparability of Auwahi Wind's reproductive success with management sites using other measurement techniques .

- In 2014, full implementation of the predator control strategy proposed by Island Conservation will be implemented. This includes a predator assessment twice a year (tracking tunnels), predator control within a 200 m buffer of Hawaiian petrel burrows and game cameras to monitor for cat and mongooses detections. We will have limited targeted rodent control in areas with the densest areas of active burrows.

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6. TABLES AND FIGURES

Table 4: Game camera Hawaiian petrel burrow monitoring summary.

Burrow #	Camera Deployment Date	Last Date of Activity	Sucessfully Fledged
3	5/29/2013	10/29/2013*	Yes
4	5/29/2013	7/16/2013	No
6	5/29/2013	8/19/2013	No
8	5/29/2013	6/15/2013	No
9	9/5/2013	No Activity	No Activity
15	6/22/2013	8/27/2013	No
20	9/5/2013	No Activity	No Activity
25	5/29/2013	8/3/2013	No
31	5/31/2013	10/22/2013*	Yes
32	5/29/2013	10/16/2013*	Yes
33	9/5/2013	10/23/2013*	Yes
34	5/31/2013	8/4/2013	No
40	5/30/2013	No Activity	No Activity
42	5/29/2013	10/22/2013*	Yes
50	5/31/2013	No Activity	No Activity
54	9/5/2013	No Activity	No Activity
55	6/27/2013	8/24/2013	No
58	9/5/2013	No Activity	No Activity

