Appendix A

Hawaiian Hoary Bat Mitigation
Resource Equivalency Analysis

RESOURCE EQUIVALENCY ANALYSIS FOR PAKINI NUI WIND FARM TO MITIGATE FOR TAKE OF THE HAWAIIAN HOARY BAT

JULY 2018

PREPARED FOR

Tawhiri Power LLC

PREPARED BY

SWCA Environmental Consultants

RESOURCE EQUIVALENCY ANALYSIS FOR PAKINI NUI WIND FARM TO MITIGATE FOR TAKE OF THE HAWAIIAN HOARY BAT

Prepared for

Tawhiri Power LLC
551 Pilgrim Drive, Suite C
Foster City, California 94404
Attn: Steven Pace
(650) 358-1550, ext. 11

Prepared by

SWCA Environmental Consultants
1001 Bishop Street
ASB Tower, Suite 2800
Honolulu, Hawai‘i 96813
(808) 548-7922
www.swca.com

SWCA Project No. 28683

July 13, 2018

CONTENTS

Tables

This page intentionally left blank.

INTRODUCTION

Pakini Nui Wind Farm, located near South Point on the Island of Hawai‘i, is a 21-megawatt (MW) operating wind energy facility (Project). Construction of the Project began in August 2006 and was completed in April 2007. The Project, consisting of 14 General Electric 1.5-MW SE turbines, began operations on April 3, 2007. Tawhiri Power LLC (Tawhiri) owns and operates the Project.

SWCA Environmental Consultants (SWCA) conducted a resource equivalency analysis (REA), an environmental economic model frequently used in damage assessments and mitigation planning, to determine the size of mitigation project that would fully offset the anticipated level of take for the endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) at the Pakini Nui Wind Farm.

Overview of Project and Mitigation Need

Tawhiri is in the process of drafting a Habitat Conservation Plan (HCP) and obtaining an incidental take permit/incidental take license (ITP/ITL) in accordance with the Endangered Species Act of 1973, as amended, and §195D of Hawai‘i Revised Statutes. Take of 26 Hawaiian hoary bats will be covered under the ITP/ITL, once approved, with a permit duration of 10 years (8 years of operation, 2 years of decommissioning). An integral part of the HCP process is proposing a mitigation project that will fully offset the impacts of the proposed taking. Tawhiri is currently in discussion with Hawai‘i Volcanoes National Park (HVNP) to define the parameters of a habitat restoration project that would be carried out in the Kahuku Unit of HVNP and would create and/or enhance foraging and pupping habitat for the Hawaiian hoary bat. The purpose of this REA is to provide biologically sound logic to assist Tawhiri in determining the appropriate size of this project to ensure that the impacts of the authorized taking through an ITP/ITL are fully offset.

Resource Equivalency Analysis

An REA is an economic model that provides a science-based, peer-reviewed method of quantifying interim and permanent resource losses (i.e., losses of animals) associated with an environmental disturbance and scaling compensatory mitigation to offset those losses (Allen et al. 2005; Dunford et al. 2004; King 1997). An REA quantifies and balances losses (take due to Project operation) and gains (benefits of compensatory mitigation) in animal-years.

An REA quantifies take in animal-years, which are the additional years the animals would have lived if they had not been killed by the disturbance. For example, the disturbance-related death of an animal that would have lived another 10 years, on average, would result in the loss of 10 animal-years. An REA also quantifies mitigation in animal-years, which often measure improved carrying capacity of newly created or improved habitat or the benefits of eliminating a different source of mortality. For example, a mitigation project that creates an acre of new habitat that supports five individuals annually can be said to produce 5 animal-years/year in mitigation credit. Once the resource losses are known and the mitigation resource gains are known per unit of application, the REA calculates the size of the project needed to offset the resource loss at a ratio of 1:1. In some cases, where the reproductive potential of the animals lost differs from the animals supported by the mitigation project, foregone reproduction (the lives of the offspring of the animal killed, also measured in animal-years) may also be quantified and offset.

Another key element of an REA is that it applies an economic discount rate to resource losses and gains so that they can be traded in present value (PV). A discount rate of 3% is most commonly used in these analyses to account for interest rates, impatience, and risk in planning projects and managing habitat in the future. Application of the discount rate results in resource gains or losses occurring in the future having less value than those occurring earlier. This motivates early mitigation, as a larger amount of mitigation

will be required if it is implemented later in the project than if it is implemented earlier. However, discount rates of even 1–2% per year shift the costs of environmental degradation to later generations and reduce incentives for long-term environmentally favorable projects (Environmental Justice Organizations, Liabilities and Trade 2018). For this reason, some analyses apply a 0% discount rate, such as the U.S. Fish and Wildlife Service's (USFWS's) REA for Indiana Bat take mitigation (USFWS 2013a).

Applications and Benefits

REAs were originally developed to quantify mitigation required to offset an environmental injury that had already occurred and REAs have been routinely applied during the Natural Resource Damage Assessment (NRDA) process since the 1990s. In the last several years, REAs have been used to estimate the mitigation needed to offset environmental injuries that are anticipated but have not yet occurred. A current example is the REA developed by the USFWS to estimate the number of power poles that need to be retrofitted to offset the anticipated project-related loss of golden and bald eagles (USFWS 2013b).

The following are benefits of an REA:

- High credibility – the approach has been evaluated and documented in scientific peer-reviewed literature and has held up in numerous court cases.
- Analyses are quantitative rather than qualitative in nature.
- Equations are straightforward but have enough input variables to allow for flexibility in project design.
- Provides a replicable method for negotiation of mitigation ratios, acceptable compensatory restoration, and/or fines.
- Valuable planning tool; can be used to evaluate the cost of multiple compensatory mitigation measures.
- Applicable to any ecosystem type where an appropriate habitat services metric can be defined.
- Currently the most commonly used method by natural resource trustees to assess damages to ecosystems.
- Used by federal regulatory agencies, such as the USFWS, NOAA, the Bureau of Land Management, the Environmental Protection Agency, the Department of the Interior, and the U.S. Army Corps of Engineers.

Data Needs

The following are data needs for an REA:

- The timing and duration of the disturbance (e.g., project construction and/or operation)
- An estimated number of animal fatalities caused by the disturbance
- An estimate of the animal's normal lifespan and the age distribution of the population so that the average animal-years lost per animal killed can be estimated without knowing the actual ages of the animals killed; age distribution can be estimated from age-specific survival rates if lifespan is known
- A determination of whether foregone reproduction needs to be modeled—that is, whether the reproductive potential of the animals killed is different from the reproductive potential of the animals served by the mitigation
- An estimate of the new resource services produced by the mitigation project per unit of application (e.g., number of animals supported per year per acre of habitat improved)

- The timing and duration of the mitigation project, including the time of implementation and the time to full benefit
- The economic discount rate being used

An REA is an appropriate tool for mitigation planning in advance of resource loss when the resource losses (project impacts) and resource gains (mitigation benefits) can be reasonably estimated. Where there is uncertainty in these estimates, it is appropriate to use conservative estimates that will result in additional mitigation so the project proponent and wildlife agencies can be confident that the full resource loss will be offset.

Hawaiian Hoary Bat

The Hawaiian hoary bat is the only existing native terrestrial mammal from the Hawaiian Archipelago and is endemic to the islands (USFWS 1998). The Hawaiian hoary bat is a subspecies of the hoary bat (*Lasiurus cinereus*) found throughout the Americas. This sub-species has been recorded on Kauaʻi, Oʻahu, Molokaʻi, Maui, and Hawaiʻi, but no historical population estimates exist. The Hawaiian hoary bat—and hoary bats in general—are solitary foliage-roosting bats, although mothers and pups roost together (USFWS 1998). Radio telemetry has shown that Hawaiian hoary bats can range widely in a single night, are territorial, and do not congregate to feed. Due to the Hawaiian hoary bat's solitary habits, conducting research on it (or the hoary bat in the continental United States) is difficult, and little information is available for many basic life history parameters.

Forest Restoration Mitigation Project

The Pakini Nui Project site does not have any roosting or pupping habitat because of a dearth of trees. Furthermore, it is expected there are few native arthropods available for foraging in the predominant invasive plants. It is most likely that any bats frequenting the area are searching for prey in the lee of the nearby cliff and only infrequently enter the area occupied by turbines.

Tawhiri proposes measures that focus on restoring high-quality native habitat in an area that has been historically overgrazed and overrun with non-native plant species. The full description of the forest restoration mitigation project is detailed in Appendix B of the HCP. The methods of the forest restoration mitigation project consist of controlling invasive plants, planting native trees and shrubs, and scarification around existing koa trees to regenerate the existing seed bank. This work will take place in an area where seed supplies for native tree species are limited and competition from invasive or aggressive grasses and woody species inhibits forest recovery. Furthermore, with the potential threat of the spread of rapid ʻōhiʻa death into HVNP, forest restoration projects of this type gain even more importance in maintaining roosting habitat for the Hawaiian hoary bat. The forest restoration mitigation project area, once restored, will provide forested habitat comprised mostly of native species, providing roosting/pupping and improved foraging habitat for Hawaiian hoary bats. The forest restoration mitigation project will mitigate for impacts to low-quality habitat by improving roosting and pupping habitat in a perpetually protected location that currently constitutes low-quality habitat.

