Kaheawa II Wind Power
Draft Habitat Conservation Plan Amendment

APPLICANT
KAHEAWA WIND POWER II, LLC
200 Liberty Street, 14th Floor
New York, NY 10281

PREPARED BY:
SWCA Environmental Consultants
307a Kamani St.
Honolulu, HI 96813

Original: December 2011; Revised: October 14, 2019

Table of Contents

Figures

Tables

Appendices

Acronyms and Abbreviations

ac	acre
Applicant	Kaheawa Wind Power II, LLC
APLIC	Avian Power Line Interaction Committee
bbl	barrels
BESS	battery energy storage system
BLNR	Board of Land and Natural Resources
CARE	Carcass Retention
CDUP	Conservation District Use Permit
CFR	Code of Federal Regulations
cm	centimeter
CO_2	carbon dioxide
DEIS	Draft Environmental Impact Statement
df	degrees of freedom
DLNR	Department of Land and Natural Resources
DOFAW	DLNR Division of Forestry and Wildlife
e.g.	for example
EIS	Environmental Impact Statement
EISPN	Environmental Impact Statement Preparation Notice
EoA	Evidence of Absence
ESA	Endangered Species Act
ESRC	Endangered Species Recovery Committee
et al	and others
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
ft	foot, feet
FY	fiscal year
GE	General Electric
ha	hectare

HBRC	Hawaii Bat Research Cooperative
HCP	Habitat Conservation Plan
HRS	Hawai'i Revised Statutes
Inc	Incorporated
ITL	Incidental Take License
ITP	Incidental Take Permit
kg	kilogram
kph	kilometers per hour
kV	kilovolt
kW	kilowatt(s)
kWh	kilowatt hour(s)
KWP	Kaheawa Wind Power
LLC	Limited Liability Company
LWSC	Low Wind Speed Curtailment
m	meter
MM	million
m/s	meters per second
MBTA	Migratory Bird Treaty Act
MECO	Maui Electric Company
met tower	meteorological tower
MOU	Memorandum of Understanding
mph	miles per hour
MW	megawatt(s)
MWh	megawatt hour(s)
N/A	not applicable
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	US Department of Commerce, National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOx	nitrogen oxides
NRAG	Nēnē Recovery Action Group
NREL	National Renewable Energy Laboratory
OCCL	Office of Conservation and Coastal Lands
O&M	operation and maintenance
p	probability
PPA	Power Purchase Agreement
Project	Kaheawa Wind Power II
PUC	Public Utility Commission

rpm	revolutions per minute
RSZ	rotor swept zone
SEEF	Searcher Efficiency
SHPO	State Historic Preservation Officer
SO2	sulfur dioxide
spp	species
TM	registered trademark
NRCS	Natural Resources Conservation Service
unpub	unpublished
USFWS	U.S. Fish and Wildlife Service
USGS-BRD	U.S. Geological Survey, Biological Resources Division
WEOP	Wildlife Education and Observation Program
WTG	wind turbine generator
yd	yard(s)

1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 Summary and Rationale for the Amendment–*UPDATED*

Kaheawa Wind Power II, Limited Liability Company (LLC) (KWP II, LLC or the Applicant) is seeking an amendment to its Incidental Take Permit (ITP) in accordance with Section 10(a)(1)(B) of the Federal Endangered Species Act (ESA) of 1973, as amended, and Incidental Take License (ITL) in accordance with Chapter 195-D, Hawai'i Revised Statutes. The letter of intent to request an amendment to the state ITL and federal ITP was sent July 10, 2014. KWP II, LLC submitted a request for this amendment on May 8, 2015. These permits are issued by the U.S. Fish and Wildlife Service (USFWS) and State Department of Land and Natural Resources (DLNR) (referred to as the agencies), respectively. The requested amended take for KWP II is summarized in Table 1.1. KWP II, LLC is requesting an additional 14 adult nēnē (total 44) and 27 adult Hawaiian hoary bats (total 38).

This HCP amendment supports the issuance of these permits, and describes how the Applicant will avoid, minimize, mitigate and monitor the incidental take of threatened and endangered species that may occur during operation of the KWP project (Project). Efforts to minimize the potential impacts the facility may have on these listed species have already been incorporated into the site design and configuration. The general and species-specific mitigation measures the Applicant has proposed are intended to increase knowledge of the species' biology and distribution, enhance populations, ~~or~~ restore degraded native habitat, or protect valuable habitat. In accordance with state law, this HCP, to the maximum extent practicable, is designed to minimize and mitigate the impacts of the take of the covered species. Mitigation measures are briefly summarized in Table 1.2 and Table 1.3 for the Covered Species.

This amended Habitat Conservation Plan (HCP) includes added, updated, or deleted text necessary to amend the original HCP, federal ITP (ITP # TE2760 A-0), and State ITL (ITL # 15) to increase take of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) and the Hawaiian goose, or nēnē (*Branta sandvicensis*). The permit and license were approved in January 2012 for a 20-year term. The proposed amendment is for an existing facility; no additional construction or changes in operations are proposed. KWP II did not begin operations until July 2012. Since the permit ends in January 2032, the number of years take projections will be based upon is 19.5 years. The terms "permit term" or "20-year permit term or period" will always equate to 19.5 years.

Operation of the Kaheawa Wind Power II (KWP II) project has the potential to result in the incidental take of four federally and state-listed threatened and endangered species: the Hawaiian petrel (*Pterodroma sandwichensis*); Newell's shearwater (*Puffinus newelli*); nēnē, or the Hawaiian goose; and Hawaiian hoary bat. Hereafter, these four species are collectively referred to as the Covered Species. These species are known to fly in the vicinity of the project area and could be injured or killed if they collide with a WTG or other project component. Two seabird species are addressed in the original HCP. This amendment only addresses the bat and nēnē. No other listed, proposed, or candidate species has been found or is known or expected to be present in the project area.

The purpose of this document is to present the changes to the HCP that pertain to the proposed increase in take of Hawaiian hoary bat and nēnē. Sections of the HCP that are being amended are indicated as UPDATED or NEW in the section headings. In Section 1.0, subsections that are not being amended are labeled NO CHANGE or NOT APPLICABLE. In later sections (2.0 and higher), subsections that are not being changed are labeled NO CHANGE or NOT APPLICABLE, and the text is deleted. These include, for example, the impacts analysis, conservation measures, and compensatory mitigation for Newell's shearwater and Hawaiian petrel, which will remain unchanged with this amendment.

Rates of incidental take of bats and nēnē were estimated for KWP II prior to operations commencing based on the rates of observed take documented at the adjacent Kaheawa Wind Power (KWP I) site and measurements of bat and nēnē activity that were made at the proposed site as well as at the neighboring KWP I site. These pre-operations inputs used to estimate projected take represent information from the best scientific methods available at the time for downed wildlife monitoring and take estimation. The pre-operations calculated incidental take estimates determined the original ITP and ITL permit requests. The revised and higher incidental take estimates of the bat that have prompted this request for take amendments are based on calculations using the latest version of the Evidence of Absence (EoA) estimation software (Version 2.06) and actual take observed as well as other parameters measured (explained in this document) during systematic downed wildlife monitoring conducted continuously at the site since the Project became operational in July 2012 (Dalthorp *et al.* 2017; Kaheawa Wind Power I and II, LLC. 2013; Kaheawa Wind Power II, LLC 2014, 2015, 2016, 2017, 2018). The revised and higher incidental take estimates of the nēnē are based on calculations using the actual nēnē take observed as well as other parameters measured (explained in this document) during systematic downed wildlife monitoring. Downed wildlife monitoring provides an estimate of the actual take that is likely to be occurring and is used adaptively by the wildlife agencies and Applicant to ensure that take is estimated as accurately as possible.

For various reasons explained in this document, the best available information at the time the take permit and license were issued for KWP II was not adequate to accurately project estimated bat take for the 20-year permit period. Since operations began at KWP II, the estimation software has improved, is more robust in a variety of situations, and is now able to estimate take with a user-chosen level of credibility that the true mortality is not greater than the estimate. At the request of the USFWS, the level of credibility all permittees and applicants use is a conservative 80%. This change alone has increased the projected estimate compared to the pre-operations estimates because it allows for more uncertainty by producing a higher ratio of unobserved take for every observed carcass. The search conditions and methods and the bat detection sensitivity have also improved considerably. Canine-assisted downed wildlife monitoring, vegetation management and scavenger trapping have improved searcher efficiency and carcass retention thereby increasing accuracy and reducing uncertainty.

The pre-operations estimate of bat take for KWP II assumed the take rate per turbine would be less than the rate recorded at KWP I between 2006 and 2012 primarily because low wind speed curtailment (LWSC) to 5.0 m/s would be implemented at KWP II. LWSC was expected to reduce the take rate relative to the rate measured at KWP I prior to 2012. LWSC was not implemented at KWP I prior to fiscal year (FY) 2015. The annual take rate per turbine at KWP II had been projected to be 0.04 bat compared to 0.07 bat for KWP I, considering the first 5 years of operations at KWP I (Section 1.4.5.5). In retrospect, the bat take rate at KWP I during those years before KWP II was operational was lower than the rate for subsequent years at KWP I either because the take or bat activity was actually lower before FY 2013 or downed wildlife monitoring search conditions and methods did not provide sufficiently accurate information to use in projecting estimated take at KWP II (or KWP I).

Given the current observed nēnē take for KWP I for 20 turbines, the estimated take for the 20-year permit period is 64 adult nēnē (KWP I 2018). A simple extrapolation of take by number of turbines (3.2 nēnē per turbine) would suggest the 20-year take estimate for nēnē for KWP II with 14 turbines would be about 45 adult nēnē, which is very close to the current projected 20-year estimate for nēnē at KWP II. The level of nēnē activity at KWP I has always been greater than the activity level in the KWP II area (see KWP I and KWP II HCP annual reports). Consequently, the 20-year projected take estimate for nēnē calculated in 2012 for KWP II was assumed to be 50% less per turbine than at KWP I. Considering observed take derived from downed wildlife monitoring, we can more accurately estimate the 20-year projected take of nēnē at KWP II, and that estimate is about 50% higher than originally predicted (i.e., similar to the take rate at KWP I).

KWP, LLC operates a 21-megawatt (MW) wind energy generation facility, KWP II, near Kaheawa Pastures above Māʽalaea in the southwestern portion of the Island of Maui, Hawaiʽi. KWP II is situated on approximately 143 acres (58 hectares [ha]) of State Conservation Land southeast of the existing 30-MW KWP I project (see Figures 1.1 and 1.2) and began commercial operations in July 2012. KWP II supplies wind-generated electricity to Maui Electric Company Ltd. (MECO).

The project components of KWP II consist of:

- 14 General Electric (GE) 1.5-MW wind turbine generators (WTGs)
- sharing of the existing operations and maintenance building (O&M) with KWP I
- one 5,000 square foot (ft^2) maintenance building next to the existing KWP I O&M building
- one substation

- underground cables carrying electrical power from the individual wind generators to a new electrical substation
- a battery energy storage system (BESS)
- an overhead electrical collection line across Manawainui Gulch connecting the collection system with the new substation
- a short overhead electrical transmission line connecting the substation to the uppermost of the two existing MECO 69 kilovolt (kV) transmission lines through the area
- a communications system of underground fiber-optic cables connecting to the existing KWP I communications tower
- service roadways connecting the WTGs and other facilities to the existing main access road serving KWP I

These components disturbed approximately 43 acres (17.4 ha) of land or approximately 30% of the project area; the remainder remains undisturbed.

During pre-construction, the Applicant collected meteorological data at the KWP II site to determine suitable areas for the proposed WTGs. The data show that the most favorable areas are to the west and south of the KWP I turbines. Because of the characteristics of the prevailing winds, constructability and other factors, the Applicant determined that the "downroad" area was the best site for the KWP II project. Fourteen WTGs were constructed along the existing KWP I access road below the existing WTGs (see Figure 1.3 and Figure 4.1).

Adjusted take estimates at KWP II for all species consider both direct and indirect take. Direct take comprises individuals that are killed or injured colliding with turbines or associated structures on site. Indirect take considers that it is possible that adult birds killed due to collisions could have been tending to eggs, nestlings, or dependent fledglings or that adult bats could have been tending to dependent juveniles. In such cases, the loss of these adults would then also lead to the loss of their eggs or dependent young. Loss of eggs or young would be indirect take attributable to the project.

Mitigation for loss of productivity resulting from nēnē and seabird take is considered in addition to mitigating for direct and indirect take. Loss of productivity is the loss of offspring that an adult could have potentially produced if it had not been killed and continued to reproduce in future years. For mitigation purposes, loss of productivity accrues between the time the direct/indirect take occurs and the time that mitigation for the direct/indirect take is provided. Although mitigation is provided to offset the impact, loss of productivity is not counted as permitted take. As of July 2019, direct take~~s~~ observed within the search area (i.e., area searched during fatality searches) at the existing KWP II facility include three Hawaiian hoary bats and five nēnē. No seabirds have been found at KWP II.

Additionally, the HCP outlines a monitoring protocol to determine the actual take of each species after the facility began operating. Most importantly, this HCP incorporates adaptive management provisions to allow for modifications to the mitigation and monitoring measures as knowledge is gained during implementation.

Table 1.1. Requested Take for KWP II at Tier 1, Tier 2, New Tier 3, and New Tier 4–*UPDATED*

Common Name	Scientific Name	Mitigation and Take	Annual Take Limit	5-Year Take Limit[1]	20-Year Take Limit
Nēnē (Hawaiian goose)	*Branta sandvicensis*	Tier 1	four adults/ immatures and one fledgling	eight adults/ immatures and one fledgling	up to 21 total nēnē: 18 adults/ immatures and ~~2~~ three fledglings
		Tier 2	up to six adults/ immatures and one fledgling	up to 12 adults/ immatures and three fledglings	up to 30 total nēnē: 27 adults/ immatures and three fledglings
		New Tier 3	not applicable (n/a)	n/a	up to 44 adult nēnē
ʻŌpeʻapeʻa (Hawaiian hoary bat)	*Lasiurus cinereus semotus*	Tier 1	five adults[2]	seven adults[3]	seven adults[3]
		Tier 2	11 adults[4]	11 adults[4]	11 adults[4]
		New Tier 3	n/a	n/a	up to ~~45~~30 adult bats
		New Tier 4	n/a	n/a	up to ~~48~~38 adult bats

[1] The 5-year take limits are included only in the state ITL; the federal ITP includes only 20-year limits.
[2] This was revised to be equivalent to five adult bats in a clarification letter from the USFWS and DOFAW (2014-TA0260), dated May 20, 2014.
[3] This was revised to be equivalent to seven adult bats in a clarification letter from the USFWS and DOFAW (2014-TA0260), dated May 20, 2014.
[4] This was revised to be equivalent to 11 adult bats in a clarification letter from the USFWS and DOFAW (2014-TA0260), dated May 20, 2014.

Table 1.2. Mitigation for Nēnē and Bat: Tier 1 and Tier 2 Mitigation Scenarios–*UPDATED*

Tier 1 Mitigation	Tier 2 Mitigation
Nēnē	
1a. Perform systematic visual observations of nēnē activity within KWP II site to document how nēnē use the project area following construction. Ongoing. 1b. Establish predator trap lines in known nesting areas, remove invasive vegetation in and around open-top release pens, and monitor movements and nesting activities throughout Maui County. Ongoing	1. Support logistics, DLNR Division of Forestry and Wildlife (DOFAW) staffing predator control and vegetation management. Monitor and model benefits of action to confirm mitigation offsets Tier 2 take.
Hawaiian Hoary Bat	
1a. Conduct surveys to document bat occupancy at different habitat types (e.g., ridges versus gulches) and elevation ranges at KWP II and vicinity to support Maui bat research. Ongoing. 1b. Restoration of bat habitat at acreage commensurate with the requested take. Ongoing at Kahikinui Forest Reserve (Appendix 29; KWP II, LLC 2016).	1a. Continue surveys to document bat occupancy at different habitat types (e.g., ridges versus gulches) and elevation ranges at KWP II and vicinity to support Maui bat research. Ongoing. 1b. Restoration of additional bat habitat at acreage commensurate with the requested take. Ongoing at Kahikinui Forest Reserve (Appendix 29; KWP II, LLC 2016).

Table 1.3. Summary of Proposed Tier 3 Mitigation for Nēnē and New Tier 3 and New Tier 4 Mitigation for Hawaiian Hoary Bat–*NEW*

Nēnē
New Tier 3
The Applicant will offset the the requested take by • Extending predator control and vegetation management for nesting and foraging at the Haleakalā Ranch pen, or at a new pen, which will increase productivity and fledgling survival rates (Appendix 31). • Providing status reports to the wildlife agencies.
Hawaiian Hoary Bat
New Tier 3
The Applicant will offset the reqyested the take by • Funding bat research on Hawaiʻi Island conducted by the U.S. Geological Survey Hawaiian Hoary Bat Research Group that will provide basic bat ecology and life history information, better inform future mitigation efforts and aid in the recovery of the species. (see DOFAW 2015 and Appendix 30). • Providing status reports to the wildlife agencies.
New Tier 4
The Applicant will offset the impacts of the take to the maximum extent practicable by • Purchasing land that is not already in conservation, where bats are present, and where the land parcel is in danger of being developed or compromised. The approximate acreage per bat would be 60 to -80 acres or 480 to -640 acres total for eight bats. The specific parcel would be determined when funding and planning for Tier 4 take is required. • Providing status reports to the wildlife agencies. OR Mitigation through an approved federal and state Hawaiian hoary bat in-lieu fee program.

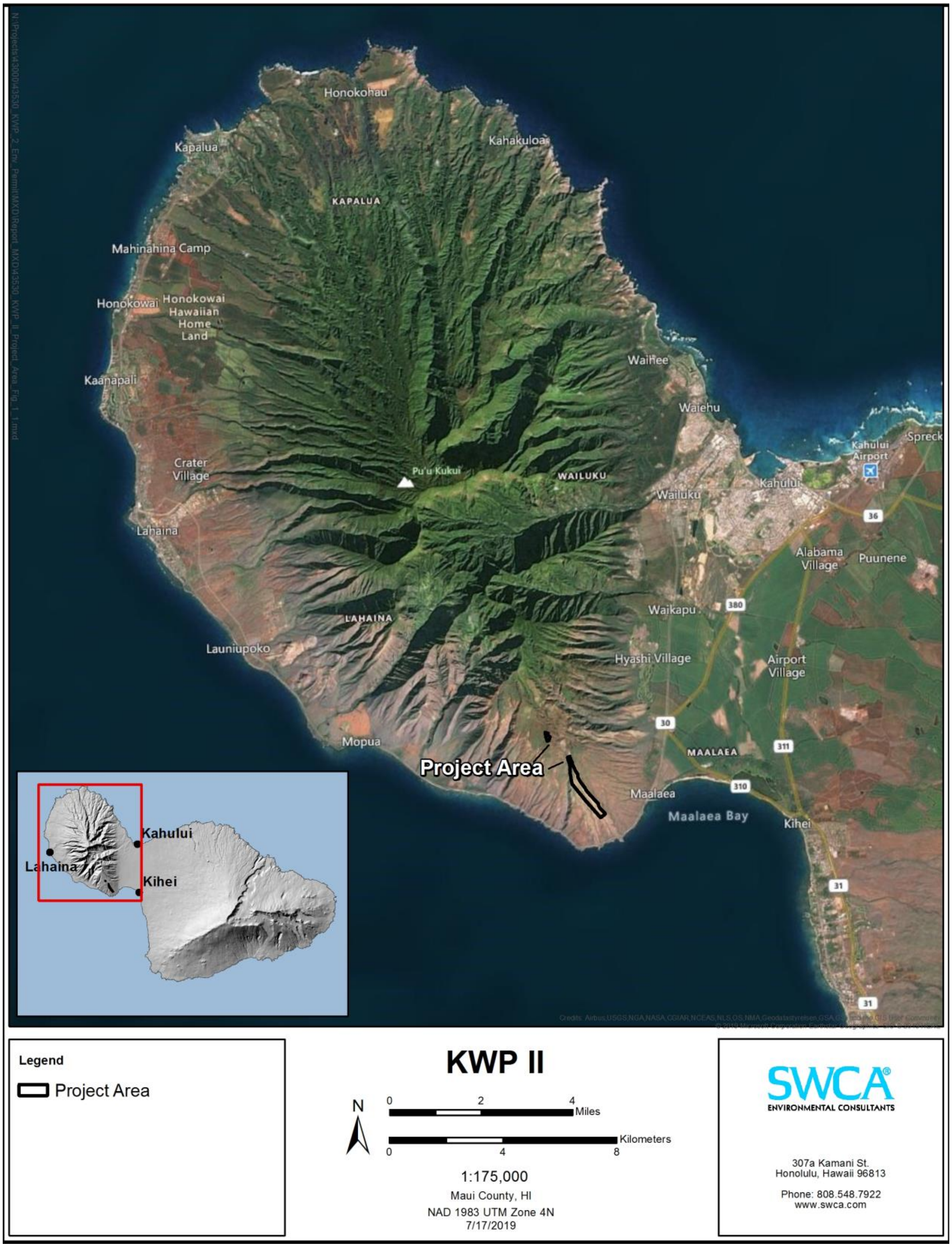


Figure 1.1. KWP II project location.–*NO CHANGE*

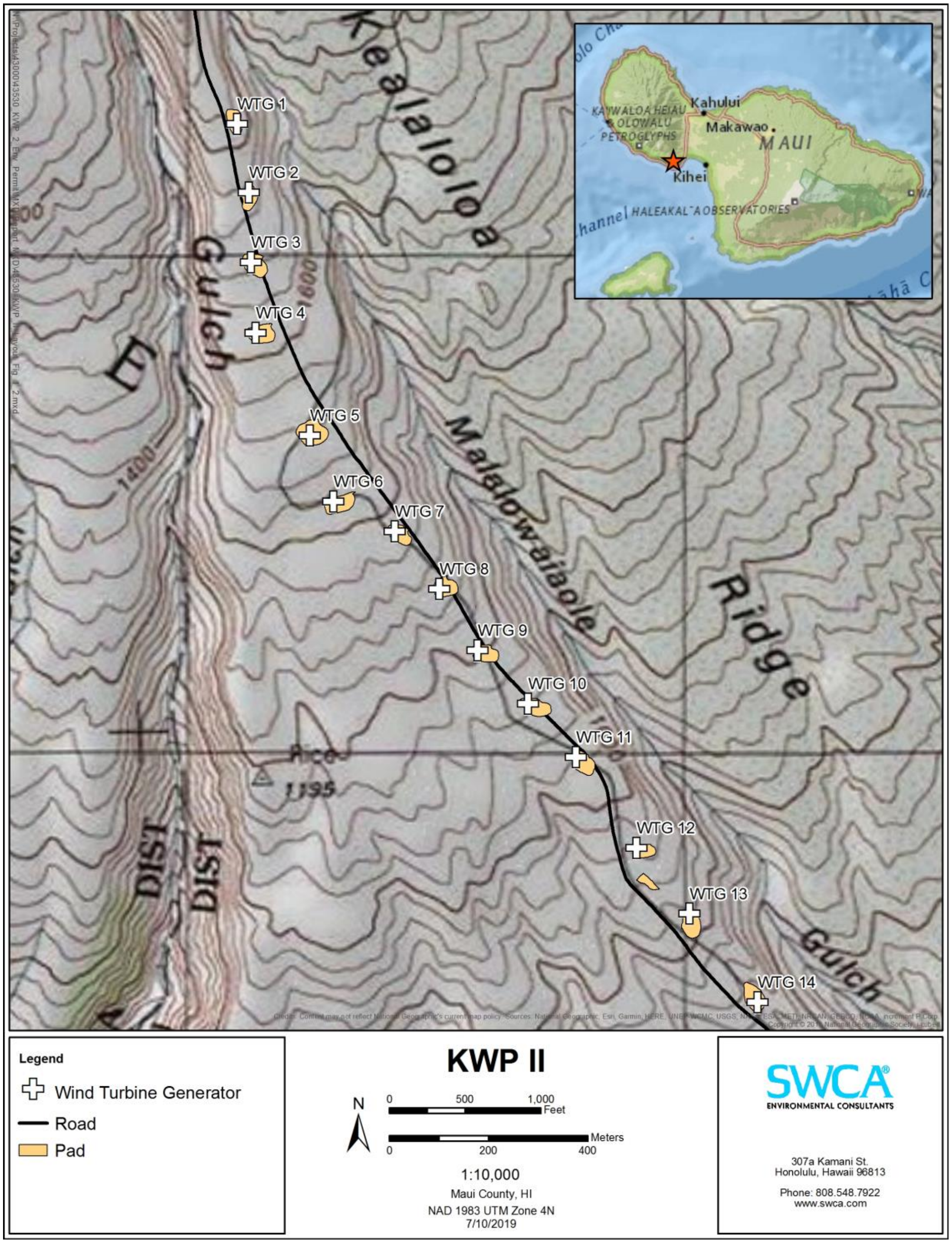


Figure 1.2. Site layout.–*NEW*

1.2 Applicant Background–*UPDATED*

KWP II, LLC is owned by TerraForm Power, Inc (TerraForm Power). In North America, TerraForm Power has a global portfolio of more than 4,000 MW of wind and solar energy generation in operation.

1.3 Regulatory Context

1.3.1 Federal Endangered Species Act–*UPDATED*

Section 9 of the ESA prohibits the unauthorized "take" of any endangered or threatened species of fish or wildlife listed under the ESA. Under the ESA, the term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect species listed as endangered or threatened, or to attempt to engage in any such conduct. "Harm" in the definition of "take" in the ESA means an act which kills or injures wildlife, and may include significant habitat modification or degradation where it kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering (50 Code of Federal Regulations (CFR) 17.3). "Harass" in the definition of take in the ESA means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering (50 CFR 17.3).

The USFWS may permit, under certain terms and conditions, any taking otherwise prohibited by Section 9 of the ESA if such taking is incidental to the carrying out of an otherwise lawful activity through the issuance of an ITP. As a condition of an ITP, an applicant must prepare and submit to the USFWS for approval of an HCP containing the following mandatory elements set forth under Section 10(a)(2)(A) of the ESA:

- The impact that will likely result from the taking
- What steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps
- What alternative actions to such taking the applicant considered, and the reasons why such alternatives are not being utilized
- Such other measures that the USFWS (under authority delegated by the Secretary of the Interior) may require as being necessary or appropriate for the purposes of the HCP

Under provisions of the ESA, the USFWS (under authority delegated by the Secretary of the Interior) will issue an ITP if the application meets the following issuance criteria identified in Section 10(a)(2)(B) of the ESA and implementing regulations:

- The taking of the listed species will be incidental
- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking on the species
- The applicant will ensure that adequate funding for implementation of the HCP, including procedures to deal with changed and unforeseen circumstances, will be provided
- The taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild
- Other measures required by the USFWS as being necessary or appropriate for purposes of the HCP will be implemented

The USFWS will document its assessment of the ITP and HCP in an ESA Section 10 findings document. If the USFWS makes the requisite findings, the USFWS will issue the ITP and approve the HCP. In such cases, the USFWS will decide whether to issue the ITP conditional on the implementation of the proposed HCP as submitted, or as amended to include other measures the USFWS determines are necessary or appropriate. If the USFWS finds that the requisite criteria are not satisfied, the permit request will be denied.

- The taking will be incidental.

- The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such takings.
- The applicant will ensure that adequate funding for the conservation plan and procedures to deal with unforeseen circumstances will be provided.
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild.
- Other necessary or appropriate measures required by the Secretary of the Interior, if any, will be met.
- The impact that will likely result from such taking.
- The measures the applicant will undertake to monitor, minimize and mitigate such impacts, the funding that will be available to implement such measures, and the procedures to be used to deal with unforeseen circumstances.
- The alternative actions to such taking the applicant considered and the reasons why such alternatives are not proposed to be utilized.
- Such other measures that the Director of the USFWS may require as necessary or appropriate for purposes of the plan.

The *Habitat Conservation Planning and Incidental Take Permit Processing Handbook*, published by the USFWS and the National Marine Fisheries Service (NMFS) in November 1996 and updated in December 2017, provides additional policy guidance concerning the preparation and content of HCPs. The USFWS and NMFS published an addendum to the *HCP Handbook* on June 1, 2000 (65 *Federal Register* 35242) (USFWS and National Oceanic and Atmospheric Administration [NOAA] 2000). This addendum, also known as the Five-Point Policy, provides clarifying guidance for the two agencies in issuing ITPs and for those applying for an ITP under Section 10. The five components addressed in the policy are discussed briefly below:

Biological Goals and Objectives: HCPs must include biological goals (broad guiding principles for the conservation program — the rationale behind the minimization and mitigation strategies), and biological objectives (the measurable targets for achieving the biological goals). These goals and objectives must be based on the best scientific information available and are used to guide conservation strategies for species covered by the plan.

Adaptive Management: The Five-Point Policy encourages the development of adaptive management plans as part of the HCP process under certain circumstances. Adaptive management is an integrated method for addressing biological uncertainty and devising alternative strategies for meeting biological goals and objectives. An adaptive management strategy is essential for HCPs that would otherwise pose a significant risk to the Covered Species due to significant information gaps.

Monitoring: Monitoring is a mandatory element of all HCPs under the Five-Point Policy. As such, an HCP must provide for monitoring programs to gauge the effectiveness of the plan in meeting the biological goals and objectives, and to verify that the terms and conditions of the plan are being properly implemented.

Permit Duration: Under existing regulations, several factors are used to determine the duration of an ITP, including the duration of the applicant’s proposed activities and the expected positive and negative effects on Covered Species associated with the proposed duration. Under the Five-Point Policy, the USFWS will also consider the level of scientific and commercial data underlying the proposed operating conservation program, the length of time necessary to implement and achieve the benefits of the operating conservation program, and the extent to which the program incorporates adaptive management strategies.

Public Participation: Under the Five-Point Policy guidance, the USFWS announced its intent to expand public participation in the HCP process to provide greater opportunity for the public to assess, review and analyze HCPs and associated documentation (e.g., National Environmental Policy Act [NEPA] review). As part of this effort, the USFWS has expanded the public review process for most HCPs from a 30-day comment period to a 60-day period.

1.3.2 Federal National Environmental Policy Act–*UPDATED*

Issuance of an ITP is a federal action subject to compliance with NEPA. The purpose of NEPA is to promote agency analysis and public disclosure of the environmental issues surrounding a proposed federal action to reach a decision that reflects NEPA's mandate to strive for harmony between human activity and the natural world. The scope of NEPA goes beyond that of the ESA by considering the impact of a federal action on non-wildlife resources, such as water quality, air quality and cultural resources.

The USFWS prepared a Final Environmental Assessment (EA) dated December 26, 2011, that evaluated the potential environmental impacts of issuing the original ITP. A Finding of No Significant Impact and the original ITP were issued January 3, 2012. A federal Environmental Impact Statement (EIS) for this amendment was prepared by the USFWS. The Notice of Intent (NOI) to draft an EIS was published in the *Federal Register* on June 1, 2018, and public scoping meetings relating to the NOI are planned for mid-June 2018, on Hawai‘i, Maui, and O‘ahu Islands.

1.3.3 Federal Migratory Bird Treaty Act–*UPDATED*

The bird species addressed in this amended HCP are also protected under the Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 United States Code 703-712). The MBTA prohibits the take of migratory birds. A list of birds protected under MBTA-implementing regulations is provided at 50 CFR 10.13. Unless permitted by regulations, under the MBTA it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product. The USFWS does not currently have a comprehensive program under the MBTA to permit the take of migratory birds by otherwise lawful activities. On December 22, 2017, the Department of the Interior Office of the Solicitor issued a memorandum opinion concluding that the MBTA does not prohibit incidental take of migratory birds.

To avoid and minimize impacts to MBTA-protected species, KWP II incorporates design and operational features based on the USFWS Land-Based Wind Energy Guidelines (2012). These voluntary guidelines contain materials to assist in evaluating possible wind power sites, wind turbine design and location, and pre- and post-construction research to identify and/or assess potential impacts to wildlife. Specific measures that have been adopted by Applicant to avoid and minimize the potential for impacts to MBTA-protected species are detailed in Section 4.3 of the HCP. The HCP also specifies that any migratory bird collisions or other impacts that occur with implementation of covered activities will be documented and reported to the USFWS.

1.3.4 Federal National Historic Preservation Act—*UPDATED*

USFWS issuance of an ITP under ESA Section 10(a)(1)(B) is considered an "undertaking" covered by the Advisory Council on Historic Preservation and must comply with Section 106 of the National Historic Preservation Act (NHPA) (36 CFR 800). The undertaking is defined as the land-use activity that may proceed once an ITP is issued to an applicant. Section 106 requires the USFWS to assess and determine the potential effects on historic properties that would result from the proposed undertaking and to develop measures to avoid or mitigate any adverse effects. Accordingly, the USFWS must consult with the Advisory Council on Historic Preservation, the State Historic Preservation Officer (SHPO), affected Tribes, the Applicant, and other interested parties, and make a good-faith effort to consider and incorporate their comments into project planning. The USFWS will determine the "area of potential effects" associated with the proposed undertaking, which is usually defined as the geographic area where the undertaking may directly or indirectly change the character or use of historic properties included in or eligible for inclusion in the National Register of Historic Places. The USFWS generally interprets the area of potential effects as the specific location where incidental take may occur and where ground-disturbing activities may affect historic properties. The USFWS, in consultation with the SHPO, must make a reasonable and good-faith effort to identify undiscovered historic properties. The USFWS also determines the extent of any archeological investigations that may be required; the cost of NHPA compliance, however, rests with the Applicant.

1.3.5 State Endangered Species Legislation (Chapter 195D, Hawai‘i Revised Statutes)– *UPDATED*

Section 195D-4, Hawai‘i Revised Statutes (HRS), states that any endangered or threatened species of fish or wildlife recognized by the ESA shall be so deemed by state statute. Like the ESA, the unauthorized take of such endangered or threatened species is prohibited [195D-4(e)]. The definition of take in 195D-2 of the HRS mirrors the ESA definition.

Under 195D-4(g), the Board of Land and Natural Resources (BLNR), after consultation with the State's Endangered Species Recovery Committee (ESRC), may issue a temporary license (subsequently referred to as an ITL) to allow a take otherwise prohibited if the take is incidental to the carrying out of an otherwise lawful activity.

To qualify for an ITL, the following must occur:

- The applicant minimizes and mitigates the impacts of the take to the maximum extent practicable (i.e., implements an HCP)
- The applicant guarantees that adequate funding for the HCP will be provided
- The applicant "posts a bond, provides an irrevocable letter of credit, insurance, or surety bond, or provides other similar financial tools, including depositing a sum of money in the endangered species trust fund created by §195D-31, or provides other means approved by BLNR, adequate to ensure monitoring of the species by the State and to ensure that the applicant takes all actions necessary to minimize and mitigate the impacts of the take"
- The plan increases the likelihood that the species will survive and recover
- The plan takes into consideration the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed
- The activity permitted and facilitated by the license to take a species does not involve the use of submerged lands, mining or blasting
- The cumulative impact of the activity, which is permitted and facilitated by the license, provides net environmental benefits
- The take is not likely to cause the loss of genetic representation of an affected population of any endangered, threatened, proposed or candidate plant species

Section 195D-4(i) directs the DLNR to work cooperatively with federal agencies in concurrently processing HCPs, ITLs, and ITPs. Section 195D-21 deals specifically with HCPs, and its provisions are similar to those in federal regulations. HCPs submitted in support of an ITL application must:

- Identify the geographic area encompassed by the plan; the ecosystems, natural communities, or habitat types within the plan area that are the focus of the plan; and the endangered, threatened, proposed and candidate species known or reasonably expected to be present in those ecosystems, natural communities or habitat types in the plan area
- Describe the activities contemplated to be undertaken within the plan area with sufficient detail to allow DLNR to evaluate the impact of the activities on the particular ecosystems, natural communities or habitat types within the plan area that are the focus of the plan
- Identify the steps that will be taken to minimize and mitigate all negative impacts, including without limitation the impact of any authorized incidental take, with consideration of the full range of the species on the island so that cumulative impacts associated with the take can be adequately assessed; and the funding that will be available to implement those steps
- Identify the measures or actions to be undertaken; a schedule for implementation of the measures or actions; and an adequate funding source to ensure that the actions or measures are undertaken in accordance with the schedule

- Be consistent with the goals and objectives of any approved recovery plan for any endangered species or threatened species known or reasonably expected to occur in the ecosystems, natural communities or habitat types in the plan area
- Provide reasonable certainty that the ecosystems, natural communities or habitat types will be maintained in the plan area throughout the life of the plan
- Contain objective, measurable goals; time frames within which the goals are to be achieved; provisions for monitoring; and provisions for evaluating progress in achieving the goals quantitatively and qualitatively
- Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals

Section 195D-25 provides for the creation of the ESRC, which is composed of biological experts, representatives of relevant federal and state agencies (i.e., USFWS, U.S. Geological Survey[USGS], DLNR), and appropriate governmental and nongovernmental members to serve as a consultant to the DLNR and the BLNR on matters relating to endangered, threatened, proposed, and candidate species.

Duties of the ESRC include reviewing all applications for HCPs, Safe Harbor Agreements, and ITLs, and making recommendations to the DLNR and the BLNR on whether they should be approved, amended, or rejected; reviewing all existing HCPs, Safe Harbor Agreements, and ITLs annually to ensure compliance and making recommendations for any necessary changes; and considering and recommending appropriate incentives to encourage landowners to voluntarily engage in efforts that restore and conserve endangered, threatened, proposed, and candidate species. Hence, the ESRC plays a significant role in the HCP planning process. The Applicant met with the ESRC during the preparation of this amended HCP on September 8, 2015, and again on October 19, 2017.

1.3.6 State Environmental Review: Chapter 343, Hawai‘i Revised Statutes–*UPDATED*

The project area is located in a State Conservation District and on land that is owned by the State of Hawai‘i; both of these are triggers for Chapter 343 review. KWP II, LLC prepared an Environmental Impact Statement Preparation Notice (EISPN), which was released for public comment on February 8, 2008. It then prepared a Draft EIS (DEIS), dated February 2, 2009 (Planning Solutions, Inc. 2009a). Following the end of the 45-day public review period for the DEIS, its review of the comments and of additional wind data that became available following publication of the DEIS led KWP II to decide to make the site evaluated in the DEIS an alternate and to identify the site that is the subject of this HCP as its Preferred Alternative. KWP II, LLC submitted a Revised Draft Environmental Impact Statement (Revised DEIS) in November 2009. The public comment period for the State Revised Draft KWP II EIS (Planning Solutions, Inc. 2009b) extended from December 8, 2009, to January 22, 2010. Feedback and comments on the proposed scope of the analysis and the completeness of the alternatives analyzed in the document were incorporated into the Final KWP II EIS (FEIS) (Planning Solutions, Inc. 2010). The FEIS was accepted by the Office of Coastal and Conservation Lands (OCCL) on May 19, 2010, completing the state environmental review process for the Project. In addition to the FEIS, KWP II LLC will also comply with Chapter 343 for any actions conducted under this HCP as required by law.

The state has determined that a Supplemental Environmental Impact Statement (SEIS) is required to be prepared for the requested amended take. The SEIS Preparation Notice was published in the state *Environmental Notice* on February 23, 2017, and comments were received until March 28, 2017. A draft SIES was published in the state *Environmental Notice* July 29, 2019, which initiate a public response period through September 23, 2019. A draft of the KWP II amended HCP was also published in the state *Environmental Notice* on October 8, 2017, and comments were received until December 7, 2017. A public meeting to solicit comments about the draft HCP amendment occurred November 27, 2017. An ESRC public site visit occurred at KWP II on February 22, 2018.

1.4 Project Description

1.4.1 Project Design and Components–*UPDATED*

KWP II consists of a 21-MW wind power generating facility and related facilities at Kaheawa Pastures above Māʽalaea, Maui, Hawaiʽi. The project area is located on approximately 143 acres (58 ha) of state land southeast of the existing KWP I facility at Kaheawa Pastures along the existing access road (see Figures 1.1 and 1.2).

The Project comprises the following components and site features:

- Internal service roads that connect the facility to the KWP I access road.
- 14 GE 1.5-MW WTGs and supporting equipment. Each WTG is set in a concrete foundation that is no more than 40 feet (12 meters [m]) * 40 feet in lateral directions. An additional 20-foot-(6-m)-wide cleared gravel perimeter is provided around each foundation to facilitate access and maintenance. Table 1.4 lists other pertinent characteristics of the selected WTGs
- An underground electrical collection network connecting all of the turbines
- A 1,258-foot (387-m) overhead collection line mounted on poles approximately 70 feet (21.5 m) above ground level crossing Manawainui Gulch
- An electrical substation and underground electrical power lines connecting the turbines with the new substation
- Interconnection facilities to connect the Project to the existing MECO power transmission system
- A BESS adjacent to the substation to provide dispatchable energy under various operating conditions. This stored energy is used to improve the ability of the MECO system to absorb additional as-available wind-generated resources
- A maintenance building to house operations personnel, equipment, and facility spare parts
- A water tank near the highway for accessing county water to be used at the project site. ~~This~~ Water is hauled uphill in a 150-gallon tank as needed and is used for nonpotable bathroom plumbing, dust control, irrigating reintroduced native plants, and emergency firefighting. The Project uses bottled water and portable pumped toilets similar to the KWP I facility (Planning Solutions, Inc. 2010); potable water is purchased and trucked up to the project area
- A communications tower attached to the operations building to support data gathering and control functions

During pre-construction, the Applicant collected meteorological data at the KWP II site to determine suitable areas for the proposed WTGs. The data show that the most favorable areas are to the west and south of the KWP I turbines. Because of the characteristics of the prevailing winds, constructability, and other factors, the Applicant determined that the downroad area was the best site for the KWP II project. Fourteen WTGs were constructed along the existing KWP I access road below the existing WTGs (see Figure 1.3 and Figure 4.1).

Figure 1.2 provides a site plan showing the locations of the above-mentioned facilities. Access to the site is from Honoapiʽilani Highway (State Highway 30) via an existing state-owned road that was improved during construction of the KWP I facility. Construction of the project disturbed approximately 43 acres (17.4 ha) of land (i.e., approximately 30% of the leased area, Table 1.5).

The total developed area of the site, or the total area that contains structures, hardened surfaces, or roads is 39.2 acres (15.9 ha). The FEIS for the Project contains a detailed technical description of the infrastructure for the project (Planning Solutions, Inc. 2010).

Table 1.4. Characteristics of 1.5-MW Wind Turbine Generators–*NO CHANGE*

Project Component	Metric

Power generation	1.5 megawatts each
Tower structure and height	Tubular; 213 feet (65 m) tall
Rotor diameter	231 feet (70 m)
Total height (tower + ½ rotor)	328 feet (100 m)
Rotor swept zone	50,130 square feet (4,657 square meters)
Rotor speed	10–21 rpm (variable)
Wind speed at which generator starts	8 mph (3.6 m/s)
Wind speed at which generator cuts out	56 mph (25.0 m/s)
Rated wind speed (unit reaches maximum output)	27 mph (11.9 m/s)

Note: Based on GE Model 1.5SE on a 64.7m tower. Mph = miles per hour, m/s = meters per second, rpm = revolutions per minute.
Source: Kaheawa Wind Power LLC (2004).

Table 1.5. Area Occupied Project Components–UPDATED

Project Component	Approximate Area Disturbed
14 WTG foundations and pads[1]	21 acres
Trenching for underground Electrical Cables[2]	2 acres
Maintenance building, substation, battery energy storage system	2 acres
Access roads[3]	16 acres
Temporary lay-down area[4]	2 acres
Total	43 acres

(1) Each foundation occupies 2,500 square feet; total disturbed area is 1.5 acres per turbine.
(2) Trenches were 2.0 feet (0.6 m) wide and 4.0 feet (1.2 m) deep and backfilled to finish grade.
-(3) Estimate based on 36-foot-wide (11-m) strip of "disturbance."
(4) One construction lay-down area for equipment staging roughly 150 × 250 feet (46 × 76 m).
Source: Planning Solutions, Inc. (2010)

To minimize the risk of attracting seabirds to the facility, in accordance with the guidelines discussed in Section 4.3, lighting is kept to the minimum necessary for safety and operations. Lighting at the project include that which is required by the Federal Aviation Administration (FAA) for aircraft safety. In March 2005, the existing KWP I facility received FAA approval of lighting only six wind turbines (at intervals of 2,500 to 3,000 feet or 762 to 915 m) with medium intensity, simultaneously flashing red lights, utilizing the minimum flash frequency. A similarly reduced lighting plan was approved for the KWP II project, resulting in lighting of an additional four turbines at KWP II.

Other lighting is provided at the operations and maintenance facility and substation for the purpose of illuminating the ground area, solely when work needed to be performed beyond daylight hours. Such lighting consists of halogen flood lights that are shielded and/or directed downward. Lights are turned on infrequently, and strictly as necessary, on the rare occasions when personnel are working at the site during darkness. Inside lights at the maintenance and operations buildings likewise are turned off at the end of each workday (more detail is provided in Section 4.3.1).

Personnel are generally present at the facility on a daily basis throughout project operation. They monitor the condition of the roadways and ensure that any needed maintenance is performed promptly as well as ensure that the turbines and supporting facilities are operating properly. Site maintenance includes vegetation control (manual and chemical) on the turbine pads to prevent new growth that may otherwise attract nēnē, as well as revegetation in other disturbed areas using species commonly found in the general project area. Additional maintenance and site work is conducted for fire prevention purposes at the direction of DLNR forestry officials, although any such work is first reviewed and approved by USFWS and DLNR wildlife officials to ensure that it is not expected to have any adverse impacts on any listed species.

The electrical power generated by KWP II is purchased by MECO via a Power Purchase Agreement

(PPA) reviewed and approved by the State of Hawai'i Public Utilities Commission (PUC). Power generated by the facility is delivered from the proposed substation to the existing MECO 69-kV transmission line that passes directly through the southern end of the project area.

KWP II implements a fire contingency plan as outlined in detail in the FEIS for the Project (Planning Solutions, Inc. 2010) that closely follows the fire contingency plan developed for KWP I (Fire Contingency Plan for CDUA MA-3103, 2005, Appendix 18).

1.4.2 Purpose and Need for KWP II Project–*UPDATED*

1.4.2.3 Original HCP Purpose and Need - UPDATED

Maui presently depends heavily upon fossil fuels for its electrical energy needs. The purpose of the KWP II project is to reduce that dependency by providing an alternative source that is renewable. The Project provides an estimated 70,000 MW-hours of electricity per year (MWh/year) to MECO's system.[1] That is equivalent to well over 5% of the electricity produced on the island in 2007, or enough electricity to power about 7,700 average Maui homes (at 750 kilowatt-hours [kWh] per month). By substituting a "local renewable" fuel source for imported fossil fuel, the Project helps the State move toward its goal of energy independence and sustainability. Based on the best available projections of the cost of fossil fuel, it could also provide electricity to Maui's residents at a lower cost than would be possible using fossil fuel.

KWP II, LLC estimates that the 21 MW of power that the project provides could reduce fossil fuel consumption by an estimated 138,000 barrels (bbls) of fuel oil per year, significantly lowering Maui's dependence on imported fossil fuels.[2] Fossil fuel pricing has historically been volatile; fuel prices are subject to fluctuation based on supply and demand conditions, as well as political concerns that can affect the long-term availability of world supply.

Based on an average cost of oil at $80/bbls over the life of the Project, the Applicant estimates that the substitution of wind energy for fossil fuel energy would reduce the amount that MECO spends on imported fuel by approximately $215,280,000 ($80/bbls*138,000 bbls/year*19.5 years). The cost to MECO to purchase 70,000 MW-hours at $250/MW-hour would be $17,500,000. Reducing the proportion of its energy that comes from fossil fuel would also buffer the system from the energy cost fluctuations that accompany volatile oil prices.

Reducing the consumption of fossil fuel for energy generation by the estimated amount (138,000 bbls per year) also benefits the environment in a number of ways. The most important of these is by reducing air pollutant emissions associated with the combustion of fossil fuels. Additional emission reductions stem from the elimination of the need to transport petroleum fuels from distant ports to the island. These reductions in fossil fuel consumption would result in the following environmental benefits:

Avoidance of approximately 107 million pounds (48.5 million kilograms [kg]) of carbon dioxide (CO_2) annually emitted into the atmosphere.

Elimination of approximately 0.75 million pound (0.34 million kg) of sulfur dioxide (SO_2) annually emitted into the atmosphere.

Elimination of approximately 195,000 pounds (88,450 kg) of nitrogen oxides (NO_X) annually emitted into the atmosphere.

---

[1]This conservatively assumes that the turbines operate at an average of 40% capacity over the course of a year. The actual number of MWh/year is expected to be somewhat higher than this.

[2]This estimate is based on the following: (a) Net capacity factor = 38%; (b) average heat rate for MECO-owned generation = 11,500 British thermal units (BTUs)/Net kilowatt hours (kWh); (c) BTU savings = 803,905–1,148,436 million (MM)BTU/year; (d) 5.825 MMBTU/bbl of distillate (diesel) fuel oil; and 21 MW installed capacity.

These gases are known to contribute to various undesirable environmental effects, including global warming and acid rain. Additionally, it has been shown that these gases are detrimental to human health and the health of other living organisms. In general, the elimination of these harmful pollutants result in reduced health costs and respiratory illnesses.

1.4.2.1. Reduced Pollutants during Operations–NEW

As of January 1, 2018, KWP II has generated 355,537 MWs of power used by Maui residents and businesses (see Figure 1.3). To produce this energy through fossil fuel combustion would have required approximately 701,256 bbls or 29,400,000 gallons of petroleum distillates. This amount of fossil fuel when combusted would have produced approximately 543,000,000 pounds of CO_2, 3,800,000 pounds of SO_2, and 990,000 pounds of NO_X. The amount of water conserved from not burning 29,400,000 gallons of fossil fuels so far is 167,200,000 gallons.

Table 1.6. Energy generated and used on Maui in Megawatt-Hours by Wind and Fossil Fuel Sources–*NEW*

Source	Maui Megawatt-Hours Generated per Year[1]					
	2012	**2013**	**2014**	**2015**	**2016**	**2017**
KWP II	28,501	44,748	69,480	65,878	80,196	66,734
KWP I	121,218	101,510	108,980	110,677	110,484	90,325
Auwahi	3,206	83,970	79,754	87,951	84,144	74,629
MECO (fuel)	943,216	847,296	805,844	715,785	704,389	720,807
Total	**1,096,141**	**1,077,524**	**1,064,058**	**980,291**	**979,213**	**952,495**
Wind total	**152,925**	**230,228**	**258,214**	**264,506**	**274,824**	**231,688**
Wind percent	**14.0**	**21.4**	**24.3**	**27.0**	**28.1**	**24.3**

[1] www.eia.gov, www.hawaiianelectric.com

1.4.3 Project Schedule and Timeline–*UPDATED*

The life of the Project is anticipated to be 20 years beginning in ~~July~~ January 2012, after which time the Applicant would arrange either to extend the life of the Project or remove the facilities. This amendment to the HCP and permits will not change the current life of the Project. The continuance of the Project's operation beyond 20 years would be subject to a renewal of KWP II, LLC's lease with the DLNR, as well as an extension of the term of this HCP, as it may be amended. Should KWP II, LLC discontinue the operation of KWP II during or after this 20-year period, the lease terms require that the turbines and other structures be removed and the site remediated and stabilized.

1.4.4 List of Preparers–*UPDATED*

The original HCP was prepared by Ling Ong, Ph.D.; Paul Sunby, B.S.; Ryan Taira, B.A.; John Ford, M.S.; Shahin Ansari, Ph.D.; Jaap Eijzenga, M.S; and Tiffany Thair, B.A., of SWCA Environmental Consultants as well as Perry White, MRP; Melissa White, M.A.; Julia Ham Tashima; and Makena White of Planning Solutions, Inc. Contributors on behalf of Kaheawa Wind Power II, LLC include Dave Cowan, Greg Spencer, and Robert Roy of First Wind Energy, LLC. Comments and guidance provided by Dr. Paula Hartzell, Dr. Scott Fretz, Sandee Hufana, and Lauren Goodmiller of DOFAW; James Kwon, Dawn Greenlee, Patrice Ashfield, and Jeff Newman of the USFWS; and members of the ESRC are gratefully acknowledged.

The amendment has been prepared by Mitchell Craig of TerraForm Power; SWCA's Amanda Ehrenkrantz and Jaap Eijzenga; and with review by Glenn Metzler and Afsheen Siddiqi of DOFAW and Diane Sether, Ph.D., of the USFWS.

1.4.5 Changes and Improvements That Have Affected Projected Take–*NEW*

The following sections explain why current take projections are higher than projected in the original HCP. The increases in projected take for the Hawaiian hoary bat and nēnē are due, at least in part, to improvements in compliance monitoring (see Section 1.4.5.1) and advances in take estimation and modeling methods (see Section 1.4.5.2. Projections of take through the remaining permit period have more certainty than previous projections because they are based on actual on-site monitoring data and were generated using the improved methods discussed below.

1.4.5.1. Compliance Monitoring

KWP II has voluntarily implemented a variety of measures since the Project began operation that have improved the ability to detect and accurately estimate fatality rates at the Project. Several of these measures have contributed to the increase in statistically projected take at the Project. Measures have included improved searcher efficiency (SEEF) using canine assistance, longer carcass retention (CARE) time due to trapping of scavengers, and increased visibility through vegetation management.

SEEF is a measure of searchers' ability to find downed wildlife and is expressed as the percentage of trial carcasses available that are found by searchers (see Appendix 2 for a SEEF trial explanation). Increasing SEEF reduces uncertainty, which means that estimates are likely to be closer to the actual mortality occurring in the searched area. Prior to 2015, all searches were conducted by human searchers walking linear transects laid out across the site, in keeping with standard industry practice.

In state FY 2015, in consultation with the USFWS and DOFAW, KWP II, LLC voluntarily initiated a 6-month study to compare the efficiency of canine-assisted searches to standard human searches (KWP II 2015). For small (bat-sized) dark-colored rat carcasses, the SEEF for humans searching was 34.7% compared to a canine-assisted SEEF of 93.9%. All other factors being equal, a SEEF of 34.7% means that for every bat found, at least two bats were assumed to have been missed by searchers (although see Appendix 27 for an explanation of expected fatality distribution and extrapolation of take from the portion searched). A higher SEEF can reduce the amount of uncertainty around the fatality estimate. SEEF trials are also conducted for medium- and large-sized birds (seabirds and nēnē) although generally, the efficiency for these size classes has always been high whether for human or for canine-assisted searching.

Following the canine trial, KWP II, LLC began using a trained canine and professional handler for all downed wildlife monitoring. SEEF for small bat-sized carcasses at KWP II in FY 2016 was 81.4%, 93.0%, and 95.3% in 2016, 2017, and 2018, respectively (see Figure 1.3; KWP II, LLC 2016, 2017, 2018). These rates include when humans conducted 43.9%, 14.1 %, 1% and 0 %of total searches made in FY 2016, 2017, 2018, and 2019 respectively, when canine-assistance was not available (KWP II, LLC 2016, 2017, 2018). KWP II will continue to use canine-assisted searching if downed wildlife monitoring is required.

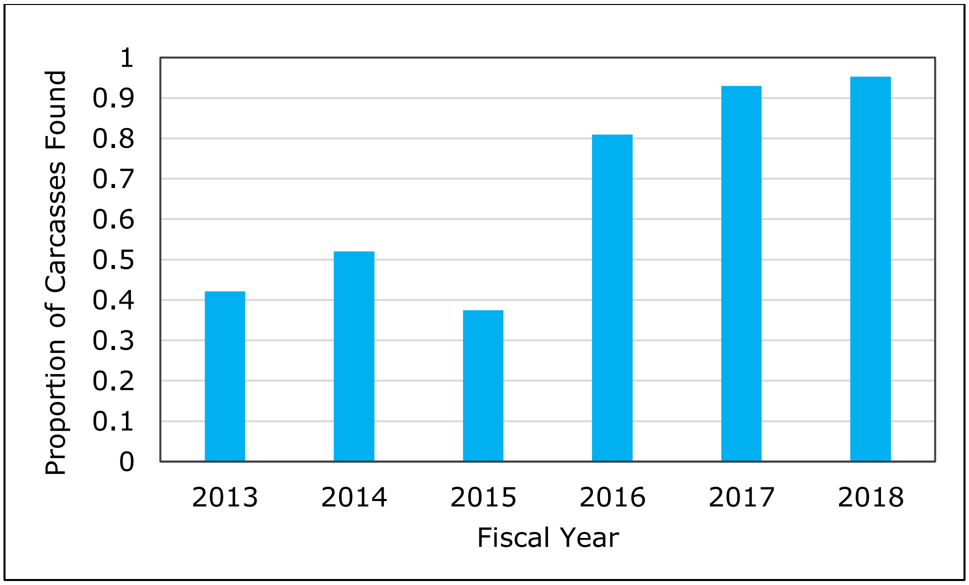


Figure 1.3. Searcher efficiency for small bat-sized carcass trials at KWP II in state fiscal years 2013 through 2018 (canine-assisted downed wildlife monitoring began in 2016).–*NEW*

If, while searching for downed wildlife, humans had consistently missed finding bat fatalities, one might have expected canine-assisted searching to have found disproportionately more bats; however, the number of bat fatalities estimated annually at KWP II since canine-assisted searching began did not increase (Figure 1.4).

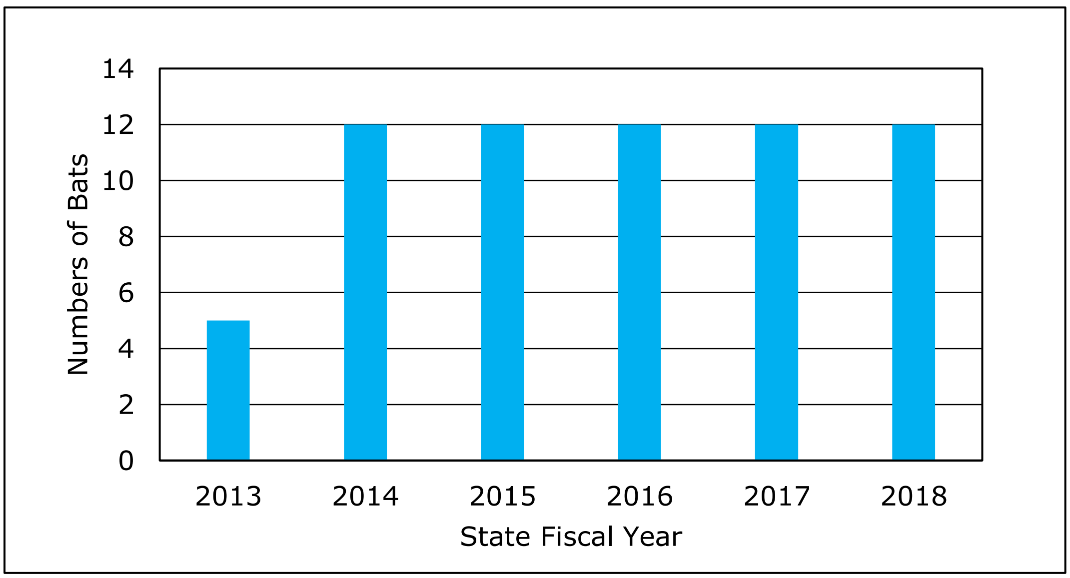


Figure 1.4. Total bat direct take at KWP II in state fiscal years 2013 through 2018 (estimated annually).–*NEW*

CARE, or carcass retention, is a measure of the rate of disappearance of downed wildlife due to scavenging by mongoose, rats, and cats, and dispersal by decomposition and wind (Appendix 28). Like SEEF, the CARE rate is one of the inputs used for take estimate calculations. Increasing the frequency of searches or lengthening the period that carcasses are present on-site increases the chances a carcass will be found and improves the accuracy of estimates by reducing the uncertainty that is created by a shorter CARE. In FY 2015, KWP II, LLC biologists began an intensive trapping program to reduce scavenger activity in the area and increase the chance that searchers (human or canine) can find downed wildlife (KWP II 2015). This program has been continued to date. Trials are conducted quarterly to continually reestimate CARE and account for changes that may vary over time.

The annual mean CARE did improve after scavenger trapping commenced (FY 2015) because carcass trials lasted longer (Figure 1.5).

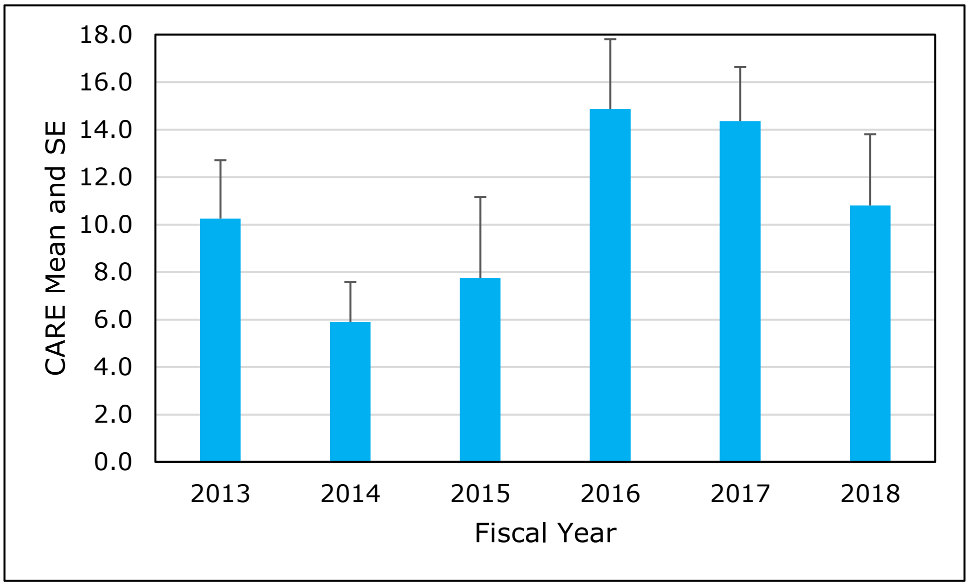


Figure 1.5. Mean and standard error of carcass retention (CARE) for bats at KWP II.–*NEW*

Ground visibility has been improved through removal of non-native shrub cover (primarily at KWP I) and regular mowing and weed trimming of grassy areas. With permission from DOFAW, in FY 2014, KWP II began periodically managing vegetation in searched areas to increase detectability of downed wildlife around turbines (KWP II 2014). Shorter vegetation increases human searchers' ability to see small carcasses and increases a dog's ability to move around and pick up scent. Prior to 2014, DOFAW had been reluctant to allow vegetation management due to concerns about nēnē disturbance. KWP II has worked closely with DOFAW to limit vegetation management to times when nēnē would not be disturbed.

1.4.5.2 Take Estimation, Modeling, and Uncertainty

Take estimation theory, modeling, and software have been evolving rapidly over the past 10 years, resulting in more accurate estimates and, importantly, greater confidence in estimates for agencies and project stakeholders (Huso 2008, 2011; Warren-Hicks *et al.* 2013; Huso and Dalthorp 2014; Dalthorp *et al.* 2014; Huso *et al.* 2015; Dalthorp *et al.* 2017). Inherent biases in estimation methods used prior to 2010 were not well understood in relation to wind-associated fatalities and thus their potential to both under- and overestimate take (depending on the method and inputs) was not always fully accounted for (Erickson *et al.* 1998; Huso 2008, 2010; Shoenfeld 2004; Warren-Hicks *et al.* 2013). Further, monitoring methods were not standardized and could vary considerably among projects. Estimation and monitoring methods have coevolved so that as biases were better understood, monitoring methods were improved and standardized to overcome the biases.

Also in this period, the USGS became a leader in the development and deployment of wind energy–specific statistical estimation methods and standardization has greatly improved (Huso 2008, 2010; Huso *et al.* 2012; Huso *et al.* 2015; and Dalthorp *et al.* 2017). The most current USGS application is called EoA software.

An important change from EoA Version 1.0 to Version 2.0 is: "The default **prior distribution** used for calculating the posterior distribution for M has been changed from uniform to an integrated reference prior, which is often referred to as the objective prior (Berger and others, 2012). In most cases, the two priors give the same posteriors. When they differ, the objective prior is more accurate in the sense that when $M*$ is calculated using the objective prior $P(M>M*)$ is closer to α than it is when the uniform prior is used (appendix B in Dalthorp *et al.* 2017). The difference is most noticeable when X is small, when the objective prior frequently gives a smaller $M*$ than does the uniform prior." (USGS 2017). The uniform prior distribution assumes that any number of fatalities might be expected before any data had been collected (i.e., from 0 to 200 fatalities). The objective prior distribution assumes a much smaller number of fatalities may occur before any data was collected. Our search results, especially for bats, tend to reveal no observed take; therefore, this change to Version 2.0 has reduced the estimated fatalities compared to Version 1.0 for the same input parameter values.

The USGS has provided improved guidance and standardized methods for generating these inputs (Huso *et al.* 2015;' Dalthorp *et al.* 2017).

As stated in the EoA (Version 2.0) user's guide (USGS 2017), "the software application is particularly useful in addressing whether the number of fatalities is below a given threshold and what search parameters are needed to give assurance that the thresholds were not exceeded. The software was designed specifically for cases where tolerance for mortality is low and carcass counts are small or even 0. The software addresses the general problem of estimating numbers of fatalities over an extended period using systematic counts of carcasses and adjustments of the carcass counts to account for imperfect detection. Imperfect detection may be due to any of several possible detection biases, for example: (1) search teams fail to find carcasses that are present in the searched area at the time of the search, (2) scavengers remove carcasses before searches are conducted, (3) carcasses fall outside the searched area, or (4) fatalities occur outside the monitored period. The overall probability of detection (*g*) is estimated primarily from results of field trials in which carcasses are placed at known locations within the searched areas at the site and monitored for retention times and for evaluating the efficiency of search teams in detecting carcasses that are not scavenged. Combining the number of carcasses (*X*) found in the systematic carcass searches with information about the detection rate, EoA estimates the total mortality (*M*) and quantifies the uncertainty associated with the estimation."

The probability of detection (*g*) can also be used to compare how likely a fatality will be found when total search area is changed from one period to the next. If an average of one bat is found annually with a *g* of 0.5, then when reducing the search area so that *g* becomes 0.25, we would expect to find an average of one bat every other year.

The measured variables and EoA software designated abbreviations (in italics) used as inputs for fatality estimation at KWP II are the following:

- Search interval (I): the number of days between search efforts at the WTGs.
- Start of monitoring: the date of the first search in a period being represented.
- Number of searches: determined by the search interval and the monitored period length.
- Spatial coverage (*a*): the fraction of the total number of carcasses expected to arrive in the searched area (from interaction with the WTGs or other structures associated with a wind farm). From the user guide: "The number of carcasses arriving at a given distance from a turbine tends to decrease with distance while the area increases so that an area nearer to a turbine generally accounts for more carcasses than does an area of equal size at a greater distance from a turbine. Thus, *a* should be a density-weighted proportion (dwp) of the area sampled (Huso and Dalthorp, 2014). When the number of carcasses of the target species is too small to model the relationship between distance and carcass density, a surrogate species is often used to estimate *a*. If no surrogate is available, then a mechanistic model or a model fit at a similar site is sometimes used." Spatial coverage essentially characterizes what portion of the total expected carcass arrivals around each WTG will never be found in areas not searched.
- Temporal coverage (*v*): the fraction of the total number of carcasses expected to arrive during the monitoring period. Year-round searching is complete (*v* = 1) temporal coverage.
- Observed take (*X*) is carcasses found by searchers only in the searched area.

- Searcher efficiency (SEEF) (*p*): from independent trials using surrogate carcasses to best represent the species whose mortality is being estimated. *p* represents the efficiency only for the first search of a carcass after the carcass arrival.
- Searcher efficiency (SEEF) after the first search (*k*): the decrease in search efficiency for a carcass not found on the first search but found (or not) on the second or later search after carcass arrival. *k* varies with carcass and searcher type (i.e., a larger size carcass may be found as easily on multiple successive searches as for the first search); a canine-assisted searcher may find a carcass as easily on subsequent searches as on the first search (or potentially even easier than the efficiency for the first search if a carcass decays and the smell becomes more pronounced and therefore easier for a canine to find).
- Carcass retention (CARE): The amount of time a carcass persists without being lost to scavenging or decay is modeled as a persistence distribution. The rate of carcass removal tends to change with time; therefore, with the input CARE trial results, four possible persistence distributions are fitted to the trial results and the best fit distribution is selected to represent the results. The distributions are characterized by shape and scale parameters.
- Assumed relative mortality rate (ρ or rho): if operations or ecological conditions change, the ρ parameter should be adjusted to reflect those changes, or ρ is assumed to be 1 for similar units of time (typically 1 year). For example, if minimization measures that are expected to reduce fatalities by 30% are implemented in year 3, then $\rho = 1$ for years 1 and 2, and $\rho = 0.7$ for year 3. Although the authors suggest reducing rho could be appropriate with increased minimization measures like low wind speed curtailment (LWSC), a reduction in rho with added or increased LWSC has not yet been approved in Hawai‘i.

To project take estimates to the end of the permitted period (20 years for KWP II), the detection probability (*g*) determined for the last period when input parameters were measured (2018) is assumed to be the same for each subsequent year in the future. The EoA software generates the year-by-year future estimated mortality and the twentieth-year estimate is used to determine if an existing permit may be exceeded in the future, and if so, what level of take would likely be requested for a permit amendment.

A significant advancement in modeling take has been the ability to generate estimates that have a corresponding level of statistical credibility. “Credibility” in this context is defined as the percent frequency at which the actual take was not more than the estimated value. Thus, 80% credibility means the actual take was likely to be at or below the estimated value 80% of the time, and, conversely, not more than the estimated value more than 20% of the time. A 100% credibility value means there is statistically no chance the actual take is higher than the estimated value. For a given observed take, an estimate generated at a higher level of credibility will be more conservative (i.e., higher) than an estimate at a lower level of credibility. Factors that contribute to uncertainty regarding the observed take, such as low SEEF and high scavenging rates, will result in a higher fatality estimate for a given level of credibility.

With the advent of statistical credibility the USFWS and DOFAW began requesting that take estimates be reported at an 80% credibility level, although there is no specific research supporting why this value is better than a higher or lower value. The suggested 80% credibility level is just considered more conservative than the 50% level. KWP II began all reporting to this standard in FY 2015. The purpose of this change is to provide a more conservative estimate of take (i.e., greater certainty that the estimated take level has not been exceeded by the Project). This one factor alone resulted in an increase in the estimated take and projection of estimated take for the 20-year permit period occurring at the site and therefore one reason a take permit amendment is requested.

Current take projections to the end of the permit period may in fact be conservative (i.e., somewhat higher than necessary). Take projections for the remaining 13.5 permit years for KWP II may be somewhat inflated because they are based on data accumulated over a period during which various monitoring improvements were implemented. Since future estimates include the variability as measured for the input parameters of monitored years, the future estimate includes the uncertainty characterized by the input variability. As additional years of monitoring are added to fatality estimates (and future projections are for shorter periods of time relative to current projections), the uncertainty will become less.

Data from the first 2 years of operation are more likely to have been affected by greater uncertainty (lower SEEF/shorter CARE). When the 80% credibility threshold is applied to the more uncertain data, the resulting estimate is adjusted upward to a greater degree than are the estimates from the next 4 years when uncertainty was reduced (higher SEEF/longer CARE). While the latter 4 years may better represent take going forward, the current projections include all 6 years of observed data. Going forward, as the proportion of data gathered using the improved methods increases, and if the input variables do not change appreciably, projections of future take will decline. For example, the 20-year projection of estimated bat take made in September 2015 when the ESRC reviewed the first draft of this HCP amendment was 80 bats; now the 20-year permit period projection is 38 bats.

If no additional bat takes are observed for the remaining permit period and the search conditions are similar throughout, the total take that will be the final estimate using EoA at the end of the 19.5 years of the permitted operations period will be 14 bats (or three more than the current permitted take). If one bat is found every other year (the average number of bats found for the first 6 years of operations) for the remaining 13.5 years (seven hypothetically observed bats), the total take estimate using EoA at the end of the 19.5 years will be 39 bats. Given no bats have been found since 2014, the projected take estimate of 38 adults bats is considered conservative.

1.4.5.2.1 Assumptions Made in the Take Estimation Calculation Inputs

Although the permit term is considered to be 20 years, actual operations began in July 2012, and the permit term ends January 2032. Therefore, all take projections are for 19.5 years. Take projections were finalized May 1, 2018.

The expected density distribution by distance from the turbines for bats falling to the ground after being struck informs the value of the total spatial coverage (*a*) at KWP II. As explained previously, *a* is the portion of the total fallout distribution actually searched. The density distribution by distance from the turbines is calculated using the distribution of bats actually found at KWP I and KWP II (Appendix 27). As of May 1, 2018, 14 bats have been found and are used to calculate the percentage of the total distribution that are expected to fall in each successive 10-m-wide band around all the turbines. We assume that 14 bats are an adequate sample size to reasonably determine these percentages. The distribution modeled using ballistics theory for short turbines and bats by Hull and Muir (2010) is similar compared to the distribution we have established with bat fatalities found at both KWP sites (Figure 1.6). The turbines at KWP I and KWP II would be classified as “small” by Hull and Muir.

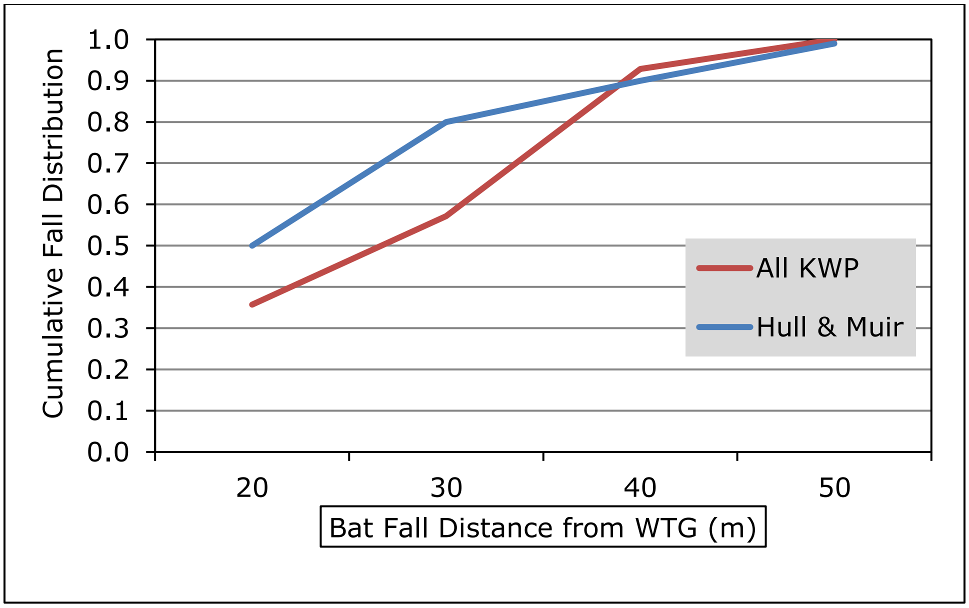


Figure 1.6. Comparison of fall distribution for all KWP bats and Hull and Muir (2010) bats at small turbines.–*NEW*

As of May 1, 2018, 30 nēnē have been found at KWP I and KWP II and are used to calculate the percentage of the total distribution that are expected in each successive 10-m-wide band around all of the turbines. Although no nēnē fatalities were found beyond 70 m when the search plots at KWP I were between an 80 and a 100-m radius from the turbines (FY 2006 through FY 2010), the search plots at KWP II have never been greater than a 75-m radius from the turbines. Therefore, we also added six "hypothetical fatalities" beyond 70 m (three between 71 and 80 m, two between 81 and 90 m, and one between 91 and 100 m) to ensure the total distribution is not biased or skewed closer to the turbines. We assume that 30 nēnē plus six hypothetical nēnē are an adequate sample size to reasonably determine where nēnē fatalities will fall relative to the turbines. The distribution modeled for short turbines and large birds (nēnē) by Hull and Muir (2010) is similar compared to the distribution we have established with nēnē fatalities found at both KWP sites (Figure 1.7).

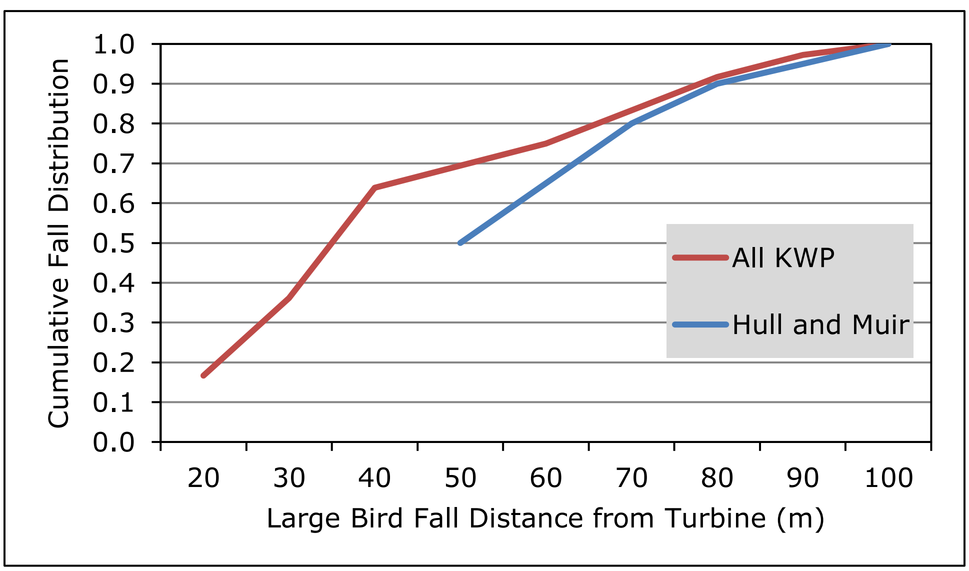


Figure 1.7. Comparison of fall distribution for all KWP nēnē and Hull and Muir (2010) large birds at small turbines.–*NEW*

The observed take input to the estimation calculation for bats and nēnē includes all take found within the search area during a formal search or within the search area but not on a formal search *if* the SEEF is 75% or higher and *k* (described above) is 0.7 or higher at the time a take is found, according to the USFWS Protocol for Incidental Carcass Finds (Appendix 34). Bats or nēnē takes that are found outside of the search area are not included as observed takes. These incidental takes are accounted for in the estimation calculation as the unobserved take that is assumed would have been found if the search area were larger. As of June 2018, there have not been any bats or nēnē found incidentally inside or outside the formal search area at KWP II. Occasionally, SEEF trials carcasses that are put out for searchers to find are scavenged before the searcher gets to the location of the carcass. As soon as a search is concluded, the SEEF proctor goes to the location of the carcass to confirm that the carcass was either missed by the searcher (the carcass is still present to be found) or was no longer available to be found (scavenged). SEEF carcasses not available to be found are not included in the SEEF trial results used as inputs to the estimation calculations. Carcass scavenging rates are formally tested during CARE trials.

