Auwahi Wind Farm Habitat Conservation Plan
FY 2013 Annual Report

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

Submitted to:

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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 semotu*), 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) 2012 report (from September 1, 2012 to July 31, 2013), and provides updates and additional discussion of activities identified in the FY 2013 semi-annual report. The following subsections provide an overview of monitoring and mitigation activities and address other required annual reporting items, including changed circumstances, an annual work plan for the upcoming year, and annual cost expenditures as required under the ITP/ITL. Detailed reports providing updates on monitoring and mitigation activities are included as attachments to this report. Table 1 summarizes the status of compliance for HCP requirements and permit conditions completed since the 2012 annual report or that are ongoing.

Table 1. Summary of Compliance Status September 1, 2012-July 31, 2013.

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; complete	Tetra Tech served as the project biologist until Auwahi Wind hired an on-site project biologist June 2013.
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. A full PCMM report is included in Attachment 1.
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. One fatality has been reported via this program.
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	Agencies were notified of a possible Blackburn's sphinx moth and a Hawaiian petrel observed during nighttime construction via email on October 2, 2012, and October 16, 2012, respectively. Incident reports for Hawaiian tropic bird and common myna fatalities were submitted via email on March 21, 2013 and May 5, 2013, respectively.
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	Two fatalities have been documented through PCMM; a table listing fatalities is provided in section 2.0 of this report.
Semi-annual progress report	ITP Condition L(ii)	Annually in February	In compliance; complete	Semi-annual report submitted to USFWS and DOFAW February 28, 2013. The next semi-annual report will be submitted in February, 2014.

Table 1. Summary of Compliance Status September 1, 2012-July 31, 2013 (continued).

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 WTGs, 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; ongoing	Materials and equipment ordered January 2013; installation commenced in April 2013 and is ongoing.
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.
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; ongoing	Draft plan submitted to USFWS and DOFAW in February 2013; in cooperation with USGS, continuing to develop this plan.
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 June-December, 2012; 2013 burrow surveys commenced in March and will continue through November 2013.
Predator control at the Kahikinui Management Area (Tier 1 mitigation)	HCP, Section 6.3.5; Petrel Management Plan	Auwahi Wind is planning a phased approach to implementation of predator control at the management area. The initial phase in 2013 will involve the deployment of tracking tunnels, kill traps within a limited portion of the management area, and game cameras to identify cat locations and kill trap effectiveness. Auwahi Wind is planning for full implementation of the predator control strategy in 2014.	In compliance; ongoing	Initiation of predator control at the management area planned for September 2013.

Table 1. Summary of Compliance Status September 1, 2012-July 31, 2013 (continued).

Requirement/Permit Condition	Document Source/Condition	Required Timeframe	Compliance Status	Actions Completed/Basis for Compliance
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	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	A letter from the National Park Service summarizing the status of use of funds is provided in Attachment 4.
Abutilon menziesii **(red ilima)**				
Ulupalakua Ranch will plant 10 red ilima from its on-going conservation efforts.	HCP, Section 4.2.3	After construction/site restoration is complete	In compliance; ongoing	Plants are currently being propagated at the Ulupalakua Ranch nursery and will be outplanted once they reach the appropriate size. They will be planted within a fenced enclosure on the wind farm site. It is anticipated that planting could occur as early as the second quarter of FY 2014.

2.0 PCMM

The Project became commercially operational on December 28, 2012. PCMM at the Project was initiated in December 2012 to document impacts to species covered by the Project HCP (Covered Species) and other species. However, due to the continued use of large construction equipment on site and ongoing reseeding and other cleanup efforts under the turbines, it was not possible to establish full search plots or have full access to the site until the turbines were commissioned in mid-January. During the commissioning period (December through mid-January), carcass searches occurred within cleared areas and along roads on a weekly basis, and information collected during these searches was considered incidental. Standardized carcass searches beneath all eight turbines and the met tower, carcass persistence trials, and searcher efficiency trials conducted following the schedule and methods outlined in the approved PCMM Plan were initiated on January 25, 2013.

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.

The survey year is divided into the wet season (November through April) and dry season (May through October). Carcass persistence and searcher efficiency trials have been completed for the wet season and are summarized for each carcass size class in Table 2 and Table 3, respectively. The results of dry season trials will be provided in the FY 2014 semi-annual report when the full season of trial data are available. A Wildlife Education and Incidental Reporting program was also implemented to document fatalities found outside the regular searches. The 2013 PCMM annual report (Attachment 1) provides a detailed description of field and analytical methods and results.

Table 2. Carcass Persistence Estimates for the Wet Season (January-April) at the Auwahi Wind Project, FY 2013.

Carcass Size Class	N	Average Carcass Persistence Time (days)	95% CI
Bats[1]	60	3.4	2.4-4.9
Small birds[2]	30	5.2	2.8 -10.3
Large birds[2]	30	92.5	37.1-367.8

[1]Mice used as surrogates; value based on combined small bird and mouse data (Hale and Karsten 2010)
[2]Carcasses 30 cm (10 inches) or smaller in size were considered "small birds" (e.g., starlings and house sparrows); carcasses greater than 30 cm (10 inches) in size were considered "large birds" (e.g., pheasants and chukars)

Table 3. Searcher Efficiency Estimates for the Wet Season (January-April) at the Auwahi Wind Project, FY 2013.

Carcass Size Class	No. Placed[1]	No. Found	Average Searcher Efficiency (%)	95% CI
Bats[2]	27	18	67	48-81
Small birds	14	9	64	36-86
Large birds	17	12	71	47-88

[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)
[2] Mice used as surrogates; value based on combined small bird and mouse data

To date, two fatalities have been documented, neither of which were Covered Species (Table 4). No fatalities have been observed at the met tower. Adaptive management opportunities are discussed in the 2013 PCMM annual report included in Attachment 1.

Table 4. Documented fatalities at the Auwahi Wind Project, FY 2013.

Species	Status	Date	Location (Turbine)	Type of Detection
white-tailed tropic bird (*Phaethon lepturus*)	MBTA[1]	3/21/2013	1	Standardized Search
common myna (*Acridotheres tristis*)	none	3/26/2013	3	Standardized Search

[1]Protected by the Migratory Bird Treaty Act

3.0 Mitigation

3.1 Hawaiian Petrel Mitigation

3.1.1 Petrel Burrow Monitoring

Petrel burrows within the Kahikinui Petrel Management Area (Kahikinui) continue to be monitored in 2013 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 will be checked once a month from March through August, and every other week during the fledgling period, from September to mid-November. All burrows were monitored during each check through July; however, after July only active burrows will be monitored. New burrows located in 2013 were marked, mapped, and added to the monitoring dataset. Currently, 58 petrel burrows are being monitored, including four burrows that were discovered in 2013. To date, signs of depredation have not been observed at any of the monitored burrows.

The 2012 Petrel Monitoring Report, summarizing in detail the results for 2012, is included in Attachment 2. The 2013 Petrel Monitoring Report will be provided as part of the 2014 annual report.

In May, 10 Reconyx game cameras were deployed at active petrel burrows to document burrow activity and the presence of predators at burrows. The cameras are currently being rotated between active burrows which will continue throughout the breeding season. Petrels were observed on all the cameras placed at active burrows during May and June. Two additional game cameras were placed within a drainage that collects water to detect predators visiting the water source; in May and June only goats and a chukar were detected at the drainage.

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 predator control strategy will allow predator control to be adaptively managed over time. The effectiveness of initial predator control efforts will inform how the strategy needs to be refined in order to best control predators in the petrel colony. Tetra Tech and Island Conservation made a site visit to Kahikinui in February 2013 to assess site characteristics (terrain, substrate, and vegetation) in relation to the suitability of various predator control methods, site access, and risk to non-target species; evaluate the potential for use of VHF and cellular-based remote trap monitoring systems; and identify challenges and other site-specific factors to consider in developing a strategy.

Given the scale, remoteness, and ruggedness of Kahikinui, the uncertainties related to effectiveness of different trap types, and the need to understand more about predator activity within Kahikinui, Auwahi Wind plans a phased approach to predator control. The initial phase will be started in 2013 and will involve the deployment of tracking tunnels to assess rat and mongoose activity; kill traps within a limited portion of Kahikinui targeting feral cats, rats, and mongooses; and game cameras to identify locations used by feral cats and evaluate the effectiveness of kill traps. This phased approach will allow Auwahi Wind to adaptively manage by first testing traps on-site and collecting more comprehensive and site-specific data on predator presence and activity. Full implementation of a predator control strategy will occur in 2014.

3.1.3 Benefits

To date, Auwahi Wind has established baseline conditions within Kahikinui. 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. A discussion of the initial benefits of predator control will be included in the FY 2014 annual report once predator control has been initiated.

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. Tier 1 mitigation consists of the restoration of approximately 130 acres of pastureland in the Waihou Mitigation Area (the Puu Makua parcel) to create roosting and foraging habitat for the Hawaiian hoary bat. 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. Currently, the parcel is being enclosed with ungulate-proof fence, and will be planted with native trees to restore the native forest.

Tier 2 mitigation consists of funding Hawaiian hoary bat research. Auwahi Wind is working with Dr. Frank Bonaccorso from the U.S. Geological Survey (USGS) to develop a research project combining radiotelemetry 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. A site visit with USGS occurred in March 2013 to confirm the feasibility of conducting the research study. A final research plan is under development, taking into account observations made during the site visit.

Acoustic monitoring at the Project was initiated in July 2013 with the installation of ground-based detectors. Auwahi Wind is also working with Wildlife Acoustics to assess the feasibility of mounting acoustic monitors at turbine nacelle height or at a height within the rotor swept area of Siemens 3.0 turbines.

3.2.1 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.

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 is provided in Attachment 3.

3.4 Hawaiian Goose

As stated in the 2012 annual report, Auwahi Wind provided a one-time payment on April 17, 2012, of $25,000 to the NPS for use in building a Hawaiian goose rescue pen and predator fence to support egg, gosling, and adult rescue efforts in Haleakala National Park. A letter from the NPS confirming use of this funding is provided in Attachment 4.

4.0 Changed or Unforseen Circumstances

There were no events or circumstances that would be considered changed or unforeseen circumstances during the FY 2013 reporting period at the Project.

5.0 Annual Workplan and Schedule

An annual work plan for FY 2014 identifying major monitoring and mitigation activities and their associated timelines is provided in Attachment 5.

6.0 Cost Expenditures and Budget

A summary of HCP-related expenditures for FY 2013 is provided in Attachment 6. This summary lists costs (including staff labor) that Auwahi Wind has expended toward fulfilling the terms of the HCP through FY 2013 and compares them against the budgeted amounts specified in Appendix 8 of the HCP.

7.0 References

Hale A. and K.B. Karsten. 2010. Estimating bird and bat mortality at a wind energy facility in North-central Texas. Presented at the Wind Wildlife Research Meeting VII, Lakewood Colorado. October 19-21 2010.

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

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Attachment 1
Post-construction Monitoring Annual Report

Auwahi Wind Farm
Post-Construction Mortality Monitoring
FY 2013 Annual Report

State of Hawaii ITL No. ITL-17 and USFWS ITP No. TE64153A-0

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EXECUTIVE SUMMARY

The Auwahi Wind Farm became commercially operational on December 28, 2012, and consists of eight Siemens 3.0-megawatt turbines located on east Maui. Post-construction mortality monitoring (PCMM) at the wind farm began in December 2012 to document impacts to species covered (referred to as the Covered Species) by the Auwahi Wind Farm Project (Project) HCP. Searches of cleared areas, intended to provide supplementary data until full search plots could be established, were conducted during the commissioning period (December through mid-January, 2013). Standardized carcass searches, carcass persistence trials, and searcher efficiency trials conducted according to the agency-approved PCMM plan were initiated on January 25, 2013. A Wildlife Education and Incidental Reporting program was also implemented to document fatalities found outside the regular searches. Surveyors did not detect fatalities of the Covered Species; however, two fatalities of other species were detected, including a white-tailed tropic bird and a common myna. Table ES-1 provides an overview of the PCMM program. This report provides a description of field and analytical methods, presents the results of initial monitoring conducted through June 2013, and identifies adaptive management measures that will improve the robustness of future fatality monitoring.

Table ES-1. Post-construction Fatality Monitoring Summary, Year One

Variable	Value
Study Metrics for Fatality Estimates	
Turbine number	8
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 (December 2012-June 2013 monitoring covered in this report)
Search interval	3.5 days July-November 7 days March-June 28 days December-February[2]
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	0
Adjusted take	0
Fatalities of Other Species[1]	
Number of fatalities documented	2

[1] Two bird fatalities detected (white-tailed tropic bird and common myna).
[2] In 2013, searched cleared areas weekly December through mid-January (during commissioning) until full plots could be established January 25th.