* Fledged Date

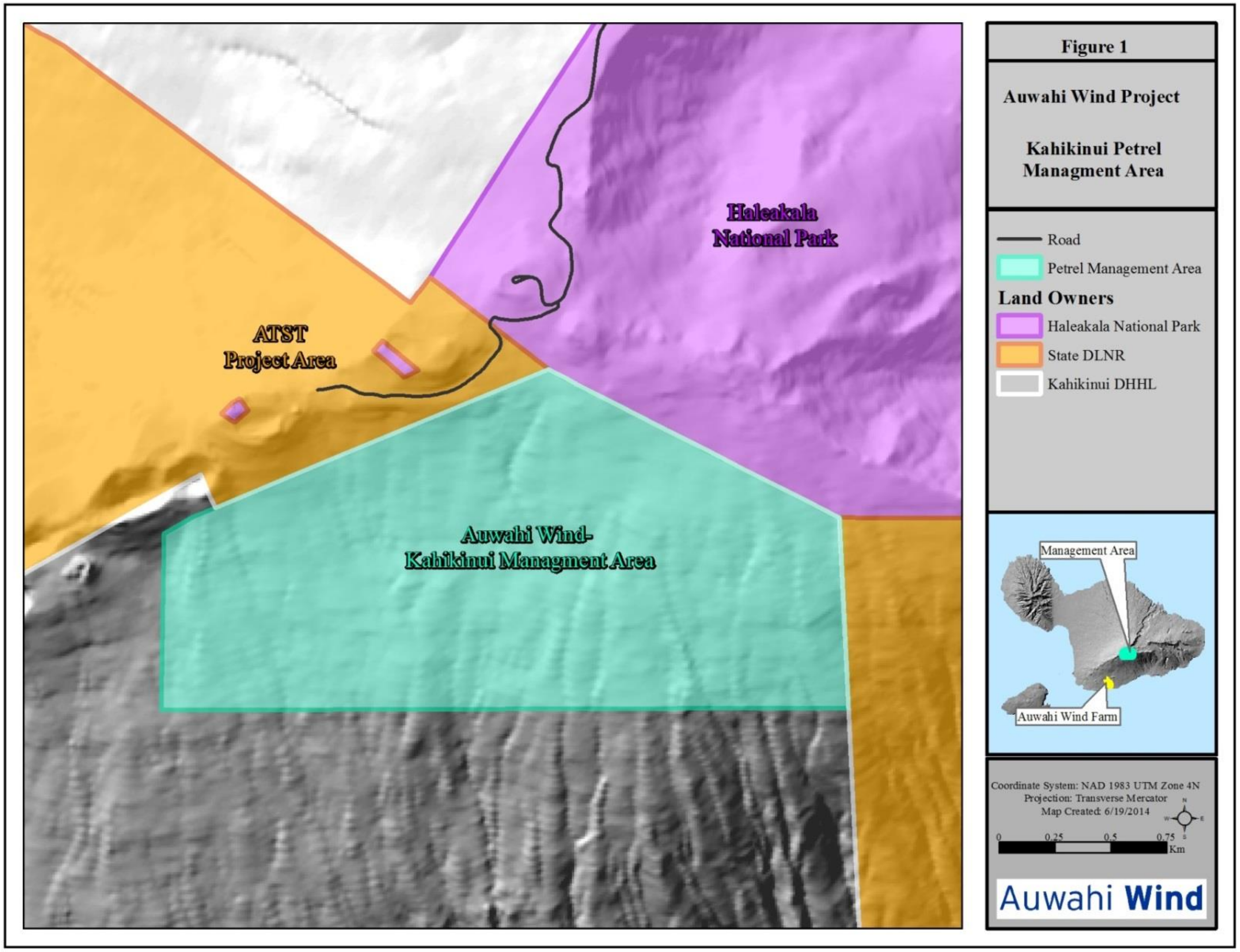

Figure 1: DHHL petrel management area, divided into management units.

[redacted]

Figure 2: All petrel burrows monitored at Kahikinui, 2013 breeding season.