The input value for the *k* parameter (SEEF percentage found after the first search [*k*]) is assumed to be 1 for both bats and nēnē for all canine-assisted searches—that is, at least for the second search made after a carcass was placed and was considered still available to be found, the canine is expected to have the same chance of finding a carcass on the second search even after it has degraded somewhat from decay and weathering. It is likely that a canine could have an even better chance of finding a carcass once it begins to decay and creates even more scent for the canine to detect (*k* would then be greater than 1). Also, since SEEF results for canines are typically very high, there are rarely any SEEF trials that are not found on the first search. For human-only searches, the *k* value for bats is assumed to be 70% (there is a 70% chance the carcass would still be available to find on the second search) and for nēnē is assumed to be 100% (nēnē are large and are still easily visible even when scavenged).

The density-weighted proportion of the total possible fatality distribution (i.e., spatial coverage (*a*)), represents the proportion of all fatalities expected that fall in the formal search area that is smaller than the area the total possible fatality distribution encompasses. We assume the distribution around the turbines is uniform. It is reasonable to believe fatalities are more likely to be blown downwind of the turbine as they fall if there were no other force than gravity propelling a carcass, especially when winds are strong. But we are not able to determine what force is imparted to a flying bat or bird from the impact of a turbine blade tip spinning at over 150 miles per hour (mph) or at what stage of the blade rotation (moving upwards, downwards, or sideways) the bird or bat is struck. Hull and Muir (2010) indicated that "after an initial impulse and deposition of velocity (taken from the contact point of the rotor), our projectile is assumed to be inert. Therefore, the only forces acting upon it are those of wind drag and gravity." But they also suggest, "A dominant wind direction, or other relation between rotor direction and likelihood of animal strike, will affect the shape of the fall. As the predominant wind strength increases, we expect the circular fall zone to contract to an ellipse aligned in the direction of travel."

1.4.5.3 Evolution of Bat Detection Equipment and Assessment of Bat Activity

Hawaiian hoary bat activity at KWP I and KWP II has been monitored using acoustic bat detectors installed at various locations around the sites on a more-or-less continual basis since 2008; however, bat detection technology has evolved considerably during the development and operation of KWP I and II, resulting in greater rates of bat detection over time and a more sophisticated characterization of when and under what conditions bats are most likely to be at risk of turbine collisions. Had these technology improvements existed at the time the initial HCPs were being developed, the resulting estimates of projected bat take would likely have been assumed to be higher. It is also possible, but difficult to prove, that bat activity did actually increase at both sites after the KWP II turbines were built and began operations.

Bat detection studies conducted by KWP I biologists in state FYs 2010 through 2012 (before KWP II began operation) used Titley AnaBat™ SD 2 detectors. Although state-of-the-art at the time, these earlier detectors required supplemental housing for weather protection. Incoming sound had to be reflected into the protected microphone, diminishing detector sensitivity and call quality. Beginning in 2013, both projects voluntarily transitioned to the more weatherproof Wildlife Acoustics SM2BAT+™

technology (KWP II 2013). These detectors are relatively waterproof and use better quality microphones, and thus can better represent the timing and frequency of bat activity at the sites. Along with the transition to new technology additional detectors were added on the ground as an adaptive management measure at KWP I in 2013. Bat detectors were also added to turbines at the nacelle height to better understand bat activity aloft.

The substantial relative increase in bat detections that resulted from the changes in detector type are evident in the timing and frequency of detections at both sites (Figures 3.5 and 3.6). Detectors deployed at KWP I and KWP II from 2008 through 2010 detected bats during an average of 1% of total detector nights (a range of 0% to 3% for 21 specific locations), at seven of 21 locations (30%) and only during 7 months (58%) of the calendar year (KWP II HCP).The location with the highest detection rate of all seven detectors deployed at KWP I and KWP II during FY 2010 (detector location 14 or 14G in annual reports) recorded in an annual detection rate of 3% of total nights (KWP I 2010). Three of the seven detectors recorded no activity during FY 2010. Rates of detection recorded at detector location 14 during FYs 2011, 2012, and 2013 were 7%, 4%, and 2%, respectively (KWP I 2011, 2012; KWP II 2013). Seven of nine (78%) detector locations at KWP I and KWP II detected bats during 8 of 12 months (75%) in FY 2011 and FY 2012.

In FY 2014, KWP II and KWP I began replacing the older bat detectors with newer, more sensitive detectors (KWP II 2014). In FYs 2015, 2016, and 2017, a new replacement detector at the same location cited above (detector location 14G), detected bat calls on 13%, 8%, and 11% of total detector nights, respectively (KWP II 2015, 2016, 2017).

All eight detectors deployed on the ground at KWP II in FYs 2015, 2016, and 2017, detected bats at an average annual nightly rate of 7%, 8%, and 8%, respectively (range: 2% to 13%) (KWP II 2015, 2016, 2017). Bats have been detected in every month of the year detectors were deployed in FYs 2015, 2016 and 2017.

1.4.5.4 Low Wind Speed Curtailment Changes

While most of the above-mentioned changes (maintaining vegetation to improve SEEF, implementing predator control, more conservative and appropriate fatality estimation, and implementing canine-assisted searches to replace human searching) are believed to have contributed to increasing the statistical projections of bat take, LWSC, expected to decrease bat take, was also implemented, extended, and increased since operations began (see Sections 4.2.2 and 4.2.3 for an explanation why LWSC is implemented). KWP II committed to voluntarily implement LWSC up to 5.0 meters per second (m/s) beginning at the start of operations (July 2012) as a minimization measure under the approved HCP. The initial period of LWSC was April 1 through November 30, sunset to sunrise. This period coincides with typical nocturnal bat activity and the months when KWP biologists had recorded higher bat activity using ultrasonic bat detectors (KWP II 2014).

The first bat fatality at KWP II occurred March 13, 2013, and as an adaptive management measure, the LWSC period began March 14, 2013 and was extended to begin the following year on March 1, 2014. But a third bat fatality at KWP II was subsequently documented on February 26, 2014, so LWSC began immediately (February 27, 2014) and was scheduled to begin the following year on February 15, 2015. After a bat fatality was documented at KWP I on December 14, 2013, the LWSC at KWP II was extended the following year from November 30 through December 15. Currently, low wind speed curtailment is implemented year-round by raising the cut-in speed of KWP II's wind turbines to 5.5 m/s between sunset and sunrise.

In addition to extending the calendar period of curtailment, KWP I and KWP II also increased LWSC to 5.5 m/s in August 2014 (from 5.0 m/s) as an adaptive management measure to further reduce bat fatalities. Since then, in 4 years, no bat fatalities have been observed within the KWP II search area. The decrease in the rate of observed bat take occurred during the period when KWP II began canine-assisted searches, which increases confidence that the observed reduction in fatalities was representative of the actual fatality rate at the time. But in July 2015, the search area was reduced at all turbines relative to before then, which would necessarily have also reduced the potential number of observed fatalities available to find within the searched area if the take rate remained similar to the rate before July 2015. Nonetheless, these changes are accounted for in the EoA take estimate.

1.4.5.5 Observed Fatality Rate Changes

Although the changes in methods described above have undoubtedly contributed to a higher projected take, it is also possible that bat activity near the turbines changed and led to more fatalities occurring than originally projected. Importantly, the rate of bat take projected in the KWP II HCP was based in part on the rate of take that had occurred over the initial 5 years at the 20-turbine KWP I site; the rate of take observed at KWP I increased considerably after the initial 5-year period.

The total observed (unadjusted) bat take at KWP I during the first 5-year period was two bats, which yielded an estimated total take of six bats (KWP I 2011). Accounting for indirect take (lost offspring) would have added the equivalent of approximately one adult bat, for a total estimated take of seven bats over 5 years, or 0.07 bat per turbine per year.

The HCP for the 14-turbine KWP II project relied on these findings and considered indirect take and a reduced fatality rate due to LWSC. LWSC was not implemented at KWP I until August 2014. On this basis, the rate of take at the highest tier level (Tier 2) was projected to be no higher than 0.04 bat per turbine per year for 20 years, or 11 adult bats total (KWP II 2014).

In the first two fiscal years (FYs 2013 and 2014) of operations at KWP II, the observed take at KWP I and KWP II totaled nine bats, or 0.13 observed bat per turbine per year (for 34 turbines), approximately two times the observed annual fatality rate per turbine at KWP I during the first 5 years before KWP II began operations.

One possible explanation for an increase in bat fatalities during this period could be lower overall average wind speeds during 2013–2015 (Figure 1.~~5~~8 and Table 1.7, unpublished TerraForm Power wind turbine anemometer data). Annual variation in average wind speeds is illustrated by the average 10-minute interval nighttime wind speeds at Turbine 1 at KWP I. Averaged wind speeds were lower in years 2013–2015 compared to the 3 years before. Whether these differences are significant, and whether they explain differences in observed bat fatality rates, is not known.

Nonetheless, bats are thought to be less likely to fly at turbine height along exposed ridges during windier conditions, preferring to forage in the sheltered ravines and valleys. And mainland studies have documented reduced bat fatalities when turbines are set to begin operating at higher wind speeds (Arnett *et al.* 2013). But Gorresen *et al*. (2013) in a 5-year occupation study on Hawaiʻi Island did not find evidence that Hawaiian hoary bats were less likely to occur in areas with above-average wind speeds.

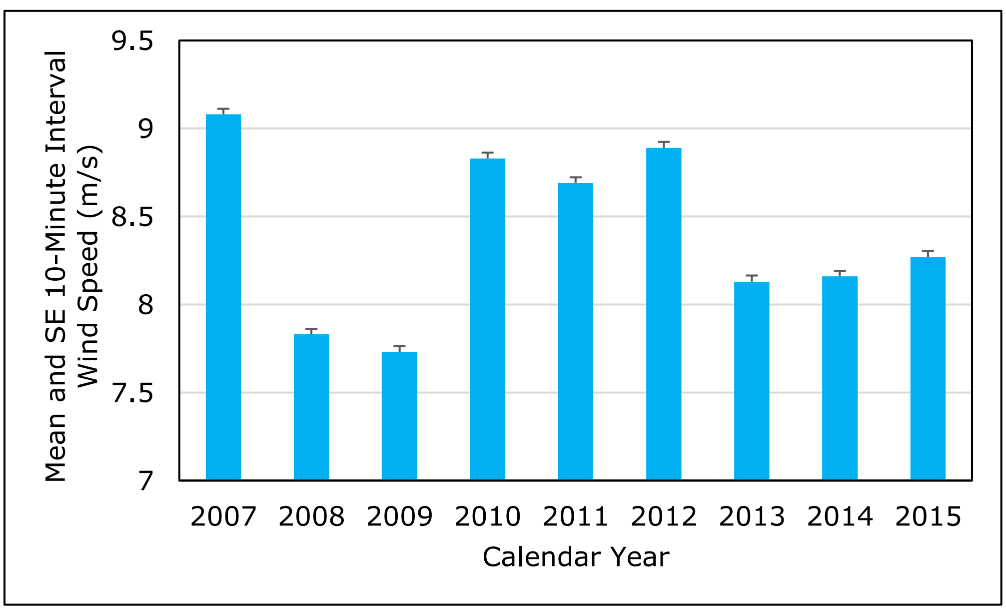


Figure 1.8. Mean and standard error of wind speed in meters per second (averaged every 10

minutes) per calendar year (2007–2015) at KWP I Turbine # 1 at night from 7 p.m. to 6 a.m.–*NEW*

Table 1.7. The Minimum, Maximum, and Standard Deviation of Wind Speed in Meters per Second (averaged every 10 minutes) and Numbers of 10-Minute Intervals (N) for Figure 1.5–*NEW*

Year	Minimum	Maximum	Standard Deviation	N
2007	0.05	21.34	5.00	24455
2008	0.05	18.92	4.93	24522
2009	0.05	21.27	5.27	24388
2010	0.05	24.06	5.16	24388
2011	0.05	21.95	5.08	24388
2012	0.11	20.29	5.31	24455
2013	0.02	22.86	5.45	24388
2014	0.19	20.47	4.84	24456
2015	0.13	20.43	5.31	24389

1.4.5.6 Summary

In summary, a combination of factors may have contributed to the increase in projected bat fatalities at KWP II, including improvements in compliance monitoring, more conservative assumptions in calculating take estimates, lower average wind speeds in 2013 through 2015, and the possibility that circumstances changed causing bats to be at greater risk of collision after KWP II was in operation. At the same time, increases in LWSC beginning in August 2014 appear to have led to a lower take rate at KWP II and is now beginning to offset the effects of the above factors.

If increasing LWSC from 5.0 to 5.5 m/s is the primary cause for the decrease in rate of take during the last 4 years, and the decreased rate of take continues to the end of the permit period, the take estimated at the end of the permit period will likely be much lower than the 38 bats requested in this amended HCP.

It appears that the pre-operations assumption that the take rate of nēnē per turbine would be lower than that recorded at KWP I was not correct. At this point, the take rate and estimated projected take per turbine at KWP II is approximately similar to the take rate at KWP I. Currently, the projected take rate for the permit period is 3.14 nēnē per turbine (44/14 = 3.14) and for KWP I is 3.20 nēnē per turbine (64/20 = 3.2).

2.0 DESCRIPTION OF THE HABITAT CONSERVATION PLAN

2.1 Purpose of this Habitat Conservation Plan–*UPDATED*

On May 8, 2015, KWP II, LLC submitted a request to the USFWS and the Hawai'i DLNR to amend ITP TE-27260A-0, dated January 3, 2012, and ITL-15, dated January 5, 2012. The requested amendment would increase the take authorized under the permits for Hawaiian hoary bat and nēnē. Upon approval of the ITP/ITL amendment, changes to the KWP II HCP are effective. This document (the HCP amendment) reflects the revisions needed to conform to the ITP/ITL amendment.

The construction and operation of the KWP II wind energy generation facility could adversely impact four species protected under the ESA and HRS 195-D, and other federal and state laws and regulations. These species are the federal and state-listed endangered Hawaiian petrel; the threatened Newell's shearwater; the endangered nēnē, or Hawaiian goose; and the endangered Hawaiian hoary bat (collectively referred to as the Covered Species). These species have the potential to collide with the stationary WTGs and other facilities or be struck by the moving WTG rotors, resulting in injury or mortality. These species also may collide with the temporary and permanent met towers, the guy wires supporting the temporary met towers and overhead collection lines; they could also be struck by vehicles and construction equipment during construction and operation.

The Hawaiian petrel ('ua'u) and the Newell's shearwater ('a'o) are endangered tropical Pacific seabirds that are endemic and nest only in the Hawaiian Islands (American Ornithologists' Union 1998). The nēnē is the rarest species of goose and is endemic to Hawai'i. The Hawaiian hoary bat ('ōpe'ape'a) is an endangered mammal unique to Hawai'i. These species are protected because of ongoing threats to their survival. For the seabirds, threats are posed mainly by predation by introduced mammals and human-created hazards; for the goose and bat, threats are assumed to largely stem from loss of habitat, although for bats there is no research to date demonstrating a negative effect on the population from loss of habitat, nor is there research that demonstrates habitat has been "lost." Considering that bats choose prey and use trees that are not native suggests that the Hawaiian hoary bat may have been able to adapt successfully to changing conditions.

Pursuant to ESA Section 10(a)(1)(B), as amended, and HRS 195-D, an HCP is required to accompany application to the USFWS for an ITP and the State of Hawai'i for an ITL. Upon issuance of the amended ITP and ITL, KWP II, LLC will be authorized for the additional incidental take for Hawaiian hoary bats and nēnē in connection with the operation of the proposed wind energy generation facility. The purpose of this HCP amendment is to make supportable determinations as to the potential impact that the wind energy generation facility could have on the Hawaiian hoary bat and nēnē; to discuss alternatives to amending the ITP and ITL and therefore increasing take levels; to propose appropriate efforts to minimize, and monitor for any impacts of take and mitigate (offset) those impacts to the maximum extent practicable; to ensure funding for the completion of these efforts; and to provide for adaptive management and adjustment of the above measures as determined necessary by the USFWS, DOFAW, and the ESRC during this HCP amendment's implementation.

KWP II, LLC is proud to play a role in increasing Maui's renewable energy portfolio and in reducing the island's dependence on imported fossil fuels. Through the successful implementation of this HCP amendment, and in keeping with the Project's other environmental benefits, the Applicant will offset ~~any~~ negative impacts to the Covered Species to the maximum extent practicable and provide a net conservation benefit to these four species.

2.2 Scope and Term–*UPDATED*

The original HCP, dated December 2011, and this HCP amendment seek to offset the potential impact of the wind energy generation facility on the Covered Species with measures that protect and perpetuate these species island-wide and statewide. This amendment will not change the original 20-year permit term (expires January 2032) throughout which this HCP amendment would be in effect. With monitoring and review by the USFWS and the DLNR, the provisions for adaptive management allow mitigation of project impacts to be adjusted appropriately. Accordingly, this HCP amendment includes provisions for post-construction monitoring and adaptive management to allow flexibility and responsiveness to new information over the life of the Project. Monitoring and adaptive management are coordinated with USFWS and the DLNR, as further detailed in Chapter 7.

2.3 Surveys and Resources–*UPDATED*

The following sources were used in the preparation of this HCP amendment:

General information on the site's physical environmental setting was summarized from the *Kaheawa Wind Power II Final Environmental Impact Statement* (Planning Solutions Inc. 2010). Additional general information on the Project and site was obtained from the HCP and EA documents previously prepared for the KWP I facility. Information on endangered species occurrence in the project area and documented take at the KWP I facility was obtained from various site-specific studies conducted prior to and since the KWP I facility commenced operation. These sources include the following:

- Studies completed in support of the KWP I and KWP II HCPs
- Annual reports documenting compliance with the HCP and status of ongoing post-construction take monitoring, research and mitigation, and on-site acoustic monitoring for bats at the KWP I and KWP II facilities
- USGS EoA estimation software and guides for Version 1.0 (Huso *et al.* 2015) and Version 2.0 (Dalthorp *et al.* 2017)
- Hawaiian Hoary Bat Guidance Document (DOFAW 2015)
- An invertebrate survey of the project area that Mike Severns conducted in September 2009 (Appendices 9 and 17) to investigate the status of protected Hawaiian snails (*Achatinella* spp.) and other native invertebrates in the project area
- A botanical survey of the proposed KWP II project area that Robert Hobdy conducted in August 2009 and January 2010 (Appendices 7 and 15). The survey reports confirm that no rare, threatened, or endangered flora occurs in the project area
- An archaeological inventory survey and cultural impact assessment of the proposed KWP II lease area prepared by Rechtman Consulting LLC (Rechtman *et al.* 2009). The two reports demonstrate project compliance with the NHPA and document the fact that no historic, archaeological, or cultural resources are expected to be adversely impacted by the project. Details are provided in the FEIS (Planning Solutions, Inc. 2010)
- ABR Inc. reports documenting passage rates and modeling collision probabilities to estimate passage rates and rates of take for the KWP II facility (Appendices 3, 13, and 23).
- Seabird colony surveys to establish potential seabird mitigation sites and a proposed seabird mitigation plan (Appendix 22)
- Modeling of seabird productivity to guide the implementation of seabird mitigation measures (Appendices 21, 24, and 25)

In addition to site-specific surveys, staff from KWP II, the USFWS, and the DLNR provided unpublished information, data, and reports to ensure that all available resources could be considered and evaluated in the preparation of this HCP amendment. Continued coordination with USFWS and DLNR biologists and KWP I staff also greatly contributed to the preparation of this HCP.

3.0 ENVIRONMENTAL SETTING

This chapter provides an overview of the existing environment in the KWP II project area. The discussion pays special attention to the aspects of the environment that may be directly affected by construction and operation of the proposed wind energy generation facility. The physical setting of the Project is described in detail in the FEIS (Planning Solutions, Inc. 2010).

3.1 Location and Vicinity–*NO CHANGE*

The KWP II project is located on the southwestern slopes of the West Maui Mountains. The lowest of the proposed WTGs is approximately 0.8 mile inland from Honoapiʽilani Highway along the existing access road; the uppermost is approximately 2.1 road-miles inland. The settlements nearest the proposed KWP II project area are Olowalu, which is over 5 miles (8 km) to the southwest, and Māʽalaea, which is approximately 1.5 miles (2.4 km) to the east of the nearest WTG (both are straight-line distances).

3.2 Land Use Designation–*NO CHANGE*

The KWP II project area is in the General subzone of the State Conservation District, as established and regulated by 205 HRS. Lands within the conservation district are typically used for protecting watershed areas; preserving scenic and historic resources; and providing forest, park, and beach reserves [205-2(e)]. The entire project area is owned by the State of Hawaiʽi. As with other conservation district lands, the two parcels on which project-related work would be done are not subject to any County of Maui zoning or community plan designations or restrictions.

3.3 Topography and Geology–*NO CHANGE*

The proposed WTGs would be constructed on the lower part of a broad interfluve between Manawainui Gulch on the west and Malalowaiaʽole Gulch on the east. The proposed baseyard (substation, BESS, and support facilities) would be constructed in Kaheawa Pastures, adjacent to the upper electrical transmission corridor. Kealaloloa Ridge, another broad interfluve, lies immediately northeast of Malalowaiaʽole Gulch and separates the proposed facilities from the isthmus of Maui to the east. The gulches are steep and rocky. Several small puʽu are present in the area, including Puʽu Lūʽau, which is near the uppermost of the two existing MECO transmission line corridors at an elevation of about 2,300 feet (701 m) above mean sea level (msl).

The ground slope along the length (i.e., the mauka-makai axis) of the area where the WTGs would be constructed varies but averages about 14%. The WTGs and other facilities would be constructed on an interfluve with cross-slopes that are variable but typically are no more than 2% to 3%.

The project area lies on the flank of the extinct West Maui volcano, which evolved through shield (1.6 to 2.0 million years ago), post-shield (1.2 to 1.5 million years ago), and rejuvenated stages. While each of the flows was relatively thin, the accumulation during each stage was thousands of feet thick. Nearly a half-million years passed between the post-shield and rejuvenated phases with no evidence of volcanic activity. The rejuvenated-stage eruptions involved several small cones and ended about 385,000 years ago. The oldest of the small cones is Kīlea, which lies a short distance inland from Olowalu on the southwest side of West Maui. The youngest cone, Puʽuhele, lies approximately 1.6 miles (2.5 km) north of Māʽalaea along the road to Wailuku. There are no known unique or unusual geologic resources or conditions in the area.

3.4 Soils–NO CHANGE

Soils in the area where the proposed WTGs would be constructed are exclusively characterized as rock lands (rRK) by the Natural Resources Conservation Service (Foote *et al.* 1972). This substrate consists of thin soils formed from gray trachyte lavas of the Honolua Series, which overlay the foundational lavas of the West Maui volcano. These lavas weather to platy gray blocks that extend across the entire ridge. Kaheawa Pastures, where the new baseyard would be constructed, is mostly underlain by deep, well-drained volcanic soils that transition into the steep, rocky gulches to the east, south, and west of the project area. Table 3.1 lists the characteristics of the major soil types that occur in the KWP II project area.

Table 3.1. Characteristics of Soil Types within the Project Area–*NO CHANGE*

Soil Type	Slope (%)	Permeability	Runoff	Erosion Hazard	Land Uses
Nāʽiwa silty clay loam	3–20	Moderately rapid	Medium	Moderate to severe	Pasture, woodland, and wildlife habitat
Oli silt loam	3–10	rapid	Medium	Moderate	Pasture and wildlife habitat
Rock land	–	–	–	–	Pasture, wildlife habitat, water supply, and urban development

Source: General Soil Survey of Hawai'i (Foote *et al.* 1972).

3.5 Hydrology and Water Resources–*NO CHANGE*

Average annual rainfall in the general project area ranges from less than 15 inches (38 centimeters [cm]) per year at the Honoapiʽilani Highway/site access road intersection to slightly over 40 inches (102 cm) per year at the uppermost of the existing KWP I WTGs. The area where the proposed WTGs would be constructed is quite arid, with annual rainfall totaling only about 12 to 20 inches per year. Most of the rainfall occurs during the winter months (more than 80%) from November through April (Planning Solutions, Inc. 2010).

The land on which the proposed WTGs would be developed consists of rocky ridges; the proposed KWP II baseyard is on grasslands near the middle of the existing KWP I wind farm. There are no wetlands or other aquatic habitats (Hobdy 2004a, 2004b, 2006a, 2006b, 2009). No perennial streams flow through the area, although storm runoff is present in Malalowaiaʽole Gulch, just to the east of the proposed WTGs, during rainy periods. On-site drainage is in a southeasterly direction toward Malalowaiaʽole Gulch and the Pacific Ocean.

The State of Hawaiʽi Commission on Water Resource Management (CWRM) (letter from CWRM to Perry White, March 14, 2008) has determined that Manawainui Gulch does not have sufficient water to support in-stream uses. Therefore, it is not considered a stream and is not subject to CWRM regulation. The U.S. Army Corps of Engineers (USACE) concluded that the KWP I project (including the access road along which the proposed WTGs are located) is entirely within an upland area and does not contain or convey waters of the U.S. subject to authorization by USACE permit (Young 2004).

The project area is located over the Ukumehame Sector of the Lahaina Aquifer (Aquifer Code 60206 as designated by the CWRM). The estimated depth to basal groundwater varies throughout the project area and is likely to be approximately 1,500 to 2,500 feet (457 to 762 m) below the surface. Groundwater likely flows in a southerly direction. Perched groundwater may also underlie the project area (VEC 2005). The KWP II project area is located mauka of the Underground Injection Control (UIC) line, which is the designated boundary that divides protected inland areas situated over drinking water sources from seaward areas located over nonpotable groundwater.

3.6 Terrestrial Flora–*NO CHANGE*

In pre-contact times, the area on which the proposed facilities would be constructed is believed to have been entirely covered with native vegetation of low stature, with dry grass and shrub lands below and mesic to wet windblown forests above. Native Hawaiians made some uses of forest resources here and had a cross-island trail cresting the ridge at 1,600 feet in elevation (Hobdy 2006a). This trail was upgraded during the mid-1800s and used as a horse trail to Lahaina. It was reopened in recent years and is the present Lahaina Pali Trail (Hobdy 2006a).

Cattle ranching in the area began in the late 1800s and continued for over 100 years. During this time, grazing animals consumed most of the native vegetation, which was gradually replaced by hardy non-native weed species. During the 1950s, MECO installed high-voltage transmission lines and maintenance roads through this area. Increased traffic brought more disturbances and weeds (Hobdy 2006a). Fires became more frequent, further eliminating remnant native vegetation (Hobdy 2006a). Grass and weed species have proliferated since cattle grazing ceased, creating a heightened fire hazard. A large fire swept across the mountain in 1999 consuming more than 2,500 acres (1,012 ha), including most of the project area. Another fire burned the same area in September 2006, scorching about 75% of the project area and affecting nearly 4,000 acres (1,619 ha) of rangeland in the adjacent region.

In the 2009 survey of the KWP II area, Hobdy (2009) identified 62 plant species, 15 of which are native to the Hawaiian Islands. During the supplemental 2010 survey, a total of 57 species were identified. This 2010 survey documented 16 native species, nine of which were not recorded during the 2009 survey. Thus, the entire KWP II area contains 24 plants native to the Hawaiian Islands; 15 of these are endemic and nine are indigenous (Appendices 9 and 15, Table 3.2). No federally or state-listed threatened, endangered, or candidate plant species were found during either survey (Hobdy 2009, 2010).

Kalamalō (*Eragrostis deflexa*), which was recorded as rare throughout the project area by Hobdy in August 2009, was presumed extinct in the early 1990s but has since be documented on West Maui, Lānaʽi, Molokaʽi, and Kahoʽolawe. Based on the statewide distribution of this native grass, the species is not likely to be listed as federally endangered (Hobdy 2009a).

Six populations of kalamalō were recorded within the project area along the rocky edges of Manawainui and Malalowaiaʽole Gulches in August 2009 (Hobdy 2009a). These populations were affected during the fire that swept through the area in June 2010. Currently, two clumps of kalamalō are known in the northern portion of the project area near WTG 2 along the steep edges of Manawainui Gulch and two additional discrete clumps occur farther makai in the rocky crevices and outcroppings along Manawainui Gulch. All individuals were observed just outside of the project area on the steep outer portions of the gulch, making them inaccessible to foot and vehicular traffic. Each cluster ranges between 6 and 10 feet (2 and 3 m) in size.

The vegetation in the KWP II project area is mostly grasses and low-growing shrubs, with occasional small trees in the wetter gullies. The most abundant species in the project area is buffelgrass (*Cenchrus ciliaris*), which proliferated after the fires in 1999. Other common species in the vicinity of the proposed WTGs are natal redtop (*Melinis repens*), ʽilima (*Sida fallax*), ʽuhaloa (*Waltheria indica*), lesser snapdragon (*Antirrhinum orontium*), and Jamaican vervain (*Stachytarpheta jamaicensis*). In the two small areas of the existing KWP I area proposed to be developed under Alternative 1 and within the proposed trenching corridor, the most common species include molasses grass (*Melinis minutiflora*), ʽūlei (*Osteomeles anthyllidifolia*), lantana (*Lantana camara*), natal redtop, and ʽaʽaliʽi (*Dodonaea viscosa*).

Of the 24 native plant species documented on-site, 15 are endemic and nine are indigenous to the Hawaiian Islands (see Table 3.2). The botanical surveys indicate that native plant species are most prevalent in the rocky habitat bordering Manawainui and Malalowaiaʽole Gulches (Hobdy 2009a). These habitats are the most protected from grazing and fire. The three hardiest species—ʽilima, ʽuhaloa, and ʽaʽaliʽi—are also present on the flatter grassy ridgetops. Native vegetation is less prevalent at the lower, drier parts of the area where fires have more recently occurred (Hobdy 2009b). Most of these native plants are common at Kaheawa and throughout the main Hawaiian Islands. Only one species found within Alternative 1, *Bidens micrantha*, is found only on Maui and Lānaʽi but is common in West Maui (Hobdy 2010).

Table 3.2. Native Hawaiian Plants Observed in the KWP II Project Area by Hobdy (2009)– *NO CHANGE*

Scientific Name	Common Name	Status[1]	Abundance (at site)[2]
FERNS			
Dennstaedtiaceae (Bracken family)			
Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) R.M. Tryon	kilau	E	rare
Pteridaceae (Brake fern family)			
Doryopteris decipiens (Hook.) J. Sm.	kumuniu	E	rare
MONOCOTS			
Cyperaceae (Sedge family)			
Carex wahuensis C. A. Meyen subsp. *wahuensis*	--------------	E	uncommon
Cyperus phleoides Nees ex Kunth subsp. *phleoides*	--------------	E	rare
Poaceae (Grass family)			
Eragrostis deflexa Hitchc.	kalamalō	E	rare
Heteropogon contortus (L.) P. Beauv. ex Roem. and Schult.	pili	I	uncommon
Trisetum inaequale Whitney	-----------	E	--
DICOTS			
Amaranthaceae (Amaranth family)			
Chenopodium oahuense (Meyen) Aellen	ʽāheahea	E	rare
Asteraceae (Sunflower family)			
Bidens micrantha subsp. *Micrantha* Gaud.	koʽokoʽolau	E	uncommon
Lipochaeta lobata (Gaud.) DC. var. *lobata*	nehe	E	rare
Melanthera lavarum (Gaud.) Wagner and Rob.	nehe	E	uncommon
Convolvulaceae (Morning glory family)			
Ipomoea indica (J. Burm.) Merr.	koali awahia	I	rare
Ericaceae (Heath family)			
Leptecophylla tameiameiae (Cham. and Schlect.) C.M. Weiller	pūkiawe	I	uncommon
Euphorbiaceae (Spurge family)			
Chamaesyce celastroides (Boiss.) Croizat Degener var. *amplectens* (Sherff) Degner and I. Degener	ʽakoko	E	uncommon
Goodeniaceae (Goodenia family)			
Scaevola gaudichaudii Hooker and Arnott	naupaka kuahiwi	E	rare
Malvaceae (Mallow family)			
Sida fallax Walp.	ʽilima	I	common
Menispermaceae (Moonseed family)			
Cocculus orbiculatus (L.) DC.	huehue	I	rare
Myoporaceae (Myoporum family)			
Myoporum sandwicense A. Gray	naio	I	rare
Myrtaceae (Myrtle family)			
Metrosideros polymorpha Gaud. var. *glaberrima* (H. Lev.) St. John	ʽōhiʽa	E	uncommon
Metrosideros polymorpha Gaud. var. *incana* (H. Lev.) St. John	ʽōhiʽa	E	rare
Papaveraceae (Poppy family)			

Scientific Name	Common Name	Status[1]	Abundance (at site)[2]
Argemone glauca (Nutt. ex Prain) Pope	puakala	E	rare
Rosaceae (Rose family)			
Osteomeles anthyllidifolia (Sm.) Lindl.	ʽūlei	I	uncommon
Santalaceae (Sandalwood family)			
Santalum ellipticum Gaud.	ʽiliahialoʽe	E	rare
Sapindaceae (Soapberry family)			
Dodonaea viscosa Jacq.	ʽaʽaliʽi	I	uncommon
Sterculiaceae (Cacao family)			
Waltheria indica L.	ʽuhaloa	I	common
Thymelaeaceae (ʽAkia family)			
Wikstroemia oahuensis (A. Gray) Rock.	ʽakia	E	rare

Notes: common = widely scatted throughout or locally abundant; E = endemic (native only Hawaiʻi); I = indigenous (native to Hawaiʻi and elsewhere); rare = only a few isolated individuals; uncommon = scattered sparsely throughout or occurring in a few small patches.

Source: Hobdy 2009a, 2009b, 2010

3.6.1 Plant Sanctuaries, Critical Habitats, and Plants of Interest in the Vicinity of KWP II–*UPDATED*

Although no federally listed plant species, plant species of concern, and/or rare Hawaiian plants have been recorded on the KWP II site, several have been documented upslope of the existing KWP I facility, specifically within Manawainui Gulch, Pāpalaua Gulch, and Kealaloloa Ridge (including the Manawainui Plant Sanctuary). The endangered species include *Remya mauiensis*, ʽiliahi (*Santalum freycinetianum* var. *lanaiense*), *Diellia erecta*, pauoa (*Ctenitis squamigera*), *Cystopteris douglasii*, *Cyanea obtuse*, haʽiwale (*Cyrtandra oxybapha*), *Schiedea pubescens*, koʽokoʽolau (*Bidens campylotheca* subsp. *pentamera*), and kokiʽo ʽulaʽula (*Hibiscus kokio*) (Hobdy 2006b). All plant species with designated critical habitat are more than 1.6 miles (2.5 km) from the KWP II property boundary and are not expected to be impacted by the Project (Hobdy 2009). Many other native species occur within these two gulches but are not rare enough to be protected by federal or state laws (Hobdy 2006b).

3.7 Non-Listed Wildlife Species–*NO CHANGE*

In addition to the Covered Species discussed in the following section, the mixed grassland/shrub land vegetation in the project area provides habitat to one endemic mollusk; endemic, indigenous, or migratory birds; and several, mostly introduced, mammals.

No federally listed species of snails were found in a recent molluscan survey conducted in the KWP II area (Severns 2009; Appendix 9). One native species of snail was found, *Succinea mauiensis* (Succinidae family). *S. mauiensis* is found in dry habitat and has a wide range on Maui. At the proposed KWP II downroad site, specimens were found only on the undersides of undisturbed rock outcroppings or in the root mat of grasses beneath rocks. The species was uncommon in the pasture where most of the development activity is proposed and more common at the upper edges of the gulches.

S. mauiensis is also likely to be present in similar habitats within Kaheawa Pastures; thus, careful planning and caution during construction activity in the vicinity of the upper edges of the gulches should be sufficient to protect the species within the project area (Severns 2009). This species may also benefit and increase in numbers with the stabilization of the pasture and protection from fire as a result of the development of KWP II (Severns 2009). The species tentatively identified as *Nesopupa* in Appendix 9 has been confirmed as *Gastrocopta lyonsiana/servilis*, which is a widespread Indo-Pacific species and therefore introduced (Severns, pers. comm.).

Thirteen bird species have been observed by KWP I biologists for the KWP II area (Table 3.3). Two other introduced species documented by Nishibayashi (1997, 1998) in the KWP I area could also occur at the KWP II area. The two species are the northern cardinal (*Cardinalis cardinalis*) and the house finch (*Carpodacus mexicanus*). Two native or endemic species occur on-site, the endangered nēnē and the Hawaiian short-eared owl (*Asio flammeus sandwichensis*). The indigenous white-tailed tropicbird (*Phaethon lepturus*) has been observed flying overhead and one migratory species, the Pacific golden-plover (*Pluvialis fulva*), is present on-site during the migratory season (late August to May). All the native species and migratory species present at KWP II are also protected by the MBTA.

Cooper and Day (2009) report nine observations of Hawaiian short-eared owls at the proposed project site during five nights of surveys in July 2009. Hawaiian short-eared owls are present year-round at Kaheawa Pastures and are observed regularly in the vicinity of KWP I. Most owl activity is concentrated in the nearby gulches, although individuals also forage over the open, flatter parts of the KWP II area. One Hawaiian short-eared owl fatality associated with a turbine collision has been reported after nearly 4 years of operation. One fatal vehicular collision has also occurred. In the vicinity of turbines, most observations of the Hawaiian short-eared owl have been below the rotor swept zone (RSZ) of the turbines and thus their susceptibility to collision appears to be low despite a regular presence in the area (Spencer, pers. comm.). One Hawaiian short-eared owl fatality was also found at the base of existing transmission lines and was not associated with KWP I.

At Wolfe Island, Ontario, it was observed that short-eared owls were most vulnerable to colliding with turbine blades during predator avoidance and during aerial flight displays (Stantec Consulting Ltd. 2007). Short-eared owls on Maui have no aerial predators and thus may only be vulnerable to colliding with turbines during flight displays. Four total fatalities of short-eared owl have been recorded at operating wind farms, one each at McBride Lake, Alberta, Canada; Foote Creek Rim, Wyoming; Nine Canyon, Wyoming; and Altamont Wind Resource Area, California (Kingsley and Whittam 2007).

White-tailed tropicbirds are sometimes seen near the project area by KWP I staff but usually remain associated with the deep gulches adjacent to the site. This species is known to nest in steep valley faces and canyon walls which are common features in nearby Ukumehame, Manawainui, and Malalowai‘ole Gulches. Six fatalities attributable to turbine collisions have been observed at KWP I as of November 2011. One fatality of a greatfrigate bird (*Fregata minor*) has also been reported.

Thus far, four ringed-necked pheasants, six black francolins, two gray francolins, two Eurasian skylarks, two spotted doves, one barn owl, and one Japanese white-eye have collided with the towers or turbine rotors at KWP I.

Based upon information provided by Maui DLNR staff and KWP I biologists, mammals occurring in the vicinity of the project area are likely to include the house mouse (*Mus musculus*), rats (*Rattus* sp.), axis deer (*Cervus axis*), small Indian mongoose (*Herpestes auropunctatus*), feral cat (*Felis silvestris*), and feral dog (*Canis lupus*), although no evidence of dogs has been documented in the project area since KWP I began operations in June 2006 and only a few reports of deer have been received during the same period.

Table 3.3. Avian Species Identified in the Project Area by KWP I Biologists (2006 to present)–*NO CHANGE*

Scientific Name	Common Name	Status (Protection)
Branta sandvicensis	Hawaiian goose, nēnē	E (MBTA, endangered)
Phaethon lepturus dorotheae	White-tailed tropicbird	N (MBTA)
Francolinus pondicerianus	Gray francolin	I
Francolinus francolinus	Black francolin	I
Phasianus colchicus	Ring-necked pheasant	I
Pluvialis fulva	Pacific golden-plover	M (MBTA)
Streptopelia chinensis	Spotted dove	I
Geopelia striata	Zebra dove	I
Asio flammeus sandwichensis	Hawaiian short-eared owl	N (MBTA, state endangered on O‘ahu)
Tyto alba	Barn owl	I (MBTA)

Scientific Name	Common Name	Status (Protection)
Alauda arvensis	Eurasian skylark	I (MBTA)
Acridotheres tristis	Common myna	I
Lonchura punctulata	Nutmeg manikin	I

Notes: E = endemic, I = introduced, M = migratory, MBTA = Migratory Bird Treaty Act N = native

3.8 Listed Wildlife Species–*UPDATED*

To date, no portion of the project area has been designated as critical habitat for any listed species. Of the four Covered Species, the nēnē and Hawaiian hoary bat use the habitats in or near the project area based on observed fatalities and visual or acoustic observations. Nēnē are known to reside in the project area and acoustic bat detectors stationed in the KWP I and KWP II project areas have recorded low levels of seasonal bat activity. Hawaiian petrels and Newell's shearwaters nest in the West Maui Mountains; individuals of these species may occasionally fly through the airspace of the KWP II project area. Hawaiian petrel and Newell's shearwater take are not being amended.

The WTGs and the single met tower associated with the KWP II project would present collision hazards to all four of the Covered Species. Lighting these structures pursuant to FAA regulations may increase the risk of avian collisions (Gehring and Kerlinger 2007). Table 3.4 lists the federally listed species with potential to be adversely impacted by operation of the KWP II project and for which federal and state authorization of incidental take is being sought. Information on each of these species is provided following Table 3.4.

Table 3.4. State and Federally Listed Species with Potential to be Impacted by the KWP II Project (E = endangered, T = threatened)–*NO CHANGE*

Scientific Name	Common, Hawaiian Name(s)	Date Listed	Status
Birds			
*Puffinus newelli**	Newell's shearwater, ʽaʽo	10/28/1975	T
*Pterodroma sandwichensis**	Hawaiian petrel, ʽuaʽu	3/11/1967	E
Branta sandvicensis	Hawaiian goose, nēnē	3/11/1967	E
Mammals			
Lasiurus cinereus semotus	Hawaiian hoary bat, ʽōpeʽapeʽa	10/13/1970	E

* These species are outside the scope of this amendment.

3.8.1 Hawaiian Petrel–*NO CHANGE*

3.8.1.1 Population, Biology, and Distribution of the Hawaiian Petrel

Hawaiian petrel was once abundant on all main Hawaiian Islands except Niʽihau (Mitchell *et al.* 2005). The population was most recently estimated to be approximately 20,000, with 4,000 to 5,000 breeding pairs (Mitchell *et al.* 2005). Today, Hawaiian petrels continue to breed in high-elevation colonies on Maui, Hawaiʽi, Kauaʽi, and Lānaʽi (Richardson and Woodside 1954; Simons and Hodges 1998; Telfer *et al.* 1987). Radar studies conducted in 2002 also suggest that breeding may occur on Molokaʽi (Day and Cooper 2002). It is believed that breeding no longer occurs on Oʽahu (Harrison 1990).

Survey work at a recently rediscovered Hawaiian petrel colony on Lānaʽi that had been previously thought to be extirpated, indicates that thousands of birds are present rather than hundreds of birds, as first surmised, and that the size of the breeding colony approaches that at Haleakalā, Maui, where as many as 1,000 pairs have been thought to nest annually (Mitchell *et al.* 2005; Tetra Tech EC, Inc. 2008a, 2008b). Radar counts of petrels on the perimeter of Maui and recent colony detections by KWP I researchers suggest that the Maui population may be much higher than the 1,000 pairs previously estimated (Cooper and Day 2003).

Hawaiian petrels are nocturnal and subsist primarily on squid, fish, and crustaceans caught near the sea surface. Unlike shearwaters, Hawaiian petrels are not known to dive or swim below the surface

(Pitman 1986). Foraging may take place thousands of kilometers from their home islands during both breeding and nonbreeding seasons (Spear *et al.* 1995). In fact, recent studies conducted using satellites and transmitters attached to Hawaiian petrels have shown that they can range across more than 6,200 miles (10,000 km) during 2-week foraging expeditions (Adams 2008).

Hawaiian petrels are active in their nesting colonies for about 8 months each year. The birds are long-lived (ca. 30 years) and return to the same nesting burrows each year between March and April. Present-day Hawaiian petrel colonies are typically located at high elevations above 8,200 feet (2,500 m). The types of habitats used for nesting are very diverse and range from xeric habitats with little or no vegetation, such as at Haleakalā National Park on Maui, to wet forests dominated by ʻōhiʻa with uluhe understory, as those found on Kauaʻi (Mitchell *et al.* 2005). Females lay only one egg per year, which is incubated alternately by both parents for approximately 55 days. Eggs hatch in June or July, after which both adults fly to sea to feed and return to feed the nestling. The fledged young depart for sea in October and November. Adult birds do not breed until age 6 and may not breed every year, but pre-breeding and nonbreeding birds nevertheless return to the colony each year to socialize.

3.8.1.2 Current Threats to the Hawaiian Petrel

The most serious land-based threat to the species is predation of eggs and young in the breeding colonies by introduced mammalian predators such as small Indian mongoose, feral cats, owls, pigs, dogs, and rats. Population modeling by Simons (1984) suggests that this species could face extinction in a few decades if predation is not controlled. Intensive trapping and habitat protection has helped to improve nesting and fledging success (Ainley *et al.* 1997). Hodges and Nagata (2001) found that nesting activity (signs of burrow activity) in sites protected from predators on Haleakalā ranged from 37.25% to 78.13%, while nesting activity in unprotected sites ranged from 23.08 to 88.17%. Nesting success (proportion of active burrows that showed signs of fledging chicks) in protected sites ranged from 16.97% to 50.00%, while nesting success in unprotected sites ranged from 0.00% to 44.00%, averaging 42.4% and 27.1%, respectively (Table 6.2; Hodges and Nagata 2001).

Ungulates can indirectly affect nesting seabirds by overgrazing and trampling vegetation as well as facilitating erosion. Climatic events such as El Niño can also impact the reproductive success of seabirds (Hodges and Nagata 2001). Other threats include occasional mortality from collisions with power lines, fences, and other structures near breeding sites or attraction to bright lights. In addition, juvenile birds are sometimes grounded when they become disoriented by lights on their nocturnal first flight from inland breeding sites to the ocean. A few, mostly juvenile, Hawaiian petrels have landed in brightly lighted areas at scattered locations on Maui most years. The problem is much smaller than the one involving Newell's shearwaters (see following section), and Simons and Hodges (1998) conclude that it is probably not a threat to remaining populations.

Three Hawaiian petrel fatalities, presumed due to collisions with WTGs, have been recorded at KWP I since the beginning of operations in January 2006 (Kaheawa Wind Power LLC 2008b, 2008c).

3.8.1.3 Occurrence of the Hawaiian Petrel on Maui

Simons and Hodges (1998) and recent observations of birds calling and performing aerial displays consistent with breeding behavior, indicate the presence of Hawaiian petrel nesting colonies in West Maui (Kaheawa Wind Power, LLC 2007a, 2007b). Cooper and Day (2003) also observed Hawaiian petrels flying inland over the northern coast toward the mountainous interior of West Maui.

Research and field investigations in support of the KWP I HCP confirmed that Hawaiian petrels congregate in West Maui over the lower portion of Kahakuloa Valley. These observations were corroborated by DLNR/DOFAW wildlife biologists from Maui and seabird researchers from the USGS and H.T. Harvey and Associates in early July 2007. Subsequent investigations have shown that the area was likely once an active seabird colony (see Section 6.5.1.1). A small nesting colony likely exists in the West Maui Mountains in the upper portions of Kahakuloa and Honokōhau Valleys (G. Spencer, First Wind, pers. comm.; Figure 3.1).

Mount Haleakalā, which defines East Maui, supports the largest known nesting colony of Hawaiian petrels (USFWS 2005; Hodges and Nagata 2001). Approximately 1,000 known nests are within the crater of the dormant shield volcano, with the highest concentration on the western rim between 2,400 and 3,055 m in elevation. The highest densities of nests (15–30 burrows per ha) occur within Haleakalā National Park. Predator trapping is conducted year-round to reduce predation pressure on these burrows. Lower densities of nesting burrows occur elsewhere in the crater and beyond the park boundaries, but these are currently not actively managed (Hodges and Nagata 2001).

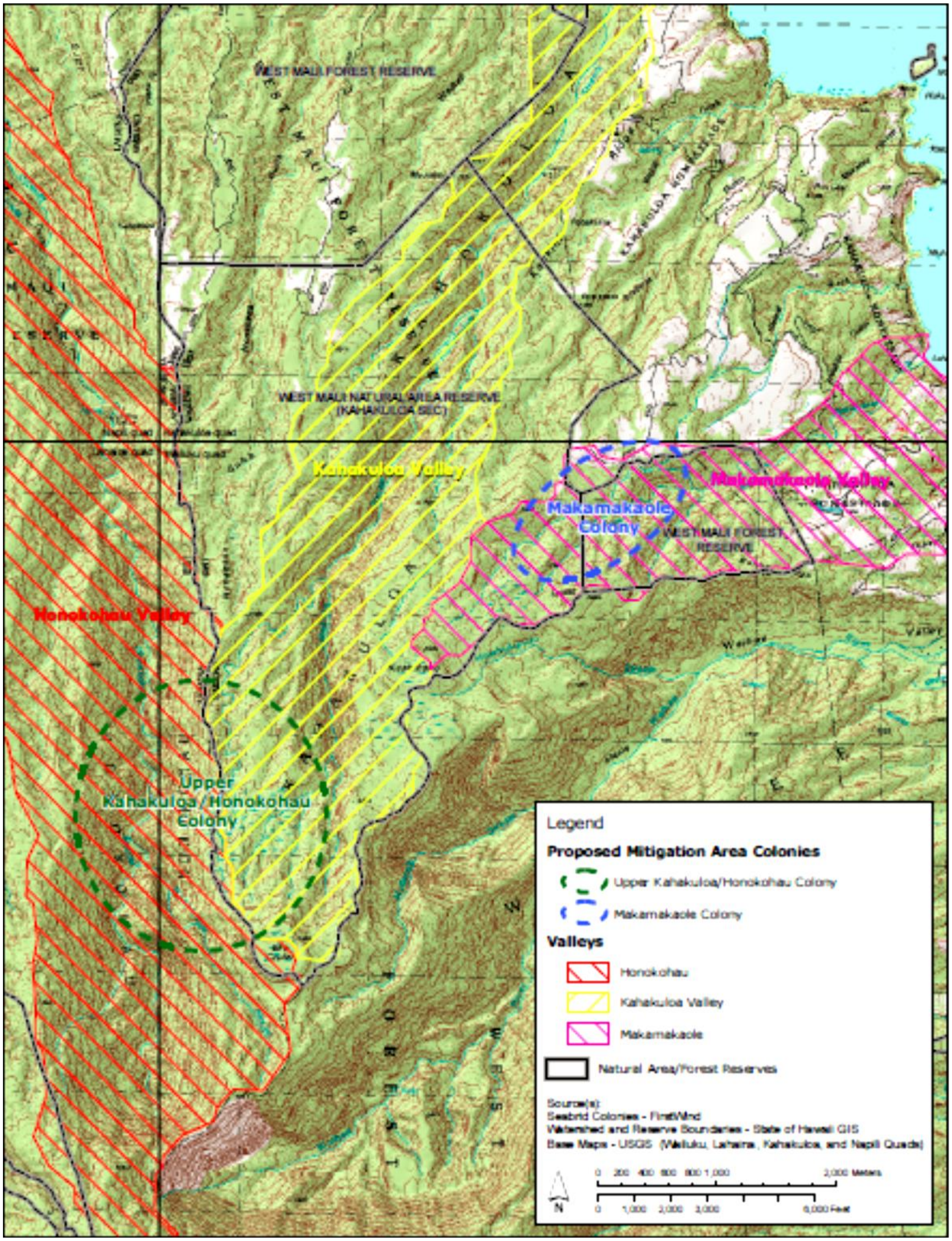


Figure 3.1. Seabird colonies and seabird congregation areas on West Maui.–*NO CHANGE*

3.8.1.4 Occurrence of the Hawaiian Petrel in the Project Area

ABR Inc. conducted radar and night-visual observations in July and October 2009 to document passage rates of seabirds over KWP II during the nesting season (Appendix 13). The estimated number of Hawaiian petrels passing through the airspace of KWP II is 6.3 birds/night for the spring/summer season and 4.12 birds/night during the fall fledging season. Passage rates in the fall are lower because the visitation rates by adults to feed their chicks decline as much as 80% in the last quarter of the nestling period (Simons 1985).

Spring/summer and fall passage rates of seabirds (Hawaiian petrels and Newell's shearwaters combined) at KWP II are within the range of variability of passage rates observed upslope at KWP I over the last 10 years (Figure 3.2a). But when comparing passage rates over other areas and islands of Hawai'i, passage rates over the KWP I and KWP II project areas are lower than the mean rate measured for West Maui (8.7 ± 3.9 targets/hour; see Figure 3.2a) and East Maui (52.8 ±16.6 targets/hour; Cooper and Day 2003; Figure 3.2b) and are less than 2.5% of the mean passage rates measured on Kaua'i (131 ± 35 targets/hour; Day and Cooper 2001).

3.8.2 Newell's Shearwater–*NO CHANGE*

3.8.2.1 Population, Biology, and Distribution of the Newell's Shearwater

The Newell's shearwater is an endemic Hawaiian subspecies of the nominate species, Townsend's shearwater (*Puffinus a. auricularis*) of the eastern Pacific. The Newell's shearwater is considered "Highly Imperiled" in the Regional Seabird Conservation Plan (USFWS 2005) and the North American Waterbird Conservation Plan (Kushlan *et al.* 2002). Species identified as Highly Imperiled have suffered significant population declines and have either low populations or some other high risk factor.

The most recent population estimate of Newell's shearwater was approximately 84,000 birds, with a possible range of 57,000 to 115,000 birds (Ainley *et al.* 1997). Radar studies on Kaua'i show a 63% decrease in detections of shearwaters between 1993 and 2001 (Day *et al.* 2003). The largest breeding population of Newell's shearwater occurs on Kaua'i (Telfer et al*.* 1987; Day and Cooper 1995; Ainley et al*.* 1995, 1997b; Day et al*.* 2003). Breeding also occurs on Hawai'i Island (Reynolds and Richotte 1997; Reynolds et al*.* 1997; Day *et al.* 2003) and almost certainly occurs on Moloka'i (Pratt 1988; Day and Cooper 2002). Recent radar studies suggest the species may also nest on O'ahu (Day and Cooper 2008). On Maui, radar studies and visual and auditory surveys conducted over the past decade suggest that one or more small breeding colonies are present in the West Maui Mountains in the upper portions of Kahakuloa Valley (G. Spencer, First Wind, pers. comm.; see Figure 3.1).

Newell's shearwaters typically nest on steep slopes vegetated by uluhe fern (*Dicranopteris linearis*) undergrowth and scattered 'ōhi'a (*Metrosideros polymorpha*) trees. Currently, most Newell's shearwater colonies are found from 525 to 3,900 feet (160 to 1,200 m) amsl, often in isolated locations and/or on slopes greater than 65 degrees (Ainley *et al.* 1997). The birds nest in short burrows excavated into crumbly volcanic rock and ground, usually under dense vegetation and at the base of trees. A single egg is laid in the burrow and one adult bird incubates the egg while the second adult goes to sea to feed. Once the chick has hatched and is large enough to withstand the cool temperatures of the mountains, both parents go to sea and return irregularly to feed the chick. The closely related Manx shearwater is fed every 1.2–1.3 days (Ainley *et al.* 1997). Newell's shearwaters arrive at and leave their burrows during darkness, and birds are seldom seen near land during daylight hours. During the day, adults remain either in their burrows or at sea some distance from land.

First breeding occurs at approximately 6 years of age, after which breeding pairs produce one egg in a given year. A high rate of nonbreeding is found among experienced adults that occupy breeding colonies during the summer breeding season, similar to some other seabird species (Ainley *et al.* 2001). No specific data exist on longevity for this species, but other shearwaters may reach 30 years of age or more (see for example Bradley *et al.* 1989; del Hoyo *et al.* 1992). The Newell's shearwater breeding season begins in April, when birds return to prospect for nest sites. A pre-laying exodus follows in late April and possibly May; egg laying begins in the first two weeks of June and likely continues through the early part of July.

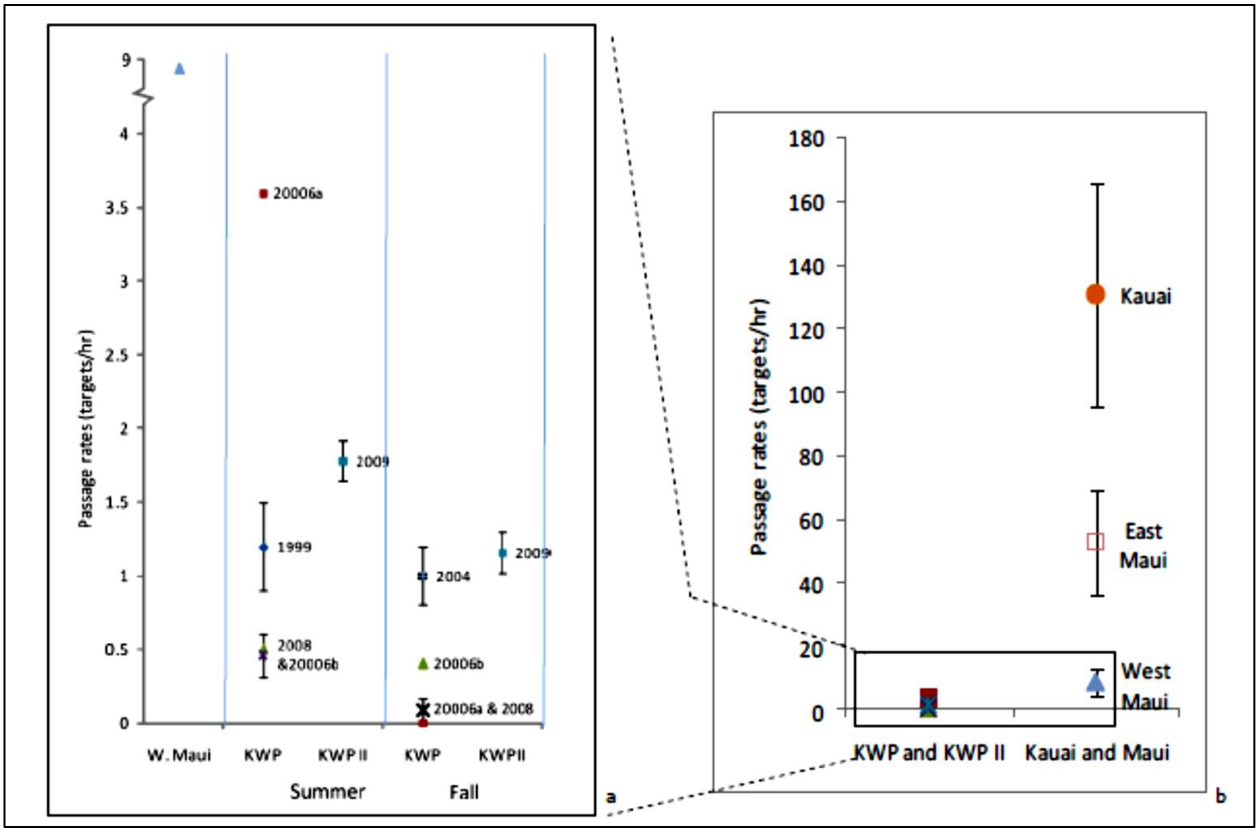


Figure 3.2. Comparison of passage rates of seabirds over KWP I and KWP II with (a) West Maui and (b) East Maui and Kaua'i. Error bars are SE. Data points are labeled with the year the surveys were conducted. The year 2006 had two survey locations at KWP I.–*NO CHANGE UPDATED*

The average incubation period is thought to be approximately 51 days (Telfer 1986). The fledging period is approximately 90 days, and most fledging takes place in October and November, with a few birds still fledging into December (SOS Data).

3.8.2.2 Current Threats to the Newell's Shearwater

As stated above, radar studies on Kaua'i showed a 63% decrease in detections of shearwaters between 1993 and 2001 (Day *et al.* 2003). It was presumed that the decrease in detections corresponded to an actual decrease in population, rather than simply a shift in areas used for breeding.

Declines in Newell's shearwater populations are attributed to loss of nesting habitat, predation by introduced mammals (mongoose, feral cats, rats, and feral pigs) at nesting sites, and fallout of juvenile birds associated with disorientation from urban lighting (Ainley *et al.* 1997; Mitchell *et al.* 2005; Hays and Conant 2007).

No Newell's shearwater fatalities have been recorded at KWP I since the ITP and ITL were issued in January 2006 (Kaheawa Wind Power LLC 2008b, 2008c).

3.8.2.3 Occurrence of Newell's Shearwater on Maui

Radar and night-visual observations by Day and Cooper (1999) and Cooper and Day (2004) indicate that Newell's shearwater nests somewhere in the West Maui Mountains and that low numbers of these birds regularly fly over or near the KWP II project area at night, to and from nesting colonies either in the West Maui Mountains or (occasionally) on Haleakalā. The size of the West Maui nesting population is unknown at this time.

3.8.2.4 Occurrence of Newell's Shearwater in the Project Area

As stated in Section 3.8.1.4., ABR Inc. conducted radar and night-visual observations over the KWP II project area in July and October 2009 (Cooper and Day 2009). The estimated number of Newell's shearwaters passing through the airspace of KWP II is 4.2 birds/night for the spring/summer season and 2.75 birds/night for the fall. Visitation rates by adults to feed their chicks decline in the last quarter of the nestling period much like Hawaiian petrels.

Passage rates of seabirds (Hawaiian petrels and Newell's shearwaters combined) at KWP II are within the range of variability of passage rates observed upslope at KWP I over the last 10 years (see Figure 3.2a). But when comparing passage rates over other areas and islands of Hawai'i, passage rates over the KWP I and KWP II project areas are lower than the mean rate measured for West Maui (8.7 ± 3.9 targets/hour; see Figure 3.2a), East Maui (52.8 ±16.6 targets/hour; Cooper and Day 2003; see Figure 3.2b) and are less than 2.5% of the mean passage rates measured on Kaua'i (131 ± 35 targets/hour; Day and Cooper 2001).

3.8.3 Nēnē–*UPDATED*

3.8.3.1 Population, Biology, and Distribution of the Nēnē

The nēnē is adapted to a terrestrial and largely non-migratory lifestyle in the Hawaiian Islands with negligible dependence on freshwater habitat. Compared to the related Canada goose (*Branta canadensis*), nēnē wings are smaller by about 16% in size and their flight capability is comparatively weak. Nonetheless, nēnē are capable of both inter-island and high-altitude flight (Miller 1937; Banko *et al.* 1999).

After nearly becoming extinct in the 1940s and 1950s, the nēnē population slowly has been rebuilt through captive breeding programs. Wild populations of nēnē occur on Hawai'i, Maui, Kaua'i, and, most recently, O'ahu. The species population estimate in 2015 was 3,034 individuals (Nēnē Recovery Action Group 2017, unpub.). The primary release site on Maui is located at Haleakalā National Park on East Maui, where 511 nēnē were released between 1962 and 2003.

Since 1995, the majority of Maui releases have been from a release pen in the Hana'ula region of West Maui in an effort to establish a second population on Maui on this part of the island (F. Duvall, Maui DOFAW, pers. comm.). This pen is located near the upper end of the KWP I project area. The total Maui population in 2015 was estimated to be 521 birds (Nēnē Recovery Action Group 2017, unpub.).

KWP I has worked with Maui DOFAW and the USFWS to establish a new nēnē release pen on land owned by Haleakalā Ranch in East Maui. This pen was completed in 2011. Forty-six fledglings have been produced at the Haleakalā Ranch pen as part of nēnē mitigation for KWP I (KWP I 2012, 2013, 2014, 2015, 2016, 2017).

The nēnē has an extended breeding season, with eggs reported from all months except May, June, and July, although the majority of birds in the wild nest during the rainy (winter) season between October and March (Banko *et al.* 1999; Kear and Berger 1980). Nēnē nest on the ground in a shallow scrape in the dense shade of a shrub or other vegetation. A clutch typically contains three to five eggs and incubation lasts for 29 to 31 days. The female incubates the eggs, with the male standing guard nearby, often from an elevated location. Once hatched, the young remain in the nest for 1 to 2 days (Banko *et al.* 1999). Fledging of captive birds occurs at 10 to 12 weeks but may occur later in the wild. During molt, adults are flightless for a period of 4 to 6 weeks. Molt occurs after hatching of eggs, such that the adults generally attain their flight feathers at about the same time as their offspring. When flightless, goslings and adults are extremely vulnerable to predators such as dogs, cats, and mongoose. From June to September, family groups join others in post-breeding aggregations (flocks), often far from nesting areas.

Nēnē occupy various habitat types ranging from beach strand, shrub land, and grassland to lava rock, at elevations ranging from coastal lowlands to alpine areas (Banko 1988; Banko *et al.* 1999). The geese eat plant material, and the composition of their diet depends largely on the vegetative composition of their surrounding habitat. They appear to be opportunistic in their choice of food plants as long as the plants meet their nutritional demands (Banko *et al.* 1999; Woog and Black 2001).

3.8.3.2 Current Threats to Nēnē

Current threats to nēnē include predation by non-native mammals, exposure in high-elevation habitats, insufficient nutritional resources for both breeding females and goslings, a lack of lowland habitat, human-caused disturbance and mortality (e.g., road mortality, disturbance by hikers), behavioral problems related to captive propagation, inbreeding depression, and infectious/inflammatory diseases of which toxoplasmosis predominates (USFWS unpub., 2004a; Work *et al.* 2015). Predators of nēnē eggs and goslings include dogs, cats, rats, and mongoose. Dogs and mongoose are also responsible for most of the known cases of adult predation (USFWS 2004a). Nēnē have also been negatively impacted by human recreational activities (e.g., hikers, hunters). In recent years, nēnē have been struck and killed by golf balls and vehicles (USFWS 2004a).

Starvation and dehydration can be major factors in gosling mortality. Approximately 81.5% of gosling mortality in Haleakalā National Park during the 1994 to 1995 breeding season was due to starvation and dehydration (USFWS 2004a). From 2005 to 2007, between 30 to 50% of the goslings at the Hakalau Forest Unit died due to drought and/or exposure (USFWS unpub~~l~~.). A lack of adequate food and water supplies also seems to be a limiting factor in Hawaiʻi Volcanoes National Park (USFWS 2004a, Work *et al.* 2015).

For nēnē populations to survive, they must be provided with generally predator-free breeding areas and sufficient food resources; human-caused disturbance and mortality must be minimized; and genetic and behavioral diversity maximized. At the same time, it is recognized that nēnē are highly adaptable, successfully utilizing a gradient of habitats ranging from highly altered to completely natural, which bodes well for recovery of the species.

Twenty-three nēnē fatalities at KWP I have been observed in the search area since the beginning of operations in 2006 through June 2017 (Kaheawa Wind Power LLC 2008b, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017). Four nēnē fatalities at KWP II have been observed in the search area from July 2012 through June 2017 (Kaheawa Wind Power II LLC 2013, 2014, 2015, 2016, 2017).

3.8.3.3 Occurrence of Nēnē in West Maui and the Project Area

The Hanaʻula release pen is located near the upper end of the KWP I project area, approximately 1,800 feet (550 m) from the nearest KWP I wind turbine and 12,011 feet (3,707 m) from KWP II turbine 1. DOFAW has suspended using this pen for future releases. A number of nēnē from the Hanaʻula release site have remained as residents within or near the KWP I and KWP II project areas. Little is known about the exact distribution and movements of the birds released at the Hanaʻula release pen, although they have been recorded as far west as Lahaina (approximately 7.7 miles or 12.3 km from the project area) and as far east as Haleakalā National Park, indicating that at least some birds from this release site move extensively around the island (J. Medeiros, Maui DOFAW, pers. comm.). The nēnē population in this region (Hanaʻula/West Maui) is estimated at 169 birds (Nēnē Recovery Action Group 2017, unpub.). This population is monitored under the KWP I and KWP II HCPs and the survey effort is now well coordinated between DOFAW and KWP I and KWP II biologists.

In 1998, four goslings were successfully fledged from the first nest reported in the area since reintroduction began (DOFAW 2000). Monitoring studies at KWP I and KWP II have resulted in discovery of a few nēnē nests annually only in the vicinity KWP I.

Nēnē presence has been monitored regularly in the KWP I and KWP II project areas prior to and after commencing operation of KWP I and KWP II. Data collected from incidental surveys and the Wildlife Education and Observation Program (WEOP) (December 2006–June 2017~~09~~) have provided information about nēnē distribution and behavior at KWP I and KWP II. Monitoring of nēnē during the construction period at KWP I (January to June 2006) also documented nēnē use of the KWP I area and downroad KWP II area. Both these data sets combined provide over 800 observations (n = 820 individuals) on nēnē distribution and span over 3.5 years.[3]

Results show that nēnē are seen almost twice as frequently (n = 532 individuals) at the KWP I area than at the KWP II downroad area (n = 288; Figure 3.3). Most of the downroad observations are in the upper elevations of the KWP II area, near the Pali Trail Junction (Mile Marker 1.75) and in the vicinity of MECO's 64-kV overhead transmission route crossing (Mile Marker 2.25). The birds periodically use the area for browsing and socializing (G. Spencer, pers. comm.). No nesting is expected to occur within the KWP II project area (see above).

In addition to the WEOP observations, systematic surveys were also conducted at KWP I and consisted of 116.8 hours of observation time, from June 2006 to June 2007. The primary purpose of the systematic surveys was to record nēnē flight behavior around the existing KWP I wind facility. Surveys were conducted in the mornings (6–10 a.m.), afternoons (10 a.m.–2 p.m.), and evenings (2–6 p.m.). Systematic surveys show that flight activity did not vary with time of day (range= 0.29–0.38 flock in flight/hour; X^2 = 0.464, degrees of freedom (*df*) = 2, probability (p) = 0.79).

Data from the WEOP surveys and systematic surveys combined document that nēnē frequently fly within the RSZ of the turbines at KWP I (66.1% of all flights observed, n = 97), with 16.9% occurring below the RSZ and 16.9% above.

[3] To standardize the effort spent surveying both KWP I and KWP II areas, data were chosen only from time periods when the entire stretch of road leading from the base of KWP II to KWP I was surveyed. For WEOP observations, the two time periods that fit this criterion were 6:30 to 9:00 a.m. and 3:30 to 7:00 p.m. As the entire roadway was surveyed during the construction period, all nēnē observations were used from that dataset.

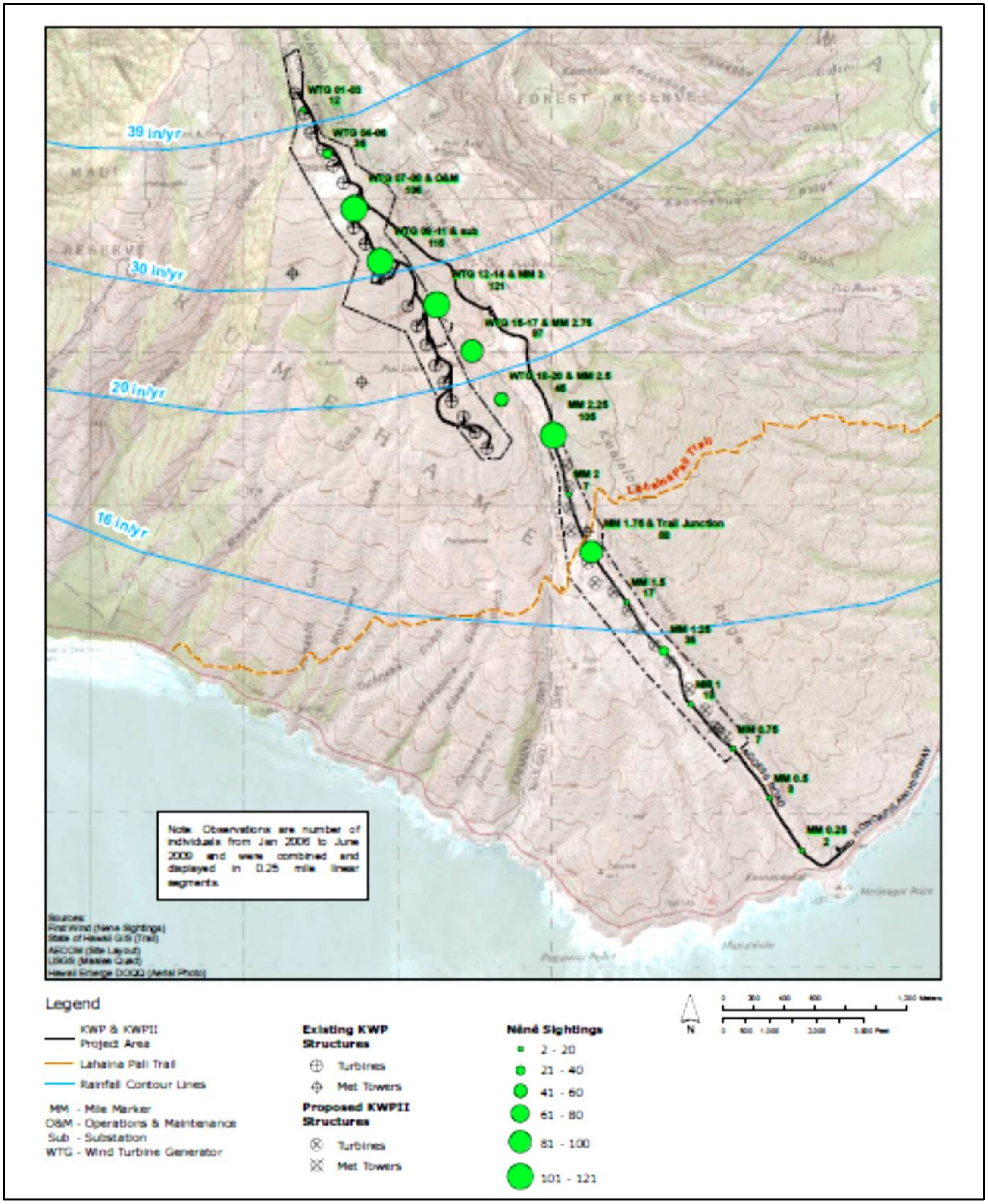


Figure 3.3. Distribution of nēnē at KWP I and KWP II areas.–*NO CHANGE*

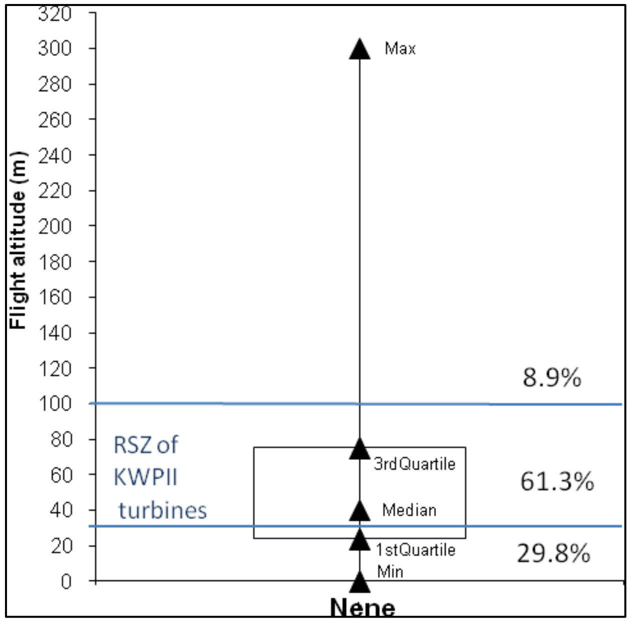


Figure 3.4. Flight altitudes of nēnē from WEOP and systematic observations (n = 97), imposed on the rotor swept zone of turbines at KWP II. (At right are the percentages of nēnē flights expected to occur at, below, and above the rotor swept zone).–*NO CHANGE*

As turbine towers at KWP II are 10 m taller, the RSZ height is also raised by 10 m (the area remains the same). Assuming that flight characteristics of nēnē at KWP II are similar to those observed at KWP I, slightly fewer nēnē (61.3%) are expected to be flying at RSZ height at KWP II, further reducing collision risk (Figure 3.4). In addition, the KWP II site is situated at an elevation that reduces its propensity for dense cloud cover that may improve the avoidance behavior of nēnē encountering turbines in their airspace. Flock sizes in flight averaged 2.7 birds.

In summary, fewer nēnē are seen in the KWP II downroad area compared to KWP I. Applying nēnē behavioral observations at KWP I to KWP II, nēnē may transit through the KWP II area at any time during daylight hours. As KWP II turbine towers are 10 m taller than the KWP I turbines, fewer nēnē flocks will fly within the RSZ of the KWP II turbines (61% versus 66%) and the flight avoidance behavior observed at KWP I is expected to further lower the risk of take at KWP II. The greater visibility on-site due to the lower elevation and the decrease in the frequency and extent of cloud cover at KWP II could also potentially decrease the risk of turbine collision for nēnē.