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Appendices

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) in east Maui, approximately 16 kilometers (10 miles) south of Kula, Hawaii. The HCP was developed in compliance with Section 10(a)(1)(B) of the Endangered Species Act and Chapter 343 of the Hawaii Revised Statues to obtain incidental take permit (ITP) TE64153A-0, which was issued by the U.S. Fish and Wildlife Service (USFWS) on February 24, 2012, and incidental take license (ITL) ITL-17, issued by the Hawaii Department of Land Natural Resources (DLNR) on February 9, 2012. The ITP/ITL authorize incidental take of four federal- and state-listed species, including Hawaiian petrel (*Pterodroma sandwichensis*), Hawaiian goose (*Branta sandvicensis*), Hawaiian hoary bat (*Lasiurus cinereus semotu*), and Blackburn's sphinx moth (*Manduca blackburni*), collectively referred to as the Covered Species.

Conditions of the ITP/ITL require the implementation of a post-construction mortality monitoring (PCMM) program at the Project. The objective of the PCMM program is to determine bird and bat fatalities, if any, due to collisions with the wind turbines or other Project structures, including the Covered Species. Documentation of take of the Covered Species, through the PCMM program also ensures compliance with the authorized provisions and take limitations set forth under the HCP and ITP/ITL. Take limits for each of the Covered Species are listed in Table 1-1. Exceeding established take limits or other unanticipated impacts to the Covered Species may trigger additional avoidance and minimization measures or mitigation.

Table 1-1. Take Limits Authorized under the Auwahi Wind Farm ITP/ITL

Covered Species	Take Authorization (over the 25-year permit period)
Hawaiian hoary bat	Tier 1: 5 adults and 2 young Tier 2: 10 adults and 4 young Tier 3: 19 adults and 8 young
Hawaiian petrel	Tier 1: 19 adults and 7 chicks Tier 2: 32 adults and 12 chicks Tier 3: 64 adults and 23 chicks
Hawaiian goose	5 adults
Blackburn's sphinx moth	28 acres of habitat[1]

[1] Not a focus of post-construction monitoring so not addressed further

This report summarizes the results of the first 7 months of PCMM at the Project. Field and analytical methods are presented, as well as a discussion of initial monitoring data and adaptive management measures considered for Fiscal Year (FY) 2014.

2.0 Methods

2.1 Fatality Monitoring

Fatality estimates at wind farms are based on the number of carcasses found during carcass searches conducted under operating turbines. Both the ability of searchers to detect carcasses over a given persistence time (searcher efficiency) and the duration that a carcass persists on site (carcass persistence time) can bias the number of carcasses located during standardized searches. Therefore, this PCMM study included:

1. standardized carcass searches to monitor for fatalities associated with the operation of the Project;
2. searcher efficiency trials to assess observer efficiency in finding carcasses; and
3. carcass persistence trials to assess site-specific duration that a carcass remains detectable to searchers.

PCMM is scheduled to occur throughout the year at the Project. The monitoring year is divided into two seasons based on moisture regimes and changes in vegetation: the wet season (November through April) and the dry season (May through October). Fatality monitoring at the Project began in December 2012 with the official start of commercial operation; however, because the use of large construction equipment continued on site, and reseeding and other cleanup efforts were ongoing under the turbines, it was not possible to establish full search plots or have full access to the site until the turbines were commissioned in mid-January. During the commissioning period (December through mid-January), carcass searches occurred within cleared areas and along roads on a weekly basis, and information collected during these searches was considered incidental. Standardized carcass searches were initiated on January 25, 2013.

2.1.1 Standardized Carcass Searches

Standardized carcass searches were designed to systematically search turbine locations for bird and bat fatalities that are attributable to collisions; or in the case of bats, also due to barotrauma (tissue damage to the lungs that results from the rapid air-pressure reduction near moving turbine blades [Baerwald et al. 2008, Rollins et al. 2012]). The following search intervals are identified under the currently approved protocol included in the Project HCP:

- Monthly surveys from December through February when seabirds are not present on Maui and when bat activity is expected to be low;
- Weekly surveys from March through June when seabirds are present on Maui and when bat use is expected to be higher; and
- Twice weekly surveys from July through November, which includes the petrel fledgling period (October through November).

Standardized carcass searches were conducted at all eight turbines and the met tower. The following describes the establishment of the search plots and field methods for fatality documentation.

2.1.1.1 Search Plots

The turbine search plots extended 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, covering 75 percent of the maximum turbine blade height (MTBH). Given the spacing of turbines, search plots were almost contiguous along the turbine string, so the actual areas searched included distances for each turbine equal to 100 percent of the MTBH and greater. Linear transects spaced approximately 6 meters (19.7 feet) apart were established within the search plot, with searchers scanning out to 3 meters (9.8 feet) on each side of the transects. Shifting light throughout the day has the potential to impact carcass detectability; thus, turbines were searched in rotating order so that each turbine was searched at a different time during the day.

Searchers used a Trimble GeoXT to delineate the cover types within each search plot in order to identify any differences in visibility and to identify non-searchable areas. Cover types included cleared area/road, lava slope, lava boulder field, and vegetated. Due to the variability within and among search plots, the definition of “non-searchable” took into account one or more of the following considerations:

- Safety – Areas deemed unsafe for walking due to the presence of extreme slopes, unstable terrain (loose or hidden moderate to large lava rocks and boulders), or lava tubes.
- Vegetation – Tall (greater than 1.5 meters) and dense (greater than 75 percent cover) shrub vegetation that would inhibit searchers from walking transects and where searcher efficiency would be extremely low (i.e., an object tossed on the ground is not at all visible). Many of these areas also coincide with dense herbaceous cover; however, dense grass was not included by itself as defining an area as non-searchable because Ulupalakua Ranch will periodically graze cattle in the Project, which will improve visibility.
- Terrain – Lava outcrops, lava slopes, and steep, vegetated slopes across would prevent searchers from following transects, or areas where searchers would be more focused on climbing/navigating than looking for carcasses.

Cover types may need to be reviewed on at least a seasonal or other basis to capture changes to visibility as cows return to the Project or vegetation dies back during the year.

Searches were conducted under the met tower in an area extending out to 10 meters from the base. Met tower searches were conducted at the same search interval as the turbines.

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 as a whole allowing the fatality estimates to be corrected for the number of carcasses potentially falling outside of searchable areas (see description of Huso [2010] estimator, below). Because the distribution of carcasses falling within search plots is not uniform (i.e., a greater proportion of carcasses tend to fall closer to the turbine) publically available information from 25 studies (with data for 1,700 carcass distances, including distance up to 100 percent of the MTBH) was used to calculate the proportion of the carcasses potentially falling within 10-meter increments from each turbine (i.e., 10-meter concentric rings around each turbine; Tetra Tech unpublished analysis). The proportion of the carcass distribution searched in each 10-meter ring was calculated and summed to determine the total proportion of the carcass distribution searched for each carcass category.

2.1.1.2 Fatality Documentation

Fatalities were photographed and documented. Pursuant to the conditions of the ITP/ITL, fatalities were reported by phone and in writing to USFWS and the Hawaii Division of Forestry and Wildlife (DOFAW). USFWS issued to Auwahi Wind Special Purposes Utility Permit No. MB92518A-0 (valid through March 31, 2015). DOFAW issued Protected Wildlife Permit No. WL14-03 (valid through April 11, 2015). Both permits allow the handling of migratory and/or native bird carcasses.

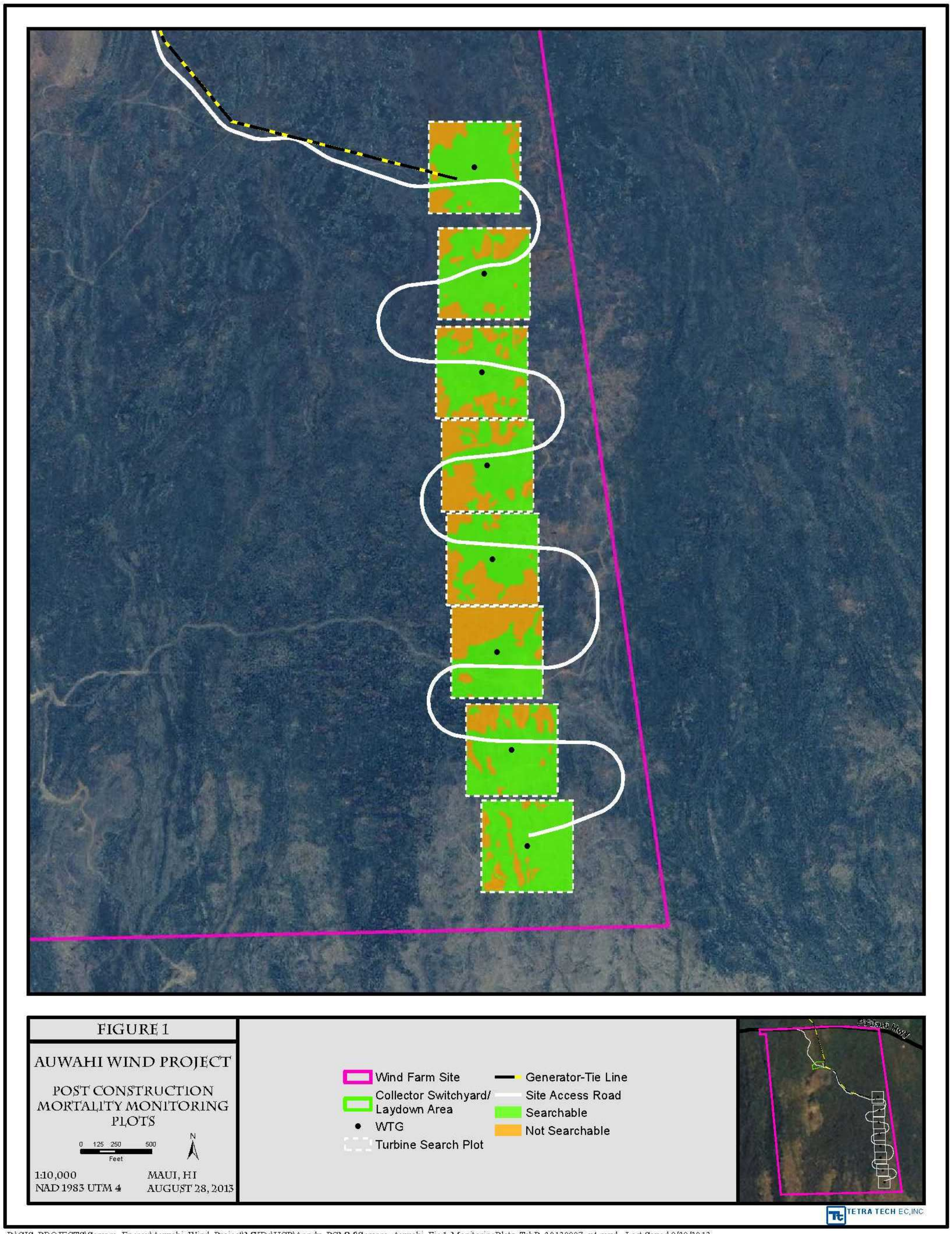

Figure 2-1. Post-construction monitoring plots at the Auwahi Wind Farm

2.1.2 Incidental Fatalities

The Wildlife Education and Incidental Reporting Program provides the means for documenting fatalities found incidentally by operations staff or ranch personal working in the wind farm site. For the purposes of this study, an incidental fatality is defined as a bird or bat carcass found outside of the search plot. Incidental fatalities are documented with the same level of detail as carcasses found during standardized searches, however, incidental fatalities are excluded from statistical analyses. Carcasses found within the search plots but outside of standardized searches are still included in the analysis, and thus not considered incidental, because the timing of the last search in the plot is known and thus a search interval can be determined. Incidental fatalities of Covered Species are not included in fatality estimate calculations because they are already accounted for in the adjustments made by the estimator.

2.1.3 Searcher Efficiency

Searcher efficiency, or the probability that an observer detects a carcass that is available to be found during a search, is used to account for imperfect detection in carcass searches. Three searcher efficiency trial events were conducted during the wet season, which incorporated the assessment of each member of the field staff and were conducted by an independent third party (tester). Searcher efficiency trials were conducted so that searchers being assessed had no prior knowledge of the trial. Bird carcasses of 2 size classes (large bird and small bird) and bats (mice as bat surrogates) were used in the trials. For the purposes of analysis, an arbitrary cutoff of 25 centimeters (10 inches) was used to separate birds into size categories and is consistent with criteria used for other PCMM studies. Species with lengths less than 25 centimeters were considered small birds (e.g., European starling); all other species with lengths greater than or equal to 25 centimeters were considered large birds (e.g., ring-necked pheasant). To achieve a higher sample size and to address variability in bat surrogates used by other mortality monitoring studies, data for small birds and mice were pooled to obtain an estimate for searcher efficiency of bats (Hale and Karsten 2010). Differences among mortality monitoring studies in surrogate species used for bats affect searcher efficiency (and carcass persistence) which can, in turn, influence fatality estimates. That is, because of their wings, bats may be easier to find than mice and therefore use of only mice may bias the searcher efficiency rate low. Therefore, by pooling data from different carcass types (i.e., small birds and mice), the bias associated with any one carcass type is reduced.