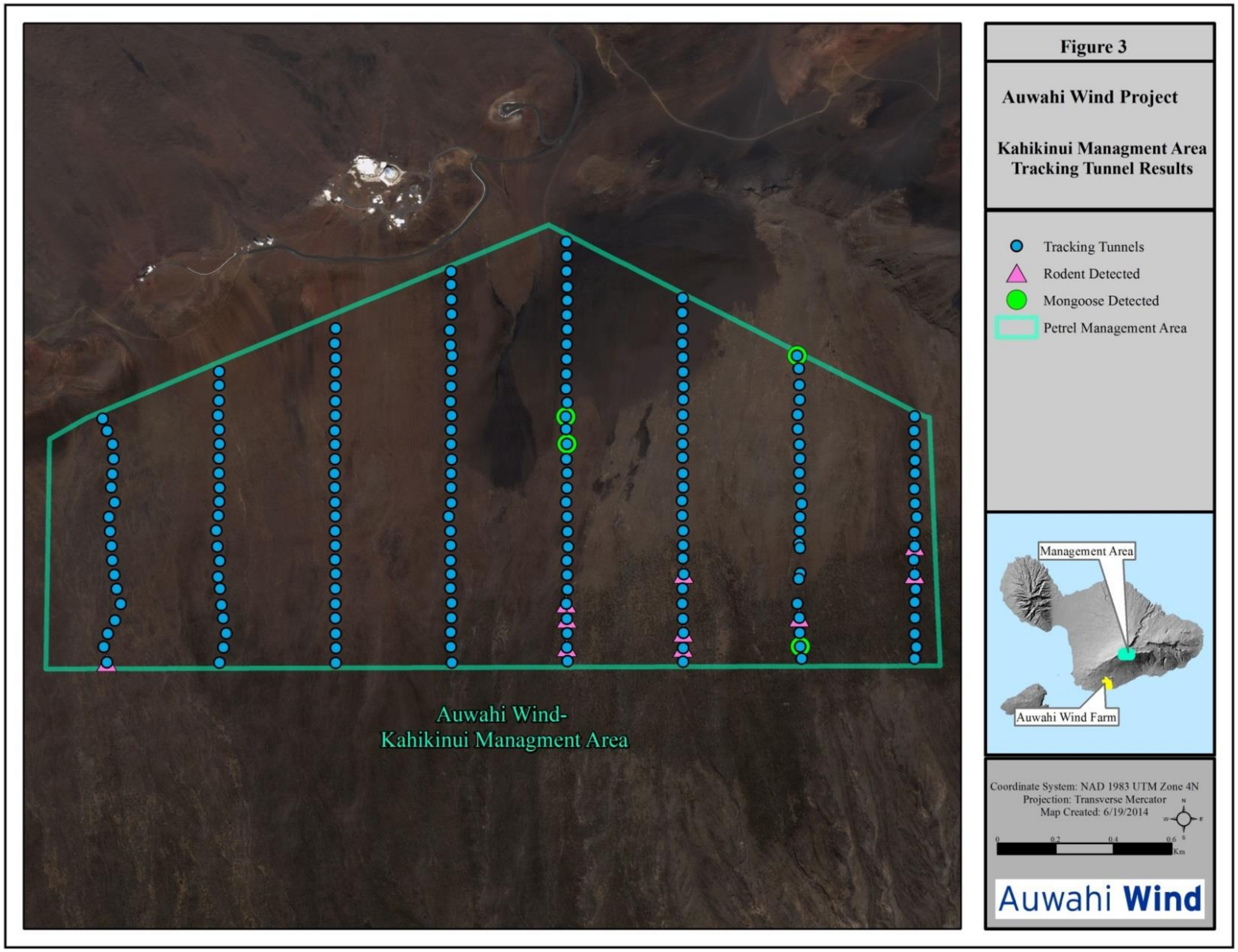

Figure 3: One/three day tracking tunnel results Kahikinui, September 2013.

[redacted]

Figure 4: Phase one deployment of predator control within the northern management unit of Kahikinui.