3.8.4 Hawaiian Hoary Bat–*UPDATED*

<u>3.8.4.1 Population, Biology, and Distribution of the Hawaiian Hoary Bat</u>

The Hawaiian hoary bat is the only existing native terrestrial mammal from the Hawaiian Archipelago (USFWS 1998). The species has been recorded on Kaua�💡i, O‘ahu, Moloka‘i, Maui, and Hawai‘i, but no historical or current population estimates exist for this subspecies. The Hawaiian hoary bat is believed to occur primarily below an elevation of 4,000 feet (1,220 m). This subspecies has been recorded between sea level and approximately 9,050 feet (2,760 m) in elevation on Maui, with most records occurring at or below approximately 2,060 feet (628 m) (USFWS 1998, Gorresen *et al.* 2013).

Hawaiian hoary bats roost in native and non-native vegetation from 3 to 29 feet (1 to 9 m) above ground level. They have been observed roosting in ‘ōhi‘a, hala (*Pandanus tectorius*), coconut palms (*Cocos nucifera*), kukui (*Aleurites moluccana*), kiawe (*Proscopis pallida*), avocado (*Persea americana*), mango (*Mangifera indica*), shower trees (*Cassia javanica*), pūkiawe *(Styphelia tameiameiae*), ironwood trees (*Casuarina equisetifolia*), and fern clumps; they are also suspected to roost in eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cryptomeria japonica*) stands. The species is rarely observed using lava tubes, cracks in rocks, or human-made structures for roosting. While roosting during the day, Hawaiian hoary bat is solitary, although mothers and pups roost together (USFWS 1998).

Preliminary study of a small sample of Hawaiian hoary bats (n = 25) on the Island of Hawaiʽi has estimated a mean short term (3–13 calendar days) core use area of 63.0 acres (25.5 ha). 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. Bats typically feed along a line of trees, a forest edge, or a road and a typical feeding range stretches around 300 yards (275 m). Bats will spend 20 to 30 minutes hunting in a feeding range before moving on to another (Bonaccorso 2011; Bonaccorso *et al.* 2015).

Breeding has been confirmed so far on the islands of Hawaiʽi, Kauaʽi, Maui, and Oʽahu (Baldwin 1950; Kepler and Scott 1990; Menard 2001; D. Johnston, pers. comm. 2014). From these observations, the breeding period is considered to be from April through September. Seasonal changes in the abundance of Hawaiian hoary bats at different elevations indicate that altitudinal migrations occur on the Island of Hawaiʽi (Gorresen *et al.* 2013). During the breeding period, Hawaiian hoary bat occurrences increase in the lowlands and decrease at high-elevation habitats. Hawaiian hoary bat occurrences are especially low from June until August in high-elevation areas. In the winter, especially during the post-lactation period in October, bat occurrences increase in high-elevation areas and in the central highlands, possibly receiving bats from the lowlands (Menard 2001).

Hawaiian hoary bats feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites (Whitaker and Tomich 1983, Todd 2012). They appear to prefer moths ranging between 0.60 and 0.89 inch (16 to 20 millimeter) in size (Bellwood and Fullard 1984; Fullard 2001). Koa moths (*Scotorythra paludicola*), which are endemic to the Hawaiian Islands and use koa (*Acacia koa*) as a host plant (Haines *et al*. 2009), are a food source (Banko *et al.* 2015). Prey is located using echolocation. Water courses and edges (e.g., coastlines, forest/pasture boundaries) appear to be important foraging areas. In addition, the species is attracted to insects that congregate near lights (USFWS 1998; Mitchell *et al.* 2005). They begin foraging either just before or after sunset depending on the time of year (USFWS 1998; Mitchell *et al.* 2005).

<u>3.8.4.2 Current Threats to the Hawaiian Hoary Bat</u>

Primary threats to the Hawaiian hoary bat are unknown; possible threats are hypothesized from studies of other species. The main observed mortality of the Hawaiian hoary bat in Hawaiʽi has been from bats snagging on barbed wire and colliding with wind turbines. The extent of the impact of barbed wire fences is unknown. Well-documented, intensive monitoring at wind farms informs the extent of bat mortality from wind turbine collision.

The availability of roosting sites is believed to be a major limitation in many bat species in general. Possible threats to the Hawaiian hoary bat include pesticides (either directly or by impacting prey species), predation, alteration of prey availability due to the introduction of non-native insects, and roost disturbance (USFWS 1998). Management of the Hawaiian hoary bat is also limited by a lack of information on key roosting and foraging areas, food habits, seasonal movements, and reliable population estimates (USFWS 1998; DOFAW 2015). In their North American range, hoary bats are known to be more susceptible to collision with wind turbines than most other bat species (Johnson *et al.* 2000; Erickson 2003; Johnson 2005; O'Shea *et al.* 2016). Most mortality has been detected after the summer breeding season, during the fall migration period. Hoary bats in Hawaiʽi do not migrate in the traditional sense, although as indicated, breeding is believed to be seasonal, and some seasonal altitudinal movements occur. Currently, it is not known if Hawaiian hoary bats are more susceptible to turbine collisions during their altitudinal migrations as hoary bats are during their migrations in the continental United States.

3.8.4.3 Occurrence of the Hawaiian Hoary Bat in West Maui and the Project Area

On Maui, this bat is believed to occur primarily in moist, forested areas, although little is known about its exact distribution and habitat use on the island, especially in the West Maui Mountains. No Hawaiian hoary bats were recorded in the area of the proposed wind turbines during nighttime visual studies using night vision equipment conducted in summer 1999 (Day and Cooper 1999) or fall 2004 (Cooper and Day 2004).

KWP I, LLC and KWP II, LLC have carried out regular bat monitoring using ultrasonic bat detectors in accordance with the provisions of their HCPs and confirmed that the species is present in low numbers in the KWP I and KWP II project areas.

As of June 2018, a total of three Hawaiian hoary bat fatalities have been documented within the search area at KWP II.

Acoustic Monitoring of Bat Activity at KWP I and II. From August 2008 to October 2013, four to eight Anabat detectors (Titley Electronics, NSW, Australia) were deployed at various locations in the Kaheawa Pastures region (Figure 3.5; Kaheawa Wind Power LLC 2009), including in areas where KWP II was to be constructed. Bat detectors were placed from ground level to 15 feet (4.6 m). On average, Anabat detectors are considered to have a detection radius of approximately 98 feet (30 m), although it can often be less depending on site conditions, weather, and other factors. Given the paucity of data on bat distribution in Hawaiʽi, the primary goal of these detectors was to determine bat presence/absence in the area and subsequently quantify relative bat activity if detected. These detectors did not document bat activity in the RSZ, which typically begins at heights above 98 feet (30 m). Surveys conducted at wind farms in the continental United States typically show notably higher detection frequencies of migratory tree-roosting bats from detectors placed at tree height (< 66 feet, or 20 m) versus those placed within the RSZ (> 131 feet, or 40 m), particularly where surveys have been conducted throughout the spring through fall seasons and not just during migration periods (Robert Roy, unpublished data). For example, at Sheffield Wind in Vermont, where detectors were deployed year-round in 2006, a total of 881 calls were recorded from detectors at tree height, while only 68 calls were recorded within the RSZ. Calls at tree height were over an order of magnitude more than calls detected within the RSZ. This dataset extends beyond the migration period and thus captures the foraging activity of tree-roosting bats at different heights, which is an area of greater concern in Hawaiʽi. Most other studies typically sample for migratory tree-roosting bats during the migration period. While this data provide good information on the causes of bat mortality during migration, it may be less applicable to Hawaiʽi. During the fall migration season, Baerwald and Barclay (2009) documented that hoary bats are more active at 98 feet (30 m) than at ground level; however, in a Wisconsin study, Redell *et al.* (2006) reported no significant difference in activity levels of so-called low-frequency species (including hoary bats) with increasing height above ground level.

At KWP I and KWP II, bat call sequences were mostly detected between the months of May and November (see Figure 3.5). Between August 2008 and June 2012, four to eight bat detectors recorded bat detections (see Figure 3.5). Detections were recorded using Titley Anabats in 8 of 12 months, and the highest rate occurred in October 2011 at 13.8% of total detector nights.

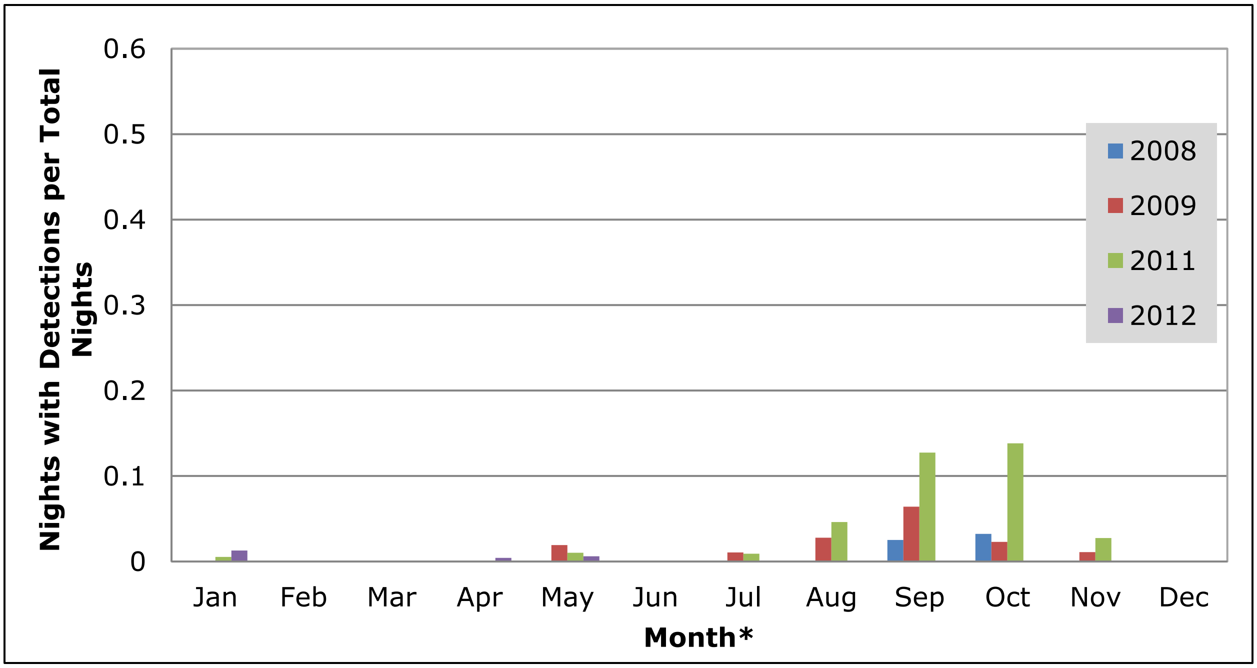


Figure 3.5. Temporal distribution of Anabat detections at KWP I and KWP II (Pre-operations) from August 2008 to June 2011 depicted as "Nights with Detections per Total Nights." (The vertical scale is intentionally the same as the scale for Figure 3.6 for ease of comparison. * No data for January through July 2008 and July through December 2012).–*UPDATED*

From October 2013 to the present, 17 Wildlife Acoustic bat detectors (SM2BAT+™) were deployed at KWP I and KWP II at ground level (replacing Anabat detectors). Due to differences in the sensitivity of the acoustic detectors and microphones used for the different equipment, the data from October 2013 to the present cannot be directly compared with the data collected using up to eight Titley Anabat SD2™ detectors from 2008 to 2012. Wildlife Acoustics detectors are more sensitive than the older Titley detectors and detect relatively more bats.

Bat activity collected at KWP II using Wildlife Acoustics SM2BAT+ in more recent years (October 2013 through June 2017) indicate bats are present at KWP II in relatively low numbers year-round, with a peak presence in early fall (Figure 3.6). Detections were recorded in every month, and the highest rate occurred in September 2015, with 58% of total detector nights having bat activity. Compared to activity rates prior to 2013, activity rates are noticeably higher and bats are detected throughout the year (see Figure 3.6). As an example of the difference between the measured activity rates using the two different detector types, the nightly presence rate during the month with the highest detected rate (in September 2015, rate = 58%; see Figure 3.6) was four times higher than during the highest rate in the period prior to 2013 (in October 2011, rate = 14%; see Figure 3.6).

In general, bats have been detected at KWP II at every turbine either on the ground or at nacelle height and bats have been detected in every month of the year (KWP II 2013, 2014, 2015, 2016, 2017, 2018). The three observed bat takes at KWP II were found in the upper half of the 14 turbines (turbines 2, 6, and 7). In FY 2017 at KWP II, 8.3% and 8.4% of nights with detections occurred at ground detectors at turbines 1–7 and 8–14, respectively, suggesting turbine-specific bat detection rates generally do not predict where fatalities are likely to occur. There is a higher level of bat detections at KWP II in the late summer to early fall months, but the three bat fatalities observed at KWP II did not occur during these months with relatively higher detection rates.

The detection patterns found at KWP I were similar to patterns observed at KWP II at every turbine and in every month (KWP I 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018). Of the 11 observed bat takes found at KWP I, only four were found during July through October, approximately what would be expected if bat take occurs randomly throughout the year. Four were found in April and May, and three were found in November, December, and February. Six of 11 (55%) observed bat takes at KWP I were found at three turbines (turbines 8, 16, and 18). The other five bat takes were found at turbines 2, 6, 9, 10, and 14. Six of 11 observed bat takes at KWP I were found at turbines 1–10 and five of 11 were found at turbines 11–20. In FY 2017 at KWP I, 5.2% and 5.1% of nights with detections occurred at ground detectors at turbines 1–10 and 11–20, respectively, suggesting that bat fatalities generally correlated with nightly bat detection rates.

Acoustic monitoring will continue throughout the 20-year permit period.

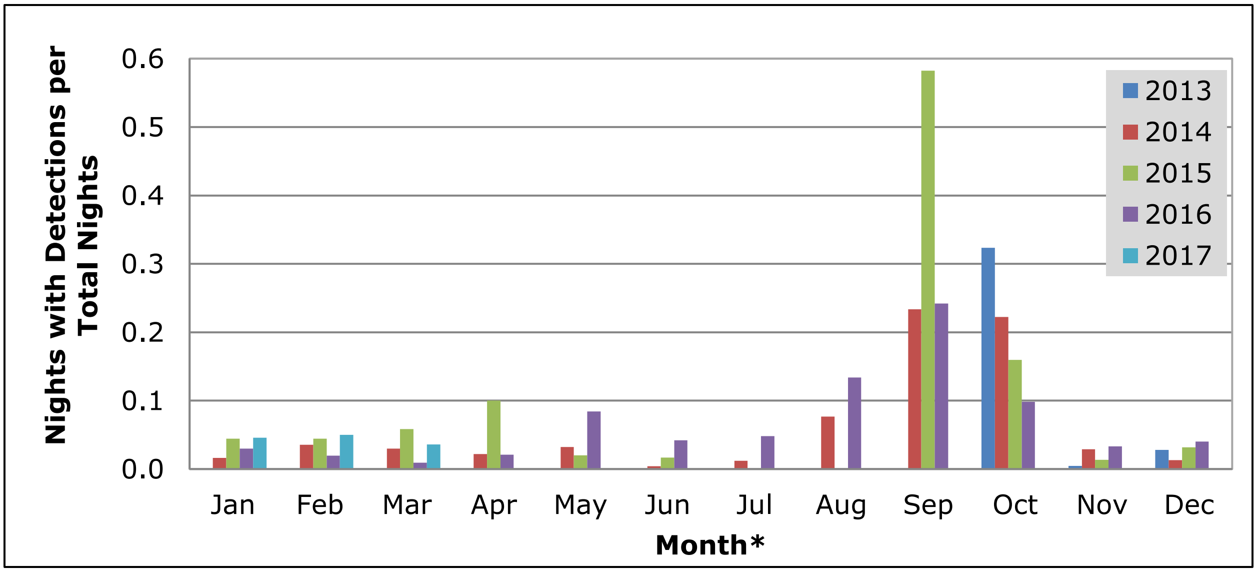


Figure 3.6. Hawaiian hoary bat activity at KWP II, using Wildlife Acoustics only ground detectors by month, from October 2013 through June 2017 (* no data for January–September 2013, July–August 2015, and July–December 2017).–*NEW*

3.8.5 Recently Listed Species–*NEW*

Except for the Covered Species, no other federally or state-threatened or endangered species have been documented in the project area. Species recently listed that are potentially present were also reviewed (Table 3.6). But these species would not use resources on the site, and project actions would not rise to the level of incidental take. Therefore, these species are not carried forward for analysis.

Table 3.6. Recently Listed Species with Potential to Occur in the KWP II Project Area–NEW

Common, Hawaiian Name(s)	Scientific Name	Listing Status; Date Listed	Presence in Project Area
Band-rumped storm petrel (ʻakeʻake)	*Oceanodroma castro*	Endangered; 10/31/16	Potential; individual petrels could fly over the project area, but the risk of take is extremely low.
Orangeblack damselfly	*Megalagrion xanthomelas*	Endangered; 10/31/16	No; required slow or standing water sources are absent.
Yellow faced bees	*Hylaeus anthracinus, H. assimulans, H. facilis, H. hilaris, H. longiceps*	Endangered; 10/31/16	No; host plants are absent.

4.0 BIOLOGICAL GOALS AND OBJECTIVES

4.1 General–*NO CHANGE*

KWP II, LLC has worked cooperatively with the USFWS and the DLNR to assess the potential for the proposed Project to cause adverse impacts to the four Covered Species through site-specific studies, and has taken all appropriate and practicable steps to avoid and minimize the potential for adverse impacts. Where the potential for impacts is unavoidable, this HCP provides means to minimize and mitigate any adverse impacts to Covered Species that may occur and provide a net conservation benefit.

This HCP has goals and objectives based on the species populations rather than their habitats. The proposed wind energy generation facility is anticipated to directly or indirectly impact individuals of the four Covered Species but will have only minor, negligible impacts on the amount or quality of habitats for these species.

Specific biological goals of this HCP are as follows:

- Minimize and mitigate, to the maximum extent practicable, the effects of take caused by the wind energy generation facility.
- Increase the knowledge and understanding of the four Covered Species’ occurrence and behavior in the project vicinity.
- Contribute to the goals of the USFWS nēnē draft revised recovery plan and DOFAW’s Nēnē Restoration Project.
- Contribute to goals of the recovery plans for the other three species, considering the most recent updated information and goals.
- Provide a net conservation benefit to each of the four Covered Species.

4.2 Project Alternatives–*UPDATED*

The project design was described in Section 1.4. The original alternatives listed in the HCP (original Sections 4.2.1, 4.2.2, 4.2.3, 4.2.4, 4.2.5 [SWCA 2011]) related to project construction and are no longer applicable because the Project has been built and is operating. As stated in the original HCP alternatives analysis, the current location and project turbine number and output size (the Proposed Action) was selected. At the time of the selection, the Proposed Action was considered optimal for fossil fuel reduction, most efficient location and turbine size, and minimal impact to wildlife given the known population status of the species potentially impacted and the net benefit expected from successful mitigation of those impacts. Current alternatives to amending the state ITL and federal ITP are considered below.

4.2.1 No Action Alternative (No Issuance of Amendment)–*NEW*

Under the No Action Alternative for the Project, an ITL/ITP amendment would not be issued by the BLNR or the USFWS, and KWP II, LLC’s amended HCP would not be in effect. An ITL/ITP amendment is not legally required for continued operation of the Project, but any incidental take occurring as a result of project operation that exceeds the existing ITL/ITP would not be authorized (i.e., take exceeding the current ITL/ITP would violate the ESA and the Applicant would assume all legal liability for operating the Project without additional take coverage). Because the Conservation District Use Permit (CDUP) for KWP II, issued by the Hawaiʽi DLNR, requires an approved HCP for the Project to operate, and failure to comply with the permit would lead to a shut-down or even decommissioning, the ability to continue operating without an amended permit would be dependent on additional curtailment activities such as temporary, long-term, or nighttime-only shut-down that would ensure the existing take permit for Covered Species was not exceeded. Nighttime-only shutdown eliminates bat take and temporary or long-term complete shutdown would reduce or eliminate any further nēnē take. Existing mitigation measures established in the current HCP would continue to be implemented for take already accrued.

As indicated in the original HCP and FEIS (Planning Solutions, Inc. 2010) for KWP II, partially or completely ceasing WTG operations would increase dependence on fossil fuels for power production and increase emissions of greenhouse gases. Considering the same assumptions quoted in the FEIS and assuming nighttime generation equals approximately 50% of total daily generation (assumed to be approximately 70,000 MWh/year), ceasing operations at night would add approximately 53.5 million pounds of CO_2, 0.375 million pounds of SO_2, and 97.5 thousand pounds of NO_x annually to Maui's environment from burning 69,000 more bbl of fossil fuels. In order to produce approximately 35,000 MWh annually from burning fossil fuels, the National Renewable Energy Laboratory (NREL) indicates approximately 16.5 million gallons of water (470 gallons/MWh) would be evaporated in the cooling process (NREL 2003).

Full nighttime curtailment or complete turbine shutdown to eliminate bat or nēnē take, respectively, would reduce potential annual generation to less than 35,000 MWh (nighttime curtailment) or 0 MWh (full curtailment). KWP II would no longer be able to generate enough revenue to continue to be financially viable and would cease operations.

4.2.2 Alternative 2 (Proposed Action)–*NEW*

Under the Proposed Action, the BLNR and the USFWS would issue an amended ITL/ITP and approve an amended HCP for the remainder of the Project's 20-year permit term, which would increase incidental take for the Covered Species and avoid, minimize, and mitigate that take to the maximum extent practicable. Adaptive management will be used to ensure maximum benefit to the species. The proposed mitigation project or actions within, could be modified by the USFWS or DOFAW based on new information. This change would take place under adaptive management and the "No Surprises" policy would not apply. Having the flexibility to determine the final mitigation plan details allows the wildlife agencies and the ESRC to determine the best mitigation project location and then tailor which activities would provide the best results for the specific location and species. The mitigation options available for the final plan are listed in Section 6.0.

The Proposed Action would include the following HCP/ITL/ITP changes:

- Increase authorized take of Hawaiian hoary bat from 11 adults [as revised by the USFWS and the DLNR] to a maximum of 38 adults during the 20-year permit (27 more adult bats)
- Increase authorized take of nēnē from 30 (of any age class) to a maximum of 44 adults (or juveniles converted to adult nēnē equivalents) during the 20-year permit (14 more adult nēnē)
- Include mitigation that will support bat research on life history, occupancy, habitat usage, and/or foraging information and aid in the recovery of the species
- Include mitigation options for bat take that conserves and protects bat habitat that would otherwise be at risk of development or continuing degradation from invasive species encroachment
- Include a mitigation option for bat take that would be contributing an approved level of funds for an in-lieu fee program managed by either the DLNR or the USFWS or both
- Continue to provide additional funding for nēnē mitigation at the existing Pi'iholo Ranch pen or begin providing funding for nēnē mitigation at the Haleakalā Ranch pen or a new pen to increase survival rates and productivity
- Continue the current LWSC regime; 5.5 m/s from February 15 through December 15 from sunset to sunrise, and begin to implement LWSC from December 15 through February 15 to 5.5 m/s from sunset to sunrise

KWP II, LLC, is responsible for ensuring that incidental take of Covered Species is mitigated to the maximum extent practicable. Any adverse impacts to nēnē would be fully offset by mitigation outlined in the Proposed Action. For the Hawaiian hoary bat, mitigation to the maximum extent practicable for the first tier of this amendment (Tier 3) is expected to provide research results that will facilitate long-term recovery and protection for the Hawaiian hoary bat. The research itself, while not directly producing replacement bats, specifically focuses on improving understanding of bat biology so that bat survival and productivity can be enhanced into perpetuity. Mitigation options that fully offset take are not known or not well characterized, which is the driving force behind conducting the proposed high-priority research to identify appropriate fully offsetting options for bat mitigation. Mitigation for the additional tier (Tier 4), if reached, is expected to fully offset take through a land acquisition or a land restoration or protection project informed by the research results of Tier 3 mitigation.

As mentioned previously, KWP II increased LWSC in August 2014 from 5.0 to 5.5 m/s, between February 15 and December 15 from sunset to sunrise. The EoA software can produce and evaluate the results of a likelihood ratio test (LR test) that tests the plausibility of the assumed relative mortality rate (ρ) designated for each of two periods being compared. The null hypothesis for this test is that the two periods' relative mortality rates are statistically the same. The two periods tested for KWP II are from July 2012 through June 2014 or state FYs 2013 and 2014 when LWSC was 5.0 m/s and from July 2014 through June 2018 or state FYs 2015 through 2018 when LWSC was 5.5 m/s (Table 4.1). The input values that were used to calculate the probabilities of detection in Table 4.1 are detailed in Appendix 27.

The null hypothesis assumes the relative fatality rate is the same for similar length periods. We provide the results of this test when comparing periods before and after LWSC was increased at KWP II. The results of the LR test for KWP II show the two periods' ρ is statistically different ($p = 0.013$). The probability that the fatality rate is the same before and after LWSC was implemented at KWP II is 1.3%, suggesting the null hypothesis ***is not supported*** (i.e., the mortality rate after LWSC was increased is statistically lower than before increasing LWSC). But it is not possible to reliably determine from this test how *much* different were the relative fatality rates between periods. According to Dalthorp *et al*. (2017) "results of the tests for the validity of the assumed relative mortality weights (ρ) and for potential bias are given because mortality estimates may not be accurate if ρ_i's are significantly mis-specified."

Table 4.1. KWP II Input for the Likelihood Ratio Test of ρ before and after Low Wind Speed Curtailment was Increased–*NEW*

Low Wind Speed Curtailment (LWSC)	Fiscal Year	rho (relative weight)	Observed Fatality	Ba	Bb	*g*	*g* 95% CI	
Before (LWSC 5.0 m/s)	2013	1	1	9.08	11.41	0.443	0.241	0.656
	2014	1	2	18.5	33.02	0.359	0.235	0.493
	Before	2	3	23.89	35.67	0.401	0.281	0.527
After (LWSC 5.5 m/s)	2015	1	0	10.95	21.68	0.336	0.187	0.503
	2016	1	0	35.09	61.84	0.362	0.27	0.46
	2017	1	0	87.96	111.1	0.442	0.374	0.511
	2018	1	0	26.69	47.44	0.351	0.247	0.463
	After	4	0	104.49	175.87	0.374	0.317	0.432

The LR test suggests that increasing the LWSC to 5.5 m/s did provide additional minimization of take (and if search conditions remain similar, will continue to reduce take relatively). It is not clear yet whether additional increases in LWSC would further minimize bat take. The results available from LWSC studies conducted in North America to date clearly show that implementing nighttime LWSC along with full feathering below the cut-in speeds can dramatically reduce fatality rates. But these studies varied in method, targeted LWSC levels, number of total fatalities detected (sample size), bat species affected, whether controls were included, and whether interturbine variation, chronological trends, and interannual variation were accounted for.

Nonetheless, the range of average reductions in bat fatality rates for LWSC treatments for these studies is as follows: for only full feathering, 30 to 70%; LWSC to 4.0 m/s, 20%; to 4.5 m/s, 47 to 57%; to 5.0 m/s, 33 to 87%; to 5.5 m/s, 60 to 73%; to 6.0 m/s, 33 to 60%; to 6.5 m/s, 74 to 78%; and to 6.9 m/s, 73% (Appendix 33; Arnett *et al*. 2009, 2010, 2013; Baerwald *et al*. 2009; Good *et al*.

2011, 2012, 2013, 2015, 2016, 2017, 2018; Martin *et al*. 2013, 2017; Stantec Consulting Ltd. 2012; Tidhar *et al*. 2013; Young *et al*. 2010, 2011, 2013) (Table 4.2 and Appendix 33). If just these results were considered, then the maximum reduction in take would occur at 5.0 m/s (87% reduction).

Table 4.2. Range of Reductions in Fatalities for Different Low Wind Speed Curtailment Levels (percent)–*NEW*

Low Wind Speed Curtailment	Low %	High %
Feathering only	30	70
to 4.0 m/s	No data	20
to 4.5 m/s	47	57
to 5.0 m/s	33	87
to 5.5 m/s	60	73
to 6.0 m/s	33	60
to 6.5 m/s	74	78
to 6.9 m/s	No data	73

To offset take of nēnē that results from project operations, KWP II, LLC, will continue to implement Tier 1 and Tier 2 mitigation measures, as described in the original HCP for the authorized take of 30 nēnē. But KWP II, LLC, will also implement additional mitigation (Tier 3) for the estimated take of an additional 14 adult nēnē over the remainder of the 20-year permit.

Mitigation for nēnē will consist of continuing predator control, vegetation management, and fence maintenance at an already established pen at Piʽiholo Ranch, on Maui, or funding nēnē mitigation similar to the nēnē mitigation at Piʽiholo Ranch and the Haleakalā Ranch, or at a new pen. The proposed mitigation is expected to result in long-term species benefits through increased adult and juvenile survival, as well as increased productivity, and is administered by DOFAW. The predator control is expected to provide sufficient benefits to a population of nēnē to exceed the mitigation obligation. The specific mitigation plan for nēnē has been determined (Appendix 31) and may be modified to continue beyond the current scope or include additional sites where predator control could be successfully implemented.

The reduced search areas now implemented at KWP II require minimal vegetation management. Previously, vegetation management of larger search areas to improve searcher efficiency for bats had regularly created areas of new grass growth attractive to nēnē. Wildlife disturbance avoidance protocols are reinforced for all employees and contractors using the site. Other than not creating new vegetation that could attract nēnē to forage and avoiding vehicle related disturbance that could lead to nēnē take through driver education and awareness, there are no options to further minimize take of nēnē at KWP II. Fortunately, mitigation to offset nēnē take has been proven successful for KWP I mitigation efforts, and we expect mitigation for nēnē take at KWP II to also be successful.

KWP II, LLC, works with the USFWS and the DLNR to assess the success of proposed mitigation measures and implement adaptive management measures, if the USFWS and/or DOFAW deem them necessary to meet the specific success criteria of the mitigation. Triggers for adaptive management are based on monitoring results or other scientific knowledge that becomes available to the wildlife agencies. For these reasons, mitigation for the Proposed Action will ameliorate adverse impacts to the nēnē population on Maui. As noted above, this alternative would provide additional species benefits when compared to the No Action Alternative because of the increase in productivity and protection of nesting of nēnē and their offspring.

4.2.3 Alternative 3 (Additional Low Wind Speed Curtailment to 6.5 m/s)–*NEW*

Under this alternative, the direct and indirect effects associated with general project operation, decommissioning, and implemented avoidance and minimization measures from the initial HCP would generally be as described for Alternative 2. But all KWP II facility turbines would be curtailed up to 6.5 m/s from sunset to sunrise year-round. This change in curtailment regime (i.e., curtailment in addition to what the Project has already committed to, which is 5.5 m/s) may positively affect bats but not nēnē.

Compensatory mitigation measures could be reduced commensurate with the reduction in the amount of incidental take of bats that may result from increased curtailment.

This alternative assumes that there would be a significant and measurable reduction in take compared to the status quo. Although existing research (Arnett *et al*. 2009, 2010, 2013; Baerwald *et al*. 2009; Good *et al*. 2011, 2012, 2013, 2015, 2016, 2017, 2018; Martin *et al*. 2013, 2017; Stantec Consulting Ltd. 2012; Tidhar *et al*. 2013; Young *et al*. 2010, 2011, 2013; Appendix 33) indicates that increases in curtailment (from "no curtailment") reduces take, there is insufficient research evidence to conclude that there is a reliable additional benefit when increasing curtailment above 5.5 m/s.

Only three studies have been designed to specifically test statistical significance between the two experimental treatments of adding LWSC to 5.0 m/s and to 6.5 m/s (Casselman Wind in 2008 and 2009 and Fowler Ridge Wind in 2010). One of these three studies, at Fowler Ridge Wind in 2010, showed a statistically significant decrease in fatality rates between LWSC to 5.0 m/s and to 6.5 m/s (Figure 4.1). There are no studies to date that test whether mortality rates decrease significantly when LWSC is raised from 5.5 m/s to 6.5 m/s. Given the scarcity of studies showing further fatality rate reductions when increasing LWSC further to 6.5 m/s, increasing the curtailment from 5.5 m/s to 6.5 m/s for KWP II to produce a measurable additional reduction in fatality rates is not sufficiently supported. The recent decision by the Hawai'i BLNR to approve the Na Pua Makani Wind Power HCP (DLNR News Release May 18, 2018) did not include increasing LWSC above 5.5 m/s to minimize potential bat take expected at that wind site.

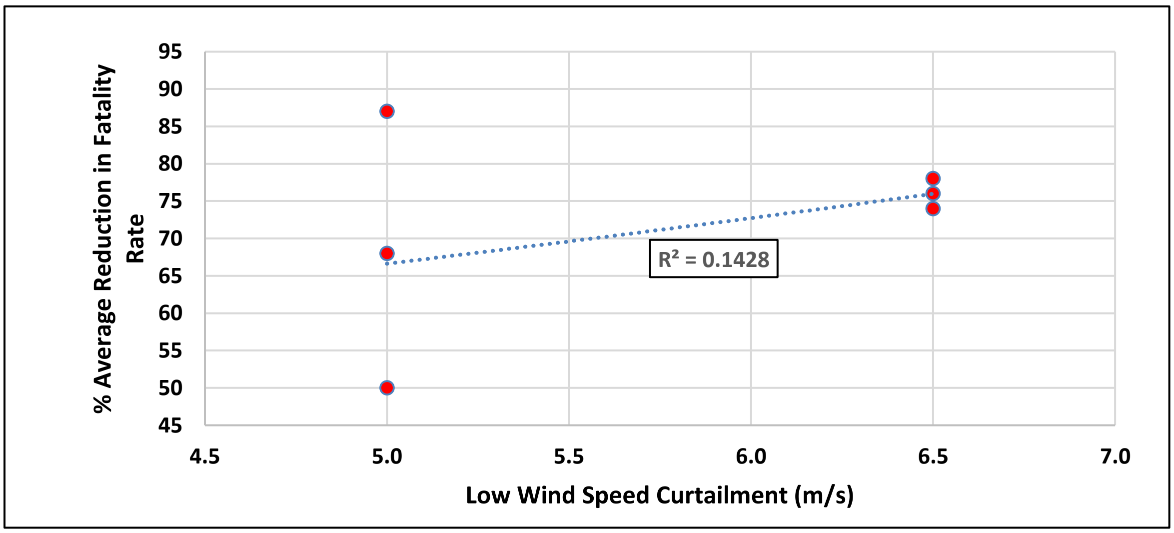


Figure 4.1. Average Reduction in Fatality Rate between 5.0 m/s and 6.5 m/s for Three Studies.–*NEW*

Research investigating the relationship between wind speed and bat activity does suggest that generally bats are detected much less frequently as wind speed increases and that a majority of bat fatalities are recorded only when wind speeds are less than 6.0 m/s (Arnett *et al.* 2008). In an analysis of ultrasonic bat detections at nacelle height (100 m) at all turbines at a wind generation site on O'ahu, 100% of detections occurred at less than or equal to 8.0 m/s wind speeds and 95% of detections occurred at less than or equal to 6.0 m/s (oral presentation by Mitchell Craig at the North American Society for Bat Research Symposium 2015). This analysis also showed that at ground level detectors (6.7 m), no bats were detected at wind speeds greater than 11 m/s, while 65% of detections near the ground occurred when wind speeds were less than 6.0 m/s and also suggested that activity rates at the ground detectors was higher than at the nacelle detectors. Gorresen *et al.* (2015) also show that bat activity decreases with higher wind speeds. 84% and 92% of bat activity was recorded when wind speeds were less than 5.5 m/s and 6.5 m/s, respectively. Considering just the Gorresen *et al.* (2015) study could suggest that increasing LWSC to 6.5 m/s might decrease bat take by 8%. If direct take is estimated to be 35.2 adult bats, then increasing the LWSC to 6.5 m/s might decrease estimated direct take by three bats. Increasing LWSC to 6.5 m/s, even if effective, may still not substantially decrease the take projected or the take request.

A general analysis of generation and income lost for KWP II for different LWSC regimes suggests that increasing the LWSC from 5.5 m/s to 6.0 or 6.5 m/s (year-round) would not jeopardize the Project financially *assuming* wind resources are sufficient to meet minimum expectations of the PPA between MECO and KWP II and the MECO priority position for KWP II on Maui that determines which wind site's power generation MECO accepts first, second, and third does not change. If observed take continues to be zero, as it has been since LWSC was increased to 5.5 m/s in August 2014, it would be very difficult to show any decrease in the fatality rate from any additional change in LWSC regime or deployment of sonic deterrents on turbines.

Compared to maintaining the status quo, increasing curtailment from 5.5 m/s to 6.5 m/s would reduce renewable energy generation from the Project by approximately 328 MWh annually (or 47% of the 70,000 MWh assumed to be produced annually) and would increase energy production from fossil fuels and increase greenhouse gas emissions. AWS Truepower LLC determined the generation losses based on the wind resource study conducted prior to operations (unpublished report to TerraForm Power). Emissions from fossil fuel generation of 328 MWh generation annually from petroleum-based fuels would add 500,499 pounds of CO_2, 3,508 pounds SO_2, and 913 pounds of NOx. In order to produce approximately 328 MWh annually from burning fossil fuels, the NREL indicates that approximately 154,160 gallons of water (470 gallons/MWh) would be evaporated in the cooling process (NREL 2003).

Based on research at mainland U.S. wind farms and in Hawai`i, at this time, the benefit of increasing LWSC from 5.5 m/s to 6.5 m/s is not sufficiently supported to be a reliable source of bat take minimization. Therefore, at this time, the alternative to increase LWSC to 6.5 m/s is not considered a reliable method to decrease take.

4.2.4 No-Action Alternative: "No Build"–*NO LONGER APPLICABLE*

4.2.5 Alternate Project Location–*NO LONGER APPLICABLE*

4.2.6 Alternate WTG Locations at Kaheawa Pastures–*NO LONGER APPLICABLE*

4.2.6.1 Upwind Siting Area

4.2.6.2 Downwind/Downstring Siting Area

4.2.6.3 Individual WTG Locations at Kaheawa Pastures

4.2.7 Greater or Fewer Number of WTGs–*NO LONGER APPLICABLE*

4.2.7.1 Reduced Scale Project (<21 MW)

4.2.7.2 Increased Scale Project (>21 MW)

4.2.8 Turbine Design and Size–*NO LONGER APPLICABLE*

4.3 Avoidance and Minimization of Impacts–*UPDATED*

4.3.1 Site-Specific Project Design Considerations–*UPDATED*

The analysis of project design alternatives supports the conclusion that the Proposed Action is preferred when all impacts on the human and natural environment are considered. Because complete avoidance of risk to the four Covered Species is impossible under the Proposed Action, the Applicant has sought to avoid and minimize the risk of collisions to the greatest extent practicable and supported by available research by making the turbines less attractive, more visible, and/or more likely to be avoided by birds and bats. Avoidance and minimization measures include the following:

- Employing relatively few turbines situated in two single rows rather than a large number of staggered turbines or multiple rows
- Using monopole steel tubular towers for turbines rather than lattice towers, to virtually eliminate perching and nesting opportunities. The tubular towers may also reduce collision risk because they are considerably more visible.
- Utilizing a rotor with a rotational speed (11 to 20 rpms) that makes the rotor visible during operation
- Choosing a site in proximity to existing electrical transmission lines to reduce the length of overhead transmission line needed from the Project to the interconnect location
- Selecting a site in proximity to the existing KWP I facility so key infrastructure can be shared, thereby minimizing the need for new disturbance and development. Also, the considerable body of data that has been collected on endangered species at the KWP I site informs KWP II site selection and avoidance/minimization measures as well as likely mitigation requirements.
- Placement of all new power collection lines underground as far as practicable to minimize the risk of collision with new wires; overhead collection lines are fitted with marker balls to increase visibility. All overhead collection lines are spaced according to Avian Power Line Interaction Committee (APLIC) guidelines to prevent possible electrocution of native species. Species most at risk at those likely to perch on power poles or lines (APLIC 2006). Only one species is identified to be at risk at KWP II, the Hawaiian short-eared owl. Using the barn owl as a surrogate species, the horizontal spacing is more than 20 inches (51 cm) to accommodate the wrist-to-wrist distance of the owl. If a vertical arrangement is chosen, a vertical spacing of more than 15 inches (38 cm, head-to-foot length) is used (APLIC 2006). Any jumper wires are insulated.
- Placement of the overhead power collection line is as close to the existing MECO transmission line as practicable (see section 1.4). These lines fall within the height range of the existing transmission lines (currently arranged as a vertical array of four lines) and also parallel their alignment across the gulch to reduce the cumulative cross-sectional area presented. Marker balls, which are present on both lines, should increase their visibility to Covered Species and minimize the risk of collisions.
- Designing and installing the site substation and interconnect to MECO's transmission lines using industry-standard measures to reduce the possibility of wildlife electrocutions
- Installing un-guyed met towers as opposed to guyed met towers to avoid potential for avian collision with guy wires
- Restricting construction activity to daylight hours as much as practicable during the seabird breeding season to avoid the use of nighttime lighting that could be an attraction to seabirds
- Requesting FAA endorsement of a lighting plan designed to reduce the likelihood of attracting or disorienting seabirds
- Having minimal on-site lighting at the O&M building and substation, using fixtures that are shielded and/or directed downward and only utilized on infrequent occasions when workers are at the site at night. In addition, timers, motion sensors, and similar devices have been employed where feasible to minimize the risk of unintended light emissions. These three lighting measures not only minimize impacts to wildlife but also ~~to~~ reduce the visual impact as viewed from local communities at night
- Implementation of a daily search protocol during construction to minimize the risk of direct impacts to nēnē and their nests (Appendix 12)
- Should construction begin and nēnē and/or a nest(s) are subsequently discovered, designated environmental personnel are immediately notified and construction activities modified or curtailed until appropriate measures are implemented, with approval of the DLNR and the USFWS, which reduces or eliminates adverse risk to nēnē or their nests (Appendix 12)

- Clearing of trees above 15 feet in height between June 1 and September 15 will not occur, as it is the period when non-volant Hawaiian hoary bat juveniles may occur in the project area
- LWSC has been implemented since the Project was operational to reduce the risk of bat take. Recent studies on the mainland indicate that most bat fatalities occur at relatively low wind speeds, and, consequently, the risk of fatalities may be significantly reduced by curtailing operations on nights when winds are light and variable. Research suggests this may best be accomplished by increasing the cut-in speed of wind turbines from their normal levels (usually 3.5 or 4 m/s, depending on the model) to at least 5 m/s. Two years of research conducted by Arnett *et al.* (2009, 2010) found that bat fatalities were reduced by an average of 82% (95% Confidence Interval [CI]: 52–93%) in 2008 and by 72% (95% CI: 44–86%) in 2009 when cut-in speed was increased to 5 m/s. No significant additional improvement over this level was detected when the cut-in speed was increased to 6.5 m/s.

  LWSC currently is implemented at night year-round by raising the cut-in speed of the Project's wind turbines to 5.5 m/s between sunset and sunrise. Curtailment may also be modified with the approval of DOFAW and the USFWS if site-specific data demonstrate a lack of bat activity during certain periods, or if experimental trials are conducted that demonstrate that curtailment is not reducing collision risk at the Project during the entire curtailment period.
- A speed limit of 15 mph is enforced to reduce possible vehicular collisions with nēnē and Hawaiian short-eared owl.
- Escape ramps are installed in each of the catchment basins of the pad-mounted transformers to allow wildlife to exit the basins when standing water is present.

4.3.2 USFWS Guidelines–*NO CHANGE*

While wind energy has been utilized for centuries, it has expanded rapidly rather recently in the United States and worldwide with advances in technology and increased interest in renewable and alternative energy sources. In recognition of the growing wind energy industry in the United States, the USFWS has prepared *Interim Guidelines to Avoid and Minimize Wildlife Impacts from Wind Turbines* (USFWS 2004b) available through the USFWS website, http://www.fws.gov. The guidelines were published simultaneously with a *Federal Register* Notice of Availability and request for comments on the guidelines.

After reviewing the comments received, the Secretary of the Interior established a Wind Turbine Guidelines Advisory Committee to provide advice and recommendations to the Secretary of the Interior on developing effective measures to avoid or minimize impacts to wildlife and their habitats related to land-based wind energy facilities. To date, no updates to the *Interim Guidelines* have been released, and compliance with them is considered voluntary. Nonetheless, the Applicant believes that these guidelines provide several substantive recommendations that are relevant and applicable to the proposed wind energy generation facility.

Table 4.1 lists the recommendations from the *Interim Guidelines* relating to site development and turbine design and operation and discusses how the Applicant plans to comply with these recommendations. It should be noted that these recommendations relate to all wildlife, whether or not they are protected under the ESA or MBTA, and the benefits of following these recommendations, where applicable, extend beyond the implementation of this HCP.

Table 4.1. Compliance of the Proposed KWP II Facility with the USFWS Interim Voluntary Guidelines for Wind Projects (USFWS 2004b).–*NO CHANGE*

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed KWP II Facility
Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the federal Endangered Species Act.	There are no locations on Maui that are both: (a) suitable for a financially viable wind energy generation facility, and (b) unlikely to be visited by listed species. Data from the existing KWP I facility indicates that occurrence of the Covered Species on the site is relatively low and take is commensurately at or below Tier 1 identified in the KWP I HCP. The proposed KWP II project minimizes habitat disturbance by sharing key infrastructure with KWP I and likewise incorporates measures to avoid and minimize risk to Covered Species as much as possible while still meeting the basic project purpose.
Avoid locating turbines in known local bird migration pathways or in areas where birds are highly concentrated, unless mortality risk is low (e.g., birds present rarely enter the rotor swept zone). Examples of high-concentration areas for birds are wetlands, state or federal refuges, private duck clubs, staging areas, rookeries, leks, roosts, riparian areas along streams, and landfills. Avoid known daily movement flyways (e.g., between roosting and feeding areas) and areas with a high incidence of fog, mist, low cloud ceilings, and low visibility.	This recommendation has been followed as much as practicable while still meeting the basic project purpose. Survey data collected to date has shown that birds do not occur in the area in high concentrations.
Avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas.	This recommendation has been followed, based on the little information available on Hawaiian hoary bats. The species is not known to hibernate or occur colonially. While a few bats have been confirmed to fly through the project area, no habitat considered suitable for roosting or breeding is present in or adjacent to the project area.
Configure turbine locations to avoid areas or features of the landscape known to attract raptors (hawks, falcons, eagles, and owls). For example, golden eagles, hawks, and falcons use cliff/rim edges extensively; setbacks from these edges may reduce mortality. Other examples include not locating turbines in a dip or pass in a ridge or in or near prairie dog colonies.	This recommendation has been followed, to the extent that it is applicable, by situating the turbines on high ground, outside of the Manawainui Gulch and Malalowaia‘ole Gulch, where most Hawaiian short-eared owl activity has been observed; much like what is observed at KWP I, Hawaiian short-eared owls at KWP II are expected to be observed occasionally flying over grasslands of the wind farm but at low risk of collision with the turbines and associated structures (see Section 3.7).

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed KWP II Facility
Configure turbine arrays to avoid potential avian mortality where feasible. For example, group turbines rather than spreading them widely and orient rows of turbines parallel to known bird movements, thereby decreasing the potential for bird strikes. Implement appropriate stormwater management practices that do not create attractions for birds and maintain contiguous habitat for area-sensitive species (e.g., sage grouse).	Turbines have been arranged as closely as feasible, given wind resource and terrain considerations, and in a linear fashion that is generally parallel to the direction of birds moving to and from the ocean. No potentially attractive water features will be constructed for the Project.
Avoid fragmenting large, contiguous tracts of wildlife habitat. Where practical, place turbines on lands already altered or cultivated and away from areas of intact and healthy native habitats. If not practical, select fragmented or degraded habitats over relatively intact areas.	The majority of the natural environment in the project area has been previously disturbed by wildfires, pasturing, and grazing uses. Existing areas of native cover types are fragmented and interspersed with disturbed, non-native dominated cover. Nēnē do utilize open areas and rock outcrops, and the Applicant has micro-sited the proposed WTGs so as not to disturb the features that are most attractive to nēnē.
Avoid placing turbines in habitat known to be occupied by prairie grouse or other species that exhibit extreme avoidance of vertical features and/or structural fragmentation. In known prairie grouse habitat, avoid placing turbines within 5 miles of known leks (communal pair formation grounds).	Not applicable–no such species occur in the area.
Minimize roads, fences, and other infrastructure. All infrastructure should be capable of withstanding periodic burning of vegetation, as natural fires or controlled burns are necessary for maintaining most prairie habitats.	This recommendation will be followed. A Wild Land Fire Contingency Plan is in place for KWP I and will be administered at KWP II as well (see Appendix 18, note that controlled burn and prairie considerations are not applicable).
Develop a habitat restoration plan for the proposed site that avoids or minimizes negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species. For example, avoid attracting high densities of prey animals (rodents, rabbits, etc.) used by raptors.	This recommendation will be followed. Revegetation of disturbed areas and other habitat improvement measures will be coordinated with DLNR staff.
Reduce availability of carrion by practicing responsible animal husbandry (removing carcasses, fencing out cattle, etc.) to avoid attracting golden eagles and other raptors.	This recommendation is not applicable as golden eagles and other raptors are not species of concern in the vicinity of the Project.

5.0 ASSESSMENT OF POTENTIAL IMPACTS

5.1 Assessment of Potential Impacts to Covered Species–*UPDATED*

Generation of electrical energy from wind is a renewable, clean, environmentally friendly technology. It reduces greenhouse gas emissions and water use in electricity generation. At the same time, the potential for wind energy turbines to adversely affect birds and bats is well documented in the continental United States (e.g., Horn *et al.* 2008; Kunz *et al.* 2007; Kingsley and Whittam 2007; Kerlinger 2005; Erickson 2003; Johnson et al*.* 2003a, 2003b).

5.1.1 Impacts to Birds–*NO CHANGE*

Erickson *et al.* (2001) estimates that an average of 2.19 bird fatalities occurs per wind turbine annually in the United States. Based on 12 wind projects in the United States, the National Wind Coordinating Collaborative (2004) estimated an average annual avian fatality rate of 2.3 birds per turbine. Though avian fatality rates differ by region, projects in California presently account for the highest wind-related avian mortality in North America. Certain types of birds in certain settings seem to have a higher risk of collision with wind energy facilities than others. When abundant in open country, as in California, raptors (hawks, eagles, falcons, and owls), have had comparatively high fatality rates, though passerines as a class generally comprise the majority of fatalities at wind facilities nationwide (Erickson *et al.* 2001; NWCC 2004; Kingsley and Whittam 2007). Although some impacts to avian species may occur as a result of habitat alteration and disturbance or operation of vehicles, most fatalities at wind facilities are attributed to collisions with wind turbine rotors, met towers, or guy wires (Kerlinger and Guarnaccia 2005).

Numbers of avian fatalities at wind energy facilities are very low compared to the numbers of fatalities resulting from some other human-related causes. Known sources of anthropogenic bird losses outside of wind energy sites include lighted buildings, windows, communications towers, power lines, smokestacks, vehicles, cat predation, pesticides, and hunting (Podolsky *et al.* 1998; Erickson *et al.* 2001; Martin and Padding 2002; Woodlot Alternatives, Inc. 2003; 69 *Federal Register* 42447–42449; Mineau 2005). Mortality from these other sources is many orders of magnitude higher than that which occurs at wind facilities.

5.1.2 Impacts to Bats–*UPDATED*

The number of bat fatalities at wind energy facilities has often exceeded the number of avian fatalities. Studies in the continental United States have shown that annual fatality rates vary by region, with an average of 1.2 bat fatalities per turbine in the Pacific Northwest and Rocky Mountains, 1.7 bat fatalities per turbine (0.1–7.8 bats per turbine) in the Upper Midwest, and as many as 46.3 bat fatalities per turbine (15.54–69.6 bats per turbine) in certain areas of the eastern United States (Johnson 2005). Differences are likely due to variations in local habitat conditions and population sizes of the most susceptible species. Facilities studied in the eastern United States where fatalities are highest are primarily located along forested ridgetops as opposed to open areas and where migratory tree-roosting species are most numerous. Geographic and topographic differences may also be factors. Most of the recorded bat fatalities in the United States (83.2%) are members of migratory tree-roosting species. Hoary bats, of which the Hawaiian hoary bat is a nonmigratory (in the classic sense) subspecies, are the most frequently (45.5%) recorded fatalities (Johnson 2005; Cryan and Brown 2007).

Available evidence indicates that bat mortality at continental U.S. wind facilities peaks in late summer and fall, coinciding with mating and migration. Increased bat fatalities also tend to occur during periods of low wind speed (< 13.5 mph or 6 m/s) and passing weather fronts (Arnett *et al.* 2008). In contrast, observed bat collision mortality during the breeding season is rare (Johnson *et al.* 2003b). Similar to birds, bats are also known to collide with high, human-made structures (Johnson 2005).

The high number of fatalities of migratory tree-roosting bats at wind energy facilities has stimulated a cooperative research effort to explore how and why bats contact turbines (Arnett *et al.* 2008). Several possible explanations have been generated. Research has suggested that some fatalities may result from mating behaviors that center on the tallest trees in a landscape (Cryan 2008). Some have suggested that some bats may be attracted to audible sound, ultrasound, and movement of wind turbine structures (Horn *et al.* 2008). But research on the sound emissions of various turbines found that ultrasonic emissions attenuated at short distances from the turbine and there was no evidence of unusual ultrasonic emissions that would attract bats (Szewczak and Arnett 2006). Other theories speculate that migratory behavior, such as stopovers, are responsible for observed fatality rates (Johnson 2005; Cryan and Brown 2007) or that forest edges produced by access roads create favorable foraging habitat (Horn *et al.* 2008). Baerwald *et al.* (2008) documented that some bats killed at wind turbines suffered from barotrauma (i.e., pulmonary hemorrhaging caused by a rapid reduction in air-pressure, such as occurs behind moving turbine blades rather than direct collision with blades), although a more recent assessment of injured bats has revealed that barotrauma was not the cause of most wind turbine–related injury (Rollins *et al*. 2012).

Impacts to bats, particularly migratory tree-roosting bats, as a result of collision with wind turbines are well documented in the continental United States (Johnson & Strickland 2003, Kunz *et al.* 2007, Arnett *et al.* 2008, Cryan 2011, Cryan *et al.* 2014) and, as more facilities come online, are increasingly apparent in Hawai‘i. Most mortality occurs during the fall migration period. Hoary bats in Hawai‘i do not migrate in the traditional sense, although, as indicated, some seasonal altitudinal movements occur.

Baerwald *et al*. (2009) conducted a study during the peak period of migration (August 1–September 7, 2007) for hoary and silver-haired bats (*Lasionycteris noctivagans*) at a wind energy installation in southwestern Alberta, Canada, where these bat species comprised the dominant fatalities. They tested three treatment groups (control turbines, treatment turbines with increased cut-in speed, and experimental idling turbines with the blades manipulated to be motionless during low wind speeds), combining the two experimental treatment results and comparing them to control turbines. They concluded that the experimental turbines had lower fatality rates for each species.

Cryan *et al*. (2014) analyzed wind turbine activities at a facility in northwestern Indiana using thermal video surveillance cameras, supplemented with near-infrared video, acoustic detectors, and radar. They found that wind speed and blade rotation speed influence the way that bats approached turbines. Bats approached turbines less frequently when the blades were spinning fast, and the prevalence of leeward versus windward approaches to the nacelle increased with wind speed at turbines with slow-moving or stationary blades.

Studies from 10 different operational mitigation wind farms in North America found reductions in fatality rates by altering turbine operations (Arnett *et al.* 2013). Most studies found at least a 50% reduction in bat fatalities when turbine cut-in speed increased by 1.5 m/s above the manufacturer's specified cut-in speed (typically 3–4 m/s). One study implementing a raised cut-in speed for temperatures above 9.5 degrees Celsius reported similar reductions in bat fatalities. Another study demonstrated equally beneficial reductions with a low-speed idling approach, whereas another discovered that simply feathering turbine blades (pitched to 80-90 degrees [i.e. parallel to the wind] and nearly stopped) below the manufacturer's cut-in speed resulted in up to 72% fewer bats killed. For further discussion, see Sections 4.2.2 and 4.2.3.

5.2 Estimating Project-Related Impacts–*UPDATED*

5.2.1 Pre-Construction Take Tier 1 and Tier 2 Estimates for Covered Species

In the State of Hawai‘i, wind-powered generation facilities are relatively new; thus, few wildlife monitoring impact studies have been conducted to document the direct or indirect impact of wind energy facilities on particular species. But post-construction monitoring to document downed wildlife has been conducted at the KWP I facility since operations began in June 2006 (Kaheawa Wind Power 2008b, 2008c) and suggests that avian mortality resulting from the KWP II project may occur at a lower rate than has occurred at facilities in the continental United States. This information is based upon the best available scientific research into the potential risk to wildlife posed by WTGs in the downroad KWP II project area, as well as the take estimates made for the KWP I project.

Estimated annual mortality resulting from the KWP II project for each of the Covered Species is provided in the following sections. Included for each species is an estimate of the amount of indirect take expected to occur based on the expected level of direct take, as discussed in Section 7.2. The equations discussed are presented below.

Total Direct Take = Observed Take + Unobserved Take

Total Adjusted Take = Total Direct Take + Indirect Take

"Total direct take" will be calculated based on the best available estimator approved by the agencies at the time. An example of an estimator, proposed in Huso (2008) is presented below.

$$\hat{m}_{ij} = \frac{c_{ij}}{\hat{r}_{ij}\hat{p}_{ij}\hat{e}_{ij}}$$

where

- **m_{ij}** Estimated mortality
- **r_{ij}** Estimated proportion of carcasses remaining after scavenging
- **e_{ij}** Effective search interval
- **p_{ij}** Estimated searcher efficiency
- **c_{ij}** Observed take

A detailed protocol of how monitoring will take place at KWP II (including methods of quantifying SEEF and scavenging rates) is provided in Section 7.2 and Appendix 2.

Sections 5.2.4 through 5.2.7 identify anticipated levels of direct and indirect take for each of the Covered Species. Due to the very low observed levels of activity at KWP II for most of the Covered Species, the mortality modeling provides very low estimated rates of direct take. For most species, based on the modeling, annual mortality is expected to average less than one individual per species per year over the life of the Project. To account for the stochasticity of take over time, where take in any given year may be higher or lower than the expected long-term average, 1-year, 5-year, and 20-year take limits are proposed (e.g., take for Species A could be authorized as three individuals in any given year but not more than five individuals total every 5 years and not more than 10 individuals for 20 years). Short-term take limits (1-year and 5-year limits) also provide benchmarks for the monitoring of take and will enable mitigation efforts to be tailored to respond to more immediate events. Twenty-year limits, however, are believed to be a better reflection of the long-term amount of take expected.

Post-construction monitoring will be used to determine total direct take attributable to the Project on an annual basis. Total direct take and indirect take of each Covered Species will be identified as Tier 1 or Tier 2. The amount requested to be authorized by the ITP and ITL will cover the total adjusted take, essentially the sum of total direct take and indirect take. For each species, the annual **Tier 1** level of take was estimated based on the expected average annual mortality, rounded up to the nearest whole integer, and then adjusted to account for expected levels of unobserved direct take. For example, modeling suggests nēnē mortality will occur at an average rate of approximately 0.5 adult per year. To identify the annual Tier 1 level of take requested to be authorized, this was first rounded up to one adult per year (i.e., almost 2 times). Then, based on assumptions concerning unobserved direct take, it was expected that the discovery of one nēnē mortality in a given year would lead to an assessment of total direct take for that year of two nēnē. So, while the modeling suggests that nēnē mortality will occur at a rate of roughly one adult bird every 2 years, because it cannot be known if or in what year mortality will occur and because of assumptions concerning unobserved direct take, it is necessary to have the annual Tier 1 take authorization for nēnē allow the total direct take of a minimum of two adult birds in any given year. In addition, to allow for the uneven distribution of take over time, it is possible for two birds to be taken in any one year, followed by no take in the subsequent years. Hence, an observed take of two birds in one year is possible and likely to be rounded up to a total direct take of three to four birds after all the adjustments have been applied. Therefore, for some of the Covered Species, a direct take of up to four birds is requested for the *annual* Tier 1 level of take.

The 5-year and 20-year Tier 1 levels, being of a longer-term duration, however, are expected to more closely reflect the expected *annual average* mortalities.

A **Tier 2** rate of take would be that which exceeds the authorized Tier 1 rate. A Tier 2 rate of take is 1.5 to 2 times the Tier 1 rate of take over a **5**- or **20**-year period. Because of expected annual variability in actual rates of take, this HCP proposes that different levels of take be authorized. Any take occurring in excess of the 1-year, 5-year, and 20-year Tier 1 limits could be considered a Tier 2 rate. But it would be possible for rates of take to occur so unevenly that take could qualify as Tier 2 in one year and "Tier 1 over the corresponding 5-year term. Therefore, Tier 2 rates of take identified over 5-year and 20-year terms will be used to make adjustments to mitigation efforts because they will have incorporated some averaging of annual variability, while Tier 2 rates measured over 1-year terms will be used as early warnings that adjustments to mitigation efforts may become necessary and to spur investigation into why a Tier 2 rate of take occurred and whether steps can be taken to reduce future take. If post-construction monitoring indicates that take has exceeded the 5-year or 20-year Tier 1 take limit for any species, the Applicant would be determined to be at a Tier 2 rate of take and would implement Tier 2 mitigation.

In this amendment, the descriptions of the methods used to calculate the Tier 1 and 2 take requests (i.e., Sections 5.2.6.4 and 5.2.7.3) are not changed. The new take requests based on site-specific post-construction fatality monitoring are described in detail in Sections 5.2.6.4.2 and 5.2.7.4.

5.2.2 Post-Construction Incidental Take Estimates–*NEW*

Year-round fatality monitoring of all 14 turbines at KWP II, conducted since operation of the Project began in July 2012, and estimation modelling using EoA software (Version 2.6) (Dalthorp *et al.* 2017) indicate that the rates of take of nēnē and Hawaiian hoary bat are higher than originally anticipated (KWP II 2017). The EofA software and input parameters are described in Sections 1.4.5.1 and 1.4.5.2 and in Appendix 27. The Tier 2 take levels for both species have been, or are expected to be, exceeded before the end of the ITP/ITL terms (see Table 1.1). Therefore, increases in the take authorizations for nēnē and Hawaiian hoary bat are being requested and additional take is added to the HCP for these two Covered Species. For the additional take, 20-year take limits are projected and proposed for each species (see Table 1.1).

The proposed 20-year take limits are extrapolated based on rates of take estimated from the 2012–2018 period and are equivalent to the estimated total adjusted take where

Total Direct Take = Observed Take + Unobserved Take

Total Adjusted Take = Total Direct Take + Indirect Take

Construction and operation of the KWP II project have created the potential for the Covered Species to collide with the WTGs, temporary and permanent met towers, overhead collection lines, and cranes used for construction of the turbines. The total direct take attributed to the KWP II project ~~will be~~is the sum of observed direct take (actual individuals found or projected to be found for future estimations during post-construction monitoring) and unobserved direct take estimated based on modeling using required inputs to the EoA software.

The unobserved direct take accounts for individuals that may be killed by collision with project components but that are not found by searchers for various reasons described here.

In addition to direct take, collision with project components can also result in the indirect take of Covered Species. It is possible that adult birds directly taken during certain times of the year could have been tending to eggs, nestlings, or dependent fledglings or that adult bats could have been tending to dependent juveniles. The loss of these adults could then also lead to the loss of eggs or dependent young the adult was tending. Loss of eggs or young is indirect take attributable to the Project.

If mitigation to replace take is delayed, loss of future productivity in years subsequent to when direct and indirect take occur can also accrue. This future loss of productivity is estimated based on adult and juvenile or fledgling survival rates, annual reproductive rate, and age to first reproduction. While loss of productivity requires additional mitigation, it is not considered incidental take and therefore does not affect the amount of take that is authorized under the permits. Loss of productivity is not calculated for bats.

5.2.3. Indirect Take–UPDATED

For the purposes of this HCP amendment, an assessment of indirect take is added to any observed direct take based on the presumed breeding status of the taken individual and potential productivity, as discussed below.

Hawaiian petrel, Newell’s shearwater, and Hawaiian hoary bats have a well-defined breeding season. For these three species, breeding status will be assigned following the general principles identified as follows:

- If an adult female bat is found during breeding season (April 1–September 15) and if an estimate of the average breeding rate of the species (percent of adult population breeding in ~~each~~a given year) is available, the average population breeding rate will be used to determine the probability that the adult was breeding.
- If an adult female bat or adult bat of unknown sex is found during breeding season, and if an estimated breeding rate is not available for the species, the adult will be assumed to have been breeding unless a female bat is clearly determined to be neither pregnant nor with dependent young. Beginning in FY 2018, the sex of all bats found during the breeding season will be determined by the USGS and will be funded by the Project.
- If an adult is found outside of the breeding season, the adult will be assumed to have been nonbreeding.
- Immatures will be assumed to be nonbreeding regardless of season.
- If age cannot be determined, an individual will be assumed to have been an adult.

The nēnē has an extended breeding season (August to April), although the majority nest from October to March. In the case of assigning breeding status to the nēnē, the following principles are applied:

- If an adult is found during the months of October through March, the average population breeding rate (60%) will be used to determine the probability that the adult was breeding.
- If an adult is found in April, August, or September, it will be assumed there was a 25% chance the bird had been actively breeding.
- If an adult is found in May, June, or July, the bird will be assumed to have been nonbreeding.
- Immatures will be assumed to be nonbreeding regardless of season.
- If age cannot be determined, an individual will be assumed to have been an adult of breeding age.

Potential productivity ranges widely among the Covered Species. Newell’s shearwaters and Hawaiian petrels are expected to produce no more than one young per pair per year. Nēnē produce average clutches of three to five eggs. While not all young hatched from a clutch of eggs can be expected to survive to fledging age, much less adulthood, if an incubating female bird is killed by collision with a turbine, that fatality may be held indirectly responsible for the loss of the eggs that were viable at the time of collision. On the other hand, if a female is killed during the time it is tending to recently fledged young, a reasonable expectation would exist that the number of fledglings lost because of loss of parental care would be fewer than the average clutch size of that species because of possible pre-collision natural losses to predation, disease, starvation, etc. that typically accrue through the breeding period.

The probability of the Covered Species colliding with WTGs also changes with time of year and/or breeding status. For example, Newell’s shearwaters and Hawaiian petrels have potential to collide with turbines only during the breeding season because during nonbreeding periods they remain at sea. Hawaiian hoary bats may preferentially reside at higher elevations during nonbreeding periods. Nēnē become territorial during the breeding and molting season (when they become flightless) while caring for goslings. Thus, nēnē are very unlikely to collide with turbines and related structures while nesting or attending to goslings.

Finally, assessments of indirect take must consider parental contributions to care of the eggs and/or young. Male Hawaiian hoary bats take no role in raising of young, so death of a male bat cannot lead to indirect take. Males of some of the bird species do contribute significant effort to raising of young, so if a female of such a species were to be killed during the breeding season, the male of the pair may be capable of successfully raising some of their young, especially if the mortality were to occur when the young were closer to fledging age.

The requested 20-year take estimate consists of a requested authorized level of take for a certain number of individual bats or nēnē and is not broken up into adults/immatures (total direct take) and fledglings/juveniles (indirect take). This single number was derived by assigning the number of young expected to be associated with the adults lost to collisions, and then estimating how many of those young would have survived to adulthood after accounting for natural mortality. This number of potential adults is then added to the estimated total direct take to yield the expected total adult adjusted take.

For example, if the total adjusted take is estimated to be four adult/immature bats (direct take) and two juvenile bats (indirect take), and assuming that 30% of juveniles survive to adulthood, the two juveniles convert to 0.6 adults (2 * 0.30 = 0.6) which is rounded to one adult. This one adult is then added to the estimated direct take of four adult/immature bats resulting in a total adult adjusted take (and requested take) of five bats.

The following sections provide assessments of potential impacts to each of the Covered Species and identify estimates of the anticipated rates of take for each. The amount of annual take requested to be authorized in the ITP and ITL for each Covered Species may be divided into two categories. One category is the number of individuals directly taken and the other consists of the number of individuals that will be assumed to be indirectly taken in terms of eggs, juveniles or fledglings. Otherwise, fledglings or weanlings are converted to adults at acceptable survival rates and only the total number of adults is presented.

5.2.4 Hawaiian Petrel–*NO CHANGE*

5.2.4.1 Risk of Hawaiian Petrel Collision with WTGs

KWP I is the only operating wind energy generating facility in Hawaiʽi where potential mortality of Hawaiian petrels and Newell's shearwaters is consistently being studied. KWP I and KWP II have commissioned several independent studies using ornithological radar to estimate the movement rates for Hawaiian petrels and Newell's shearwaters through the site during the roughly 8-month spring-fall breeding season when these birds are present near Kaheawa Pastures. The earlier of these (Cooper and Day 2004; Day and Cooper 1999; Sanzenbacher and Cooper 2009) focused on the KWP I project area. KWP I biologists also independently conducted a radar study in the summer and fall of 2006. The most recent and comprehensive study was performed in summer and fall 2009 at the downroad portion of the proposed KWP II project area (Cooper and Day 2009).

The primary objective of the 2009 summer and fall studies was to document movement rates of Hawaiian petrels and Newell's shearwaters over the proposed KWP II project area during the nesting and fledging period. The Cooper and Day (2009) reports are provided as Appendices 3 and 13. The passage rates from the summer and fall studies were 116–148% higher than that previously documented at KWP I. For take estimates, it is assumed that the passage rates over KWP II are 1.3 times that over KWP I.

The total direct take of Hawaiian petrels at KWP I after 5.33 years of operation is 4.96 birds. The average annual total direct take of Hawaiian petrels at KWP I is approximately 0.93 birds (4.96/5.33 years = 0.93 birds/year) for the entire project site or 0.047 petrels/turbine/year. The take estimate for

Hawaiian petrels at KWP II for all project components (primarily turbines and met towers) is calculated based on the average rate of take per turbine at KWP I, adjusted for the increased passage rate over the site. This results in an estimated take of 0.86 birds/year for the Project (0.047 petrels/turbine *14 turbines * 1.3 time KWP I passage rate = 0.86 birds/year).

5.2.4.2 Other Direct Take of Hawaiian Petrels

In addition to collisions with turbines and met towers, some limited potential exists for Hawaiian petrels to collide with cranes during the construction phase of the project. Cranes used during construction are typically comparable in height to the turbine towers (Kaheawa Wind Power, LLC

2006). But the construction phase is expected to last 6 to 8 months, with cranes on-site for only 3 to 4 months and, during that period, they will not always be vertical. The potential for Hawaiian petrels to collide with construction cranes is considered to be negligible given the brevity of the construction period and the low occurrence rate of the species on-site.

A crane will permanently be available for KWP II (probably shared with KWP I) for maintenance purposes and will be present at KWP II as needed. Except for emergencies, this crane would be used only during the day and stored in its horizontal position at ground level when not in use and at night. Consequently, this crane is not considered to pose a collision threat to Hawaiian petrels. No Hawaiian petrels collided with cranes used to construct KWP I.

Potential also exists for Hawaiian petrels to collide with the 1,225-foot (374-m) section of the collection line that crosses the gulch at the upper portion of the project area (see Section 1.4 for details). This line will be mounted on poles approximately 60–90 feet (18–25 m) above ground level and will be a maximum of 340 feet (104 m) above the deepest part of the gulch. Precautions to minimize collisions include installing marker balls on the collection line to enhance visibility and placing the collection line in close proximity to an existing transmission line of the same height that also crosses the gulch and is similarly marked (see Section 4.3.1). Observation of Hawaiian petrels on Kaua'i by Day *et al.* (in review) suggests that collision avoidance rates of power lines by Hawaiian petrels is very high (207 observed birds with 40 birds exhibiting collision avoidance responses and zero resultant collisions). Thus, the collision rate of Hawaiian petrels with overhead collection lines is considered very small and assigned a value of 0.05 birds/year (one bird every 20 years) given the low occurrence rate of species on the site, their avoidance capabilities and the minimization measures that will be emplaced.

Construction or maintenance vehicles have potential to strike downed petrels (birds already injured by collision with turbines or towers) while traveling project roads. Project personnel will be trained to watch for downed petrels and other wildlife and speed limits (10 mph [16 kph]) will be enforced to minimize potential for vehicular strikes to result in death of birds that otherwise might have been able to be rehabilitated. Despite this, it is assumed that day-to-day maintenance of the wind facility may very occasionally result in the fatality of a petrel. This source of potential mortality does not result in an increase in the amount of direct take expected from the proposed project because such birds would be those not avoiding the WTGs or met tower and, thus, have been accounted for in the mortality modeling.

Therefore, for this HCP, it is projected that take of Hawaiian petrels as a result of collision with project components and vehicle strikes will occur at the average rate of 0.91 petrels/year (0.86 (turbines and met towers) + 0.05 (collection line) = 0.91).

5.2.4.3 Indirect Take of Hawaiian Petrel

Adult and immature birds have potential to collide with turbines and associated structures while commuting between nesting and feeding grounds during the pre-laying period (March to April) and incubation or chick-feeding periods (May through October). Indirect take accounting for possible loss of eggs or chicks would be assessed to any direct take of adult Hawaiian petrels occurring during the breeding period of May through October, but would not be assessed if direct take of this species occurs during the pre-laying period or at other times of year. The risk of collision outside the pre-laying period or breeding season is considered minimal as these birds do not return to land during that time.

Potential for survival of offspring following a collision appears dependent upon the time at which the parent is lost. Both parents alternate incubating the egg (May-June), allowing one or the other to leave the colony to feed. Therefore, during the egg-laying/incubation period it is expected that both parents are essential for the successful hatching of the egg (Simons 1985). Both parents also contribute to the feeding of chicks. Chicks are fed 95% of the total food they will receive from their parents within 90 days of hatching (Simons 1985). Because hatching generally occurs in late June, chicks should have received 95% of their food by the end of September. After this time, it is likely that many chicks could fledge successfully without further parental care as some chicks have been seen abandoned by their parents up to three weeks prior to fledging (Simons 1985). Consequently, it is considered probable that after this time many chicks would also be capable of fledging if subsequent care was provided by only one parent. Based on this, for the purposes of this HCP and assessing indirect take, both parents are considered essential to the survival of a Hawaiian petrel chick through September, but it is assumed that a chick has a 50% chance of fledging successfully if adult take occurs in October.

Not all adult Hawaiian petrels visiting a nesting colony breed every year. Simons (1985) found that 11% of breeding-age females at nesting colonies were not breeding. Eggs are laid and incubated between June and July, of which an average of 74% successfully hatch (Simons 1985). Therefore, it appears there would be an 89% chance (100% - 11% = 89%) that an adult petrel taken from May through June was actually breeding or incubating, a 66% (0.89 x 0.74 = 0.66) chance in July and August that the individual had successfully produced a chick. Most nonbreeding birds and failed breeders leave the colony for the season by mid-August (Simons 1985) therefore there is nearly a 100% chance that birds taken in September or October would be tending to young. Based on the above life history parameters and as identified in Table 5.1 below, indirect take would be assessed at the rate of 0.89 egg per adult taken between May and July, 0.66 chick per adult taken in August, 1.00 chick per adult taken in September, and 0.50 chick per adult taken in October (life history data presented can also be found in Appendix 5).

Table 5.1. Calculation of Indirect Take for Hawaiian Petrel–*NO CHANGE*

Hawaiian Petrel	Season	Average no. of Chicks per Pair (A)	Likelihood of Breeding (B)	Parental Contribution (C)	Indirect Take (A*B*C)
Adult	Mar–Apr	–	0	–	0.00
Adult	May–July	1	0.89	1.0	0.89 eggs
Adult	Aug	1	0.66	1.0	0.66 chicks
Adult	Sept	1	1.00	1.0	1.00 chick
Adult	Oct	1	1.00	0.5	0.50 chicks
Adult	Nov–Apr	–	0.00	–	0.00
Immature	All year	–	0.00	–	0.00

5.2.4.4 Estimating Total Take for the Hawaiian Petrel

The estimated average mortality rate of Hawaiian petrel allowing for potential collisions with WTGs and permanent met towers and adjusted for potential for collection line strikes is 0.91 petrel/year, or essentially one petrel per year. Based on estimated rates of direct and indirect take, take of this species resulting from project operations is expected to average no more than approximately two birds per year (0.91 adult/year + maximum of 0.91 chick/year = 1.82 birds). Because of assumptions concerning unobserved direct take, any one Hawaiian petrel found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one, with total direct take then likely to be rounded up to two birds (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates).

Moreover, as take may be distributed unevenly over the years (see Section 5.2), the Applicant proposes that the ITP and ITL allow for a total direct take of at least four Hawaiian petrels and the indirect take of three chicks for any given year for the duration of the project (see below for calculations on indirect take). Five-year and 20-year take limits based on the expected multiyear average rate of take are also proposed. This calculation does not use a multiple of the annual rate of take because the actual expected take will vary year-to-year (e.g., take for Species A could be authorized as three individuals in any given year but not more than five individuals total every 5 years and 15 adults every 20 years). See Section 5.2 for a detailed explanation.