Turbines were randomly selected for trials. For each trial event, three to five carcasses from each size category were placed in the field on a given day. These carcasses were placed at randomly generated points within the selected turbines' search plots with points stratified (and weighted) by cover type to ensure that they were represented in proportion to their presence within the study area. Trial events typically occurred over 2 to 3 days. All trial carcasses were retrieved by the end of each trial day; if a trial carcass that was not found by searchers could not be relocated at the end of the trial, it was assumed to have been scavenged and thus unavailable to be found by searchers. Subsequently, these carcasses were not included in the analysis.

Data from searcher efficiency trials were modeled using a logistic regression to determine if carcass size influenced searcher efficiency. Bootstrap estimates of searcher efficiency and 95 percent confidence intervals (CI) were calculated, using 1,000 replicates for carcass category (large bird, small bird, and bat).

The estimated searched efficiency is defined by Huso (2010) as:

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

Where 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.

2.1.4 Carcass Persistence Time

The carcass persistence time is the number of days a carcass persists in the study area before it is removed and is used to account for bias associated with carcasses being removed before they can be discovered by searchers. Carcasses may be removed from the search plot due to scavenging or other means (e.g., decomposition). Because carcass persistence is expected to vary with season and carcass size, two 21-day carcass persistence trials are scheduled in each season, using carcasses of varying size classes (large bird, small bird, and mice as surrogates for bats). Similar to the treatment of searcher efficiency trials, data for small birds and mice were pooled to obtain an estimate for persistence time of bats. Hale and Karsten (2010) found that using mice as surrogates for bats could significantly affect carcass persistence estimates. In their study, bats persisted on average 3 days longer than mice and the shorter persistence times for mice resulted in an upward bias of fatality estimates (Hale and Karsten 2010). Therefore, by pooling data from different carcass types (i.e., small birds and mice) the variability associated with using one carcass type is reduced.

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. Fifteen trial carcasses from each carcass category were utilized per trial,with three carcasses were placed at each turbine. 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.

Data from carcass persistence trials were modeled using an interval censored parametric failure time model (a type of survival model) to determine if size or season influenced carcass persistence. The carcass size was included as a variable, as larger carcasses might persist longer. Four distributions were included in the analysis: exponential, Weibull, log-logistic, log-normal. To determine the best fit distribution, model selection was based on the Akaike information criterion (AIC). The AIC is a measure of the "relative goodness of fit" of a statistical model. The model with the lowest AIC value was considered to best explain the variance in searcher efficiency, with estimates generated from this model used in the calculation of adjusted fatality estimates. Models that had an AIC value that differed by two or more were not considered to adequately explain variations in searcher efficiency. 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 (2010) as:

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

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

The persistence time of trial carcasses that survived until the end of the trial period is right censored, in that the day the carcass is last observed is equal to the end of the trial. However, carcasses not removed by the end of the trial could have persisted longer. Therefore, calculating an average carcass persistence time using all of the data would underestimate persistence because it would incorrectly assume that carcasses that "survived" until the end of the trial were scavenged on the last day of the trial. Carcass persistence time is obtained by summing the days each trial carcass persisted and dividing by only those carcasses that were scavenged; thus the carcasses that were not scavenged by the end of the trial are excluded from the denominator when obtaining the average persistence time. Consequently, average carcass persistence time can exceed the 21-day trial period.

To obtain additional information about scavenging activity at the wind farm, game cameras were placed throughout the Project in May 2013. After initial testing, six Reconyx™ game cameras were deployed from May 6 to May 10, 2013. The game cameras were placed in the vicinity of wind turbines, at least 100 m from the PCMM plots to avoid interfering with ongoing PCMM activities. At each location the camera was focused on a carcass (chicken, chukar, starling, sparrow, or mouse). Cameras were checked after the carcasses had been in place for two days. During each check, the surveyor switched out the game camera memory cards and replaced any carcasses that had disappeared between checks.

2.2 Estimating Adjusted Take

2.2.1 Direct Take

Fatalities at wind projects are statistically estimated because searcher efficiency is less than 100 percent and often carcass persistence is shorter than the search interval. Additionally, only a proportion of the distribution of carcasses beneath a turbine is typically included in the search area (due to search plot size, presence of non-searchable areas, and other factors). Thus, the Huso estimator (Huso 2011; Huso et al. 2012) is currently the best available method for estimating the adjusted number of fatalities given a sufficient sample size, and has been shown to reduce bias in fatality estimates. However, the Huso estimator 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). The U.S. Geological Survey is developing a rare event calculator (referred to as "evidence of absence") that will provide an estimate of the likelihood that the true number of fatalities (based on the detection of no carcasses or a small number of carcasses during standardized carcass searches) is less than a certain (user defined) threshold, taking into account all of the factors included in the Huso estimator (see below). The agencies are evaluating how the rare event calculator may be considered for use in Hawaii wind farm projects when it has been peer reviewed and becomes publicly available.

The Huso (2012) estimator uses the following equation:

$$\hat{f}_{ijk} = \frac{c_{ijk}}{\hat{p}_{jk} * \hat{r}_{jk} * a_{ik} * \hat{v}_{jk}}$$

Where:

$\hat{f}_{ijk}$ is the estimated fatality

i is an arbitrary turbine

j is the arbitrary search interval

k is the arbitrary carcass category

c_{ijk} is the observed number of carcasses

$\hat{p}$ is the estimated searcher efficiency

$\hat{r}$ is the average probability of persistence

a is the proportion of the carcass distribution searched

$\hat{r}_{jk}$is a function of the average carcass persistence time, and the length of the search interval preceding a carcass being discovered. $\hat{r}_{jk}$is calculated using the lower value of *I*, the actual search interval when a carcass is found or $\hat{\tilde{I}},$ the effective search interval, and is estimated through searcher efficieny trials previously described.

$\hat{v}_{jk}$ is the proportion of the effective search interval sampled where $\hat{v}$ = min (1, $\tilde{I}/I$).

$\hat{p}_{jk}$ is the estimated probability that a carcass in the *k*th category that is available to be found will be found during the *j*th search

a_{ik} is the proportion of the carcass distribution searched for the k^{th} category at the i^{th} turbine

$\hat{p}_{jk},$ $\hat{r}_{jk},$ and $\hat{v}_{jk}$ are assumed not to differ among turbines but can differ with carcass size and season

2.2.2 Indirect Take

For the Hawaiian petrel and Hawaiian hoary bat, take levels established under the ITP/ITL also account for indirect take, or the indirect loss of dependent young resulting from the take of an adult bird or bat during the breeding season. Therefore, direct take (adjusted as described above) will be used to assess Project-related indirect take. That is, for every petrel or bat carcass detected during the breeding season, modifiers as described in detail in Section 5.2 of the HCP and as required under Special Condition 2 of the ITL, must be applied to estimate indirect take by accounting for the likelihood that a given adult is reproductively active, the likelihood that the loss of a reproductively active adult results in the loss of its young, and average reproductive success. Indirect take is added to adjusted direct take to determine the estimated total take.

3.0 Results

3.1 Fatality Monitoring

3.1.1 Standardized Carcass Searches

The initial searches conducted during commissioning (December 2012 through mid-January 2013) in the cleared areas were conducted weekly. No fatalities were documented during this period.

Starting in January, a total of 11 standardized searches were conducted during the wet season. From May through June 30, eight standardized searches have been conducted during the dry season at all eight turbines. A total of 152 turbine searches have been conducted from January through June, 2013 (Table 3-1). Weather interrupted four searches, but these were later completed or extended due to surveyor availability. However, none of these instances affected the ability to maintain the required search intervals (Table 3-2). Based on the current search plot size and configuration, a total (Project-wide) of 96.0 percent of the bat distribution, 81.1 percent of the small bird distribution, and 86.5 percent of the large-bird distribution was covered during standardized carcass searches. The proportion of the carcass distributions searched by turbine is presented in Appendix A.

Table 3-1. Auwahi Wind Farm Fatality Survey Dates during Year 1 (FY 2013)

Season	Survey Period	Dates	Season	Survey Period	Dates
Wet Season	1	1/25-1/28	Dry season	12	5/6-5/7
	2	2/25-2/28		13	5/13-5/16
	3	3/4-3/7		14	5/20-5/21
	4	3/11-3/14		15	5/27-5/28
	5	3/18-3/23		16	6/3-6/4
	6	3/25-3/28		17	6/10-6/11
	7	4/1-4/3		18	6/17-6/19
	8	4/8-4/11		19	6/24-6/25
	9	4/15-4/17			
	10	4/22-4/25			
	11	4/29-5/2			

Table 3-2. Average Search Intervals or Number of Days between Standardized Carcass Searches at the Auwahi Wind Farm during Year 1 (FY 2013)

Month	Average Search Interval (days)
January[1]	Initiated PCMM
February	31.0
March	6.7
April	7.1
May	6.9
June	7.0

1/ Initiation of standardized carcass searches occurred on January 25, 2013.

Two fatalities were documented during the wet season (Table 3-3). One was an injured white-tailed tropic bird reported by Ulupalakua Ranch staff in March 2013. Because the bird was found within a search plot and on a day when surveyors would be conducting a search in that area, it is not considered an incidental fatality. According to approved downed wildlife handling and reporting procedures, because this species is protected by the MBTA, field staff contacted USFWS and DOFAW immediately, and a DOFAW biologist came to collect the bird. A common myna feather spot was also documented in March 2013 and subsequently reported to the agencies. To date, no fatalities of any of the Covered Species have been documented.

Table 3-3. Fatalities Documented at the Auwahi Wind Farm from January 25 –June 30, 2013

Species Group	Common Name	Special Status	No. Fatalities/ Injuries	Turbine No.	Date
seabird	white-tailed tropic bird (*Phaethon lepturus*)	MBTA	1	1	3/21/2013
songbird	common myna (*Acridotheres tristis*)	--	1	3	3/26/2013

3.1.2 Incidental Finds

No incidental fatalities have been reported to date.

3.1.3 Spatial and Temporal Distribution of Fatalities

Sufficient data are not yet available to provide insight in to the spatial and temporal distribution of fatalities at the Project. These trends will be discussed in future monitoring reports, should a sufficient number of fatalities be documented.

3.2 Searcher Efficiency Trials

Three searcher efficiency trials occurred during the wet season, beginning on March 19, March 25, and April 23. A total of 20 mice, 21 small birds, and 22 large bird carcasses were placed in the field. However, 35 percent of the bat carcasses, 33 percent of small bird carcasses, and 23 percent of large bird carcasses were removed by scavengers prior to surveyors conducting carcass searches and were therefore not included in the analysis. A majority of the carcasses that were not retrieved (79 percent in total) were in vegetated areas.

Searcher efficiency ranged from 71 percent for large birds (95 percent CI = 47-88) to 64 percent for small birds (95percent CI = 36-86; Table 3-4). Dry season searcher efficiency trials are scheduled to occur through October 2013, and results will be presented in the FY 2014 semi-annual report.

Table 3-4. Searcher Efficiency Estimates for the Wet Season at the Auwahi Wind Farm, FY 2013.

Size Class	No. Carcasses Found	No. Carcasses Placed and Retrieved[1]	Average Searcher Efficiency (%)	95% CI
Bat[2]	18	27	67	48-81
Small bird	9	14	64	36-86
Large bird	12	17	71	47-88

[1]Only includes carcasses that were retrieved from the field after the trial, confirming that they were available to be found by searchers. Carcasses that were not retrieved (and thus potentially scavenged) were removed from the analysis.
[2]Mice used as surrogates; searcher efficiency estimate based on pooled data for small birds and mice.

3.3 Carcass Persistence Trials

Two carcass persistence trials were conducted during the wet season. The first was initiated on January 29 and the second was initiated on April 4. A total of 90 trial carcasses were placed with a minimum of 30 for each class size (including mice as bat surrogates; Table 3-5). Based on AICc value, the Weibull distribution was the best fit to the carcass persistence time. Carcass persistence times for the wet season at the Project were 92.5 days for large birds (95% CI=37.1-367.8), 5.2 days for small birds (95% CI=2.8-10.3), and 3.4 days for bat surrogates (small birds and mice combined; 95% CI=2.4-4.9). Dry season carcass persistence trials will be conducted through the rest of the dry season, the results of which will be presented in the FY 2014 semi-annual report.