HVNP acquired the 150,865-acre Kahuku Unit in 2003 for the preservation of habitat for threatened, endangered, and other rare plants and animals. To this end, HVNP fenced large tracts of land within this unit and removed ungulates to reduce the immediate threat to the preservation of these rare species and their habitat. The forest restoration mitigation project area, which is adjacent to the Kaʻū Forest Preserve, provides habitat for a number of rare, threatened, and endangered species, including the Hawaiian hoary bat and nēnē (*Branta sandvicensis*). Hawaiian hoary bats were detected in the forest restoration mitigation project area year-round (Fraser and HaySmith 2009), although these detections were not associated with a restoration project. Unfortunately, much of the lowland forest (< 1,372 meters [4,500 feet] elevation) is badly degraded

by decades of land clearing and destruction by cattle, mouflon sheep, and pigs. Large forest tracts have been converted to alien grass pastures and are invaded by Christmas berry (*Schinus terebinthifolius*), strawberry guava (*Psidium cattleianum*), and kāhili ginger (*Hedychium gardnerianum*). HVNP staff have constructed boundary fences and removed animals (feral pigs and cattle), but additional measures, such as invasive plant control and the planting of native trees, are needed to facilitate forest recovery and restoration of wildlife habitat. Without active restoration, much of the area would remain dominated by non-native pasture grasses and would not provide roosting or pupping habitat for Hawaiian hoary bat.

METHODS

Standard methods for the REA were applied, with resource loss and gain measured in bat-years. The following sections review the assumptions and rationale for the estimates of resource losses and gains used in the REA. These estimates and assumptions are summarized for quick reference in Table 1. For the purposes of the REA, if information on the Hawaiian hoary bat is unknown, available information for the hoary bat in the Americas is used. If that information is also lacking, available information from another lasiurine species is used. If this information is unavailable, information from foliage-roosting bats within the same family (Vespertilionidae) is used.

Although Tawhiri acknowledges that some of the Hawaiian hoary bat life history inputs are not known and must be based on surrogates, the REA is presented as the best available method in the absence of better methods or agency guidance.

Table 1. Data Need, Estimates Used, and Sources for Pakini Nui Hawaiian Hoary Bat Mitigation Resource Equivalency Analysis

Data Need	Estimates Used	Source
The timing and duration of the disturbance and an estimated number of animal fatalities.	Take of 26 bats in 8 years of operation	Section 4.1 of the HCP
An estimate of the animal's normal lifespan and the age distribution of the population so that the average animal-years lost per animal killed can be estimated without knowing the actual ages of the animals killed; age distribution can be estimated from age-specific survival rates if lifespan is known.	Maximum lifespan is 10 years. Assumed annual survival rates of juveniles (30%) and adults (85%) were used to characterize the age distribution of the population.	Lifespan: as noted in Amlin and Siddiqi (2015) Adult survival: O'Shea et al. 2011; Pryde et al. 2006 Juvenile survival: Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take (USFWS 2016)
An estimate of the new resource services produced by the mitigation project per unit of application (e.g., number of animals supported per year per acre of habitat improved).	The forest restoration mitigation project area may currently support limited use by bats. Bats were detected at the project by Fraser and HaySmith 2009), but bat roosting and pupping habitat is limited. Use at baseline is estimated in the model as one bat per 80 acres (0.5 bat per 40 acres) One bat per 80 acres is a conservative assumption that includes the possibility that bats may currently travel through and potentially forage in the mitigation project area. For comparison, two bats per 40 acres is considered full carrying capacity based on mapping core range habitat sizes (Bonaccorso et al. 2015). The model assumes that the forest restoration mitigation project area will support two bats-years per 40 acres in the sixth year following planting in each section (full value).	Professional opinion, Fraser and HaySmith 2009; Bonaccorso et al. 2015

Data Need	Estimates Used	Source
The timing and duration of the mitigation project, including the time of implementation and the time to full benefit.	Funding for the forest restoration mitigation project will be provided in year 1. Noxious and invasive plant removal and the planting of tree seedlings will take place on approximately an eighth (12.5%) of the forest restoration mitigation project area every year for years 2–9 of the mitigation project. Koa, the fastest growing tree species to be planted and/or regenerated, will reach 15 feet in height after about 5 years and will provide roosting habitat 6 years following scarification. Therefore, the creation of pupping habitat will begin on 12.5% of the forest restoration mitigation project area 6 years after planting (year 7 of the forest restoration mitigation project) and expand on an additional 12.5% of the forest restoration mitigation project area until year 14 (final planting in year 9 plus 6 years of growth, including the initial year). High-quality pupping habitat would result following 15–20 years of tree growth.	Professional opinion based on design of project, as described in Appendix B of the HCP
The economic discount rate being used.	0% annual discount rate	The standard rate typically used in REAs (e.g., USFWS eagle take REA) is 3%; however, 0% is consistent with the discount rate used for the Indiana Bat REA.

Maximum Lifespan

A lifespan of 10 years was used in the REA, in alignment with the latest State of Hawai‘i Department of Land and Natural Resources guidance (as noted on pages 15 and 16 of Amlin and Siddiqi 2015).

Annual Adult Survival Rate

No data for adult survival rates of hoary bats or other lasiurine species were available through a literature search; however, information of other foliage roosting vespertilionid bats is as follows:

- Colorado big brown bats (*Eptesicus fuscus*) – Annual adult survival at five maternity colonies monitored from 2001 to 2005 was estimated at 0.79 (95% confidence interval [95% *CI*] = 0.77–0.82) (O'Shea et al. 2011)
- New Zealand long-tailed bat (*Chalinolobus tuberculatus*) – Annual survival varied from 0.75 (95% CI = 0.54–0.88) to 0.89 (0.48–0.99) at Hanging Rock and 0.55 (0.39–0.71) to 0.91 (0.44–0.99) at Grand Canyon (Pryde et al. 2006).

In this REA, an annual adult survival rate of 85% is used. This is likely an overestimate of survival, which is consistent with the recommended conservative approach to the REA. This overestimate of survival will produce an overestimate of the bat-years lost per bat fatality and result in a higher amount of mitigation due. It is important to note that this survival rate is *not* appropriate for use in a population viability analysis, as it would not be conservative in that context.

Juvenile to Adult Survival Rate

Juveniles are converted to adults by multiplying by 0.3, which is in accordance with the *Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take* (USFWS 2016). This translates to a 30% survival rate for juveniles to adults (juveniles mature at 1 year old) and is used in this REA.

Population Age Distribution

This is currently unknown, and a population age distribution was generated using a 30% juvenile to adult survival rate, an 85% annual adult survival rate and a maximum lifespan of 10 years.

Habitat and Territoriality

Hawaiian hoary bats roost primarily in woody vegetation exceeding 15 feet in height (Bonaccorso et al. 2015, cited in Amlin and Siddiqi 2015). Hawaiian hoary bat roosts are typically in dense canopy foliage or in subcanopy when canopy is sparse, with open access for launching into flight (USDA 2009). A study of a sample of Hawaiian hoary bats (n = 28) on the Island of Hawai‘i estimated a mean foraging range of 391 to749 acres (230.7 ± 72.3 hectares) and mean core use area of 45 to 79 acres (25.2 ± 6.9 hectares) (Bonaccorso et al. 2015). The size of home ranges and core areas varied widely between individuals. Core areas included feeding ranges that were actively defended—especially by males—against conspecifics. Female core ranges overlapped with male ranges.

Timing and Duration of the Disturbance

An estimated 26 fatalities are expected over the 10-year permit term (8 years of operation, 2 years of decommissioning).

Simulating Population Structure and Age-Related Fatality

Annual survival rates were used to simulate population structure. The survivorship of a cohort of 100 bats was calculated over the 10-year lifespan. The number surviving in each year was assumed to be representative of the relative number of bats in each age class at any one time (Table 2). This simulation indicated that approximately 75% of bats died by age 2.

Table 2. Simulated Age Distribution of the Population from the Annual Survival Rate and the Estimated Bat Fatalities per Year of Each Age Assuming This Distribution.

Age in years	Assumed Annual Survival Rate (%)	Simulated Survival to Age (100 bats)	Assumed Age Distribution of the Population (%)	Estimated Bat Fatalities per Year
0–1	30	100.00	39.42	1.28
1–2	85	30.00	11.83	0.38
2–3	85	25.50	10.05	0.33
3–4	85	21.68	8.54	0.28
4–5	85	18.42	7.26	0.24
5–6	85	15.66	6.17	0.20
6–7	85	13.31	5.25	0.17
7–8	85	11.31	4.46	0.14
8–9	85	9.62	3.79	0.12
9–10	0	8.17	3.22	0.10
Totals		**253.68**	**100.00**	**3.25**

Estimating Resource Losses

All ages of bat were assumed to be equally vulnerable to Project-related fatality, thus the age distribution of the bats killed is proportional to the simulated age distribution of the bats present. The fatality rate was assumed to be constant over the 8 years of operation. The bat-years lost with every year of Project operation were modeled using a matrix that estimated survival to each successive year for each age cohort of bats that would occur in the absence of the Project.