Birds “taken” through assessment of unobserved direct take will be assumed to have been of the same age and breeding status as the individual that was found. As the amount of indirect take assessed is dependent upon when the direct take occurs during the breeding season, for the purposes of calculating the expected indirect take, it was assumed that direct take has an equal probability of occurring anytime between March and November. This period includes the pre-laying period (March to April), the breeding season (May to October) and fledging period (November). It is expected that only adults will be taken from March to October and only fledglings will be taken in November. This distribution of fatality over the breeding season (9 months long) was used to determine the expected amount of indirect take. For example, for a total direct take of eight petrels, a total direct take of two individuals would be expected to occur from March to April (= 8 x 2 months/9 months) over the life of the Project (Table 5.2). Table 5.2 shows the expected distribution of direct take over the breeding season and the indirect take that would be subsequently assessed (derived from Table 5.1) for the Tier 1 requested take levels.

Table 5.2. Allocation of Indirect Take for Hawaiian Petrel for the Requested Tier 1 Level of Take–*NO CHANGE*

Hawaiian Petrel	Adult					Fledgling	Total
	Mar–Apr	May–Aug	Aug	Sept	Oct	Nov	
Direct take	5	6	2	2	2	2	19
Indirect take	0	5.3	1.3	2	1	0	9 (= 9.6)

Expected rates of take and rates of take requested to be authorized by the ITL and ITP through the expected 20-year life of the Project are summarized below, along with rates of take considered to qualify as Tier 2.

Expected Rate of Take		
Annual average	0.91 adults/immatures and 0.91 chick/eggs	1.82 birds/year
20-year project life	19 adults/immatures and 9 chicks/eggs	
Requested Tier 1 ITL Authorization		
Annual limit of take	4 adults/immatures and 3 chicks/eggs	7 birds/year
5-year limit of take	8 adults/immatures and 4 chicks/eggs	
20-year limit	19 adults/immatures and 9 chicks/eggs	
Tier 2 Take Rate		
One-year period	8 adults/immatures and 4 chicks/eggs	
5-year period	> 8–16 adults/immatures and > 4–8 chicks/eggs	
20-year limit	> 19–29 adults/immatures and > 9–14 chicks/eggs	

As indicated in Section 3.8.1.1, the current population of Hawaiian petrel is estimated to be approximately 20,000 birds, with 4,000 to 5,000 breeding pairs (Mitchell *et al.* 2005). Thus, the Tier 1 rate of take (28 birds/20 years or 1.4 birds per year) represents 0.007% of the population annually or approximately 0.14% of the estimated Hawaiian petrel population if all the take occurs at once, and the higher rate (43 petrels/20 years or 2.15 adults per year) represents approximately 0.01% of the population annually or 0.22% in the unlikely event that all the take occurs at once. Given these very low percentages, it is considered extremely unlikely that take of Hawaiian petrel caused by the proposed project would result in significant adverse effects to Hawaiian petrel at the population level. The seabird colony at Haleakalā, Maui, is composed of as many as 1,000 nesting pairs or approximately one-fifth to one-quarter of the total breeding population (Mitchell *et al.* 2005; Tetra Tech EC, Inc., 2008a, b). The number of birds breeding in West Maui is not known. The Tier 1 and Tier 2 yearly take rates could represent from 0.07% to 0.1% of the minimum (1,000 pairs) Maui population annually if all birds taken were breeding birds rather than nonbreeding visitors to their colonies. In the very unlikely event that all the take occurs at once, it would represent 1.4% of the population at Tier 1 and at Tier 2, 2.15% of the Maui population. These percentages for both Tier 1 and Tier 2 take rates are low and the loss of Hawaiian petrels as a result of the Project is considered unlikely to result in a biologically significant reduction in the Maui population of this species.

Predation by introduced mammals and downing due to urban lighting are considered the primary threats to recovery of Hawaiian petrel. The proposed mitigation measures described in the following chapter are expected to more than offset the anticipated take and contribute to recovery of the species. For this reason, no significant adverse impacts to the species' overall populations, and no significant cumulative impacts to the species, are anticipated. With the low expected rate of take, the proposed mitigation measures are expected to produce a measurable net benefit in the form of a marginal increase in the population of Hawaiian petrels.

5.2.5 Newell's Shearwater–*NO CHANGE*

5.2.5.1 Risk of Newell's Shearwater Collision with WTGs

No take of Newell's shearwater has been documented at KWP I since the start of project operations (KWP I, LLC 2011). This would result in a projected 20-year take of zero at KWP II if the same method for calculating take for Hawaiian petrels (Section 5.2.4.1) is applied to Newell's shearwaters. However, some risk of take for Newell's shearwater may exist and a low level of take may occur over the 20-year period. Fatality estimates for Hawaiian petrels and Newell's shearwaters were originally based on radar data, and seabird targets recorded flying over the KWP I site were proportioned based on a 60% petrel to 40% shearwater ratio). New data has shown that the proportion of Hawaiian petrels flying over the site compared to Newell's shearwaters is likely to be much greater than previously estimated. The most recent data suggests that 90% or more of the seabirds flying over KWP I are likely to be Hawaiian petrels with possibly only 10% Newell's shearwaters (Cooper *et al.* 2011, Appendix 23). Thus 90% of the seabird fatalities are expected to be Hawaiian petrels and 10% Newell's shearwaters. By this reasoning, with an expected direct take of 19 petrels for KWP II, the direct take of Newell's shearwater at KWP II for turbines and met towers over 20 years is 2.1 individuals (19 petrels/9 x 1 = 2.1) or 0.1 individuals per year.

5.2.5.2 Other Direct Take of Newell's Shearwaters

In addition to collisions with turbines and met towers, some limited potential exists for Newell's shearwaters to collide with cranes during the construction phase of the project. As discussed for Hawaiian petrel, potential for Newell's shearwaters to collide with construction cranes is considered negligible, given the brevity of the construction period and the low rate of occurrence of the species on-site. Also, the permanently stationed maintenance crane is not expected to constitute a collision threat to Newell's shearwater because it is expected to be used only during the day and stored in a horizontal position at night. No Newell's shearwaters collided with cranes used to construct the KWP I facility.

Potential also exists for Newell's shearwaters to collide with the 1,225-foot (374-m) section of the collection line that crosses the gulch at the upper portion of the project area (see Section 1.4 for details). This line will be mounted on poles approximately 60–90 feet (18–25 m) above ground level and will be a maximum of 340 feet (104 m) above the deepest part of the gulch. Precautions to minimize collisions include installing marker balls on the collection line to enhance visibility and placing the collection line in close proximity to an existing transmission line of the same height that also crosses the gulch and is similarly marked (see Section 4.3.1). Observation of Newell's shearwaters on Kaua'i by Day *et al.* (in review) suggests that collision avoidance rates of power lines by Newell's shearwaters may be approximately 97% (392 observed birds with 29 birds exhibiting collision avoidance responses and one resultant collision [= 1/30]). Thus, the collision rate of Newell's shearwaters with the overhead collection line is expected to be low. Given that the collision rate with overhead collection lines for Hawaiian petrels is estimated to be 0.05 bird/year (one bird every 20 years), and only 10% of the seabirds transiting the site are Newell's shearwaters, the estimated collision rate of Newell's shearwaters with overhead collection lines is 0.1 bird in 20 years (1 bird/9 = 0.1 bird). Given the low occurrence rate of species on the site, their avoidance capabilities, the minimization measures that will be emplaced, the risk of collision for Newell' shearwater on the overhead lines is considered negligible.

As with Hawaiian petrels, some potential also exists for construction or maintenance vehicles to strike downed shearwaters (birds already injured by collision with turbines, towers, or collection lines) while traveling project roads. Project personnel will be trained to watch for downed shearwaters and other wildlife and speed limits (10 mph) will be emplaced and enforced to minimize potential for vehicular strikes to result in death of birds that otherwise might have been able to be rehabilitated. Despite this, it is assumed that day-to-day maintenance of the wind facility may very occasionally result in the fatality of a shearwater. This source of mortality does not result in an increase in the amount of direct take expected from the proposed project because the collisions by these birds are accounted for in the mortality modeling.

Therefore, for this HCP, it is projected that take of Newell's shearwater as a result of collision with project components and vehicle strikes will occur at the average rate of 0.1 shearwater/year.

5.2.5.3 Indirect Take for Newell's Shearwater

As with Hawaiian petrels, adult and immature shearwaters are most likely to collide with turbines or associated structures while commuting between nesting and feeding grounds during the pre- laying period (April to May), incubation and chick-feeding periods (June to October) and fledging period (October to November). Newell's shearwaters are not expected to be flying across the project area at other times of year. Based on the above, an indirect take assessment would be applied to any adult shearwaters found directly taken from June through October. Indirect take would not be assessed to adult shearwaters found at other times of year or applied to immature shearwaters. As with Hawaiian petrels, both shearwater parents care for their eggs and chicks. As little information is available for Newell's shearwaters on nestling growth and development or adult visitation rates, it is conservatively assumed that both parents are necessary throughout the breeding season for successfully fledging a chick.

Not all Newell's shearwaters visiting a nesting colony breed. It was estimated by Ainley *et al.* (2001) that only 46% of all active burrows produced an egg or chick. Therefore, it appears there would be a 46% chance that an adult petrel taken from June through August was actually breeding. Most nonbreeding birds and failed breeders leave the colony for the season by August (Ainley *et al.* 2001), therefore there is nearly a 100% chance that birds taken in September or October would be tending to young. Based on the above life history parameters and as identified in Table 5.3, indirect take would be assessed at the rate of 0.46 egg or chick per adult taken between May and August, 1.00 chick per adult taken in September through October (life history data presented can also be found in Appendix 5).

Table 5.3. Calculation of Indirect Take for Newell's Shearwater–*NO CHANGE*

Newell's Shearwater	Season	Average No. of Chicks per Pair (A)	Likelihood of Breeding (B)	Parental Contribution (C)	Indirect Take (A*B*C)
Adult	Apr–May	–	0	–	0
Adult	June–Aug	1	0.46	1	0.46 egg/chick
Adult	Sept–Oct	1	1	1	1 chick
Adult	Nov–May	–	0	–	0
Immature	All year	–	0	–	0

5.2.5.4 Estimating Total Take for Newell's Shearwater

The estimated average mortality rate of Newell's shearwater allowing for potential collisions with WTGs and permanent met towers and adjusted for potential for overhead collection line strikes is 0.1 shearwaters/year. Based on estimated rates of direct and indirect take, annual take of this species resulting from project operations is expected to average 0.2 bird/year (0.1 adult/year + (1 chicks/year x 0.1) = 0.2 bird/year).

Because of assumptions concerning unobserved direct take, any one Newell's shearwater found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one, with total direct take then likely to be rounded up to two birds (based on expected results from take monitoring and subsequent adjustments for searcher efficiency and scavenging rates). Based on the above, the Applicant suggests the ITP and ITL should allow for a total direct take of up to two Newell's shearwaters and the indirect take of two chicks for any given year for the duration of the project (see below for calculation of indirect take). Due to the low expected take over the project term, the 1-year, 5-year and 20-year limits are identical.

Birds "take through assessment of unobserved direct take will be assumed to have been of the same age and breeding status as the individual that was found. As the amount of indirect take assessed is dependent upon when the direct take occurs during the breeding season, for the purposes of calculating the expected indirect take, it was assumed that direct take has an equal probability of occurring anytime between April and November. This period includes the pre-laying period (April to May), the breeding season (June to October) and fledging period (November). It is expected that only adults or immatures will be taken from April to October and only fledglings will be taken in November. This distribution of fatality over the breeding season (8 months long) was used to determine the expected amount of indirect take. Due to the low expected rate of take, it was assumed that all adults may be taken during the breeding season. Table 5.4 shows the possible distribution of direct take over the breeding season and the indirect take that would be subsequently assessed (derived from Table 5.1) for the **Tier 1** requested take levels.

Table 5.4. Allocation of Indirect Take for Newell's Shearwater for Tier 1 Requested Take Levels–*NO CHANGE*

Newell's shearwater	Adult	Adult	Adult	Fledgling	Total
	Apr-May	June-Aug	Sept-Oct	Nov	
Direct take	0	1	1	0	2
Indirect take	0	0.46	1	0	2 (= 1.46)

Actual expected rates of take and rates of take of Newell's shearwaters requested to be authorized by the ITL and ITP through the expected 20-year life of the Project are summarized below. Also, provided below are rates of take proposed to qualify as Tier 2 for purposes of identifying when it would be appropriate or necessary to consider adaptive management practices.

Expected Rate of Take

Annual average	0.1 adult/immature and 0.1 chick/egg	birds/year
20-year project life	2 adult/immature and 2 chicks/eggs	

Requested Tier 1 ITL Authorization

Annual limit of take	2 adults/immatures and 2 chicks/eggs	4 birds/year
5-year limit of take	2 adults/immatures and 2 chicks/eggs	
20-year limit	2 adults/immatures and 2 chicks/eggs	

Tier 2 Take Rate

1-year period	> 2–5 adults/immatures and >2–3 chicks/eggs
5-year period	> 2–5 adults/immatures and >2–3 chicks/eggs
20-year period	> 2–5 adults/immatures and >2–3 chicks/eggs

As indicated in Section 3.8.2.1, the most recent population estimate of Newell's shearwater was approximately 84,000 birds, with a possible range of 57,000 to 115,000 birds (Ainley *et al.* 1997). But radar studies and population modeling have indicated that the population of Newell's shearwater is likely on a decline, especially on Kauaʻi (Ainley *et al.* 2001; Day *et al.* 2003). Declines in Newell's shearwater populations are attributed to loss of nesting habitat, predation by introduced mammals (mongoose, feral cats, rats, and feral pigs) at nesting sites, and fallout of juvenile birds associated with disorientation from urban lighting (Ainley *et al.* 1997; Mitchell *et al.* 2005; Hays and Conant 2007).

The Tier 1 take rate (0.2 bird/year) represents approximately 0.0004% of the estimated Newell's shearwater population annually (using the lower estimate of 57,000 birds), and the Tier 2 rate (8 shearwaters/20 years = 0.4 adults per year) represents approximately 0.0007% of the population annually. In the unlikely event that all the take occurs at once, Tier 1 take represents 0.007% of the estimated population and Tier 2 take represents 0.01%. Given these very low percentages, it is considered extremely unlikely that take caused by the proposed project would result in significant adverse effects to Newell's shearwater at the population level at Tier 1 or Tier 2 rates of take. As such, the proposed mitigation measures (Section 6.5) are expected to more than offset the anticipated take and contribute to the species' recovery. For this reason, no significant adverse impacts to the species' overall population and no significant cumulative impacts to the species are anticipated.

5.2.6 Nēnē–*UPDATED*

DOFAW operation of the captive release and reintroduction pen at Hanaʻula, near the upper end of the KWP I site, has for all intents established the population of nēnē in the Kaheawa area. As of 2006, 104 nēnē had been released from this pen since releases began in 1994. The population in 2009 in West Maui, including Hanaʻula, was estimated at 106 birds (DOFAW 2009). As of 2015 the population in West Maui including Hanaʻula was estimated at 169 birds (NRAG 2017, unpub.). This represents 32.4% of the total estimated Maui population of 521 and 5.6% of the estimated species total of 3,034. The total estimated nēnē population has increased from 1,900 in 2009 to 3,034 in 2015 (NRAG 2017, unpub.) or a 60 % increase in 7 years (NRAG 2017, unpub.).

Observations at KWP I and KWP II confirm that nēnē are resident in and around the project area and are observed on the ground browsing, socializing, nesting, and using habitat and terrain features for cover. Nēnē have not been observed to nest at the KWP II area for lack of suitable nesting habitat (see Sections 3.8.3.3 and 5.2.6.2). Nēnē commonly fly at altitudes that are within the RSZ of the KWP I and KWP II WTGs, with most birds observed during daylight and crepuscular periods.

5.2.6.1 Nēnē Collision Risk and Avoidance Behavior–Estimating Direct Take–UPDATED

Some nēnē fatalities occurred at KWP I as a likely result of attraction to foraging opportunities near WTGs presented by new vegetation growth on the KWP I site following KWP II BESS construction. Nonetheless, future best management practices for any future ground-disturbing maintenance activity will include minimizing grass cover.

5.2.6.2 Ground Displacement of Nēnē–NO CHANGE

In general, animal species can be indirectly and adversely affected by the clearing of their habitat in multiple ways. The most obvious is through displacement. For animal species with small home ranges, or for projects that result in disturbance to large areas, clearing of habitat can completely remove the home range of an individual animal and thus reduce the carrying capacity of the area affected. Such animals are then typically displaced to either compete for space with individuals in remaining habitat or forced to occupy sub-optimal or non-suitable habitat. In either case, the loss of habitat usually results in an overall decrease in the effective population size of the species because some individuals may no longer be able to establish territory, attract a mate, and reproduce.

Clearing of habitat can also adversely affect species through reduction of habitat patch sizes and through habitat fragmentation. Some animals will not utilize patches of habitat that are below some minimum threshold size even though that minimum size is larger than their own home range. Thus, while clearing for a development project might reduce in size but not completely eliminate a certain patch of habitat, the clearing could cause the remaining habitat to be rendered unsuitable for continued use by a particular species. Similarly, clearing could cause one larger patch of habitat to be divided or fragmented into two or more smaller patches, with these smaller patches then being incapable of supporting a species that requires large blocks of habitat.

Even in cases where clearing of vegetation may divide one large block of habitat into two smaller blocks that each remains large enough to continue to support a given species, the development that follows vegetation clearing can sometimes create a barrier to movement by that species between the habitat patches. In some cases, the population of the species occurring on one or both sides of the barrier could then be made at risk of extinction because the remaining population may be less able to withstand additional perturbations.

In addition to possibly causing deleterious reduction in habitat patch sizes, fragmentation of habitat can result in harmful changes to the quality of surviving habitat. Clearing of vegetation creates edges that can alter microclimatic conditions within habitat by exposing the habitat to wind and sun. Changes in microclimatic conditions have potential to alter habitat to a point where it becomes unsuitable for use by a particular species. This type of effect is typically realized in forested habitats (where, for example, a previously shaded, humid understory could through clearing be dried through new exposure to sun and wind) as opposed to open habitats.

With regard to nēnē and the KWP II project, the KWP II project area supports vegetation that provides some (though limited) browsing and sheltering opportunities. Clearing for turbine pads, roads and other project-related facilities would cause the loss of approximately 43 acres (17.4 ha) of mostly grassy vegetation out of the 143-acre (58-ha) KWP II project area, with the clearing generally occurring in linear swaths or in circular areas around turbine locations. This clearing is not expected to result in adverse modification to the microclimate of surviving habitat in the KWP II project area since those types of habitat are already fully exposed to sun and wind.

Clearing for the project, while it would result in the presence of (mostly linear and narrow) barren areas within the otherwise rocky and vegetated landscape of KWP II, is also not expected to cause adverse effects to nēnē as a result of habitat fragmentation. Through the first 5 years of KWP I operations, KWP I and DOFAW biologists have observed nēnē using portions of the combined KWP I and KWP II area and, at KWP I, successfully nesting within and adjacent to the project area. Nēnē are frequently seen at KWP I utilizing the roads and turbine pads for loafing, walking, and vigilance (behavioral categories from Woog and Black [2001]). These observations suggest that nēnē readily adapt to the presence of WTGs and should continue to utilize available habitat in the vicinity of the KWP II wind facilities. These observations further indicate that nēnē incorporate clearings of the type constructed for a wind power project into their home ranges. As such, these clearings do not create barriers to movement between vegetated areas and do not cause habitat occurring on one side of a clearing to be reduced in size to a point where it could no longer be considered capable of supporting nēnē.

The remaining question is whether the magnitude of loss of the existing grassy habitat that provides limited feeding and sheltering opportunities would be sufficient to cause the displacement of geese from the KWP II area.

Differences in vegetation between the KWP I and KWP II project areas and observation of patterns of habitat usage by nēnē at KWP I and KWP II indicate that the quality of nēnē habitat is not consistent between the two project areas. Habitat such as that in the KWP I project area, which has proven capable of supporting nesting and the nutritional requirements of nēnē, does not appear to be present in the KWP II area. Unlike the KWP I project area, vegetation in the KWP II project area is dominated by non-native windblown, fire-adapted grasses with some scattered shrubs and trees in the gullies.

The KWP II area is also drier than the KWP I area, with lower elevations of the KWP II area receiving as much as 20 inches less rainfall than the upper parts of KWP I (see Figure 3.3).

Hobdy (2009b) identified a total of 15 native species in the KWP II project area. Some of the native plant species present at KWP II are identified as species that nēnē can utilize either as a food source or shrubs to shelter or nest under (USFWS 2004a). The food species are ʻilima (*Sida fallax*), ulei (*Osteomeles anthyllidifolia*), and pili (*Heteropogon contortus*), and nēnē are known to shelter or nest under ʻaʻaliʻi (*Dodonaea viscosa*). ʻIlima, is widely scattered throughout the KWP II area but is of very short stature; pili and ulei are scattered sparsely throughout the area or occur only in a few small patches (Hobdy 2009b, 2010). ʻIlima is one of the most common native dry land plants in all of Hawaiʻi (Hobdy 2009b, 2010).

Nēnē are most often seen at the upper project area of KWP II near the Lahaina Pali Trail or slightly above the project area at the 2.25 Mile Marker (see Figure 3.3). During the winter months, if rainfall is adequate, the bunch grass-dominated pastures at KWP II produce greater numbers of seed heads, creating a short-term source of browse for some birds. But this is an unpredictable food source and likely only a temporary and supplemental resource for nēnē. Moreover, unmanaged grasslands are typically nutritionally poor in general, especially so when they occur in dry areas (Woog and Black 2001).

ʻAʻaliʻi is a common native shrub species scattered sparsely throughout the KWP II area. Over the years repeated wildfire events have severely affected this region and appear to have suppressed the growth of native shrubs, which do not seem to occur in large enough patches or high enough stature to provide adequate nesting or shelter for the nēnē in the area. In addition, given the poor nutritional quality of the surrounding habitat, it is unlikely to be used with any regularity. So far, evidence suggests that the higher elevation portions of the upper KWP II project area may only provide a temporary foraging habitat for nēnē particularly after the rains, and no nēnē thus far have been detected nesting in the proposed project area. The absence of suitable nesting/sheltering habitat and the low nutritional quality of most plant species common in the area have probably discouraged nēnē from becoming more established in the KWP II project area. The proposed conversion of approximately 43 acres of open field habitat for KWP II project-related purposes may reduce to some degree the amount of low-quality foraging habitat available for nēnē in the project area.

In addition, a very small area will be trenched for the underground cables which may temporarily eliminate a very limited number of native food plants or plants that have potential shelter or nesting functions. The trenched area is a 1,500-foot-long corridor and nēnē food plants that may be impacted include naupaka kuahiwi (*Scaevola gaudichaudii),* pukiawe (*Leptecophylla tameiameiae*), and ʻilima (Hobdy 2010). All three species were either scattered sparsely throughout the area or occur only in a few small patches or consisted of a few isolated individuals (uncommon to rare in the area). Another 2 acres will be permanently disturbed for the construction of the maintenance building, BESS, and substation. These two activities will result in the loss of some native food plants such as ulei, which is common in the area, and pukiawe, ʻilima, and ʻōhiʻa, which are either scattered sparsely throughout the area or occur only in a few small patches or consisted of a few isolated individuals (uncommon to rare in the area). ʻAʻaliʻi is also a common native shrub species in the area, and some individuals may be lost during clearing but are not expected to measurably displace the sheltering/nesting habits of the species. To date, no nēnē have been recorded nesting in the area planned for construction.

In conclusion, given the very limited function of the areas to be altered in the main KWP II project area, and the abundance of better quality habitat elsewhere, the construction of KWP II is not expected to measurably displace, or adversely reduce, foraging, or nesting opportunities for any individuals of the resident population.

5.2.6.3 Indirect Take of Nēnē–UPDATED

Indirect take to account for loss of dependent young is assessed for adult nēnē only when mortality occurs during the breeding season (August to April). Adults found during the months of October through March are assumed to have had a 60% chance of having been actively breeding because 60% of the population has been recorded to breed in any given year (Banko *et al.* 1999). Adult nēnē mortality that occurs outside the peak breeding season (April, August and September) are assumed to have had a 25% chance of breeding. Male and female nēnē care for their young fairly equally, so indirect take is assessed equally to the direct take of any male or female adult nēnē found during the breeding season. The number of young possibly affected by loss of an adult is based on the average number of fledglings produced per pair (studies indicate that average number of fledglings produced annually per pair of nēnē is 0.3 (Hu 1998).

Based on these assumptions, as indicated in Table 5.6 below, the amount of indirect take that is assessed for each direct take of an adult nēnē during the months of October through March is 0.09. Amount of indirect take assessed for each direct take of an adult bird during the remainder of the breeding season is 0.04 (life history data presented can be found in Appendix 5).

Table 5.6. Calculation of Indirect Take of Nēnē–*NO CHANGE*

Nēnē	Season	No. Fledglings per Pair (A)	Likelihood of Breeding (B)	Parental Contribution C	Indirect (A*B*C)
Adult, any gender	Oct–Mar	0.3	0.6	0.5	0.09
Adult, any gender	Apr, Aug, and Sep	0.3	0.25	0.5	0.04
Adult, any gender	May–Jul		0		0
Immature	All year		0		0

5.2.6.4 Estimating Total Adjusted Take for Nēnē–UPDATED

5.2.6.4.1 Pre-construction Tier 1 and Tier 2 Take Estimates

This section describes the estimation of total adjusted take (Total Adjusted Take = Total Direct Take + Indirect Take) for nēnē for the original HCP. It does not reflect the calculation of total take over the 20-year permit term for the HCP amendment. Annual take for KWP II was originally projected based on post-construction monitoring data from KWP I, assuming fatality rates would be similar between the two projects. This differs from the calculation of take for the HCP amendment (Section 5.2.6.4.2), which is based on post-construction monitoring data from KWP II directly. The pre-construction Tier I and Tier 2 take estimates presented below are unchanged from the original HCP.

Based on estimated rates of direct and indirect take, annual take of this species resulting from project operations is expected to be no more than 0.55 bird or essentially one bird per year. This is based on the expected rate of 0.5 adult/year with assessment for indirect take (0.5 + (0.09 fledgling/year x 0.5) = 0.55).

The DLNR and the ESRC have recommended that annual take limits allow for at least one **observed** take a year. Because of assumptions concerning unobserved direct take, any one nēnē found to have collided with a project component in a year will lead to an assessment of total direct take for that year of greater than one that likely would be rounded up to two birds (based on expected results from take monitoring and subsequent adjustments for SEEF and scavenging rates). Moreover, as take may be distributed unevenly over the years (see Section 5.2), based on the above, the Applicant suggests the ITP and ITL should allow for a total direct take of at least four adult nēnē and the indirect take of one fledgling for any given year for the duration of the project (see below for calculation of indirect take). The requested Tier 1 take is 1.5 times the calculated expected take to accommodate any factors that have not yet been considered in the risk assessment (such as a slow increase in the resident nēnē population over time which may increase the risk of take).

While the birds attributed to unobserved take would be assumed and, therefore, of unknown age or gender, for the purposes of this HCP it is assumed that all birds taken through unobserved direct take will be adults. Because nēnē could be flying through the project area at any time of year, the likelihood of an unobserved take of nēnē being in breeding condition is 37.5% based on a breeding period of 4.5 months (a 1-month incubation period followed by parental care for 3.5 months; 4.5/12 = 0.375).

Consequently, following the above table, indirect take is assessed to nēnē lost through unobserved direct take at the rate of 0.06 fledgling/nēnē (0.3 x 0.375 x 0.50 = 0.0563). A 5-year and 20-year take limit based on the expected multiyear average rate of take has been proposed. This calculation does not use a multiple of an annual rate of take because the actual expected take will vary year to year (e.g., take for Species A could be authorized as three individuals in any given year but not more than five individuals total every 5 years and 15 adults every 20 years). See Section 5.2 in the original HCP for a detailed explanation. Expected rates of take and rates of take authorized by the ITP and ITL through the expected 20-year life of the Project for Tier 1 and Tier 2 are summarized below.

Expected Rate of Take		
Annual average	0.5 adult/immature and 0.05 fledgling	0.55 bird/year
20-year project life	11 adults/immatures and 1 fledgling	
Requested Tier 1 ITL Authorization		
Annual limit of take	4 adults/immatures and 1 fledgling	5 birds/year
5-year limit of take	8 adults/immatures and 1 fledgling	
20-year limit	18 adults/immatures and 23 fledglings	
Tier 2 Take Rate		
1-year period	6 adults/immatures and 1 fledgling	
5-year period	12 adults/immatures and 3 fledglings	
20-year period	27 adults/immatures and 3 fledglings	

5.2.6.4.2 Estimating Total Adjusted Take for Nēnē Based on Post-Construction Fatality Monitoring Data–NEW

The following section presents the methods used to project estimated take for the HCP amendment. These methods are different from those used to estimate Tiers 1 and 2 because they are based on data collected on-site since the original ITP/ITL was issued.

Estimating Total Direct Take

This section describes the estimation of total adjusted take (Total Adjusted Take = Total Direct Take + Indirect Take) for nēnē for the HCP amendment. The calculations for the amendment are based on the post-construction fatality monitoring data collected at KWP II.

As of June 1, 2019, five nēnē mortalities have been documented within the search area at KWP II. These were observed on April 22, 2014; December 22, 2014; February 23, 2015; October 13, 2015; and February 6, 2018. Projection of these findings using the EoA model (Versions 1.0 and 2.6; Huso et al. 2015, Dalthorp et al. 2017) results in a 20-year expected total direct take of not more than 42.3 adults with 80% credibility (see Appendix 27 for calculations). Based on the five observed fatalities, the estimated direct take at the 80% credibility level as of June 2018 was 13 nēnē. Unobserved direct take not yet accrued for years 7 through 20 is estimated to be 23.2 nēnē (42.3 – 13 = 29.3).

Estimating Indirect Take

Indirect take is calculated separately for observed take (season and age of fatalities are known) and take that is unobserved (season and age of fatalities are unknown).

Using Table 5.6 and considering in what month take was observed, indirect take for the five observed take is assessed to be 0.31 fledgling (0.09 + 0.04 + 0.09 + 0.09 + 0.09 = 0.40).

For the purposes of estimating indirect take for unobserved direct take, the projected 37.3 adults/immatures that may have been directly taken or will be in the future (42.3 estimated total – 5 observed to date = 37.3 projected) are treated as unobserved direct take. As described in Section 5.2.6.3, indirect take of nēnē lost through unobserved direct take is assessed at the rate of 0.06 fledglings/nēnē. Thus, the indirect take for 37.3 adults would be 2.24 fledglings (37.3 * 0.06 = 2.24). Adding the indirect take of 0.40 fledgling from observed fatalities, the total fledglings indirectly taken is projected to be 2.64 fledglings.

Nēnē mature at age 2 for males and age 3 for females and an annual mortality rate is estimated at 20% (i.e., an annual survival rate of 80%, see Appendix 5 for life history information). One fledgling is thus the equivalent of 0.64 adult (1 * 0.8 * 0.8 = 0.64). Assuming all fledglings mature at age 2, and an annual survival rate of 80% for 2 years, 2.64 fledglings would be expected to yield 1.69 adults after 2 years (2.64 * 0.64 = 1.69). The estimate of indirect take (1.69 adults) is added to the estimate of direct take to yield the total adjusted take.

Estimating Total Adjusted Take (Direct Plus Indirect Take)

The addition of indirect take (1.69 adults) to the expected total direct take of 42.26 individuals results in a total adjusted take with 80% credibility of no more than 44 adult nēnē over the 20-year permit term.

The take requested for the 20-year (Tier 3) limit is 44 adult nēnē or 14 more adult nēnē than the currently authorized take of 30 nēnē (of any age). The amended annual rate of estimated take at the 80% credibility level therefore is expected to be 2.26 nēnē per year (compared to the currently permitted rate of 1.5 nēnē per year).

Requested Additional ITL/ITP Take Authorization

Tier 3	**(20-year take)**	**44 nēnē**

The most current statewide population estimate for nēnē (from 2016) is 2,855 individuals, with 616 birds occurring on Maui (NRAG 2017, unpub.). In 2010, the statewide estimate was between 1,888 and 1,978 individuals (DOFAW 2010) and for Maui was 366 individuals. Considering the current statewide population, the total amended estimated take (at an annual rate of 2.26 birds/year [44/19.5 = 2.26]) requested for nēnē over the 20-year period represents a take of 0.08% (2.26/2,855 = 0.08%) of the statewide population per year. In the unlikely event that the entire requested take was to occur at once, it would impact roughly 1.54% (44/2,855 = 1.54 %) of the species' population. This would not be expected to cause a decline in the status of the species. For the island of Maui, the annual rate of take represents 0.37% (2.26/616 = 0.37%) of the island's population per year. In the unlikely event that the entire requested take was to occur at once, it would impact roughly 7.14% (44/616 = 7.14%) of Maui's population. The possibility of all take occurring within a year is unlikely given the rates of take observed as of June 2018 at KWP II (6 years of operation) and KWP I (12.5 years of operation). Further, the mitigation is expected to fully offset the impacts of the take. Therefore, no adverse effect to the species population is expected.

5.2.7 Hawaiian Hoary Bat–*UPDATED*

Low rates of call detections from Hawaiian hoary bats had been measured at KWP I and KWP II prior to the start of operations at KWP II (see Section 3.8.4.3). But following the replacement in 2013 of the original bat detector equipment with newer, more sensitive detectors, the measured detection rates increased fourfold (Figures 3.5 and 3.6). While it cannot be known whether these higher detection rates were occurring prior to 2013, if they had, the predicted fatality rates would have been commensurately higher in the original permit request. At this point, the projected 20-year take is 3.45 times higher than the take projected in 2012 for the 20-year permit term (38/11 = 3.45). There are various native and non-native trees in the gulches on either side of the ridge where the turbines are located and ironwood trees are spreading over the hillsides all around the site and in nearby gulches, so bats could roost nearby. On Oʻahu, a mother and two pups used an ironwood tree for roosting; therefore, bats could even use nearby trees for maternity roosts (pers.com. Mitchell Craig, TerraForm Power). Hawaiian hoary bats breed from 0 to 4,200 feet (1,280 m) in elevation (Menard 2001), so it is possible that volant juveniles also occur in the project area in the latter portion of the breeding season.

5.2.7.1 Collision Risk and Other Potential Causes of Take at KWP II–UPDATED

The potential for take of the Hawaiian hoary bat was believed to be very low based on the surveys that had been conducted at the KWP and KWP II project areas prior to KWP II construction, the limited available information regarding the species occurrence on West Maui, and the apparent relatively low susceptibility of resident (versus migrating) bats to collisions with wind turbines in general for bat species found in other parts of the world. But the occurrence of individuals in the project area has been documented, and 14 observed fatalities have been recorded at the KWP I and KWP II facilities over the project's operation.

Potential for bats to collide with met towers or cranes is considered to be negligible because they would be immobile and should be readily detectable by the bats through echolocation. Of 64 wind turbines studied at Mountaineer Wind Energy Center, in the Appalachian Plateau in West Virginia, bat fatalities were recorded at operating turbines but not at a turbine that remained nonoperational during the study period. This supports the expectation that presence of the stationary structures, such as an un-guyed lattice met tower and crane, should not result in bat fatalities (Kerns *et al.* 2005). No bats have been found to have collided with the guyed met towers at KWP after ~~five~~ 5 years of operation or with any cranes during the construction phase of that project. No downed bats have been found during the weekly searches of the permanent met tower at the Kahuku Wind Power site, which was erected in the winter of 2010. Potential for the bats to collide with met towers is also essentially accounted for in the estimated rate of take extrapolated from the KWP data since the rate of take at KWP was developed by dividing the sum of all project-related take (take caused by met towers was zero) and dividing that by the number of turbines.

5.2.7.2 Indirect Take–UPDATED

Hoary bats are thought to move to higher elevations during the months of January through March (Menard 2001), and so may be less prevalent in the project area during those months. Based on measured detection rates, bats around KWP I and KWP II are most prevalent in August through October (see Figure 3.6), although they are found there in every month of the year (Table 5.8). These three months have also been found to have the highest detection rates at other wind sites in Hawai'i (Auwahi 2017, Kahuku 2017, and Kawailoa 2017). During a 5-year island-wide study of Hawaiian hoary bat occupancy on Hawai'i Island, the habitat that had the highest detection ~~activity~~ rates during the summer and fall was the coastal lowlands, which female bats are thought to prefer for pupping (Gorresen *et al.* 2013). Considering all habitats on Hawai'i Island, the peak detection rate ~~activity~~ during this study occurred in August and September.

Although detections peak in August through October, only 29% of 14 observed fatalities (for KWP I and KWP II found within or outside of search areas) were found in the three months with highest detection rates while 50% were found in February through May and 21% in November and December (KWP I 2017, KWP II, LLC 2017). No fatalities have been observed in January, June, July, and October. At Auwahi Wind Farm, the only other wind farm on Maui, in FYs 2013 through 2017, 13 Hawaiian hoary bat fatalities were found (Auwahi 2017). One fatality was observed each in January, June, July, and November; two were observed in both August and October, and three in September. During the 2.5 years when bat assessment occurred, between July 2013 and December 2015, the highest detection rates at Auwahi Wind Farm occurred in August, September, and October, with activity measured in all months (Auwahi 2016).

Months with highest detection rates at KWP I and KWP II did not necessarily correlate with months when fatalities were observed. During September, when bat detection rates were generally highest, only 14% of fatalities were found at KWP (I and II), while 29% of observed fatalities were found during August through October. But at Auwahi Wind Farm, 23% of fatalities were found in September and 54% were found in August through October.

Menard (2001) suggests Hawaiian hoary bats breed between April and August. Females are solely responsible for the care and feeding of young, and twin pups are typically born each year, although single pups sometimes occur. Any female bats or bats whose sex has not been determined and directly taken from April 1 through September 15 will be assumed to be pregnant or lactating unless proven otherwise and indirect take will be assessed 1.8 juveniles per adult as indicated in Table 5.7 below (life history data presented can be found in Appendix 5). No indirect take will be assessed for female bats found at other times of year, or for male or immature bats found at any time of year.

Table 5.7. Calculating Indirect Take for the Hawaiian Hoary Bat–*NO CHANGE*

Hawaiian Hoary at	Season/ Breeding Condition	Average No. of Juveniles per Pair (A)	Likelihood of Breeding (B)	Parental Contribution (C)	Indirect Take (A*B*C)
Female or sex unknown	Apr 1 – Sep 15	1.8	1.0	1.00	1.80
Female	Sep 16 – Mar 31	–	0.0	–	0.00
Male	All year	–	0.0	0.00	0.00
Immature	All year	–	0.0	–	0.00

5.2.7.3 Estimating Total Take for the Hawaiian Hoary Bat–UPDATED

This section describes the estimation of total adjusted take (Total Adjusted Take = Total Direct Take + Indirect Take) for Hawaiian hoary bat for the original HCP. It does not reflect the calculation of total take over the 20-year permit term for the HCP amendment. Annual take for KWP II was originally projected based on post-construction monitoring data from KWP I, assuming fatality rates would be similar between the two projects. This differs from the calculation of take for the HCP amendment (Section 5.2.7.4), which is based on post-construction fatality monitoring data from KWP II that was collected following issuance of the original ITP/ITL. The pre-construction Tier I and Tier 2 take estimates presented below are unchanged from the original HCP.

As indicated, the average rate of direct take of Hawaiian hoary bats as a result of project operations was expected to be 0.84 bat/year. The original implementation of low wind speed curtailment-was anticipated to further reduce take by an average of 70% (Arnett *et al.* 2009, 2010), thus the expected take was 0.25 bat/year. Indirect take associated with this level of direct take would result in a maximum of 0.45 juvenile/year (= 0.25 x 1.8) resulting in a total adjusted take of 0.70 bat/year or essentially one bat/year (see Table 5.8, life history data presented can be found in Appendix 7).

As with the other species addressed in this HCP, the DLNR and the ESRC had recommended that annual take limits allow for the possibility of at least one **observed** take a year. Again, because of assumptions concerning unobserved direct take, any one Hawaiian hoary bat found to have collided with a project component in a year may lead to an assessment of total direct take for that year of greater than one likely to be rounded up to between three and five bats (based on expected results from take monitoring and expected subsequent adjustments for SEEF and scavenging rates).

A 5-year and a 20-year take limit based on the expected multiyear average rate of take were also proposed prior to operation. This calculation does not use a multiple of the annual rate of take because the actual expected take will vary from year to year (e.g., take for Species A could be authorized as three individuals in any given year but not more than five individuals total every 5 years and 15 adults every 20 years); see Section 5.2 for a detailed explanation. Expected rates of take and rates of take requested to be authorized by the ITP and ITL for the original HCP through the expected 20-year life of the Project are summarized below, along with rates of take considered to qualify as Higher.

Expected Rate of Take

Average	0.25 adult and 0.45 juvenile	0.70 bat/year over the 20-year project life
	5 adults and 3 juveniles (assuming half of all direct take is female)	

Requested Tier 1 ITL Authorization

Annual limit of take	5 adults[4]
5-year limit of take	7 adults[5]
20-year limit	7 adults[4]

Tier 2 Take Rate

1-year period	11 adults[6]
5-year period	11 adults[5]
20-year period	11 adults[5]

The Applicant's mitigation for the anticipated take (see Section 6.7) has contributed to restoration of native bat habitat and is expected to result in an overall net conservation benefit for the species (see Appendix 32).

Based on fatality monitoring at KWP I from 2006 to 2018 and at KWP II from 2012 to 2018, and recent bat acoustic monitoring from 2013 to 2017 (see Section 3.8.4.3), Hawaiian hoary bats are likely to occur year-round at KWP II. Table 5.8 identifies the months where fatalities have been documented at KWP I and KWP II.

[4] This was revised to be equivalent to five adult bats in a clarification letter from the USFWS and DOFAW (2014-TA0260), dated May 20, 2014. The annual take limit was also removed.
[5] This was revised to be equivalent to seven adult bats in a clarification letter from the USFWS and DOFAW (2014-TA0260), dated May 20, 2014. The annual take limit was also removed.
[6] This was revised to be equivalent to 11 adult bats in a clarification letter from the USFWS and DOFAW (2014-TA0260), dated May 20, 2014. The annual take limit was also removed.

Table 5.8. Total Hawaiian Hoary Bat Observed Fatalities by Month for KWP I (January 2006 through June 2018) and KWP II (July 2012 through June 2018)–NEW

Month	Fatalities		
	KWP I*	KWP II	Total
Jan	0	0	0
Feb	1	1	**2**
Mar	0	1	**1**
Apr	3*	0	**3**
May	1	0	**1**
Jun	0	0	0
Jul	0	0	0
Aug	2	0	2
Sep	2*	0	**2**
Oct	0	0	0
Nov	1*	1	**2**
Dec	1	0	**1**
Total	**11**	**3**	**14**

* Includes one incidentally observed take

5.2.7.4 Estimating Total Adjusted Take for Hawaiian Hoary Bats Based on Post-Construction Fatality Monitoring Data–NEW

5.2.7.4.1 Estimating Total Direct Take

This section describes the estimation of total adjusted take (Total Adjusted Take = Total Direct Take + Indirect Take) for Hawaiian hoary bat for the HCP amendment. These calculations are based on the post-construction fatality monitoring data collected at KWP II through May 1, 2018. An additional fatality was found in October 2018 but was located outside the search plots so was categorized as “incidental”. Incidentally found carcasses are not included in the EoA calculations described below and are accounted for as unobserved direct take.

Research with different levels of LWSC as treatments show that fatality rates of bats may be reduced when turbine blades are feathered below any cut-in speed and also if LWSC is implemented (see Sections 4.2.2 and 4.2.3). Implementing LWSC at KWP II is expected to reduce overall direct take. LWSC began at KWP II in July 2012 (the beginning of operations) at 5.0 m/s and continued through December 1, 2012. In 2013 and 2014, LWSC to 5.0 m/s began on March 14 and February 15, respectively, and continued through December 4 and 16, respectively. In 2014, LWSC was increased from 5.0 m/s to 5.5 m/s on July 28, 2014, and will continue at 5.5 m/s for the duration of the 20-year permit unless determined to be ineffective or unnecessary at this level. LWSC is currently implemented year-round.

As of June 2018, after 6 years of operations, three fatalities had been recorded in the KWP II search plots: one each on March 13, 2013, November 5, 2013, and February 26, 2014. All three fatalities occurred prior to raising the LWSC from 5.0 m/s to 5/5 m/s in August 2014.

Based on the three fatalities observed within the search plots, the estimated direct take at the 80% credibility level as of June 2018 was 12 bats. Using the EoA model (Huso et al. 2015, Dalthorp et al. 2017), the estimated 20-year (Tier 4) total direct take is no more than 35.2 bats with 80% credibility (see Appendix 27 for calculations). SEEF and CARE trials used in this calculation include all trials through June 2018. Unobserved direct take not yet accrued for years 7 through 20 is estimated to be 23.2 bats (35.2 - 12 = 23.2).

5.2.7.4.2 Estimating Indirect Take

All three fatalities, two males and one of unknown sex, were documented at KWP II during the nonbreeding season (April 1 through September 15) in February, March, and November; therefore, no indirect take (i.e., consideration of potential lost offspring) was assessed for the documented fatalities.

While the other bats taken under these scenarios are assumed and therefore to be of unknown age or gender, for the purposes of this HCP, it is assumed that every Hawaiian hoary bat taken through unobserved direct take is adult and has a 50% chance of being female (assuming the sex ratio of males to females is 1:1). Bats fly through the project area throughout the year, and the probability of an individual female bat having dependent young during a 12-month period is assumed to be 25% (3 out of 12 months). The average period of dependence is based on the information that Hawaiian hoary bats have one brood a year, and that hoary bats in North America have an average 56-day gestation period followed by parental care to weaning averaging 34 days, or approximately 3 months in total (Hayssen et al. 1993, Hayes and Wiles 2013, and NatureServe 2015). There is not enough information for hoary bats from Hawaiʻi to determine the gestation and pre-weaning dependent period for the subspecies. Consequently, indirect take will be assessed to bats lost through unobserved direct take at the rate of 0.225 juvenile per bat (0.5 x 0.25 x 1.8 = 0.225).

For the purposes of estimating indirect take for the 20-year permit term, the 32.2 of the 35.2 projected estimated direct take for the 20-year permit are considered unobserved direct take (35.2 total estimated direct take – 3 observed to date = 32.2 unobserved take). Calculation of indirect take for unobserved direct take is described in Section 5.2.7.2. Indirect take is assessed to bats lost through unobserved direct take at the rate of 0.225 juvenile per bat. Based on these calculations, an indirect take totaling 7.25 juveniles (32.2 x 0.225 = 7.25), is estimated.

The estimated indirect take from unobserved direct take for the 20-year period is therefore 7.25 juveniles.

For purposes of indirect take, juvenile bats are converted to adults based on a 30% survival rate of juvenile to adult. Hawaiian hoary bats are considered mature 1 year after their birth. This converts the total indirect take of 7.25 juveniles to 2.17 adults.

5.2.7.4.3 Estimating Total Adjusted Take (Direct Plus Indirect Take)

Adding the indirect take of 2.17 adults to the estimated total direct take of 35.2 bats results in an estimated total adjusted take of 37.4 adult bats for the 20-year permit period or 38 adult bats.

The proposed projected take limit is 27 adult bats greater than the currently authorized take limit of 11 adult bats (see Section 5.2.5.3, footnotes 4-6). The Project proposes adding two additional tiers (Tier 3 and Tier 4) to account for uncertainty in projecting take 14 years in advance. Mitigation for Tier 3 take of 19 bats (30 - 11=19) has already been contracted.

The Tier 3 and 4 take levels were created considering hypothetical outcomes based on take observed during the first 6 years. As mentioned previously, the EoA calculation for total projected take assuming no more take is observed during annual downed wildlife monitoring (as has been true for the last 4 years) would be 14 adult bats, and if one bat were found every other year, or seven more take observed (as has occurred on average in the first 6 years), the total take estimated would be about 39 adult bats, or a difference of 25 bats. Tier 3 (19 more bats) represents about 75% of the difference between the extremes of no more take observed and take observed at a rate similar to the average for the first 6 years (which is a higher rate than has occurred in the last 3 years).

Requested Amended ITL/ITP Take Authorization

Tier 3	**30 bats**
Tier 4 (20-year take)	**38 bats**

5.2.7.5 Population Assessment and Impact of Take–NEW

Individual bats are very difficult to count, and so population estimation is limited to relative activity, distribution, and seasonality. The Recovery Plan for the Hawaiian Hoary Bat (USFWS 1998; page 15) states "since no accurate population estimates exist for this subspecies and because historical information regarding its past distribution is scant, the decline of the bat has been largely inferred." The Natural Resources Conservation Service (NRCS) Biology Technical Note No. 20 speculates, "It is a Federal and State endangered species, but many have questioned whether the subspecies is truly endangered with so little known about its status" (NRCS 2009). The initial ESA and state listing of the Hawaiian hoary bat were based on insufficient information and not any quantified critical threats known to be jeopardizing the species existence. As well, no studies have clearly determined that the species is in decline or that available habitat has been reduced.

Understanding population status and specific habitat requirements of the Hawaiian hoary bat has been identified as primary data needs for species recovery (USFWS 1998, Gorresen et al. 2013). Occupancy models and genetic studies have been, and continue to be, conducted to determine population indices and effective population sizes, although effective population does not necessarily equate to actual population size (Gorresen 2008, Gorresen et al. 2013). Although population estimates are not currently available, studies indicate that the bat population on Hawai'i Island is stable and potentially increasing (Gorresen et al. 2013).

Although overall numbers of Hawaiian hoary bats are assumed to be low, they are thought to occur in the greatest numbers on the islands of Hawai'i and Kaua'i (Menard 2001). But since 2001, Hawaiian hoary bats have been found in greater numbers than previously known on Maui and O'ahu (see KWP and Auwahi Wind Power annual HCP reports for Maui and Kawailoa and Kahuku Wind Power annual HCP reports for O'ahu). We know now that bats occur on all the main Hawaiian islands, including Kaho'olawe, and breeding populations have been confirmed on all of the main Hawaiian islands except for Ni'ihau (DOFAW 2015). Acoustic monitoring of bat activity throughout the main Hawaiian Islands almost always picks up bat detections; however, there is no way to convert acoustic detections into a viable population estimate. Nonetheless, as bat detection research expands, so does the known distribution, suggesting the Hawaiian hoary bat population is larger than previously guessed (Gorresen et al. 2013, Kawailoa Wind Power 2016).

Hawaiian hoary bats have been observed year-round in a wide variety of habitats and elevations below 7,500 feet (2,286 m) and a few sightings from limited surveys have been reported as high as 13,199 feet (4,023 m). Hawaiian hoary bats have been detected in both wet and dry areas of Hawai'i but seem to be more abundant on the drier, leeward side (Jacobs 1994) and generally less abundant in wet areas (Kepler and Scott 1990). Several researchers have examined spatial and temporal variation in occurrence patterns of bats in Hawai'i, with conflicting conclusions about possible altitudinal or regional migration (Tomich 1986; Jacobs 1994; Menard 2001; Gorresen et al. 2013; Bonaccorso et al. 2015). Bats on the Island of Hawai'i are habitat generalists and occur from sea level to the highest peaks on the island (Gorresen et al. 2013).

It is difficult to gauge what impact take of Hawaiian hoary bats resulting from the Project may have on the subspecies. Original incidental take estimates for permitted wind facilities in Hawai'i have been underestimated due to a lack of baseline data on the Hawaiian hoary bat and other factors beyond our knowledge at the time of permitting. Each of the permitted wind facilities operating in Hawai'i have required an amendment to their HCP to increase the amount of authorized take of the Hawaiian hoary bat. Assessing risk to the Hawaiian hoary bat with respect to wind facilities, in combination with substantial gaps in baseline population and life history information for the bat, has increased concern with respect to the potential cumulative impacts on the Hawaiian hoary bat. Sources of these potential impacts include existing and future wind energy development as well as other sources of anthropogenic take. But post-construction fatality monitoring results and preliminary research efforts suggest the population of Hawaiian hoary bats throughout the Hawaiian Islands is larger and more widespread than had previously been known (Kawailoa Wind Power 2015; F. Bonaccorso, USGS-Biological Resources Division, pers. comm., 2014).

Four factors suggest that this Project, along with similar wind energy facilities, will not contribute significantly to cumulative impacts for the Hawaiian hoary bat: 1) Hawaiian hoary bats are more widespread than previously assumed; 2) mitigation commitments in this HCP are designed to provide a net benefit to the species, including contributions to improving the understanding of how to effectively mitigate for impacts to the Hawaiian hoary bat; and, 3) other wind facilities in Hawai'i will similarly provide compensatory mitigation for the anticipated take of Hawaiian hoary bats.

Tree trimming and harvesting activities are not necessarily incompatible with bat habitat needs (Patriquin and Barclay 2003, Johnson and Strickland 2003), although they have the potential to impact juvenile bats, which may be unable to fly away from an occupied tree when it is cut or disturbed. The USFWS recommends that harvesting or trimming woody plants more than 15 feet tall should not occur between June 1 and September 15. No one knows exactly how much bat take occurs statewide as a result of tree trimming and harvesting.

Mortality has been documented from limited assessments of bats snagging on barbed wire. Annual mortality estimates range from 0 to 0.8 Hawaiian hoary bats/100 km of barbed wire (Zimpfer and Bonaccorso 2010). Although observed fatalities are uncommon, the extent of the impact of barbed wire fences is largely unknown because most fences are not checked regularly, and any bats that may be caught on these fences may be quickly taken by predators or scavengers. Based on the low estimates of mortality related to bat impalement on barbed wire fences, this impact is not expected to contribute significantly to the cumulative impacts to the species.

Authorized take levels of other listed species covered by permitted Hawai'i wind farm HCPs are typically higher than actual fatality rates based on current monitoring data. The potential for take of these species associated with individual projects appears to be fairly well understood, conservatively estimated, and mitigated to achieve a net benefit for the species. Based on this information, the USFWS does not believe there are significant population-level cumulative impacts to these species.

The projected yearly rate of take is 1.95 adult bats (adults and juveniles surviving to adult) per year (38 estimated/19.5 years). The annual rate of take of 1.95 adults/year means that approximately 6.5 juveniles need to be produced each year to replace the lost adults (using a ratio of 0.3 juvenile to one adult) (see Section 5.2.7.3). Because the Hawaiian hoary bat is reproductively mature in 1 year and a female Hawaiian hoary bat produces on average 1.8 pups a year surviving to weaning, it will take the weaned offspring of approximately 3.4 reproductively active females each year to replace the lost adults (3.6 * 1.8 * 0.3 = 1.95 adults).

If the Maui bat population is similarly stable or slightly increasing, as has been suggested for the population of Hawaiian hoary bats on the Island of Hawai'i, and similarly widespread across habitats, significant impacts to the Maui population from this estimated yearly rate of take at KWP II appear unlikely. The proposed mitigation would include research that will further elucidate the bats distribution and foraging habits and protect or restore roosting and foraging habitat (see Section 6.7).

5.3 Cumulative Impacts–UPDATED

Updated cumulative effects analyses for nēnē and the Hawaiian hoary bat are found in Sections 5.3.3 and 5.3.4.

The only other wind project on Maui other than KWP I and KWP II is the 21-MW Auwahi Wind Farm at 'Ulupalakua Ranch, located on the leeward slope of Haleakalā on the southern coast of East Maui. Four state and federally listed wildlife species have been identified as having the potential to be adversely impacted by construction and operation of the Auwahi project: Hawaiian hoary bat, Hawaiian petrel, nēnē, and Blackburn's sphinx moth (*Manduca blackburni*). Mitigation measures to compensate for the take of these Covered Species at the Auwahi Wind Farm have been developed in cooperation with the USFWS, DOFAW, and the ESRC. There is a potential for cumulative impacts to these species from this Project.

The construction and operation of the Advanced Technology Solar Telescope at the Haleakalā High Altitude Observatory Site has the potential to impact the endangered Hawaiian petrel. The National Science Foundation (NSF) prepared a final HCP in October 2010 pursuant to the requirements of the ESA and HRS 195D that estimates incidental take of 35 Hawaiian petrel individuals (30 fledglings and 5 adults) over a 6-year period (NSF 2010). An EA to address impacts of the ITL and associated conservation measures was also prepared (NSF 2011).

At a broader scale, KWP II represents one of many projects of various types that can be expected to occur on the Island of Maui. Some of the causes assumed to be contributing to decline of the Covered Species (such as mammal predation, bright light disorientation, and loss of nesting or roosting habitats) may be on the increase due to continued real estate development on Maui and will likely continue increasing in the future. Even when conducted in compliance with all applicable local, state, and federal environmental regulations, there is the potential for cumulative impacts to occur from these projects because many do not trigger review under endangered species provisions and thus are not required to meet the net environmental benefit standard. By implementing the HCP and amendment, KWP II ensures that the net effects of this Project will contribute to the recovery of the Covered Species and thus not contribute to cumulative impacts that may occur as a result of these other developments.

Take for the Hawaiian hoary bat and/or nēnē has been authorized or likely will be authorized on O‘ahu, Maui, Kaua‘i, and Hawai‘i through several HCPs (Table 5.9).

Authorized take levels of other listed species covered by permitted Hawai‘i wind farm HCPs are typically higher than actual fatality rates based on current monitoring data. The potential for take of these species associated with individual projects appears to be fairly well understood, conservatively estimated, and mitigated to achieve a net benefit for the species. Based on this information, the USFWS does not believe there are significant population-level cumulative impacts to these species.

Table 5.9. Take A~~a~~uthorizations for Hawaiian Hoary Bat and Goose on Maui, O'ahu, Kaua'i, and Hawai'i (as of June 2018)–*UPDATED*

Permittee	Permit Duration	Location	Species Covered	No. of Permitted Adult Take Over Permit Duration	Projected Permit Term Estimated Take (80% credibility[1])
Habitat Conservation Plan Permits					
KWP I	2006–2026	Mā'alaea, Maui	Hawaiian hoary bat	50	44[2]
			Hawaiian goose	60	64[2]
KWP II	2012–2032	Mā'alaea, Maui	Hawaiian hoary bat	11	38
			Hawaiian goose	30	44
Kahuku Wind Power	2010–2030	Kahuku, O'ahu	Hawaiian hoary bat	23	29[2]
Kawailoa Wind Power	2012–2032	Haleiwa, O'ahu	Hawaiian hoary bat	60	222
Auwahi Wind Farm	2012–2037	'Ulupalakua Ranch, Maui	Hawaiian hoary bat	23	140
			Hawaiian goose	5	5
Kauai Lagoons	2012–2042	Lihu'e, Kaua'i	Hawaiian goose	17	17
Na Pua Makani	pending HCP approval and permit issuance 2016–2037	Kahuku, O'ahu	Hawaiian hoary bat	51	51
			Hawaiian goose	6	6
Lālāmilo	pending HCP approval and permit issuance 2016–2036	Lālāmilo, Hawa'i	Hawaiian hoary bat	6	6
Pakini Nui	pending HCP approval and permit issuance 2016–2036	South Point, Hawa'i	Hawaiian hoary bat	26	26
			Hawaiian goose	3	3

[1] The take estimate is based on Evidence of Absence software (Versions 1.0 and 2.6) (Huso *et al*. 2015, Dalthorp *et al.* 2017), existing literature, and site-specific data.

[2] Unpublished report to the USFWS and DOFAW.

5.3.1 Hawaiian Petrel–*NO CHANGE*

The only other authorized take of Hawaiian petrel on Maui is at the KWP I facility. Since 2006, KWP I, LLC has documented three observed direct takes of adult Hawaiian petrels (Kaheawa Wind Power, LLC 2008b; KWP I, LLC 2011). Take authorization for this species is being requested for the ATST and the Auwahi Wind Farm due to the potential for colliding with project components. In order to mitigate impacts to Newell's shearwaters, ATST has proposed to fence and manage a 328-acre area adjacent to the western perimeter of Haleakalā National Park (NSF 2010). Auwahi Wind Farm has proposed to conduct predator control and monitoring at the Kahikinui Forest Project (Tetra Tech EC, Inc. 2011b). These mitigation efforts are expected to offset the requested take and provide a net benefit to the species. Other developments on Maui with the potential to have cumulative impacts to the Hawaiian petrel include tall structures (communication towers, turbines, etc.), developments with excessive lighting, and developments that decrease nesting habitat.

The proposed mitigation measures described for the Hawaiian petrel are expected to more than offset the anticipated take and contribute to recovery of the species by providing a net conservation benefit, as required by state law. Similar offsets are expected for the ATST and Auwahi Wind Farm, if it is constructed. With the low expected rate of take at KWP II, the proposed mitigation measures are expected to produce a measurable net benefit in the form of a marginal increase in the population of

Hawaiian petrels. For this reason, the cumulative impact of take authorized for KWP II combined with previously and future authorized take is not expected to result in a significant cumulative impact to the species.

5.3.2 Newell's Shearwater–*NO CHANGE*

The only other authorized take of Newell's shearwater on Maui is at the KWP I facility. To date, no take of Newell's shearwater has been observed at KWP I. Other developments on Maui with the potential to have cumulative impacts to the Newell's shearwater include tall structures (communication towers, turbines, etc.), developments with excessive lighting, and developments that decrease nesting habitat.

Take for Newell's shearwater has also been authorized on O'ahu and Kaua'i (see Table 5.9). Mitigation for Kahuku Wind Power on O'ahu consists of colony-based management (fencing and trapping) on Maui or Kaua'i. Social attraction and artificial burrows could also be used to enhance the colony numbers by attracting seabirds to a managed site, safe from predation. The mitigation is expected to offset the requested take and provide a net benefit to the species by contributing knowledge to new management techniques for the species such as social attraction.

Mitigation by KIUC for its short-term seabird HCP is comprehensive. It consists of rehabilitating downed seabirds, colony-based management and research and additional take monitoring. The Save our Shearwaters (SOS) Program rescues and rehabilitates downed seabirds that would otherwise have died due to power line collisions and light attraction. It provides a significant conservation benefit to these seabirds, which supplements KIUC's main mitigation effort, which is implementing colony-based management. Seabird colony management will occur at Limahuli Valley and Hono o Na Pali Natural Area Reserve. The measures that will be implemented at Limahuli Valley include ungulate-proof fencing, ungulate removal, feral cat removal, rodent control, alien plant control, and monitoring the breeding success of the seabirds. Measures to be implemented at Hono o Na Pali Natural Area Reserve include cat-trapping, rodent control, owl removal, and monitoring the breeding success of the seabirds. Research initiatives include a 2-year auditory survey to locate additional breeding colonies and updating at-sea seabird population estimates. Funds will also be provided to implement an appropriate underline monitoring program.

The proposed mitigation measures described for Newell's shearwater from the various HCPs are expected to more than offset the anticipated take and contribute to the species' recovery by providing a net conservation benefit, as required by state law. The proposed mitigation measures are expected to produce a measurable net benefit in the form of an increase in the species' population by increasing productivity and survival rates of birds through predator control and other management measures such as fencing and ungulate control and supplementary programs such as SOS. The research and development of new management techniques proposed by the different projects will also improve effectiveness of the management of the seabird colonies. The research and development will also have far-reaching effects beyond the mitigation measures implemented by any of the Applicants. All the improved management measures will be available to be utilized by most parties involved in the management of Newell's shearwater colonies once developed. This is expected to result in better protection and greater reproductive success and adult survival for many colonies, including those that are currently unmanaged. For this reason, the cumulative impact of take authorized for KWP II, combined with previously and future authorized take, is not expected to result in a significant cumulative impact to the species.

5.3.3 Nēnē–UPDATED

Incidental take of nēnē has been authorized or requested at several locations on Maui (see Table 5.9). ~~Over~~ 12.5 years, from January 2006 to ~~June~~ 2018, KWP I, LLC estimated take of 64 full-grown nēnē (KWP I, LLC 2008b, 2009, 2010, 2011, 2013, 2014, 2015, 2016, 2017, 2018). In ~~the~~ 6 years from July 2012 through June 2018, KWP II, LLC estimated take of 14 nēnē (KWP II, LLC 2013, 2014, 2015, 2016, 2017, 2018). From 2005 to 2011, two nēnē fatalities have been documented at Pi'iholo Ranch, while 48 nēnē have been released at this site (DOFAW 2008). From 2011 through 2017, 46 fledglings have been produced at the Haleakalā Ranch pen as part of nēnē mitigation for KWP I (KWP I 2012, 2013, 2014, 2015, 2016, 2017). Take has also been authorized for this species at the Auwahi Wind

Farm due to the potential for colliding with WTGs and other project components, but as of FY 2017, no nēnē have been observed injured or killed (Auwahi Wind Energy, LLC 2017). Other developments on Maui with the potential to have cumulative impacts to nēnē include developments that decrease nesting and foraging habitat, as well as golf courses, which may attract nēnē to the area, increasing their vulnerability to vehicular collisions or golf ball strikes (Mitchell *et al.* 2005). Since 2008, the estimate of the total nēnē population increased from 1,900 to 3,034 in 2015, a 60% increase in 7 years (NRAG 2017, unpub.).

Proposed and implemented mitigation measures for nēnē at KWP I, KWP II, and Auwahi Wind sites are each expected to more than offset the estimated incidental take either approved or requested and contribute to the species' recovery by providing a net conservation benefit, as required by state law. Similar measures are expected for other developments on Maui with the potential to impact nēnē. Given the relatively large increase in the Maui nēnē population in the past 7 years and the expectation that impacts of any future projects will include mitigation to provide a measurable net benefit for nēnē, the cumulative impact of take authorized for KWP II combined with previously and future authorized take is not expected to result in a significant cumulative impact to the species.

5.3.4 Hawaiian Hoary Bat–*UPDATED*

In addition to KWP II, the only other authorized incidental takes of Hawaiian hoary bats on Maui are at the KWP I facility and Auwahi Wind Farm. As of June 2018, a total of eight Hawaiian hoary bat fatalities have been documented within the search area at KWP I; three have been documented at KWP II, and 16 at Auwahi Wind Power (Auwahi Wind Energy, LLC, 2014, 2015, 2016, 2017) (Table 5.10). The estimated total bat take from wind energy generation sites on Maui over the last 12.5 years is 83 adult bats and for the State of Hawaiʻi is 164 adult bats.

Table 5.10. Documented Fatalities and Total Estimated Take of Hawaiian Hoary Bats at Wind Farms in Hawaʻi through Fiscal Year-2018–*NEW*

Location	Operations Began	Observed Direct Take[1,2]	Estimated Take (80% credibility[3])
Auwahi Wind Farm (Maui)	December 2012	16	**42**
Kaheawa I Wind Power (Maui)	June 2006	8[4]	**28**
Kaheawa II Wind Power (Maui)	July 2012	3	**13**
Kahuku Wind Power (Oahʻu)	March 2011	4	**12**
Kawailoa Wind Power (Oahʻu)	November 2012	32[4]	**69**
Pakini Nui Wind Farm (Hawaiʻi)	April 2007[1]	3	**not applicable**
Total		**66**	**164**

[1] Observed direct take is take found only within search areas during intensive downed wildlife monitoring.

[2] Data from Kahuku Wind Power (2017); KWP I, LLC (2017), and KWP II, LLC (2017); Kawailoa Wind Power (2017); Auwahi Wind Energy, LLC (2017), and Pakini Nui Wind Power Draft HCP (2016), and USFWS unpublished data.

[3] The take estimate is based on Evidence of Absence software (Versions 1.0 and 2.6) (Huso *et al*. 2015, Dalthorp *et al.* 2017), existing literature, and site-specific data, including indirect take calculated as adults.

[4] One additional bat was found outside of the search area.

Other developments on Maui with the potential to have cumulative impacts to the Hawaiian hoary bat include resort or recreational developments, farming, road construction, pesticide use, and other developments that decrease roosting and possibly prey-generating habitat. It is not known at this time to what extent these activities will result in any direct or indirect take of the Hawaiian hoary bat.

On Oʻahu, take of Hawaiian hoary bats has been authorized for Kahuku Wind Power and Kawailoa Wind Power (see Table 5.9). The estimated total take (direct plus indirect take) for these two Oʻahu projects as of FY 2018 has been 81 bats over approximately 12 years (cumulative operations) (see Table 5.10). The Na Pua Makani Wind Farm draft HCP has been approved by the Hawaiʻi BLNR and requests incidental take authorization for 51 Hawaiian hoary bats on Oʻahu over a 21-year period (Na Pua Makani 2016). Mitigation for these projects consists of funding for research and for appropriate management measures. Lālāmilo and Pakini Nui Wind Farms on Hawai'i Island also have draft HCPs in review and both include Hawaiian hoary bat take authorization requests of six and 26 bats, respectively (Lālāmilo 2016, Pakini Nui 2016). These requests cover take that would occur over a 20-year period.

Research was the main component of KWP I mitigation due to the need for research to help determine basic life history parameters and identify effective management measures, which in turn helped guide future management and recovery efforts. Kahuku Wind Power, Auwahi Wind Project, and KWP II so far have mitigated for bats for originally permitted take by restoring forest habitat on Maui to increase or improve bat foraging and roosting habitat (Appendix 29). Mitigation by KWP II, LLC and Auwahi Wind Farm, LLC funds further bat population and ecology research on Maui and eventually may include additional habitat restoration or land conservation. Bat population and ecology research provides direct insight to inform future mitigation measures for wind sites on Maui that may include habitat restoration or land acquisition. The forest restoration efforts currently underway for originally permitted take are expected to increase survival and reproductive success to fully offset take and provide a net benefit to the species.

Kawailoa Wind Power, LLC's current mitigation for take of Hawaiian hoary bat on O'ahu also contributes to restoration of native bat habitat at U'koa Wetland; it includes a research component and is anticipated to have similar benefits (Kawailoa Wind Power, LLC 2011). Similar mitigation measures are expected for Na Pua Makani Wind Farm on O'ahu and Lālāmilo and Pakini Nui Wind Farms on Hawai'I Island.

The Hawaiian hoary bat is considered in the USFWS recovery plan (1998) to be a species managed statewide and not currently managed by unique island recovery zones. But HRS 195D does consider impacts on an island basis. Cumulative impacts are considered for the species on a statewide basis and for Maui alone. Considering the current available take estimates from wind energy generation sites, potential amendments to currently approved federal and state take permits and wind generation sites that are likely to apply for take permits, the total projected take of bats at a conservative 80% credibility level in Hawai'i may be up to 556 adult bats over 20- to 21-year permit periods and 222 adult bats for Maui alone (see Table 5.9).

Most basic demographic parameters typically used to model population viability are not known for most bat species (Frick *et al.* 2017), including the Hawaiian hoary bat. These parameters include population size, ratio of males to females, annual birth rate, survival to weaning, survival to first reproduction, survival rate of adults by age, longevity, and sources of mortality. Consideration of the impact on Hawaiian hoary bats from wind energy operations and the species' viability is only possible using demographic parameters assumed from other bat species. A stochastic model of population growth (assuming a normal distribution of lambda; mean = 1.01; standard deviation = 0.1; 10,000 simulations) was used to identify the starting population that would be capable of offsetting permitted bat take on Maui (N = 222, see Table 5.4) and the State of Hawai'i (N = 556, see Table 5.4) over a period of 20 years. If the annual growth rate of the species is assumed as 1% of the total population of adults (Frick *et al.* 2017) and a 20–year period is considered, the starting population before any take has occurred would have to be at least 2,700 adults statewide, or 1,100 adults in Maui alone, to end up with a net gain (mean of more than 561 statewide or 228 in Maui) to offset the proposed take after 20 years. Although the population size is unknown and will likely never be known, 2,700 adults statewide is a relatively small population size necessary to sustain the impact of the take from all of the wind farms operating or planned to be operating in Hawai'i.

6.0 MITIGATION FOR POTENTIAL IMPACTS AND SELECTION OF MITIGATION MEASURES– *UPDATED*

The proposed mitigation program for KWP II was influenced greatly by the approved mitigation program for KWP I and the data that has been collected by KWP I biologists since operations commenced. In coordination with biologists from the DLNR and the USFWS, the Applicant will build upon the existing KWP I mitigation program, or perform other appropriate mitigation measures, to achieve the biological goals and objectives identified in Chapter 4.

The following principles were followed in selecting the proposed mitigation measures:

- The level of mitigation in general should be commensurate with the level of requested take for required tier and provide a net benefit to the species and increase the likelihood of recovery of the endangered or threatened species that are the focus of the HCP.
- Mitigation should be species-specific and, to the extent practicable, location or island-specific.
- Mitigation measures should be practicable and capable of being done given currently available technology and information.
- Mitigation measures should have measurable goals and objectives that allow success to be assessed.
- Mitigation measures should be consistent with or otherwise advance the strategies of the respective species' draft or approved recovery plans.
- Mitigation measures that serve to directly "replace" individuals that may be taken (e.g., by improving breeding success or adult and juvenile survival) are preferred, although efforts to improve the knowledge base for poorly documented species also have merit, particularly when the information to be gained can benefit future efforts to improve survival and productivity.
- Off-site mitigation measures to protect breeding or nesting areas for birds, and roosting areas for bats, located on otherwise unprotected private land are preferred over those on public land, and sites on state land are preferred over those on federal land.
- Measures to decrease the level of take resulting from a private activity unrelated to the project (e.g., rescue/rehabilitation of downed seabirds outside the project area as a result of disorientation by outdoor lights not related to the Project) may be considered if agreed upon by the agencies.
- Alternate or supplemental mitigation measures should be identified for future implementation if monitoring shows the level of take is found to be higher (or lower) than anticipated. See Appendix 26 for further information on triggers and timelines for contingencies and Tier 2 mitigation.

The following sections provide details of the measures proposed, and these are summarized in Tables 1.2 and 1.3 (these replace Tables 6.1 and 6.2 in the original KWP II HCP). The estimated cost for each measure is presented in Appendix 6. Should alternate mitigation measures or locations be identified or otherwise become available that would present the Applicant with a greater chance of meeting the biological goals and objectives of this HCP, the Applicant reserves the right to propose such alternate mitigation instead of the measures identified below if such mitigation receives approval from the USFWS and the DLNR. All mitigation measures chosen for the project are subject to review by the DLNR and the USFWS over the lifetime of the Project and may be modified or continued without modification, depending on measured levels of take and the success of mitigation measures, and as agreed upon by the Applicant, the USFWS and the DLNR. As discussed, the Covered Species considered to have potential for additional incidental take beyond what was authorized in the original HCP ITP/ITL during operation of the KWP II project include the nēnē and Hawaiian hoary bat. The mitigation proposed to compensate for impacts to these species is based on anticipated levels of incidental take and includes additional mitigation for loss of productivity for nēnē that may be required as a result of delayed mitigation as determined through on-site surveys, modeling, and the results of post-construction monitoring. Lost productivity is defined as future offspring that would have been produced if adult nēnē would have survived in subsequent years.

KWP II intends to mitigate fully and in a timely manner for all lost productivity for nēnē, with the understanding that delay in mitigation will result in continued compounding of required mitigation. The USFWS, the DLNR and KWP II, LLC agree that timely mitigation for lost productivity is required but that any additional mitigation required because of agency delay will not accrue against permitted authorized incidental take. The USFWS and the DLNR have recommended that mitigation begin to replace lost productivity concurrently with the mitigation for direct take.

Once total estimated adjusted take has reached 75% of its current tier, planned and agreed-upon mitigation for the next tier will be initiated and funding assurances, if insufficient, for the next tier will be established.

6.1 Tier 1 and Tier 2 Mitigation for Covered Species

Possible rates of incidental take for all species discussed in this document have been identified as Tier 1, and Tier 2. These take levels were previously defined in Section 5.2. Initial yearly mitigation efforts are designed to compensate for requested take at the 20-year Tier 1 level. Total adjusted take as estimated through post-construction monitoring is used to determine which tier take is occurring at and the necessary levels of mitigation required to achieve mitigation success.

The proposed nēnē mitigation includes funding measures intended to increase populations of this species.

Nēnē mitigation is accomplished primarily by improving survival and productivity of the existing nēnē populations through predator control on Maui at the Pi‘iholo Ranch release pen (Appendix 31). This will enhance efforts to establish separate breeding populations on Maui, as recommended by the draft revised recovery plan for the species (USFWS 2004a).

Mitigation for the Hawaiian hoary bat consists of funding studies intended to provide a better understanding of the status and distribution of the species on Maui in order to facilitate future state, federal, or private conservation and management efforts (see Appendix 29). Funding also has been provided to restore native plant habitat to increase foraging or roosting sites for the Hawaiian hoary bat. The estimated cost for each measure for the Covered Species is presented in Appendix 6. As mitigation efforts may occur on state land for any of the Covered Species, all required permits will have been obtained before any mitigation measures commence.

Because authorized take of some of the Covered Species has the potential to occur early in the project, but the benefits expected from mitigation efforts would not be fully realized until some later point in time, it is possible that take could occur before mitigation measures have allowed for increases in productivity. This would result in a lag between the time of incidental take and intended replacement, possibly resulting in a slight loss of productivity by the species over that time. Therefore, the proposed levels of mitigation are also intended to compensate for possible loss of productivity by incidentally taken sexually mature adult birds for the anticipated lag-period.

Results of post-construction monitoring is used to determine annually whether take is occurring at Tier 1, Tier 2, or higher rates. In general, mitigation efforts are adjusted to compensate for the requested take at the required tier.

The Applicant has coordinated with the USFWS and the DLNR when Tier 2 rates of take occurred in order to adjust mitigation efforts accordingly and to implement adaptive management measures. Sections 5.2.4~~2~~.4, 5.2.5~~3~~.4, 5.2.6~~4~~.4, and 5.2.7~~5~~.3 identify the rates of take that are considered Tier 2 for each species, as well as the amounts of time considered necessary to determine those rates.

6.2 Proposed Tier 3 and Tier 4 Mitigation for the Hawaiian Hoary Bat and Nēnē–*NEW*

Proposed Tier 3 and Tier 4 mitigation measures are identified in Section 6.7.3 to compensate for the additional requested take for the Hawaiian hoary bat and nēnē. Mitigation measures for both species build upon the mitigation measures identified above.