Table 3-5. Carcass Persistence Estimates (AICc for model = Size, distribution = Weibull: 486.88 for the Wet Season at the Auwahi Wind Farm, FY 2013

Size Class	No. Carcasses Placed	Average Carcass Persistence Time (days)	95% CI
Bat[1]	60	3.4	2.4-4.9
Small bird	30	5.2	2.8-10.3
Large bird	30	92.5	37.1-367.8

[1]Mice used as surrogates; value based on combined small bird and mouse data.

Monitoring with game cameras confirmed the high rate of scavenging activity on site. Ninety-two percent of the game camera carcasses (n = 12) were scavenged. Ten of the carcasses were scavenged by a mongoose, one by a cat, and one by an unknown scavenger. All of the scavenging events observed with cameras occurred within 24 hours of setting out the carcass. For mongooses, all of the initial discoveries of the carcasses occurred during daylight hours. Two mongooses were observed scavenging simultaneously at one of the carcasses. The cat discovered the carcass at night. During the initial testing phase, a cat and mongoose were observed fighting over a carcass. Figure 3-1 shows representative photos of scavengers documented with the game cameras.

Figure 3-1. Representative Photos of Scavengers at the Auwahi Wind Farm Captured with Game Cameras

3.4 Adjusted Take Estimation

3.4.1 Direct Take

During the first seven months of monitoring at Auwahi, take of the Covered Species was not documented; therefore, estimates of adjusted take were not calculated.

3.4.2 Indirect Take

Indirect take was not calculated because take of Covered Species has not been documented to date.

4.0 Discussion

4.1.1 Evaluation of Current Study Protocol

An effective PCMM program is structured to minimize detection bias (i.e., the denominator in the Huso [2012] estimator) which takes into account the proportion of turbines searched, the proportion of the carcass distribution searched, searcher efficiency, and carcass persistence time. When detection bias is low and is close to 1, there is little scaling up from the number of carcasses detected in the field. As detection bias increases (falls closer to 0) the adjusted fatality number will increase exponentially. Most importantly, each factor contributing to detection bias may differ by season, cover type, terrain, and other variables that characterize the location and layout of an individual project. Thus, on a Project-specific basis, the significance of each factor's influence on detection bias must be evaluated, and driving factors should be assessed in terms of their ability to be improved to maximize study effectiveness, taking into account logistical feasibility and cost. The focus of the first monitoring year at the Project is to start with the baseline study protocol approved in the HCP, and through monitoring and field trials, identify components that worked effectively and areas where field methods warrant adjustment.

At the Project, all turbines were searched; therefore, no adjustment needs to be made for a proportion of unsearched turbines. As described above, the search plots beneath each turbine were mapped during plot set up in January 2013 to identify the searchable area within each plot, which relates to the proportion of the carcass distribution searched. Based on the carcass distributions calculated with data from 25 publically available PCMM studies at other sites across the county (Tetra Tech, unpublished analysis; see Section 3.1.1), standardized carcass searches are adequately sampling the potential distribution of carcasses with 96 percent of the bat, 82 percent of the large bird, and 86 percent of the small bird carcass distributions occurring within searchable portions of the search plots. Thus, the current search plot size and configuration appears sufficient. However, because cows have been reintroduced to the wind farm the vegetation is much lower and visibility has increased. Therefore, the search plot maps will be evaluated to determine if remapping in the field to reflect current visibility is warranted.

Searcher efficiency was relatively high for all carcass size classes, and fairly consistent among size classes. Often searcher efficiency is higher for larger carcasses and lower for small carcasses. It is possible that due to the number of unrecovered mouse carcasses (i.e., those scavenged before a survey could be conducted), the wet season searcher efficiency rate for bats may be inflated. Searcher efficiency trials during the dry season and through FY 2014 will provide greater insight into factors that may be affecting searcher efficiency at the Project.

Optimally, standardized carcass searches should be conducted at a frequency that minimizes the amount of extrapolation that would be required to estimate mortality associated with the number of carcasses missed by searchers due to scavenging. Carcass persistence times for bats (using small birds and mice as surrogates) were low (3.4 days on average) relative to the 7-day and 28-day search intervals, such that an estimate of adjusted take would scale up substantially due to this source of bias. Game cameras documented a relative high level of scavenger activity onsite, with both cats and mongooses active at the Project. Thus, options for improving carcass persistence time include increasing the search interval and/or implementing predator control at the Project.

4.1.2 ITP/ITL Take Levels

To date, based on the results of PCMM, the tier 1 (Hawaiian petrel and Hawaiian hoary bat) and baseline (Hawaiian goose) take levels have not been exceeded. Recent advances in PCMM statistical analysis highlight the importance of measuring confidence in the detection of rare events (i.e., the confidence that zero detections of carcasses really indicates zero fatalities), referred to as evidence of absence. Tetra Tech and Auwahi Wind will continue to work with Manuela Huso, a U.S. Geological Survey statistician, as the rare event calculator is developed. This will help determine if and how it may be appropriately applied to PCMM at the Project.

5.0 Adaptive Management

Based on the discussion above, Auwahi Wind proposes the following adaptive management measures to maintain the effectiveness of the PCMM program:

- Auwahi Wind will initiate predator control at the Project. Predator control has been demonstrated to be effective at other Hawaii wind farms, and given the documented presence of cats and mongooses on site, it has a high potential to increase carcass persistence time. The effectiveness of searcher efficiency trials may also be improved by reducing the number of trial carcasses removed by scavengers.
- In an effort to maximize the robustness of fatality estimates, Auwahi Wind will continue to assess the effectiveness of the current study protocol through the end of the first full year of monitoring. Future adjustments to the search interval, search plot size, and other methodology will be consider as necessary.
- Auwahi Wind may reassess cover types and visibility within the search plots to adjust for the presence of cattle grazing and dry season conditions.
- Auwahi Wind will expand the search plots at select turbines to include additional areas along Project roads to increase the proportion of the carcass distribution for large birds surveyed during standardized carcass searches. As recommended by Manuela Huso, this will facilitate the sampling of distances farther from the turbine. If it is determined that distances closer to the turbine provide adequate coverage of the carcass distribution search plots, size will again be reassessed.

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Appendix A

Proportion of Carcass Distributions Searched at the Auwahi Wind Farm

Table A-1. Proportion of the carcass distribution searched at the Auwahi Wind Farm.

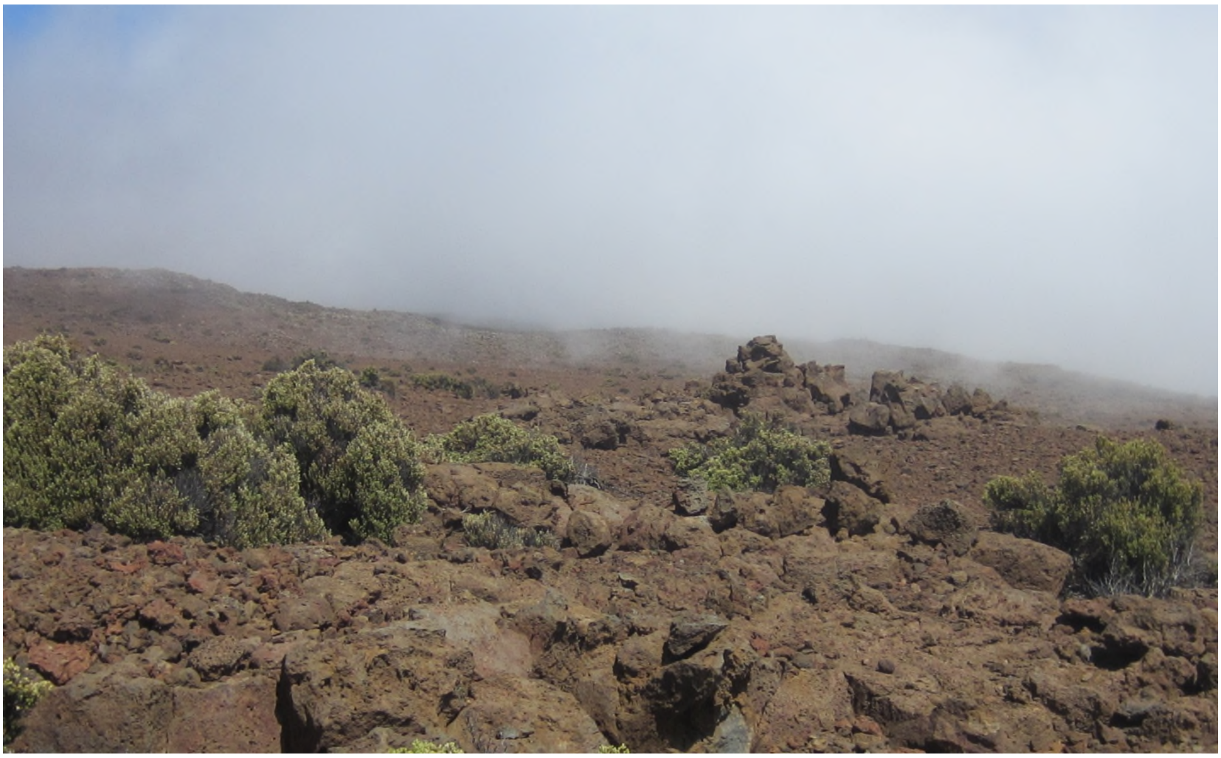
Turbine No.	Proportion of Bat Carcass Distribution Searched	Proportion of Large Bird Distribution Searched	Proportion of Small Bird Distribution Searched
1	99.4	88.7	93.6
2	96.7	83.2	88.0
3	97.9	83.8	88.7
4	94.5	77.1	81.7
5	92.8	78.2	82.3
6	93.2	75.1	79.8
7	98.4	85.4	90.3
8	94.7	82.8	87.2
Overall	96.0	81.8	86.5

Attachment 2

Kahikinui Management Area Hawaiian Petrel Monitoring Report

2012 Auwahi Wind Energy Hawaiian Petrel Report

Auwahi Wind Energy Project
Maui County, Hawaii



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EXECUTIVE SUMMARY

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

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 at the management area 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 2012 petrel surveys were to: assess the number of active burrows in order to define the management area under Tier 1 take levels; determine petrel reproductive success prior to implementation of predator control (i.e., baseline conditions); and test methods for documenting small mammal presence and petrel reproductive success.

A total of 54 burrows were monitored within the management area in 2012 (40 initially located during the 2011 surveys and 14 additional burrows found during the 2012 surveys). Burrow checks were conducted monthly from June to October 2012 and then weekly during the fledgling period, from mid-October to mid-November 2012. During each survey, surveyors checked the status of known petrel burrows and searched nearby suitable habitat for additional burrows. Any new burrows located in 2012 were marked, mapped, and added to the monitoring dataset. All known burrows were monitored during each check through September, after which only active burrows were monitored in subsequent burrow checks.

Thirty-three (61 percent) of the burrows were active and 21 (39 percent) were inactive within the management area in 2012. Of the 33 active burrows, 14 (42 percent) successfully produced a fledgling, one (3 percent) probably successfully produced a fledgling, four (12 percent) failed, and 14 (42 percent) either failed or were occupied by a non-breeder. The causes of nest failures were: egg abandonment at two burrows (Burrows 25 and 34); depredation at one burrow (assumed cat or mongoose, Burrow 22); and an unknown cause at one burrow (Burrow 31). Burrows were located throughout the management area, although the distribution was patchy. Nearly half of the burrows were located within two clusters in the northern section of the management area.

Based on the survey findings, eggs were assumed to have been laid in 19 to 33 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 chicks fledged/active burrow within the management area was 45.5. The percentage of chicks fledged/eggs laid within the management area was 42.4 – 79.0.

Petrel reproductive success within the management area in 2012 was compared to other petrel studies conducted on Mount Haleakala. Only one of the reproductive success parameters, the percentage of chicks fledged per active burrow, was presented in all studies because this metric does not require the differentiation of burrows occupied by prospecting birds from burrows that failed. The percent of chicks fledged/active burrow within the management area was within the range reported by studies at Haleakala National Park, but higher than that reported by ATST conservation area or control area. The burrows within Haleakala National Park likely benefited from predator control activities; whereas, predator control activities have not been implemented at the management area or ATST conservation area or control area.

Tracking tunnels were used to monitor the presence and distribution of small mammals (rodents and mongooses) within the management area. We placed seven to 24 individual tracking tunnel stations along three north-to-south transects, totaling 54 tracking tunnel stations. Rodents were detected along one of the three transects, Transect B, located in the central part of the management area. Rats were detected at six of the seven tunnel stations and mice were detected at one of the tunnel stations along Transect B. Transect B is at a slightly higher elevation than the other two transects and runs through a relatively dense cluster of petrel burrows. No mongooses were detected at any of the tracking tunnels. The tracking index was 28.6 percent for rats and 4.8 percent for mice. Rats and mice were found within the upper section of the management area, in proximity to ATST and Haleakala National Park, suggesting that human activity could be providing a supplemental food resource, which could allow small mammals to maintain populations at higher densities.