No economic discount rate was applied, so the rate of PV bat-years lost per year of Project operation did not change over the 8 years of operation modeled. The annual estimates of resource losses were summed over the remaining permit term to produce the total PV bat-years lost that must be offset with mitigation.

Estimating Resource Gains

Mitigation credit is generated by increasing the carrying capacity of the habitat in the forest restoration mitigation project area. The forest restoration mitigation project area is within the known range of the Hawaiian hoary bat and is proposed on lands for which there is currently no management plan nor is there funding for habitat restoration. The methods used by the National Park Service to achieve this restoration are reliable in that Hawaiian hoary bat forage availability is reasonably certain to be improved within the first 6 years because the removal of invasive plants, reintroduction of native plants, and overall increased native biodiversity of the vegetation are expected to boost bat forage biodiversity and availability.

Long-term roosting and potential pupping resources are expected to begin establishing after about 5 years (when koa seedlings should reach 15 feet in height) and would be fully established within 15–20 years. The improved functionality and resources of the forest restoration mitigation project area are expected to continue to provide those resources for the life of each individual tree. Without the forest restoration mitigation project, it is assumed that this forest restoration mitigation project area currently supports one bat per 80 acres to account for the provision of low-quality forage and transitory space. As discussed in the following section, this ratio can be significantly improved as a result of the forest restoration mitigation project.

RESULTS

The resource loss (PV bat-years) was divided by the per-acre mitigation resource gain (PV bat-years) to estimate the acres of mitigation needed to fully offset the loss. The REA assumes that the forest restoration mitigation project will begin the first permit year. This forest restoration mitigation project is designed such that tree saplings will be planted in dense nodes that should outcompete the invasive grasses for the life of the tree without additional management intervention, which in some cases may be hundreds of years.

The mitigation credit generated by the forest restoration mitigation project depends on the lifetime of the mitigation project (the anticipated duration of increased carrying capacity resulting from habitat improvement). 10 years post-funding was modeled.

According to the REA, the total size of the forest restoration mitigation project needed to fully offset the proposed take is 1,074 acres.

LITERATURE CITED

Allen, P.D. II, D.J. Chapman, and D. Lane. 2005. Scaling environmental restoration to offset injury using habitat equivalency analysis. In *Economics and Ecological Risk Assessment: Applications to Watershed Management*, edited by R.F. Bruins and M.T. Heberling, pp. 165–184. Boca Raton, Florida: CRC Press.

Amlin, A., and A. Siddiqi. 2015. *Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance Document*. State of Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu, Hawai‘i.

Bonaccorso, F.J., C.M. Todd, A.C. Miles, and P.M. Gorresen. 2015. Foraging Range Movements of the Endangered Hawaiian Hoary Bat, *Lasiurus cinereus semotus* (Chiroptera: Vespertilionidae). *Journal of Mammalogy* 96(1):64–71.

Dunford, R.W., T.C. Ginn, and W.H. Desvousges. 2004. The Use of Habitat Equivalency Analysis in Natural Resource Damage Assessments. *Ecological Economics* 48(2004):49–70.

Environmental Justice Organisations, Liabilities and Trade. 2013 Discounting the Future. Available at: http://www.ejolt.org/2013/01/discounting-the-future. Accessed June 20, 2018.

Fraser, H., and L. HaySmith. 2009. *Hawaiian Hoary Bat Monitoring Protocol*. Pacific Island Network. Natural Resource Report NPS/PWR/PACN/NRR. 2009/DRAFT. National Park Service, Fort Collins, Colorado.

King, D.M. 1997. *Comparing Ecosystem Services and Values, with Illustrations for Performing Habitat Equivalency Analysis*. Prepared by King and Associates, Inc., Washington, D.C., for the U.S. Department of Commerce, Silver Springs, Maryland.

National Park Service. 2018. About Us. Available at: https://www.nps.gov/aboutus/index.htm. Accessed May 31, 2018.

O’Shea T.J., L.E. Ellison, and T.R. Stanley. 2011. Adult Survival and Population Growth Rate in Colorado Big Brown Bats (*Eptesicus fuscus*). *Journal of Mammalogy* 92(2):433–443. Available at: http://dx.doi.org/10.1644/10-MAMM-A-162.1.

Pryde, M.A., M. Lettink, and C.F.J. O’Donnell. 2006. Survivorship on Two Populations of Long-tailed Bats (*Chalinolobus tuberculatus*) in New Zealand. *New Zealand Journal of Zoology* 33:85–95.

U.S. Department of Agriculture. 2009. Bats of the U.S. Pacific Islands. Biology Technical Note No. 20. Natural Resources Conservation Service, Pacific Islands Area.

U.S. Fish and Wildlife Service (USFWS). 1998. Recovery Plan for the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). U.S. Fish and Wildlife Service, Portland, Oregon.

———. 2013a. Region 3 Indiana Bat Resource Equivalency Analysis Model for Wind Energy Projects, Draft Version: January 31, 2013. Bloomington, Minnesota.

———. 2013b. Eagle Conservation Plan Guidance, Module 1 – Land-based Wind Energy Version 2: April 2013.

———. 2016. *Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take*. Pacific Islands Field Office, Honolulu, Hawai‘i.

Wilkinson, G.S., and J.M. South. 2002. Life History, Ecology and Longevity in Bats. *Aging Cell* 1:124–131.

Appendix B

A Proposal to Restore 1,200 Acres of Lowland Mesic-Wet ʻŌhiʻa Forest to Benefit Hawaiian Hoary Bat and Other Threatened and Endangered Species in Kahuku Unit, Hawaiʻi Volcanoes National Park

A Proposal to Facilitate Forest Recovery Across 1200 acres of Lowland Mesic-Wet ʻŌhiʻa Forest to Benefit Hawaiian Hoary Bat and other Threatened and Endangered Species in Kahuku Unit, Hawaii Volcanoes National Park
10 years

Contact: Sierra McDaniel 808-985-6097
Sierra_McDaniel@nps.gov

Proposed Work

The park will facilitate forest recovery across 1200 acres of degraded forest/pasture in Kahuku. Currently, staff are constructing boundary fences and removing animals, but additional measures, such as invasive plant control and planting of native trees, are needed to facilitate forest recovery and restoration of wildlife habitat. Efforts are focused in areas where a limited seed supply of native tree species, and competition from alien pasture grasses and aggressive woody species inhibits forest recovery. Work crews will sweep and control target weeds, such as kahili ginger (*Hedychium gardnerianum*), blackberry (*Rubus argutus*) christmasberry (*Schinus terebinthifolia*), and strawberry guava (*Psidium cattleianum*), propagate and plant 90,000 seedlings of native trees across 1200 acres of degraded ʻōhiʻa forest/pasture (Figure 1). In addition, grasses around select existing koa trees will be removed either with herbicide or mechanical scarification to regenerate koa from the seed bank. The work will benefit the Hawaiian Hoary Bat and at least eight additional listed endangered species, two species of concern, and 17 rare species. The total cost of the project is $1,463,728 across ten years.

Background

In 2003, Hawaii Volcanoes National Park (HAVO) acquired the 150,865 acres Kahuku Unit. The area provides habitat for a number of rare, threatened and endangered plant and animal species (Benitez et al. 2005, Tweed et al. 2007, Pratt et al. 2011, McDaniel pers. comm.), including the endangered Hawaiian Hoary Bats which have been detected in a variety of forest habitats ranging from 2,000 ft. to 7,400 ft. elevation in Kahuku (Fraser and Haysmith 2009).

Unfortunately, much of the lowland forest (<4,500 ft elevation) is badly degraded by decades of land clearing and impacts by cattle, mouflon and pigs. Large forest tracts have been converted to alien grass pastures with portions invaded by christmasberry and incipient populations of strawberry guava, blackberry and kahili ginger. The park is constructing boundary fences and removing animals, but additional measures, such as invasive plant control and planting of native trees, are needed to facilitate forest recovery and restoration of wildlife habitat. Without active restoration efforts much of the area will remain dominated by nonnative pasture grasses without native forest regeneration.

We propose to actively facilitate forest recovery in a 1200 acre block of degraded ‘ōhi’a forest/pasture (Figure 1).