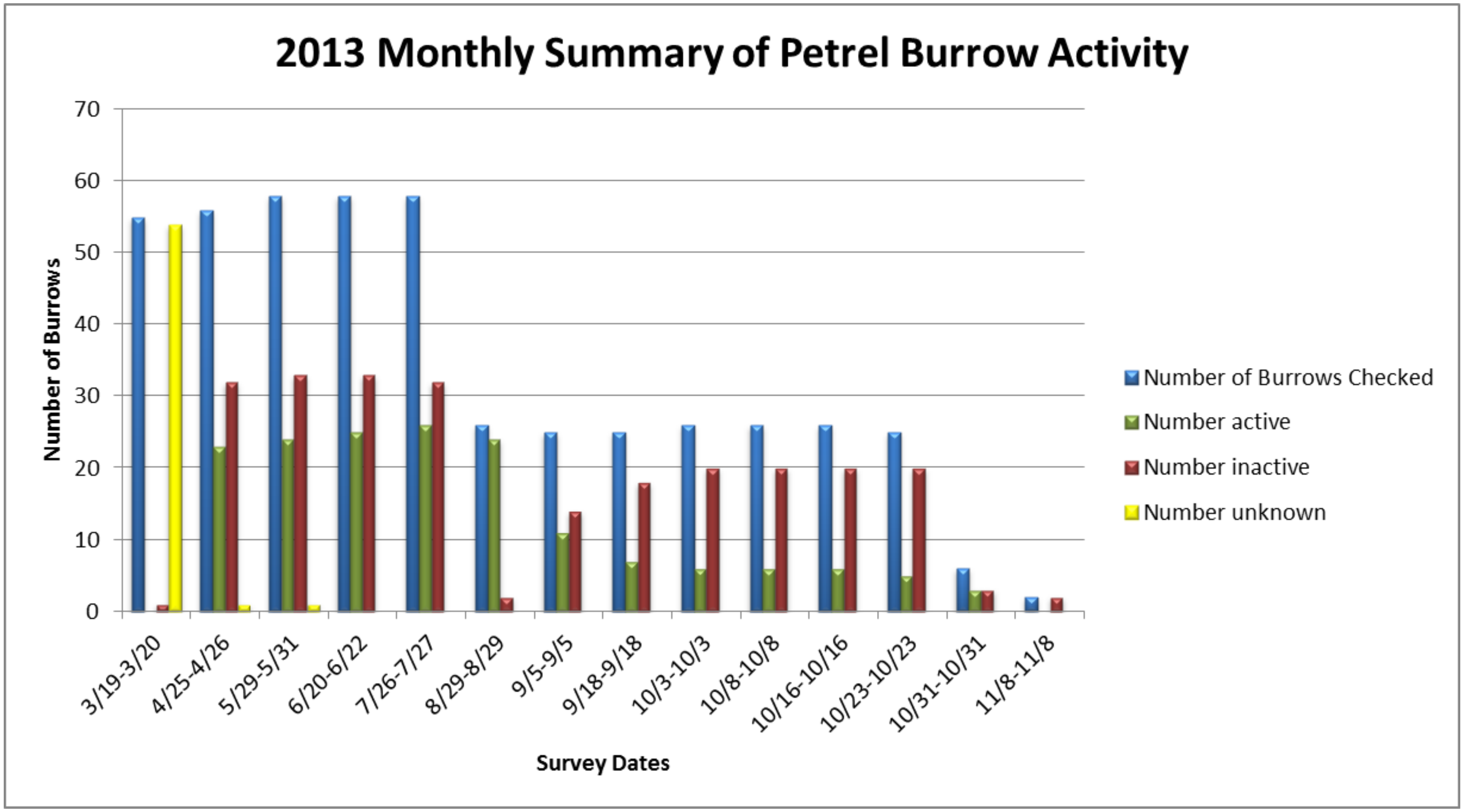

Figure 5: Seasonal petrel activity within Kahikinui, 2013 breeding season.

Attachment 2

Hawaiian Hoary Bat Research Plan

AUWAHI WIND ENERGY PROJECT

HAWAIIAN HOARY BAT RESEARCH PLAN

Prepared for

Auwahi Wind Energy LLC

Prepared by

TETRA TECH

February 2014

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1.0 INTRODUCTION

To fulfill its mitigation requirements in the Auwahi Wind Farm (Project) Habitat Conservation Plan (HCP) (Tetra Tech 2012a), Auwahi Wind Energy, LLC (Auwahi Wind) must provide funding for a Hawaiian hoary bat research project. Bat research funding fulfills Auwahi Wind's mitigation requirements for Tier 2 bat take under the Project's Incidental Take Permit/Incidental Take License. The Hawaiian hoary bat is listed as endangered in part due to lack of knowledge concerning its distribution, abundance, and ecology (USFWS 1998). A primary research goal in the 1998 recovery plan for the Hawaiian hoary bat is to "determine actual population status and habitat requirements" for the species. This information is critical to assessing the conservation status of this species and developing appropriate policy for land use practices and bat recovery in Hawaii.

To this end, Hawaiian hoary bat research has been conducted on the Island of Hawaii, and to a lesser extent on Oahu, Kaui and Maui, and has been primarily based on acoustic monitoring. Study results indicate that bats may be more widely distributed than previously believed, use both native and non-native habitats, and may display seasonal variation in activity and habitat use patterns (Duffy 2007, NRCS 2009, Gorressen et al. 2013). However, whether these observed seasonal trends are consistent among islands is unknown (F. Bonaccorso, personal comm.). Ongoing studies are focused on using near-infrared and thermal video cameras, automated video motion-detection software, and acoustic recorders to document seasonal occupancy and activity patterns and conditions related to bat fatalities at wind energy facilities (U.S. Geological Survey [USGS], unpublished). Yet, there continue to be significant information gaps related to the specific habitat requirements and patterns of use for this species. Research was identified as key to conserving the species and the critical factor in its downlisting and/or delisting in the recovery plan for the Hawaiian hoary bat (USFWS 1998) and in the five-year status review for this species (USFWS 2009).

Goals of this research as outlined in the Project HCP are twofold. The first is to contribute to the knowledge of the Hawaiian hoary bat on Maui. The second is to evaluate bat use and activity patterns over time in the vicinity of the Waihou mitigation area, an approximately 130-acre parcel targeted for native forest restoration (Figure 1). Details of Auwahi Wind's HCP mitigation requirements including other management activities within the Waihou mitigation area are provided in the Auwahi Wind Energy Project Hawaiian Hoary Bat Waihou Mitigation Area Management Plan (Tetra Tech 2012b). This research plan outlines the study approach, describes field and analytical methods, and provides a research timeline. Reporting requirements and anticipated study costs are also included.

This research project will be implemented during 3 phases of restoration at the Waihou mitigation area: during the initial restoration efforts, the middle of the restoration period (approximately years 8-10), and towards the end of the restoration period (approximately years 16-18). This study plan, developed in collaboration with Dr. Frank Bonaccorso of the USGS, focuses on the research that will occur during the initial restoration effort. Research conducted during the future phases of the restoration period will generally follow the methods outlined below, but will be adapted to account for new information gained about the species and advances in field and analytical methods since the first phase of research.

2.0 OBJECTIVES

The objectives of the research project are to:

(1) Determine bat core area size and composition on Maui using acoustic monitoring and radiotelemetry; and

(2) Evaluate bat use and activity patterns over time in the vicinity of the Waihou mitigation area.