6.3 Wildlife Education and Observation Program–*NO CHANGE*

A WEOP will be implemented for all regular on-site staff to minimize project-related impacts to listed species and other wildlife. The program will be long term, ongoing, and updated as necessary. Staff will be trained to identify listed and non-listed species of birds and other wildlife that may be found on-site, to record observations of native species protected by the ESA and/or MBTA, and to take appropriate steps when and if dead or downed wildlife is found. A plan for the WEOP is attached as Appendix 4. As part of their safety training, temporary employees, contractors, and any others that may drive project roads will be educated on speed limits, the possibility of downed wildlife being present on roads, and the possibility of nēnē presence on the ground or flying low across roads. Personnel will be instructed to contact the Site Environmental Compliance Officer immediately if they detect any downed wildlife on-site.

6.4 Downed Wildlife Protocol–*NO CHANGE*

The protocol for the recovery, handling, and reporting of downed wildlife will follow that developed for Kaheawa Pastures Wind Energy Generation Facility (Kaheawa Wind Power, LLC 2006) or other protocols approved by the USFWS and the DLNR. This protocol was developed in cooperation with the DLNR and the USFWS. All regular on-site staff will be trained in the protocol, which will include documenting all observed mortality or injury to wildlife (including MBTA-protected birds not otherwise covered by this HCP).

Any state or federally listed species found dead or injured in the project area will be handled in accordance with the approved protocol. Injured state or federally listed species will be photographed from a discrete distance and monitored until collection by an authorized individual. The Maui Wildlife Program manager at the DLNR and the fish and wildlife biologist at the USFWS will be notified within 24 hours by phone and written notification will be provided within 3 calendar days upon discovery of any injured or dead Covered Species. All (Covered and non-Covered) species will be documented in accordance with approved protocols; collections will be made only by staff personnel permitted by the USFWS and the DLNR to handle and salvage wildlife. Injured individuals or carcasses will be handled according to guidelines in Appendices 2 and 14 of the HCP.

6.5 Petrels and Shearwaters–*NO CHANGE*

The major threats identified for Hawaiian petrels and Newell's shearwaters are: 1) introduced predators, which can prey on adults, eggs and fledglings; 2) feral ungulates, which degrade habitat and may trample burrows; and 3) artificial lighting, which may disorient fledglings and increase their risk of collision with artificial structures (Mitchell *et al.* 2005). Predation has been shown to have significant negative effects on fledging success for the Hawaiian petrel (Hodges 1994; Hodges and Nagata 2001; Hu *et al.* 2001; Telfer 1986), and predation on adults of both species has also been documented (Simons 1983; Ainley *et al.* 2001). In Haleakalā National Park, Hodges and Nagata (2001) identified predation as accounting for 41% of total terrestrial mortality (adults, fledglings, and eggs) in cases in which a cause of death could be determined. Predation mortality was attributed to cats and mongooses (38%), rats (41%), dogs (14%), and owls (6%) (Hodges and Nagata 2001). Human-related causes (roadkills, collapsed burrows, and collision with structures) accounted for 49% of all mortalities, with natural causes accounting for the remaining 10%. It is expected that the causes of Newell's shearwater mortality in connection with the on-land portion of their lives are similar to those of the Hawaiian petrel due to their similar reproductive strategies, the pervasiveness of these threats, and as documented on Kaua'i (Telfer 1986, Ainley *et al.* 2001).

Nesting success rates can vary greatly from year to year and are probably dependent upon many environmental factors. Data from Hodges (1994), Hu *et al.* (2001), and Hodges and Nagata (2001) show that predator control (trapping and fencing) generally results in a significant increase in Hawaiian petrel nesting success, as shown in Table 6.3.

Table 6.3. Comparison of Hawaiian Petrel Nesting Success (Percent Nests that Successfully Fledge a Chick) With and Without Predator Control–*NO CHANGE*

Location	Year(s)	Nesting Success (%)		Reference
		Without Predator Control	With Predator Control	
Haleakalā, Maui		42.0	57.0	Hodges 1994
Mauna Loa, Hawai'i	1995-96	41.7	61.5	Hu *et al.* 2001
Haleakalā, Maui	1982	0.0	32.7	Hodges and Nagata 2001
Haleakalā, Maui	1990	10.0	49.2	Hodges and Nagata 2001
Haleakalā, Maui	1991	25.6	48.6	Hodges and Nagata 2001
Haleakalā, Maui	1992	15.2	17.0	Hodges and Nagata 2001
Haleakalā, Maui	1993	32.8	38.2	Hodges and Nagata 2001
Haleakalā, Maui	1994	44.0	23.0	Hodges and Nagata 2001
Haleakalā, Maui	1995	31.8	50.0	Hodges and Nagata 2001
Haleakalā, Maui	1996	28.1	46.7	Hodges and Nagata 2001
Unweighted average		27.1	42.4	

In addition to the identified threats, a major factor limiting the ability to manage Hawaiian petrel and Newell shearwater colonies are the remote areas to which their populations have contracted since the advent of introduced predators and human development. This makes ungulate and predator management difficult (Mitchell *et al.* 2005). One method for increasing protection is by attracting first-time breeders to new colonies in accessible areas that are well situated for management. Seabird attraction to specific areas can be achieved by broadcasting audio playbacks of vocalizations of conspecifics (i.e., social attraction). This technique has been shown to increase site prospecting and occupancy and has led to successful breeding in a wide range of species of seabirds (Gummer 2003), including the Galapagos petrel (*Pterodroma phaeopygia*) (Podolsky and Kress 1992), which is very closely related to the Hawaiian petrel; the Laysan albatross (*Phoebastria immutabilis* (Podolsky 1990), which also breeds in Hawai'i; and the Bermuda petrel (*Pterodroma cahow* (Dobson and Madeiros 2009) as well as a large number of additional seabird species in New Zealand (Steve Sawyer, pers. comm.).

6.5.1 Tier 1 Mitigation–*NO CHANGE*

The proposed Tier 1 mitigation for seabirds is designed to meet Tier 1 mitigation requirements for KWP II as well as KWP I per amendment submitted to DOFAW and the USFWS in October 2011. The seabird mitigation plan follows a similar approach for both species, and for each species consists of establishing a new colony by enclosing an area with a predator (dog, cat, mongoose, rat)-proof fence, installing 50 artificial burrows, and broadcasting audio playbacks of conspecific calls to draw birds to the fenced area. This social attraction project will be implemented at Makamaka'ole, West Maui (see Figure 3.1; Appendices 11 and 22).

6.5.1.1 Hawaiian Petrel

Makamaka'ole was identified as a possible Hawaiian petrel nesting site in 2007 by First Wind biologists based on observations of Hawaiian petrel activity in the area. This finding was corroborated by seabird biologists from DOFAW (Fern Duvall), the USGS (Josh Adams), and H.T. Harvey and Associates (David Ainley). In 2010, after consultation with DOFAW and the USFWS, First Wind carried out an assessment of the site to determine the extent of petrel activity. The 2011 assessment consisted of audio-visual point counts (June–August), radar surveys (June–August), burrow searches (May–October), and a feasibility assessment for the construction of a pest-proof fence at the site (July). Significant Hawaiian petrel passage rates and calling activity, including circling and paired flights were documented, but only a single, unoccupied burrow was found at the site. In July 2011, a canine team from Ecoworks, based in New Zealand, was brought in with two specially trained dogs to help find Hawaiian petrel burrows at Makamaka'ole. After a very comprehensive search effort, the team identified three old, disused burrows and one Hawaiian petrel carcass that was estimated to be several months old (Steve Sawyer, pers. comm.).

The Ecoworks team concluded the following:

- Makamakaʽole is a historic nesting site. No birds appear to maintain active nest sites. Several razorback ridge areas contain evidence that resembles typical petrel nesting sites in New Zealand as well as on Kauaʽi (David Ainley, pers. comm.). Peat type, soil mounds, old burrow remnants, fern habitat, ridges with optional landing and takeoff aspects all are very similar.
- Based on 4 nights of visual observations in 2011, Hawaiian petrels continue to congregate in the airspace above Makamakaʽole Valley even though no active burrows were found.
- Hawaiian petrels travel up the Makamakaʽole Stream from the sea to a historic staging area where aerial courtship is facilitated by updrafts created as winds collide with a 350-foot vertical rock face. Petrels do a considerable amount of aerial courting (pers.com Dr. Nicholas Carlile), (i.e., grey-faced petrels [*Pterodroma macroptera*] at Nick's Head, collared petrels at Waitambua, and taiko at Awatotara Valley/Lower Tuku, New Zealand); it is also comparable to behavior observed at Haleakalā and Lanaʽi adjacent to petrel breeding sites (David Ainley, pers. obs.).
- There is likely to be a remnant Hawaiian petrel colony somewhere in the Makamakaʽole-Kahakuloa watershed, highly likely to be several thousand feet above sea level and very difficult to access, manage, or protect sufficiently.
- Some of these juvenile birds probably land at Makamakaʽole and begin to excavate burrows; however, these birds are highly likely killed by a mongoose or a feral cat in a short time as their searching for cavities or suitable burrowing sites is quite noisy (David Ainley, pers. obs, Haleakalā).
- A total of 11 mongoose were trapped in two traps during 12 trap nights in July 2011, and there was sign of pig and cat activity in the area. These catch rates for mongoose appear substantially higher than areas known to contain dense habitation by mustelids and other pest vertebrates in New Zealand. Coupled with evidence of the only active nest site in the area containing remains of Hawaiian petrel, it suggests that the chances of a bird surviving even a short period of time on the ground at Makamakaʽole is extremely low.
- Based on the density of mongoose at lower elevations in Hawaiʽi, it is unlikely that predator control alone is going to be enough at lower altitudes (0–2,500 feet amsl) to protect any nesting Hawaiian petrel or Newell's shearwater (Steve Sawyer and Tim Day, Xcluder pers. comm).

In addition to the conditions at the sites where remnant nesting locations in the Makamakaʽole-Kahakuloa watershed may be located, making effective management exceedingly difficult, locating these specific areas is likely to be very difficult even with dogs on the ground as current work with the Fiji petrel shows (Nicholas Carlisle, pers. comm.). Using methods to shift the colony from these remote, unmanageable areas to sites in which threats to nesting seabirds can be kept to a minimum is an important tool to protect the Hawaiian petrels nesting on West Maui.

6.5.1.2 Newell's Shearwater

Based on radar information and documented flight calls at Makamakaʽole and vicinity (see also Cooper and Day 2003), it was determined that the area was within an important flight route for Newell's shearwater flying to nest sites higher in up in the watershed. Cooper and Day (2003)

detected only 51 radar targets they interpreted as Newell's shearwater, a very low number compared to Hawaiian petrel on Maui or Newell's shearwater on Kauaʽi. Maui SOS data indicate that Newell's shearwater fallout is decreasing, similar to the historic pattern on Kauaʽi, where the population has decreased 75% over the past few decades (Ainley *et al.* 2001, Holmes 2010). Therefore, the species' numbers are very low on Maui and likely decreasing.

A survey in 2007 along the Eke Trail revealed the presence of a potential nesting site within the upper Kahakuloa section of the West Maui Natural Area Reserve (NAR), with an estimated 20–30 birds calling and exhibiting attendance (Greg Spencer, pers. comm.). Subsequent attempts to fine-tune the specific location of the suspected colony and locate the nesting burrows in 2011 proved to be challenging due to NAR's concerns about impacts to existing resources and prevailing weather conditions that almost always inhibit access to the site. Thus far, First Wind has made five helicopter flights to the site and was forced to cancel a number of additional scheduled flights but has not yet been able to land. Consequently, should nesting occur at the site, it is possible management actions that would provide adequate protection for prospecting sub-adults and breeding adults may not be feasible due to inaccessibility. The upper Kahakuloa area is currently the only documented site that represents a possible nesting colony for Newell's shearwaters in West Maui. Based on the location of Makamakaʻole relative to the upper Kahakuloa site, its demonstrated location within the suspected flight paths of Newell's shearwater (Section 2.4.2 of original HCP), Makamakaʻole is considered an ideal site for the proposed enclosure and social attraction project. Using methods to shift the colony from these remote, unmanageable areas to sites where threats to nesting seabirds can be kept to a minimum is an important tool to protect the few Newell's shearwaters left nesting on West Maui.

6.5.1.3 Hawaiian Petrel and Newell's Shearwater Passage Rates over Makamakaʻole

Radar surveys were conducted at Makamakaʻole from May through September 2010. Given that Hawaiian petrel and Newell's shearwater targets cannot be reliably differentiated by radar, the radar targets are proportioned out as 90% Hawaiian petrel and 10% Newell's shearwater based on the most recent analysis of inland seabird passage rates over West Maui (Cooper *et al.* 2011; Appendix 23). Auditory point count surveys at Makamakaʻole were conducted mainly in July 2010. Auditory surveys were also conducted at Kahakuloa in May 2007 to detect Newell's shearwaters. Follow-up auditory surveys were conducted in June 2011 at a slightly lower elevation site. These data are used to estimate the potential numbers of birds that may fly over the site and be potential immigrants to the new colony established by social attraction.

6.5.1.3.1 Hawaiian Petrel

Auditory and visual surveys have documented Hawaiian petrels circling over Makamakaʻole during the breeding season. Call activity rates in July ranged from 0–50 calls/5 minutes, with peak activity occurring around 20:00 to 20:30. The average call rate over the site was 17 calls/5 minutes and Hawaiian petrels and activity remains high in the area for approximately 2 hours, from 19:30 to 21:30. A similar pattern is apparent at Haleakalā (David Ainley, pers. comm.).

Radar data collected at Makamakaʻole give an indication of the number of birds that may be in the area in one night. The identity of these birds was confirmed by infrared imaging. Up to 42 individual Hawaiian petrel targets were documented flying inland to the site in a single night, with the site averaging approximately 26 Hawaiian petrel targets during the survey period. Based on long-term observations, up to 75 Hawaiian petrels are estimated to have been in that area at any one time (Greg Spencer, pers. comm., 2010). The population of Hawaiian petrel in the existing colony in the vicinity of Makamakaʻole is assumed to be approximately 600 pairs. This is a crude estimate based on the fact the up to 75 Hawaiian petrels have been observed circling and calling, including pair formation, at times, in the valley next to the proposed site of the predator exclosures. It is assumed that these birds represent roughly 10% of the expected colony size (N. Holmes, pers. comm.).

The radar and auditory data provide strong evidence that sufficient numbers of birds fly over Makamakaʻole to support the number of immigrants needed for successful social attraction at the site.

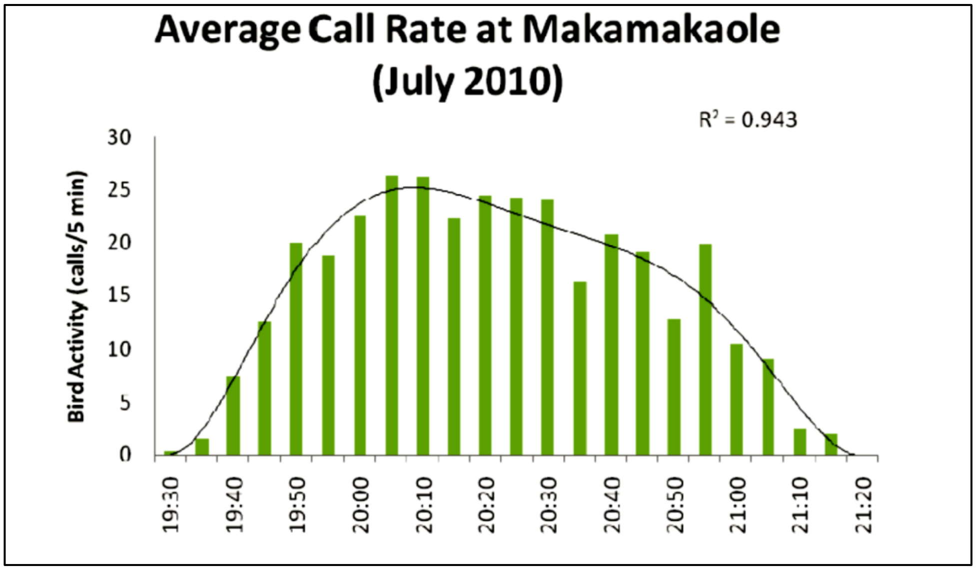


Figure 6.1. Average Hawaiian petrel call rates at Makamakaʻole, July 2010.–*NO CHANGE*

Table 6.4. Radar Data from Makamakaʻole–*NO CHANGE*

Date	Total Targets	Number of Hawaiian Petrels (90% of total)	Number of Newell's Shearwaters (10% of total)
5/28/2010	20	18	2
5/29/2010	45	40.5	4.5
5/30/2010	42	37.8	4.2
7/6/2010	14	12.6	1.4
7/7/2010	39	35.1	3.9
7/8/2010	35	31.5	3.5
7/9/2010	29	26.1	2.9
8/9/2010	37	33.3	3.7
8/10/2010	47	42.3	4.7
9/6/2010	10	9	1
9/7/2010	26	23.4	2.6
9/8/2010	18	16.2	1.8
9/9/2010	19	17.1	1.9
Average	29.3	26.4	2.9

6.5.1.3.2 Newell's Shearwater

Presently, there are no direct data on what the population of Newell's shearwater might be on West Maui owing to the extremely rugged terrain and unyielding bad weather, which has precluded surveys within the period during which the shearwaters are most vocally active. Therefore, a current best estimate of population size is based on indirect means.

In Cooper and Day (2003) the radar detection rates of Newell's shearwaters and Hawaiian petrels are given for surveys conducted in June 2001 (see Figure 2.2). For the six sites around West Maui, detection ranged from 0.4 to 21 birds/hour, or 1 to 62 birds per night (data collected during the first 3 hours of each night). Cooper and Day (2003) concluded that shearwaters and petrels may use specific "corridors" for accessing their breeding colonies. It is possible that the same colony could be accessed by more than one corridor on West Maui, where all valleys converge toward the summit. Certainly, this is true for Hawaiian petrels based on their data around East Maui/Haleakalā. For the section of the coast containing Makamaka'ole, detection ranged 5.6 to 21/hour. The total for three sites in that area ('Iao, Waihe'e, and Kahakuloa) was 48 birds/hour. (Newell's shearwaters in remainder of West Maui were negligible.) Cooper and Day (2003) also concluded that any detections that occurred 60 minutes past sunset were likely Newell's shearwaters, although in their visual detections they only saw Hawaiian petrels. Their summary of the proportion of detections that they assigned to Newell's shearwaters and Hawaiian petrels is given in Figure 6.2. On the basis of their estimate, where 25 to 50% of detections were Newell's shearwaters (an average of 30% for the three sites), then, the detection rate for Newell's shearwaters in the northeast portion of West Maui, in 2001, ranged from two to seven birds/hour, or six to 21 Newell's shearwaters per night (bracketing Makamak'ole, between Kahakuloa and Waihe'e); or, assuming that Newell's shearwaters detected at all three sites were all heading for the same colony, then 32 birds/hour, or 96 birds in a night.

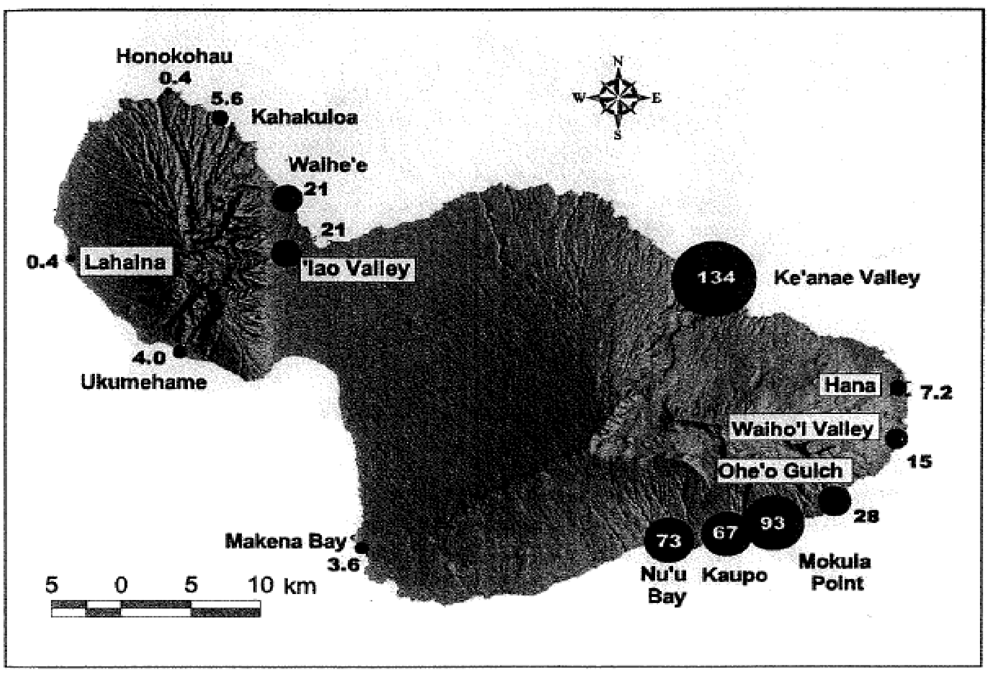


Figure 6.2. From Cooper and Day (2003). Radar detection rates, birds/hour, for the first three hours of the night on surveys conducted June 7–21, 2001.–*NO CHANGE*

Based on work at Haleakalā during 2008–2011 by Adams (2008) (Ainley *et al.* David Ainley pers. comm.), it is known that Hawaiian petrels bring fresh food to their nestlings at all hours of the night, even up to 4:30 am (just before dawn). In other words, the petrels do not fly around the colony for hours before entering their burrows. Therefore, the assumption is made in the present analysis that one-third of what Cooper and Day (2003:Figure 6.2) thought were Newell's shearwaters actually were Hawaiian petrels. The detection of Newell's shearwaters in the northeast portion of West Maui in 2001 would therefore range from four to 14 birds per night, bracketing Makamaka'ole, or 64 birds per night if Newell's shearwaters detected at the three northeast West Maui sites were all headed for the same colony. Assuming that very few Newell's shearwaters arrived later than the first three hours of the night (probably a few arrived later, but not many), the radar data indicate that these figures estimate the number of Newell's shearwaters flying to the colony(ies) of northeast West Maui each night in June 2001.

During detection surveys at Makamaka'ole in 2010–2011, one to three Newell's shearwaters were heard flying upslope during the first three hours of each night in June–July (this is not birds/hour); the maximum was 13 vocal detections of Newell's shearwaters in one night (First Wind, unpubl. data). This is fewer by a third of what was detected by Cooper and Day (2003) 10 years earlier on either side of Makamaka'ole Valley. And a reduction in population size is consistent with the DOFAW Maui SOS data. According to Brenda Zaun (USFWS, pers. comm.), on the basis of electronically monitoring arrival and departures of Newell's shearwaters in burrows at Kilauea Point National Wildlife Refuge, at least one adult Newell's shearwater, and usually just one, visits its chick each night. Therefore, the number of detections at West Maui would be equivalent to the number of breeding Newell's shearwater pairs.

The overall conclusion is that at least 40, and no more than 100 pairs of Newell's shearwaters still nest in West Maui and are confined to the northeastern portion that contains Makamaka'ole.

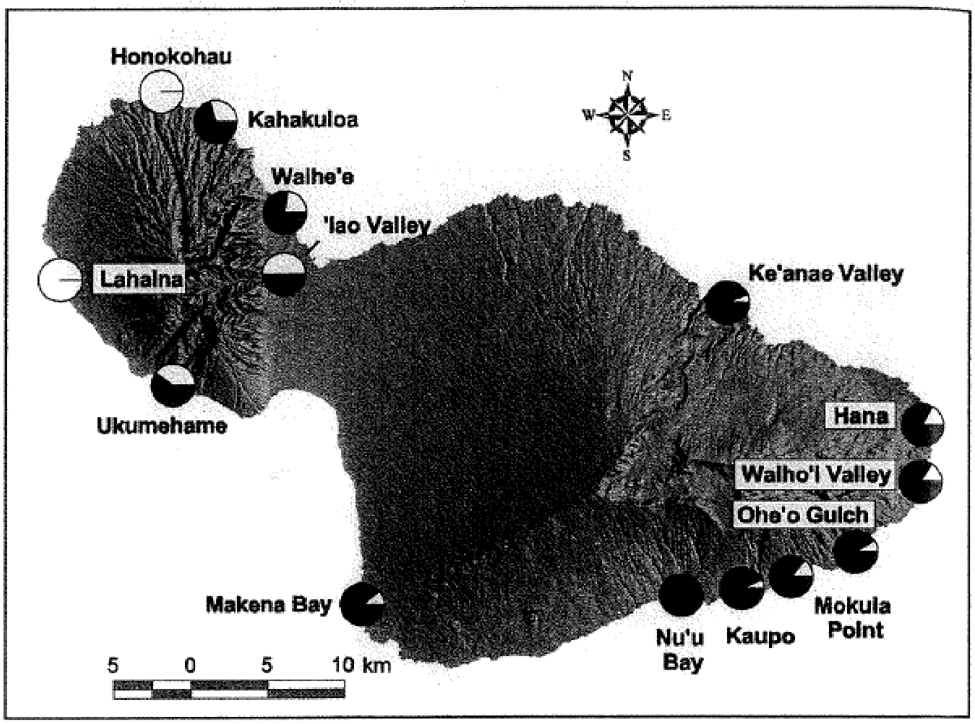


Figure 6.3. From Cooper and Day (2003). Radar targets by species. Pie charts showing the proportion of Newell's shearwaters (white) and Hawaiian petrels (dark) thought to compose the targets detected by radar, June 7–21, 2001. Distinguishing Newell's shearwaters from Hawaiian petrels was done only under the assumption that detections 60 minutes after sunset were Newell's shearwaters.–*NO CHANGE*

Table 6.5. Parameter Values Used in the Population Model, Existing Colony (full predation) and Mitigation Colony (no predation), for Hawaiian Petrel at Makamaka'ole.–*NO CHANGE*

Parameter	Value		Source
	Existing Colony	Mitigation Colony	
Survival			
Annual age 0 survival	0.66	Same	Calculated using ratio of ages 0 to 2 survival rates, based on Ainley *et al.* 2001
Annual age 1 survival	0.79	Same	Calculated using ratio of ages 1 to 2 survival rates, based on Ainley *et al.* 2001
Annual age 2 survival	0.90	Same	Back-calculated to result in a fledgling to age 6 survival rate of 0.2689 (from Simons 1984)
Annual age 3 survival	0.90	Same	Assumed to be same as age 2 year survival rate (see HTH and PRBO 2011b)
Annual adult (> =4) survival	0.80	0.93	Simons 1984, high level of predation; no predation could be as high as 0.94 (see HTH and PRBO 2011a for explanation)

Parameter	Value		Source
	Existing Colony	Mitigation Colony	
Fecundity			
Breeding probability	0.51	0.89	Hodges and Nagata 2001, no predator control (high level of predation); Simons 1985, no predation
Reproductive success (4 and 5)	0.27	0.50	Calculated based on ratio of estimate of 0.5 for ages 4 and 5, from Bell *et al.* 2005 to the estimate of 0.72 based on the literature and the assumed reproductive rate of 0.39 for ages > =6; Bell *et al.* 2005
Reproductive success (> =6)	0.39	0.72	Simons 1985, for high predation; see HTH and PRBO 2011a for explanation regarding no predation scenario
Sex ratio	1:1	Same	Nur and Sydeman 1999; Simons 1985
Age at first breeding	6	Same	Simons 1984
Maximum breeding age	36	Same	Simons 1984

A maximum of 13 individuals were recorded flying over Makamakaʽole during auditory point count observations in 2010. Newell's shearwaters were detected (based on auditory observations) 8 days out of the 14 days that auditory point count surveys were made. Radar data at Makamakaʽole estimate that 1 to 5 individuals may fly over the site on any given night; this estimate is supported by the auditory detections.

These data strongly suggest that sufficient numbers of Newell's shearwaters fly over Makamakaʽole to be good candidates to be immigrants to the social attraction site.

6.5.1.4 Social Attraction and Artificial Burrows

Ground-nesting and burrowing seabird species can be encouraged to nest at a prospective site by the placement of artificial burrows accompanied by vocalization playbacks. This increases the density of nesting pairs in the area which in turn attracts more individuals and ultimately allows for more effective management (Podolsky and Kress 1992). Artificial burrows may also be positioned in a manner that facilitates monitoring. So far, the use of artificial burrows has been attempted with some success for Newell's shearwaters at Kilauea Point National Wildlife Refuge on Kauaʽi (Joyce *et al.* 2008; USFWS, unpubl. data). These techniques have shown considerable success for an increasing number of ground-nesting seabird species at several locations in the Pacific and Atlantic Oceans. The Action Plan for Seabird Conservation in New Zealand states that colony establishment and enhancement is expected to contribute long-term conservation benefit to threatened seabird taxa (Taylor 2000a, 2000b). According to Hawaiʽi's Comprehensive Wildlife Conservation Strategy, while protecting seabird populations and their breeding colonies remains an important management priority, reestablishing former (or even remnant) breeding colonies is also important to reduce the risk of eventual extinction (Mitchell *et al.* 2005).

For colonial seabird species, the presence of breeding birds in suitable habitat is attractive to additional nesters, presumably because it is a strong indicator that a site is safe and productive. Social attraction uses this behavior to lure seabirds to historic or safer breeding areas by using a combination of social cues that encourage colonization. Cues can be visual (decoys, mirrors) or acoustic (sound playback systems) depending on the nesting habits of the target species. Acoustic attraction is particularly important for nocturnal species. For example, in a project to attract Leach's storm-petrels using vocalizations, 70% of birds nested within 50 cm of a loudspeaker compared with only 16% nesting three or more m from speakers (Podolsky and Kress 1989b). Broadcasting calls from multiple birds (indicating a large colony) and using a complete set of typical colony sounds appears to attract the most birds (Podolsky and Kress 1989b; Podolsky and Kress 1992). This technique is well proven by over a dozen projects accomplished in New Zealand.

Artificial nest boxes are commonly used in conjunction with vocalizations to increase the availability and quality of nesting sites. They provide easy access to nests by prospecting birds, and subsequently are useful for monitoring; they can be modified to exclude larger, more aggressive seabird species and may decrease incidents of egg predation (e.g., from common mynas). Furthermore, some species have higher breeding success in artificial nest boxes than in natural nests (Priddle and Carlisle 1995; Bolton *et al.* 2004). Band-rumped storm-petrels, dark-rumped petrels, Newell's shearwaters, and wedge-tailed shearwaters have all nested successfully in artificial structures (Byrd *et al.* 1983; Podolsky and Kress 1989a; Bolton *et al.* 2004; Brenda Zaun, USFWS pers. comm.), as have a multitude of seabird species elsewhere, including alcids, petrels, and shearwaters.

Social attraction has been used to successfully establish colonies of colonial waterbird species throughout the world (Kress and Nettleship 1988; Gummer 2003). The earliest successes were with terns (Laridae) (Kress 1983), but successes are also reported for albatross (Diomedidae), several species of shearwaters (see below), *Pterodroma* petrels (Podolsky and Kress 1989a, 1992; Kress 1990; Sawyer and Fogle 2010; Miskelly *et al.* 2004), murres (Alcidae) (Kress and Borzik 2002), Cassin's auklets (Pyle 2001), rhinoceros auklets (www.Oikonos.org), and storm-petrels (Hydrobatidae) (Podolsky and Kress 1989b).

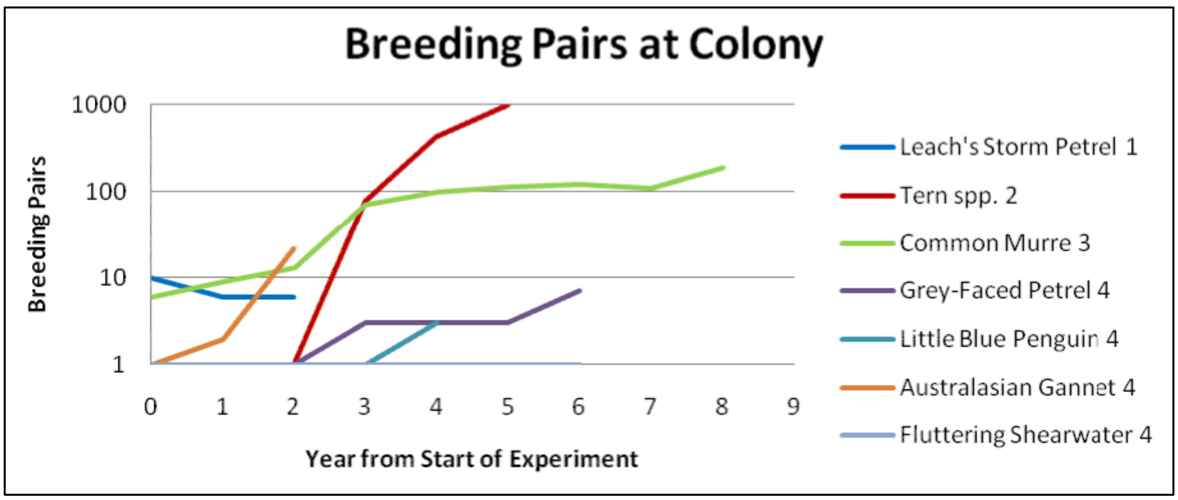
Podolsky and Kress (1992) were able to demonstrate the attraction of the Galapagos petrel (*Pterodroma phaeopygya*, previously known as the dark-rumped petrel) to playbacks of vocalizations demonstrating the potential of social attraction to establish new colonies. Evidence of breeding was discovered 2 years into the project (Kress 1990). At Nick's Head Peninsula, New Zealand, calls of six pelagic seabird species were broadcast in 2005. After 3 years, grey-faced petrels successfully nested at the site (Sawyer and Fogle 2010) and fluttering shearwaters (*Puffinus gavial*) were observed in burrows. More recently, social attraction of shearwaters and petrels in New Zealand has been successful at establishing breeding pairs (Sawyer, pers. comm.). An attempt to establish colonies of common diving petrels (*Pelecanoides urinatrix*), fairy prions (*Pachyptila turtur*), fluttering shearwaters, and white-faced storm-petrels (*Pelagodroma marina*) on Mana Island, New Zealand, was successful in attracting three species to the target site (59 diving petrels, two fairy prions, and two white-faced storm-petrels) (Miskelly *et al.* 2004). But there were no breeding attempts after 3 years of attraction, so a translocation program was initiated for common diving petrels and fairy prions. The combination of methods resulted in successful colony establishment (Miskelly and Gummer 2004; Miskelly and Taylor 2004). In Hawai'i, calling stations have been installed in order to reestablish breeding colonies of Bulwer's petrels, which were extirpated from Midway Atoll by rats. This is currently also planned for Ka'ena Point, O'ahu, which is now protected by a predator-proof fence (Lindsay Young, pers. comm.). Additionally, a small-scale project broadcasting calls of Phoenix petrel (*Pterodroma alba*) was initiated in 2001 at Jarvis Island National Wildlife Refuge.

A fencing and social attraction approach at Makamaka'ole is expected to have a very high chance of success. The site is very accessible, being located within walking distance from the end of a road, and includes a range of topographical features and aspects, including slopes, gullies, flat areas, ridges, banks, etc., as well as a range of soil types and options for birds to form natural burrows. The site which has received preliminary consideration for fencing primarily faces north into the prevailing wind, which aids the birds with takeoff. The proposed fenceline will avoid waterways, which are more easily breached by vertebrate pests. The site is close to a community, which may allow for community participation in the long-term conservation effort; those residents who so far are aware of the situation are supportive, which will contribute to assuring long-term success (Steve Sawyer and Greg Spencer, pers. comm.). In addition to providing protection to the target species of birds, the site can be used as a sanctuary for highly threatened and endangered plants and invertebrates if warranted.

Based on the presence of inactive, old, and disused burrows and the significant amount of Hawaiian petrel activity over the site, the area is believed to be a historic nesting site where nesting attempts still occur but fail due to high predator densities. It is interesting to note that historic maps show that one of the features at Makamaka'ole was identified as 'Ua'u Hill. The presence of a significant number of Hawaiian petrels transiting and even courting adjacent to the proposed attraction site indicate there is a significant source of birds that may be drawn into the enclosure. In contrast, a recent acoustic attraction project at Young Nick's Head, New Zealand, was successful in attracting grey-faced petrels, a congeneric of the Hawaiian petrel, without any birds having been recorded at or near the site since they went locally extinct 81 years prior. Within 7 months of installation of the sound system, birds landed at the site, and within 6 years, seven pairs are breeding at the site (Sawyer and Fogle 2010). Hawaiian petrel, like New Zealand *Pterodroma*, are expected to respond well to acoustic attraction, as demonstrated with the Galapagos petrel (Kress 1992). Historic records mention indigenous Hawaiians calling birds in to catch and eat (Steve Sawyer, pers. comm.). War whooping is very effective for calling in gadfly petrels (Gangloff *et al.* 2009).

6.5.1.5 Colony Establishment and Credit Accrual

The rate of increase in colony size following reestablishment appears to be somewhat rapid, once breeding begins, as judged from experience especially in New Zealand on other petrels. Assuming that the colony would initially be populated by prospectors (ages 2–5), breeding is expected to commence as early as year 2. For fluttering shearwater and common diving petrel, where chick translocation was used, the increase in the number of breeding pairs from year 6 to year 10 was rapid. By attracting sub-adult prospectors, there is no need to wait through the first few years of a petrel's life, which is spent entirely at sea. Acoustic attraction experiments on petrel species in New Zealand confirm that they can show signs of success earlier, as seen with studies conducted for fluttering shearwater (Bell *et al.* 2005) and common diving petrel (Miskelly and Taylor 2004). The rate of colony attraction appears to be such that there is a relatively rapid increase in breeding pairs with time after the initial breeding starts, kind of a 'snowballing' effect. Figure 6.4 illustrates rates of colony attraction based on published and unpublished data.



[1] Podolsky and Kress 1989
[2] Kress 1983
[3] Parker *et al.* 2007
[4] Steve Sawyer, unpub.

Figure 6.4. Colony attraction for social attraction projects.–*NO CHANGE*

6.5.1.5.1 Hawaiian Petrel

Modeling by H.T. Harvey and associates (Appendix 24) based on published demographic parameters, data from social attraction projects referenced above and a set of reasonable assumptions, projects the presence of 14 active breeding burrows within the enclosure in 20 years. Although Tier 1 mitigation requirements for KWP I and KWP II combined would not be reached during the 20-year license period (i.e., at least one individual above the Tier 1 take level of 42 individuals, at least 28 of which are adults), considerable progress would be made, especially for adults. Although the mitigation targets would not be exceeded within the license period, 67% and 65% of adult and fledgling Tier 1 take would be met, respectively. But mitigation accelerates with time, and the net recovery benefit would be reached by year 24 for adults and year 25 for fledglings (see Appendix 24). Colonization and success of the enclosure starts fairly slowly, but colony growth accelerates rapidly each year. The assumed rate of social attraction for Makamaka’ole is based on Bell *et al.* (2005), which is a conservative value. Other studies (e.g., Miskelly and Taylor 2004) found much higher rates of social attraction within the first several years of establishment. In addition to birds transiting the area, up to 75 petrels are seen circling, calling, and performing paired flights in the valley immediately adjacent to the proposed site. Therefore the initial colonization rate at Makamaka’ole may well be higher than predicted by the model. If initial success is even slightly greater than predicted, it is likely that the proposed mitigation project will reach Tier 1 mitigation goals for both KWP I and KWP II within the 20-year license period.

Since the projection of colony growth is based on data available from other projects, the actual rate of colony growth is unknown. Therefore, the success of the project will be evaluated at 5 years post-implementation to make sure the project is on track and will use data from the first 5 years to project when mitigation goals can be expected to be reached. Mitigation credit will be calculated as described by H.T. Harvey and Associates (see Appendix 24), where a Tier 1 scenario for birds breeding in an unprotected area (Table 6.5) is subtracted from a reasonable, but conservative scenario within the enclosure. If monitoring results confirm that mitigation goals will not be reached within 20 years, adaptive management will be triggered, as described in Section 6.5.1.7, to ensure mitigation requirements are fulfilled within 20 years.

Any ground- and burrow-nesting birds in West Maui would be and have been subject to intense predation by cats, mongoose, and rats. During work at Makamaka’ole in July through August 2011, 11 mongoose were trapped in 12 days using two traps; only predated carcasses of Hawaiian petrels and deserted burrows thus far have been found in the lower Makamaka’ole area, over which the petrels circle at night (First Wind, unpubl. data). According to the NARS management plan (NARS 1989), mongoose tracks have been found on the Pu‘u Kukui Trail well above Makamaka’ole (2,980 feet and higher) and rat sign has been found as high as 4,200 feet on West Maui (more or less the summit). Cats and rats occur at the summit of Haleakalā (10,029 feet) and mongoose are also found at high altitudes; thus, there is reason to believe that these predators are likely widespread on West Maui, which is half that altitude. The annual adult survival rate of 0.80, which is the adult survival determined by Simons (1984) prior to initiation of predator control, is representative (average) of all of West Maui, including low-altitude areas such as Makamaka’ole, where adult survival is nil, and more remote and steeper areas at higher altitude, where predation pressure may be lower and adult survival may be slightly higher.

Table 6.6. Newell’s Shearwater Auditory Data–*NO CHANGE*

Date	Total Calls	Total Individuals Detected	Comments
6/26/2010	1	1	
7/6/2010	2	2	1 observation from radar location
7/7/2010	7	7	1 observation from radar location
7/8/2010	16	13	at least 10 discrete observations from 1 point count station
7/9/2010	1	1	1 observation from radar location
7/15/2010	1	1	
7/27/2010	3	3	
8/3/2010	1	1	

6.5.1.5.2 Newell’s Shearwater

Modeling by H.T. Harvey and Associates (see Appendix 25) based on published demographic parameters, data from social attraction projects referenced above, and a set of reasonable assumptions that are explained in Appendix 25, projects the presence of six active breeding burrows within the enclosure in 20 years. Tier 1 mitigation requirements for both KWP I and KWP II combined would be reached during the 20-year license period (i.e., at least one individual above the Tier 1 take level of eight individuals, at least which of which are adults), by year 16. The proposed mitigation will also make significant progress toward the Tier 2 take level.

Since the projection of colony growth is based on data available from other projects, the actual rate of colony growth is unknown. Therefore, the success of the project will be evaluated at 5 years post-implementation to make sure the project is on track and will use data from the first 5 years to project when mitigation goals can be expected to be reached. Mitigation credit will be calculated as described by H.T. Harvey and Associates (see Appendix 25), where a Tier 1 scenario for birds breeding in an unprotected area is subtracted from a reasonable, but conservative scenario within the enclosure (Table 6.7).

Newell's shearwaters are assumed to be equally or more susceptible to predation than Hawaiian petrels; thus, similar predation pressure as described for the Hawaiian petrel was used in the selection of demographic parameters of the existing population of Newell's shearwaters on West Maui.

Table 6.7. Parameter values used in the population model, existing colony (full predation and mitigation scenarios) and mitigation colony (mitigation scenario only), for Newell's shearwater at Makamaka'ole.–*NO CHANGE*

Parameter	Value		Source
	Existing colony	Mitigation colony	
Survival			
Annual age 0 survival	0.654	Same	Griesemer and Holmes (2010)
Annual age 1 survival	0.780	Same	Griesemer and Holmes (2010)
Annual age 2 survival	0.815	0.890	Griesemer and Holmes (2010), high predation; Griesemer and Holmes (2010), no predation
Annual age 3 survival	0.830	0.905	Griesemer and Holmes (2010), high predation; Griesemer and Holmes (2010), no predation
Annual age 4 and 5 survival	0.770	0.920	Ainley *et al.* (2001), Griesemer and Holmes (2010); assumed same survival as for ages 6 and older under no predation
Annual adult (> =6) survival	0.877	0.930	Ainley *et al.* (1995), Griesemer and Holmes (2010), high predation; Schreiber and Burger (2001), Manx shearwater
Fecundity			
Breeding probability (3, 4, 5)	0.25	0.4	Assumed to be half of breeding probability for ages 6 years and older
Breeding probability (> =6)	0.5	0.8	Griesemer and Holmes (2010), high predation; Griesemer and Holmes (2010), no predation
Reproductive success (3, 4, 5)	0.21	0.29, 0.39, 0.50	Calculated based on ratio of estimate of 0.5 for ages 4, 5 from Bell *et al.* 2005 to the estimate of 0.7 based on Griesemer and Holmes (2010); Bell *et al.* (2005), gradual increase from year 2 to 8 (see HTH and PRBO 2011c)
Reproductive success (> =6)	0.30	0.4, 0.55, 0.70	Griesemer and Holmes (2010), high predation; Griesemer and Holmes (2010), low predation, gradual increase from year 2 to 8 (see HTH and PRBO 2011c)
Sex ratio	1:1	Same	Nur and Sydeman 1999
Average age at first breeding	6	Same	Ainley *et al.* 2001
Maximum breeding age	36	Same	Ainley *et al.* 2001

6.5.1.6 Project Design

An area has been identified for the construction of two approximately 5-acre predator (dog, cat, mongoose, and rat) proof enclosures to protect breeding Hawaiian petrels and Newell's shearwaters. The enclosures will follow design specifications, materials, and installation criteria based upon proven New Zealand pest-proof fence technology (Steve Sawyer, Ecoworks; and Tim Day, Excluder). This enclosure size has proven to be optimal because it provides adequate space for 50 or more artificial and natural burrows while ensuring the effectiveness of the fence in excluding predators and pests (ungulates) and the practicability of eradicating the predator species from within the enclosure. The two enclosures will be separated from each other, in part to reduce the potential for competitive inter-specific interactions. The placement of the fence will conform to the natural contours of the immediate landscape, and will be situated below the crests of ridgelines to in order to stay below the flight path of the petrels and assure a minimal risk of collision. Similar projects for Gadfly petrels and shearwaters in New Zealand have not encountered any problems related to seabirds colliding with fences such as proposed for this project. Having the enclosure uphill of the fence effectively increases the height of the fence for mammalian predators outside the fence. The layout of the fenced enclosures will be designed to avoid any waterways, which are difficult to manage and are a likely pathway for pest incursions. An electric wire will be placed 4 m from the fence to discourage ungulates from approaching and potentially compromising the fence. The fence itself will be designed to keep out dogs, cats, mongoose, and rats, while allowing mice to come and go. Mice will be controlled down to an approximate 2% activity rate within the enclosure by maintaining a 25m grid of bait stations (Diphacinone), and a trapping program will be carried out within a 100m buffer zone around the enclosure using Conibear-type traps placed in ply boxes for cats and mongoose along ridges within a 1 km radius of the enclosure to depress predator densities in the surrounding buffer zone. All trapping and baiting activities will be in accordance with applicable regulations and labels. In addition, barn owl control will be implemented before petrels and shearwaters return to the area and may be continued during the breeding season if owls are observed re-occupying the area. The acoustic attraction setup will be based on methods proven to be effective in New Zealand, and will consist of remote solar powered digital acoustic attraction players and weather-resistant omni-directional speakers using local Makamakaʽole, Lanaʽihale, and/or Haleakalā Hawaiian petrel vocal recordings and as-available Newell's shearwater recordings. Each enclosure will only broadcast calls of one species (i.e. only Newell's shearwater calls will be broadcast within the designated Newell's shearwater enclosure). Before social attraction begins, 50 artificial burrows specifically designed for each species will be installed within a 40m radius of the speakers, which may be followed in subsequent years by ongoing installation of up to 50 more burrows elsewhere within the enclosures and possibly additional speaker deployments. The use of artificial burrows has aided recolonization in social attraction projects for Procellariids in New Zealand and elsewhere (see section 2.3 of original HCP). A timeline of implementation and figures for the design and location of the enclosure can be found in Appendix 22.

The enclosures will be located within the Kahakuloa Natural Area Reserve (Appendix 22). The Newell's shearwater enclosure will be located entirely within the existing fenced area, but the Hawaiian petrel enclosure, as presently designed will intersect with the existing ungulate fence along its northeastern corner. To ensure that the enclosure is entirely included within the existing ungulate fence, and to minimize collision risk, the portion of the existing fence that will intersect the Hawaiian petrel enclosure will be rerouted to follow the lower edge of the Makamaka'ole Stream precipice at least four meters from the predator proof fence. This action, which will be executed in cooperation with the NARS, will not impact the effectiveness of the existing ungulate fence, and will be paid for by the Applicant.

6.5.1.7 Adaptive Management Plan for Tier 1 Mitigation

As described above, the proposed mitigation project is expected to offset Tier 1 take within the 20-year life of the project. However, if the Makamakaʽole social attraction project does not produce the anticipated mitigation benefits, adaptive management at the Makamakaʽole site, or management at an additional site or sites would be conducted to ensure mitigation requirements are met within the life of the project.

The proposed mitigation project at Makamakaʽole may be delayed due to unanticipated circumstances, or additional landowner permit requirements. Discussions with NARS are ongoing, and the NARS permitting process is not expected to cause significant delays to the project. Additional landowner permit requirements for the Makamakaʻole social attraction project are not anticipated.

Throughout the first five years of social attraction at Makamakaʻole, management may be adapted to change methods, scale, or strategy at Makamakaʻole to incorporate updated techniques with the concurrence of USFWS and DLNR. Success of the mitigation project will be monitored annually, and after five years the performance of the project will be evaluated against predictions based on the presented models

Table 6.8. Minimal number of breeding pairs occupying the enclosures after 5 years of social attraction to confirm meeting mitigation requirements.–*NO CHANGE*

Species	Number Needed to Offset KWP II Tier 1	Total Needed to Offset KWPII Tier 1 + KWP II Tier 2	Total Needed to Offset KWP I Tier 1	Total Needed to Offset KWP I Tiers 1 and 2
Newell’s shearwater	1	2	1	2
Hawaiian petrel	1	2	1	2

If based on results achieved during years 1 through 5, the success of the Makamakaʻole social attraction project does not appear (based on Table 6.7, above) capable of offsetting the level of take anticipated during the 20-year permit term (at a minimum, Newell’s shearwater mitigation will offset KWP II Tier 1 take, KWP I’s anticipated 20-year take levels, and KWP II’s Tier 2 requested take level, if triggered, based on observed take) the Applicant will, in year 6, implement one or more adaptive management or additional mitigation measures to supplement the mitigation effort to the extent necessary to offset anticipated levels of take. For an explanation of how Tier 2 is triggered see Section 4 of the original HCP. During years 1–5, the Applicant will develop management plans for the following alternative Tier 1 mitigation project sites. Alternatives will be evaluated in the order listed and implemented as needed to fulfill mitigation requirements. When mitigation commences at an alternative site, mitigation projects at the previous sites will continue for the duration of the permit term unless the Service and DOFAW agree the conservation action may be terminated.

Hawaiian petrel:

a) Implement predator control at Hawaiian petrel colony on the Haleakalā Crater Rim.

b) Implement predator control at Hawaiian petrel colony at the ATST mitigation site on the Haleakalā Crater.

Newell’s shearwater:

a) Install predator fencing and manage predators around a Newell’s shearwater colony or colonies in West Maui or, if the USFWS and DOFAW agree management of a West Maui site is not feasible, control predators at a Newell’s shearwater colony or colonies in East Maui.

b) If based on feasibility criteria such as presented in Table 6.7 in situ management of Newell’s shearwater colonies is not feasible in West Maui, implement a social attraction project at an alternative site on Maui.

c) If the USFWS and DOFAW agree that neither in-situ management nor social attraction of Maui Newell’s shearwaters are feasible, install predator fencing and manage predators around a Newell’s shearwater colony or colonies on either Molokaʻi or Lānaʻi (see Section 6.5.2.2).

d) If DOFAW and the USFWS confirm management of Maui Newell’s shearwater colonies is not feasible, or will fall short of mitigation goals, implement a social attraction project or projects on Molokaʻi or Lānaʻi to ensure that the collective mitigation efforts result in successful achievement of mitigation goals for KWP II Tier 1 requested take in addition to KWP I’s anticipated 20-year take levels and KWP II’s Tier 2 requested take level, if triggered based on observed take.

Attracting breeding individuals of both Hawaiian petrel and Newell’s shearwater to an area within which they can be protected from predation threats is believed to have the potential of saving the remaining colonies of both species on West Maui. Under current conditions both species are undergoing continuous population decline and, without intervention, are likely headed toward extinction on West Maui in the near future. Modeling (Appendix 24) shows that with an estimate of approximately 40 existing breeding pairs in West Maui, based on best available information, the West Maui Newell's shearwater population will reach extinction threshold of 10 pairs within 11 years. After that point stochastic events become a large factor in the extinction of the remaining population. The population is projected to have fewer than 2 breeding pairs within 29 year. The Hawaiian petrel population is projected (Appendix 24) to reach extinction threshold of 10 pairs within 27 years. Such has been the recent history of these species nesting at lower elevations (equivalent to West Maui) on Kauaʽi. In contrast, once established in the predator free enclosures, the "rescued" colonies will have a positive population growth, and are projected to be self-sustaining (without immigration) at around 25 breeding pairs (David Ainley pers. comm.). Therefore, with the establishment of a viable self-sustaining or growing colony for each species, versus the currently unmanaged presumably declining colonies on West Maui, the net recovery benefit in the long term may far exceed the short-term benefits described above.

The actual measures implemented at Makamakaʽole or alternative sites will be subject to approval by the agencies. Input will be sought from the Seabird Recovery Group for the State of Hawaiʽi. However, if mitigation efforts at another seabird colony are identified as a greater need or having a greater potential benefit, priority will be given to other colonies on East Maui, West Maui or another island or in other areas as determined by the DLNR and the USFWS.

Newell's shearwater will not be a Covered Species in the HCP unless the USFWS and the DLNR approve the requested reduction in Newell's shearwater take permitted at KWP I to a total take of eight Newell's shearwaters. A decision regarding the requested permitted take reduction is anticipated before the start of the 2012 breeding season of this species; take is not anticipated before the start of the 2012 breeding season.

6.5.2 Alternatives for Tier 1 Mitigation–*UPDATED*

Makamakaʽole is considered by DOFAW, the USFWS, and others to be an important site for the recovery of the species. In addition, it is within a known flight path of Newell's shearwaters. However, if the preferred alternative is unsuccessful, or does not fulfill mitigation requirements, the following alternative mitigation actions are proposed. Figure 6.5 shows the locations of the sites described below. After discussing with the Applicant, DOFAW and the USFWS will determine the most appropriate alternative for mitigating the impacts of this project.

6.5.2.1 Alternatives for Hawaiian Petrel

If necessary to offset KWP I and KWP II Tier 1 take of the Hawaiian petrel, KWP II would augment the Makamakaʻole social attraction efforts by implementing management measures at the south crater rim of Haleakalā Crater (South Rim site). The National Park Service has identified at least 100 burrows, and based on Hawaiian petrel monitoring and GIS modeling, they assert that at least 600 active burrows are present along the South Rim (C. Bailey pers. comm.). The nesting area is composed of large boulders, rocky outcrops, and cinder fields (Simons 1983). Vegetation in the area is very sparse (Hodges and Nagata 2001). The National Park Service has confirmed this area is protected from habitat damage by feral goats and pigs, but burrows within this area are not protected from mammalian predators, and are experiencing a much lower level of breeding attempts and breeding success (Hodges and Nagata 2001). If KWP II, LLC participates in the management effort with KWP I, LLC. the two entities will contract the labor and purchase equipment (e.g., traps and bait) required to conduct predator trapping in this area (or a section thereof, depending on mitigation requirements), and to conduct monitoring to document success. The NSF has proposed six years of monitoring at a control site on Haleakalā pursuant to its ATST project. Measured rates of reproductive effort, reproductive success, and adult and juvenile survival at the mitigation site would be compared to vital rates measured at the ATST or another control site. If appropriate control site monitoring data are not available, reproductive effort, reproductive success, and juvenile and adult survival rates agreed to by the Agencies shall be used in place of control site monitoring data. Trapping and monitoring protocols will closely follow the protocols that have already been established by the National Park Service for managing the rest of the colony (Hodges and Nagata 2001). This effort would run for an initial period of 13 years (permit years 6 through 18, assuming initiated as adaptive management after year 5); population modeling by H.T. Harvey and Associates (Appendix 21) indicates 13 years of management of approximately 100 burrows would offset all of the Tier 1 level of take requested in the KWP I and KWP II permit applications. If after the initial 13 years of predator trapping, mitigation is still not at least one fledgling above Tier 1 requested take for both projects, mitigation will continue until that is achieved. Additional details will be refined with concurrence of the National Park Service, the DLNR, and the USFWS.

The effort will, at minimum, include traps spaced 50 m apart on the north side and south side of the burrow concentration. Traps will not be placed in the direct vicinity of active burrows to avoid attracting predators to burrow areas, and to avoid non-target capture. Traps will not be placed on slopes of more than 30% or in areas where a conflict may arise with public access, archeological sites, culturally sensitive areas, or in areas with sensitive natural resources. Configuration of the trapping grid will be dependent on the distribution of active burrows at the site, topographic and substrate characteristics, and other logistical considerations, including those regarding avoidance of adverse impacts on the colony or other sensitive species that may be present in the area. In the nonbreeding season, trapping may be augmented with additional control methods. The limits of the area to be treated, the eventual area in which treatment will take place, need for additional years of treatment and other details of the mitigation efforts will be decided with concurrence of the National Park Service, DLNR and USFWS.

6.5.2.2 Alternatives for Newell's Shearwater

As described above and discussed and agreed upon with the agencies, Makamakaʻole is the preferred site for mitigation. West Maui is largely dark and free from power lines that project above surrounding terrain. Based on feasibility and location within the Newell's shearwater flight path of the Makamakaʻole-Kahakuloa watershed, the proposed project has a very high likelihood of success. However, if the preferred alternative is unsuccessful, or does not fulfill mitigation requirements, the following alternative mitigation actions are proposed. Figure 6.5 shows the locations of the sites described below. After discussing with the Applicant, DOFAW, and the USFWS will determine the most appropriate alternative for mitigating the impacts of this project.

For Newell's shearwaters there are two possible sites on Maui where in-situ colony protection may be possible, but not enough information is available to confirm feasibility of management at these sites. Therefore, as part of the preferred mitigation plan, during the first breeding season after issuance of the ITL/ITP, the Applicant will confirm a breeding site at the upper Kahakuloa area where Newell's shearwaters have been detected previously, including no fewer than 14 survey nights, but no more than 20 survey nights, not necessarily consecutive, between the months of May-August. Fewer nights will be acceptable if the Applicant and USFWS/DOFAW agree that data collected is sufficient to support decisions regarding delineation of a breeding site, determine the feasibility of management and determination of fencing or alternative actions. Surveys may be finished during the second year, at which time the Applicant will assure applicable landowner permitting processes in support of proposed management actions are completed. This approach will be carried out either concurrently or in consecutive years (within years 1–5) at a second site on East Maui to ensure the most informed decisions about feasibility of in situ colony protection at these sites can be made. There is no indication, or data available at this time, to suggest that other locations on Maui offer colony protection opportunities.

Both of the potential alternative in-situ colony protection sites are located within areas already fenced for the purposes of ungulate control. Measures to protect the Newell's shearwaters at these sites will consist of the construction of a pest-proof fence enclosure, similar to the fenced enclosure proposed for the preferred mitigation site. Further protection measures will be similar to those described for Makamakaʻole, if feasible. The size and location of the fenced enclosure will depend on where the birds are found, and on the landscape features at those sites. Minor crossings of drainages would be minimized but may be possible using one-way valves in culverts, allowing unobstructed runoff flow, to ensure predators are kept out of the enclosure. The drawback is that debris may be lodged in the one-way valves in these drainage crossings during runoff events, preventing them from fully closing and enabling potential predator ingress. To be effective, multiple in-line valves may need to be installed. Additional feasibility considerations include the topography: excessively steep slopes and significant gulches are not possible to fence, accessibility: the site needs to be accessed fairly reliably for predator control and monitoring purposes, there have to be enough burrows (natural and/or artificially supplemented), and the enclosure has to be maintained and kept reliably predator free. Regardless of physical constraints to feasibility of this approach, approval of the landowner(s) will have to be obtained, and a contractor will have to be able and willing to construct the enclosure. Table 6.8 lists general, non-binding guidelines for determining feasibility, although feasibility of any site will be determined on a case-by-case basis. Feasibility will be made in consultation with the project contractor, landowner(s), DOFAW, the USFWS, and other subject specialists when applicable.

Table 6.9. Factors That Will Affect the Feasibility of Installing and Maintaining a Predator-Proof Fence–*NO CHANGE*

Feasibility Criteria	
Burrows:	Enclosure needs to contain at least eight naturally occurring burrows, documented shearwater activity, and allow protection for 20 years.
Access:	Site needs to be reliably accessible at least once a week for ongoing monitoring, and more frequently during fence installation. On-site basecamp consisting of a platform and Weatherport may be needed to accommodate overnight stays by field staff.
Topography:	Fenced enclosure cannot be built on or below steep slopes (in general, no greater than 50%, but varies depending on soil and rainfall).
Streams and drains:	Avoid significant waterway crossings as much as possible; high rainfall and low accessibility make these risky to effectively install and maintain.
	Surface water runoff needs to be effectively managed to prevent accelerated erosion.
Construction:	Fenced enclosure as specified for Makamaka'ole is the currently recommended design standard. A contractor must be willing and able to build the enclosure.
Soil type:	Soil needs to be sufficient for an underground skirt and be stable enough to resist erosion.
Site clearance:	Need sufficient clearance for the fence alignment plus a 4-m buffer.
	Significant excavation or fill should be avoided.
	Site access limitations may not allow large machinery, such as excavators, to be transported to the site.
Effectiveness:	Complete and permanent predator removal must be feasible.
Permit:	Landowner permission required for all activities including burrow ground searches, fence construction and maintenance, and any related management actions.

The site chosen by KWP II for colony-based mitigation would be selected with the concurrence of the DLNR and the USFWS. It is likely that KWP II, LLC and KWP I, LLC will collaborate for this mitigation effort. KWP II would either support an existing conservation need at a known colony or direct mitigation at a newly discovered colony where no management presently exists. The success of the mitigation efforts of KWP II will be measured using the method that is currently implemented at that site at the time. If the chosen mitigation site was previously unmanaged, the same measures of success used to estimate success at managed sites will be applied as appropriate.

If USFWS and DLNR determine that the mitigation measures at the Makamakaʻole social attraction site are insufficient, (see section 6.5.1.7) and based on feasibility criteria such as presented in Table 6.7 it is determined that in-situ management opportunities are not feasible in West Maui, a second social attraction site will be implemented, as necessary, to offset project-related take of Newell's shearwater. During years 1-5, the Applicant will locate the area or areas in East Maui best suited for Newell's shearwater social attraction project(s) based on flight passage rates and access (landowner permission, terrain, and accessibility). Because the population of Newell's shearwater may be higher in East Maui than it is in West Maui, the benefits of a Newell's shearwater social attraction project or projects in East Maui are expected to be greater than those described for the Makamakaʻole social attraction project. The most likely sites may be on state land and TNC-managed land along the Koʻolau

Gap, or Keʻanae Valley located north of Haleakalā National Park, and on state land east of Haleakalā National Park. To insure timely implementation of contingencies the applicant will collect data on calling rates and passage rates at these sites and information gained from the Makamakaʽole social attraction project to develop plans for a social attraction site or sites in east Maui sufficient to offset take addressed in the HCP. During years 1–5, the Applicant will conduct surveys consisting of at least 14 survey nights, and no more than 20 nights, not necessarily consecutive, for each site where access is granted and evidence suggests birds are present in sufficient numbers between the months of May–August. Fewer nights will be acceptable if the Applicant and USFWS/DOFAW agree that data collected is sufficient to support decisions regarding feasibility of implementing subsequent social attraction projects. By the end of year 5, the DLNR and the USFWS, in consultation with the ESRC and/or Seabird Recovery Working Group, will select the area and the Applicant's plans will be finalized so that implementation of an East Maui social attraction project could begin as early as year 6 if needed.

If the USFWS and DOFAW, in coordination with KWP II, determine anticipated benefits of the Makamakaʽole social attraction project and any additional mitigation projects are not expected to offset KWP II's Tier 1 take, the USFWS and DOFAW may direct KWP II to implement in-situ management at a Newell's shearwater breeding site or sites on Maui. Criteria for in-situ management feasibility and appropriate will be established by the USFWS and DOFAW in coordination with KWP II, LLC; the landowner; and the contractor appointed to construct a possible fence. If DOFAW and the USFWS determine that no additional social attraction or in-situ management actions are feasible and appropriate on Maui, mitigation options on other islands within Maui Nui will be considered.

The USFWS requires that if the previously identified in-situ management and social attraction projects on Maui are not feasible, or combined do not fulfill mitigation requirements, opportunities for predator exclusion or management be investigated on Molokaʽi or Lanaʽi. During the first breeding season after the determination that mitigation requirements cannot be met through the proposed projects on Maui, KWP II will confirm a breeding site on southeast Molokaʽi at Kainalu Gulch where Newell's shearwaters have been detected previously, including no fewer than 14 survey nights, but no more than 20 survey nights, not necessarily consecutive, between the months of May–August. Fewer nights will be acceptable if the Applicant and the USFWS/DOFAW agree that data collected is sufficient to support decisions regarding delineation of a breeding site, determine the feasibility of management and determination of fencing or alternative actions. Surveys may be finished during the second year, at which time the Applicant will assure applicable landowner permitting processes in support of proposed management actions are completed. This approach will be carried out either concurrently or in consecutive year at a site on Lana`i where Newell's shearwaters have been detected previously, to ensure the most informed decisions about feasibility of in situ colony protection at these sites can be made. The surveys and determinations may be completed in series, if alternatives are still needed, but will be concluded within the first five years of the KWP II permit life. The surveys and feasibility determinations will be carried out in series according to the sequence outlined above, starting with upper Kahakuloa. Once a feasible alternative has been identified, no further surveys at that, or other sites, will be required.

Data collected during the breeding site searches on Molokaʽi or Lanaʽi will also inform feasibility, and expected outcome of a social attraction project in the vicinity of these sites and/or on Mokapu islet, off the North shore of Molokaʽi. If the USFWS and DOFAW conclude that predator exclusion and management is not feasible at these sites on Molokaʽi and Lanaʽi, and a social attraction project similar to that described for Makamakaʽole is considered feasible and likely to meet the (remaining) mitigation obligations, a social attraction project will be implemented at or in the vicinity of these sites.

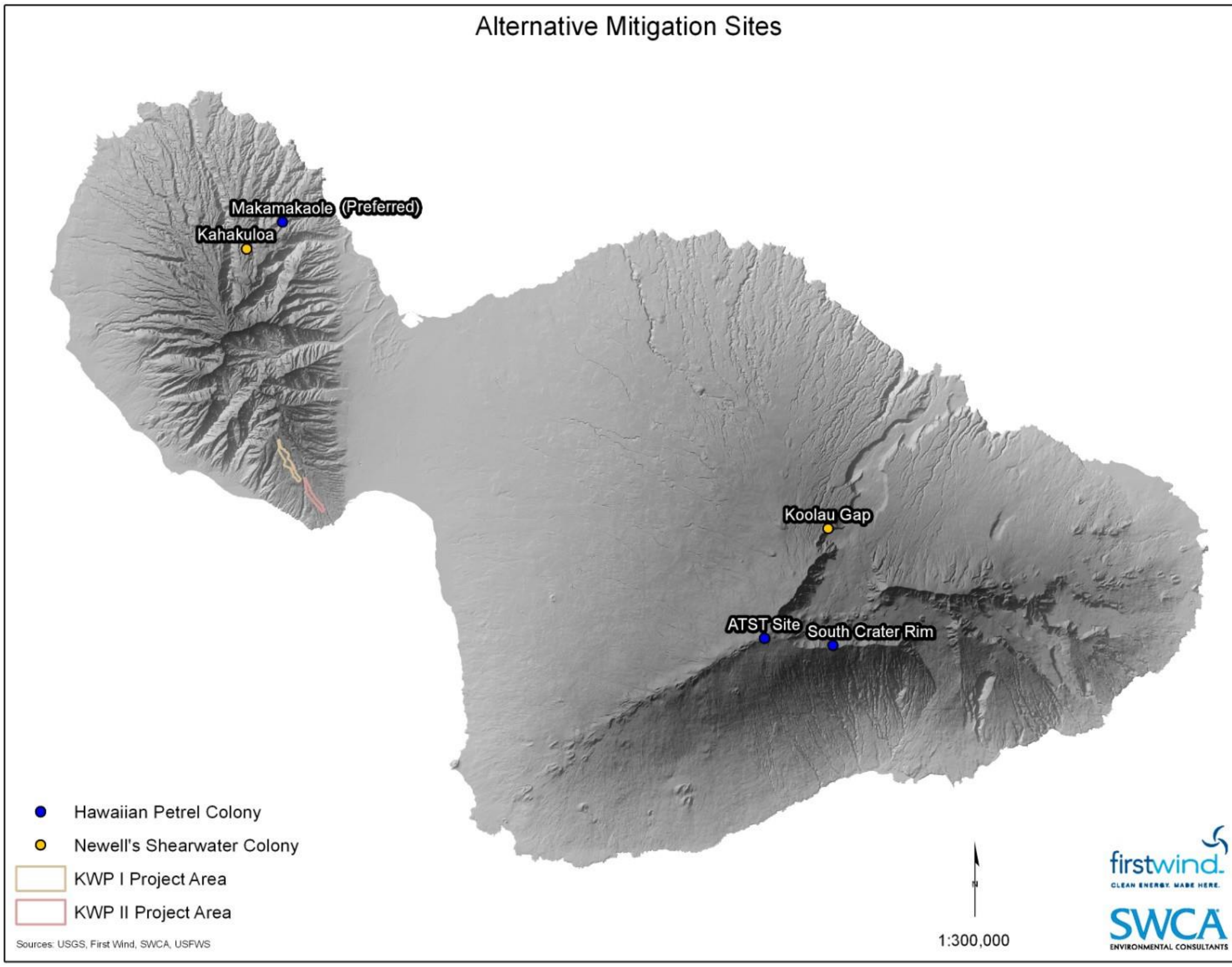


Figure 6.5. Locations of alternative mitigation sites for Hawaiian petrel and Newell's shearwater.–*NO CHANGE*

6.5.3 Mitigation for Tier 2 Rates of Take–*NO CHANGE*

The best available information indicates the mitigation projects described in the Tier 1 mitigation section, when combined, would produce mitigation benefits adequate to offset all Tier 1 and Tier 2 take addressed in the KWP I and KWP II permit applications. The proposed Makamakaʻole social attraction mitigation project is expected to mitigate for all of the Tier 1 take of KWP I and KWP II, and at least a portion of the requested take under the Tier 2 of take. For Newell's shearwater the proposed mitigation project at Makamakaʻole is projected to cover 76% of the total Tier 2 take in 20 years and a similar project in East Maui would produce benefits that are equal to the Makamakaʻole project. For Hawaiian petrels the proposed project is projected to cover 32% of Tier 2 tier take for adults and 40% of the Tier 2 for fledglings. Proposed mitigation at the Haleakalā Crater Rim site, in conjunction with anticipated benefits at Makamakaʻole, is sufficient to fully offset all Tier 1 and Tier 2 take of Hawaiian petrel. Feasibility and anticipated benefits of in-situ predator control at Newell's shearwater nesting areas in West and East Maui will be assessed during project years 1–5.

Although the mitigation efforts for KWP I and KWP II are being implemented jointly, take will be monitored and assessed for each project separately. KWP II will be considered to be at the Tier 2 rate of Take for Hawaiian petrels or Newell's shearwater if the 5-year take limits for Tier 1 are exceeded within a five year period (i.e., in years 1–5, 6–10, 11–15, or 16–20), or if 20-year Tier 1 requested take is exceeded for the respective species; mitigation for KWP I occurs on a bird by bird basis, rather than full implementation for whole tiers of take. If take occurs at Tier 2, the Applicant, the USFWS, and the DLNR will first consider whether the mitigation efforts being provided under the existing programs in place are likely to be sufficient to offset requested take at Tier 2.

Should the Tier 2 take rate for Hawaiian petrel be triggered, and the mitigation measures described in the Tier 1 mitigation section are exhausted, additional mitigation will involve implementation of additional management measures at the south crater rim of Haleakalā Crater (South Rim site). The South Rim site area contains an estimated 5–15 Hawaiian petrel nesting burrows per ha (Hodges and Nagata 2001) and is largely unprotected from predators and experiencing a much lower level of breeding attempts and breeding success.

6.5.3.1 Haleakalā Crater

National Park Service data indicates at least 600 active burrows are present along the South Crater Rim (C. Bailey unpublished data). The nesting area is composed of large boulders, rocky outcrops, and cinder fields (Simons 1983). Vegetation in the area is very sparse (Hodges and Nagata 2001). The National Park Service has indicated that this area is protected from habitat damage by feral goats and pigs, but burrows within this area are only partially protected from mammalian predators. If KWP II, LLC participates in the management effort with KWP I, the two entities will contract the labor and purchase equipment (e.g., traps and bait) required to conduct predator trapping in this area (or a section thereof, depending on mitigation requirement), and to conduct monitoring to document success. Trapping and monitoring protocols will closely follow the protocols that have already been established by the National Park Service for managing the rest of the colony (Hodges and Nagata 2001). The effort will, at minimum, include traps spaced 50 m apart on the north side and south side of the burrow concentration. Traps will not be placed in the direct vicinity of active burrows to avoid attracting predators to burrow areas, and to avoid non-target capture. Traps will not be placed on slopes of more than 30%, or in areas where a conflict may arise with public access, archeological sites, culturally sensitive areas, or in areas with sensitive natural resources. Configuration of the trapping grid will be dependent on the distribution of active burrows at the site, topographic and substrate characteristics, and other logistical considerations, including those regarding avoidance of adverse impacts on the colony or other sensitive species that may be present in the area. In the nonbreeding season, trapping may be augmented with additional control methods. The limits of the area to be treated, the eventual area in which treatment will take place, need for additional years of treatment and other details of the mitigation efforts will be decided with concurrence of the National Park Service, the DLNR, and the USFWS.

The NSF has proposed 6 years of monitoring at a control site on Haleakalā pursuant to its Advanced ATST project. Measured rates of reproductive effort, reproductive success, and adult and juvenile survival at the mitigation site would be compared to these vital rates measures at a control site. If appropriate control site monitoring data are not available, reproductive effort, reproductive success, and juvenile and adult survival rates agreed to by the agencies shall be used in combination with, or in place of, control site monitoring data.

The actual number of burrows that will be protected will depend on the number of years left on the permit at the time when Tier 2 is triggered and whether one or both projects are in Tier 2. The actual number of active burrows required to be managed will initially be determined by modeling and the mitigation measures will be monitored to document the results achieved. The South Rim site (given that 600 active burrows have been estimated in the area based on site-specific observations) contains sufficient burrows to mitigate for Tier 2 of both projects combined, regardless of when Tier 2 mitigation is triggered. Mitigation measures will be extended beyond the ITL/ITP permit term if necessary to compensate for the requested take.

6.5.3.2 Advanced Technology Solar Telescope Site

A 328-acre (133-ha) mitigation area is proposed for mitigation for the ATST (NSF 2010) may be used instead of or in addition to the additional Haleakalā Crater Rim Hawaiian petrel mitigation area to offset Tier 2 project-related take. The site is adjacent to the western perimeter of Haleakalā National Park, is unencumbered land owned by the State of Hawai'i, and includes all observatories, broadcast facilities, communication towers, and other structures in the area. The site includes a number of cinder cones.

The site includes 131 known Hawaiian petrel burrows, 61 of which have been identified as active (NSF 2010). The burrow density in the area adjacent to this mitigation area was found to have a significantly lower burrow density than areas inside the national park (Hodges and Nagata 2001), and with an expanding population at the National Park and initial implementation of ungulate and predator control at the site by the NSF (NSF 2010) the number of burrows may well be higher. Mitigation measures are proposed to be implemented under the ATST HCP until 2016, after which the site may be available as an alternative site for this HCP, if the site has not been allocated as a management site for another project. Considering this area's similarity to the South Rim site described above, the number of burrows needed to offset the requested Tier 1 take will be the same as determined for the South Rim site.

6.5.4 Additional Research to Improve Avoidance and Minimization Measures for Tier 2–*NO CHANGE*

If Tier 2 rates of take are found to occur annually and persist for more than three consecutive years, KWP II will conduct on-site investigations in an effort to determine the cause(s) of the unexpectedly Tier 2 levels of take, and to identify and implement measures, where practicable, to reduce take levels. On-site investigations may include, but will not be necessarily limited to, additional surveys using radar, night-vision, thermal imaging, or newer state-of-the-art technologies, as appropriate, to document bird movements and behavior during periods when collisions are believed to be occurring, and particularly to determine whether certain turbines, seasonal or other site-specific conditions account for greater mortality. Investigations may also include experimental changes in project operations, and experimental measures to divert or otherwise repel birds from the area. Measures to reduce and minimize further take could include, but would not be limited to, implementing permanent changes in project operation, moving structures that cause a disproportionately high amount of take, and implementing methods to divert or repel birds from project facilities. Determining the appropriateness of any such measures would take into account costs and practicability, and will be done with concurrence from DOFAW and the USFWS.

6.5.5 Measures of Success–*NO CHANGE*

Mitigation efforts provided by KWP II, LLC will contribute to habitat and colony enhancement, and the control of predator populations and thus will provide a net benefit to, and aid in the recovery of, the two seabird species.

Strictly speaking, mitigation will be deemed to be successful if the mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier. In practice, however, mitigation measures are likely to provide much greater net benefits.