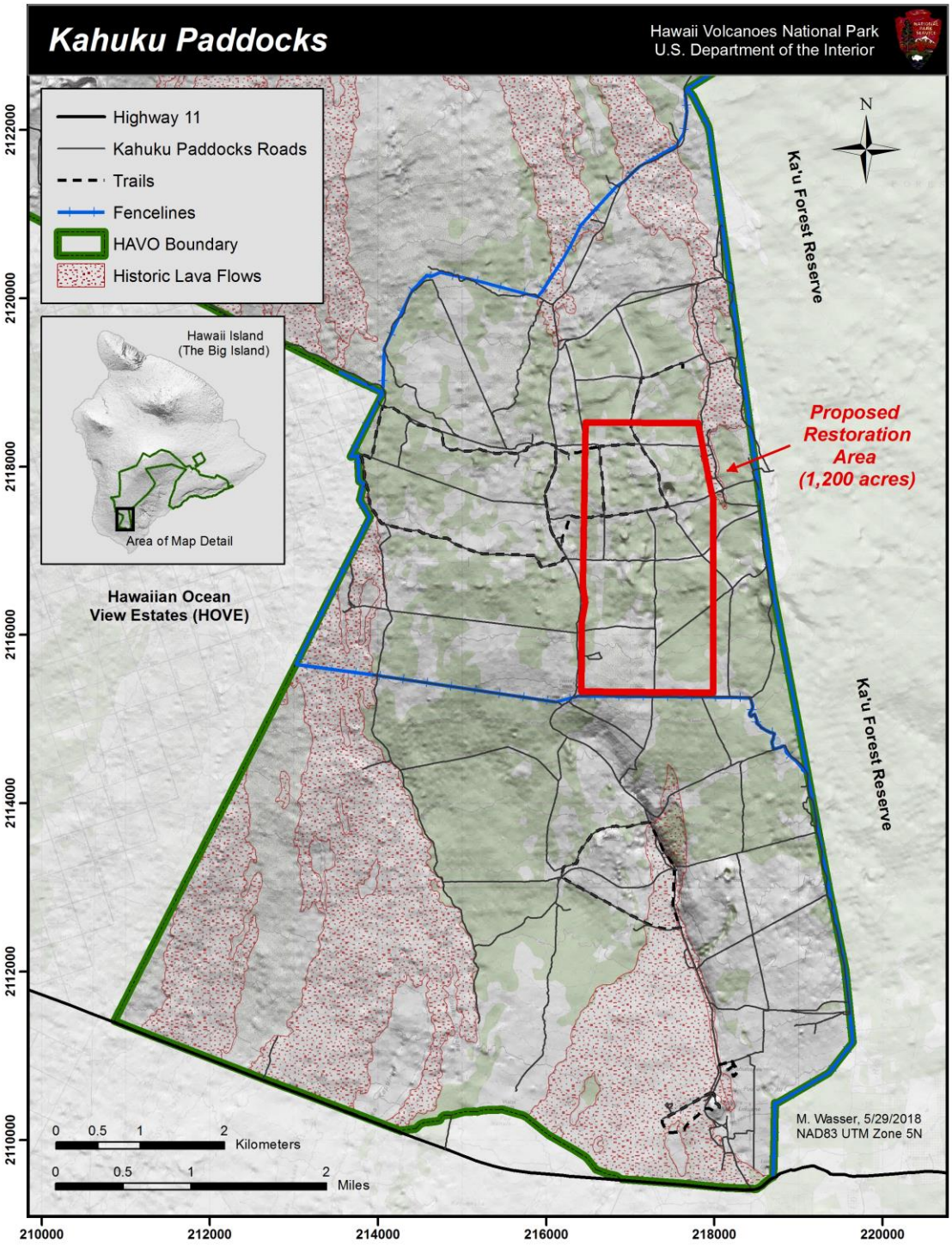


Figure 1. Map lower of Kahuku. Proposed restoration activities would be conducted within a 1200 acre area (red rectangle).

The proposed restoration work would benefit the Hawaiian Hoary Bat along with 8 additional listed endangered species, two SOC, and 17 locally rare species in the area (Table 1). Kahuku is also part of the Ka`ū Forest Complex which is among the priority 1 watersheds by the state of Hawaii because of its high conservation value, unique ecosystems and critically endangered rare plant and wildlife populations. The local community surrounding the park is very interested and eager to learn about and participate in restoration at the park. This restoration project will engage hundreds of community members and students while providing an opportunity to learn about the unique natural resources of Kahuku.

Table 1. Federally-listed endangered, rare and uncommon species that would benefit from active restoration of lower Kahuku

Species	**Taxon**	**Status**
Branta sandvicensis	Bird	Endangered
Buteo solitarius	Bird	Endangered
Clermonita lindseyana	Plant	Endangered
Cyanea stictophylla	Plant	Endangered
Drosophila heteroneura	Insect	Endangered
Lasirus cinereus ssp *semotus*	Mammal	Endangered
Pittosporum hawaiiense	Plant	Endangered
Prichardia lanigera	Plant	Endangered
Vestiaria coccinea	Bird	
Cyrtandra menziesii	Bird	SOC
Trematolobelia wimmeri	Plant	SOC
Antidesma platyphyllum	Plant	Rare
Charpenteria obovata	Plant	Rare
Clermontia clermontioides	Plant	Rare
Clermonita hawaiensis	Plant	Rare
Clermontia montis-loa	Plant	Rare
Cyanea pilosa	Plant	Rare
Cyrtandra platyphylla	Plant	Rare
Marattia douglasii	Plant	Rare
Melicope radiata	Plant	Rare
Phyllostegia ambigua	Plant	Rare
Phytolacca sandwicensis	Plant	Rare
Pittosporum hosmeri	Plant	Rare
Rumex giganteus	Plant	Rare
Scaevola chamissoniana	Plant	Rare
Tetraplasandra hawaiiensis	Plant	Rare

Touchardia latifolia	Plant	Rare
Urera glabra	Plant	Rare

Objective

1. Prevent establishment of target weed species to promote natural recovery across 1200 acres

2. Plant 90,000 nursery reared seedlings of important native species to facilitate forest recovery in nodes across 1200 acres in former pasture in the Kahuku Unit. In addition, grasses around select existing koa trees will be removed either with herbicide or mechanical scarification to regenerate koa from the seed bank.

3. Evaluate community vegetation changes within and outside of the active restoration area.

Methods

1. **Prevent establishment of target weed species.** Work crews will conduct ground searches to locate and target weed species. GPS data will be collected for areas searched and number of plants treated. Target species include blackberry, strawberry guava, kahili ginger, and christmasberry. Control methods will follow established park prescribed treatments for each species (Table 2).

2. **Plant 90,000 nursery reared seedlings and remove grasses from select existing koa trees using herbicide or mechanical scarification.**
   Seeds of native tree and shrub species will be collected within the local area and processed for propagation. All propagation will be conducted at the HAVO native plant facility. Facilities will be kept free of pest species; individuals will be rigorously monitored and sanitized before planting to avoid contamination of target locations. Techniques for propagating and planting common native species have been developed and applied at HAVO. Prior to planting and seed broadcasting, alien grasses will be temporarily suppressed by applying a 2% solution of imazapyr and glyphosate. In addition, grasses around select existing koa trees will be removed either with herbicide or mechanical scarification to regenerate koa from the seed bank.

   Planting and seeding nodes will be strategically placed to link existing forest fragments or build biodiversity around existing solitary trees. Nodes built around scattered tall ʻōhiʻa and koa trees in the pasture may attract birds to

disperse seeds, have higher nutrient inputs because of leaf litter fall and higher moisture levels because of cloud water interception. Planting seedlings in dense nodes will reduce light levels as the canopy develops and suppress the dominate invasive grasses. This will create forest habitat that would be extant for the life of the trees, needing very little long term management.

3. **Monitor project success**. Vegetation monitoring plots will be established both within and outside of the project area to evaluate impacts of management actions on the vegetation community composition and structure. Plots will be established in the first year of the project and read at year 7 to determine if success criteria have been met.
    - Outplanted seedling survival averages 60% across all outplanted species at one year post planting.
    - Native species richness significantly increases over time.
    - The canopy is composed entirely of native tree species

Implementation Schedule

Year 1- Begin project coordination and site visits with work leaders, begin collection of plant material and propagation. Conduct invasive plant sweeps and removal. Establish vegetation monitoring plots.

Year 2-5 - Begin planting of nursery reared seedlings. Complete planting of 45,000 seedlings by year 5 (approximately 11,250 per year).

Year 5-10- Complete planting of 45,000 (approximately 11,250 per year) nursery reared seedlings by year 10. Re-read vegetation plots in year 7.

Table 2. Invasive species targeted for control.

Species	**Common Name**	**Control Method**
Cestrum nocturnum	Night cestrum	10% Garlon 3A Cut Stump
Hedychium gardnerianum	Kahili ginger	1.5g/l Escort
Morella faya	Faya tree	10% Garlon 3A cut stump, 50 % Garlon 3A Frill
Psidium cattleianum	Strawberry guava	10% Garlon 3A Cut Stump
Rubus argutus	Blackberry	1% Garlon 3A Foliar
Schinus terebinthifolius	Christmasberry	1% Garlon 4 Diesel

Budget

This project would be carried out over a 10 year period. The park has already significantly invested in this area by constructing fences and removing all of the nonnative ungulates. Matching funds or in-kind support provided by HAVO staff includes overall project coordination (e.g. planning, compliance, logistical support, supervision of collection of plant material, and activities in the nursery and field).