The study is anticipated to demonstrate how the Waihou mitigation area and the surrounding area offer foraging and/or roosting areas for bats currently and over the course of restoration. Quantitatively comparing acoustic and radio-telemetry data as native plantings mature over time should document the Waihou mitigation area's importance as a foraging area for bats. Although bats are expected to potentially forage up to 12 miles in a night from the Waihou mitigation area due to their movement capabilities, all field efforts will be conducted within the Waihou mitigation area.

3.0 STUDY AREA

The Waihou mitigation area is located on lands owned by ʻUlupalakua Ranch on east Maui and is centrally located between the Kula Forest Reserve, Auwahi Forest Restoration Project, and the Kanaio Natural Area Reserve. The area is dominated by pastureland, with a small component of existing native forest. Auwahi Wind installed an ungulate-proof fence along the boundary of an approximately 130-acre (53-ha) portion of the Pu'u Makua parcel within the Waihou mitigation area (Figure 1). Over the next several years Auwahi Wind will implement management activities to restore Pu'u Makua to be native forest. Elevations in this parcel range from 5,285 ft (1,611 m) above sea level (ASL) at the top of a steep, south-facing slope to 4,259 ft (1,298 m) ASL in the gently sloping pasture below.

Over time, restoration efforts are intended to increase native vegetation cover suitable for bat foraging, roosting and breeding. Additionally, the restoration of native forest within the Pu'u Makua parcel is expected to improve the functional connectivity between these protected forest areas. The Pu'u Makua parcel is protected in perpetuity by a conservation easement.

4.0 STUDY APPROACH

Bat spatial use and activity patterns in the vicinity of the Waihou mitigation area will be assessed using a combination of acoustic monitoring and radio-telemetry. Acoustic monitoring will be used to initially establish a baseline of seasonal occupancy for bats within the mitigation area and to focus subsequent mist-netting and radio-telemetry efforts. Acoustic monitoring will also be conducted concurrent with the timing of radio-tracking to identify core foraging areas. After the initial period of acoustic monitoring, bats will be captured within the mitigation area fitted with radio-transmitters, and radio-tracked. The following subsections describe each of these study components in detail.

4.1 Acoustic Monitoring

Acoustic monitoring will be conducted for a period of approximately one year anticipated to begin in 2015 (or concurrent with the initial phase of restoration) to document the seasonal occupancy and activity levels of bats in the Waihou mitigation area. These preliminary data will guide the timing of subsequent radiotelemetry efforts in the following year such as to maximize the likelihood of conducting radiotelemetry efforts during a period when bat occupancy is at an annual peak for the mitigation area. Activity levels of insectivorous bats are generally associated with insect abundance and may be used to identify areas of high bat use, (e.g., Gorresen et al. 2008). Acoustic data will also be used to identify hotspots of bat activity which will help focus mistnetting efforts (Gorreson et al. 2008).

Up to six Wildlife Acoustics Songmeter SM2BAT Ultrasonic Recorders (Wildlife Acoustics, Inc., Concord, MA) with high frequency microphones will be deployed across the mitigation area to record bat echolocation calls and associated date and time data. These detectors are full spectrum, direct recorders and are designed for long term passive monitoring that can record continuously to memory cards for up to several months. Acoustic monitoring locations will be determined based on accessibility and safety, and potential suitability of habitat for roosting and/or foraging bats (i.e., forested areas along roads). Locations will be spaced such that they provide coverage of the mitigation area, but spaced to avoid double counting bats. Detectors will be programmed to switch on and off automatically just prior to sunset and after sunrise. Each detector will be powered by solar panels. Four high density SD memory cards in each detector will insure that adequate memory for data logging is available while requiring low human effort for maintenance. Detectors may be checked approximately on a bimonthly schedule during the year-long monitoring period to insure proper function and to download memory cards.

All of the collected call files will be processed with Kaleidoscope Bioacoustics Software (Version 2) to filter any ambient noise and then audibly and visually inspected for quality assurance. Acoustic detections will be categorized as "search calls" (single or multiple low repetition clicks) or "feeding buzzes" (rapidly repeating clicks characteristic of a prey attack by a bat). These data in turn will be used to calculate an activity level metric such as number of passes and/or call pulses per unit time (e.g., 10-minute period, hour, night, or month), or similar, which will be used to identify high-use areas within the mitigation area. In future years, assuming the availability of adequate data, a statistical means test may be used to compare changes in use levels overtime to assess changes in bat occupancy.