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1. Introduction

1.1 Background

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 (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 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 2012 Hawaiian petrel management activities executed in the Auwahi Wind Kahikinui petrel management area (management area).

As part of the HCP process, Auwahi Wind estimated take of Hawaiian petrels (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 at the management area beginning in 2013 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). Petrel management activities will be considered successful if predator control is implemented and mitigation efforts result in an increase in petrel survival or reproductive that successfully offsets approved take, as outlined in the Hawaiian Petrel Management Plan (Management Plan; Tetra Tech 2012b), approved by USFWS and 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 more dense at the lower elevations than the higher elevations. Vegetation consists mostly of native shrubs, primarily *Styphelia tameiameiae* (pukiawe) and *Vaccinium reticulatum* (ohelo).

Reconnaissance petrel surveys were conducted within the management area in 2011, during which biologists located 44 petrel burrows (33 active and 11 inactive; Tetra Tech 2012a). Following the 2011 surveys, the management area was tentatively divided into two sections for inclusion in the HCP: a Tier 1/Tier 2 area to the west and a Tier 3 area to the east (Figure 1). These designations were refined after the 2012 surveys, as described in this report.

Several Hawaiian petrel monitoring studies are currently being undertaken near or adjacent to the management area. The National Park Service (NPS) has been monitoring the largest known Hawaiian petrel colony, located at the top of Mount Haleakala, annually since 1988 (NPS 2012, Carlile et al. 2003). In addition, DOFAW has surveyed for petrel burrows on DLNR lands, and the Advanced Technology Solar Telescope (ATST) project monitors burrows under their state HCP.

The NPS has taken a number of measures to reduce feral animal populations around the petrel colony within Haleakala National Park. In 1976, a fence was erected around the perimeter of the main colony of petrels to exclude ungulates (C. Bailey pers. comm.). This fence benefited petrels by preventing burrows from being trampled by ungulates (Simons 1983). In addition, the NPS has been trapping rats since 1968 and cats and mongooses since 1981 (C. Bailey pers. comm., Carlile et al. 2003). Year-round trapping of all three species has occurred since 1981, and the NPS added rodenticide to predator control measures in 1997 (C. Bailey pers. comm., Carlile et al. 2003).

The other two petrel monitoring studies were initiated more recently than NPS efforts. In 2012, DOFAW biologists began petrel surveys to identify burrow locations on the DLNR portion of Kahikinui Forest Reserve in order to develop a comprehensive management strategy. This survey area is just east of the management area (Figure 1). The ATST project is monitoring petrel burrows as mandated by their state HCP to mitigate potential impacts from the construction of the ATST facilities (Chen et al. 2011). The ATST project is located just to the north of the management area at an astrophysical research center located at the summit of Mount Haleakala (Figure 1).

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). 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 on Maui are present from late February to early November (Figure 2). 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. A single egg is laid within the nest chamber, and the male and female take turns incubating the egg. Once the egg hatches, parents briefly brood the chick before beginning extended foraging trips at sea. 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, Figure 2).

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. 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 the 2012 Surveys

The objectives of the 2012 petrel surveys were to: assess the number of active burrows in order to define the management area under Tier 1 take levels; determine petrel reproductive success prior to implementation of predator control (i.e., baseline conditions); and test methods for documenting small mammal presence and petrel reproductive success. These objectives were met using four main components:

1. Management area-wide surveys (i.e., comprehensive surveys) conducted to document the petrel burrows within the management area;
2. Burrow checks conducted at known burrows to obtain an estimate of the number of active burrows and their reproductive success;
3. Testing of game cameras to evaluate their effectiveness at documenting predator presence and reproductive success; and
4. Testing of tracking tunnels to document the presence of mongooses and rodents for use in future predator control planning.

2. Methods

2.1 Comprehensive Burrow Surveys

A comprehensive survey was conducted from September 17 to September 24, 2012 to locate all active petrel burrows within suitable nesting areas of the management area (Figure 3; see Section 2.2.3 for burrow definitions). Searches were conducted in previously surveyed areas to ensure all burrows were located and in unsurveyed areas to maximize the number of burrows available to be managed. Surveyors began searches in the upper elevations of the management area to minimize travel time and covered areas further downslope as the surveys progressed. Searches in 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 comprehensive survey was conducted by a combination of conservation dogs and handlers and a crew of biologists.

Conservation dogs were used on the comprehensive surveys at the request of the USFWS (D. Greenly, pers. comm.) because trained dogs can locate petrel burrows based on the strong and distinctive musty scent associated with petrel burrows. Two dog teams from Ecoworks New Zealand were contracted to conduct burrow surveys. Each dog team consisted of a conservation dog and a handler. The dogs were trained and certified to work with protected and threatened wildlife species under the New Zealand Department of Conservation’s Threatened Species Detector Dog Program and had experience searching for seabirds throughout the Pacific region. The two dogs were a 2-year old Smithfield Collie and a 5-year old Labrador retriever. Prior to the surveys, the dogs were taken to known active burrows to identify the target scent.

The dog teams searched for petrel burrows by walking transects spaced approximately 40 m apart and perpendicular to the slope of the mountain (Figure 3). This spacing was thought to be close enough that the dogs should be able to detect petrel scent between transects (S. Sawyer, pers. comm.). The dogs were allowed to move freely though the area and investigate burrows, but the handlers also directed the dogs towards areas to ensure uniform coverage. The dogs indicated petrel scent by sitting and the handler then recorded the location of the burrow. Each dog team was equipped with two Global Positioning System (GPS) units; a hand-held GPS unit for the handler to navigate and a GPS dog tracking collar to record survey coverage.

The original intention was to have the conservation dogs search the entire management area; however, one of the dogs was affected by the altitude and was unable to complete the surveys. As a result, biologists conducted searches in areas not surveyed by dogs. A survey crew of 3 to 6 biologists spaced 5 – 10 m apart systematically searched for petrel burrows by walking transects perpendicular to the mountain slope (Figure 3). Two GPS units were carried by the biologists to collect tracks and record the boundaries of the survey coverage. The biologists surveyed areas upwind of the dog team to avoid interfering with the dog's ability to detect petrel scent.

The survey crew was trained to identify the signs of a petrel burrow, bird activity, and depredation. Surveyors visually inspected each potential burrow encountered with a flashlight to search for signs of petrel activity. Signs of activity included footprints, droppings, nest material, egg shells, and feathers. Any evidence of depredation (the remains of eggs, nestlings, or adults) or sign of predators (scat, tracks, or direct observations) were noted. Each active burrow was assigned a unique identification number and marked with aluminum tags and spray paint at the burrow entrance. Photos were taken at each active burrow.

2.2 Burrow checks

All burrows found within the management area in 2011 or 2012 were monitored to obtain an estimate of the number of active petrel burrows and reproductive (fledging) success before implementation of predator control. Petrel burrows were monitored following methods used by the NPS (NPS 2012). Each burrow was visited two to eight times during the breeding season. A total of 54 burrows were monitored within the management area in 2012 (40 initially located during the 2011 surveys and 14 additional burrows found during the 2012 surveys). Four burrows discovered during the 2011 surveys were not monitored in 2012; two of the burrows could not be relocated; one was destroyed by rock fall prior to the 2012 surveys; and the suspected petrel diggings observed at a potential burrow in 2011 were not excavated any further when evaluated in 2012.

Burrow checks were conducted monthly from June to October 2012 and then weekly during the fledgling period, from mid-October to mid-November 2012. During each survey, surveyors checked the status of known petrel burrows and searched nearby suitable habitat for additional burrows. Any new burrows located in 2012 were marked, mapped, and added to the monitoring dataset. All known burrows were monitored during each check through September, after which only active burrows were monitored in subsequent burrow checks. Game cameras were also used to evaluate burrow activity and reproductive success (see section 2.3).

2.2.1 Burrow Activity and Reproductive Success

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 such as burrows checks and game cameras were used. Each time a burrow was visited it was categorized as active, inactive, or unknown (see definitions in section 2.2.2). At the end of the breeding season the activity pattern of each burrow was evaluated for annual reproductive success (see definitions below).

2.2.2 Burrow Activity Assignments per Visit

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, 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.

Active Burrows—A burrow was considered to be active if three or more toothpicks were knocked over or if clear signs of recent burrow activity (fresh tracks, diggings, guano, eggs, chicks or adults) were observed within the burrow prior to the placement of the toothpick barrier.

Inactive Burrows—A burrow was considered to be inactive if the toothpicks were still standing and burrow showed no sign of recent activity.

Unknown Burrows—A burrow was considered to be unknown if no clear signs of recent burrow activity (fresh tracks, diggings, guano, eggs, chicks, or adults) were observed within the burrow prior to the placement of the toothpick barrier (i.e., at the first check or time of discovery).

2.2.3 Annual Reproductive Success Assignments

At the end of the breeding season, burrows were classified into one of five categories of reproductive success based on of the activity pattern observed during the monthly burrow checks.

Seasonally Inactive Burrows—A burrow was classified as seasonally inactive if it showed no toothpick disturbance and there were no signs of activity within the burrow during any of the 2012 nest checks.

Successful Burrows—A burrow was considered to be successful if a chick fledged from the burrow, indicated by the presence of a petrel chick, chick down feathers at the burrow entrance, and/or disturbance of toothpicks during or after the September surveys, and no sign of depredation were observed.

Probably Successful Burrows—A burrow was considered probably successful if chick down was present at the burrow entrance, the burrow was not discovered until the September surveys, activity at the burrow ceased before the October surveys, and no sign of depredation was observed.

Failed Burrow— Failed burrows were those that were observed to be active at some point during the season, but failed. A burrow was considered to have failed if signs of depredation were observed, an egg was found off the nest, or reproductive sign from 2012 was observed (egg, egg shell fragments, chick down) within the burrow but activity at the burrow ceased before the September surveys.

Failed or Occupied by a Non-breeder Burrow—This category is required because non-breeding petrels can be present in burrows well into the breeding season (Simons and Hodges 1998; Figure 2). Non-breeding birds may be young birds seeking mates and prospecting for nest sites or mature adults that do not elect to breed. Because survey limitations prevent us from positively distinguishing burrows visited by prospecting and non-breeding birds from failed burrows, these burrows were combined into a single category. A burrow was considered failed or occupied by a non-breeder if there were initially signs of activity but no reproductive sign from 2012 was observed (egg, egg shell fragments, chick down) within the burrow and activity at the burrow ceased before the September surveys.

2.2.4 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 (i.e., if all burrows were occupied by non-breeders or if all burrows 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 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 Failed or Occupied by a Non-Breeder Category and those burrows where egg laying was confirmed.

2.3 Game Camera Monitoring

Two Reconyx Hyperfire™ High Performance cameras were used to supplement the evaluation of burrow activity and breeding success by providing images of adults and fledglings entering and exiting the burrows. After initial field testing, the two cameras were deployed at eight burrows in the management area to determine breeding success. Cameras were left at burrows until petrel activity ceased, after which, the camera was moved to another burrow with petrel sign.

2.4 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 the inked section in the center of the tracking card and the tracking card was 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 tracks of the animals as they left the tunnel. Feral cat activity would not be recorded with the tracking tunnels because they are specifically designed for smaller mammals.

We placed seven to 24 individual tracking tunnel stations along three north-to-south transects, totaling 54 tracking tunnel stations using methods outlined in Gilles and Williams (2007; Figure 4). All three transects were established in close proximity to petrel burrows; in addition, one of the transects (Transect C) was designed to intersect a large drainage that intermittently contains water, which may be attractive to small mammals. The transects were spaced approximately 1 kilometer apart. Within each transect, the tracking tunnel stations were set at 50 m intervals. The 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 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 rat species, house mouse, 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).

3. Results

3.1 Comprehensive Surveys and Burrow Monitoring

Approximately 150 ha of the management area were surveyed during the 2012 comprehensive surveys, bringing the total area surveyed in 2011 and 2012 to 219 ha (Figure 5). A total of 14 new petrel burrows were found in 2012: five were found by the conservation dogs during the comprehensive surveys; three were found by biologists during the comprehensive surveys; and six were found incidentally by biologists during the burrow checks (Figure 3).

3.2 Burrow Activity and Reproductive Success

Thirty-three (61 percent) of the burrows were active and 21 (39 percent) were inactive within the management area in 2012 (Figure 6). Of the 33 active burrows, 14 (42 percent) successfully produced a fledgling, one (3 percent) probably successfully produced a fledgling, four (12 percent) failed, and 14 (42 percent) either failed or were occupied by a non-breeder (Figures 7 and 8). The causes of nest failures were: egg abandonment at two burrows (Burrows 25 and 34); depredation at one burrow (assumed cat or mongoose, Burrow 22); and an unknown cause at one burrow (Burrow 31; Figure 6). In addition to the depredation event observed at Burrow 22, biologists also found two dead adult petrels not associated with a burrow and cat tracks and scat within the management area (Figure 4).