The total requested funding is $1,463,728 across 10 years. Funding will support a plant propagator or biological science technician to propagate, plant and monitor vegetation changes, pest control workers to remove nonnative vegetation, D6 equipment and operator, project supplies, transportation costs, greenhouse facility cost, and cultural resource survey. An annual inflation rate of 2% is built into the calculations.

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
		Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**total**
Pest control worker	270 worker days sweep and remove target weeds from 1200 acres 1x	$92,259.00	$0	$0	$0	$0	$0.00	$0	$0	$0	$0	$92,259.00
Pest control worker	site prep (herbicide grasses prior to planting and maintenance of grasses) 35 worker days per year	$12,198.69	$12,443	$12,692	$12,945	$13,204	$13,468.34	$13,738	$14,012	$14,293	$14,579	$133,572.25
Plant propagator/biological science technican seed collection, processing, propagation, site prep, planting, monitoring	75% GS-7 step 5 + 45% benefits (from 2018 OPM salary table $48,123 + $21, 655 = $69,788 per year)	$54,456	$55,545	$56,656	$57,789	$58,944	$60,123	$61,326	$62,552	$63,803	$65,079	$596,273
Planting labor combination of staff and volunteers	50 plants per person per day @ $200 per day = 225 days per 11250 plants	$0	$47,754	$48,709	$49,684	$50,677	$51,691	$52,725	$53,779	$54,855	$0	$409,874
D6 equipment and operator	remove grasses and facilitate seedling recruitment	$8,323	$0	$8,659	$0	$9,009	$0	$9,373	$0	$9,752	$0	$45,117
Greenhouse	construction and maintenance	$15,000	$0	$0	$0	$0	$3,000	$0	$0	$0	$0	$18,000
Greehouse	site prep leveling, gravel fill or surface hardening	$20,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,000
Supplies	Propagation supplies, planting tools, herbicide	6,800	3,876	3,954	4,033	4,113	6,196	4,279	4,365	4,452	4,541	$46,609
Transportation	GSA 12 months per year	$7,491	$7,641	$7,794	$7,949	$8,108	$8,271	$8,436	$8,605	$8,777	$8,952	$82,023
Compliance	cultural resource survey	$20,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$20,000
Project total with 2% inflation		**$236,527**	**$127,258**	**$138,463**	**$132,400**	**$144,057**	**$142,749**	**$149,877**	**$143,314**	**$155,932**	**$93,152**	**$1,463,728**

References:

Baker, J. K., and D. W. Reeser. 1972. Goat management problems in Hawaii Volcanoes National Park: A history, analysis, and management plan. U.S. Department of the Interior National Park Service Natural Resources Report Number 2. Office of the Chief Scientist, Washington D.C.

Benitez, D. M., T. Belfield, R. Loh, L. Pratt, and A. D. Christie. 2008. Inventory of vascular plants of the Kahuku addition, Hawai'i Volcanoes National Park. Pacific Cooperative Studies Unit Technical Report 157. University of Hawaii at Manoa. Honolulu, Hawai'i.

Fraser, H. and L. Haysmith. 2009. Draft Hawaiian Hoary Bat Monitoring Protocol. Pacific Islands Inventory and Monitoring. Natural Resource Report NPS

Hess, S. C. 2008. Wild sheep and deer in Hawai"i— a threat to fragile ecosystems. USGS Fact Sheet FS 2008-3102. http://pubs.usgs.gov/fs/2008/3102/

McDaniel, S., R. Loh, S. Dale, and C. Yanger. 2011. Experimental restoration of mesic and wet forests in former pastureland, Kahuku Unit, Hawaii Volcanoes National Park. Technical Report No. 175. Pacific Cooperative Studies Unit, University of Hawai`i, Honolulu, Hawai`i.

Pratt, L. W., T. K. Pratt, and D. Foote. 2011. Rare and Endangered Species of Hawaii Volcanoes National Park. Hawai'i Cooperative Studies Unit Technical Report HCSU-025. University of Hawai'i at Hilo.

Tweed, E., P.M. Gorresen, R.J. Camp, P.J. Hart and T.K. Pratt. May 2007. Forest Bird Inventory of the Kahuku Unit of Hawai`i Volcanoes National Park. Technical Report No. 143. 175. Pacific Cooperative Studies Unit, University of Hawai`i, Honolulu, Hawai`i.

Appendix C

Mitigation Costs and Funding

Appendix C. Pakini Nui HCP Funding Matrix

Category	Item	10-Year Total	Timing of Expense	Annual Expense	Number of Years
Compliance	Fatality searches, SEEF, and CARE during operations	$ 480,000	Rolling basis	$ 60,000	8
DLNR Compliance Audit	Compliance audit	$ 80,000	Annually	$ 8,000	10
Hawaian Hoary Bat	Habitat restoration at HNVP Kahuku Unit (including vegetation monitoring)	$ 1,463,728	Years 1 and 6	$ 731,864	2
	Bat activity and invertebrate monitoring	$ 50,000	Annual average	$ 5,000	10
Hawaiian Petrel and Band-rumped Storm Petrel	Colony protection at HVNP	$ 115,100	One-time Contribution, Year 1	$ 115,100	1
Nene	Predator control at breeding pen	$ 30,000	One-time Contribution, Year 1	$ 30,000	1
Contingencies (Funding Assurances)	10% of compliance and mitigation project totals. Requested by USFWS to assure funds for adaptive management,inflation, and other changed circumstances.	$ 126,886	On reserve if needed.		
	5% of mitigation project totals. Requested by DOFAW to assure funds for mitigation project management.	$ 82,941	On reserve if needed.		
Compliance Sub-total		$ 560,000			
Mitigation Project Sub-total		$ 1,658,828			
Contingency Sub-total		$ 209,828			
Grand Total		$ 2,428,656			

Appendix D

Assist Recovery of Endangered Seabird Populations on Mauna Loa in Hawai‘i Volcanoes National Park

Assist Recovery of Endangered Seabird populations on Mauna Loa in Hawaii Volcanoes National Park

Proposed Work

The park constructed a five mile barrier fence encompassing over 600 acres of nesting habitat to protect the largest subcolony of endangered Hawaiian Petrels or ʻUaʼu (*Pterodroma sandwichensis*) on Hawaiʻi Island. Construction began in 2013 and was completed in 2016. The park conducted predator control and surveillance within the fence during the 2016 and 2017 breeding seasons; no cats have been detected and no predation events were documented therefore the area has been deemed free of cats. Funds requested here will augment post-construction management actions for three years including: remote surveillance for ingress predators (due to fence damage, etc.), annual fence inspection and maintenance, replacement of anti-bird strike materials surveys and nest density monitoring to assess bird response to predator removal. Total cost for three years is $115,100.

Background

The Hawaiian Petrel was once one of the most numerous seabirds in the main Hawaiian Islands. Due to sheer numbers, this and other seabird species likely were ecologically significant as a source of marine nutrients for generally impoverished tropical soils (Loope 1998). Hawaiian Petrels also had an important place in native culture: Hawaiians harvested chicks and adults as a food source. These endangered birds still persist in remnant colonies at the margins of their former range - generally at high elevations or on steep slopes where nesting birds are best able to evade introduced mammalian predators.

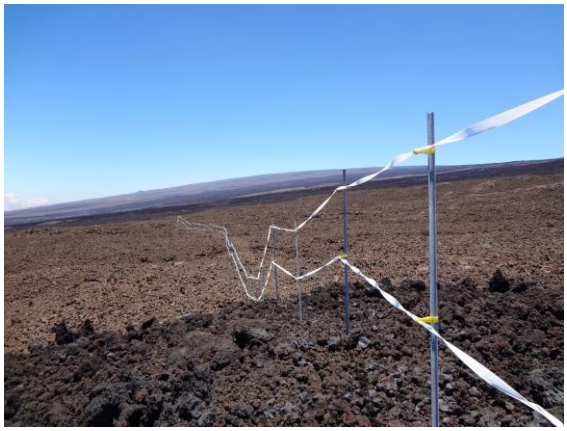
On Hawaii Island, the primary known nesting colonies occur in Hawaiʻi Volcanoes National Park, on the subalpine slopes of Mauna Loa, between 8,0000 and 10,000 feet. Even in this extreme environment, predation by feral cats has been documented as the primary threat to the species. To address the primary threat, the park selected a fence design that was developed, tested, and successfully used in Australia (Moseby and Read 2006) and modified this design for high elevation sites. Complimentary research conducted in the park resulted in recommendations to incorporate materials that make fences more visible to flying petrels and thus reduce the risk of fence strike (Swift 2004). After years of planning, the five mile fence was constructed between 2013 and 2016 at a cost of $1M, including in-kind support and contributions from multiple funders in addition to the NPS.