In addition to establishing a baseline record of bat seasonal occupancy, acoustic data will provide an indication of the importance of the mitigation area as a foraging area based on the proportion of bat calls identified as "feeding buzzes" versus "search calls". Comparisons to similar information that USGS is gathering elsewhere on Maui Island can be made to examine local relationships at the Waihou mitigation area relative to landscape patterns observed at other sites in the eastern Maui region.

Acoustic monitoring will also be conducted concurrently with radio-telemetry efforts (see below) to quantify "feeding buzzes" within bat core areas established within the Waihou mitigation area. Areas with recorded feeding buzzes would indicate that a core area is used as a feeding area. If no feeding buzzes are observed, then the area might have other uses such as frequent transit to/from a roosting area or a social/mating area. The greater the number of feeding buzzes recorded, the more important an area is as a placed for foraging. The number of core-use areas with documented feeding activity will serve as a metric of habitat use.

4.2 Radio-telemetry

Based on the initial acoustic monitoring, radio-telemetry will be conducted during the three month period of greatest acoustic activity in the annual cycle. Bats will be captured by attracting them to mist-nets set near loudspeakers playing calls of hoary bats as an acoustic lure (Avisoft UltraSound Gate). Mist nets will be set up in areas of high bat use within the mitigation area as determined by acoustic monitoring. Bats will be examined for reproductive condition and adults fitted with radio-tags according to guidelines of the American Society of Mammalogists. Additionally, when possible, wing tissue punches will be collected to contribute to larger scale research efforts focused on Hawaiian hoary bat genetics. Efforts will be made to radio-tag a balanced ratio of adult males and females. Upon release, intensive telemetry monitoring will be conducted during peak hours of bat activity (6 to 10 PM) for the duration of tag life (~20 days per tag).

ARC-GIS Home Range Extension software will be used to plot positions on a GIS map and calculate 50% (core-use) kernels of spatial use. Activities that will be distinguished on maps for each individual will include flight, night-roosts, and day roosts. Radio-tracking data will be used to determine if bats establish core use areas with frequent "feeding buzzes" quantified by deploying acoustic detectors in the core areas once identified, simultaneous to radio-tracking as described above.

Successful radio-tracking of at least 12 adult bats over an eight week concentrated period of effort is needed to provide a robust measure of core area. If a high proportion (8 to 12 individuals) of the bats radio-tagged in 2015 yield sufficiently robust information to calculate probabilistic minimum areas of core areas, the initial research phase will conclude. If fewer than 8 individuals are successfully radio-tracked, then a second period of telemetry may be considered.

Although the mitigation area appears to possess topographic features and road/footpath access that will enable good ranges of reception of the mitigation area, radio-telemetry may be enhanced in some circumstances with the use of portable towers for improved reception in a topographically challenging steep terrain or by use of fixed wing aircraft or helicopters. The need for such enhanced techniques also will be evaluated during the course of the study.

5.0 SCHEDULE AND DURATION

Table 1 provides a tentative schedule for research activities.

Table 1. Preliminary Schedule of Research Activities.

Activity	Approximate Time Frame
Site visit to the Waihou mitigation area	Second quarter 2013 (completed)
Finalize research plan	February 2014
Preliminary acoustic monitoring at the Waihou mitigation area	Spring 2015
First phase of radio-telemetry data collection	2016—specific timing dependent on results of acoustic monitoring
Second phase of data collection	TBD
Third phase of data collection	TBD

6.0 REPORTING

Within each year that research activities are conducted, a summary of work completed during that fiscal year will be complete for inclusion in the HCP annual reports prepared for the project (due September 1 each year). Once available, the results of each of the three phases of the data collection, will be presented in the HCP annual reports.

7.0 COSTS

The approximate budget for preliminary acoustic monitoring and the first year of radio-telemetry data collection is presented in Table 2. Additional radio-telemetry work during subsequent phases of restoration at the Waihou mitigation area would be covered under a separate budget.