Burrow activity changed throughout the course of the season. The highest number of unknown burrows occurred during the initial burrow check in June; these burrows were recorded as unknown status because there was no clear sign of recent burrow activity (fresh tracks, diggings, or guano, eggs, or adults within the burrow; Figure 9). The highest number of active burrows observed during any one month of monitoring occurred in July with 22 active burrows, although active burrows were discovered through September. Surveys were ended on November 4 because all of the burrows had ceased to be active.

Burrows were located throughout the management area, although the distribution was patchy. Nearly half of the burrows were located within two clusters in the northern section of the management area. Burrows were clustered throughout the rest of the management area, with lower densities in the eastern section (Figure 6). The distance between burrows was variable; active burrows were as close as 1.2 m apart and as far as 2,110 m apart. Most of the successful burrows were located in the western and southern sections of the management area (Figure 7). All of the failed burrows were located within the two burrow clusters in the northern section of the management area (Figure 7).

Based on the survey findings, eggs were assumed to have been laid in 19 to 33 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 chicks fledged/active burrow within the management area was 45.5 (Table 2). The percentage of chicks fledged/eggs laid within the management area was 42.4 – 79.0 (Table 2).

3.3 Game Camera Monitoring

Petrel activity was confirmed using cameras at four of the eight burrows (Burrows 33, 52, 54, and 55) where game cameras were placed. Two burrows were documented fledging with the game cameras: Burrow 54 fledged at 19:19 on October 27, 2012 and Burrow 55 fledged at 19:35 on October 31, 2012. Rats were observed at four of the burrows where game cameras were placed (Burrows 4, 32, 33, and 55). Rats did not appear to impact reproductive success because all four burrows were documented as successful, although only Burrow 55 had a camera set at the time of fledging.

3.4 Tracking Tunnels

Rodents were detected along one of the three transects, Transect B (Figure 4). Along Transect B, rats were detected at six of the seven tunnel stations and mice were detected at one of the tunnel stations. Transect B is at a slightly higher elevation than the other two transects and runs through a relatively dense cluster of petrel burrows. No mongooses were detected at any of the tracking tunnels. The tracking index was 28.6 percent for rats and 4.8 percent for mice.

Table 2: Comparison of Hawaiian Petrel Reproductive Success

Study	Status	Predator Control	Survey Year	Survey Dates	Number of Burrows	Percent Chicks Hatched/Egg Laid	Percent Chicks Fledged/ Chick Hatched	Percent Chicks Fledged/Egg Laid	Percent Chicks Fledged/ Active Burrow
Simons 1983[1]	Accessible Burrows[1]	Yes	1979	April to November	41	67.8	57.1	38.7	29.3
Simons 1983[1]	Accessible Burrows	Yes	1980	March to November	40	71.4	100.0	71.4	50.0
Simons 1983[1]	Accessible Burrows	Yes	1981	March to November	47	70.9	86.4	61.3	40.4
Natividad Hodges 1994[1]	Accessible Burrows	Unknown	1993	March to November	38	85.7	95.8	82.1	60.5
Natividad Hodges 1994[1]	Accessible and Inaccessible Burrows	Yes[2]	1993	March to November	58	-	-	76.7	56.9
Natividad Hodges 1994[1]	Accessible and Inaccessible Burrows	No	1993	March to November	43	-	-	64.3	41.9
Chen et al. 2011 Conservation Area[3]	Inaccessible Burrows	No	2011	August to November	168	-	-	-	15.5 – 20.2[6]
Chen et al. 2011 Control Area[4]	Inaccessible Burrows	No	2011	September to November	13	-	-	-	0.0
This Report	**Inaccessible Burrows**	**No**	**2012**	**June to November**	**33**	**-**	**-**	**42.4 – 79.0[5]**	**45.5**

[1]The nest chambers of all of the burrows were either accessible or made accessible through excavation.
[2]Sixty-eight live traps were placed at 10 meter intervals just below the rim of the crater.
[3]Assumed nests that showed activity during the initial search with no activity during recheck failed. Video cameras were installed at 17 burrows.
[4]Assumed nests that showed activity during the initial search with no activity during rechecks failed.
[5]For eggs laid, a range in values was used because the nest chambers were inaccesible. Low values included those burrows where egg laying was confirmed (e.g., Failed, Probably Successful, and Successful burrows). High values included the Failed or Occupied by a Non-Breeder Category and those burrows where egg laying was confirmed.
[6]Range represents inclusion of known successful burrows only and known successful plus probably successful burrows.

4. Discussion

4.1 Delineation of the Management Area

The entirety of the management area contained 33 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. The comprehensive surveys only found six additional burrows in the areas previously covered in 2011, suggesting that surveys were effective in locating burrows and that new burrows found after predator control is implemented should be recognized as a net increase in the breeding colony.

4.1.1 Baseline Reproductive Success and Comparison of Results with Other Projects

Reproductive success within the management area in 2012 was compared to other petrel studies conducted on Mount Haleakala (Table 2). However, direct comparisons of petrel reproductive success among projects is challenging due to the variation in survey techniques, reproductive success criteria, and proximity to management activities. Only one of the reproductive success parameters, the percentage of chicks fledged per active burrow, was presented in all studies (Table 2). This metric does not require the differentiation of burrows occupied by prospecting birds from burrows that failed, allowing for greater consistency between study results. The percent of chicks fledged/active burrow within the management area (45.5 percent) was within the range reported by studies at Haleakala (29 – 50 percent, Simons 1983; 42 – 61 percent, Natividad Hodges 1994), and higher than that reported by ATST conservation area or control area (Chen et al. 2011, 15 – 20 percent or 0 percent, respectively, Table 2). The burrows within Haleakala National Park (Simons 1983 and Natividad Hodges 1994) likely benefited from predator control activities; whereas, predator control activities have not been implemented at the management area or ATST conservation area or control area.

Although petrels in the management area are successfully fledging young, as documented by game cameras, determining the number of fledged young per egg laid is challenging because of the presence of non-breeding birds throughout most of the breeding season and because nest chambers are usually inaccessible. As a result, nearly half (14) of the active burrows within the management area were recorded in the group Failed or Non-breeder. The fledging events documented with the game cameras occurred between October 27 and October 31, which is consistent with the range reported at Haleakala National Park (October 8 – 30; Simons 1985).

In order to generate an accurate estimate of fledglings/eggs laid, it must be possible to identify if an egg is laid. This level of clarification can occur in one of two ways. Burrows can be excavated, as done by Simons (1983) and Natividad (1994); however, this option was not considered within the management area because of potential disturbance to the petrels. An alternative approach is to use a fiber-optic burrow scope. However, both the NPS (C. Bailey, pers. comm.) and ATST (H. Chen, pers. comm.) have had limited success with burrow scopes, and NPS found that only 10 percent of petrel nest chambers are viewable with a fiber-optic burrow scope (C. Bailey pers. comm.). Therefore, this option was also not considered further. Because of the lack of viability of these options, an estimate of fledglings/eggs laid within the management area is presented as a range of values. The percent of chicks fledged/egg laid within the management area (42 – 79 percent) was similar to studies conducted at Haleakala National Park (38 – 71 percent, Simons 1983; 64 – 82 percent, Natividad Hodges 1994, Table 2). Hatching Success (the percent chicks hatched/egg laid) and fledging success (the percent chicks fledged/egg hatched) were not reported by Tetra Tech because the nest chambers of all the petrel burrows within the management area were inaccessible.

Project biologists attributed causes for nest failure to abandonment, unknown causes, and depredation. The cause of abandonment is unclear but could be the result of inexperienced breeders as young petrels abandon nests more frequently than older, more experienced birds (C. Bailey pers. comm.). Prior to abandonment, the adults of both abandoned eggs were observed incubating at the burrow entrances. The eggs may have been laid at the burrow entrances as a result of inexperienced birds or the adults may have inadvertently caused the eggs to roll from the nest chamber. These birds represented an anomaly on the study site, as no other birds were seen incubating. This behavior was also observed at one other burrow in 2011, which also resulted in nest failure due to abandonment. At the burrow with an unknown cause of failure, chick down was observed at the burrow entrance in August; however, the burrow ceased to be active following the August surveys.

Although rats and feral cat sign were observed in the management area, there was no clear indication as to what species of predator killed the adult petrel within Burrow 22 because the remains consisted of a pile of adult feathers scattered within the burrow. It is suspected that a cat or mongoose killed the bird because an adult petrel is unlikely to have been killed by rats, and the location of the feathers within the burrow, rules out avian predators. The single documented predation event resulted in a predation rate of 3 percent (one of the 33 active burrows) and was similar to that reported within the adjacent ATST Conservation Area (5 percent, 8 of 168 active burrows; Chen et al. 2011). However, this is likely an underestimate due to the inability to separate early burrow failures with prospecting birds.

Only rats and mice were identified within the tracking tunnels. The lack of mongoose detections during the tracking tunnel surveys could be due to the limited trapping effort, or seasonal use of the area by mongooses. Rats and mice were found within the upper section of the management area, in proximity to ATST and Haleakala National Park, suggesting that human activity could be providing a supplemental food resource, which could allow small mammals to maintain populations at higher densities. In turn, an abundance of rodents may support cats that then exploit seasonally abundant prey such as nesting birds (Simons 1985, Hess et al. 2007). Rats were also observed in the lower section of the management area by game cameras, indicating that rats are not limited to the upper section of the management area. However, all four of the burrows where cameras recorded rats successfully fledged young, indicating that the presence of rats does not necessarily result in nest failure. Because of the limited sampling in 2012, tunnels or other devices may be deployed throughout the breeding season in 2013 in order to capture spatial and temporal use of the management area by small mammals.

Despite the apparent availability of burrows on the east side of the management area and the proximity to the NPS's managed population, fewer active petrel burrows were found on the east side. Although micro-climate or other unknown factors may drive activity, predators may also influence this pattern. Most cat sign, including a pair of nesting petrels killed by a cat and cat scat with eggshell fragments, was documented on the east side of the management area (Figure 4). The presence of cats may be related to the close proximity to a local water source, the large gullies which may provide natural travel ways for feral cats, the location of the source population, or other variables.

4.2 Implications and Recommendations for 2013

- Predator control will be implemented within the management area in 2013. If the number of active burrows increases, the managed area may be reduced.
- The limited number of newly discovered active burrows during the comprehensive surveys indicates that new burrows found after predator control is implemented should be recognized as a net increase in the breeding colony.
- The implementation of predator control is likely to improve reproductive success of the known burrows within the management area, resulting in a net increase in the breeding colony.
- Determining reproductive success is challenging because of the presence of non-breeding birds throughout most of the breeding season and because nest chambers are usually inaccessible. Additional resolution in identifying fledgling success can be accomplished by increasing the use of game cameras to document fledging events; however, game cameras cannot separate the prospecting birds from early season failures.

- Reproductive success within the management area in 2012 was consistent with that reported in most petrel studies conducted on Mount Haleakala but higher than at ATST. However, comparing reproductive success to other studies is difficult because survey techniques, reproductive criteria, management activities, and proximity to management activities vary.

- Using the ATST control for comparison rates of reproductive effort may not be appropriate for several reasons. In order for a control site to provide adequate and appropriate baseline data for comparison, the following conditions need to be met: the control site must currently experience the same environmental and biological conditions as the Auwahi Wind management area (e.g., the same predation pressures); the control site's petrel population needs to have a similar demographic make-up (e.g., age structure) as the Auwahi Wind management area; and, monitoring methods need to be similar.

    - The two sites are environmentally different from one another because the ATST control is located at a higher elevation than the Auwahi Wind management area. ATST reported a strong negative correlation between elevation and mortality/predation rates (Chen et al. 2011). Biological conditions at the ATST control are much different than the Auwahi Wind management area. The percent of chicks fledged/active burrow within the ATST control was 0 percent versus 45.5 percent at the management area.

    - It is unclear whether the petrel population within the ATST control has a similar demographic make-up as the mitigation site. Petrels at both sites would need to be banded to determine such information.

    - Differences in somewhat different monitoring limit the ability to make direct comparisons between the ATST control and the Auwahi Wind management area (e.g., initiation of surveys and level of effort).

    - Given the differences in environmental and biological conditions and the monitoring methods between the ATST control and the Awauhi Wind management area, we consider the best solution is to reference the reproductive and survival rates identified in the HCP.