Funds provided by this proposal would augment the current park management of Hawaiian petrels within the fence. The park conducts one complete fence inspection per year; additional funds would support more frequent fence inspections and to rapidly respond to potentially damaging events, like a significant storm, with a complete inspection and repair as needed, thus minimizing potential impacts to nesting birds, such as predator ingress. Real-time surveillance for predator ingress would be improved with the addition of eight remote texting game cameras; images are sent to park staff via emails, allowing for a rapid response by park staff should ingress be detected. Monitoring for ingress predators within the exclosure is best accomplished by placing cameras at nest sites, as potential routes are excluded by the fence, thus providing additional reproductive data on a subset of nests. This will improve the park's estimate of reproductive success as cameras have proven to provide more accurate information on this cryptic species than human observation of indirect cues (such as guano and the

presence of chick down). While the fence was completed in 2016, the strike primary deterrent (two strands of white woven tape) were installed in 2013, when the fence posts were installed, to alert birds to the presence of the poles and to condition them to the coming fence. With additional funds available, the white tape can be replaced efficiently as soon as it is deemed necessary. The park conducted five consecutive years of nest density survey to establish baseline density estimates before and during fence construction and to refine the new monitoring protocol techniques. This level of monitoring is not sustainable given current fiscal uncertainty and will therefore occur only when funding is available. Additional funds will provide the support needed to conduct this systematic monitoring at 5 or 6 years post construction, an appropriate time to expect change given the maturation rate of the species.

Feral cat preying on a chick via remote camera.

Aerial view of the lowest section of the fenced area.



The white visibility tape is beginning to show minor wear.

Assessing nest activity is challenging for this cryptic species; remote cameras can greatly improve monitoring results.

Objectives

Conduct additional fence inspections, to better ensure fence integrity and rapid response to damage. Increase capacity to conduct real time, remote surveillance to detect and respond to any incidents of predator ingress using texting cameras. Ensure integrity of bird deterrent markings on fence by replacing as needed. Monitor the bird response to predator removal at by conducting a follow up systematic survey to detect changes in nest density over time.

Methods

1- Set game cameras (texting) to monitor real time for ingress predators; monitor reproductive success at a subset of nests.

2- Conduct additional fence inspection each year to better ensure integrity of fence. Inspection would be in response to potentially damaging event if one occurs, otherwise would be planned opposite the park's annual inspection.

3- Replace deteriorated anti-strike devices (white marking tape or alternate) to ensure the fence remains visible to transiting birds.

4- Monitor petrel response to removal of predators. Nest surveys will be conducted in 50m x 50 m grids as outlined in the Hawaiian Petrel Monitoring Protocol (Hu et al. 2015). Data collected will be used to calculate nest densities and contribute to the detection of trends over time.

Implementation Schedule

Years 1-3 - Conduct surveillance for ingress predators (via remote cameras) and annual fence inspections.

Year 1, 2 *or* 3 - When needed, replace deteriorated anti-strike devices to ensure the fence remains visible to petrels.

Year 3 - Conduct nest density survey and monitoring to measure bird response to the removal of predators.

Deliverables

- Complete replacement of 10 miles (2 strands) of white tape to ensure the fence remains visible to Hawaiian petrels.
- Reproductive success results for a subset of Hawaiian petrel nests for each of three years.
- Results of consistent, remote surveillance for ingress predators.
- Comprehensive annual fence inspections and repairs.
- Post predator removal nest density estimates, comparable to estimates obtained before and during construction.

Budget

TASK	Item	Description	Y1	Y2	Y3	Total
Surveillance for predator ingress	personnel	3 pp/year	7,500	7,500	7,500	**22,500**
	helicopter	4 hours	4,000	4,000	4,000	**12,000**
	remote cameras (texting)	8	3,000	0	0	**3,000**
	texting camera data package	10 mos/year	2,200	2,200	2,200	**6,600**
Annual fence inspection/repair	personnel	2 pp/year	5,000	5,000	5,000	**15,000**
	helicopter	4 hours	4,000	4,000	4,000	**12,000**
	supplies	lump	500	500	500	**1,500**
Replace bird deterrents *may occur in a different year	personnel	2 pp	5,000	0	0	**5,000**
	helicopter	4 hours	4,000	0	0	**4,000**
	supplies	lump	6500	0	0	**6500**
Nest density monitoring	personnel	8 pp	0	0	20000	**20,000**
	helicopter	6 hours	0	0	6000	**6000**
	supplies	lump	0	0	1000	**1000**
		Total	**41,700**	**23,200**	**50,200**	**115,100**

References:

Hu, D., G. E. Ackerman, C. S. N. Bailey, D. C. Duffy, and D. C. Schneider. 2015. Hawaiian petrel monitoring protocol, Pacific Island Network. Natural Resource Report NPS/PACN/NRR. National Park Service, Fort Collins, Colorado.

Loope, L.L. 1998. Hawaii and Pacific islands. Pp 747-774 in M.J. Mac, P.A. Opler, C.E. Puckett Haecker, and P.D. Doran (editors). Status and Trends of the Nation's Biological Resources, Volume 2. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA.

Moseby, K.L. and J.L. Read. 2006. The efficacy of feral cat, fox and rabbit exclusion fence designs for threatened species protection. Biological Conservation 127: 429-437.

Swift, R. 2004. Potential Effects of Ungulate Exclusion Fencing on Displaying Hawaiian Petrels at Hawai'i Volcanoes National Park. MS thesis. Oregon State University, Corvallis, OR.

Appendix E

Incidental Report Form and Downed Wildlife Protocol

STANDARD PROTOCOL FOR State of Hawai'i INCIDENTAL TAKE LICENSE AND U.S. Fish and Wildlife Service INCIDENTAL TAKE PERMIT HOLDERS RESPONDING TO DEAD OR INJURED WILDIFE INCLUDING THREATENED AND ENDANGERED SPECIES AND MBTA SPECIES

Do not move wildlife unless in imminent danger.
During business hours, call DOFAW immediately for your island.

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 264 – 0922, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Hawai'i	(808) 974 – 4221, (808) 974 – 4229 (808) 887 – 6063	(808) 640 – 3829
O'ahu	(808) 973 – 9786 (808) 295 – 5896	(808) 295 – 5896 (808) 226 – 6050
Kaua'i	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117	(808) 645 – 1576 (808) 635 – 5117

Fill out information on the downed wildlife form.

OVERVIEW

The islands of Hawai'i contain numerous native and endemic species of wildlife that are protected by strict state and federal laws. This protocol is geared towards downed (injured or deceased) wildlife and focused on the endangered Hawaiian hoary bat and avian species protected by the Endangered Species and Migratory Bird Treaty Species Acts. The likelihood of encountering injured or dead wildlife that are protected by state and federal endangered species laws should be considered equal to encountering non-listed species. Therefore, all downed wildlife should be treated with the same safeguards and care to ensure adequate response and documentation according to the following set of guidelines.

Always be prepared for discovery of downed birds and bats. Please ensure that all staff and personnel are trained in the following protocol, and that contact information, written protocols, and supplies are ready for response.

The first response for downed birds and bats is to call the local Hawai'i Division of Forestry and Wildlife (DOFAW) Office. DOFAW staff is generally able to respond by sending someone to the scene to retrieve the injured or deceased wildlife. In the event that DOFAW personnel are not able to respond right away, they may instruct those reporting the incident to provide necessary response. Please follow their directions carefully.

If DOFAW staff cannot be contacted, or if the downed animal is in imminent danger, you should be prepared to handle the animal yourself, following the protocol below, and transport them to DOFAW or a permitted wildlife rehabilitator. Again, you should only handle injured wildlife if DOFAW staff cannot be contacted or if the animal is in imminent danger.

PREPARING TO RESPOND FOR DOWNED OR INJURED BIRDS AND BATS

In all cases, ensure that all field staff is trained in the response protocol for injured birds and bats. Ensure they have read and understand the protocol, and have the protocol posted (including highlighted contact information) in a prominent location. Make sure that all staff know who to contact, and where supplies for handling injured wildlife are located. Staff should be regularly briefed on protocols, especially at the beginning of each distinct season that might correspond with a heightened likelihood of encountering downed wildlife.

At a minimum, for vehicles or foot patrols where maintaining a wildlife response kit (carrier) may be impractical, keep a copy of the protocol handy and accessible along with a large clean towel, soft cloth such as a t-shirt or flannel, several flags or tent stakes, and a pair of gloves, all of which are to be specifically designated for use in injured wildlife response.

For facilities and dedicated vehicles, please prepare and maintain one or more carriers designated for handling and transporting injured wildlife. This response kit should contain a large clean towel; soft cloth such as a t-shirt or flannel; several flags or tent stakes; several pairs of gloves (plastic/latex disposable gloves and also heavy duty gloves such as leather or heavy rubber that can be sanitized); eye protection; a ventilated cardboard box, pet carrier or other non-airtight container; and a copy of the protocol. For larger facilities (managed areas such as wildlife refuges, preserves, wetlands, or conservation areas), or areas where downed birds and bats are likely, please maintain several containers of various sizes. The container must provide enough room for the animal to comfortably move around, but also be sturdy enough to hold active birds or bats.