For the social attraction scenario for both species, mitigation credit will be calculated as described by H.T. Harvey and Associates (Appendices 24 and 25). A baseline scenario for birds breeding in an unprotected area is subtracted from a reasonable scenario within the enclosure (Tables 6.5 and 6.6). This is based on the assumption that at least some of the birds attracted to the colony may have landed and nested elsewhere where they would have been subjected to a baseline level of predation at an unmanaged site. The enclosures will be monitored for number of birds present and for burrow occupancy, and in 5-year intervals progress towards reaching mitigation goals will be modeled. This approach is considered to be conservative as the colony within the enclosure is expected to have a positive population growth, with the shift of an immigration supported colony to a self-sustaining colony expected with approximately 25 breeding pairs. The unprotected population, absent drastic management measures, will certainly continue to have a negative population growth and head for extinction.

For a colony-based management approach as described for the alternative mitigation measures for both species, mitigation will be deemed to be successful if the mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier. The realized credit will be based on the number of burrows protected, and the duration during which the protection was realized, using the models as presented in Appendix 21. The NSL has proposed 6 years of monitoring at a control site on Haleakalā pursuant to its ATST project. Measured rates of reproductive effort, reproductive success, and adult and juvenile survival at the mitigation site would be compared to these vital rates measures at a control site. If appropriate control site monitoring data are not available, reproductive effort, reproductive success, and juvenile and adult survival rates agreed to by the Agencies shall be used in combination with, or in place of control site monitoring data.

The goal of the habitat conservation program (minimization, mitigation and monitoring) is to compensate for the incidental take of each species authorized at each tier (Take Scenario), plus provide a net conservation benefit, as measured in biological terms. Ultimately, it is designed to prevent the extinction of Hawaiian petrels and Newell's shearwaters in West Maui.

Although the overall expenditure at the Tier 1 is not expected to exceed a total of $3.16 million, the budgeted amounts are estimates and are not necessarily fixed. KWP II, LLC will provide the required conservation measures in full, even if the actual costs are greater than anticipated. One way of accomplishing this is that past, current or future funds allocated to a specific Covered Species may be re-allocated where necessary to provide for the cost of implementing conservation measures for another Covered Species, and funding for any individual Covered Species is not limited to those amounts estimated in Appendix 6. KWP II, LLC also recognizes the cost of implementing habitat conservation measures in any 1 year may exceed that year's total budget allocation, even if the overall expenditure for the conservation program stays within the total amount budgeted over the life of the project. Accomplishing these measures may, therefore, require funds from future years to be expended; or, likewise, unspent funds from previous years to be carried forward for later use. For practical and commercial reasons, such reallocation of funds among years may require up to 18 months lead time to meet revenue and budgeting forecast requirements. However, if reallocation between species or budget years is not sufficient to provide the necessary conservation, KWP II will nonetheless be responsible for ensuring that the necessary conservation is provided.

6.6 Nēnē–*UPDATED*

KWP I biologists maintain an ongoing collaboration with biologists from DLNR and USFWS, as well as regional experts, to identify, select, and implement appropriate measures to mitigate for take of nēnē under the terms of the KWP I HCP. Several provisions in the KWP I HCP guide mitigation for nēnē. A similar approach is proposed for the KWP II project, with the intention of providing a net ecological benefit to the species in alignment with State and Federal species recovery goals. The Applicant will provide support for nēnē population protection and/or enhancement. The estimated cost for each proposed measure is presented in Appendix 6. All proposed measures are intended to promote the recovery of the species within portions of its historic range.

Mitigation efforts are targeted at addressing two of the seven recovery goals as identified in the *Draft Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*)*, which is quoted below:

> "2) Manage habitat and existing populations for sustainable productivity and survival complemented by monitoring changes in distribution and abundance;
>
> 3) Control alien predators which addresses control of introduced mammals to enhance nēnē populations"

6.6.1 Avoidance and Minimization Measures–*NO CHANGE*

The following measures will be employed to avoid and minimize the potential for construction and operation of the proposed project to adversely affect nēnē (see Appendix 12):

- Surveys will be performed in areas to be cleared for project construction to ensure that no active nēnē nests would be disturbed or destroyed by vegetation clearing activities.
- Areas temporarily disturbed during construction of the KWP II project will be re-vegetated in consultation with DOFAW biologists to ensure that nēnē will not be attracted to areas where they would be at increased risk of adverse impacts from project operation (however, planting vegetation favorable for nēnē in selected areas may be considered beneficial to the species), or create a fire hazard.
- Similarly, any ongoing management of vegetation in the project area, such as mowing, clearing or future planting, will be conducted in consultation with DOFAW biologists to ensure

that nēnē will not be attracted to areas where they would be at increased risk of adverse impacts from project operation.

6.6.2 Tier 1 Mitigation–*UPDATED*

Predation has been identified as a main limiting factor in the recovery of nēnē (Banko *et al.* 1999). At Haleakalā National Park, adults were predated upon by cats, dogs, and mongoose (Banko *et al.* 1999). Adults were particularly vulnerable to predation while incubating, tending to goslings, and while molting. Cats, mongoose, and rats preyed upon goslings and nests were visited and eggs removed by mongoose and rats. Predator control of rats at Haleakalā National Park resulted in declines in egg predation, where at the Palika site 63% of nests (12 of 19) were predated prior to control from 1993 to 1994, while only 18% of nests (3 of 17) were predated following control from 1994 to 1995 (Baker and Baker 1996). The reduction in rat predation was attributed to the trapping and diphacinone poisoning conducted at the park. Exclusion of mammalian predators has similarly increased nesting success of nēnē at Volcanoes National Park, Hawaiʽi. Mongoose have also been documented causing significant nesting failures of wild nēnē on the Islands of Hawaiʽi and Maui (Hoshide *et al.* 1990; Banko 1992; Black and Banko 1994; Baker and Baker 1999).

Proposed predator removal measures may consist of deploying traps, leg holds, and/or snares or broadcasting rodenticide. These measures are expected to significantly improve adult and juvenile survival and increase productivity of nēnē pairs commensurate with the Tier 1 level of requested take and provide a net benefit to the species. The proposed mitigation measures are expected to result in the direct replacement of adults with adults and the replacement of fledglings with fledglings and no loss of productivity is expected. However, if adults are replaced by fledglings, the proposed mitigation will also need to account for possible loss of production during the lag years between take of adult birds and the sexual maturity of fledglings (see Table 6.7).

Female nēnē mature at age 3 and males at age 2 (Banko *et al.* 1999). For the purposes of this HCP the take of a mature female will require accounting for 2 years of possible lost productivity (an adult lost in year 1 would be replaced by fledglings in year 1, with indirect take separately accounted for, no gosling production would occur in years 2 and 3 because the birds released in year 1 are still immature; in year 4, the now adult female released as a gosling in year 1 could begin reproducing). Only 1 year of lost productivity will be attributed for the take of a mature male.

Average loss of productivity through mortality of one adult has been determined to be 0.09 gosling/individual/year (see Section 5.2.6.3). When adults are replaced by goslings loss of productivity will be assessed at an additional 0.09 fledgling for an adult male (1 year loss of productivity) and 0.18 fledgling for an adult female (2 years loss of productivity) assuming same year replacement (see Table 6.7). The mortality rate of captive-reared released goslings to year 1 was reported to be 16.8% for females and 3% for males (Hu 1998; Banko *et al.* 1999). For the purposes of this HCP, an annual mortality rate of 17% is assumed to occur for both genders of geese through maturity (age two or three depending on gender). Male and female nēnē are assumed to be equally vulnerable to collision with the turbines and associated structures. Table 6.9 identifies the number of fledglings that will be required to offset the Tier 1 level of take anticipated for nēnē during operation of the KWP II project. It is anticipated that all take will be replaced with fledglings within the same year or earlier. If increased adult survival can be demonstrated, the estimate can be adjusted accordingly.

Table 6.10. Fledgling Requirement for Tier 1 Take Assuming Same Year Replacement–*NO CHANGE*

	Direct Take		Indirect Take	
	Male	Female	Fledglings	Total Fledglings Required
Total requested baseline take	9	9	2	
Fledglings required	13.1 (= 9/0.83/0.83)	15.7 (= 9/0.83/0.83/0.83)	2	30.8
Loss or productivity	0.81 (= 0.09 x 9 x 1 year)	1.62 (= 0.09 x 9 x 2 years)		2.4
			Grand total	**33.2**

Based on the numbers provided in Table 6.7, if take of nēnē at the KWP II facility occurs at Tier 1 level over the 20-year life of the Project (take of 18 adults and two fledglings), this would require a net accrual of 34 fledglings total as compensation for the Tier 1 requested take.

6.6.2.1 Preferred Tier 1 Mitigation Measure–NO CHANGE

On April 14, 2011 Governor Neil Abercrombie signed a proclamation approving the immediate translocation of nēnē, from their nesting grounds within the Kaua'i Lagoons Resort (located between two runways at the Lihue Airport on Kaua'i) to neighboring islands. This proclamation invoked provisions of 128 HRS, and affirmed the state's responsibility to protect the health, safety, and welfare of the people and nēnē populations by mitigating potential bird-strikes with aircraft and enhancing the population of this federally listed endangered species on those designated neighboring islands.

The DLNR and Department of Transportation have been directed to develop and implement a 5-year Nēnē Action Plan that will translocate and monitor the Kaua'i Lagoons nēnē population. According to the proclamation, "the five-year Nēnē Action Plan will be consistent with efforts to protect, maintain, restore, or enhance the endangered species to the greatest degree practicable." The emergency proclamation signed by Governor Abercrombie is to terminate on June 30, 2016. The nēnē are being translocated from Kaua'i to release pens on Maui and on the Island of Hawai'i and their monitoring and management subsequent to their release is funded by the proclamation for 5 years until June 2016. DOFAW anticipates that the translocated nēnē populations will increase and at the end of the proclamation, additional release pens will be needed to accommodate the increased bird population. Birds return to the release pen to nest and productivity of nesting pairs fall as a result of overcrowding. In 2010, at Pu'u O Hoku Ranch on Moloka'i, 42 goslings hatched but only two fledged into the wild, resulting in a 5% rate of fledging success for goslings. The high mortality was due to aggressive adults harassing and trampling young, which was attributed to overcrowding. Under normal managed conditions, all goslings bred within the release pen are expected to fledge (Medeiros pers. comm.).

Mitigation for KWP II will consist of providing funding to DOFAW to build an additional release pen and five years of funding for conducting predator control, vegetation management and monitoring at the additional pen beginning in 2016. The best location for the release pen will be determined by DOFAW and the USFWS in consultation with nēnē biologists. Monitoring will include an annual census, banding of adults and fledglings, identifying nests and quantifying reproductive success at the release pen area. Predator control measures to reduce populations of mammalian predators will be conducted in and around the release pen and are expected to increase the survival of fledglings and adults in and around the vicinity of the pen and also increase the productivity of breeding pairs.

The construction of a new pen will be used to accommodate family units from the other overcrowded release pens. When mitigation commences in 2016, monitoring will document the changes in the nēnē population and reproductive success at the pen. The actual number of fledglings or adults accrued at the new pen above the baseline productivity from an overcrowded pen will count toward the mitigation requirements of KWP II. The baseline will assume a 5% rate of fledging success for goslings in an overcrowded pen, using 2010 data from Pu'u O Hoku Ranch.

It is expected that five breeding pairs with their goslings will be transferred to the pen from overcrowded pens *each year* (Medeiros pers. comm.). The five breeding pairs that are transferred are expected to be moved with at least 10 associated goslings (Medeiros pers. comm.). Table 6.9 shows that KWP II will be expected to accrue a minimum 42 fledglings after 5 years of management. This is calculated with the assumptions that 90% of the goslings fledge under managed conditions in the new pen, that a small amount of natural mortality occurs, and that these goslings would have had a 5% chance of survival in the overcrowded pen. This rate of accrual will exceed the Tier 1 requested take by eight fledglings (a total of 34 fledglings needed, see Table 6.8) in 5 years. Table 6.9 does not take into account the increasing number of breeding pairs that will be present each year, only the goslings from the five breeding pairs that are transferred each year. In reality, a total of 25 breeding pairs that could be nesting in the pen will have been added by the end of year 5. This additional accrual is not accounted for in Table 6.9 as the previously released breeding pairs are not expected to return to the pen to breed every year. In addition, fledglings that have matured may also be expected to return to the pen to breed in subsequent years. Therefore, it is 5 that there will be substantially more than five breeding pairs in the new release pen after five years of management. Thus, the accrual of 42 fledglings after 5 years of management is considered to be a very conservative estimate.

Table 6.11. Fledgling accrual for KWP II Tier 1 mitigation–*UPDATED*

Number of Goslings						Total Accrual
No. goslings reared in pen (from five breeding pairs)	10	10	10	10	10	
No. fledge (90% of all goslings)	9	9	9	9	9	
Accrual (minus baseline of 5% survival in a crowded pen)	8.6	8.6	8.6	8.6	8.6	42.8

When mitigation commences in 2016, monitoring will document the changes in the nēnē population and reproductive success at the pen. The actual number of fledglings or adults accrued at the new pen above the baseline productivity from an overcrowded pen will count toward the mitigation requirements of KWP II. Data from all years will also be used to document population trends and identify emerging and existing threats.

If monitoring after the first 5 years indicates that additional mitigation is required for mitigation efforts to be commensurate with the Tier 1 level of requested take or to provide a net benefit to the species, mitigation efforts will continue until mitigation requirement are fulfilled. Predator trapping will be continued if it is shown to be effective. Other measures that may be implemented include habitat improvement measures, such as providing additional water sources at appropriate locations, or mowing grasses in habitat beyond the vicinity of the pen to improve foraging habitat as described by Woog and Black (2001). The most appropriate measure to be undertaken will be determined based on data collected from the ongoing monitoring and best available science and implemented with approval of the DLNR and the USFWS.

After the Tier 1 mitigation obligations are met by KWP II, LLC, DOFAW will continue the long-term management of the release pen.

However, should circumstances regarding nēnē population status or health change and indications are such that other conservation or management practices are deemed more important or pressing in aiding the recovery of the species, the Applicant in consultation with the USFWS and the DLNR will direct the funds toward whatever management or management activity is deemed most appropriate at the time.

6.6.2.2 Additional Tier 1 Mitigation Measures–NO CHANGE

In addition to the above, as part of mitigation for Tier 1 levels of take, a wildlife biologist will make systematic visual observations of nēnē activity from representative locations within the KWP II project area during the first year of project operation. The objective of these observations will be to document how nēnē use the project area following construction and to record observations of nēnē behavior and activity in the vicinity of the WTGs, including in-flight response to collision hazards (e.g., changing flight direction to avoid WTGs).

Observations will be made from at least three locations (upper, middle, and lower points within the project area), and will occur on a weekly basis for at least 3 hours (1 hour at each site). The time spent surveying from a particular location may exceed one hour if lengthening observation time provides more information useful in characterizing use patterns. The timing of observation periods will vary to cover daylight and crepuscular periods. Night-vision or thermal imaging equipment (as available) may be used during low-light periods.

Incidental observations of nēnē activity and response to the turbines will also be recorded under the WEOP (Appendix 4). Observations made as part of the WEOP will continue over the life of the project. These observations will contribute to a better understanding of how nēnē respond to wind facilities and will inform interpretations and management actions relevant to the population ecology of nēnē in West Maui. It is anticipated that avoidance and minimization measures will be refined and improved as a result of these studies, thereby reducing future nēnē fatalities at wind facilities.

6.6.2.3 Tier 1 Mitigation Plan–NEW

Tier 1 nēnē mitigation has been contracted to DOFAW and began in February 2017 (Appendix 31). The overall objective of the Maui Nui Nēnē Monitoring and Predator Control Management Project is to assist in the recovery of the nēnē. This will be accomplished by maintaining predator traps, controlling cattle egrets and removal of invasive vegetation in and around the Pi'iholo Ranch pen, the Haleakalā Ranch pen, or a new pen. In FY 2018, three fledglings were successfully produced at the Pi'iholo Ranch pen as a result of funding provided by KWP II, LLC (KWP II, LLC 2018).

The survival rate for fledgling to adult is assumed to be 64% (80% for each of 2 years to maturity). Therefore, 1.56 fledglings must be produced for every adult nēnē take estimated. For Tier 1 at least 31 fledglings (18 * 1.56) + 3 = 31) would be required.

Lost productivity occurring with delays in fledgling production would also require additional years to satisfy mitigation obligations. Total lost productivity accrued through FY 2018 is four fledglings.

If the Pi'iholo Ranch pen does not consistently produce fledglings, establishing predator trap lines in known nesting areas such as those historically occurring near Lahainaluna and Olowalu, Maui, for example, or funding nēnē mitigation similar to the nēnē mitigation at Pi'iholo Ranch, at Haleakalā Ranch, or a new pen may be considered as an alternate source of fledgling production

6.6.3 Mitigation for Tier 2 Rates of Take–*UPDATED*

Tier 2 mitigation for nēnē take will include continuing predator control, fence maintenance, and vegetation management at the Pi'iholo Ranch pen or funding nēnē mitigation similar to the nēnē mitigation at Pi'iholo Ranch, at Haleakalā Ranch, or a new pen. For Tier 2, an additional 14 fledglings (9*1.56 = 14) would be required to be produced to replace the estimated take of nine adult nēnē. If an average of five fledglings are produced at any nēnē mitigation pen every year then Tier 1 and Tier 2 take mitigation would be satisfied in approximately 9 years (45 fledglings required/5 produced annually = 8.5 years)

Any extra fledglings already accrued in excess of that required for Tier 1 mitigation will also be applied to compensate for Tier 2 mitigation. Actual monitoring will document the changes in the nēnē population and reproductive success at the pen and the number of fledglings or adults accrued above the baseline productivity will count toward the mitigation requirements of KWP II. Monitoring will follow the same structure as outlined in Section 6.6.2.1.

However, should circumstances regarding nēnē population status or health change and indications are such that other conservation or management practices are deemed more important or pressing in aiding the recovery of the species, the Applicant with approval of the USFWS and the DLNR will direct the funds toward whatever management or management activity is deemed most appropriate at the time.

Additionally, if monitoring after the first 3 years indicates that additional mitigation is required for mitigation efforts to be commensurate with the Tier 2 level of requested take or to provide a net benefit to the species, mitigation efforts will continue till mitigation obligations are met. The most appropriate measures to be undertaken will be determined based on data collected from the ongoing monitoring and best available science and implemented with the approval of the DLNR and the USFWS.

After the Tier 2 mitigation obligations are met by KWP II, LLC, and if no additional mitigation would be required, DOFAW will continue the long-term management of the release pen.

6.6.4 Proposed Tier 3 Mitigation for Additional Take of Nēnē–*NEW*

Proposed mitigation for the Tier 3 nēnē take level is presented in Table 1.3 and ~~will~~ would be a continuation of Tier 1 mitigation underway (Appendix 31 specifically describes Tier 1 mitigation). As an adaptive management trigger, if annual review of the results of ongoing mitigation indicates take offset is not accruing in advance of take, then the wildlife agencies may require additional predator control measures at any established release pens or implement predator control measures at additional popular nesting and foraging sites on Maui. A Memorandum of Understanding (MOU) and scope of work (SOW) for Tier 1 level take between the Applicant and the DLNR details the specific mitigation plan, responsibilities, and expectations for mitigation that is funded by the Applicant (Appendix 31). This MOU is updated and extended when necessary to include Tier 2 and Tier 3 funding and goals assuming the Tier 1 efforts are successful and the USFWS and the DLNR agree that predator control and fence maintenance at the Piʻiholo Ranch pen (or other pens described previously) is still appropriate and that the Tier 3 mitigation proposed is approved. Total mitigation for Tier 3 would be commensurate with the take of 14 additional adult nēnē. For Tier 3 an additional 22 fledglings (14 * 1.56 = 22) would be required to be produced. Mitigation planning for take exceeding the Tier 2 level of take of 30 nēnē would commence when estimated take is approximately 27 nēnē (Tier 1 take level plus 75% of the difference between Tier 1 and Tier 2 (20 + (10 * 0.75) = 27.5) and if take is projected to continue beyond 30 nēnē.

Funding would be provided to employ personnel and/or provide equipment to implement predator control measures, monitor efforts, and provide status reports to the wildlife agencies. Proposed predator removal measures may consist of deploying traps, leg holds, and/or snares, or cattle egret control. These measures are expected to significantly improve adult and juvenile survival and increase productivity of nēnē pairs to fully offset the requested take and provide a net benefit to the species and increase the likelihood of recovery of the nēnē.

Monitoring would be conducted to document changes in the nēnē population and reproductive success at the mitigation site. The number of fledglings or adults accrued above the baseline productivity at the mitigation site would count toward the mitigation requirements of KWP II. Monitoring would follow the same structure as outlined in Section 6.6.2.1.

Should circumstances change regarding the status or health of the nēnē population and other conservation or management practices are deemed more important or pressing to aid the recovery of the species, the USFWS and the DLNR will consult with the Applicant and determine alternative mitigation the Applicant will implement.

6.6.5 Additional Measures for the Protection of Nēnē–*UPDATED*

If the nēnē population at Hanaʻula (associated with the release facility located above the KWP II project area), which is currently on the increase and believed to be self-sustaining, shows a decline over any 5-year period for reasons directly attributable to take resulting from operation of the KWP II project, KWP II will shoulder the entire cost of construction and operation of the new release pen if the decline is attributable to KWP II only; however, if the decline is caused by the cumulative take at KWP I and KWP II, the cost of construction and operation of the additional release pen will be shared between KWP II and KWP I. The birds present at Hanaʻula will be translocated to the replacement site as needed.

6.6.6 Measures of Success–*UPDATED*

Strictly speaking, mitigation is deemed to be successful if the mitigation efforts result in one more fledgling or adult than that required to compensate for the requested take of the required tier. In practice, however, mitigation measures are likely to provide much greater net benefits.

This success is measured by an increase in adult or juvenile survival or increased productivity (average number of fledglings per pair) at the mitigation site over the baseline productivity level. A taken adult may be replaced through increased survival rates of adults in the area or adults may be replaced by fledglings.

The magnitude and scope of these measures will be determined in consultation with the wildlife agencies and will be based upon monitoring data recorded at the mitigation site and best available science at that point in time. Adaptive management measures must be approved by the wildlife agencies and may include increasing predator control efforts at the mitigation site, changing the mitigation site or adding new mitigation sites.

Success Metrics/Adaptive Management Proposed:

1. Results of each year's efforts will be reviewed by the USFWS, the DLNR-DOFAW (Oʻahu) and by the ESRC at the annual HCP review.
2. Based on results and review the agencies will provide suggested changes to the SOW (if warranted). These could include increasing trap effort, changing trap types, building an addition to the Piʻiholo Ranch pen (with a new SOW approved), or funding nēnē mitigation similar to the nēnē mitigation at Piʻiholo Ranch, the Haleakalā Ranch pen, or a new pen.
3. If after 2 years of effort at the Piʻiholo Ranch pen less than an annual average of three fledglings are produced, this site may be abandoned or an additional pen created at Piʻiholo Ranch or funding nēnē mitigation similar to the nēnē mitigation at Piʻiholo Ranch will begin at the Haleakalā Ranch pen or at a new pen or predator control will begin at nesting sites such as those historically near Olowalu and Lahainaluna on Maui.
4. Funding will be provided for whatever SOW is effective until all mitigation for nēnē fledglings required to be reproduced to replace adults, fledgling or gosling is completed for the approved Tiers 1 and 2 and Tier 3 when the HCP amendment is approved.

These mitigation measures may also aid in establishing one or more self-sustaining populations on Maui, in accordance with the recovery plan for the nēnē (USFWS 2004a).

The goal of the habitat conservation program (minimization, mitigation, and monitoring) is to compensate for the incidental take of each species authorized at each tier (Take Scenario), plus provide a net conservation benefit as measured in biological terms and increase the likelihood of recovery of the endangered or threatened species that are the focus of the HCP. The budgeted amounts are estimates and are not necessarily fixed. KWP II, LLC will provide the required conservation measures in full, even if the actual costs are greater than anticipated. One way of accomplishing this is that past, current or future funds allocated to a specific Covered Species may be re-allocated where necessary to provide for the cost of implementing conservation measures for another Covered Species, and funding for any individual Covered Species is not limited to those amounts estimated in Appendix 6. KWP II, LLC also recognizes the cost of implementing habitat conservation measures in any one year may exceed that year's total budget allocation, even if the overall expenditure for the conservation program stays within the total amount budgeted over the life of the project. Accomplishing these measures therefore may require funds from future years to be expended or likewise unspent funds from previous years to be carried forward for later use. For practical and commercial reasons, such reallocation of funds among years may require up to 18 months' lead-time to meet revenue and budgeting forecast requirements. However, if reallocation between species or budget years is not sufficient to provide the necessary conservation, KWP II, LLC will nonetheless be responsible for ensuring that the necessary conservation is provided.

6.7 Hawaiian Hoary Bat–*UPDATED*

Recommendations by the USFWS and DOFAW for mitigation for the Hawaiian hoary bat have consisted of habitat restoration to improve or provide additional roosting, breeding and foraging habitat. Mitigation targets have been identified based on the levels of take identified as "Tier 1" or "Tier 2." On-site monitoring during operations will be used to determine the tier at which Hawaiian hoary bat take is occurring. Mitigation is intended to compensate for take at Tier 1 level as described in Section 6.7.1. If monitoring shows that take is actually occurring below or in excess of Tier 1 level, adjustment to mitigation efforts would be made as described below (Section 6.7.2). The estimated cost for each proposed measure is presented in Appendix 6.

6.7.1 Take Minimization and Tier 1 Mitigation Progress–*UPDATED*

Research to determine if bat take at KWP II can be further minimized and mitigation for take of the Hawaiian hoary bat by KWP II was developed through discussions with the USFWS, the DLNR, and bat experts at the USGS, and involved identifying measures believed most likely to contribute to the recovery of the species. Based on the feedback received, KWP II implemented a combination of:

1. on-site surveys to add to the knowledge base of the species' status on West Maui
2. on-site research into bat interactions with the wind facility
3. implementation of bat habitat improvement measures to benefit bats as approved by the DLNR, the USFWS, and the ESRC in consultation with KWP II.

6.7.1.1 Bat Habitat Utilization at KWP II and Vicinity

The Applicant surveys for and monitors Hawaiian hoary bats within and in the vicinity of the KWP II site. Surveys have been conducted throughout every year~~s~~ when systematic fatality monitoring has been conducted, (i.e., during the first 6 years as determined under the Adaptive Management provisions), to allow observed activity levels to be correlated with any take that was observed (Section 3.8.4.3 and KWP II, LLC 2013, 2014, 2015, 2016, 2017, 2018). A critical component identified as essential to Hawaiian hoary bat recovery is the need to develop a standardized survey protocol for the Hawaiian hoary bat monitoring program to enable results collected by different parties to be directly comparable. KWP II also joined the Hawaiʻi Bat Research Cooperative (HBRC) and as a contribution to the ongoing research efforts in the State, conducts its own surveys and monitoring at KWP II and the vicinity. Survey protocols were developed prior to the start of project operations, in consultation with HBRC, with approval by the USFWS and the DLNR. More than 12 acoustic bat detectors were deployed at KWP II and the vicinity (including KWP I).

The goal of this research is to document bat occurrence, habitat use and habitat preferences on site, as well as identify any seasonal and temporal changes in Hawaiian hoary bat abundance. This research is an extension of a five-year survey already underway on the islands of Hawaiʻi and Kauaʻi and another that commenced on Maui and is intended to increase basic knowledge about Hawaiian hoary bat ecology and distribution.

6.7.1.2 Research on Bat Interactions with the Wind Facility

In conjunction with the study to determine habitat utilization by bats at KWP II and its vicinity, KWP II has conducted additional on-site surveys that will contribute to identifying areas of potential interactions and vulnerabilities of Hawaiian hoary bats at wind facilities, as follows:

1. KWP II has surveyed for bat activity near turbine locations throughout every year~~s~~ of operation using acoustic bat detectors. Surveys are conducted during years when systematic fatality monitoring is conducted (see Appendix 2 and Section 7.2.1). USGS (HBRC) monitoring protocols are used and adjusted if necessary. Thermal imaging or night vision technology may be used to assist acoustic monitoring as trends are detected and would follow similar protocols developed during pre-construction monitoring. The use of additional techniques and technologies will also be considered. These data are analyzed in an effort to determine seasonal and daily peak bat activity periods on-site, and comparison of data with pre-construction activity levels may help determine if bats have been attracted to the wind facility.

2. Incidental bat observations are recorded under the WEOP (Section 6.3~~1~~ and Appendix 4).

These on-site surveys are expected to advance avoidance and minimization strategies that wind facilities in Hawai‘i and elsewhere can employ in the future to reduce bat fatalities. Minimizing bat fatalities at the wind facility is not considered mitigation for take that occurs there.

6.7.1.3 Implementation of Management Measures

The Tier 1 mitigation for bats was based on the recommendations received from the USFWS and DOFAW in May 2011. The USFWS and DOFAW received the results of Home Range Tools for ArcGIS®, Version 1.1 (compiled September 19, 2007) calculations based on Hawaiian hoary bat tracking data collected by USGS-BRD Wildlife Ecologist, Dr. Frank Bonaccorso (Bonaccorso *et al.*, 2015). This dataset from a tracking study indicates a mean short-term (3-13 calendar days) core use area of 63.0 acres (25.5 ha) of rainforest habitat on the Island of Hawai‘i used by 25 bats (14 males and 11 females). Male bat core areas do not appear to overlap; female core areas may overlap with male core areas. A core area was defined as the area that incorporates 50% of tracked movements; therefore, the USFWS and DOFAW assume that the core area is a minimum habitat requirement for bats.

The Tier 1 requested take of six adult bats and three juveniles (see Section 5.2.7.3) equates to a total of 7 adults (with an estimated 30% survival rate of juveniles to adulthood; see Appendix 5 for life history information). Assuming a 1:1 adult sex ratio, the potential take of seven adults would result in the take of up to four adult male bats. As female core areas can overlap with male core areas, and up to two female bat core areas may be found within a male core area, mitigation requirements are based on the number of adult male bats requested to be taken.

Fencing of the Kahikinui Forest Reserve to exclude ungulates is the mitigation activity implemented and the mitigation SOW is detailed in–see Appendix 29. This mitigation enables the koa-’Ōhi’a montane mesic forest to regenerate and is expected to create additional habitat for the Hawaiian hoary bat. Native plants have been outplanted to enhance the regeneration of the mesic forest to meet the criteria for successful restoration (Section 6.7.4). KWP II contributed funding to DOFAW for the fencing and management of the Forest Reserve (including the monitoring of bat activity on-site) commensurate with the Tier 1 requested take.

Kahikinui is a State of Hawai‘i conservation area which is already afforded a certain level of conservation. Kahikinui currently is in a permanent conservation easement and is protected from development but otherwise unmanaged.

KWP II provided funding to DOFAW to fence and manage and monitor for bats at a distinct area within the Kahikinui project (see Appendix 29). Partnerships have been secured to ensure management of the whole of Kahikinui, KWP II has contributed to a portion of the cost for overall management. The fencing, ungulate removal, and habitat restoration of Kahikinui is expected to take six years with a subsequent yearly maintenance of the habitat and fence line throughout the remainder of the 20-year Permit period. The monitoring of bats at Kahikinui and the implementation of restoration actions is the responsibility of DOFAW (based on criteria 3a–d in Section 6.7.4 and an approved SOW). However, KWP II will remain responsible for ensuring that the mitigation actions are sufficient to offset the requested take and will result in a net benefit to the Hawaiian hoary bat. A SOW between the Applicant and DOFAW details the specific mitigation plan, responsibilities, and expectations of the parties. If the plan is not being met the Applicant, DOFAW, and the USFWS will review the implementation process and results and determine what, if any, corrective actions are warranted. KWP II, LLC will then implement the identified actions to meet mitigation success criteria.

The location of the mitigation area may be modified with the approval of DOFAW and the USFWS.

It is anticipated that the measure outlined above or any others that are developed in the future will be conducted in partnership with other conservation groups or entities and that these activities will complement other restoration, reforestation, or conservation goals occurring in that area at the time. Other sites may be considered if they are determined by the USFWS and DOFAW to be more appropriate for the implementation of the mitigation measures. Funds will be directed toward whatever management or research activity is deemed most appropriate at the time.

6.7.2 Minimization and Mitigation Progress for Tier 2 Rates of Take–*UPDATED*

6.7.2.1 Additional Research

KWP II continues to review the fatality records in an effort to determine whether measures in addition to the low wind speed curtailment can be implemented that will reduce or minimize take. If causes cannot be readily identified, KWP II will continue to conduct supplemental investigations that may include:

1. additional analysis of fatality and operational data
2. deployment of acoustic bat detectors to identify areas of higher bat activity during periods when collisions are believed to be occurring
3. determining whether certain turbines are causing most of the fatalities or if fatality rates are related to specific conditions (e.g., wind speed, other weather conditions, season)

Additional measures KWP II, LLC has implemented include raising LWSC from 5.0 m/s to 5.5 m/s and extending curtailment to year-round. Other measures to reduce bat fatalities will be implemented as identified feasible, and supported by research and may include changes in project operations, such as modifying structures and lighting, and implementing measures to repel or divert bats from areas of high risk without causing harm if practicable. These data may also be used to refine low-wind speed curtailment options, such as determining the times of year when curtailment is mandatory, or if curtailment can be confined to a subset of "problem" turbines. These additional measures will be implemented by KWP II, LLC with the concurrence of the USFWS and the DLNR.

As described in Sections 1.4.5.5 and 5.2.7.3, no bat fatalities have been observed at KWP II since LWSC was increased to 5.5 m/s. The success of any additional minimization that could be implemented (further reducing bat take) would be impossible to determine if no bats fatalities are found.

6.7.2.2 Implementing Bat Habitat Management Measures

The Tier 2 requested take of nine adult bats and five juveniles (see Section 5.2.7~~5~~.3) equates to a total of 11 adults (with an estimated 30% survival rate of juveniles to adulthood; see Appendix 5 for life history information). Tier 2 mitigation included additional funding for the Kahikinui Forest Restoration Project (see Appendix 29).

6.7.3 Tier 3 and Tier 4 Mitigation for Additional Take of Hawaiian Hoary Bat–*NEW*

6.7.3.1 Background

As of November 2014, the mitigation for the authorized take of 11 adult bats (Tier 1 and 2) at KWP II has been funded and mitigation measures are being implemented. The following sections describe the potential mitigation options generally and the proposed mitigation specifically for Tier 3 and 4. Adaptive management (see Section 7.3) would be used to redirect the proposed mitigation, with the approval of the wildlife agencies, to provide a greater benefit for the species.

The estimated cost to mitigate for the Tier 3 take of 19 bats would be approximately $950,000 per ESRC federal and state mitigation guidance indicating the cost/bat of $50,000 for research-specific mitigation (See Appendix 6). Tier 4 mitigation (for eight bats) costs estimates are not yet determined. The guidance provided in the *Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance* (DOFAW 2015) communicates that it is appropriate to allocate a mitigation credit of one Hawaiian hoary bat for each $50,000 of funding that is included in a proposed or amended HCP and assured of implementation by the applicant or permittee through a letter of credit or other financial assurances acceptable to the USFWS and DOFAW. The ESRC originally based this calculation on the reasonable expected cost of ongoing land-based mitigation projects, estimated at $50,000 per enhanced management area for one bat (or 40 acres, as defined in DOFAW 2015 and KWP II HCP). Therefore, the ESRC suggested that an appropriate estimated cost for mitigating take of one bat is $50,000 and recommended that this figure be applied to different types of mitigation, including funding research as well as habitat restoration (DOFAW 2015). Nonetheless, the DOFAW (2015) guidance provides a limited-term per-bat mitigation suggested cost of $50,000 for research specific mitigation with the caveat that this cost estimate is likely to change in the future, and mitigation will be tied directly to specific actions known to benefit the species as opposed to specific dollar amounts. Since the ESRC Hawaiian Hoary Bat Guidance (DOFAW 2015) was provided, the ESRC has concluded the $50,000 per bat cost applies to research-only mitigation. KWP II, LLC will provide funding in full for the required conservation measures (monitoring, minimization, adaptive management, and mitigation).

Because of the paucity of information regarding Hawaiian hoary bat population size, habitat use, and limiting factors, the USFWS and DOFAW have recommended that mitigation for this species consist of a research component and a habitat management component. As described in DOFAW (2015) and further in the Research section below, filling information gaps on the Hawaiian hoary bat is a high priority to inform better management and improve mitigation approaches that increase the likelihood of recovery of the species.

The research component of the mitigation program is intended to reduce uncertainty in mitigation effectiveness and inform more consistent, scientifically justifiable and quantifiable mitigation practices for Hawaiian hoary bats in the future–both during and after the term of this HCP. It is unknown whether the research portion of the proposed mitigation will be the preferred path for the life of the permit. Research results may suggest a completely new strategy for bat mitigation in the future, or other refinements and improvements to improve effectiveness of existing hoary bat habitat management strategies.

With approval of the USFWS and DOFAW, mitigation activities may consist entirely of habitat restoration or protection, research, or a combination of both (as currently proposed). Any land-based restoration or protection mitigation proposed for Tier 4 is expected to offset the requested take of Tier 4 to the maximum extent practicable, if reached. Alternatively, mitigation for Tier 4 could be through an approved federal and state Hawaiian hoary bat in lieu fee program, if available and approved at the time of mitigation implementation.

6.7.3.2 Potential Mitigation Options

6.7.3.2.1 Research

Research, although important to the conservation of many resources, is not typically considered compensatory mitigation because it does not directly offset adverse effects to species or their habitats. In rare circumstances, research that is directly linked to reducing threats, or that provides a quantifiable benefit to the species, may be included as part of a mitigation package. These circumstances may exist when (a) The major threat to a resource is something other than habitat loss; (b) the USFWS can reasonably expect the outcome of research to more than offset the impacts; (c) the proponent commits to using the results/recommendations of the research to mitigate action impacts; or (d) no other reasonable options for mitigation are available. KWP II, LLC, working with the USFWS, evaluated the proposed research project with regard to the following four circumstances:

The major threat to the resource is something other than habitat loss.

The greatest *overarching* challenge to Hawaiian hoary bat conservation is the lack of basic biological understanding of how to improve bat productivity and survival and increase long-term population viability. In order to address this challenge, a Hawaiian hoary bat workshop was held April 14–15, 2015, in Honolulu, Hawai‘i, to discuss issues ranging from take avoidance, to research priorities, to future mitigation strategies. Participants included Hawaiian hoary bat researchers from DOFAW, the USGS, the U.S. Forest Service, the University of Hawai‘i, the Pacific Cooperative Studies Unit, the USFWS, as well as government regulators, consultants, stakeholders, and the public. On September 8, 2015, DOFAW introduced to the ESRC a white paper outlining new guidelines for ITL applicants regarding bat avoidance, minimization, and mitigation that were based on the outcomes of the 2015 bat workshop. The USFWS provided comments on the paper, and the document, *Hawaiian Hoary Bat Guidance Document 2015*, was finalized in December 2015 (DOFAW 2015). The white paper acknowledges challenges in designing mitigation plans due to the paucity of data pertaining to Hawaiian hoary bat conservation and directs proponents to include both habitat management and research in mitigation proposals. Furthermore, measurements of the metrics that are used to estimate the three R's (redundancy, resilience, and representation) for Hawaiian hoary bats are largely unknown for this species. The research proposed by KWP II, LLC is designed to inform those metrics.

The three greatest *physical* threats to Hawaiian hoary bats based on observed fatalities are wind turbines, removal of trees during the bat pupping season, and barbed wire. All of these threats have the potential to cause a localized reduction in bat numbers. These three threats are limited to specific sites but may be located across the state.

- Threats by wind turbines represent the highest amount of *observed* take of Hawaiian hoary bats statewide. Fatalities are minimized through LWSC, but fatalities are not completely avoided. Complete dusk to dawn, year-round shut-downs would reduce power output by 50% and cause KWP II to fail to meet the contractual obligations of its PPA.
- Threats to pups in roosting trees is avoided or minimized by avoiding tree removal during the pupping season. KWP II, LLC avoids removal of trees above 15 feet at its facilities and mitigation sites during the pupping season.
- Barbed wire on federal projects is avoided or minimized depending on project need (military and security applications are the typical exceptions). The USFWS recommends smooth wire when replacing fencing to all parties. KWP II, LLC avoids use of barbed wire at its facility and mitigation projects.

The greatest *unquantified* threats to Hawaiian hoary bats are from habitat loss, fire, pesticides, reduction in prey, and predation. These threats may pose a risk to Hawaiian hoary bat numbers, reproduction, and distribution. These threats may occur statewide. KWP II, LLC implements a fire management plan at its facility, although the site does not provide roosting habitat for bats.

The USFWS can reasonably expect the outcome of research or education to more than offset impacts.

This depends on the temporal scale applied. The outcome of the proposed research will not provide an immediate increase in bat productivity or a physical replacement of a fatality. But the research proposed does focus on the identified priorities such as diet, foraging, and distribution will inform the management and protection of the correct type of habitat, prey, foraging, and roosting resources that the bat needs. As a result, productivity is expected to be improved in the future as a result of implementation of the proposed research results and thus is expected to improve the offset of impacts to the bats.

The applicant commits to using the results and recommendations of the research to mitigate action impacts.

KWP II, LLC will implement recommendations based on outcome of the proposed research into its ongoing and future mitigation projects if deemed appropriate by the wildlife agencies under the adaptive management provisions. By adopting the "best scientific data available" standard in the ESA, Congress indicated it expected that the USFWS will make decisions on the basis of "available" information. The reinitiating of consultation provisions of Section 7 of the ESA, and the adaptive management provisions of the HCP, provide a mechanism for the USFWS and KWP II, LLC to adjust the HCP's conservation strategy to reflect new scientific information.

No other reasonable options for mitigation are available.

This factor largely fails to prioritize the importance of what is needed to sustain and recover the bat. KWP II, LLC and the wildlife agencies recognize the need for restoration and protecting habitats for Hawaiian hoary bats. The bats do not roost in buildings or caves. They roost in native and non-native trees that have suitable physical characteristics. The bats may forage in a variety of landscapes that have suitable insect prey (Coleopterans and Lepidopterans of a certain size are an important component of their diet). Land-based habitat protection, either through restoration or acquisition needs to be a component of Hawaiian hoary bat mitigation. But the degree to which restoration and preservation can improve the bats' representation, resilience, and redundancy needs to be informed by the priority research outcomes. To obtain full offset with land-based mitigation actions, we need to have an understanding of what may be limiting their populations.

While research is not typically a preferred mitigation practice because it does not directly offset adverse effects to species or their habitats, it has been used in cases when information is needed to inform better management of the species and therefore indirectly contributes to offsetting the impacts of authorized take. In recognition of the need for better scientific information on the Hawaiian hoary bat to inform and develop more effective and scientifically justifiable mitigation options in support of recovering this species, the USFWS and DOFAW have approved wind energy-related HCPs that include a Hawaiian hoary bat research component as part of the mitigation program to offset the impacts of authorized take. The inclusion of a research-based mitigation measure for the Hawaiian hoary bat in HCPs is consistent with the findings presented in the *Hawaiian Hoary Bat Guidance Document 2015* (DOFAW 2015). This guidance suggests that it is appropriate to allocate a mitigation credit of one Hawaiian hoary bat for each $50,000 of funding originally allocated for specific Hawaiian hoary bat research projects intended to inform and improve mitigation approaches and the function of bat habitat managed under a HCP. A provision for such research funding can be included in a proposed or amended HCP, provided the applicant or permittee ensures through a letter of credit or other financial assurances acceptable to the USFWS and DOFAW.

The results of funding research are likely to contribute to reducing uncertainty in mitigation effectiveness and inform more consistent, scientifically justifiable and quantifiable mitigation practices for Hawaiian hoary bats in the future – both during and after the term of this HCP. The ESRC has identified priority research questions that may be eligible for mitigation funding, including population dynamics, limiting ecological factors, and improved take monitoring (DOFAW 2015). The research component of this plan has been closely coordinated with the ESRC to ensure it addressed these priorities.

During the HCP development or amendment process, or implementation of adaptive management, the USFWS and DOFAW may provide the description of specific research projects for suggested inclusion in the HCP mitigation program. Once research projects are approved by the USFWS and DOFAW, such projects would receive mitigation credit, as described above, if the research project is implemented and performance targets are met even if the substantive outcome of the research is different than expected. The source of the research proposals is discussed below.

Specific Hawaiian hoary bat research proposals were solicited nationwide in 2016 through an ESRC request for proposals. A Hawaiian hoary bat subcommittee of the state's ESRC evaluated the 21 proposals received and identified several projects that may meet Hawaiian hoary bat mitigation needs for prospective HCP applicants or permittees to consider for inclusion in their HCPs. These projects were identified based on the priority research needs identified in the *Hawaiian Hoary Bat Guidance Document 2015* (DOFAW 2015). Research funded as part of implementation of this HCP has incorporated one of these research proposals as approved by the USFWS and DOFAW.

The contract for executing and funding the selected research project under the HCP is the responsibility of KWP II, LLC. However, all modifications to the cost or plan for implementing a selected research project(s) contained in this HCP amendment would need to be approved by the USFWS and DOFAW, since such changes, if approved, also become part of the HCP and the ITL/ITP terms and conditions.

In addition, KWP II is responsible for ensuring that the research project included in the approved HCP as Hawaiian hoary bat mitigation or adaptive management occurs. The "No Surprises" policy associated with an ITL/ITP does not change that obligation. If the proposed mitigation does not meet required performance targets, the permittee is responsible to complete the project performance targets. While the permittee is responsible for ensuring the research occurs and performance targets are met, the permittee is not responsible for ensuring an outcome of the research.

The contractor for the research project has been expected to define measurable performance targets and timelines for the USFWS and DOFAW approval prior to onset of the research project. The research project contractor also is expected to provide semi-annual and annual progress reports to the permittee, the USFWS, and DOFAW. The report needs to clearly describe the progress and any setbacks towards meeting the project performance targets and timelines, a summary of the findings to date, and any changes to study methods and approaches that may be needed. The USFWS and DOFAW reviews the report to 1) make sure the contractor is meeting the performance targets and timelines agreed to at the onset of the project; 2) request clarifications; 3) recommend changes to the report or project; and 4) approve or deny the continuation of the research project.

The research project chosen for funding supports the research priority of identifying limiting factors of bat habitat by conducting a long-term experimental study to measure changes in bat activity and invertebrate abundance across the study and between various habitat, as identified by the ESRC in its 2016 request for proposal.

Basic ecological research commenced as the Tier 3 initiative and is expected to be completed within 5 years (see Section 6.7.4 and Appendix 30).

6.7.3.2.2 Protect or Enhance Native Bat Habitat

For the Tier 4 mitigation obligation, KWP II, LLC would contribute to protecting and/or restoring habitat considered favorable for roosting, pupping, and/or feeding and include monitoring efforts and providing status reports to the wildlife agencies. Restoration or protection of habitat could include all or a combination of ungulate fencing, ungulate control, fire-fuel management, native tree outplanting, native plant seed dispersal, invasive species control, long-term maintenance, and invasive species monitoring or purchase of appropriate land for conservation. Any restoration will also include pre- and post-restoration bat monitoring with ultrasonic bat detectors with at least one detector for every 40 acres and deployed from July through October. Any potential land purchase would also require bat detection assessment to determine that bats are present in order for the purchase to be approved.

6.7.3.2.3 In-Lieu Fee Program

Mitigation for Tier 4 could be implemented through an approved federal and state Hawaiian hoary bat in-lieu fee program, if available and approved at the time of mitigation implementation.

6.7.3.3 Proposed Mitigation

The proposed mitigation would occur through the end of the KWP II take permit unless take is reduced by yet undetermined means or mitigation is planned for a fixed period.

As of June 2018, the total bat take estimate considering observed take is 12 adults (KWP II, LLC 2017) with 26 more estimated (out of 38 total estimated) during the remaining 14 years of the permit. If the rate of take is reduced by yet undetermined means and total take is not projected to exceed 30 bats (Tier 3 limit), then the project would not plan for or fund Tier 4 mitigation.

Planning for Tier 4 mitigation for the take of an additional eight bats would commence when total take estimate reaches approximately 25 bats (Tier 2 take level plus 75% of the difference between Tier 2 and Tier 3 (11 + (19 * 0.75) = 25) and if take is projected to continue above 30 bats.

The mitigation measures, or others developed in the future, may be implemented in partnership with other conservation groups or entities and will complement other restoration, reforestation, or conservation goals occurring in that area and at the same time. The location and size of mitigation sites also may be changed with the approval of the ESRC, the DLNR and the USFWS in order to provide optimal benefit. If at any time new scientific information indicates mitigation measures other than habitat restoration are more important or pressing for recovery of the Hawaiian hoary bat, KWP II may revise the mitigation plan with the approval of the USFWS and the DLNR, provided any revision will not require a significant increase in the cost of total mitigation as estimated in this HCP amendment.

The mitigation plan proposed here incorporates applied research (Tier 3) that is closely tied to the habitat management component and a land-based component for Tier 4 (both are detailed below). This approach is consistent with recommendations of the ESRC, which includes representatives from the USFWS, the USGS, the State of Hawaiʻi, and others (DOFAW 2015).

6.7.3.3.1 Tier 3 Mitigation

Although mitigation for Tier 3 level bat take can only be considered “approved” when this HCP amendment has been approved by the Hawai‘i BLNR and the USFWS, a final mitigation plan for research, to better understand bat movements, roosting behavior, and diet, has been agreed to be appropriate by the DLNR, the USFWS and the ESRC on September 28, 2016. Appendix 30 is the SOW detailing the plan for research being conducted by the USGS and Pacific Island Ecosystems Research Center (PIERC). Although this plan has not been formally approved by the USFWS and the BLNR, KWP II, LLC contracted with and begun funding the USGS/PIERC research in FY 2018. The total cost of the USGS/PIERC project is $1,832,000. TerraForm Power holds a contract to fund the entirety of the project. As previously indicated basic research on Hawaiian hoary bat ecology is necessary to understand how to successfully mitigate for bat take through restoration, protection or enhancement of this bat’s preferred habitat. KWP II, LLC has chosen to begin this timely research as mitigation rather than wait an undetermined length of time for the formal approval.

6.7.3.3.2 Tier 4 Mitigation

Commence and complete the following (based on a final mitigation plan to be approved by the DLNR, the USFWS, and the ESRC):

Purchasing land on Maui that is not already in conservation, where bats are present, and where the land parcel is in danger of being developed or compromised. The approximate acreage per bat would be 60–80 acres or 480–640 acres total for eight bats. The specific parcel would be determined when funding and planning for Tier 4 take is required. Prior to any planned land purchase bat detectors would be deployed to ensure that bats are present on or near the parcel. At least 10 bat detectors would be deployed throughout the parcel for at least three months. Bat detection would have to occur on at least three detectors during the assessment period.

OR

Mitigation through an approved federal and state Hawaiian hoary bat in-lieu fee program.

6.7.4 Measures of Success–*UPDATED*

The success of the Tier 1 and Tier 2 mitigation efforts has been determined as follows:

1. Both components of on-site research into Hawaiian hoary bat habitat utilization and bat interaction with wind facilities were considered successful when KWP II, LLC joined the HBRC and the specified survey and monitoring were carried out, including proper deployment and operation of bat detectors, data reduction and analysis, and reporting of findings to the DLNR, the USFWS, and the ESRC.
2. KWP II exceeded the Tier 1 rate of take. Measures to reduce bat fatalities include increasing LWSC from 5.0 to 5.5 m/s and will be considered successful when corrective measures implemented result in an estimated 50% or greater reduction in bat fatalities over previous levels when averaged over a 5-year period.
3. Implementation of management measures was considered successful when KWP II, LLC contributed funding sufficient to restore the acreage required to compensate for the Tier 1 requested take (for take at or below Tier 1) within 6 months of beginning project operations; and when Tier 2 rate of take was identified and additional funding sufficient to restore the acreage required to compensate for the Tier 2 requested take (for Tier 2 take upon exceeding the 5-year or 20-year Tier 1 requested take) was provided within 6 months of the determination. Management measures will be considered successful if *Prior to the start of management measures:*

    a. Ground and canopy cover at the mitigation site is measured

    And after 6 years:

    b. The fencing is completed

c. The ungulates have been removed within the fenced area and the area is kept free of ungulates for the 20-year permit term

And after 20 years:

d. The cover of non-native species (excluding kikuyu grass) in the managed areas is less than 50%
e. The mitigation area should have a canopy cover composed of dominant native tree species (particularly koa and ‘ōhi’a) that are representative of that habitat after 15 years of growth. According to Wagner et al. (1999), mature koa/’Ōhi’a montane mesic forests “consist of open-to-closed uneven canopy of 35 m tall koa emergent above 25 m tall ’Ōhi’a.” Therefore, there should be at least a 25% increase in canopy cover over original conditions throughout the mitigation area, and closed canopy areas should attain at least 60% canopy cover.
f. Restoration trials are implemented
g. Radio-transmitter monitoring (or other measures as appropriate) is conducted every 3 to 5 years to detect changes in bat density and home range core area size as the site is restored

These criteria were refined by DOFAW before management commenced in the Kahikinui area. If these criteria are not met as proposed, the Applicant will consult with the DLNR and the USFWS and implement a revised strategy to meet success criteria as approved by the USFWS and the DLNR. The FY 2017 DOFAW progress report for the Kahikinui State Forest Reserve Project relative to funds provided by KWP II, LLC is Appendix 32.

The measures of success for Tier 3 mitigation as bat ecological research and Tier 4 mitigation as bat habitat protection and/or restoration efforts are listed below.

6.7.4.1 Tier 3 Mitigation - NEW

Tier 3 mitigation will be considered successful if the approved research project as described in Appendix 30 has been funded at $50,000 per estimated bat take ($950,000 for 19 bats), and if

- the tasks and activities toward accomplishing the research goals and objectives have been completed as proposed or as modified with the approval of DOFAW and the USFWS (regardless of outcome or findings);
- a final report has been submitted and approved by DOFAW and the USFWS; and
- the specified raw data has been provided to the agencies.

KWP II, LLC will fund the following parts of the research plan ($950,000):

1. Capture and release of Hawaiian hoary bats
2. Radio-tagging bats caught
3. Banding bats caught
4. Radio-tracking tagged bats
5. Reporting

If the research project described in Appendix 30 is not proceeding as expected according to quarterly and annual reviews the principal investigator and the agencies would determine what steps would be required to accomplish the goals as expected. Additional cost could be required and would be expected to be paid by KWP II, LLC to fulfill the stated goals.

6.7.4.2 Tier 4 Mitigation - NEW

Consistent with the *Interim Bat Guidance Report* (Fretz 2018), Tier 4 mitigation will be considered successful when the preferred land parcel of between 480 and 640 acres in size has been purchased and documented to be dedicated to conservation in perpetuity. A preferred land parcel will have been proven to have bats occupying the land (through bat detector deployment), is not previously designated as "conservation zoned," and is at risk of deterioration by development or invasive species encroachment.

If mitigation is through an approved federal and state Hawaiian hoary bat in-lieu fee program, mitigation success will be determined by completed payment for the entire Tier to the in-lieu fee program.

If these criteria for Tier 4 are not met as proposed the Applicant, DOFAW, and the USFWS will review the implementation process and results and determine what, if any, corrective actions are warranted.

The goal of the habitat conservation program (minimization, mitigation, and monitoring) is to compensate for the incidental take of each species authorized at each tier (Take Scenario), and provide a net conservation benefit, as measured in biological terms. KWP II, LLC will provide the required conservation measures in full, even if the actual costs are greater than anticipated. One way of accomplishing this is that past, current, or future funds allocated to a specific Covered Species may be reallocated where necessary to provide for the cost of implementing conservation measures for another Covered Species, and funding for any individual Covered Species is not limited to those amounts estimated in Appendix 6. KWP II, LLC also recognizes the cost of implementing habitat conservation measures in any one year may exceed that year's total budget allocation, even if the overall expenditure for the conservation program stays within the total amount budgeted over the life of the project. Accomplishing these measures may therefore require funds from future years to be expended; or, likewise, unspent funds from previous years to be carried forward for later use. For practical and commercial reasons, such reallocation of funds among years may require up to 18 months' lead time to meet revenue and budgeting forecast requirements. But if reallocation between species or budget years is not sufficient to provide the necessary conservation, KWP II, LLC will nonetheless be responsible for ensuring that the necessary conservation is provided.

6.7.5.3 Adaptive Management for Higher than Projected Take - NEW

The current projected take and amendment request is 38 bats. As explained in Section 5.2.7.4, assuming search conditions are similar, approximately seven bats would be expected to be observed on the ground in the search area in the next 14 years to reach a total estimated take of 39 bats. If no more bats are observed on the ground in the remaining permit years, the projected estimated total take would be 14 bats.

If searched area remains the same throughout the remaining permit period and search conditions continue to be similar (primarily canine-assisted searching, SEEF at least 85%, CARE averaging at least 7 days), the following triggers would be used to adaptively manage a higher than projected rate of take:

1. During the next 2 permit years (permit years 7 and 8 or state fiscal years 2019 and 2020) if more than two bats have been observed on the ground in search areas (assuming the search area size has not changed) KWP II, LLC will implement additional minimization techniques to ensure the requested take will not be exceeded.
2. Assuming the first trigger is not met, during the next 5 years or less (permit years 7 through 11, state FYs 2019–2023) if more than three bats have been observed on the ground in search areas KWP II, LLC will implement additional minimization to ensure the requested take will not be exceeded.
3. Assuming the second trigger is not met, during permit years 12 through 16 if more than five bats have been observed on the ground in search areas (for permit years 7 through 16; state FYs 2019–2028) KWP II, LLC will implement additional minimization to ensure the requested take will not be exceeded.
4. Assuming the third trigger is not met, during permit years 17 through 19 if more than six bats have been observed on the ground in search areas (for permit years 7 through 19; state FYs 2019–2031) KWP II, LLC will implement additional minimization to ensure the requested take will not be exceeded.

Once the permittee and/or wildlife agencies have determined the observed take is exceeding the permit year trigger, the appropriate minimization technique determined with concurrence with the wildlife agencies would be implemented immediately if minimization includes just a change in wind turbines operations and within 6 months if minimization includes deployment of equipment on the wind turbines.

Minimization will include any or any combination of the following:

1. a higher level of LWSC if additional research demonstrates a higher likelihood of success than does current research,
2. periods of complete cessation of operations during the night (such as during the first 2 hours of the night or during annual periods of highest activity, for example),
3. implementing deterrents that have been proven to reduce fatality rates on at least 50% of the wind turbines (with the highest bat detection and/or fatality rates),
4. implementing early warning systems on at least 50% of the wind turbines (with the highest bat detection and/or fatality rates) that detect the presence of bats and shutting down at least 50% of the wind turbines (with the highest bat detection and/or fatality rates) for at least 15 minutes (assuming no additional bat activity is detected), or
5. a not yet identified option.

6.8 Mitigation for Other Native Species – The Hawaiian Short-Eared Owl–*NO CHANGE*

Since the start of project operations at KWP I four years ago, one observed take of the Hawaiian short-eared owl attributable to collision with a turbine has been documented. One vehicular collision has also occurred. Hawaiian short-eared owls also occur at the KWP II area (see Section 3.7). Hence, it is reasonable to expect that a low level of take may also occur at KWP II over the life of the project. While this native species is common on Maui, KWP II, LLC intends to offer mitigation to compensate for the impacts that the wind facility may have on the species in the vicinity.

Mitigation for possible take of the Hawaiian short-eared owl by KWP II, LLC will consist of funding research and/or rehabilitation of injured owls. Therefore, within 60 days of the commercial operation date, KWP II, LLC will contributed a total of $25,000 to appropriate programs or facilities such as the Hawaii Wildlife Center to support owl research and rehabilitation. The Hawaii Wildlife Center, located on the Island of Hawai‘i, is currently under construction and is still fundraising to complete the facility. One need identified by Linda Elliot (founder, president and center director) was funding to complete the recovery yard at the Hawaii Wildlife Center which will houses the outdoor holding pens and aviaries for raptors. This recovery yard will have the capacity to rehabilitate native raptors from the entire Hawaiian Archipelago. The Hawaiian short-eared owl is one of two native raptors in the state, the other being the Hawaiian hawk, or i‘o (*Buteo solitarius*). The cost of completing the recovery yard, which will consist of grading, laying down of gravel substrate, irrigation and plumbing, improving drainage, predator-proof fencing, installing gates, and landscaping is estimated at $25,000.

The allocation of funds to research and/or rehabilitation will be determined by the DLNR and the USFWS. If funding is allocated to research, funding may be used for (but not limited to) the purchase of radio transmitters, receivers, or provide support for personnel to conduct research, such as a population census. However, these funds will be used for whatever management or research activity is deemed most appropriate at the time, with the concurrence of the USFWS and the DLNR.

The rehabilitation efforts of injured owls are anticipated to offset any impact that the wind facility may have on the local population in the area. An annual report will be obtained from the rehabilitation facility documenting the number of Hawaiian short-eared owls rehabilitated each year. If research is funded, it is anticipated that the research conducted will result in an increased understanding of the habitat requirements and life history characteristics of Hawaiian short-eared owl populations, leading to the development of practicable management strategies and possibly help with the recovery of the Hawaiian short-eared owl on O‘ahu, where it is state-listed as endangered.

6.9 Restoration of Vegetation and Prevention of Soil Erosion–*NO CHANGE*

KWP II, LLC received approval of its CDUA (Appendix 1) from the OCCL in August 2010. As part of that process, a plan for revegetating disturbed areas and reintroducing native plants is being proposed. The proposed revegetation strategy is included here for reference. KWP II, LLC plans to implement a revegetation strategy to restore vegetation in temporarily disturbed areas intended to meet the dual objectives of stabilizing disturbed areas immediately following construction, and a longer-term effort to re-introduce and establish several native plant species throughout the site. Most elements of this plan are derived from experiences and lessons learned at the adjacent KWP I project site, which underwent construction in early 2006, and which has a comparable plant ecological history. KWP II, LLC anticipates working alongside and in collaboration with DLNR Forestry and Wildlife specialists to ensure that revegetation initiatives consider and incorporate all wildlife, forestry, fire and rangeland concerns and are in alignment with the management provisions of the conservation district. The goal is to immediately stabilize soil and prevent erosion following construction. Details of the revegetation plan are included in Appendix 8.

6.9.1 Immediate Revegetation to Control Soil Erosion–***NO CHANGE***

Due to the rocky nature of much of the KWP II area, revegetation is anticipated in only limited areas. Much of the area modified for the project will result in coarse rocky surfaces, and thus will remain unvegetated, including the turbine pads (kept open for increased searcher efficiency), cuts into native rock, and riprap slopes. Re-vegetation will be implemented for erosion control in areas where finished grading results in exposed soil, such as along the edges of some turbine pads and along certain road cuts and fill slopes. In such areas KWP II, LLC proposes to apply a hydro-seed mixture of annual rye (*Lolium multiflorum*) to establish an initial cover of vegetation. Annual rye grass is expected to provide rapid cover that will gradually dies back and allows natural recruitment of neighboring species. Supplemental irrigation for a 90-day period and monitoring will be necessary to ensure that immediate revegetation measures are successful. This phase of the project will be considered successful if it can be demonstrated that > 75% of the bare areas, fill slopes, and road cut segments that receive treatment have established cover within one year following treatment. If initial applications appear to be only partially successful, subsequent hand and/or hydro-seeding applications or additional temporary measures (e.g., excelsior, jute, or coir matting) may be installed to ensure adequate coverage and erosion control. Over time, areas re-vegetated with annual rye will be supplemented with suitable hardy native seedlings, or other appropriate non-invasive plants in accordance with the re-vegetation plan (Appendix 8).

6.10 Managing Invasive Species–*NO CHANGE*

KWP I, LLC is also working actively to minimize and reduce the ingress of certain undesirable invasive plant species. For example, fireweed (*Senecio madagascariensis*) is a pasture weed that is highly toxic to grazing livestock and is known to readily exploit disturbed areas. KWP II, LLC intends to continue measures to minimize and avoid the introduction of invasive species to the Kaheawa Pastures area during the proposed wind farm development using best management practices (Appendix 1). These measures include the cleaning and inspection of all equipment, materials, and vehicles brought onto the site during construction to prevent the introduction of invasive or harmful non-native species. KWP II, LLC will ensure that construction materials brought from off-site will be inspected and documented along with recommendations for managing materials prior to transport and use. An inspection station at the staging area near the main highway will be established to reduce the possibility of introducing alien plant species to the site prior to project work. Each vehicle will be inspected and cleaned of debris or plant materials prior to authorizing traveling up to the site. KWP II, LLC will support and collaborate with the Fireweed Group on existing efforts to control and manage fireweed. KWP II, LLC will consult with the Hawaiʽi Department of Agriculture and Maui Invasive Species Commission to establish protocols and training orientation methods for preventing invasive species introductions. Post-construction protocols will also be developed to minimize the spread of existing invasive species and monitor the potential establishment of new introduced species. However, non-native vegetation will be removed from search plots if such vegetation creates unsearchable conditions within the required search areas.

6.11 Enhancement of Mid-Elevation Native Plant Habitat–*NO CHANGE*

The USFWS has suggested that the area affected by the development of the Kaheawa Wind Power Phase 2 wind energy generation facility (KWP II) presently under construction above Māʽalaea in the southwestern portion of the Island of Maui, could represent future habitat for the recruitment of certain rare and native plant species. The approximately 143 acres (58 ha) project site is situated southeast of the existing 30-MW Kaheawa Wind Power (KWP I) project area, and both projects reside on Conservation District Land administered by the Hawaiʽi DLNR. There are no Critical Habitat designations and no state or federally listed species known to occur in the project area.

The area to be disturbed during construction of the KWP II facility is former pasture that was converted from native plant communities well over 100 years ago, and is currently dominated by a mixture of native and non-native grasses and low shrubs with scattered small trees. The area is prone to periodic wildfires, which suppress native plants and favor the spread of non-native, fire- tolerant grasses. Several native plant species are spread throughout the project area, mixed among the grasses, but are less prevalent at the lower, drier parts of the project area where fires have occurred more recently (Hobdy 2009b, June 2010). At KWP II, native plants are more prevalent in the rocky habitat bordering Manawainui and Malalowaiaʽole Gulches (Hobdy 2009a, 2009b).

Construction of the proposed KWP II facility will disturb approximately 43 acres (17 ha) of land. Approximately one third of the disturbed area will be revegetated upon completion of earthwork to ensure adequate stabilization, such as cut and fill slopes and road cuts. Turbine pads, as well as some portion of the road cuts, will be stabilized with hard materials (e.g., rip-rap and compacted gravel) rather than vegetation in order to ensure stability or increase searchability of turbine plots for downed wildlife.

Benefits expected to result in favorable conditions for native species recruitment

KWP I biologists have had considerable success reintroducing nursery grown native plants at various locations throughout the existing wind farm site, including along cut and fill slopes and other open earth portions of the roadsides and turbine pads. These outplantings and their propagules have become the dominant botanical cover in the areas treated and after 5 years' time have enabled other recruits of native species to take hold in these areas. Between July 2007 and June 2008, approximately 7,500 young aʽaliʽi (*Dodonaea viscosa*) were propagated from seed collected at the KWP I site. These seedlings were outplanted with the help of volunteers and survival was excellent. A second intensive outplanting effort comprising roughly 16,000 individual plants of several key native species occurred during the winter and spring of 2009 at KWP I. These efforts have enabled many disturbed areas to become reestablished with native species common in the area and would undoubtedly represent conditions necessary for the recruitment of certain rare or listed species, should natural conditions enable their establishment independent of nursery propagation and enhancement-oriented reintroduction.

KWP II biologists propose to reintroduce native plants at the project site in discrete locations over several years, with the intent of eventually re-establishing some key species of plants that existed historically and/or at the time of project construction. This may involve collecting native seeds and cuttings in the area, propagating these at local nurseries, and subsequently outplanting these species at the site. If native species are selected that did not occur before construction but are believed to be good candidates for reintroduction, these will be reviewed in advance to be sure they will thrive and not represent a nuisance by creating an attractive habitat feature that could increase the risk of take for HCP-covered species.

Native species that may potentially be used in the reintroductions at KWP II include species identified in the botanical assessments of the area such as ʽaʽaliʽi, pili grass, ʽūlei, and ʽilima These relatively fast-growing and easily propagated species provide excellent root structure for maintaining surface substrate retention, as well as provide a native seed source for the project area. Pili grass and ʽaʽaliʽi are particularly appropriate for the conditions at Kaheawa Pastures because these species are among the few native Hawaiian plants shown to be fire tolerant (Tunison *et al.* 1994, Loh *et al.* 2009), appear resilient enough to withstand extensive periods of time between rain events, and may function to retain recruits of rare native species, should they emerge.

The specific locations of native outplantings will be determined based on site-specific factors such as the size of the disturbed area, slope, erosion potential, and substrate. Due to physical constraints of the site (i.e., the presence of surface bedrock material), KWP II, LLC may propose to direct some native outplantings outside of the immediate project area (i.e., near the puʽu), if such locations are deemed to offer a greater ecosystem and/or landscape level benefit. The specific locations of any outplanting areas adjacent to the site will be determined in consultation with the DLNR, the USFWS, and native plant community specialists.

It may be important and prudent to control the influx of unwanted non-native weeds that were not present prior to construction, either manually or in conjunction with an approved herbicide. Any use of herbicides will be done only in consultation with the DLNR, and only in accordance with applicable restrictions on handling and use.

KWP II biologists plan to approach this phase of the site revegetation plan in a manner that emulates the successful native plant reintroduction efforts at KWP I while incorporating the knowledge of past experience working in the region. KWP II, LLC will work in collaboration with KWP I, LLC to share resources and coordinate logistics. Knowledgeable experts will be consulted for their advice and guidance to ensure that appropriate site selection, species, and timing of outplanting will result in the highest probability of establishment.

The long term revegetation efforts at KWP II are expected to be very successful given the success at KWP I. A well-established seed collection and propagation program already exists in cooperation with local nurseries, other native plant specialists, contract landscape specialists, community conservation groups, and volunteers. The entire outplanting effort will be implemented, maintained, monitored, and documented using resources available at KWP II and KWP I and in collaboration with community and conservation groups. This effort will be considered to be successful if a minimum of 5,000 individual plants are installed during the first three years following construction, with an average survival rate of greater than 75% (i.e., a minimum of 3,750 surviving plants), for all plants one year after installation, as determined by representative sampling of planted areas. If mortality exceeds 25%, replacement plantings will be installed as needed to achieve the 75% minimum.

Besides grazing, frequent wildfires have significantly altered the vegetation at the site and its immediate surroundings. The fires have benefitted fire-adapted weeds, and altered microsites making the area unsuitable for recruitments of most native plant and invertebrate species. KWP I has already significantly reduced both the potential frequency and the impacts of wildfires in the area. Roads and turbine pads function as fire breaks, and on-site personnel are equipped and trained to suppress incipient fires. The KWP I wildfire contingency plan (Appendix 18) ensures adequate response and suppression of potential wildfires. In addition, KWP II staff is participating in and advocating for the development of a Community Wildfire Protection Plan, which once implemented, will provide for minimization of wildfires at the regional level. Minimization of wildfires, along with implementation of measures described above, increase the suitability of the area for the recruitment of both rare and common native species.

Measures to protect existing native species and their habitats

The KWP II project site is not known to contain any listed or candidate species and no Critical Habitat designations at this time. A somewhat rare native grass species, *Eragrostis deflexa*, was identified during a recent botanical assessment of the project area. This species is distributed in small, discrete patches mostly among rocky enclaves along the edges of the deep gulches bordering the site where it is able to withstand the impacts of wildfires. The areas where this grass is known to occur are physically outside of the operational foot-print of the project area and have been delineated as sensitive areas to be avoided. Long-term protection from wildfires may enable *E. deflexa* to further recover and proliferate, which would enhance the native ecological diversity of the area. Combined with the native plant re-establishment efforts planned at KWP II, protecting the integrity of existing native-dominated sections of the project area will promote the health and long-term stability of these unique resources.

7.0 IMPLEMENTATION

7.1 HCP Administration–*NO CHANGE*

The Applicant will administer this HCP under the direction of the USFWS and the DLNR. The schedules for implementation of HCP requirements and reporting requirements are outlined in Appendix 19. In addition, outside experts may be periodically consulted, including biologists from other agencies (e.g., National Park Service, the USGS), private conservation organizations, conservation partnerships (e.g., Nēnē Recovery Action Group), consultants and academia. When appropriate, and as requested by the USFWS and the DLNR, HCP-related issues may be brought before the ESRC for formal consideration.

The Applicant will meet at least semiannually with the USFWS and DLNR. Additional meetings/conferences may be called by any of the parties at any tithe me to address immediate concerns. The purpose of the regular meetings will be to evaluate the efficacy of monitoring methods, compare the results of monitoring to the estimated take, evaluate the success of mitigation, and develop recommendations for future monitoring and mitigation. Regular meetings will also provide opportunities to consider the need for adaptive management measures, or changes to the monitoring protocol or mitigation measures. In addition, the Applicant will meet annually with the ESRC to provide updates of monitoring, mitigation, and adaptive management, and to solicit input and recommendations for future efforts. Additional meetings may be requested by the ESRC at any time to address immediate questions or concerns.

The USFWS or the DLNR may suspend or revoke their respective permits if KWP II, LLC fails to implement the HCP in accordance with the terms and conditions of the permits or if suspension or revocation is otherwise authorized or required by law. Suspension or revocation of the permits shall be done in accordance with applicable federal or state law.

7.2 Monitoring and Reporting–*UPDATED*

Monitoring and reporting by the Applicant addresses both compliance and effectiveness. Compliance monitoring verifies the Applicant's implementation of the HCP terms and conditions. Annual reports and other deliverables as described below are provided to the USFWS and the DLNR to allow them to independently verify that the Applicant has performed all of the required activities and tasks on schedule. Monitoring investigates the impacts of the authorized take and the success of the HCP's mitigation program. The monitoring involves surveys to make sure the authorized level of take is not exceeded, and that the effects of take are minimized and mitigated to the greatest extent practicable (i.e., minimization and mitigation measures are sufficient and successful).

7.2.1 Monitoring–*UPDATED*

The Applicant documents bird and bat injuries and fatalities, including Covered and non-Covered Species, following methods that have been used effectively at other wind energy generation facilities in Hawaiʻi and the continental United States. Another alternative is for KWP II, LLC to contribute to a cooperative monitoring program led by DOFAW (total costs estimated to be approximately $225,000 to $250,000 per year). In this program, DOFAW would establish the monitoring protocol and provide personnel to conduct the monitoring. If the program is established, KWP II, LLC will contribute to DOFAW an amount up to its budget allocation for self- performing the monitoring. Additional funding for the program may be provided by DOFAW or obtained by DOFAW through grants or other sources.

Details of the proposed monitoring protocol are provided in Appendix 2. The actual monitoring protocol has been finalized with the approval from the agencies prior to the start of project operations. Key components include:

- Use of KWP II technical staff and/or third-party contractors who have been trained by experienced biologists having specialized expertise in conducting wind turbine/bird interaction studies. Criteria for selecting third-party contractors approved by the USFWS and the DLNR will be developed with approval of the DLNR and the USFWS. Additional funds are provided in the event a third-party contractor is required for monitoring and will only be used for this purpose.

- With agency concurrence, carcass removal (i.e., scavenging) and SEEF trials are conducted each season using carcasses of different size classes within different vegetation types. Two seasons will be addressed: the winter/spring season (December–May) and summer/fall (June–November). Three size classes have been chosen to represent the size classes of the Covered Species: bat-sized, medium birds and large birds. The vegetation is classified according to structure (bare ground and mowed grass) and the vegetation types and their boundaries are mapped at KWP II after construction. Carcass removal and SEEF trials will be conducted with sufficient replication to produce statistically reliable results. These results provide a basis for estimating unobserved take (see Appendix 2 on the potential study design); the Applicant covers all costs and responsibilities for acquiring carcasses for trials.
- Intensive searches were conducted for the first three years under the direction of a qualified biologist, after which the approach was reduced in total area searched to a sampling method based on the results obtained up to that point, subject to the approval of DOFAW and the USFWS. The reduction in searcher effort was first evaluated using data collected up to that point, and final decisions on searcher effort reduction required the approval of DOFAW, the USFWS, and the ESRC.
- The frequency of searches during the intensive search years ensured that a variety of conditions were included. For example, days after moonless, cloudy, or stormy nights are of particular interest, because the wind turbines would be least visible and the risk of collision would presumably be greater, especially during peak fledging periods.
- Incidental observations by on-site staff of bird use, injury and mortality are documented in accordance with the WEOP and Downed Wildlife Protocol described in Sections 6.3 and 6.4.
- Annually, on the anniversary of the start of operations, the USFWS and DOFAW determines, in coordination with the applicant and based on the best available information, the project's take tier, anticipated adequacy of ongoing mitigation, and the necessity for additional mitigation implementation. KWP II, LLC will ensure projected 20-year benefits of mitigation remain at or above the anticipated 20-year mitigation requirements during years six through 20. Projected 20-year mitigation benefits may fall short of projected mitigation requirements for one period, not to exceed 365 days in length, during years six through 20.

7.2.1.1 Long Term Monitoring–NEW

The long-term monitoring protocol for KWP II from Years 4 through 20 of the permit term includes a reduced search effort relative to the intensive monitoring protocol. It consists of searching roads and graded pads that occur within 70-m radius from each turbine (Appendix 27). SEEF and CARE trials are conducted at least quarterly. The long-term monitoring protocol is detailed in Appendix 28.

7.2.2 Reporting–*NO CHANGE*

During construction, weekly reports of nēnē activity in and around construction areas will be provided to the agencies.