Table 2. Anticipated Costs for the First Phase of Research Activities.

Project Budget	Year 1 (Acoustic Monitoring)	Year 2 (First Year Radio-telemetry)	Total
A. Personnel / Salaries for USGS Senior Scientist	11,252	11,621	22,872
B. Fringe Benefits for USGS Senior Scientist	3,376	3,486	6,862
I. Subtotal: Total Salary+Fringe (A+B)	**14,627**	**15,107**	**29,734**
C. Travel	775	1,394	2,169
D. Equipment	4,974	-	4,974
E. Materials & Supplies	2,014	-	2,014
F. Contractual Services for Staff at Hawaii Cooperative Studies Unit	42,364	42,783	85,147
G. Other Direct Costs	-	387	387
II. Subtotal: Other Expenses (C+D+E+F+G)	**50,127**	**44,565**	**94,692**
III. Total: Staff Requests & Other Expenses (A+B+C+D+E+F+G)	**64,754**	**59,672**	**124,426**

Note: Phases 2 and 3 radio-telemetry data collection would require additional budget.

8.0 REFERENCES

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Figure 1

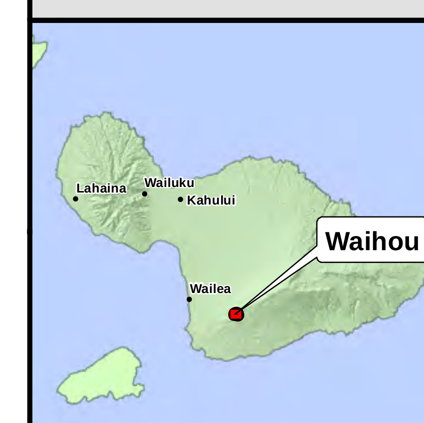
Auwahi Wind Project

Waihou Mitigation Area
Bat Research Plan

Puu Makua
Parcel Boundary

Maui, HI
March 11, 2014

Tier 1 Mitigation Parcel



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0 250 500 1,000 1,500 2,000 Feet

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Attachment 3

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

The Leeward Haleakalā Watershed Restoration Partnership
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Dept. of Hawaiian Homelands
Dept. of Land & Natural Resources
Haleakalā National Park
Haleakalā Ranch
Ka`ono`ulu Ranch
Kama`ole Ranch
Kaupō Ranch
Living Indigenous Forest Ecosystems
Maui County
Nu`u Mauka Ranch
Thompson Ranch
`Ulupalakua Ranch
US Geological Survey
US Fish & Wildlife Service
John Zwaanstra

Annual report to Sempra for mitigation restoration at Auwahi, 'Ulupalakua Ranch, Maui
3/21/13 through 5/16/14

Summary:
Leeward Haleakalā Watershed Restoration Partnership (LHWRP) staff and community volunteers have outplanted 6,284 native seedlings of 20 different native species into an 11 acre section of the Auwahi III exclosure. Part of LHWRP's restoration methodology is involving volunteers in the revegetation, seed collection, and invasive species control of the forest, as well as educating them on watershed and natural and cultural resources issues. Thirteen planting events were held, 7 of these were conducted with 95 volunteers contributing 513 hours of time and labor.

Status of required Endangered species plantings and acres outplanted for initial phase of restoration:
Eleven acres of Auwahi III have undergone initial restoration with moderate to dense plantings of *'a'ali'i* (Dodonaea viscosa) to lock out weeds and create hospitable micro-sites for tree survival and recruitment. Within this area, 181 *'aiea* (Nothocestrum latifolium) have been planted. We hope to collect more *'aiea* seeds this summer after a very wet winter for future outplantings in 2015.