For small birds or bats, cardboard pet carriers or 'living world' plastic carriers work well as they have many ventilation holes and handles for easy carrying. Waxed pet carriers are preferred because they are sturdier, hold up longer, and can be thoroughly cleaned between uses. Sturdy cardboard boxes with holes punched in them to allow cross ventilation are also good. For birds, holes no wider than one inch in diameter should be punched on all four sides of the box. For bats, holes must be no larger than one-half inch diameter. A minimum of eight holes per side is sufficient. The carrier should be padded inside, well-ventilated and covered (to provide a sense of security).

Plastic dog kennels are recommended for handling larger birds, such as petrels, shearwaters, owls, hawks, ducks, stilts and geese. All cages must have towels or rags placed in the bottom to help prevent slipping and protect bird feet and keels. The towel or other cushioning material should be sufficient to cover the bottom of the container effectively

Cardboard boxes that are used for transporting injured wildlife should only be used once then discarded to avoid cross-contamination and/or disease or pathogen transfer. If plastic kennels or waxed pet carriers are used, be sure that they are adequately cleaned or sterilized between uses. Never put two animals in the same container.

Always wear personal protective equipment when handling downed wildlife. Disease and contamination exposure can work in both directions (bird or bat to person, and vice versa); always use protection against direct contact. If it becomes necessary to handle a bird, always wear disposable gloves. If multiple animals are being handled ensure that a new pair of gloves is used between each bird.

DOWNED WILDLIFE PROTOCOL

IF YOU FIND A LISTED DECEASED BIRD OR BAT:

All listed (MBTA and T&E species) wildlife found deceased must be reported ASAP upon detection to DOFAW and USFWS.

1. Mark the location with a flag or tent stake. Record the time and location of the observation including the animal species and its condition, photo documentation and call DOFAW immediately. Contact information is in prioritized order; if you don't reach the first person on the list, please call the next. If possible, have someone stay with the animal while someone else calls.

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 264 – 0922, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Hawai'i	(808) 974 – 4221, (808) 974 – 4229 (808) 887 – 6063	(808) 640 – 3829
O'ahu	(808) 973 – 9786 (808) 295 – 5896	(808) 295 – 5896 (808) 226 – 6050
Kaua'i	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117	(808) 645 – 1576 (808) 635 – 5117

NOTE: For remote sites with spotty coverage, ground staff may need to have a planned communication system with radios, or a cell carrier known to provide adequate coverage, that will allow communication with a designated contact able to relay information to DOFAW at the appropriate numbers listed in the above table.

2. If necessary place a cover over the wildlife carcass or pieces of carcass *in-situ* (a box or other protecting item) to prevent wind, or scavenger access from affecting its (their) position(s).

3. **Do not** move or collect the wildlife unless directed to do so by DOFAW.

4. ITL and ITP holders should notify DOFAW and the USFWS as to the estimated time of death and condition of the carcass, since fresh carcasses suitable for necropsy may be handled and transported differently than older ones.

5. Usually DOFAW staff will have you leave the animal in place while they come and get the animal, but dependent on the situation they may provide other instructions. Please follow their directions carefully.

6. Fill out a Downed Wildlife Form (attached). Make written notes concerning the location including GPS points, circumstances surrounding the incident, condition of the animal, and what action you and others took. This information should be reported to the appropriate official(s), including DOFAW and USFWS HCP staff, within 24 hours. Downed wildlife should remain in its original position and configuration.

DOWNED WILDLIFE PROTOCOL

IF YOU FIND A LISTED INJURED BIRD OR BAT WHICH IS NOT IN IMMINENT DANGER:

1. Do not put yourself in danger. Always wear personal protective equipment and clothing, including gloves and eye protection, to protect yourself when handling injured wildlife.

2. Mark the location with a flag or tent stake. Record the time and location of the observation including the animal species and its condition, and call DOFAW immediately. Contact information is in prioritized order; if you don't reach the first person on the list, please call the next. If possible, have someone stay with the animal while someone else calls.

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 264 – 0922, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Hawai'i	(808) 974 – 4221, (808) 974 – 4229 (808) 887 – 6063	(808) 640 – 3829
O'ahu	(808) 973 – 9786 (808) 295 – 5896	(808) 295 – 5896 (808) 226 – 6050
Kaua'i	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117	(808) 645 – 1576 (808) 635 – 5117

3. Usually DOFAW staff will have you leave the animal in place while they come and get the animal, but dependent on the situation they may provide other instructions. Please follow their directions carefully.

4. While waiting for DOFAW staff to arrive, minimize noise and movement in the area around the wildlife. Watch the animal so that its location is not lost if it moves away. If possible, keep sources of additional harassment or harm, such as pets, vehicles, and loud noises, away from the animal. Note any changes in the condition of the animal.

5. Fill out a Downed Wildlife Form (attached). Make written notes concerning the location including GPS points, circumstances surrounding the incident, condition of the animal, photo documentation and what action you and others took. This information should be reported to the appropriate official(s) including DOFAW and USFWS HCP staff within 24 hours.

Do not attempt to release the bird or bat yourself. Do not move injured wildlife unless explicitly instructed by DOFAW. DOFAW will need to document circumstances associated with the incident. The animal may also have internal injuries or be too tired or weak to survive. Never throw the bird or bat into the air as this could cause more injury or result in death. Let trained staff or veterinary personnel familiar with wildlife rehabilitation and care examine the animal and decide when, where, and how to proceed.

DOWNED WILDLIFE PROTOCOL

IF YOU FIND A LISTED INJURED BIRD OR BAT WHICH IS IN IMMINENT DANGER:

1. Do not put yourself in danger. Always wear personal protective equipment and clothing, including gloves and eye protection, to protect yourself when handling injured wildlife.

2. Attempt to contact DOFAW as soon as possible, in all circumstances.

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 264 – 0922, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Hawai'i	(808) 974 – 4221, (808) 974 – 4229 (808) 887 – 6063	(808) 640 – 3829
O'ahu	(808) 973 – 9786 (808) 295 – 5896	(808) 295 – 5896 (808) 226 – 6050
Kaua'i	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117	(808) 645 – 1576 (808) 635 – 5117

If the animal is in imminent danger and you are able to protect it from further harm, mark the location where it was found with a flag or tent stake.

3. Pick up the bird or bat as safely as possible. Always bear in mind your safety first, and then the injured animal. If picking up a bird, approach and pick up the bird from behind as soon as possible, using a towel or t- shirt, or cloth by gently wrapping it around its back and wings. Gently covering the head (like a tent) and keeping voices down will help the animal remain calm and greatly reduce stress. If picking up a bat, use only a soft light-weight cloth such as a t-shirt or towel (toes can get caught in towel terry loops). Place the cloth completely over the bat and gather up the bat in both hands. You can also use a kitty litter scooper (never used in a litter box before) to gently "scoop" up the bat into a container.

4. Record the date, time, location, condition of the animal, and circumstances concerning the incident as precisely as possible. Place the bird or bat in a ventilated box (as described above) for transport. Never put two animals in the same container. Provide the animal with a calm, quiet environment, but do not keep the animal any longer than is necessary. It is critical to safely transport it to a wildlife official or veterinary professional trained to treat wildlife as soon as possible. While coordinating transport to a facility, keep the injured animal secure in the rescue container in a warm, dark, quiet place. Darkness has a calming effect on birds, and low noise levels are particularly important to help the animal remain calm. Extra care should be taken to keep wildlife away from children and pets.

5. Transportation of the animal to DOFAW per coordination with DOFAW staff may be required as soon as possible.

6. Fill out a Downed Wildlife Form (attached) and report to the appropriate official(s) including DOFAW and USFWS HCP staff within 24 hours.

7. If you must keep the bird or bat overnight, keep it in a ventilated box with a secure lid. Please keep the animal in a quiet, dark area and do not attempt to feed, handle, or release it. Continue to try to contact DOFAW staff and veterinary care facilities.

DOWNED WILDLIFE PROTOCOL

Never put birds or bats near your face. When handing a bird or bat to someone else, make sure that the head, neck, and wings are secure and in control first to avoid serious injury to handlers and to minimize injury to the animal. Never allow an alert bird with injuries to move its head freely while being handled – many birds will target eyes and can cause serious injury if not handled properly. Communicate with the person you are working with.

Never feed an injured bird or bat. The dietary needs of most species are more delicately balanced than many people realize. Most injured animals are suffering from dehydration, and attempting to feed or water the animal may kill it, as it is probably not yet able to digest solid food or even plain water. Often, when an injured animal arrives at a veterinary or rehabilitation facility, it is given a special fluid therapy for several days before attempts to feed the animal begin.