If the minimal monitoring search interval at the project site is exceeded, the Applicant will report the event to the USFWS and DLNR within a week. If the minimal search interval is exceeded more than once per season (for reasons other than weather, health or safety), the Applicant, the DLNR, and the USFWS will discuss possible adaptive management measures to address and correct the problem. Semiannual meetings with the DLNR and the USFWS will be held in March and September to provide brief progress reports and summarize the findings of scavenging, SEEF trials and results of mitigation efforts. Electronic copies of HCP-related data will also be submitted with the progress reports. If necessary, take limits will be reviewed and changed circumstances or adaptive management measures will be discussed with the DLNR and the USFWS as needed. In addition, should a take of a Covered Species occur, the DLNR and the USFWS will be notified within 24 hours by phone and an incident report will be filed within three business days (Appendix 14).

Annual reports summarizing the results of each of the two years of intensive monitoring will be prepared and submitted to the DLNR and the USFWS. These reports will identify 1) actual frequency of monitoring of individual search plots; 2) results of SEEF and carcass removal trials with recommended statistical analyses, if any; 3) directly observed and adjusted levels of take for each species; 4) whether there is a need to modify the mitigation for subsequent years; 5) efficacy of monitoring protocols and whether monitoring protocols need to be revised; 6) results of mitigation efforts conducted as part of the HCP; 7) recommended changes to mitigation efforts if any; 8) budget and implementation schedule for the upcoming year; and, 9) continued evidence of the Applicant's ability to fulfill funding obligations. The annual report will be submitted by August 1 each year along with electronic copies of HCP related data. The report will cover the period from June to July of the previous year. Agencies will have 15 calendar days to respond to the report, after which a final report incorporating responses to the agencies will be submitted by September 1. The report may also be presented to the ESRC as required.

In subsequent years, monitoring may consist of a reduced level of effort, consisting of smaller search plots at a subset of turbines, with plots relocated periodically to sample a variety of locations. The ongoing effort will be supplemented by the WEOP, as implemented by on-site staff. Depending upon the findings, the location and focus of the ongoing effort can be modified, with the concurrence of the USFWS and the DLNR, to target areas or times of particular interest. A table summarizing the results of incidental observations will be submitted to the DLNR and the USFWS twice each year. The first would be submitted in January (post-fledging for seabirds in the previous year) and the second in July (post-fledging for nēnē). In addition, in accordance with the Downed Wildlife Protocol, biologists at DLNR and USFWS will be notified whenever an MBTA or Covered Species is found dead or injured. The Applicant will confer formally with the USFWS and the DLNR at least once a year following submittal of the annual report to review each year's results, review the rates of take (directly observed and as adjusted), and plan appropriate future mitigation and monitoring measures. Any changes to future mitigation and monitoring would only be made with the concurrence of the USFWS and the DLNR.

7.3 Summary of Adaptive Management Program–*UPDATED*

According to USFWS policy (see 65 *Federal Register* 35242), adaptive management is defined as a formal, structured approach to dealing with uncertainty in natural resources management, using the experience of management and the results of research as an ongoing feedback loop for continuous improvement. Adaptive approaches to management recognize that the answers to all management questions are not known and that the information necessary to formulate answers is often unavailable. Adaptive management also includes, by definition, a commitment to change management practices when determined appropriate. KWP II, LLC shall implement specific adaptive management measures in addition to those it may propose, if such measures are determined to be necessary and appropriate by the USFWS and the DLNR to achieve the conservation benefits of the plan.

In the case of KWP II, some uncertainty exists related to estimated rates of take and the success of the proposed mitigation measures. However, there is reasonable basis for expecting the proposed mitigation measures to be successful for the nēnē, including a long history of nēnē releases on Maui and other islands. Nonetheless, uncertainties regarding take of Covered Species remain and, as a result, adaptive management provisions have been incorporated into this HCP. The Applicant may also consider whether changes in operational practices are needed to reduce levels of take. The following adaptive management measures have been/can be implemented to attempt to reduce take of Hawaiian hoary bats:

- As an avoidance and minimization measure, from July 2012 to July 2014, LWSC was in effect from at least sunset to sunrise from April through November (see Section 4.3.1). As of July 29, 2014, the LWSC regime was modified to extend from February 15 to December 15 (due to known fatalities occurring on February 24 and 26, 2014, at KWP I and II, respectively and a fatality on December 14, 2013, at KWP I). The nighttime curtailment period is currently extended to year-round. The cut-in and cut-out speed was raised from 5.0 m/s to 5.5 m/s.
- If bat deterrent devices become commercially available, are effective and feasible, cost similar to or less than existing planned mitigation, and mitigation obligations have not yet been met, they may be implemented during the course of the permit term, with the agreement of the USFWS and the DLNR. In that situation, bat take may not exceed Tier 3 take levels therefore

additional mitigation for Tier 4 may not be required. LWSC may also no longer be necessary and if this is determined, it will be reduced or discontinued. Reduction or discontinued LWSC will require prior approval of the DLNR and the USFWS.

The proposed tiered approach to mitigation was designed with adaptive management in mind as it is acknowledged that actual rates of take may not match those projected and results of mortality monitoring performed to date at the KWP facilities. When estimated take at the 80% credibility level for a current tier reaches 75% of the current tier limit, mitigation, funding and funding assurances for the next higher tier will be planned for and implemented. Take will not be authorized for the pending tier until funding assurances for the pending tier are in place. Mitigation efforts will increase if monitoring demonstrates that incidental take is, or may be, occurring above Tier 1 levels. Any changes in the mitigation effort would be made only with the approval of the USFWS and the DLNR. Regardless of recorded take levels, the avoidance and minimization measures described in Section 4.3 would be employed for the duration of the KWP II project.

Monitoring of bats and nēnē mitigation efforts is intended to inform the Applicant, the USFWS, and the DLNR as to whether these efforts are adequately compensating for the total direct take and indirect take assessed to the KWP II facility. If monitoring reveals that a particular mitigation effort is not achieving the necessary level of success as dictated by the amount of take assessed to the KWP II facility, the Applicant will, as adaptive management and as approved by the USFWS and the DLNR, develop and implement a revised mitigation strategy intended to meet the project mitigation requirements. Tier 1 and Tier 2 bat mitigation and Tier 1 nēnē mitigation results are reported annually with the HCP annual report and reviewed by the ESRC during the annual report review to determine if the projects are proceeding as expected and to address any changes that might be necessary to assure success. As of FY 2018, the Tier 1 and Tier 2 bat mitigation project is proceeding as expected and has successfully met the 6-year benchmarks. Tier 3 bat mitigation as research includes a quarterly agency review of progress to confirm the project is proceeding as expected and meeting the benchmarks that also have been approved by the agencies. Tier 1 nēnē mitigation, began in 2017, has involved the Piʽiholo Ranch pen maintenance and predator control. Nonetheless, as with bat mitigation, the annual results are reviewed by the agencies and the ESRC and any changes to mitigation planned or underway is determined.

While research is not typically a preferred mitigation practice because it does not directly offset adverse effects to species or their habitats, it has been used in cases when information is needed to inform better management of the species and therefore indirectly contributes to offsetting the impacts of authorized take. Bat research can be justified as mitigation when there is an adaptive management approach wherein the results/recommendations of the research will then be applied to improve future mitigation efforts (DOFAW 2015).

If the take of any of the Covered Species exceeds that authorized by the ITP and ITL at any Tier level, but remains within the range identified in Section 5.0 for that species, the Applicant will implement the additional mitigation for that species described in Section 6.0. As an adaptive management trigger, the Applicant will promptly discuss take projections that may indicate exceeding a current Tier with the USFWS and the DLNR to review the total take of that species recorded to date at the KWP II facility and the mitigation performed to date on behalf of that species, or whether changes in mitigation are needed to compensate for the next higher (or any higher) rate of take. Any changes to the mitigation efforts would be made after the Applicant, the USFWS, and the DLNR have consulted and determined the best course of action to fulfill mitigation requirements.

7.4 Funding–*UPDATED*

The HCP includes a habitat conservation program with measures that KWP II, LLC undertakes to monitor, minimize, and mitigate the incidental take of each Covered Species, plus provide a net conservation benefit, as measured in biological terms. An estimate of the costs of funding the proposed conservation program is presented in Appendix 6 of the HCP. KWP II, LLC will provide the required conservation (monitoring, minimization, and mitigation) measures in full, even if the actual costs are greater than anticipated. The budgeted amounts are estimates and are not necessarily fixed. One way of accomplishing this is that past, current or future funds allocated to a specific Covered Species may be reallocated where necessary to provide for the cost of implementing conservation measures for another Covered Species, and funding for any individual Covered Species is not limited to those amounts estimated in Appendix 6. KWP II, LLC also recognizes the cost of implementing habitat conservation measures in any one year may exceed that year’s total budget allocation, even if the overall expenditure for the conservation program stays within the total amount budgeted over the life of the project. Accomplishing these measures may, therefore, require funds from future years to be expended or likewise unspent funds from previous years to be carried forward for later use. For practical and commercial reasons, such reallocation of funds among years may require up to 18 months’ lead time to meet revenue and budgeting forecast requirements. However, if reallocation between species or budget years is not sufficient to provide the necessary conservation, KWP II, LLC will nonetheless be responsible for ensuring that the necessary conservation is provided. Funding re-allocation for one species to another will not impede the implementation of mitigation measures for either species.

Funding for the implementation of the HCP is provided by KWP II, LLC as an annual operating expense paid *pari passu* with other operating expenditures (operation and maintenance costs, insurance, payroll, lease payments to the State of Hawai‘i, audit costs, and agency fee costs) and, most importantly, ahead of both debt service to lenders and dividends to equity investors. A variety of measures assure that the project operates as a viable commercial entity, fully capable of meeting all HCP obligations for the life of the permit term. These include:

1. A 20-year PPA with MECO, with a set price structure. As a result, the Project will not be subject to unforeseen swings in energy markets. As long as the Project is operating it is assured to generate revenue within a predictable range.
2. Performance of the turbines (i.e., to generate revenue) is warranted by the manufacturer. Turbines must maintain a high level of availability (upwards of 97%) to comply with the warranty. The Project’s owners are thus protected from losses due to equipment non-performance, failure, etc.
3. The project’s financing requires that it meet all obligations, including HCP-related monitoring and mitigation. These costs are built into the project’s financial pro forma. Failure to fulfill permit obligations would constitute a material breach of financing terms and would trigger remedial steps. Failure to remedy could lead to default and loss of ownership.
4. Revenue would be generated and the HCP activities would be funded regardless of who the owner/operator is. In the unlikely event that KWP II, LLC defaulted, the lender would assume ownership and presumably seek to sell the project to a new owner. In order to operate the project, the lender or any new owner would be required to continue to fulfill the obligations under the HCP in order to be in compliance with the project’s Conservation District Use Permit (CDUP) from the Hawai‘i DLNR. Any new owner would not be able to operate the project unless they were in compliance with the CDUP, which in turns requires compliance with the HCP.
5. The CDUP for KWP II, issued by the Hawai‘i DLNR, requires an approved HCP for the Project to operate. Failure to comply with the permit would lead to a shut-down, and if the project is not brought into compliance, could in the worst instance lead to decommissioning.
6. If for any reason the project is no longer operational (or is shut down) then an agreement with the DLNR (the landowner) requires decommissioning, including removal of all structures and remediating/revegetating the site within 12 months. The decommissioning obligation for KWP II, LLC is secured with a LC of $1.4 million.

Additional assurance that adequate funding is available to support the proposed monitoring, mitigation measures and adaptive management necessary to achieve the results specified in this amendment, regardless of their actual costs, are provided by KWP II, LLC in the form of a bond, letter of credit (LOC) with a banking institution subject to regulation by the United States, or similar instrument naming the DLNR as beneficiary. The LOC is in an amount sufficient to cover the costs of the current Tier mitigation for all Covered Species (if not fully funded), annual compliance monitoring, adaptive management, and genetic bat sexing and was or will be secured prior to ITP/ITL issuance. Take will not be authorized for the next pending tier until funding assurances for the pending tier are in place. A financial accounting will be provided before the next Tier is reached to include the following: the amount of the LOC for the existing tier; mitigation already funded; and mitigation cost estimated for the new tier.

The LOC is available to fund mitigation in the unlikely event that there are unmet mitigation obligations due to a revenue shortfall, default, change of ownership, bankruptcy or any other cause. The LOC is automatically renewed prior to expiration, unless it is determined to no longer be necessary by the USFWS and the DLNR. As beneficiary, the DLNR has the ability to draw upon the LOC to fund any outstanding mitigation and compliance obligations of the Project.

The LOC presented for approval must contain the following provisions: it must be payable to the DLNR; the initial expiration date must not be less than one year from the effective date of the LOC and contain a provision for automatic renewal for periods of not less than one year unless the bank provides written notice of its election not to renew to the USFWS and the DLNR at least 90 days prior to the originally stated or extended expiration date of the LOC; it must contain provisions allowing collection by the DLNR for failure of the permittee to replace the letter of credit when 90-day notice is given by the bank that the LOC will not be renewed and the LOC is not replaced by another LOC approved by the USFWS and the DLNR at least 30 days before its expiration date; and the LOC shall be payable to the DLNR upon demand, in part or in full, upon notice stating the basis therefore (e.g., default in compliance with the permit or HCP or the failure to have a replacement for an expiring LOC).

As of June 2018, Tier 1 and 2 bat mitigation has been funded ($375,000) and Tier 3 bat mitigation is in the process of being funded and implemented. If this amendment is accepted, Tier 3 bat mitigation cost is estimated to be $950,000. Nēnē mitigation funded as of June 2018, is $162,750. An additional estimated $237,250 for Tier 1 take limits is yet to be funded. Seabird mitigation is ongoing and is estimated to cost KWP II, LLC $20,000 per year, or $280,000 for 14 more years. The total funding obligation for mitigation measures for the current tiers and not completely funded therefore is $1,467,250 (Table 7.1).

Contingency for third party compliance monitoring (in case KWP II, LLC is unable to fund compliance monitoring while still operating) is similar to the cost for ongoing compliance monitoring. Funding assurance is provided for one or the other but not both. DOFAW has indicated that to meet the requirement of HRS 195D-4 "to ensure monitoring of the species by the State", 5% of the current mitigation funding obligation for all species must be provided in the assurances in case the Project ceases operations before current mitigation obligations have been met. And 5% of the current mitigation obligation total of $1,467,250 is $146,725.

Contingency funding to account for inflation and possible adaptive management changes is also requested by the USFWS and is at least 10% of mitigation costs not yet funded. Current tier mitigation not yet funded equals $1,467,250 and 10% of this total is $146,725.

Therefore, the total funding assurance required at the time of this amendment is for the remaining Tier 1 nēnē mitigation, Tier 3 bat mitigation, Tier 1 seabird mitigation costs, the HRS 195D-4 monitoring assurance requirement and USFWS contingency for inflation and potential adaptive management changes amounts to $1,687,338 ($1,467,250 + $73,363 + $146,725).

KWP II, LLC funding assurance (LOC) of $1,000,000 was secured in a form approved by the USFWS and the DLNR within 30 days of KWP II permit issuance and is renewed annually. An additional LOC was secured in March 2014 for $554,590. In March 2018 these two LOCs were combined into one LOC for $1,554,590. Unless negotiated otherwise, $132,748 more funding assurances will be implemented before amended ITP/ITL issuance. As the projected mitigation funding indicated above is paid, funding assurances will be reduced in equal amount, at least annually.

Table 7.1. Monitoring and Mitigation Funding Assurances–*NEW*

Species	Mitigation Tier	Mitigation Obligation	Funded	Funding Assurance Required
Hawaiian hoary bat	1 and 2	$375,000	$375,000	$0
	3	$950,000	$0	$950,000
	4	$400,000[1]	$0	$0
Nēnē	1	$400,000	$162,750	$237,250
	2	$150,000[1]	$0	$0
	3	$300,000	$0	$0
Seabirds	1	No limit established	$348,000	$280,000
Expected Mitigation Funding Total				$1,467,250
Federal Contingency (10% expected total)				$146,725
State Monitoring Assurance (5% expected total)				$73,363
Total Funding Assurance Required (as of FY 2017)				**$1,687,338**
Funding Assurance Established				**$1,554,590**
Remaining Funding Assurance to Establish prior to Amended Permit (unless sufficient mitigation has been paid for to reduce the funding assurance)				**$132,748**

[1] Estimated cost. Actual cost will be determined and could be more or less than the estimates.

When KWP II, LLC reaches 75% of the take within a tier, funding assurances for additional tiers would be required for all covered species before the next tier of take is authorized. The effective date for the next tier of take authorization will be dependent on submission of proof of that tier's funding assurance in a form acceptable to the USFWS. Absent that proof, the USFWS may consider KWP II, LLC to be out of compliance and the permit subject to suspension or other enforcement action.

7.5 Changed Circumstances–*UPDATED*

The HCP process allows for acknowledgment of, and planning for, reasonably anticipated changes in circumstances affecting the subject species, other species occurring in the project area, or in efforts expended toward mitigation. Changed circumstances are *changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that can reasonably be anticipated by plan or agreement developers and the USFWS and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)* (50 CFR 17.3). Changed circumstances are not unforeseen circumstances, as described below.

Changed circumstances that may affect the implementation of the HCP include, but are not limited to, the following:

1. ***Listing of New Species or Delisting of a Covered Species***

   If a new species that occurs on the island of Maui is added to the federal or state endangered species list, KWP II, LLC will evaluate the likelihood of incidental take of the species due to Project operation. If incidental take appears possible, KWP II, LLC may seek coverage for the newly listed species under an amendment to the existing HCP and will avoid take of the newly listed species unless and until the permit is amended. KWP II, LLC may also reinitiate consultation with the USFWS and DOFAW to discuss whether mitigation measures in place provide a net benefit to the newly listed species or if additional measures may be recommended by the USFWS or DOFAW. Should any of the Covered Species become delisted over the permit term, KWP II, LLC will consult with the USFWS and DOFAW to determine if mitigation measures should be discontinued.

2. ***Designation of Critical Habitat***

   If the USFWS designates Critical Habitat, and such Critical Habitat may be adversely affected by the activities covered in the HCP, this will be considered a changed circumstance provided for in the plan. KWP II, LLC, in consultation with the USFWS, will implement adjustments in covered activities in the area of designated Critical Habitat to ensure that project activities are not likely to result in the destruction or adverse modification of the Critical Habitat. If necessary to avoid destruction or adverse modification of critical habitat, KWP II will make adjustments in activities until KWP II has an approved amendment. Such adjustments may also require amendment of the ITP, in accordance with then applicable statutory and regulatory requirements, or until the USFWS notifies KWP II, LLC that the adjustments are no longer necessary.

3. ***Catastrophic Events***

Hurricanes and severe storms periodically strike or affect the Hawaiian Islands, and the likelihood of a hurricane causing severe damage on Hawai'i during the term of the HCP is high enough to merit treatment as a changed circumstance. Such storms or fires could affect the activities covered by the HCP in several ways: cause significant damage to or destruction of project facilities; pose a threat to the Covered Species by causing injury or death either directly, or indirectly through the destruction of habitat; or alter the natural and built environment in areas surrounding project facilities in ways that increase or decrease the potential effects of project facilities on the Covered Species.

Construction of the facilities at KWP II is consistent with applicable codes and industry standards, which are intended to avoid significant damage in severe weather conditions. Should a hurricane, severe storm, or fire cause significant damage to Hawai'i during the term of the HCP, any resulting effects on the Covered Species will be considered based on the best available information at the time. The HCP mitigation efforts will be modified to respond to impacts to the covered species from a hurricane should the USFWS and DOFAW reasonably determine in consultation with KWP II, LLC that such a response is necessary.

4. Invasive Species

Introduced animal and plant species have had, and will continue to have, a detrimental effect on the Covered Species. The likelihood that the threat from this source will increase during the term of this HCP is sufficient to warrant treating this threat as a changed circumstance. The habitat enhancement and management measures to be implemented through this HCP could be compromised by new and/or increased populations of invasive species. Should these measures be compromised by invasive species during the term of this HCP, the HCP mitigation efforts will be modified should the USFWS and DOFAW reasonably determine after consultation with KWP II, LLC that such a response is necessary.

5. ***Disease Outbreaks Affecting Covered Species***

6. Should prevalence of disease increase substantially and become identified by the DLNR and the USFWS as a major threat to the survival of a covered species during the term of this HCP, this threat will be treated as a changed circumstance. The habitat enhancement and management measures to be implemented through this HCP could be compromised by new and/or prevalence of increased disease. Should these measures be compromised by disease during the term of the HCP, the HCP mitigation efforts will be modified should the USFWS and the DLNR reasonably determine after consultation with KWP II, LLC that such a response is necessary.

6. ***Changes in Known Risks to or Distribution of Currently Listed Species***

New research could alter the understanding of the potential impacts to species listed at the time this HCP was prepared. The likelihood that our understanding of risks to species and/or the distribution of their populations would change in a manner that would alter the assessment made in preparing this HCP is sufficient to warrant treating this possibility as a changed circumstance. If, as a result of new information, incidental take of a non-Covered state or federally listed species appears possible, or if an increase in take of Covered Species is reasonably anticipated, KWP II, LLC would seek coverage under an amendment to the existing HCP and avoid nonauthorized take until the permit is amended. As part of that process, KWP II, LLC may discuss with the USFWS and DOFAW whether mitigation measures in place meet permit issuance criteria for the non-Covered Species or if additional measures are warranted.

7. ***Development of an Effective, Economical, and Commercially Viable Bat Deterrent***

Preliminary research indicates that technologies may be developed during the Project permit term that could deter the Hawaiian hoary bat from flying into the airspace near the WTG rotors (Szewczak and Arnett 2007, Arnett *et al.* 2013). Such a development could be used independently or in coordination with low wind speed curtailment to further reduce the risk of Hawaiian hoary bat fatalities. If an effective, economical, and commercially-viable bat deterrent technology becomes available during the Project's permit term, KWP II, LLC will consult with the USFWS and DOFAW to determine if implementation of the technology is appropriate and, if implemented, how to measure the effectiveness of the measure.

8. Global Climate Change Alters Status of the Covered Species

Global climate change within the life of the ITP /ITL (20 years) conceptually has the potential to affect covered species through region-wide changes in weather patterns, sea level, average temperature, and levels of precipitation affecting the species or their habitats (Intergovernmental Panel on Climate 2007). Covered species may be affected through changes in temperature, precipitation, the distribution of their food resources, and possible changes in the vegetation at their preferred habitats.

As an expected result of global climate change, hurricanes or storms may occur with greater intensity (Webster *et al.* 2005; U.S. Climate Change Science Program 2009), which may increase the risk of damage to established mitigation sites. Sea level is predicted to rise approximately 1 m in Hawai'i by the end of the twenty-first century (Fletcher 2009). Given this prediction, any rise in sea level experienced during the life of the Project likely will be less than 3 feet (1 m).

Precipitation may decline by 5%–10 % in the wet season and increase 5% in the dry season, due to climate change (Giambelluca *et al.* 2009). This may result in altered hydrology at mitigation sites. Vegetation may change with decreased precipitation or increased temperatures and threat of fire. Other mitigation sites may be considered for continued mitigation if selected sites are considered no longer suitable and will be changed should USFWS and DLNR reasonably determine after consultation with KWP II, LLC that such a response is necessary. Other adjustments to the HCP will be made due to climate change effects that adversely affect covered species if the USFWS and the DLNR reasonably determine after consultation with KWP II, LLC that such a response is necessary.

9. Adaptive management

The U.S. Department of the Interior defines adaptive management as a structured approach to decision making in the face of uncertainty that makes use of the experience of management and the results of research in an embedded feedback loop of monitoring, evaluation, and adjustments in management strategies (Williams and Brown, 2009; Williams *et al.* 2009). Uncertainties may include a lack of biological information for the Covered Species, a lack of knowledge about the effectiveness of mitigation or management techniques, or doubt about the anticipated effects of the Project. Adaptive management is a required component of HCPs that allows for the incorporation of new information into conservation and mitigation measures during HCP implementation. Effective implementation of this approach requires explicit and measurable objectives, and identifies what actions are to be taken and when they are to occur. Adaptive management measures do not trigger the need for an amendment unless they would increase amount of incidental take or effects to the covered species through a reduction in mitigation.

10. Increased abundance of predators at the seabird mitigation site.

> If an increase in predator occurrence is observed or becomes unmanageable during the implementation of mitigation for seabirds at Makamakaʻole and/or any other seabird study areas supported by KWP II mitigation, or if such changes affect monitoring or the success of mitigation, then the Applicant will consult with the DLNR and the USFWS, and the USFWS and the DLNR will reasonably determine if measures to prevent further ingress of predators are necessary. KWP II, LLC will implement such measures to meet mitigation obligations. Such measures may include more aggressive removal of predators and/or modification of mitigation actions. If the USFWS and the DLNR determine that no such measures are available, mitigation measures for seabirds will be implemented at another site as determined by the DLNR and the USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by the DLNR and the USFWS will be implemented by KWP II, LLC.

The Applicant will report such changes as they occur and the DLNR and the USFWS would work with the Applicant as soon as possible to discuss any necessary changes in the implementation of the HCP. The Applicant will implement changes determined to be necessary by the USFWS and the DLNR as soon as possible and will assist DLNR and USFWS in any related response or remediation efforts. Such changes are, therefore, provided for in this HCP and do not constitute unforeseen circumstances or require the amending of the ITP or ITL.

The Applicant will implement additional conservation and mitigation measures deemed necessary to respond to changed circumstances as provided for and specified in the HCP's adaptive management strategy (50 CFR 17.22(b)(5) and 50 CFR 17.32(b)(5).

7.6 Unforeseen Circumstances and "No Surprises" Policy–*UPDATED*

Unforeseen circumstances are changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that could not reasonably have been anticipated by the plan or agreement developers and the USFWS at the time of the conservation plan's or agreement's negotiation and development, and that result in a substantial and adverse change in the status of the Covered Species (50 CFR 17.2).

It is further acknowledged that circumstances may arise that are not fully contemplated by this HCP and that may result in substantial or adverse impacts to the biological status of any of the four subject species or their habitat. Such impacts may or may not be a result of the operation of the proposed facility. If and when the Applicant, the USFWS, or the DLNR become aware of any circumstances that may affect any listed species and/or the ability of the Applicant to implement this HCP, all involved entities will be immediately notified and meet as soon as possible to discuss the circumstances and identify appropriate action.

In negotiating unforeseen circumstances, the USFWS will not require the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water or other natural resources beyond the level otherwise agreed upon for the species covered by the HCP without the consent of the Applicant [50 CFR 17.22(b)(5)(iii) and 50 CFR 17.32(b)(5)(iii)]. If additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances, and the HCP is being properly implemented, the USFWS may require additional measures of the Applicant only if such measures are limited to modifications within conserved habitat areas, if any, or to the HCP's operating conservation program for the affected species, and maintain the original terms of the HCP to the maximum extent possible.

A "No Surprises" policy provides that, in negotiating "unforeseen circumstances" provisions for HCPs, the USFWS and the DLNR shall not require the commitment of additional land or financial compensation beyond the level of mitigation that was otherwise adequately provided for the four listed species under the proper implementation of this HCP. Additionally, the USFWS and the DLNR will not seek, nor will the Applicant be required to provide, any other mitigation beyond that provided for in the mitigation and minimization program, adaptive management program, or changed circumstances section (Section 7.5) of this HCP. Any other changes will be limited to measures that can be accomplished within the parameters of the existing wind energy generation facility and its operation and as agreed upon by the Applicant. Additional conservation and mitigation measures will not involve the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water or other natural resources otherwise available for development or use under the original terms of the HCP without the consent of the Applicant.

The "No Surprises" policy also provides that "if additional mitigation measures are subsequently deemed necessary to provide for the conservation of a species that was otherwise adequately covered under the terms of a properly functioning HCP, the obligation for such measures shall not rest with the HCP Permittee." Specific to this HCP, the permittee will not have to mitigate for any increased take of nēnē (either assessed as direct take or indirect take) due to population or habitat enhancement measures (see Sections 6.4.2.2 and 6.4.3.2 of the original HCP) that may be conducted in the vicinity of the project as part of their mitigation requirements.

The USFWS and the DLNR will have the burden of demonstrating that unforeseen circumstances exist, using the best scientific and commercial data available. These findings must be clearly documented and based upon reliable technical information regarding the status and habitat requirements of the affected species. The USFWS and the DLNR will notify the Applicant in writing should the USFWS or the DLNR believe that any unforeseen circumstance has arisen.

7.7 Permit Duration and Amendments–*NO CHANGE*

The Applicant proposes to have a HCP in effect for the duration of the wind energy generation facility's operation, which is anticipated to be 20 years.

7.7.1 Minor Amendments

Informal, minor amendments are permissible without a formal amendment process provided that the change(s) necessitating such amendment(s) does not cause an adverse effect on any of the four Covered Species that is significantly different from the effects considered in the original HCP. Such informal amendments could include, but are not necessarily limited to, routine administrative revisions, changes to surveying or monitoring protocols that do not decrease the level of mitigation or increase take. A request for a minor amendment to the HCP may be made with written notice to USFWS and DLNR. The amendment will be implemented upon receiving written concurrence from both the agencies.

7.7.2 Formal Amendments

Formal amendments are required if the change(s) necessitating such amendment(s) could produce an adverse effect on any of the four Covered Species that is significantly different than any of those considered in the original HCP. For example, a formal amendment would be required if the documented level of take exceeds that covered by the HCP's adaptive management program.

A formal amendment also would be required if another listed species is found to occur in the project area and could be adversely affected by project activities. This HCP may be formally amended upon written notification to the USFWS and the DLNR with the same supporting information that was provided with the original application. The need for a formal amendment should be determined at least one year before permit expiration, as a formal amendment may require additional baseline surveys and data collection, additional or modified minimization and/or mitigation measures, and/or additional or modified monitoring protocols, a supplemental NEPA evaluation, and additional public review.

7.7.3 Renewal or Extension

This HCP can be renewed or extended, and amended if necessary, beyond its initial 20-year term with the approval of the USFWS and the DLNR. The process for seeking renewal of the Federal permit shall be governed by the regulations in effect at the time (currently codified at 50 CFR & 13.22). The following addresses the process to seek renewal of the state permit. The Applicant will submit a written request to both agencies, will either certify that the original information and conditions are still correct or provide a description of relevant changes, and will provide specific information concerning the level of take that has occurred under the HCP's implementation. Such a request shall be made at least 180 days prior to the conclusion of the permit term. Under State of Hawai'i law, the HCP will remain valid and in effect during processing only if the renewal or extension is processed during the original permit term. The permit may not be renewed for levels of take beyond those authorized by the original permit.

7.7.4 Other Measures

Issuance criteria under ESA Section 10(a)(2)(B) authorize the USFWS to obtain such other assurances as may be required that the HCP will be implemented.

8.0 CONCLUSION–*UPDATED*

KWP II, LLC looks forward to working with the USFWS and the DLNR throughout the approval and long-term implementation of the HCP amendment for the KWP II project. While commercial wind energy generation facilities are acknowledged to be environmentally friendly endeavors, they are not without potential negative environmental impacts. The Applicant is committed to making all reasonable and appropriate efforts to avoid, minimize and compensate for these impacts as evaluated and determined through the HCP process and its adaptive management strategy.

9.0 REFERENCES CITED–*UPDATED*

Adams, Josh. 2008. Petrels in the Pacific: Tracking the Far-ranging Movements of Endangered ʻUaʻu (Hawaiian Petrel), U.S. Geological Survey, Western Ecological Research Center. Available at: www.microwavetelemetry.com/newsletters/spring_2007Page4.pdf.

American Ornithologists' Union. 1998. *Check-list of North American Birds*. 7th ed. American Ornithologists' Union, Washington, D.C.

Ainley, D.G., L. DeForest, N. Nur, R. Podolsky, G. Spencer, and T.C. Telfer. 1995. Status of the threatened Newell's Shearwater on Kauaʻi: Will the population soon be endangered?

Ainley, D.G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 2001. The status and population trends of the Newell's shearwater on Kauaʻi: Insights from modeling. *Studies in Avian Biology* 22:108–123.

Ainley, D.G., T.C. Telfer, and M.H. Reynolds. 1997. Townsend's and Newell's Shearwater (*Puffinus auricularis*). In *The Birds of North America*, No. 297, edited by A. Poole and F. Gill. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Arnett, E.B., ed. 2005. *Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines*. Final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas. Available at: http://www.batcon.org/windliterature.

Arnett, E.B., W.K. Brown, W.P. Erickson, J.K. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Koford, C.P. Nicholson, T.J. O'Connell, M.D. Piorkowski, and R.D. Tankersley, Jr. 2008. Patterns of Bat Fatalities at Wind Energy Facilities in North America. *Journal of Wildlife Management* 72(1):61–78.

Arnett, E.B., C.D. Hein, M.R. Schirmacher, M M.P. Huso, and J.M. Szewczak. 2013. Evaluating the effectiveness of an ultrasonic acoustic deterrent for reducing bat fatalities at wind turbines. *PLoS ONE* 8(6):e65794. Doi:10.1371/journal.pone.0065794.

Arnett, E.B., M.M.P. Huso, M.R. Schirmacher, and J.P. Hayes. 2010. Changing wind turbine cut-in speed reduces bat fatalities at wind facilities. *Frontiers in Ecology and the Environment* 9(4):209–214. Doi:10.1890/100103.

Arnett E.B., G.D. Johnson, W.P Erickson, and C.D. Hein. 2013. *A Synthesis of Operational Mitigation Studies to Reduce Bat Fatalities at Wind Energy Facilities in North America*. Report submitted to the National Renewable Energy Laboratory. Bat Conservation International. Austin, Texas.

Arnett, E.B., M. Schirmacher, M.M.P. Huso, and J. Hayes. 2009. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. Annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas.

Auwahi Wind Energy, LLC. 2014. *Auwahi Wind Farm Habitat Conservation Plan FY2014 Annual Report*. Kula, Hawaiʻi.

———. 2015. *Auwahi Wind Farm Habitat Conservation Plan FY2015 Annual Report*. Kula, Hawaiʻi.

———. 2016. *Auwahi Wind Farm Habitat Conservation Plan FY2016 Annual Report*. Kula, Hawaiʻi.

———. 2017. *Auwahi Wind Farm Habitat Conservation Plan FY2017 Annual Report*. Kula, Hawaiʻi.

Avian Power Line Interaction Committee (APLIC). 1994. *Mitigating Bird Collisions with Power Lines: The State of the Art in 1994*. Edison Electric Institute. Washington, D.C.

———. 2006. *Suggested Practices for Avian Protection On Power Lines: The State of the Art in 2006*. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, California.

Baerwald, E.F., and R.M.R. Barclay. 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. *Journal of Mammalogy* 90(6):1341–1349.

Baerwald, E.F., G.H. D'Amours, B.J. Klug, and R.M.R. Barclay. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology* 18(16):695–696.

Baker, P. E., and H. Baker. 1996. Nēnē report: Egg and gosling mortality in Haleakala National Park, 1994-95. Final report submitted to Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu.

Baker, H., and P.E. Baker. 1999. Nēnē Gosling Mortality in Haleakalā National Park, Maui, 1995/96 Breeding Season. Unpublished report submitted to Hawaiʽi Department of Land and Natural Resources, Division of Forestry and Wildlife.

Baldwin, P.H. 1950. Occurrence and behavior of the Hawaiian bat. *Journal of Mammalogy* 31:455–456.

Banko, P.C. 1988. Breeding biology and conservation of the Nēnē, Hawaiian goose (*Nesochen sandvicensis*). Ph.D. dissertation, University of Washington, Seattle.

———. 1992. Constraints on productivity of wild Nēnē or Hawaiian Geese *Branta sandvicensis*. *Wildfowl* 43:99–106.

Banko, P.C., J.M. Black, and W.E. Banko. 1999. Hawaiian Goose (Nēnē) (*Branta sandvicensis*). In *The Birds of North America*, No. 434, edited by A. Poole and F. Gill. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Banko, P., R. Peck, S.G. Yelenik, E. Paxton, F. Bonaccorso, K. Montoya-Aiona, and D. Foote. 2015. Dynamics and Ecological Consequences of the 2013-2014 Koa Moth Outbreak at Hakalau Forest National Wildlife Refuge. Hawaiʽi Cooperative Studies Unit Technical Report HCSU-058.

Bat Conservation International and the National Renewable Energy Laboratory. 2013. Acoustic Deterrent Workshop, National Wind Technology Center, Louisville, Colorado. August 23, 2013.

Bell, M., B. D. Bell, and E. A. Bell. 2005. Translocation of fluttering shearwater (*Puffinus gavia*) chicks to create a new colony. *Notornis* 52:11–15.

Bellwood, J.J., and J.H. Fullard. 1984. Echolocation and foraging behavior in the Hawaiian hoary bat, *Lasiurus cinereus semotus*. *Canadian Journal of Zoology* 62:2113–2120.

Black, J.M., and P.C. Banko. 1994. Is the Hawaiian goose (*Branta sandvicensis*) saved from extinction? In *Creative Conservation: Interactive Management of Wild and Captive Animals*, edited by P.J.S. Olney, G.M. Mace, and A.T.C. Feistner. pp. 394–410. London: Chapman and Hall.

Bolton, M., R. Medeiros, *et al.* 2004. The use of artificial breeding chambers as a conservation measure for cavity-nesting procellariiform seabirds: A case study of the Madeiran storm petrel (*Oceanodroma castro*). *Biological Conservation* 116: 73–80.

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

Bonaccorso, F.J. 2011. Opeʽapeʽa – Solving the puzzles of Hawaii's only bat. *Bats* 28(4):10–12.

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.

Bradley, J.S., R.D. Wooller, I.J. Skira, and D.L. Serventy. 1989. Age-dependent survival of breeding short-tailed shearwaters *Puffinus tenuirostris*. *Journal of Animal Ecology* 58:175–188.

Byrd, G. V., D. I. Moriarity, *et al.* 1983. Breeding biology of the wedge-tailed shearwater at Kilauea Point, Hawaii. *The Condor* 85: 292–296.

Cooper, B.A., and R.H. Day. 1998. Summer behavior and mortality of Dark-rumped Petrels and Newell's Shearwaters at power lines on Kauaʽi. *Colonial Waterbirds* 21:11–19.

———. 2003. Movement of Hawaiian petrels to inland breeding sites on Maui Island, Hawaiʽi.

Waterbirds 26:62–71.

———. 2004. *Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Wind Energy Facility on Maui Island, Hawaiʽi, Fall 2004*. Prepared for Kaheawa Wind Power, LLC, Makawao, Hawaiʽi, and UPC Wind Management, LLC, Newton, Massachusetts. ABR, Inc., Forest Grove, Oregon, and Fairbanks, Alaska.

———. 2009. *Radar and Visual Studies of Seabirds at the Proposed KWP II Down-Road Alternative Wind Energy Facility, Maui Island, Hawaii, Summer 2009*. Prepared for First Wind.

Cryan, P.M. 2008. Mating behavior as a possible cause of bat fatalities at wind turbines. *Journal of Wildlife Management* 72(3):845–849.

———. 2011. Wind turbines as landscape impediments to the migratory connectivity of bats. *Environmental Law* 41:355–370.

Cryan, P.M., and A.C. Brown. 2007. Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. *Biological Conservation* 129(1–2):1–11.

Cryan, P.M., P.M. Gorresen, C.D. Hein, M.R. Schirmacher, R.H. Diehl, M.M. Huso, D.T.S.

Hayman, P.D. Fricker, F.J. Bonaccorso, D.H. Johnson, K. Heist, and D.C. Dalton. 2014.

Behavior of bats at wind turbines. *Proceedings of the National Academy of Sciences* 111(42):15126–15131.

Dalthorp, D., M.M.P. Huso, and D. Dail. 2017. *Evidence of Absence (v2.0) Software User Guide*. Data Series 1055. U.S. Geological Survey. Available at: https://doi.org/10.3133/ds1055.

Dalthorp, D. H., M.M.P. Huso, D. Dail, and J. Kenyon. 2014. Evidence of Absence, Version 2.0 (software). Corvallis, Oregon: U.S. Geological Survey. Available at: http://pubs.usgs.gov/ds/0881/.

Day, R.H., and B.A. Cooper. 1995. Patterns of movement of dark-rumped petrels and Newell's shearwaters on Kauaʽi. *The Condor* 97:1011–1027.

———. 1999. *Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Windfarm on Maui Island, Hawaiʽi, Summer 1999*. Prepared for Zond Pacific, Wailuku, Hawaiʽi. ABR, Inc., Forest Grove, Oregon, and Fairbanks, Alaska.

———. 2001. Results of Petrel and Shearwater Surveys on Kauaʽi, June 2001. Unpublished report prepared for U.S. Fish and Wildlife Service, Honolulu, Hawaiʽi. ABR, Inc., Forest Grove, Oregon, and Fairbanks, Alaska.

———. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June, 2002. Final report submitted to National Park Service, Hawaiʽi National Park. ABR, Inc., Fairbanks, Alaska.

———. 2008. *Interim Report: Oahu Radar & Audiovisual studies, Fall 2007 and Summer 2008*.

ABR, Inc. Environmental Research and Services.

Day, R.H., B.A. Cooper, and T.C. Telfer. 2003. Decline of Townsend's (Newell's) shearwaters (*Puffinus auricularis newelli*) on Kauaʽi, Hawaiʽi. *The Auk* 120:669–679.

del Hoyo, J., A. Elliott, and J. Sargatal. 1992. Ostrich to ducks. In *The Handbook of the Birds of the World* Vol. I. Barcelona, Spain: Lynx Editions.

Department of Land and Natural Resources (DLNR). 2007. Proposed hazard reduction and reforestation operations, in the aftermath of the Upper Waiohuli wildfire. January 23- February 5, 2007, Kula Forest Reserve.

Division of Forestry and Wildlife (DOFAW). 2000. Survey of the nēnē population on Maui. *ʽElepaio* 60:25–28.

———. 2009. Annual report. Pittman-Robertson Non-Game Management Grant. Nēnē Surveys.

———. 2015. *Hawaiian Hoary Bat Guidance Document 2015*. State of Hawaiʽi Department of Land and Natural Resources, Division of Forestry and Wildlife. December 17.

Draft Habitat Conservation Plan or the Construction of the Advanced Technology Solar Telescope at the Haleakalā High Altitude Observatory Site Maui, Hawaii, 2010. Available at: http://hawaii.gov/dlnr/dofaw/pubs/DRAFT_HCP_ATST_OEQC.pdf.

Ebbert, S.E., and G.V. Byrd. 2002. Eradications of invasive species to restore natural biological diversity on Alaska Maritime National Wildlife Refuge. In *Turning the Tide: The Eradication of Invasive Species*, edited by C. Veitch and M. Clout, pp. 102–109. IUCN SSC Invasive Species Specialist Group. IUCN, Gland, Switzerland, and Cambridge, United Kingdom.

Erickson, W.P. 2003. Updated information regarding bird and bat mortality and risk at new generation wind projects in the West and Midwest. National Wind Coordinating Committee, Wildlife Workgroup Meeting, November 18. Resolve, Inc., Washington, D.C. Available at: http://www.nationalwind. org/events/wildlife/2003 -2/presentations/erickson.pdf.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young, Jr., K.J. Sernka, and R.E. Good. 2001.

Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States. Prepared for the National Wind Coordinating Committee. Cheyenne, Wyoming: WEST, Inc.

Erickson, W.P., M.D. Strickland, G.D. Johnson, and J.W. Kern. 1998. Examples of statistical methods to assess risks of impacts to birds from wind plants. In *PNAWPPM-III: Proceedings of the Avian-Wind Power Planning Meeting III, San Diego, CA.* National Wind Coordinating Committee Meeting, Washington, D.C., May. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by LGL, Ltd., King City, Ontario.

Fiedler, J.K., T.H. Henry, C.P. Nicholson, and R.D. Tankersley. 2007. *Results of Bat and Bird Mortality Monitoring at the Expanded Buffalo Mountain Windfarm, 2005*. Available at: http://www.batcon.org/windliterature.

Fletcher C.H. 2009. Current Understanding of Global Sea-level Rise and Impacts in Hawaiʽi. Available at: http://www.soest.hawaii.edu/coasts/sealevel/FletcherSeaLevel09_web.pps.

Follett P.A., P.A. Anderson-Wond, M.T. Johnson, and V.P. Jones. 2003. Revegetation in dead *Dicranopteris* (Gleicheniaceae) fern patches associated with Hawaiian rain forests. *Pacific Science* 57(4):347–357.

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. *Soil Survey of the Islands of Kauaʽi, Oʽahu, Maui, Molokaʽi, and Lanaʽi, State of Hawaiʽi*. U.S. Department of Agriculture, Soil Conservation Service.

Fretz, S. 2018. *Interim Report on Assignment to Review the Hawaiian Hoary Bat Guidance Document. Memorandum.* May 31. Available at: https://dlnr.hawaii.gov/wildlife/files/2018/07/Bat-Task-Force-Interim-Report_053118.pdf. Accessed June 4, 2019.

Frick, W.F., E.F. Baerwald, J.F. Pollock, R.M.R. Barclay, J.A. Szymanski, T.J. Weller, A.L. Russell, S.C. Loeb, R.A. Medellin, and L.P. McGuire. 2017. Fatalities at wind turbines may threaten population viability of a migratory bat. *Biological Conservation*. 209:172–177.

Fullard, J.H. 2001. Auditory sensitivity of Hawaiian moths (Lepidoptera: Noctuidae) and selective predation by the Hawaiian hoary bat (Chiroptera: *Lasiurus cinereus semotus*). *Proceedings of the Royal Society of London B.* 268:1375–1380.

Gangloff, B., Raust, P., Thibault, J, and Bretagnolle, V. 2009. Notes on the Phoenix petrel (*Pterodroma alba*) from Hatuta'a Island, Marquesas. *Waterbirds* 32(3):453–458.

Gehring, J., and P. Kerlinger. 2007. *Avian Collisions at Communication Towers: II. The Role of Federal Aviation Administration Obstruction Lighting Systems*. Prepared for State of Michigan.

Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013. Online rainfall atlas of Hawaii. *Bulletin of the American Meteorological Society* 94:313–316. Doi: 10.1175/BAMS-D-11-00228.1.

Giambelluca, T., H. Diaz , and O. Timm. 2009. Climate Variability and Change in Hawai'i. Abstract. In *Hawai'i Conservation Conference 2009 Hawai'i in a Changing Climate: Ecological, Cultural, Economic and Policy Challenges and Solutions*.

Good, R.E., W. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay, and C. Fritchman. 2011. Bat monitoring studies at the Fowler Ridge Wind Energy Facility, Benton County, Indiana. Prepared for Fowler Ridge Wind Farm. Cheyenne, Wyoming: WEST, Inc.

Gorresen, M.P., F.J. Bonaccorso, C.A. Pinzari, C.M. Todd, K. Montoya-Aiona, and K. Brinck. 2013. *A Five Year Study of Hawaiian Hoary Bat (Lasiurus cinereus semotus) Occupancy on the Island of Hawaii*. Hawai'i Cooperative Studies Unit Technical Report HCSU-041.

Gorresen, M.P., A.C. Miles, C.M. Todd, F.J. Bonaccorso, and T.J. Weller. 2008. Assessing bat detectability and occupancy with multiple automated echolocation detectors. *Journal of Mammalogy* 89(1):11–17.

Griesemer A.M., and N.D. Holmes. 2010. Newell's shearwater population modeling for HCP and recovery planning – Draft. University of Hawai'i and State of Hawai'i.

Gummer, H. 2003. *Chick Translocation as a Method of Establishing New Surface-Nesting Seabird Colonies: A Review*. New Zealand Department of Conservation.

Haines, W. P., M.L. Heddle, P. Welton, and D. Rubinoff. 2009. A recent outbreak of the Hawaiian koa moth, *Scotorythra paludicola* (Lepidoptera: Geometridae), and a review of outbreaks between 1892 and 2003. *Pacific Science* 63:349–369.

Harrison, C. 1990. *Seabirds of Hawaii*: *Natural History and Conservation*. Ithaca, New York: Cornell University Press.

Hayes, G., and G. J. Wiles. 2013. *Draft Washington Bat Conservation Plan*. Olympia, Washington: Washington Department of Fish and Wildlife.

Hays, W.S.T., and S. Conant. 2007. Biology and Impacts of Pacific Island Invasive Species. 1. A Worldwide Review of Effects of the Small Indian Mongoose, *Herpestes javanicus* (Carnivora: Herpestidae). *Pacific Science* 61(1):3–16.

Hayssen, V., A. van Tienhoven, and A. van Tienhoven. 1993. *Asdell's Patterns of Mammalian Reproduction: A Compendium of Species-Specific Data*. Ithaca, New York: Cornell University Press.

Hobdy, R.W. 2004a. *Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Primary Route*. Prepared for Kaheawa Wind Power, LLC.

———. 2004b. *Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Alternate Route Section*. Prepared for Kaheawa Wind Power, LLC.

———. 2006a. *Botanical Resources Survey*. *Kaheawa Pastures Wind Energy Project II, Ukumehame, Maui, Hawai'i*. Prepared for Kaheawa Wind Power, LLC.

———. 2006b. *UPC Kaheawa Wind Power Botanical Resources Assessment in the Turbine Fatality Search Plots, Kaheawa, Hana'ula, West Maui*. Prepared for Kaheawa Wind Power, LLC.

———. 2009a. *Botanical Resources Survey for the Kaheawa Wind Energy Project, Ukumehame, Maui, Hawaii*.

———. 2009b. *Post-Fire Botanical Survey and Assessment*. Kaheawa Wind Power II, Ukumehame, Maui, Hawai'i. Prepared for Kaheawa Wind Power II LLC. January 2009.

———. 2010. *Biological Resources Survey, Kaheawa Wind Energy Project 2 (KWP 2), Kaheawa, Maui, Hawaii*. Prepared for First Wind Energy, LLC.

Hodges, C.S. 1994. Effects of introduced predators on the survival and fledging success of the endangered Hawaiian dark-rumped petrel (*Pterodroma phaeopygia sandwichensis*). M.S. thesis, University of Washington, Seattle.

Hodges, C.S.N., and R.J. Nagata. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. *Studies in Avian Biology* 22:308–318.

Horn, J.W., E.B. Arnett, and T.H. Kunz. 2008. Behavioral responses of bats to operating wind turbines. *Journal of Wildlife Management* 72(1):123–132.

Hoshide, H.M., A.J. Price, and L. Katahira. 1990. A progress report on Nēnē *Branta sandvicensis* in Hawai'i Volcanoes National Park from 1974-89. *Wildfowl* 41:152–155.

Hu, D.E. 1998. Causes of endangerment and extinction in Hawaiian birds. Ph.D. dissertation, University of California, Davis.

Hu, D., C. Glidden, J.S. Lippert, L. Schnell, J.S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian dark-rumped petrels on Mauna Loa, Hawai'i. In *Evolution, Ecology, Conservation, and Management of Hawaiian Birds: A Vanishing Avifauna*, edited by J.M. Scott, S. Conant, and C. van Riper III, pp. 234–242.

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

Huso, M.M.P. 2008. Statistical properties of fatality estimators. Paper presented at NWCC Research Meeting, Milwaukee, Wisconsin. November.

———. 2011. An estimator of wildlife fatality from observed carcasses. *Environmetrics* 22:318–329.

Huso, M.M.P., and D. H. Dalthorp. 2014. Accounting for unsearched areas in estimating wind turbine-caused fatality. *Journal of Wildlife Management* 78:347–358.

Huso, M.M.P., N. Som, and L. Ladd. 2012. *Fatality Estimator User's Guide*. U.S. Geological Survey Data Series 729.

Huso, Manuela M.P., D.H. Dalthorp, D.A. Dail, and L.J. Madsen. 2015. Estimating wind-turbine caused bird and bat fatality when zero carcasses are observed. *Ecological Applications* 25(5):1213–1225. Available at: http://dx.doi.org/10.1890/14-0764.1.

Intergovernmental Panel on Climate Change (IPCC). 2007. Summary for policymakers. In *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller. Cambridge, United Kingdom, and New York, New York: Cambridge University Press.

Jacobs, D.S. 2004. Distribution and abundance of the endangered Hawaiian hoary bat, *Lasiurus cinereus semotus*, on the Island of Hawai'i. *Pacific Science* 48(2):193–200.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. *Annual Report for the Maple Ridge Wind Power Project Post-Construction Bird and Bat Fatality Study–2006*. Prepared for PPM Energy and Horizon Energy, Curry and Kerlinger LLC, Cape May Point, New Jersey. Available at: http://www.batcon.org/windliterature.

Johnson, G.D. 2005. A review of bat mortality at wind-energy developments in the United States. *Bat Research News* 46:45–49.

Johnson, G.D., W.P. Erickson, and M.D Strickland. 2003a. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. *American Midland Naturalist* 150(2):332–342.

———. 2003b. What is Known and Not Known About Bat Collision Mortality at Wind plants? In *Proc. Workshop on Avian Interactions at Wind Turbines*, edited by R.L. Carlton. October 16–17, 2002, Jackson Hole, WY. Electric Power Research Inst., Palo Alto, CA.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, and D.A. Shepherd. 2000. *Final Report, Avian Monitoring Studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-Year Study*. Prepared for Northern States Power Company, Minneapolis, Minnesota. Cheyenne, Wyoming: WEST Inc.

Joyce, T., B. Zaun, D. Kuhn, and N. Holmes. 2008. A seabird social attraction project at Kilauea Point National Wildlife Refuge. Abstract from the 16th Hawaii Conservation Conference, 2008. Available at: http://hawaii.conference-services.net/resources/337/1232/pdf/HCC16_0225.pdf.

Kaheawa Wind Power, LLC. 2004. *Kaheawa Pastures Wind Energy Generation Facility Final Environmental Assessment*. Prepared by Kaheawa Wind Power LLC, Makawao, Hawai'i.

———. 2006. *Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan*.

Ukumehame, Maui, Hawai'i.

———. 2007a. *Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan 2006 Annual Report*, Part 1.

———. 2007b. *Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan 2006 Annual Report*, Part 2.

———. 2008a. *KWP I and KWP II Acoustic Monitoring of Bat Activity*. Unpublished report.

———. 2008b. *Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 1 Annual Report (Part II)*. First Wind Energy, LLC, Environmental Affairs, Newton, Massachusetts.

———. 2008c. *Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 2 Annual Report*. First Wind Energy, LLC, Environmental Affairs, Newton, Massachusetts.

———. 2009. *Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Year 3 Annual Report*. First Wind Energy, LLC, Environmental Affairs, Newton, Massachusetts.

———. 2010. *Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Year 4 Annual Report*. First Wind Energy, LLC, Environmental Affairs, Newton, Massachusetts.

———. 2011. *Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 5 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai'i.

———. 2012. *Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 6 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai'i.

———. 2014. *Habitat Conservation Plan: Fiscal Year 2014 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai'i.

———. 2015. *Habitat Conservation Plan: Fiscal Year 2015 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai'i.

———. 2016. *Habitat Conservation Plan: Fiscal Year 2016 Annual Report*. SunEdison, LLC, Wailuku, Hawai‘i.

———. 2017. *Habitat Conservation Plan: Fiscal Year 2017 Annual Report*. TerraForm Power, LLC, Wailuku, Hawai‘i.

———. 2018. *Habitat Conservation Plan: Fiscal Year 2018 Annual Report*. TerraForm Power, LLC, Wailuku, Hawai‘i.

Kaheawa Wind Power I and II, LLC. 2013. *Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 1 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai‘i.

Kaheawa Wind Power II, LLC (KWP II, LLC). 2011. *Kaheawa Wind Power II Wind Generation Facility Habitat Conservation Plan*. Ukumehame, Maui, Hawai‘i.

———. 2014. *Habitat Conservation Plan: Fiscal Year 2014 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai‘i.

———. 2015. *Habitat Conservation Plan: Fiscal Year 2015 Annual Report*. First Wind Energy, LLC, Wailuku, Hawai‘i.

———. 2016. *Habitat Conservation Plan: Fiscal Year 2016 Annual Report*. SunEdison, LLC, Wailuku, Hawai‘i.

———. 2017. *Habitat Conservation Plan: Fiscal Year 2017 Annual Report*. TerraForm Power, LLC, Wailuku, Hawai‘i.

———. 2018. *Habitat Conservation Plan: Fiscal Year 2018 Annual Report*. TerraForm Power, LLC, Wailuku, Hawai‘i.

Kahuku Wind Power. 2012. *Habitat Conservation Plan: Fiscal Year 2012 Annual Report*. FirstWind Energy, LLC, Kahuku, Hawai‘i.

-------. 2016. *Habitat Conservation Plan: Fiscal Year 2016 Annual Report*. SunEdison, LLC, Kahuku, Hawai‘i.

------. 2017. *Habitat Conservation Plan: Fiscal Year 2017 Annual Report*. TerraForm Power, LLC, Kahuku, Hawai‘i.

Kawailoa Wind Power LLC. 2011. *Kawailoa Wind Power Final Habitat Conservation Plan*. O‘ahu, Hawai‘i.

———. 2015. *Kawailoa Wind Power Habitat Conservation Plan Fiscal Year 2015 Annual Report*. SunEdison, LLC, Oahu, Hawai‘i.

———. 2016. *Habitat Conservation Plan: Fiscal Year 2016 Annual Report*. Tetra Tech, Inc., 61-488 Kamehameha Hwy, Haleiwa, Hawai‘i.

———. 2017. *Habitat Conservation Plan: Fiscal Year 2017 Annual Report*. Tetra Tech, Inc., 61-488 Kamehameha Hwy, Haleiwa, Hawai‘i.

Kear, J., and, A.J. Berger 1980. *The Hawaiian Goose: An Experiment in Conservation*. Vermillion, South Dakota: Buteo Books.

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

Kerlinger, P. 2005. Bird studies: what we know and what has been done? 2nd Wind Power Siting Workshop: Siting Wind Power Projects in the Eastern U.S. Sponsored by the American Wind Energy Association. www.awea.org

Kerlinger, P., and J. Guarnaccia. 2005. Avian Risk Assessment for the Kenedy Wind Project, Kenedy County, Texas. Report Prepared for Superior Renewable Energy. Curry & Kerlinger, Cape May Point, New Jersey.

Kerns, J., W.P. Erickson, and E.B. Arnett. 2005. Bat and Bird Fatality at Wind Energy Facilities in Pennsylvania and West Virginia, edited by E.B. Arnett, pp. 24–95. In *Relationships Between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines*. A Final Report Submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas, USA. http://www.batcon.org/ wind literature. Accessed 1 Sept. 2007.

Kingsley, A., and B. Whittam. 2007. Wind Turbines and Birds: A Background Review for Environmental Assessment, Draft. Canadian Wildlife Service, Environment Canada, Gatineau, Quebec.

Kress, S. W. 1990. Egg rock update 1990. Newsletter of the Fratercula Fund of the National Audubon Society.

Kress, S. W., and R. V. Borzik. 2002. Egg rock update 2002. Newsletter of the Seabird Restoration Program of the National Audubon Society.

Kress, S. W., and D. N. Nettleship. 1988. Re-establishment of Atlantic puffins (*Fratercula artica*) at a former breeding site in the Gulf of Maine. *Journal of Field Ornithology* 59:161–170.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007. Assessing impacts of wind-energy development on nocturnally active birds and bats: A guidance document. *Journal of Wildlife Management* 71: 2449–2486.

Kushlan, J.A., M. J. Steinkamp, K.C. Parsons, J. Capp, M.A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R.M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J.E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. *Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1*. Waterbird Conservation for the Americas, Washington, D.C.

Lālāmilo Wind Farm Draft Habitat Conservation Plan. 2016. Lālāmilo, South Kohala, Hawai‘i.

Martin, E.M., and P.I. Padding. 2002. *Preliminary Estimates of Waterfowl Harvest and Hunter Activity in the United States During the 2001 Hunting Season*. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Laurel, Maryland.

Menard, T. 2001. Activity Patterns of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) in Relation to Reproductive Time Periods. Master’s thesis, University of Hawai‘i at Mānoa.

Miller, A.H. 1937. Structural modifications in the Hawaiian goose (*Nesochen sandvicensis*): A study in adaptive evolution. *University of California Publications in Zoology* 42(1):1–80.

Mineau, P. 2005. Direct Losses of Birds to Pesticides–Beginnings of a Quantification. In *Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference*, March 20–24, 2002, Asilomar, California, Vol. 2. Edited by C.J. Ralph and T.D. Rich, pp. 1065–1070. USDA Forest Service General Technical Report PSW-GTR-191.

Miskelly, C., and H. Gummer. 2004. Third and final transfer of fairy prion (titiwainui) chicks from takapourewa to Mana Island, January 2004. Wellington, New Zealand, Department of Conservation.

Miskelly, C. M., and G. A. Taylor. 2004. Establishment of a colony of common diving petrels (*Pelecanoides urinatrix*) by chick transfers and acoustic attraction. *Emu* 104:205–211.

Miskelly, C., G. Timlin, and R. Cotter. 2005. Common diving petrels (*Pelecanoides urinatrix*) recolonize Mana Island. *Notornis* 51:245–246.

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. *Hawaii's Comprehensive Wildlife Conservation Strategy*. State Department of Land and Natural Resources. Honolulu, Hawai'i. Available at: http://www.state.hi.us/dlnr/dofaw/cwcs/index.html. Accessed August 21, 2008.

Na Pua Makani Wind Farm Final Draft Habitat Conservation Plan. 2016. Kahuku, Oahu, Hawai'i.

National Renewable Energy Laboratory (NREL). 2003. Consumptive Water Use for U.S. Power Production. NREL/TP-550-33905. Available at: http://www.nrel.gov/docs/fy04osti/33905.pdf.

National Wind Coordination Collaborative (NWCC). 2004. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions. Fact Sheet. 2nd ed.

Natural Resources Conservation Service. 2009. *Bats of the U.S. Pacific Islands*. Biology Technical Note No. 20.

NatureServe. 2008. NatureServe Explorer: An Online Encyclopedia of Life. Version 7.0. Available at: http://www.natureserve.org/explorer. Accessed December 24, 2008.

———. 2015. NatureServe Explorer: An Online Encyclopedia of Life. Available at: http://explorer.natureserve.org/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=106446&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=106446&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=106446&selectedIndexes=103130&selectedIndexes=102007, Accessed July 23, 2016.

Nishibayashi, E. 1997. Downed wildlife survey at six leeward West Maui wind monitoring towers. Unpublished report prepared for Zond Pacific, Inc., Wailuku, Hawai'i. Eric Nishibayashi Biological Consulting, Kahului, Hawai'i.

———. 1998. Native bird activity at proposed access road. Unpublished report prepared for Zond Pacific, Inc., Wailuku, Hawai'i. Eric Nishibayashi Biological Consulting, Kahului, Hawai'i.

National Science Foundation (NSF). 2010. *Draft Habitat Conservation Plan for the Construction of the Advanced Technology Solar Telescope at the Haleakalā High Altitude Observatory Site Maui, Hawaii, 2010*. Available at: http://hawaii.gov/dlnr/dofaw/pubs/DRAFT_HCP_ATST_OEQC.pdf.

———. 2011. *Environmental Assessment for the Issuance of an Incidental Take License and Proposed Conservation Measures Associated with the Advanced Technology Solar Telescope, Haleakalā, Maui, Hawai'i*.

Nur, N., W.J. Sydeman. 1999. Demographic processes and population dynamic models of seabirds: Implications for conservation and restoration. *Current Ornithology* 15:149–188.

O'Shea, T.J., P.M. Cryan, D.T.S. Hayman, R.K. Plowright, and D.G. Streicker. 2016. Multiple mortality events in bats: a global review. *Mammal Review* Doi:10.1111/mam. 12064.

Pakini Nui Wind Farm Draft Habitat Conservation Plan. 2016. South Point, Hawai'i.

Pascal, M., O. Lorvelec, V. Bretagnolle V., and J-M. Culioli. 2008. Improving the breeding success of a colonial seabird: a cost-benefit comparison of the eradication and control of its rat predator. *Endangered Species Research* 4:267–276.

Patriquin, K.J., and R.M.R. Barclay. 2003. Foraging by bats in cleared, thinned and unharvested boreal forest. *Journal of Applied Ecology* 40:646–657.

Pitman, R.L. 1986. *Atlas of Seabird Distribution and Relative Abundance in the Eastern Tropical Pacific*. La Jolla, California: NOAA, NMFS, Southwest Fisheries Center Administrative Report LJ-86-02C.

Planning Solutions, Inc. 2009a. *Draft Environmental Impact Statement Kaheawa Wind Power II Wind Energy Generation Facility, Ukumehame, Maui, Hawaii*.

———. 2009b. *Revised Draft Environmental Impact Statement Kaheawa Wind Power II Wind Energy Generation Facility, Ukumehame, Maui, Hawaii*.

———. 2010. *Revised Final Environmental Impact Statement Kaheawa Wind Power II Wind Energy Generation Facility, Ukumehame, Maui, Hawaii*.

Podolsky, R.H. 1990. Effectiveness of social stimuli in attracting Laysan Albatross to new potential nesting sites. *The Auk* 107 (1):119–125.

Podolsky, R., D.G. Ainley, G. Spencer, L. DeForest, and N. Nur. 1998. Mortality of Newell's shearwaters caused by collisions with urban structures on Kaua'i. *Colonial Waterbirds* 21:20–34.

Podolsky, R. H., and S. W. Kress. 1989a. Attraction and colonization of dark-rumped petrels (*Pterodroma phaeopygia*) to Santa Cruz island, Galapagos. In *Annual Report of the National Audubon Society*. Ithaca, New York: National Audubon Society.

———. 1989b. Factors affecting colony formation in leach's storm- petrel. *Auk* 106:332–336.

Podolsky, R., and S.W. Kress. 1992. Attraction of the endangered dark-rumped petrel to recorded vocalizations in the Galápagos Islands. *The Condor* 94:448–453.

Pratt, T.K. 1988. Recent observations, March-May 1988. *'Elepaio* 48:65–66.

Priddle, D., and N. Carlile. 1995. An artificial nest box for burrow-nesting seabirds. *Emu* 95:290–294.

Rechtman, R.B., J.R. Dudoit, and A.K. Dircks Ah Sam. 2009. *An Archaeological Inventory Survey for the Kaheawa Wind Power (KWP I) Phase 2 Project Area (TMK: 2-3-6-001: Por. 014 and 2-4-8-001: por. 001)*. Prepared for First Wind Energy LLC, Honolulu, Hawai'i.

Reynolds, M.H., B.A. Cooper, and R.H. Day. 1997. Radar study of seabirds and bats on windward Hawai'i. *Pacific Science* 51:97–106.

Reynolds, M.H., and G.L. Ritchotte. 1997. Evidence of Newell's shearwater breeding in Puna District, Hawaii. *Journal of Field Ornithology* 68(10):26–32.

Richardson, F., and D.H. Woodside. 1954. Rediscovery of the nesting of the dark-rumped petrel in the Hawaiian Islands. *The Condor* 56: 323–327.

Rollins, K.E., and D.K. Meyerholz, G.D. Johnson, A.P. Capparella, and S.S. Loew. A forensic investigation into the etiology of bat mortality at a wind farm: Barotrauma or traumatic injury? *Veterinary Pathology* 49(2):362–371.

Sanzenbacher P.M., and B.A. Cooper. 2009. *Radar and Visual Studies of Seabirds at the Proposed KWP II Wind Energy Facility, Maui Island, Hawaii: Use of 2008 Data to Model Annual Collision Fatalities at Proposed Wind Turbines*. Prepared for First Wind, Newton, Massachusetts.

Sawyer, S.L., and S.R. Fogle. 2010. Acoustic attraction of grey-faced petrels (*Pterodroma macroptera gouldi*) and fluttering shearwaters (*Puffinus gavia*) to Young Nick's Head, New Zealand. *Notornis* 57:170–172.

Schreiber, E.A., and J. Burger. 2001. *Biology of Marine Birds*. Boca Raton, Florida: CRC Press.

Severns, P.M. 2009. *An Assessment of Hawaiian Native Molluscan Fauna Kaheawa Pastures, West Maui, Hawai'i*.

Shoenfeld, P. S. 2004. *Suggestions Regarding Avian Mortality Extrapolation. Report to the West Virginia Highlands Conservancy, Hillsboro, West Virginia*.

Simons T.R. 1983. Biology and conservation of the endangered Hawaiian dark-rumped petrel (*Pterodroma phaeophygia sandwichensis*). *CPSU/UW* 83(2).

———. 1984. A population model of the endangered Hawaiian dark-rumped petrel. *Journal of Wildlife Management* 48(4):1065–1076.

———. 1985. Biology and behavior of the endangered Hawaiian dark-rumped petrel. *The Condor* 87:229–245.

Simons, T.R., and C.N. Hodges. 1998. Dark-rumped Petrel (*Pterodroma phaeopygia*). In *The Birds of North America*, No. 345, edited by A. Poole and F. Gill. Philadelphia, Pennsylvania: The Birds of North America, Inc.

Spear, L. B., D. G. Ainley, N. Nur, and S. N. G. Howell. 1995. Population size and factors affecting at-sea distributions of four endangered *procellariids* in the tropical Pacific. *The Condor* 97:613–638.

Stantec Consulting Ltd. 2007. *Environmental Review Report for Wolfe Island Wind Project*. Kingston, Ontario.

SWCA Environmental Consultants. 2016. *Draft Habitat Conservation Plan for Pakini Nui Wind Farm*. South Point, Hawai'i. Tawhiri Power, LLC.

Szewczak, J.M., and E.B. Arnett. 2006. *Field Test Results of a Potential Acoustic Deterrent to Reduce Bat Mortality from Wind Turbines.* An investigative report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas.

Taylor, G.A. 2000a. Action plan for seabird conservation in New Zealand. Part A: Threatened seabirds. *Threatened Species Occasional Publication 16*. Department of Conservation, Wellington, New Zealand.

———. 2000b. Action plan for seabird conservation in New Zealand. Part B: Non-threatened seabirds. *Threatened Species Occasional Publication 17*. Department of Conservation, Wellington, New Zealand.

Telfer, T.C. 1986. *Newell's Shearwater Nesting Colony Establishment Study on the Island of Kaua'i*. Final report, Statewide Pittman-Robertson Program. State Department of Land and Natural Resources, Honolulu, Hawai'i.

Telfer, T.C., J.L. Sincock, G.V. Byrd, and J.R. Reed. 1987. Attraction of Hawaiian seabirds to lights: Conservation efforts and effects of moon phase. *Wildlife Society Bulletin* 15:406–413.

Tetra Tech EC, Inc. 2008a. *Draft Environmental Assessment For Issuance of an Endangered Species Act Section10 (a)(1)(B) Permit for the Incidental Take of Listed Species for the Lanai Meteorological Towers Project*. Castle and Cooke Resorts, LLC. Prepared for U.S. Fish and Wildlife Service.

———. 2008b. *DRAFT Habitat Conservation Plan for the construction and operation of Lanai met towers, Lanai, Hawai'i (Revised February 8, 2008, TTEC-PTLD-2008-080)*. Unpublished report prepared for Castle and Cooke LLC, Lanai City, Hawai'i. Available at: http://www.state.hi.us/dlnr/dofaw/pubs/Lanai_ MetTowers_HCP.pdf.

———. 2010. *Environmental Impact Statement Preparation Notice/Environmental Assessment for Auwahi Wind Farm Project Ulupalakua Ranch, Maui, Hawai'i*. Auwahi Wind Energy LLC.

———. 2011a. *Draft Environmental Impact Statement for Auwahi Wind Farm Project, Ulupalakua Ranch, Maui, Hawai'i*. Auwahi Wind Energy LLC.

———. 2011b. *Draft Habitat Conservation Plan for Auwahi Wind Farm Project, Ulupalakua Ranch, Maui, Hawai'i*. Auwahi Wind Energy LLC.

Tomich, P.Q. 1986. Mammals in Hawai'i, 2nd ed. Bishop Museum. Special Publication 76.

U.S. Climate Change Science Program. 2009. Climate and Coasts. Abstract. In *Hawai'i Conservation Conference 2009 Hawai'i in a Changing Climate: Ecological, Cultural, Economic and Policy Challenges and Solutions*.

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.

———. 2003. Federal Register, Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for 60 Plant Species from the Islands of Maui and Kahoolawe, HI; Final Rule. 68(93):25934–25982.

———. 2004a. *Draft Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*)*.

U.S. Fish and Wildlife Service, Portland, Oregon.

———. 2004b. *Interim Guidelines to Avoid and Minimize Wildlife Impacts From Wind Turbines*. Available at: http://www.fws.gov.

———. 2005. *Regional Seabird Conservation Plan, Pacific Region*. U.S. Fish and Wildlife Service, Migratory Birds and Habitat Programs, Pacific Region, Portland, Oregon.

———. 2012. *Land-Based Wind Energy Guidelines*. Available at: http://www.fws.gov/windenergy/docs/WEG_final.pdf. U.S. Fish and Wildlife Service, Arlington, Virginia.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*, Vols. I and II. Rev. ed. Honolulu, Hawai'i: University of Hawai'i Press.

Warren-Hicks, W., J. Newman, R. Wolpert, B. Karas, and L. Tran. 2013. *Improving Methods for Estimating Fatality of Birds and Bats at Wind Energy Facilities.* California Energy Commission. Publication No. CEC-500-2012-086.

Webster, P.J., G.J. Holland, J.A. Curry, and H.R. Chang. 2005. Changes in tropical cyclone number, duration, and intensity in a warming environment. *Science* 309(5742):1844–1846.

Whitaker, J.O., and P.Q. Tomich. 1983. Food habits of the hoary bat, *Lasiurus cinereus*, from Hawaii. *Journal of Mammalogy* 64:151–152.

Williams, B.K., and E. Brown. 2009. *Adaptive Management: The U.S. Department of the Interior Applications Guide*. Adaptive Management Working Group, U.S. Department of the Interior, Washington, D.C.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. *Adaptive Management: The U.S. Department of the Interior Technical Guide*. Adaptive Management Working Group, U.S. Department of the Interior, Washington, D.C.

Woog, F., and J.M. Black. 2001. Foraging behavior and the temporal use of grasslands by nēnē: Implications for management. *Studies in Avian Biology* 22:319–328.

Work, T. M., J. Dagenais, R. Rameyer, and R. Breeden. 2015. Mortality patterns in endangered Hawaiian Geese (Nene; *Branta sandvicensis*) *Journal of Wildlife Diseases* 51(3): 688–695.

Young, G.P. 2004. Letter to Michelle McLean, November 8. Department of Army, Honolulu, Hawai'i .

Zimpfer, J., and F. Bonaccorso. 2010. Barbed Wire Fences and Hawaiian Hoary Bats: What We Know. 2010 Hawai'i Conservation Conference abstract. Hawai'i Convention Center, Honolulu.

Appendix 1

LINDA LINGLE
GOVERNOR OF HAWAII

ALLAN A. SMITH
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

KEN C. KAWAHARA
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

Office of Conservation and Coastal Lands
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:TM

CDUP: MA-3380

Perry White
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

JUL 20 2007

Dear Mr. White,

SUBJECT: Conservation District Use Permit (CDUP) MA-3380

This letter is to inform you that on July 20, 2007, the Chairperson of the Board of Land and Natural Resources, pursuant to Chapter 13-5, Hawaii Administrative Rules, approved Conservation District Use Application MA-3380 for Meteorological Measurement Towers Located at Located at Olowalu-Ukumehame, Lahaina/Wailuku, Maui, portions of TMK: (2) 4-8-001:001 and (2) 3-6-001:014 subject to the following conditions:

1. The applicant shall comply with all applicable statutes, ordinances, rules, and regulations of the Federal, State and County governments, and the applicable parts of Section 13-5-42, Hawaii Administrative Rules;

2. The applicant, its successors and assigns, shall indemnify and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury or death arising out of any act or omission of the applicant, its successors, assigns, officers, employees, contractors and agents for any interference, nuisance, harm or hazard relating to or connected with the implementation of corrective measures to minimize or eliminate the interference, nuisance, harm or hazard;

3. The applicant shall comply with all applicable Department of Health administrative rules;

4. Where any interference, nuisance, or harm may be caused, or hazard established by the use the applicant shall be required to take measures to minimize or eliminate the interference, nuisance, harm, or hazard within a time frame and manner prescribed by the Chairperson;

5. Any work done on the land shall be initiated within one year of the approval of such use, and unless otherwise authorized be completed within three years of the approval. The applicant shall notify the Department in writing when construction activity is initiated and when it is completed;

6. Should an impact with flying wildlife occur, KWP II shall remove the tower(s) until such time as the tower(s) are covered by an Incidental Take License and accompanying (amended) Habitat Conservation Plan;

7. Before proceeding with any work authorized by the Board, the applicant shall submit four (4) copies of the construction and grading plans and specifications to the Chairperson or his authorized representative for approval for consistency with the conditions of the permit and the declarations set forth in the permit application. Three (3) of the copies will be returned to the applicant. Plan approval by the Chairperson does not constitute approval required from other agencies;

8. The applicant shall obtain a land disposition from the Land Division for the proposed use;

9. In issuing this permit, the Department has relied on the information and data that the applicant has provided in connection with this permit application. If, subsequent to the issuance of this permit, such information and data prove to be false, incomplete or inaccurate, this permit may be modified, suspended or revoked, in whole or in part, and/or the Department may, in addition, institute appropriate legal proceedings;

10. Should historic remains such as artifacts, burials or concentration of charcoal be encountered during construction activities, work shall cease immediately in the vicinity of the find, and the find shall be protected from further damage. The contractor shall immediately contact SHPD (692-8015), which will assess the significance of the find and recommend an appropriate mitigation measure, if necessary;

11. The applicant understands and agrees that this permit does not convey any vested rights or exclusive privilege;

12. Best management practices for prevention of introducing exotic species to the site shall be observed;

13. Upon the end of the duration of data collection or the end of the equipment lifecycle or within three years, all equipment shall be removed and the land shall be restored to its original condition;

14. The applicant acknowledges that the approved work shall not hamper, impede or otherwise limit the exercise of traditional, customary or religious practices in the immediate area, to the extent such practices are provided for by the Constitution of the State of Hawaii, and by Hawaii statutory and case law;

15. Other terms and conditions as may be prescribed by the Chairperson; and

16. Failure to comply with any of these conditions shall render this Conservation District Use Permit null and void.

Please acknowledge receipt of this approval, with the above noted conditions, in the space provided below. Please have an authorized signature sign two copies. Retain one and return the other within thirty (30) days. A copy of the Staff report is included for your information. Should you have any questions on any of these conditions, please feel free to contact Tiger Mills at 587-0382.