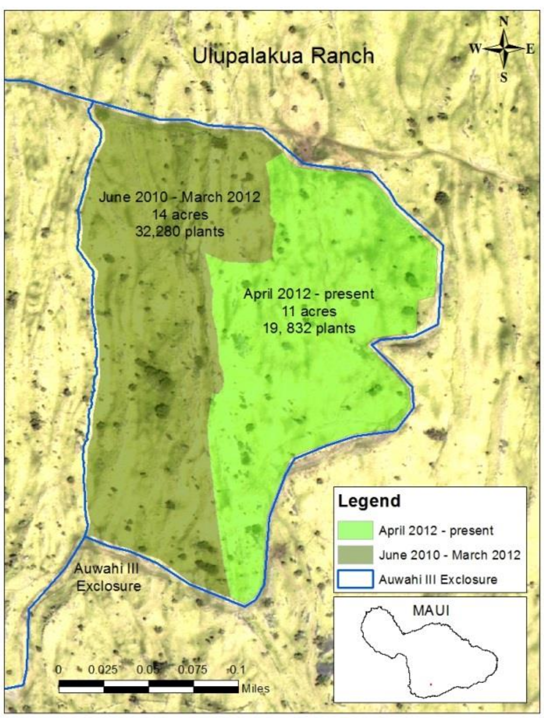

Figure 1. Left, map showing status of restoration within the Auwahi III exclosure. Right, 2 healthy *'aiea* seedlings well over head high after only two years.

Attachment 4

FY 2015 Annual Work Plan and Timeline

FY 2015 Annual Work Plan and Timeline

			2014						2015			
	July	Aug	Sept	October	November	December	January	Febuary	March	April	May	June
Fatility Searches	*Bi Weekly Searches*					*Weekly Searches*	*Reduced Searching (per USFWS/DOWFAW approval)*					
Searcher Efficiancy Trials	*Dry Season Trials*				*Wet Season Trials*							
Carcass Persistance Trials	*Dry Season Trials*				*Wet Season Trials*							
HAPE Monitoring	*Burrow Monitoring*								*Burrow Monitoring*			
Predator Control	*Traps Operational All Units*	*Predator Activity Assessment*	*Traps Operational All Units*					*Predator Activity Assessment*	*Traps Operational All Units*			
Acoustic Monitoring on Site	*Acoustic Units Operational 2 yrs*											
Ungulate Control	*Quarterly Fence Inspection*			*Quarterly Fence Inspection*			*Quarterly Fence Inspection*			*Quarterly Fence Inspection*		
Vegetation Monitoring and Control			*Semi-Annual Invasive Vegetation Management*				*Annual Vegetation Monitoring*		*Semi-Annual Invasive Vegetation Management*			
Reforestation							*Site Prepartion*		*20 Acres Outplanted*			
Bat Research Plan (Tier 2)									*Begin Tier 2 Bat Research Plan with USGS*			
ITP & ITL Conditions	*Incidental Take Summary Tables Submitted*	*Annual HCP Report Submitted*					*Incidental Take Summary Tables Submitted*	*SemiAnnual Progress Report Submitted*				

Attachment 5

Year 3 Expenditures for HCP Implementation

Auwahi Wind HCP-related Expenditures for FY 14

	Tier, Ongoing, or One-time	Event	Proposed Cost	Total Costs Incurred to Date (up to July 2014)	Costs Incurred FY 14 (July 1, 2013 -June 30, 2014)
General Measures	Ongoing	Wildlife Education and Incidental Reporting Program	$5,000	$4,500	$1,500
	Ongoing	Downed Wildlife Post-Construction Monitoring and Reporting and Mitigation Monitoring	$1,810,000	$285,145	$185,145
	Ongoing	*DOFAW Compliance Monitoring (only if needed)	$200,000	N/A	N/A
		Subtotal General Measures	$1,815,000	$289,645	$186,645
Hawaiian Hoary Bat	Tier 1	Retrofit fencing and restoration measures at the Waihou Mitigation Project	$522,000	$378,073	$63,173
	Tier 1	Acoustic Monitoring onsite	$40,000	$13,691	$8,691
	Tier2	Monitoring Research	$250,000	$32,726	$32,726
Hawaiian Petrel		Subtotal Bats	$812,000	$424,491	$104,591
	Tier 1	Burrow Monitoring and Predator Control	$550,000	$288,572	$74,572
		Subtotal Petrels	$550,000	$288,572	$74,572
Nene	One-Time	Research and Management Funding	$25,000	$25,000	N/A
		Subtotal Nene	$25,000	$25,000	N/A
Backburn's Sphinx Moth	One-Time	Restoration of 6 acres of Dryland Forest	$144,000	$144,000	N/A
		Subtotal Moth	$144,000	$144,000	N/A
		Total HCP-related Expenditures	$3,346,000	$1,171,708	$365,808