Handle wild birds and bats only if it is absolutely necessary. The less contact you have with the animal, the more likely it will survive.

DOWNED WILDLIFE FORM
LISTED SPECIES

Please be as descriptive as possible. Complete and accurate information is important.

Observer Name:	
Date of Incident:	
Date of report:	
Species (common name):	
Age (Adult/Juv), if known:	
Sex (if known):	
Incidental or Routine Search:	
Time Observed (HST):	
Time Initially Reported (HST):	
Time Responders Arrive (HST):	
General Location:	
GPS Coordinates (specify units and datum):	
Date Last Surveyed:	
Closest structure (e.g. Turbine #):	
Distance to Base of closest structure and/or nearest WTG:	
Bearing from Base of closest structure and/or nearest WTG:	
Ground Cover Type:	
Wind Direction and Speed (mph):	
Cloud Cover (%):	
Cloud Deck (magl):	
Precipitation:	
Temperature (^{o}F):	

Condition of Specimen [include a description of the animal's general condition, as well as any visible injuries, be specific (e.g., large cut on right wing tip.)]:
Probable Cause of Injuries and Supportive Evidence [attach photos and map] Be descriptive, e.g.,'teeth marks visible on upper back,' or 'found adjacent to tire marks in mud.':
Action Taken (include names, dates, and times):

Additional Comments:

IF YOU FIND DOWNED NON-LISTED WILDLIFE:

1. Do not put yourself in danger. Always wear personal protective equipment and clothing, including gloves and eye protection, to protect yourself when handling wildlife.

2. Fill out a Downed Wildlife Form for Non-listed Species (below). Make written notes concerning the location including GPS points, circumstances surrounding the incident, condition of the animal, photo documentation (if possible) and what action you and others took. This information should be reported to the appropriate official(s) including DOFAW HCP staff.

3. If you find an animal in imminent danger, following protocols above for listed species is recommended.

DOWNED WILDLIFE FORM
NON-LISTED SPECIES

Please be as descriptive as possible. Complete and accurate information is important.

Observer Name:	
Date of Incident:	
Species (common name):	
Age (Adult/Juv), if known:	
Sex (if known):	
Incidental or Routine Search:	
Time Observed (HST):	
General Location:	
GPS Coordinates (specify units and datum):	
Closest structure (e.g. Turbine #):	
Distance to Base of closest structure and/or nearest WTG:	
Bearing from Base of closest structure and/or nearest WTG:	
Condition of specimen:	
Probable Cause of Injuries and Supportive	
Action Taken:	
Additional Comments:	

Appendix F

Standardized Protocols for Incidental Finds

Wildlife agency standardized protocols for wildlife fatalities found outside the designated search area or discovered incidentally outside of a routine search

Evidence of Absence software (Dalthorp et al 2017; https://pubs.er.usgs.gov/publication/ds1055) utilizes the number of observed carcasses and the detection probability to produce a probability distribution of the number of fatalities that may have occurred based on imperfect detection. The number of carcasses entered as "Observed" assumes that the carcasses were found in the designated search area and during a routine search. In January 2018, the wildlife agencies discussed the need for establishing a standardized protocol for fatalities of protected wildlife species that are modeled with Evidence of Absence Ver. 2.0.6. but fail to meet the input criteria required by the model. Such exceptions may include carcasses found outside of the designated search area during a routine search, or carcasses incidentally discovered outside of a routine search day. "Rules" for treating these exceptions in the Evidence of Absence model should recognize and encumber the best science in order to maintain the validity of the software's output and not purposefully violate the basic mathematical assumptions that drive the model.

To best accommodate these types of Observed carcasses, the wildlife agencies provide the following standardized guidance. For the purposes of this guidance, assume the carcass found is of the species you are modeling.

Fatality found outside of the designated reduced search area

This situation would only apply to projects that have a carcass search area that has been reduced below where a carcass could potentially fall.

The Downed Wildlife Protocol and accompanying reporting procedures should be followed for carcasses found outside of the reduced routine search area. The carcass will be considered accounted for in the Unobserved take by the Evidence of Absence model. The report should clearly note the measured location of the carcass and relationship to the area searched in addition to the standard data required on the downed wildlife report. Measurements reported in meters will be based on distance from the turbine base or nearest structure. Such measurement should be conducted with a tape measure and with GPS. Project reports should also clearly identify the carcasses that fall in this category.

Fatality found outside of the designated "full" search area.

This situation would imply that the initial monitoring and search area based on turbine height and carcass size may have been undersized and will require expanding the area.

A designated "full" search area is expected to account for all carcasses. The lack of project specific data for small carcass sizes as resulted in the general adoption of the standards presented in Hull and Muir (2010). The wildlife agencies recommend an additional buffer zone of 20% be added to account for the wind effect on carcass fallout and uncertainty until adequate data is gathered for a site. The additional 20% buffer zone would need to be included in the routine searches. The buffer should be located on the down-wind side of the project if the wind is predominantly from one direction. The calculated area based on Hull and Muir plus the buffer area is designated as the "full" search area. Fatalities found during a routine search of the "full" search area (Hull & Muir predicted + 20% buffer zone) would be treated as an Observed fatality in the model.

If the carcass is found beyond this "full" monitoring area, the Downed Wildlife Protocol and accompanying reporting procedures should still be followed. In addition, the permittee should contact the appropriate wildlife agency personnel listed in the Downed Wildlife Protocol to discuss adjusting the size of the fall out area and if expanding the area searched is needed to account for all potential fallout.

Fatality found incidentally (not during a routine scheduled search) in the designated search area
The model takes into account the frequency of searches. If a carcass is found incidentally, then it must be determined if the carcass would have been found on the next routine search day and therefore counted as Observed, or if the carcass would have been missed or be gone on the next routine search and accounted for in the Unobserved portion of fatalities." The Hawaiian hoary bat carcasses are important to ongoing genetic research, so leaving the listed carcass in place is not in the best interest for the species. If a carcass is found incidentally, in the designated search area the Downed Wildlife Protocol and reporting should be followed. The report should clearly indicate who found the carcass, and under what circumstances (turbine maintenance, weeding, mowing, etc). The report should also indicate the method of determining how to categorize the carcass. The three methods are:

1) Permittee chooses to include the carcass as Observed in the model, regardless of searcher efficiency.

2) Wildlife agencies will include the carcass as Observed in the model when the documented detection probability is sufficiently high so as to reasonably assume the carcass would have been found on a subsequent scheduled search. Specifically, this method makes the assumption that the search efficiency and *k* value are such that there is a high probability that the carcass would have been found on a subsequent search. This method will be used for all large and medium carcasses found. This method will also be used for smaller carcasses when it is reasonable to assume the carcass or carcass trace would have been found on a subsequent search. The wildlife agencies will assume a carcass would have been found when the documented searcher efficiency ≥75% and *k* value ≥ 0.7.

In the case of small carcasses where the searcher efficiency is less than 75% (based on permittee's documented efficacy), a double-blind search with a replacement surrogate should be conducted to determine how the recovered carcass shall be categorized: Observed or Unobserved. That trial shall include the following criteria:

- **a.** The surrogate (typically a rat) should be identical to that used for search efficacy trials and similar in size to the carcass found.
- **b.** The surrogate carcass should be labeled as a surrogate for the specific carcass it is representing, and placed by a third party in the proximity of where the carcass that was recovered was found with label hidden.
- **c.** The placement of this carcass should be conducted by the same party responsible for placing carcasses for efficiency trials, whenever possible.

d. Under no circumstances should the searcher conducting the routine search, be the one placing the surrogate or have knowledge of the surrogate's location or the timing of the placement.

e. Routine fatality searches should be carried out following standard search procedures.

f. The outcome of the trial should be reported in the compliance report and include the date the surrogate was placed and the date the carcass was found. If the carcass was never found, the third party should check on the status of the carcass. If the carcass is still present, leave it in place for subsequent searches. Include this information in the compliance report.

g. If the surrogate was found, the original carcass should be reported as Observed. If the surrogate was not found, the original carcass should be reported as Unobserved.

Note: The wildlife agencies expect the permittee's to conduct thorough, fair, and impartial searches and not to purposefully conduct searches for carcasses outside of the scheduled routine fatality searches in an attempt to manipulate fatality documentation or calculation of take. The agencies also acknowledge the amount of effort it takes to conduct the thorough routine fatality searches and trials necessary to measure carcass retention and searcher efficiency. If a carcass is found outside of a routine search and a searcher efficiency trial is scheduled to be conducted within the next 30 days, it may be possible to include option 3 within that searcher efficiency trial. However, you must contact the wildlife agencies for approval.

Literature Cited

Dalthorp, Daniel, Huso, Manuela, and Dail, David, 2017, Evidence of absence (v2.0) software user guide: U.S. Geological Survey Data Series 1055, 109 p., https://doi.org/10.3133/ds1055.

Hull, C. L. and S. Muir (2010). Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. Austalasian Journal of Environmental Management 17: 77-87.