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

P:\GIS_PROJECTS\Sempra_Energy\Auwahi_Wind_Project\Petrel_Related\2012_Survey_Report\MXDs\Sempra_Auwahi_2012_Petrel_Report_Figure_01_StudyArea_8511i_20130213.mxd- Map Scale correct at: ANSI A (11" x 8.5")

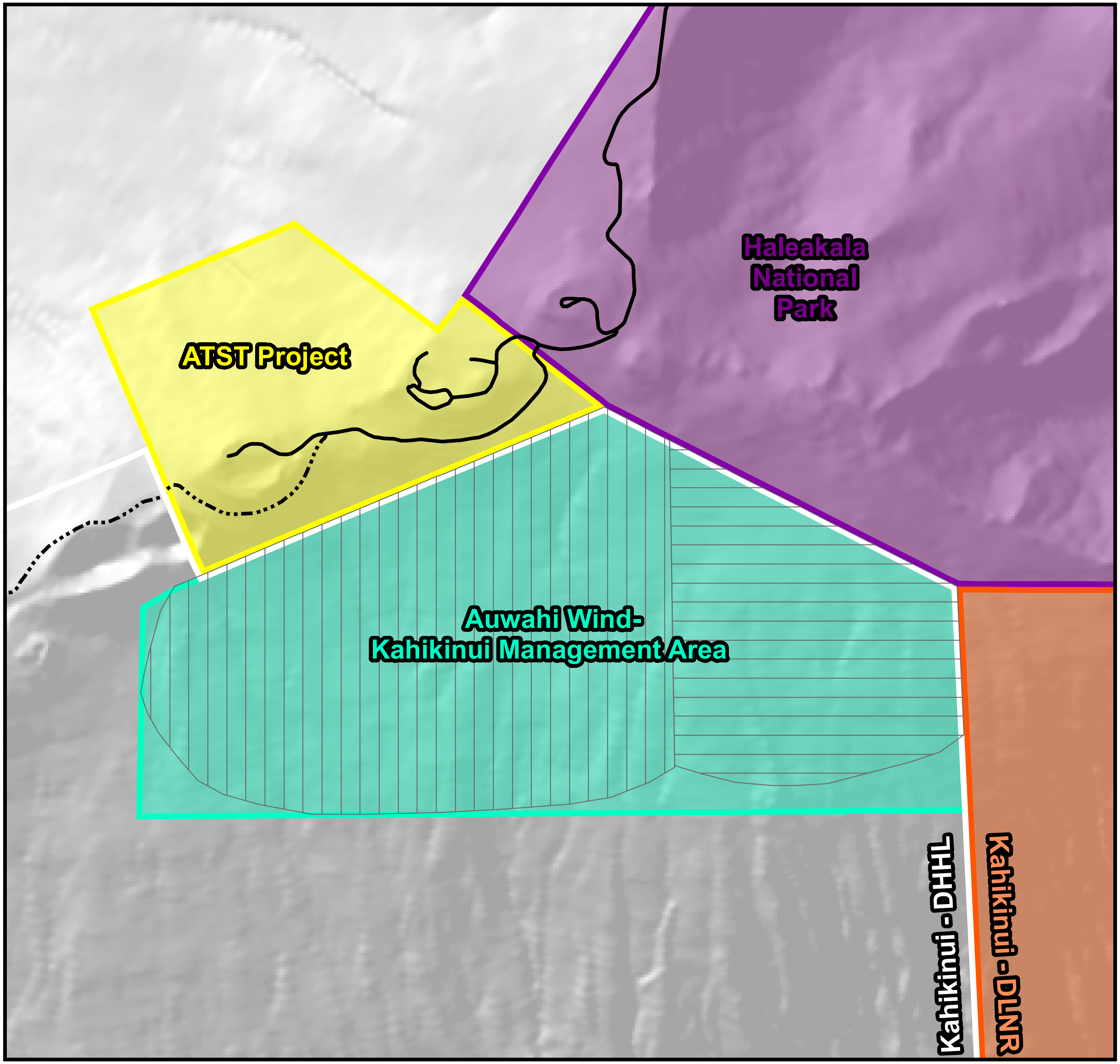


FIGURE 1

AUWAHI WIND PROJECT

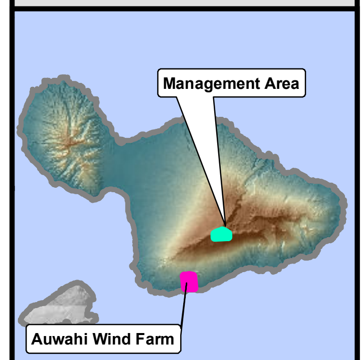
KAHIKINUI PETREL MANAGEMENT AREA

Road

Dirt Road

Tier 1 and 2 Management Area

Tier 3 Management Area



DATA SOURCES:

Roads:
Tetra Tech. 2011
Petrel Survey Points/Areas:
Tetra Tech. 2012
Land Ownership:
Hawaii statewide GIS Program 2010

0 330 660 1,320
Feet

N

1:20,000
NAD 1983 UTM 4

Maui, HI
Feb 13, 2013

TETRA TECH

Figure 2. Annual Breeding Cycle of Hawaiian Petrels (Simons 1983).

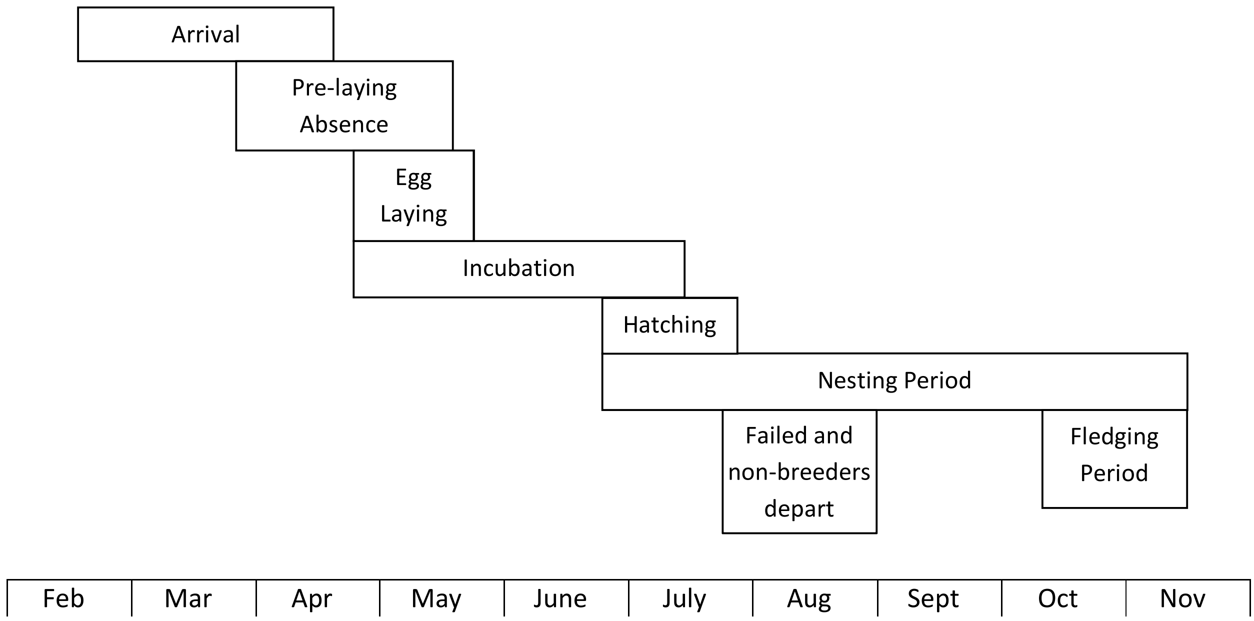


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Figure 8. 2012 Petrel Burrow Reproductive Success

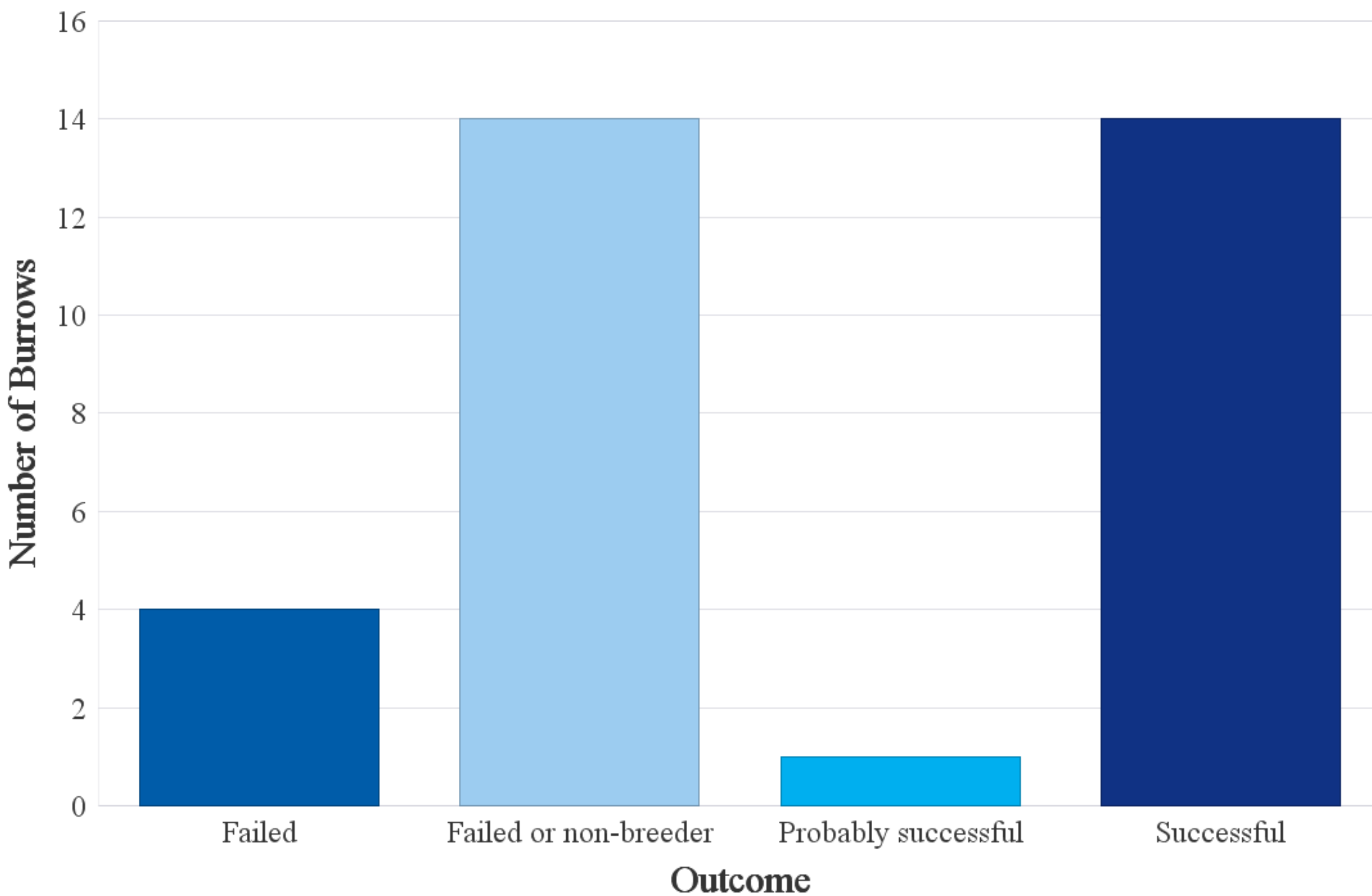
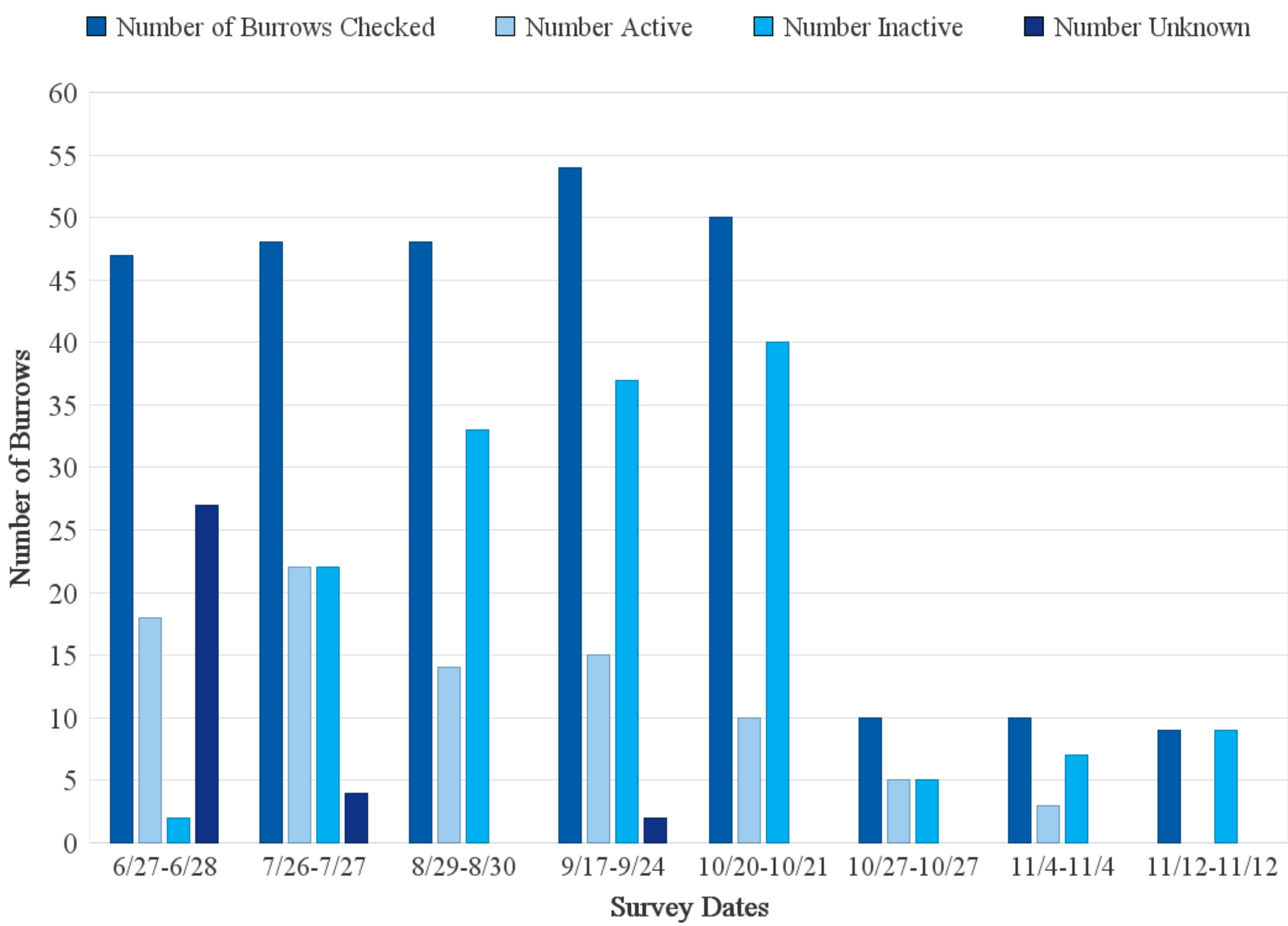


Figure 9. 2012 Monthly Summary of Burrow Activity



Attachment 3

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

Tri-Isle Resource Conservation & Development Council, Inc.
P.O. Box 338
Kahului Hawaii 96733

The mission of Tri-Isle Resource Conservation & Development is to protect, preserve, and develop island communities with a focus on Maui County through the implementation, management and fiscal sponsorship of innovative agricultural, civic, cultural, economic and environmental projects.

May 10, 2013

Marie VanZandt
Auwahi Wind Energy LLC
20100 Piilani Hwy
Kula, HI 96790

Re: **Leeward Haleakala Watershed Restoration Partnership**
Auwahi Forest Restoration Project

Dear Ms. VanZandt:

Tri-Isle RC&D Council, Inc. is submitting, on behalf of Leeward Haleakala Watershed Restoration Partnership, the annual progress report for the above referenced grant.

Please do not hesitate to contact me should you have any questions.

Sincerely,

John A. Hau'oli Tomoso, MSW, ACSW, LSW
Executive Director

The Leeward Haleakalā Watershed Restoration Partnership
P.O. Box 652, Makawao, HI 96768
Ph. (808) 573-8989
Fax (808) 573-1932
www.lhwrp.org
www.auwahi.org

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, ʻUlupalakua Ranch, Maui
Progress from 5/11/12 through 3/20/13

Summary:
In the first year of progress since funds were received, LHWRP staff were able to outplant 8,792 native seedlings of fifteen different native species into the eastern 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. 20 volunteer events were held, with over 328 volunteers contributing their time and labor to this project.

Status of required Endangered species plantings and acres restored:
Three *ʻaiea* (Nothocestrum latifolium) were planted.
Twenty *ʻiliahi* (Santalum haleakalae var. lanaiense)were planted.
Restoration completed in 5.8 acres planted.

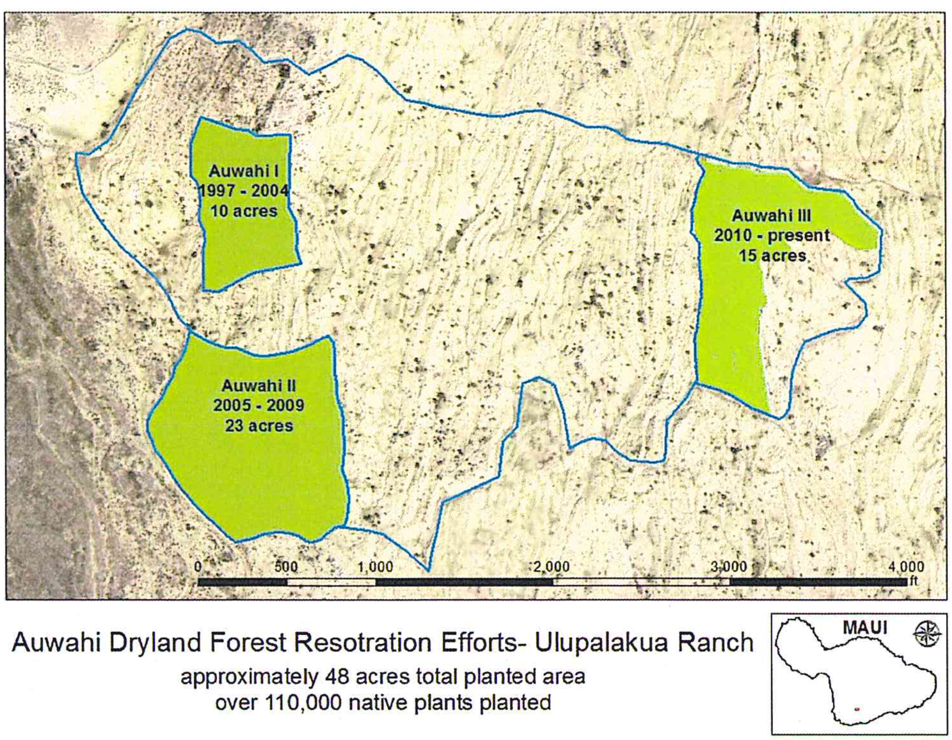


Figure 1. Map showing status of restoration within the Auwahi III exclosure.

Attachment 4

Status Update from the National Park Service on Use of Funds for Hawaiian Goose Mitigation

National Park Service
Department of the Interior

Haleakalā National Park
Makawao, Maui, Hawai'i

2013 NĒNĒ MITIGATION ACTIVITIES: FUNDS FROM SEMPRA

Introduction

In May 2012, Haleakalā National Park (HALE) received $25,000 from Sempra US Gas & Power. These funds are part of a Habitat Conservation Plan to mitigate take of endangered nēnē (*Branta sandvicensis*) from the Auwahi Wind Project.

The purpose of the funds is to assist HALE with the building and maintenance of a "rescue pen" to enhance survival of young nēnē. Nēnē nest during the winter months at the high elevation, subalpine habitat of HALE. Weather conditions typically reach freezing temperatures. Nēnē goslings have low survival rates at HALE because of harsh weather conditions during the nesting season.

Nēnē Pen

The "rescue pen" is approximately 40' x 20' and divided into two 20' x 20' sections to hold two families at one time, if necessary. The pen is contains native shrubs, a shelter and is covered above by mesh and along the sides by cloth to protect nēnē from high winds (figure 1).

Figure 1. Nene pen with shelter, watering device and nene.

The foundation of the pen was built relatively quickly, with eight staff members working for 10 work days (total of 80 work days, figure 2). The entire pen took a total of approximately 205 work days to complete. Additional work days are necessary to maintain the pen.

Figure 2. HALE staff constructing nēnē pen

Nēnē "Rescue"

Two nēnē families have been placed into the pen. One gosling survived from these rescue attempts.

The first family was originally seen in the wild with two goslings. After one day, the family had only one gosling. Biologists decided to place the family with the remaining gosling into the pen to increase the gosling's chance of survival (figure 3). After approximately three weeks, the gosling matured and the family was released into the wild. The family was seen in the wild later that summer with the gosling matured to successful fledgling age.

The nest of the second family was from a wild pair and originally had two eggs. After one gosling hatched, the nest was examined and the other egg was found abandoned. Biologists decided to place the family into the "rescue pen".

This family was difficult to capture. During the first attempt, the gosling and gander were captured, but the female goose flew away. The gosling and gander were then released and reunited with the female. During the second attempt, the gosling and female goose were captured, but the gander flew away. Since the female provides most of the care for the gosling, and the gander showed high affinity to the family, the female goose and gosling were placed into the pen.

The gander was difficult to capture. Attempts to capture the gander failed. The gosling and female goose were in the pen without the gander for three days. Although the gosling and female goose were provided with adequate food and water, the gosling was found dead on the third day. Biologists have since developed a thorough protocol for placing nēnē families into the pen.

Figure 3. Female nēnē and gosling of first family placed in pen

Costs

Total costs, to date, for building the pen and caring for nēnē is approximately $53, 555. Funds received from Sempra were used toward these expenses.

Costs to build pen

Supplies and materials	$	8,500
Labor	$	32,530

Total	$	41,030

Costs to care for capture and care of two nēnē families:

Labor	$	12,000
Supplies	$	525

TOTAL	$	12,525

Submitted:
August 11, 2013
Cathleen Natividad Bailey
Supervisory Wildlife Biologist
Haleakalā National Park
Phone: (808) 572-4491
Email: Cathleen_Bailey@nps.gov

Attachment 5

FY 2014 Annual Work Plan and Schedule

Auwahi Wind Annual Work Plan and Schedule

				2013						2014			
		July	Aug	Sept	October	November	December	January	Febuary	March	April	May	June
Post Construction Mortality Monitoring	Fatility Searches	*Bi Weekly Searches*					*Weekly Searches*						
	Searcher Efficiency Trials	*Dry Season Trials*				*Wet Season Trials*						*Dry Season Trials*	
	Carcass Persistance Trials	*Dry Season Trials*				*Wet Season Trials*						*Dry Season Trials*	
Petrel Mitigation	HAPE Monitoring	*Burrow Monitoring*										*Burrow Monitoring*	
	Predator Control		*Predator Activity Assessment*	*Traps Operational Unit 1*					*Trap Deplomement in All Units*	*Traps Operational All Units*			
Bat Mitigation	Acoustic Monitoring on Site	*Deploy Acoustic Units*	*Acoustic Units Operational 2 yrs*						*Proposed Bat Research Plan Submitted*				
	Ungulate Control			*Ungulate- Proof Fence Completed*				*Begin Systematic Ungulate Removal*					*Annual Fence Inspection*
	Vegetation Monitoring and Control									*Begin Invasive Vegetation Management*	*Seed Collection and Plant Propagation*		
Reporting	ITP & ITL Conditions	*Incidental Take Summary Tables Submitted*	*Annual HCP Report Submitted*					*Incidental Take Summary Tables Submitted*	*SemiAnnual Progress Report Submitted*				

Attachment 6

Year 2 Expenditures for HCP Implementation

Auwahi Wind HCP-related Expenditures for FY 2013

	Tier, Ongoing, or One-time	Event	Proposed Cost	Costs Incurred to Date (2012- July 2013)
General Measures	Ongoing	Wildlife Education and Incidental Reporting Program	$5,000	$3,000
	Ongoing	Downed Wildlife Post-Construction Monitoring and Reporting and Mitigation Monitoring	$1,810,000	$100,000
	Ongoing	*DOFAW Compliance Monitoring (only if needed)	$200,000	N/A
		Subtotal General Measures	$2,015,000	$103,000
Hawaiian Hoary Bat	Tier 1	Retrofit fencing and restoration measures at the Waihou Mitigation Project	$522,000	$314,900
	Tier 1	Acoustic Monitoring Onsite	$40,000	5,000
	Tier2	Monitoring Research	$250,000	TBD
		Subtotal Bats	$812,000	$319,900
Hawaiian Petrel	Tier 1	Burrow Monitoring and Predator Control	$550,000	$214,000
		Subtotal Petrels	$550,000	$214,000
Nene	One-Time	Research and Management Funding	$25,000	$25,000
		Subtotal Nene	$25,000	$25,000
Backburn's Sphinx Moth	One-Time	Restoration of 6 acres of Dryland Forest	$144,000	$144,000
		Subtotal Moth	$144,000	$144,000