Aloha,

Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

Receipt acknowledged:

____
Applicant's Signature

Date__________________

c: Chairperson
Maui Board Member
Maui District Land Office
County of Maui, Department of Planning

Appendix 2

Proposed KWP II Post-Construction Monitoring Protocol

Sampling to estimate the mortality occurring at a wind energy facility must consider spatial and temporal factors at different scales. At the scale of the individual turbine, the area searched should encompass the majority of where expected mortalities will fall; in addition, the search interval has to be of a frequency where most carcasses will be discovered before they are scavenged. When spatial and temporal variation within a site are considered, individual turbines within a site should be sampled sufficiently to account for the spatial variation that exists among turbines, as well as across seasons of the year when species of interest are at the greatest risk of turbine collision.

The accuracy of a mortality estimate itself depends on several factors. The probability of finding a carcass depends on the search interval and scavenging rates at the site. Scavenging rates are typically estimated by conducting trials to yield representative carcass retention times and search intervals are then adjusted accordingly. Another factor that determines the probability of finding a carcass is searcher efficiency. Searcher efficiency will account for individuals that may be killed by collision with project components but that are not found by searchers for various reasons, such as heavy vegetation cover.

This monitoring protocol outlines the scavenger and searcher efficiency trials that KWP II will conduct as well as the search methods that will be used to locate carcasses impacted by the operation of the wind facility.

EARLY POST-CONSTRUCTION STUDIES

The field methods proposed below are based primarily on a refinement of the methods that have been used at KWP since operations began in June 2006 (Kaheawa Wind Power 2006). Other recent studies of bird and bat fatalities at wind power projects in the U.S. and Europe were also reviewed to develop and refine previously-approved methods and search techniques (e.g., Kerns and Kerlinger 2004, Pennsylvania Game Commission 2007, Stantec 2008, Stantec 2009, Arnett 2005, Jain et al. 2007, Fiedler et al. 2007).

The initial period of fatality monitoring at KWPII will entail frequent, systematic searches of the area beneath each turbine by trained technicians. Carcass removal and searcher efficiency trials will be conducted within this period. Subsequently, intensive sampling at a pre-determined reduced effort will be conducted for one year at 5-year intervals with attendant SEEF trials and carcass removal trials. A regular rapid assessment technique will be developed for the interim years to determine direct take occurring between years of intensive monitoring.

<u>Factors Considered for Scavenger and Searcher Efficiency (SEEF) Trials</u>

Factors that may affect the results of scavenger and SEEF trials include seasonal differences, vegetation types and carcass sizes.

Seasonal differences are presumed to affect the outcome of scavenger trials. The rate of carcass retention may vary due to seasonal changes in density of predators on site, or seasonal changes in predator behavior. For the monitoring protocol at KWP II, the year is divided into two seasons, the winter/spring season (December – May) and summer/fall (June – November). Scavenger trials already conducted at the adjacent KWP facility have suggested that scavenging rates vary with the two seasons identified above (Kaheawa Wind Power 2008). The outcome of SEEF trials are not expected to vary with season.

Different vegetation types are likely to affect the outcome of both scavenger and SEEF trials. It is anticipated that more complex vegetation structures will result in lower scavenging rates and lower searcher efficiency. Search plots at KWPII will consist either of bare ground or short stature grass and will be maintained throughout the life of the project.

Carcass sizes will also likely affect the outcome of both scavenger and SEEF trials. Three size classes have been established to reflect the size classes of the Covered Species: bat size, medium birds (seabirds) and large birds (nēnē). Based on studies conducted at KWP and elsewhere, it is expected that as size increases, both carcass retention times and searcher efficiency will increase.

Placement of Carcasses for Searcher Efficiency and Carcass Removal Trials

Each carcass used in searcher efficiency or carcass removal trials will be placed randomly within the search plots. These points will be generated within each identified vegetation zone using ArcView 9x with the Generate Random Points tool in Hawth's Analysis Tools 3.27. Parameters that will be specified for each randomly chosen location will include the minimum distance between random points and minimum distance of the point from the vegetation zone boundary. Minimum distances between random points will ensure that carcasses are not placed too close together. This will maintain the independence of the samples and prevent predator swamping. The distance of each point from the boundary of the vegetation zone will ensure that carcasses will be within the specified vegetation zone and not be placed on edges or within transition zones. These points will subsequently be loaded into a GPS as waypoints to allow the accurate placement of the carcasses.

Carcass Removal Trials

The objective of performing carcass removal studies at KWP II will be to determine the average amount of time an avian or bat carcass remains visible to searchers before being removed by scavengers or otherwise rendered undetectable. Carcass removal trials have been ongoing at the KWP facility since November, 2005. To date a total of 27 trials have been conducted using a variety of species and numbers of specimens. Carcass retention times average 6.6 days for small (n=7) carcasses and 10.3 days for medium sized carcasses (n=59), while large birds typically remain visible to observers for the standard two week duration of trials or longer (Kaheawa Wind Power, 2008b, 2009, 2010a,b). Similar but more frequent trials will be conducted at KWP II with the purpose of maintaining an ongoing record of scavenging rates at different times of year, and among different vegetation and ground cover types, that will best reflect site-specific conditions in the event that a take does occur. Eight to twelve carcass removal trials will be conducted during the initial survey year, designed to enable four to six trials within a corresponding season (summer/fall and winter/spring) and will be used to adjust the number of estimated direct takes of covered species observed by correcting for carcass removal bias.

Each carcass removal trial will consist of placing a pre-determined number of carcasses (up to a maximum of nine specimens) of varying size classes on the ground at random locations within representative vegetation classes. The carcass will be placed such that it approximates what would be expected if a bird/bat came to rest on the ground after having collided with an overhead structure. The intent will be to distribute trials along the length of the project area to represent a range of elevations, habitat conditions, vegetation cover types, and seasonal variability. Fresh carcasses will be used whenever available, if frozen carcasses are used, all carcasses will be thawed before being deployed. An example of a possible sampling design is presented in Table 1.

All carcasses will be checked on days daily for up to 30 days or until all evidence of the carcass is absent. On day 30, all remaining materials, feathers or parts will be retrieved and properly discarded. Results of trials provide a basis for determining the search frequency necessary to ensure that birds and bats are not scavenged before they can be detected by searchers (see Barrios and Rodriguez 2004 and Kaheawa Wind Power 2008). In some instances, carcasses may be monitored beyond the 30 day survey duration if the information being gathered substantially informs the conclusions of the monitoring exercise. Data will be analyzed by season, and according to vegetation and carcass size classifications.

Table 1. Possible Sampling Scheme for KWP II Scavenger Trials for One Season

Vegetation types	Season	Size class	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Total sample size
Bare ground	Winter / Spring	Bats	2		2		2		2		8
		Med birds	2		2		2		2		8
		Large birds		2		1		2		1	6
Grass	Winter / Spring	Bats	2		2		2		2		8
		Med birds	2		2		2		2		8
		Large birds		1		2		1		2	6
		Total	**8**	**3**	**8**	**3**	**8**	**3**	**8**	**3**	**44**

Searcher Efficiency Trials (SEEF)

Searcher Efficiency (SEEF) Studies represent an important component of downed wildlife monitoring and provide an estimate of carcass detection probability. As with SEEF trials at KWP, trials will be conducted in association with the regular search effort to estimate the percentage of avian/bat fatalities that are found by searchers. Searcher efficiency will be evaluated according to vegetation classification and differences in carcass detection rates for different sized birds and for bats. Estimates of searcher efficiency will be used to adjust estimates of direct take by accounting for carcass detection bias.

Personnel conducting carcass searches will not be told when or where trials will be conducted. Trials will be administered during the twice weekly monitoring period but dates will be chosen randomly, as far as practicable. Each trial will consist of 3 - 8 bird carcasses and/or bats or bat surrogates. Prior to a search commencing, each carcass will be placed within chosen vegetation zones, as described above, at randomly selected locations that will be searched on the same day. Each trial carcass will be discreetly marked and located by GPS so it can be relocated and identified when found. If carcasses of the covered species are not available, carcasses of surrogate species will be used as previously described. Data will be analyzed according to vegetation and carcass size classifications. More trials will be conducted if analyses indicate that more trials are needed to provide statistical confidence in the resultant values and enable mean searcher detection probabilities to be ascertained for the project site.

Searcher efficiency rates at KWP using Wedge-tailed Shearwaters as surrogates for the two Covered seabird species have ranged from an average of 64 -70% in shrubs (n=90), 78 - 81%% in grass (n=145) to 97 - 100% detectability on bare ground (n=51). Using house sparrows and Zebra doves as surrogates for bats at KWP, the average searcher efficiency rates ranged from 33 - 42% in shrubs (n=15), to 36 – 50% in grass (n=20), and 67 – 97% detection on bare ground (n=30) (Kaheawa Wind Power 2009, 2010a). Using carcasses of bats (if available), small mammals, seabirds and geese as surrogates for each Covered Species in SEEF trials performed during the initial three years of study will provide a better representation of detection variability among differing vegetation and terrain conditions for the different sized Covered Species, resulting in greater confidence in this species-specific adjustment variable.

Procurement of Carcasses for Trials

If using state or federally protected species as surrogates for trials, all state and federal laws pertaining to transport, possession, and permitted use of these species along with appropriate animal use protocols will be followed. A scientific permit will be obtained for all species that may be used in trials. Carcasses used in the trials will be selected to best represent the size, mass, coloration, and if possible should be closely related to or roughly the same proportions as the four Covered Species. For example, Wedge-tailed shearwaters and Lesser Canada Goose (*Branta canadensis parvipes*) both exhibit close taxonomic resemblance to the two covered seabird species and nēnē, respectively, and have been used successfully at KWP in carcass removal trials. All carcasses used for the trials will be fresh or freshly thawed. Dark colored mammals (e.g., small rats, mice) and small passerines (e.g. house finch, house sparrow) may be used as surrogates for bats. Other types of avian carcasses that may prove useful for trials include locally-obtained road kills, downed seabirds, owls, and waterbirds, or species not protected under the MBTA such as pheasant (*Phasianus colchicus*) and rock dove (*Columba livia*). Nēnē mortalities that occur elsewhere but render the carcasses available for these studies would provide an important opportunity to learn how long nēnē remain visible to searchers at KWP II. Use of species protected under ESA or MBTA will require permission from DLNR and USFWS.

Search Intervals

The search interval will initially consist of once weekly searches. Consultation with the Endangered Species Recovery Committee (ESRC) and DLNR has indicated a preference for a search interval that is equal to the time interval where approximately 90% of all carcasses are retained. KWP II will be conduct its own carcass removal trials, and search intervals may be adjusted to more accurately reflect seasonal carcass removal rates by size class. The actual search interval and target carcass retention rates will be decided with the concurrence of the agencies.

Should SEEF trials indicate that mean carcass retention times are less than 7 days, trapping may be conducted to depress scavenger populations and increase carcass retention times. All applicable permits will be obtained.

Search Areas Beneath Meteorological Towers

The search area beneath the temporary met towers will be circular and extend 10 m beyond the supporting guy wires. The search area beneath the permanent unguyed met tower (80 m) will also be circular and be half the height of the tower at 40 m search radius.

Search Areas Beneath Individual Turbines

Several studies of small-bodied animals (songbirds and bats), with adequate sample sizes (n = 69 – 466), have shown that the majority of carcasses are found within a search area of less than 50% of the maximum turbine height (Arnett 2005, Jain et al. 2007, Fiedler et al. 2007; see Fig. 1a, b, 2a, b, c, d, e). Most of the carcass distributions (% fatalities vs. distance from turbine) appear to be well described by 2nd degree polynomials, with most fatalities found at approximately 25% of the distance of turbine height, then decreasing with few fatalities occurring beyond 50% of the maximum turbine height (Fig 2a, b, c).

These data are also supported by the distribution of carcasses that have been found at the operating KWP facility. To date, after more than 3000 turbine plot searches conducted during the four years operation at KWP, only seven carcasses have been found that are clearly attributable to collisions with the turbines. The carcasses consist of one Hawaiian hoary bat, one Hawaiian petrel, four nēnē, one barn owl, one Hawaiian short-eared owl, nine introduced game birds (ring-necked pheasant, Black francolin) two white-tailed tropicbirds, and one Great frigatebird with carcass distances from the turbine ranging from 1 – 67.6 m (75% of maximum turbine height at 90 m). Search plots for KWP are of 90 m radius (100% turbine height) and no intact carcasses were found beyond a distance of 50% turbine height, with the exception of one white-tailed tropicbird and one Hawaiian short-eared owl where the main carcasses were found at 75% and 67% maximum turbine height, respectively. In both cases, portions of the wing were discovered downwind of the carcass. The partially intact white-tailed tropicbird wing was measured a distance of 170 m from the nearest turbine, probably blown across the bare and recently burned slope below the substation facility by steady moderate to strong winds from the NE. The Hawaiian short-eared owl wing section was found at a distance of 87 m (97% maximium turbine height) (Kaheawa Wind Power, 2010a). It should not be ruled out that carcass materials documented in these cases may have been manipulation or moved by scavengers.

Most of these studies have concentrated on the fatality distributions of small birds and bats. However, these fatality distributions are also expected to apply to larger bodied birds, though it is expected that larger-bodied birds, because of their greater weight, they will likely be found closer to the base of the turbines.

Given the considerations detailed above, it is proposed that search areas beneath individual turbines for KWP II will consist of searches to 75% turbine height (75 m radii), a search area which encompasses the distribution of all the carcasses found to date attributable to turbine collisions at KWP.

Spatial and Temporal Sampling Scheme During the First Year of Intensive Sampling

Frequency of Sampling

Sampling at KWP II will consist of once weekly carcass searches to 75% turbine height. The actual search intervals will be adjusted based on the results of the seasonal carcass removal trials as they become available. The search intervals will be determined in consultation with DLNR and USFWS.

Plot Maintenance

All search plots will be maintained as bare ground or short stature grass (less than 24”) for the life of the project.

Determining Spatial and Temporal Variation on Site

The weekly search frequency is anticipated to accurately describe variation in mortality rates at different turbines within the site, as well as identify periods when Covered Species that potentially occur year round on site (nēnē and Hawaiian hoary bat) are at greater risk of collision. Each turbine will be sampled 54 times a year, resulting in a total of 756 turbine searches per year for the entire facility.

Intensive Sampling During the Second Year

If sufficient data is collected in the first year, search plots and search frequencies may be adjusted to enable the most efficient sampling regime. The change in sampling regime will be determined by KWP II in consultation with DLNR, USFWS and members of the ESRC .

However, the same sampling regime as Year 1 will be continued if data indicates that more sampling is needed before any change can be made.

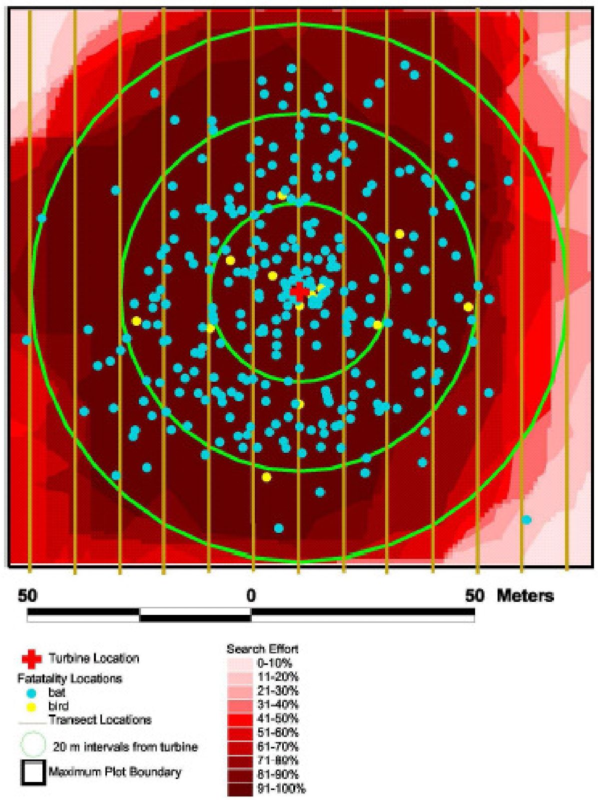


Figure 1a. Bat and bird fatalities (n=466 bats) at all turbines combined at Meyersdale Wind Energy Center in Pennsylvania, 2 August to 13 September 2004 (Arnett 2005). The maximum turbine height was 115 m.

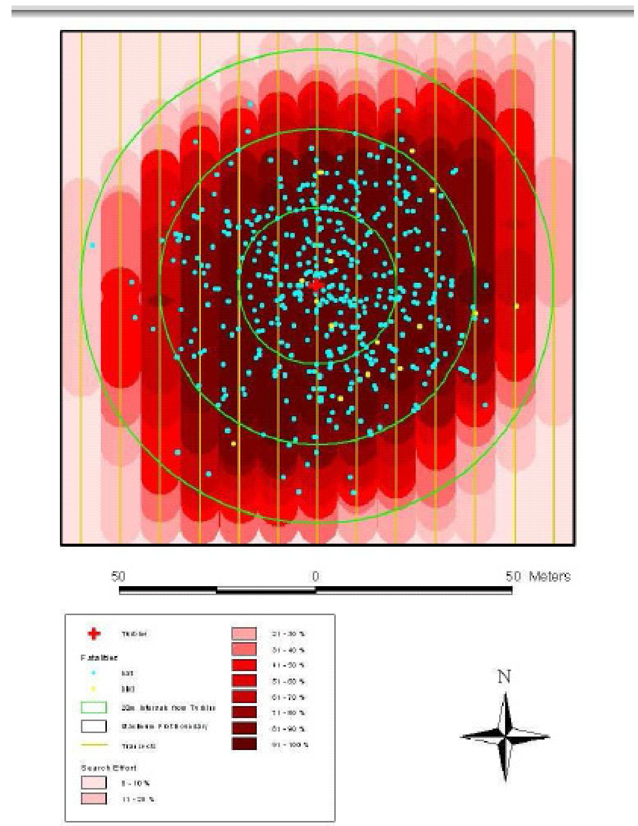
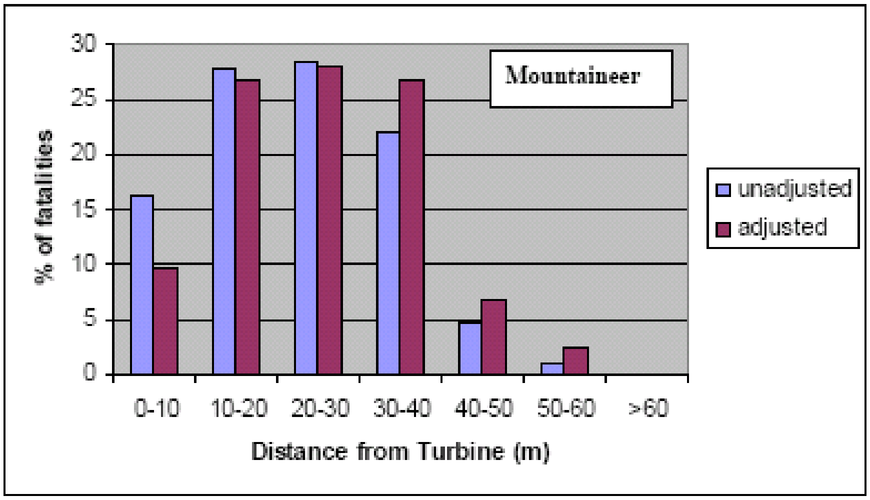
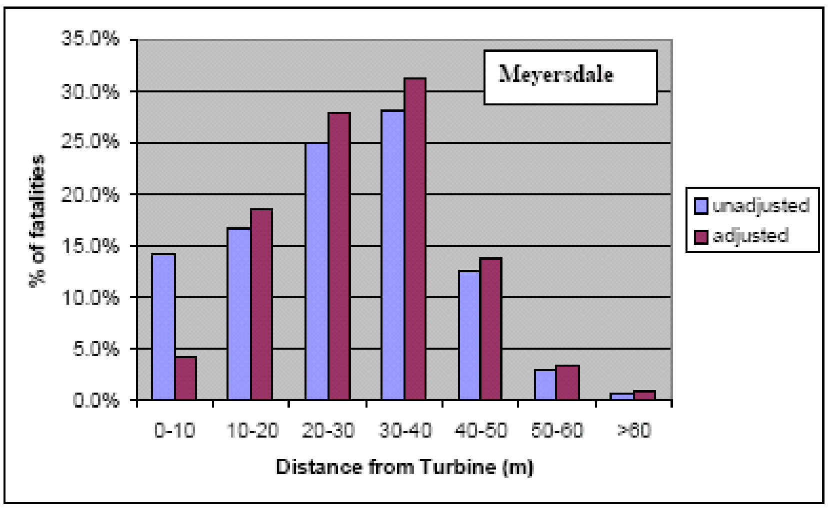


Figure 1b. Bat and bird fatalities (n=499 bats) at all turbines combined at Mountaineer Wind Energy Center in West Virginia, 31 August to 11 September 2004 (Arnett 2005). The maximum turbine height was 104.5 m.

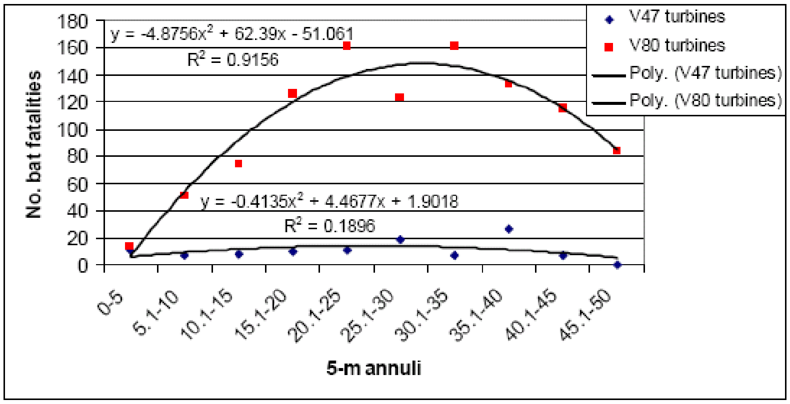


a

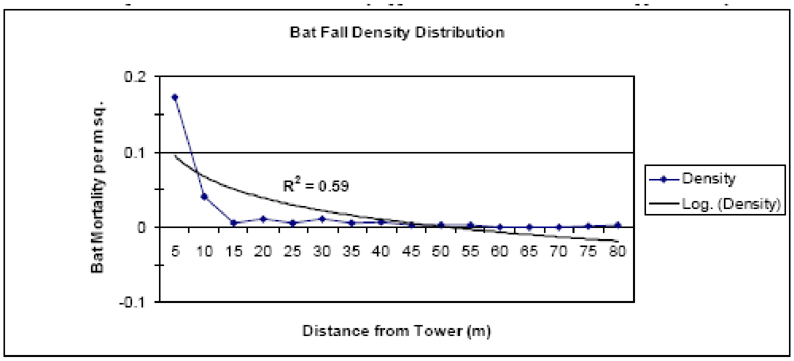


b

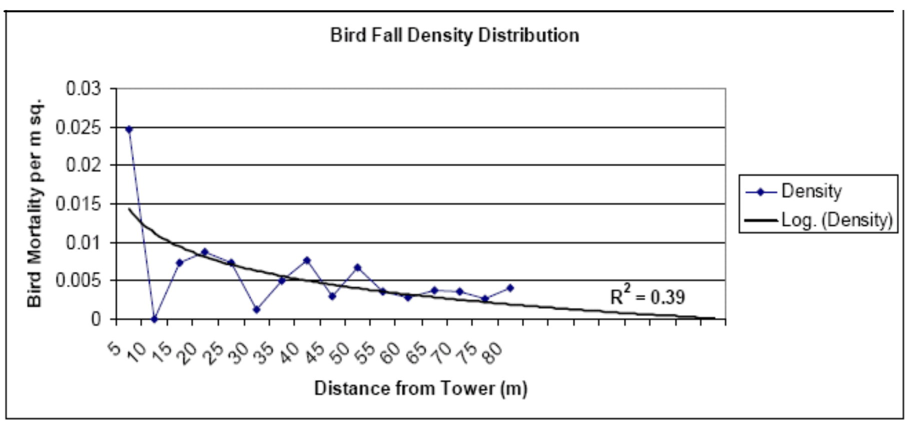
Figure 2a, b. Distribution of fatalities (birds and bats) as a function of distance from a turbine for Mountaineer and Meyersdale sites based on unadjusted counts, and counts adjusted for searcher detection and sampling effort (figures from Arnett 2005). The maximum turbine height was 104.5 m.



c



d



e

Figure 2c. Number of bats found within 5m annuli around V47 turbines (n = 20) and V80 turbine (n=243) from 5 April to 20 December 2005 and associated trend line for Buffalo Mountain, Tennessee (figure from Fielder et al 2007). The trend line for the V80 predicts that bat fatalities would reach zero at 59.6 m from the turbine (maximum turbine height is 120m). Data from the V47 is not considered in this report due to small sample sizes.

Figure 2d,e. Maple Ridge Wind Power, New York bat and bird fatality density distributions from September 1 to November 15, 2006, in relation to distance from towers with associated trend lines. The maximum turbine heights were 122 m (figures from Jain et al 2007). The trend lines predict that bird carcass densities approximate zero at 110m and at 45m for bats. The maximum turbine height was 122 m.

Post Three-Year Intensive Sampling Period

Spatial and temporal trends on site should also be well understood at the end of the three-year intensive sampling period, enabling correction factors to be appropriately applied. Depending on findings, the correction factors may enable a decrease or modification of sampling effort (e.g. increase in search intervals or decrease in the number of turbines searched), identify specific turbines or times of the year when sampling effort should be concentrated, and inform adaptive management considerations. Discussion with ESRC, USFWS and DLNR has indicated a preference for the reallocation of effort whereby mitigation efforts are increased in exchange for a reduction in fatality monitoring. It is expected that the intensive monitoring effort will be scaled back by about 50%. It is also proposed that intensive fatality monitoring after the post three-year intensive sampling period be conducted at the beginning of 5-year bins; years 6, 11 and 16, resulting in a total of 6 years of intensive monitoring during the life of the project (Table 2). SEEF trials and carcass removal trials will be repeated during these years to determine if any of the variables have changed over time (Table 2). All adjustments to direct take will use the most recent estimates from the SEEF and carcass removal trials.

In addition to this reduced monitoring effort, regular rapid assessment (RRA) of each search plot will be conducted in the interim years. This may consist of personnel searching each plot to 75% turbine height on an ATV (all terrain vehicle). The frequency at which the surveys take place will be determined at the conclusion of the carcass removal trials for that 5-year period. SEEF trials will also be conducted to determine the searcher efficiency of the chosen RRA method. All adjustments to direct take found in the interim years will use the estimates from the SEEF and carcass removal trials for that 5-year time period.

The intensive monitoring during the first year of the 5-year period and the subsequent 4-year rapid assessment is designed to inform the Applicant if the take is still occurring at Tier 1 levels or whether take has moved to a Tier 2 or Lower tier based on 5-year and 20-year take limits outlined in the HCP. Five-year total direct take levels will be determined for each 5-year bin while 20-year total direct take levels will be a cumulative total from the start of project operation.

This long-term sampling regime will be refined by KWPII in consultation with ESRC, USFWS, DLNR, statisticians and wind energy experts after the initial 2-year intensive sampling period.

Years

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
IM	IM	IM	RRA	RRA	IM	RRA	RRA	RRA	RRA	IM	RRA	RRA	RRA	RRA	IM	RRA	RRA	RRA	RRA
SEEF trials	SEEF trials		SEEF trials		SEEF trials	SEEF trials				SEEF trials	SEEF trials				SEEF trials	SEEF trials			
CRT	CRT				CRT					CRT					CRT				
1st 5-year bin					2nd 5-year bin					3rd 5-year bin					4th 5-year bin				

IM = intensive monitoring; RRA = regular rapid assessment; CRT= carcass removal trials

Total direct take for 5-year bin = total direct take for IM + total direct take for RRA years

Table 2. Timetable for SEEF and scavenger removal trials and search techniques

REFERENCES

Arnett E. 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas, USA.

Barrios, L. and A. Rodriguez. 2004. Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. Journal of Applied Ecology 41:72-81.

Fiedler, J.K., T.H. Henry, R.D. Tankersley, and C.P. Nicholson. 2007. Results of Bat and Bird Mortality Monitoring at the Expanded Buffalo Mountain Wind Farm, 2005. 36 pp.

Jain A. P. Kerlinger, R. Curry, L. Slobodnik. 2007. Maple Ridge Wind Power Avian and Bat Fatality Study Year One Report FINAL REPORT. Prepared for PPM Energy and Horizon Energy and Technical Advisory Committee (TAC) for the Maple Ridge Project Study

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003.

Kaheawa Wind Power. 2008b. Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 2 Annual Report. First Wind, LLC, Environmental Affairs, Newton, MA. 26 pp.

Kaheawa Wind Power, LLC. 2009. Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Year 3 Annual Report. First Wind Energy, LLC, Environmental Affairs, Portland, ME 37pp.

Kaheawa Wind Power, LLC. 2010a. Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Year 4 Annual Report. First Wind Energy, LLC, Environmental Affairs, Portland, ME 35pp.

Kaheawa Wind Power, LLC. 2010b. Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Q1-Year 5 Progress Report. First Wind Energy, LLC, Environmental Affairs, Portland, ME 10pp.

Osborn, R. G., K. F. Higgins, R., E. R. Usgaard, C. D. Dieter, and R. D. Neiger. 2000. Bird mortality associated with wind turbines at the Buffalo Ridge Wind Resource Area, Minnesota. American Midland Naturalist 143:41-52.

Pennsylvania Game Commission. 2007. Protocols to Monitor Bird and Bat Mortality at Industrial Wind Turbines. Exhibit C Used in Conjunction with the Wind Energy Cooperative Agreement.

Stantec Consulting. 2008. 2007 Spring, Summer, and Fall Post-Construction Bird and Bat Mortality Study at the Mars Hill Wind Farm, Maine. Report prepared for UPC Wind Management, LLC. January 2008. 31 pp.

Stantec Consulting. 2009. Post-construction Monitoring at the Mars Hill Wind Farm, Maine – Year 2. Report prepared for First Wind, LLC. January 2009. 33 pp.

Appendix 3

FINAL REPORT

RADAR AND VISUAL STUDIES OF SEABIRDS AT THE PROPOSED KWP II DOWN-ROAD ALTERNATIVE WIND ENERGY FACILITY, MAUI ISLAND, HAWAII, SUMMER 2009

BRIAN A. COOPER AND ROBERT H. DAY

PREPARED FOR

FIRSTWIND, LLC
NEWTON, MA

PREPARED BY

ABR, INC.–ENVIRONMENTAL RESEARCH AND SERVICES
FOREST GROVE, OREGON ♦ FAIRBANKS, ALASKA

RADAR AND VISUAL STUDIES OF SEABIRDS AT THE PROPOSED KWP II DOWN-ROAD ALTERNATIVE WIND ENERGY FACILITY, MAUI ISLAND, HAWAII, SUMMER 2009

FINAL REPORT

Prepared for

FIRSTWIND, LLC
85 Wells Avenue, Suite 305
Newton, MA 02459–3210

Prepared by

Brian A. Cooper
ABR, Inc.—Environmental Research & Services
P.O. Box 249
Forest Grove, OR 97116–0249

and

Robert H. Day
ABR, Inc.—Environmental Research & Services
P.O. Box 80410
Fairbanks, AK 99708–0410

September 2009

Printed on recycled paper.

EXECUTIVE SUMMARY

- We used radar and audiovisual methods to collect data on movements of endangered Hawaiian Petrels (*Pterodroma sandwichensis*) and threatened Newell's (Townsend's) Shearwaters (*Puffinus auricularis newelli*) at the proposed Kaheawa Wind Power II Down-road Alternative wind energy generation facility, on Maui Island during summer 2009. We conducted evening and morning surveys during 20–24 July 2009.
- The objectives of the study were to: (1) document movement rates of Hawaiian Petrels and Newell's Shearwaters at the proposed KWP II Down-road Alternative facility; (2) estimate the daily number of petrels/ shearwaters that fly within areas that would be occupied by wind turbines at the proposed facility; and (3) estimate annual fatality rates of petrels/shearwaters at proposed turbines and meteorological (met) tower.
- We recorded 37 radar targets that fit our criteria for petrels and shearwaters.
- The mean movement rate across all nights was 1.78 ± 0.14 targets/h. After adjusting our sampling results for hours of the night that we did not sample (i.e., non-peak periods), we estimated a mean movement rate of 10.0 petrel-like/shearwater-like targets/night during summer 2009.
- We recorded one Hawaiian Petrel during visual sampling. This bird was heading east (i.e., toward Haleakala) at 40 m agl at 2126 on 24 July.
- To determine the risk of collision-caused mortality, we used petrel/shearwater movement rates observed on radar in summer 2009, petrel/shearwater flight altitudes from previous studies, and dimensions and characteristics of the proposed turbines and met towers to generate an estimate of exposure risk. We then applied estimates of the fatality probability (i.e., the probability of collision with a portion of the turbine or tower and dying while in the airspace occupied by the structure) and a range of estimated avoidance probabilities (i.e., the probability that a bird will detect and avoid entering the airspace containing the turbine or tower) to this estimate of exposure to calculate annual fatality rates that could be expected at the proposed turbines and met tower.
- We estimate that ~1,607 Hawaiian Petrels and 882 Newell's Shearwaters pass over the 1.5-km-radius radar sampling area in an average year (including birds at all altitudes).
- We estimated annual fatality rates at wind turbines and met towers by assuming that 90%, 95%, or 99% of all petrels/shearwaters flying near a turbine/tower will see and avoid the structure. Based on these scenarios, annual fatality rates for wind turbines ranged from 0.016–0.217 Hawaiian Petrel/turbine/yr and 0.009–0.119 Newell's Shearwaters/turbine/yr. For the 65-m met tower, we estimated a fatality of 0.008–0.081 Hawaiian Petrel/tower/yr and 0.004–0.044 Newell's Shearwaters/tower/year. Although the range of assumed avoidance rates of wind turbines and met towers (90–99%) is not fully supported by empirical data at this time we speculate that avoidance rates of petrels and shearwaters at wind farm structures (e.g., wind turbines and met towers) potentially are ≥95%, based upon fatality rates at existing windfarms and avoidance behavior of petrels observed at other structures (e.g., powerlines and communication towers); thus, we believe that fatality rates will be within the lower half of the range of estimates.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

We thank FirstWind for funding this study and for providing the ornithological radar used for sampling. We thank Greg Spencer and Dave Cowan (FirstWind) for help with logistics and thank Greg Spencer and Ian Bordenave (FirstWind) for their assistance with the visual sampling. At ABR, Rich Blaha and Dorte Dissing produced study figures and Alice Stickney and Pam Odom assisted with report production.

INTRODUCTION

First Wind, LLC, formerly UPC Wind Management, LLC, operates the 30-MW Kaheawa Pastures Wind Energy Generation Facility, referred to as Kaheawa Wind Power I (KWP I), on the island of Maui (Figure 1). A new wind project adjacent to the existing facility is being considered for development by FirstWind and will be operated as Kaheawa Wind Power II (i.e., the KWP II Down-road Alternative). Two federally-listed seabird species occur on Maui: the endangered Hawaiian Petrel (*Pterodroma sandwichensis*; Hawaiian name ’Ua’u) and the threatened Newell’s (Townsend’s) Shearwater (*Puffinus auricularis newelli*; Hawaiian name ’A’o). Ornithological radar and night-vision techniques have been shown to be successful in assessing numbers and movement rates of these petrels and shearwaters on the Hawaiian Islands (e.g., Kaua’i [Cooper and Day 1995, 1998; Day and Cooper 1995, Day et al. 2003b], Maui [Cooper and Day 2003], Moloka’i [Day and Cooper 2002], and Hawai’i [Day et al. 2003a]). Previous radar and visual studies documented the presence of petrel/shearwater targets, including visual observations of Hawaiian Petrels, in the vicinity of the existing KWP I project site (Day and Cooper 1999, Cooper and Day 2004a). These data were used to model the potential number of annual fatalities at the KWP I development (Cooper and Day 2004b). In addition, radar studies were conducted in 2008 (Sanzenbacher and Cooper 2008, 2009) to model the potential number of fatalities in a nearby portion of an alternate KWP II site that was located just upslope of the KWP II Down-road Alternative.

The currently operational KWP I wind-energy facility consists of an articulated row of 20 1.5-MW turbines (GE 1.5se) with a hub height of ~55 m and a rotor diameter of 70.5 m, plus one 30-m-high, guyed NRG monopole meteorological (met) tower and two 55-m-high, guyed lattice met towers (Figure 2). The proposed KWP II Down-road Alternative project would consist of ~14 additional 1.5-MW turbines (GE 1.5se), each with a hub height of ~65 m and a rotor diameter of 70.5 m, plus one 65-m-high, free-standing met tower.

ABR conducted additional radar and visual studies on Maui in July 2009 with a specific focus on an area proposed for the KWP II Down-road Alternative. The objectives of the study were to: (1) document movement rates of Hawaiian Petrels and Newell’s Shearwaters at the proposed KWP II Down-road Alternative facility; (2) estimate the daily number of petrels/shearwaters that fly within areas that would be occupied by wind turbines or met towers at the proposed facility; and (3) estimate annual fatality rates of petrels/shearwaters at proposed turbines and meteorological (met) tower.

Background

Two seabird species that are protected under the Endangered Species Act (ESA) are likely and/or known to occur in the KWP II Down-road Alternative project area: the endangered Hawaiian Petrel and the threatened Newell’s (Townsend’s) Shearwater. The Hawaiian Petrel and the Newell’s Shearwater are forms of tropical Pacific species that nest only on the Hawaiian Islands (American Ornithologists’ Union 1998). Both species are Hawaiian endemics whose populations have declined significantly in historical times: they formerly nested widely over all of the Main Islands but now are restricted in most cases to scattered colonies in more inaccessible locations (Ainley et al. 1997b, Simons and Hodges 1998). The one exception is Kaua’i Island, where colonies still are widespread and populations are substantial in size. Of note, Kaua’i (along with Lana’i) also has no introduced Indian Mongooses (*Herpestes auropunctatus*) which prey on these seabirds.

The Hawaiian Petrel nests primarily on Maui (Richardson and Woodside 1954, Banko 1980a; Simons 1984, 1985; Simons and Hodges 1998, Cooper and Day 2003), Kaua’i (Telfer et al. 1987, Gon 1988, Day and Cooper 1995; Ainley et al. 1995, 1997a, 1997b; Day et al. 2003a), Hawai’i (Banko 1980a, Conant 1980, Hu et al. 2001, Day et al. 2003a), Lana’i (Shallenberger 1974; Hirai 1978a, 1978b; Conant 1980; G. Spencer and J. Penniman, pers. comm.), and Moloka’i (Simons and Hodges 1998, Day and Cooper 2002). On Maui, these petrels are known to nest on Haleakala Crater (Brandt et al. 1995, Simons and Hodges 1998) and are believed to nest in West Maui (Cooper and Day 2003), with recent observations of birds calling and exhibiting aerial displays consistent with breeding behavior, despite the

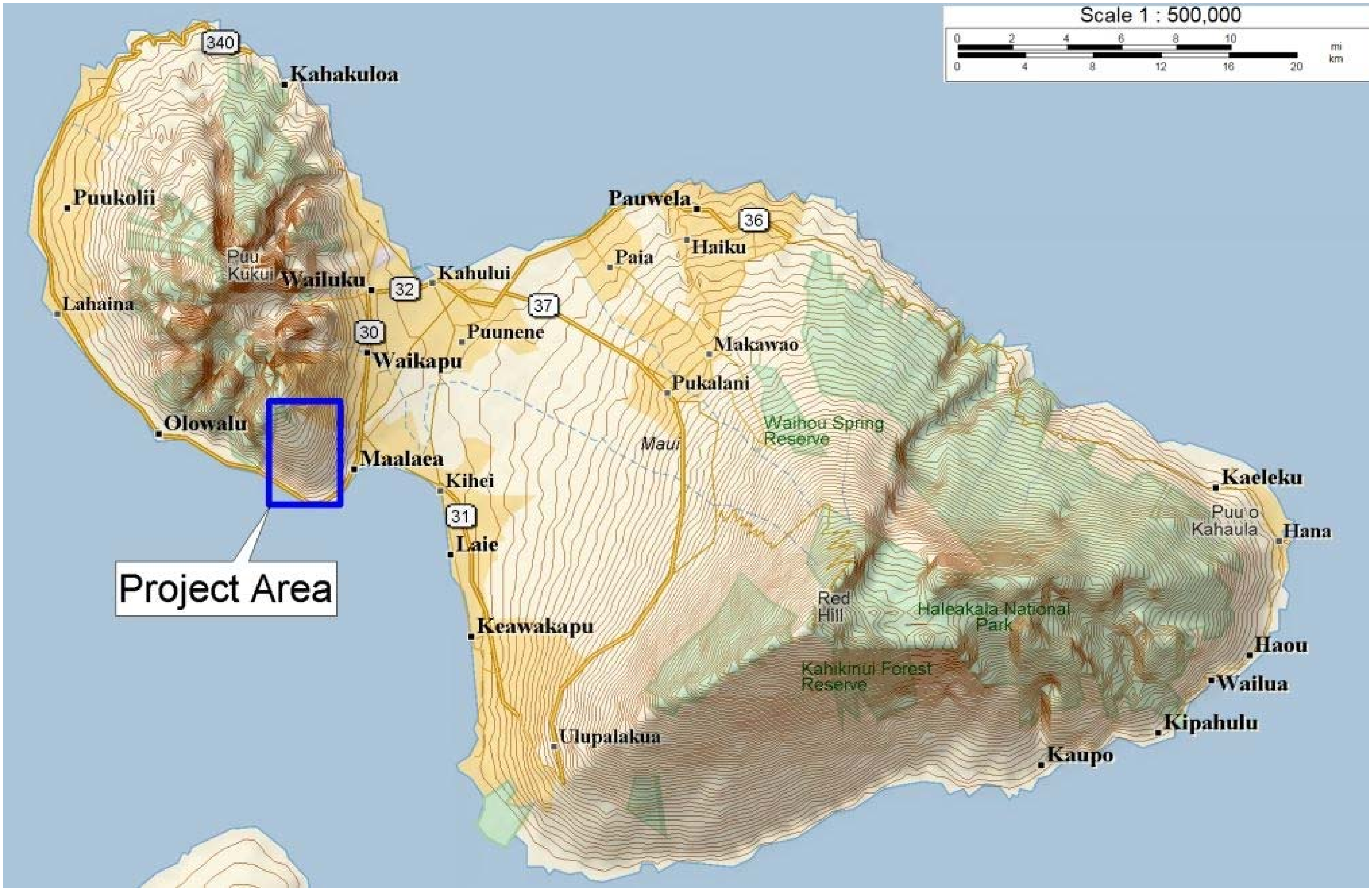


Figure 1. Maui Island, Hawaii, with approximate location of the Kaheawa Pastures Wind Energy Facilities (KWP I and KWP II).

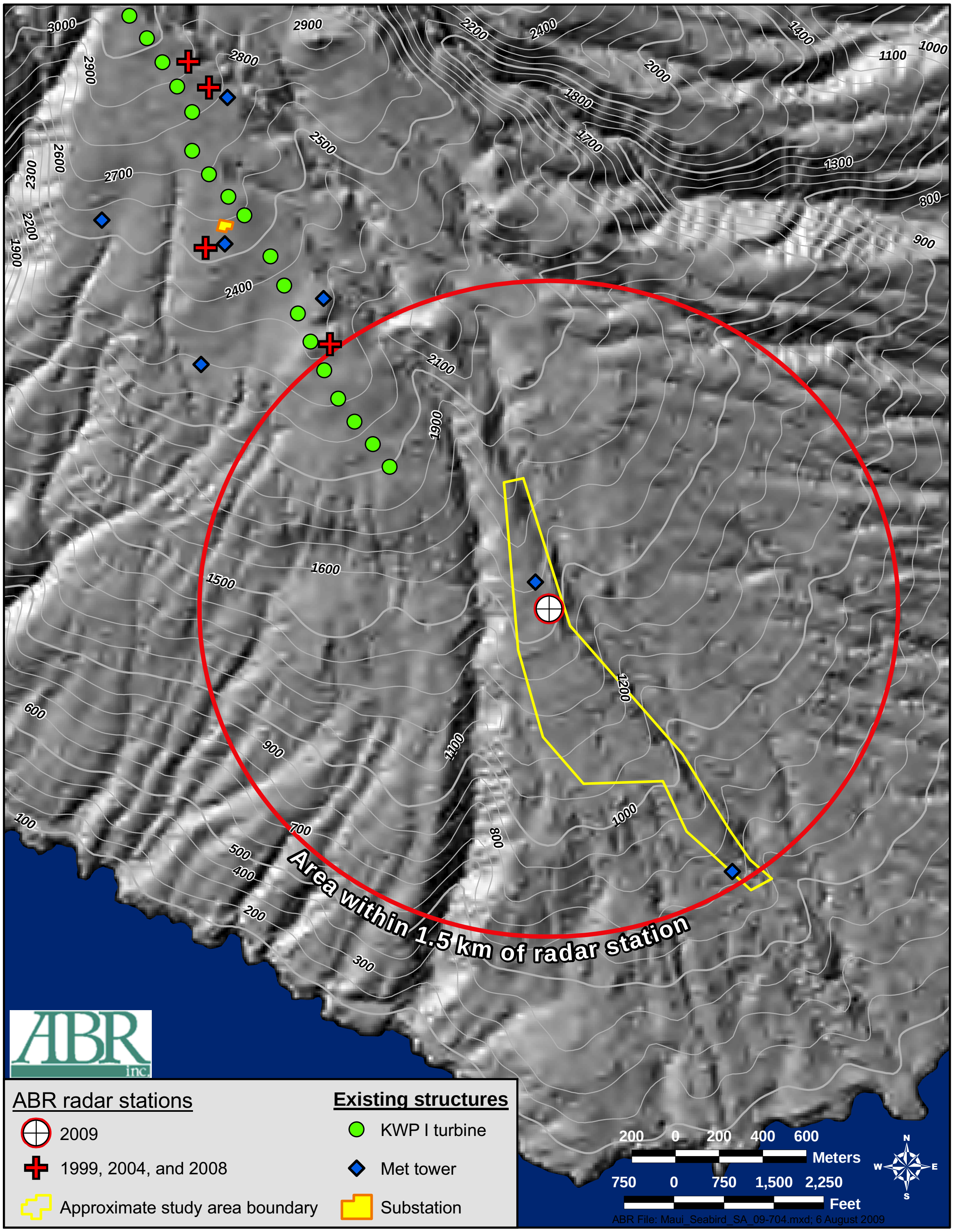


Figure 2. Location of 2009 radar sampling stations relative to sampling stations from previous studies (Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009) and areas under consideration for siting of wind turbines at the proposed KWP II Down-road Alternative wind energy facility, Maui, Hawaii.

minimal historical evidence and introduction of Indian Mongoose on Maui. For example, on 16 June 1999, a Hawaiian Petrel was heard calling from a bed of uluhe ferns (*Dicranopteris linearis*) at 3,300 ft (~1,000 m) elevation in the Kapunakea Preserve, which lies on the northwestern slope of the West Maui Natural Area Reserve (A. Lyons, *fide* C. Bailey). In addition, recent observations of consistent calling from a single location suggests that there is another small colony of Hawaiian Petrels in the West Maui Mountains ~14 km north of the KWP project areas (G. Spencer, FirstWind, pers. comm.). On the other hand, daily movement rates of Hawaiian Petrels near KWP I and II (i.e., on the southern slope of West Maui Mountain; Day and Cooper 1999, Cooper and Day 2004a, Sanzenbacher and Cooper 2008 and 2009) are much lower than those over the eastern and northern sides of Maui (Cooper and Day 2003), suggesting that few birds use that area.

Newell’s Shearwaters nest on several of the main Hawaiian Islands, with the largest numbers clearly occurring on Kaua’i (Telfer et al. 1987, Day and Cooper 1995; Ainley et al. 1995, 1997b; Day et al. 2003b). These birds also nest on Hawai’i (Reynolds and Richotte 1997, Reynolds et al. 1997, Day et al. 2003a), almost certainly nest on Moloka’i (Pratt 1988, Day and Cooper 2002), and may still nest on Oahu (Sincock and Swedberg 1969, Banko 1980b, Conant 1980, Pyle 1983; but see Ainley et al. 1997b). On Maui, recent auditory observations suggest that a small colony of Newell’s Shearwaters is present in the west Maui Mountains ~14 km north of the KWP project areas (G. Spencer, FirstWind, pers. comm.), matching a prediction of their occurrence there by Cooper and Day (2003). Newell’s Shearwaters typically nest on steep slopes that are vegetated by uluhe fern (*Dicranopteris linearis*) undergrowth and scattered o'hia trees (*Metrosideros polymorpha*).

There is interest in studying these two species because of concerns regarding collisions with structures such as met towers and turbines. To date, there is documented mortality of only one Hawaiian Petrel at a wind turbine and zero Newell’s Shearwaters at wind-energy facilities (wind turbines or met towers) within the Hawaiian Islands (G. Spencer, FirstWind, pers. comm.). Note, however, that fatality studies have been conducted only for 3.5 yr at one wind-energy location in the Hawaiian Islands (KWP I, Maui) and 3 mo at six met towers at the same site prior to operation. Hence, there have not been enough studies of adequate duration or geographic scope to answer the question definitively of whether these species are prone to collisions at these types of structures. There has, however, been well-documented petrel and shearwater mortality because of collisions with other human-made objects (e.g., transmission lines, communication towers) on Kaua’i (Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998) and Maui (Hodges 1992), and there have been collision-caused fatalities of other seabirds at other Hawaiian Islands (Fisher 1966).

STUDY AREA

The operational KWP I windfarm and proposed KWP II Down-road Alternative expansion are located on the southern slope of West Maui Mountain, in an area called Kaheawa Pastures (Figure 1). These sites lie on a moderately sloping portion of West Maui Mountain, ~1–6 km inland from McGregor Point. Vegetation at the site consists of non-native grasslands at lower elevations and a mixture of grasslands and scattered shrubs at moderate to higher elevations. Although the KWP II Down-road Alternative area consists of a dry Mediterranean habitat, vegetation becomes much wetter upland, toward the summit of West Maui Mountain. Presumably, vegetation communities also are dominated by native species in these higher, wetter areas. These upland habitats may provide suitable nesting habitat for Newell's Shearwaters, based on our experience on Kaua’i and other sites. In addition to the vegetation, the steepness of the land at higher elevations on West Maui Mountain also suggests that suitable nesting habitat exists for Hawaiian Petrels, as it does on Haleakala (Brandt et al. 1995), Kaua’i (Telfer, pers. comm.), and Lana’i (Hirai 1978b).

In previous studies at the KWP I and KWP II sites (Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009), sampling was conducted at four other stations; however, for the current study, we established a new sampling station with a focus on providing maximal radar coverage of potential siting areas for the proposed KWP II Down-road Alternative development (Figure 2). The study area is situated in lower elevations slightly to the east and south of the existing KWP I turbine string, and our 2009 sampling station was located adjacent to the existing KWP I access road, just south of the Lahaina Pali trail (20° 47'52.6" N, 156° 32'16.5" W; elevation ~490 m).

METHODS

We used marine radar and visual equipment to collect data on the movements, flight behaviors, and flight altitudes of petrels and shearwaters at a single sampling station during summer (20–24 July) 2009 (Table 1). The daily sampling effort consisted of 3 h each evening (1900–2200 h) and 2 h each morning (0400–0600 h). These sampling periods were selected to correspond to the evening and morning peaks of movement of petrels and shearwaters, as described near breeding colonies on Kaua'i (Day and Cooper 1995). During sampling, we collected radar and audiovisual data concurrently so the radar operator could help the audiovisual observer locate birds for species identification and data collection. In return, the audiovisual observer provided information to the radar operator on the identity and flight altitude of individual targets (whenever possible). For the purpose of recording data, a calendar day began at 0700 and ended at 0659 the following morning; that way, an evening and the following morning were classified as occurring on the same day.

The ornithological radar used in this study was a Furuno (Model FCR-1510) X-band radar transmitting at 9.410 GHz through a slotted wave guide with a peak power output of 12 kW; a similar radar unit is described in Cooper et al. (1991) and Mabee et al. (2006). The antenna face was tilted upward by ~10°, and we operated the radar at a range setting of 1.5 km and a pulse-length of 0.07 μsec.

Issues associated with radar sampling include ground clutter and shadow zones. Whenever energy is reflected from the ground, surrounding vegetation, and other objects around the radar unit, a ground-clutter echo that can obscure targets of interest (i.e., birds) appears on the radar's display screen. Shadow zones are areas of the screen where birds can fly at an altitude that potentially would

Table 1. Sampling dates and number of inbound and outbound seabird radar targets and number of audio-visual observations of species of interest at the proposed KWP II Down-road Alternative wind-energy site, Maui, Hawaii, July 2009.

Date	Site	Period	Number of radar targets: Inbound[1]	Outbound[1]	Total	Number of audio-visual detections[2]
20 July	Lower	Eve	0	7	7	0
		Morn	0	1	1	0
21 July	Lower	Eve	0	5	5	0
		Morn	1	2	3	0
22 July	Lower	Eve	4	0	4	3 SEOW
		Morn	1	0	1	1 TROP
23 July	Lower	Eve	6	1	7	3 SEOW
		Morn	1	0	1	2 SEOW, 1 BAOW, 1 UNOW
24 July	Lower	Eve	6	0	6	1 HAPE, 1 BAOW, 1 UNOW
		Morn	1	1	2	1 SEOW

[1] Flight direction categories for landward and seaward categories included all birds flying toward and away, respectively, from either the colonies located on the opposite end of west Maui to the north of the study site or colonies on Haleakala.
[2] HAPE = Hawaiian Petrel; HOBA = Hoary Bat; NESH = Newell's Shearwater; SEOW = Short-eared Owl; BAOW = Barn Owl: TROP = unidentified Tropicbird; UNOW = Unidentified owl.

put them behind a hill or row of vegetation where they could not be detected because the radar operates only on line-of-sight. We attempted to minimize ground clutter and shadow zones during the selection of radar sampling stations; various structures and landscape features visible on radar indicated that our sampling stations provided good coverage of the study area.

We sampled for six 25-min sessions during each evening and for four 25-min sessions each morning (Table 1). Each 25-min sampling session was separated by a 5-min break for collecting weather data. To help eliminate non-target species, we collected data only for those targets that met a suite of selection criteria, following methods developed by Day and Cooper (1995), that included appropriate flight characteristics and flight speeds (≥30 mi/h [≥50 km/h]). We also removed radar targets identified by flight characteristics or visual observers as being of other bird species.

We conducted audiovisual sampling for birds and bats concurrently with the radar sampling to help identify targets observed on radar and to obtain flight-altitude information. During this sampling, we used 10X binoculars during crepuscular periods and Generation 3 night-vision goggles (Model ATN-PVS7; American Technologies Network Corporation, San Francisco, CA) during nocturnal periods. The magnification of the night-vision goggles was 1X, and their performance was enhanced with the use of a 3-million-Cp floodlight that was fitted with an IR filter to avoid blinding and/or attracting birds. Audiovisual observations were conducted within 25 m of the radar to facilitate coordination between observers, and we also listened for petrel and shearwater vocalizations.

Before each 25-min sampling session, we also collected environmental and weather data, including:

- wind speed (to the nearest 1.6 km/h [1 mi/h]);
- wind direction (to the nearest 1°);
- percent cloud cover (to the nearest 5%);
- cloud ceiling height, in meters above ground level (agl; in several height categories);
- visibility (maximal distance we could see, in categories);
- light condition (daylight, crepuscular, or nocturnal, and with or without precipitation)
- precipitation type; and
- moon phase/position (lunar phase and whether the moon was above or below the horizon in the night sky).

For each appropriate radar target, we recorded the following data:

- species (if identified by visual observer);
- number of birds (if identified by visual observer);
- time;
- direction of flight (to the nearest 1°);
- cardinal transect crossed (000°, 090°, 180°, or 270°);
- tangential range (the minimal perpendicular distance to the target when it passed closest to the radar; used in reconstructing actual flight paths, if necessary);
- flight behavior (straight, erratic, circling);
- velocity (to the nearest 5 mi/h [8 km/h]); and
- flight altitude (meters agl, if identified by visual observer).

For each bird (or bat) recorded during audiovisual sampling, we recorded:

- time;
- species (to the lowest practical taxonomic unit [e.g., Hawaiian Petrel, unidentified petrel/shearwater]);
- number of individuals composing each target;
- ordinal flight direction (000°, 045°, 090°, 135°, 180°, 225°, 270°, 315°); and
- flight altitude (meters agl).

For any birds heard but not observed, we recorded species, number of calls, direction of calls, and approximate distance.

DATA ANALYSIS

We entered all radar and visual data into Microsoft Excel databases. Data files were checked visually for errors after each night's sampling, then were checked electronically for irregularities at the end of the field season, prior to data analyses. In addition, radar data were filtered to remove non-target species, and only known petrel/shearwater targets or unknown targets with appropriate characteristics (i.e., target size, flight characteristics, and airspeeds ≥30 mi/h) were included in data analyses. Airspeeds were calculated by correcting observed target flight speeds (groundspeeds) for speed and relative direction of wind, as measured each half-hour at the radar station (Mabee et al. 2006).

We tabulated counts of numbers of radar targets of petrels and shearwaters recorded during each sampling session, then converted those counts to estimates of movement rates of birds (radar targets/h), based on the number of minutes sampled. No sampling time was lost to rain or other factors; we standardized estimates by actual minutes of sampling effort each half hour. We used all of the estimated movement rates across sampling sessions at a station to calculate the mean ± 1 standard error (SE) nightly movement rate of petrels and shearwaters by station and pooled data across nights to derive an overall hourly movement rate for the study.

We also classified general flight directions of each radar target as landward or seaward and summarized those directional categories by station, date, and time period. To categorize the general flight direction of each target, we defined a landward flight as a radar target flying toward the West Maui Mountains or Haleakala (on East Maui) and classified targets flying in the opposite directions as seaward targets.

MODELING FATALITY RATES

The risk-assessment technique that we have developed involves the use of radar data for estimating the fatality rates for petrels and shearwaters near structures in the Hawaiian Islands. This modeling technique uses the radar data on seasonal movement rates to estimate numbers of birds flying over the area of interest (sampling station) across a 255-d year (for Hawaiian Petrels) or a 210-d year (for Newell's Shearwater) when breeding birds are present on the island. The model then uses information on the physical characteristics of the structures (e.g., wind turbines or met towers) themselves to estimate horizontal and vertical interaction probabilities and combines these interaction probabilities with the movement rates to generate exposure rates (Figure 3). These rates represent the estimated numbers of petrels/shearwaters that pass within the airspace occupied by a proposed wind turbine or within the airspace occupied by a met tower and its associated guy wires each year. We then combine these exposure rates with (1) the probability that an interaction results in fatality, and (2) the probability that birds detect structures and avoid interactions, to estimate fatality rates.

We calculate an exposure rate by multiplying the seabird movement rate observed on radar by horizontal- and vertical-interaction probabilities. The movement rate is an estimate of the average number of birds passing in the vicinity of the proposed turbines/towers in a day, as indicated by numbers of targets on the radar screen and the mean flock size/target. It is generated from the radar data by: (1) multiplying the average movement rates by 5.0 h to estimate the number of targets moving over the radar site in the first 3 h and last 2 h of the night (i.e., during the peak movement periods of petrel/shearwaters); (2) adjusting the sum of those evening and morning counts to account for the estimated percentage of movement that occurs during the middle of the night (when we did not sample); and (3) multiplying that total number of targets/night by the mean number of seabirds/target to generate an estimate of the number of petrel/shearwaters passing in the vicinity of the proposed met towers/turbines during an average day.

We used the radar-based movement data from our current study at the proposed KWP II Down-road Alternative development to estimate seabird movement-rates in summer and assumed that those rates represented average rates observed in an average year. We used data from all-night sampling sessions on Kaua'i (Day and Cooper 1995) to estimate movement rates occurring during the hours between our evening and morning sampling periods. These data suggested that an additional 12.6% of the total combined evening

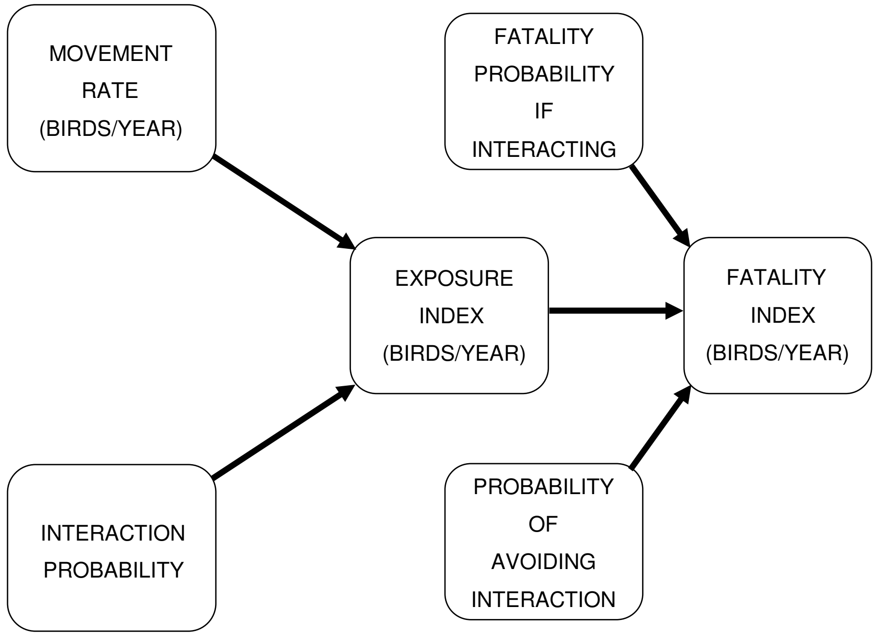


Figure 3. Major variables used in estimating possible fatalities of Hawaiian Petrels and Newell's Shearwaters at wind turbines at the proposed KWP II Down-wind Alternative wind energy facility, Maui, Hawaii. See Tables 2 and 3 for details on calculations.

landward movements and seaward morning movements occurred between the evening and morning peak-movement periods (Day and Cooper, unpubl. data). We also corrected the number of targets for flock size: mean flock sizes of petrels and shearwaters combined in Hawai'i are 1.05 ± SE 0.01 birds/flock (*n* = 2,062 flocks; Day and Cooper, unpubl. data). In addition, we used the timing of inland flights at the nearby Ukumehame site from Cooper and Day (2003) to correct for proportions of targets that were Hawaiian Petrels and those that were Newell's Shearwaters; those data suggested that 60% of the targets were Hawaiian Petrels and 40% of the targets were Newell's Shearwaters.

The number of petrels visiting breeding colonies tends to decline from summer to fall because attendance at colonies by nonbreeders and failed breeders declines as chick-rearing progresses (Serventy et al. 1971, Warham 1990, Ainley et al. 1997b, Simons and Hodges 1998). Although we do not yet have fall data for the site, we split the 255-d breeding season for Hawaiian Petrels (Simons and Hodges 1998) and 210-d breeding season for Newell's Shearwaters (Ainley et al. 1997b) into a spring/summer period of 180 days and 150 days for petrels and shearwaters, respectively, and a fall period of 75 days and 60 days for petrels and shearwaters, respectively. We corrected the seasonal estimates of nightly movement rates by the numbers of days for the spring/summer and fall seasons to generate estimates of movements for each season and species. We assume that the sum of these two estimates represents estimated movement rates for an entire breeding season (i.e., an average year).

Because the resulting estimate of the number of birds/yr is not an integer, we then round it upward to the next whole number to generate an estimate of the average number of birds passing within 1.5 km of the radar site during a year. This rounding technique results in slightly-inflated fatality estimates, but we choose to take a conservative approach in these studies associated with endangered species.

INTERACTION PROBABILITIES

Horizontal

Interaction probabilities consist of horizontal and vertical components. The horizontal-interaction probability is the probability that a bird seen on radar will pass through or over the airspace occupied by a met tower or turbine located somewhere on the radar screen. This probability is calculated from information on the two-dimensional area (side view) of the tower/turbine and the two-dimensional area sampled by the radar screen to determine the interaction probability. The 65-m, free-standing met-tower system consists of a central lattice tower without any supporting guy wires. The tower is 65 m high with a width at the base of ~6 m and a width at the top of ~0.5 m. The proposed wind turbines have ~65-m monopole towers and 35.25-m-long blades. Two calculations of area were made for turbines because of the large differences in area of the structure that depended on the orientation of the blades relative to the flight path of an approaching bird: a minimal area occupied by each proposed turbine if a bird approaches it from the side (i.e., side profile) and a maximal area occupied by each turbine if a bird approaches it from the front (i.e., front profile, including the rotor-swept area). The ensuing ratio of cross-sectional area of the proposed tower/turbine to the cross-sectional area sampled by the radar (1.5 km) indicates the probability of interacting with (i.e., flying over or through the airspace occupied by) the proposed tower or turbine.

Vertical

The vertical-interaction probability is the probability that a bird seen on radar will be flying at an altitude low enough that it might pass through the airspace occupied by a proposed met tower/turbine located somewhere on the radar screen. This probability is calculated from data on flight altitudes and from information on the proposed turbine heights. We used data from throughout the Hawaiian Islands (n = 2,010 birds; Cooper and Day, unpubl. data) to calculate the percentage of petrels/shearwaters with flight altitudes at or below the maximal height of the turbines (i.e., 51.0% ≤100 m agl) and met towers (i.e., 33.0% ≤65 m agl). We would have preferred to use flight-altitude data from the project area for the flight-altitude computations, but adequate sample sizes do not currently exist to do so.

FATALITY RATES

The annual estimated fatality rate is calculated as the product of: (1) the exposure rate (i.e., the number of birds that might fly within the airspace occupied by a tower/turbine); (2) the fatality probability (i.e., the probability of collision with a portion of the tower/turbine and dying while in the airspace occupied by the structure); and (3) the avoidance probability (i.e., the probability that a bird will detect and avoid entering the airspace containing the tower/turbine). The annual fatality rate is generated as an estimate of the number of birds killed/yr as a result of collisions with the tower/turbine, based on a 255-d breeding season for Hawaiian Petrels and a 210-d breeding season for Newell's Shearwaters.

Fatality Probability

The estimate of the fatality-probability portion of the fatality rate formula is derived as the product of: (1) the probability of dying if a bird collides with a tower/turbine; and (2) the probability of colliding with a turbine if the bird enters the airspace occupied by the structure (i.e., are there gaps big enough for birds to fly through the structure without hitting any part of it). Because any collision with a wind turbine or tower falls under the ESA definition of "take" we used an estimate of 100% for the first fatality-probability parameter. Note that the actual probability of fatality resulting from a collision is less than 100% because of the potential for a bird to hit a turbine component and not die (e.g., a bird could brush a wingtip but avoid injury/death). The second probability (i.e., striking the structure) needs to be calculated differently for met towers and turbines. In the met-tower design, the tower frame is a lattice structure, so we conservatively estimated the probability of hitting the tower if the bird enters the airspace at 100%. Similarly, a bird approaching a wind turbine from the side has essentially a 100% probability of getting hit by a blade; in contrast, a bird approaching from the back or front of a turbine may pass through the rotor-swept area without colliding with a blade, if it is flying fast enough. We calculated the probability of collision for the "frontal" bird approach based upon the length of a petrel (43 cm; Simons and Hodges 1998); the average groundspeed of petrels on Maui (mean velocity = 42.5 mi/h; *n* = 347 probable petrel targets; Cooper and Day, unpubl. data) and the time that it would take a 43-cm-long petrel to travel completely through a 2-m-wide turbine blade spinning at its maximal rotor speed (22 revolutions/min); also see Tucker (1996). These calculations indicated that 19.5% of the disk of the rotor-swept area would be occupied by a blade sometime during the length of time (i.e., 0.13 sec) that it would take a petrel to fly completely past a rotor blade (i.e., to fly 2.43 m).

Avoidance Probability

The final parameter is the avoidance probability, which is the probability that a bird will see the turbine and change flight direction, flight altitude, or both, so that it completely avoids flying through the space occupied by a met tower/turbine. Because avoidance probabilities are largely unknown, we present fatality estimates for a range of probabilities of collision avoidance by these birds by assuming that 90%, 95%, or 99% of all petrels or shearwaters flying near a tower/turbine structure will detect and avoid it. See discussion for explanation of avoidance rates used.

RESULTS

VISUAL OBSERVATIONS

One Hawaiian Petrel was detected by visual observers (Table 1). This bird was heading eastward toward Haleakala at 40 m agl at 2126 on 24 July. That bird also was observed on radar. In addition, we had numerous observations of Short-eared Owls (*Asio flammeus sandwichensis;* Pueo), plus a few Barn Owls (*Tyto alba*), and one unidentified tropicbird (at 0542 on 22 July). No Hawaiian Hoary Bats (*Lasiurus cinereus semotus*; 'Ope'ape'a) were recorded.

MOVEMENT RATES

We recorded 37 radar targets during 25.0 h of sampling in summer 2009 that fit our criteria for petrels and shearwaters (Table 1). Passage rates tended to be higher in the evening than in the morning: only 8 (21.6%) of the 37 targets were recorded during the morning sampling period. Mean nightly movement rates during summer 2009 were 1.78 ± 0.14 targets/h. After adjusting our sampling results for hours of the night that we did not sample (i.e., non-peak periods), we estimated a mean movement rate of 10.0 petrel-like targets/night during summer 2009 (Table 2).

We observed two different patterns of movement that depended on wind strength. During 20 and 21 July, there were strong Trade Winds (i.e., with average wind speeds mostly 20–35 mi/h), and we observed a pattern of 5–7 outbound targets in the evening followed by lower numbers of outbound targets in the morning (Table 1; Figure 4). During the final three nights of sampling, the winds were light (i.e., with average wind speeds mostly 0–5 mi/h [i.e., below turbine cut-in speed, since the KWP I turbine blades were not spinning]) and we observed a pattern of 4–6 inbound targets in the evening and lower numbers of targets in the morning (Table 1; Figure 5). Further, there appeared to be a shift in the spatial distribution of birds during low wind conditions that was not seen during strong winds: during the low winds, the majority of the inbound targets flew over the lower half of the proposed turbine string, and all were heading in the general direction of breeding colonies on Haleakala—not West Maui Mountain.

EXPOSURE RATES

The exposure rate is calculated as the product of three variables: annual movement rate, horizontal-interaction probability, and vertical-interaction probability. As such, it is an estimate of the number of birds flying in the vicinity of the wind turbine/met tower (i.e., crossing the radar screen) that could fly in a horizontal location and at a low-enough altitude that they could interact with a tower/turbine. Based on our summer 2009 movement rate data, we estimate that ~1,607 Hawaiian Petrels and 882 Newell's Shearwaters pass over the 1.5-km-radius radar sampling area in an average year (including birds at all altitudes; Tables 2 and 3). To generate annual exposure rates of birds exposed to each turbine or met tower (e.g., birds/tower/yr), we then multiplied the annual movement rate by the horizontal-interaction probability and the vertical-interaction probability. By applying those proportions to our data (and

Table 2. Estimated average exposure rates and fatality rates of Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at GE 1.5se wind turbines at the proposed KWP II Down-road Alternative wind-energy site, Maui, Hawaii, based on radar data collected in July 2009. Values of particular importance are in boxes.

Variable/parameter	HAPE		NESH	
	Minimum	Maximum	Minimum	Maximum
MOVEMENT RATE (MVR)				
A) Mean movement rate (targets/h)				
A1) Mean rate during nightly peak movement periods in spring/summer based on July 2009 data (targets/h)	1.776	1.776	1.776	1.776
A2) Mean rate during nightly peak movement periods in fall based on July 2009 data (targets/h)	1.776	1.776	1.776	1.776
B) Number of hours of evening and morning peak-period sampling	5	5	5	5
C) Mean number of targets during evening and morning peak-movement periods				
C1) Spring/summer (A1 * B)	8.88	8.88	8.88	8.88
C2) Fall (A2 * B)	8.88	8.88	8.88	8.88
D) Mean proportion of birds moving during off-peak h of night	0.126	0.126	0.126	0.126
E) Seasonal movement rate (targets/night) = ([C * D] + C)				
e1) Spring/summer	10.0	10.0	10.0	10.0
e2) Fall	10.0	10.0	10.0	10.0
F) Mean number of birds/target	1.05	1.05	1.05	1.05
G) Estimated proportion of each species	0.60	0.60	0.40	0.40
H) Daily movement rate (birds/day; = E * F * G)				
H1) Spring/summer	6.30	6.30	4.20	4.20
H2) Fall	6.30	6.30	4.20	4.20
I) Fatality domain (days/year)				
I1) Spring/summer	180	180	150	150
I2) Fall	75	75	60	60
J) Annual movement rate (birds/year; = ([H1 * I1] + [H2 * I2]), rounded to next whole number)	1,607	1,607	882	882
HORIZONTAL INTERACTION PROBABILITY (IPH)				
K) Turbine height (m)	100	100	100	100
L) Blade radius (m)	35.25	35.25	35.25	35.25
M) Height below blade (m)	29.5	29.5	29.5	29.5
N) Front-to-back width (m)	6	6	6	6
O) Minimal side profile area (m^2; = K * N)	600		600	
P) Maximal front profile area (m^2; = [M * N] + [π * L^2])		4,081		4,081
Q) Cross-sectional sampling area of radar at or below 100 m turbine height (= 3000 m * 100 m = 300,000 m^2)	300,000	300,000	300,000	300,000
R) Minimal horizontal interaction probability (= O/Q)	0.00200000		0.00200000	
S) Maximal horizontal interaction probability (= P/Q)		0.01360211		0.01360211
VERTICAL INTERACTION PROBABILITY (IPV)				
T) Proportion of petrels flying ≤ turbine height)	0.51	0.51	0.51	0.51

Table 2. Continued.

Variable/parameter	HAPE		NESH	
	Minimum	Maximum	Minimum	Maximum
EXPOSURE INDEX (ER = MVR * IPH * IPV)				
U) Daily exposure index (birds/turbine/day; = H * (R or S) * T; rounded to 8 decimal places)				
U1) Spring/summer	0.00642528	0.04369870	0.00428352	0.02913247
U2) Fall	0.00642528	0.04369870	0.00428352	0.02913247
V) Annual exposure index (birds/turbine/year; = J * (R or S) * T; rounded to 8 decimal places	1.63914000	11.14788498	0.89964000	6.11850314
FATALITY PROBABILITY (MP)				
W) Probability of striking turbine if in airspace on side approach	1.00	1.00	1.00	1.00
X) Probability of striking turbine if in airspace on frontal approach	0.20	0.20	0.20	0.20
Y) Probability of fatality if striking turbine[1]	1.00	1.00	1.00	1.00
Z1) Probability of fatality if an interaction on side approach (= W * Y)	1.00000		1.00000	
Z2) Probability of fatality if an interaction on frontal approach (= X * Y)		0.19500		0.19500
FATALITY INDEX (= ER * MP)				
Annual fatality rate with 90% exhibiting collision avoidance (birds/turbine/year; = V * (Z1 or Z2) * 0.1)	0.16391	0.21738	0.08996	0.11931
Annual fatality rate with 95% exhibiting collision avoidance (birds/turbine/year; = V * (Z1 or Z2) * 0.05)	0.08196	0.10869	0.04498	0.05966
Annual fatality rate with 99% exhibiting collision avoidance (birds/turbine/year; = V *(Z1 or Z2) * 0.01)	0.01639	0.02174	0.00900	0.01193

[1] Used 100% fatality probability due to ESA definition of "take"; however, actual probability of fatality with collision <100% (see methods).

rounding up to the nearest whole number), we estimate that 2–12 Hawaiian Petrels and 1–7 Newell's Shearwater fly within the space occupied by each wind turbine in an average year (Tables 2 and 4) and estimate that 1 Hawaiian Petrel and 1 Newell's Shearwater fly within the space occupied by the 65-m-high met tower in an average year (Tables 3 and 4). Note that all these calculations are exposure rates and, thus, include an unknown proportion of birds that would detect and avoid the turbines and met towers. Hence, exposure rates estimate how many times/year a petrel or shearwater would be exposed to wind turbines or met towers and not necessarily the number that actually would collide with those structures.

FATALITY MODELING

The individual steps and estimates involved in calculating fatality rates are shown in Table 2 (turbines) and Table 3 (met tower). We speculate that the proportions of birds that detect and avoid turbines and towers is substantial (see Discussion), but limited petrel- or shearwater-specific data are available to use for an estimate of the avoidance rates for those types of structures. Because it is necessary to estimate the fatality of petrels and shearwaters at the proposed project, however, we assumed that 90%, 95%, or 99% of all birds will be able to detect and avoid the towers and turbines. If we also assume that 100% of the birds colliding with a turbine/tower die (although see above), the ranges of annual fatalities are 0.016–0.217 Hawaiian Petrel/turbine/yr and 0.009–0.119 Newell's Shearwaters/turbine/year (Table 2). For the 65-m met tower, we estimate a fatality rate of 0.008–0.081 Hawaiian Petrel/tower/yr and 0.004–0.044 Newell's Shearwaters/tower/year (Table 3). For cumulative annual fatalities, the

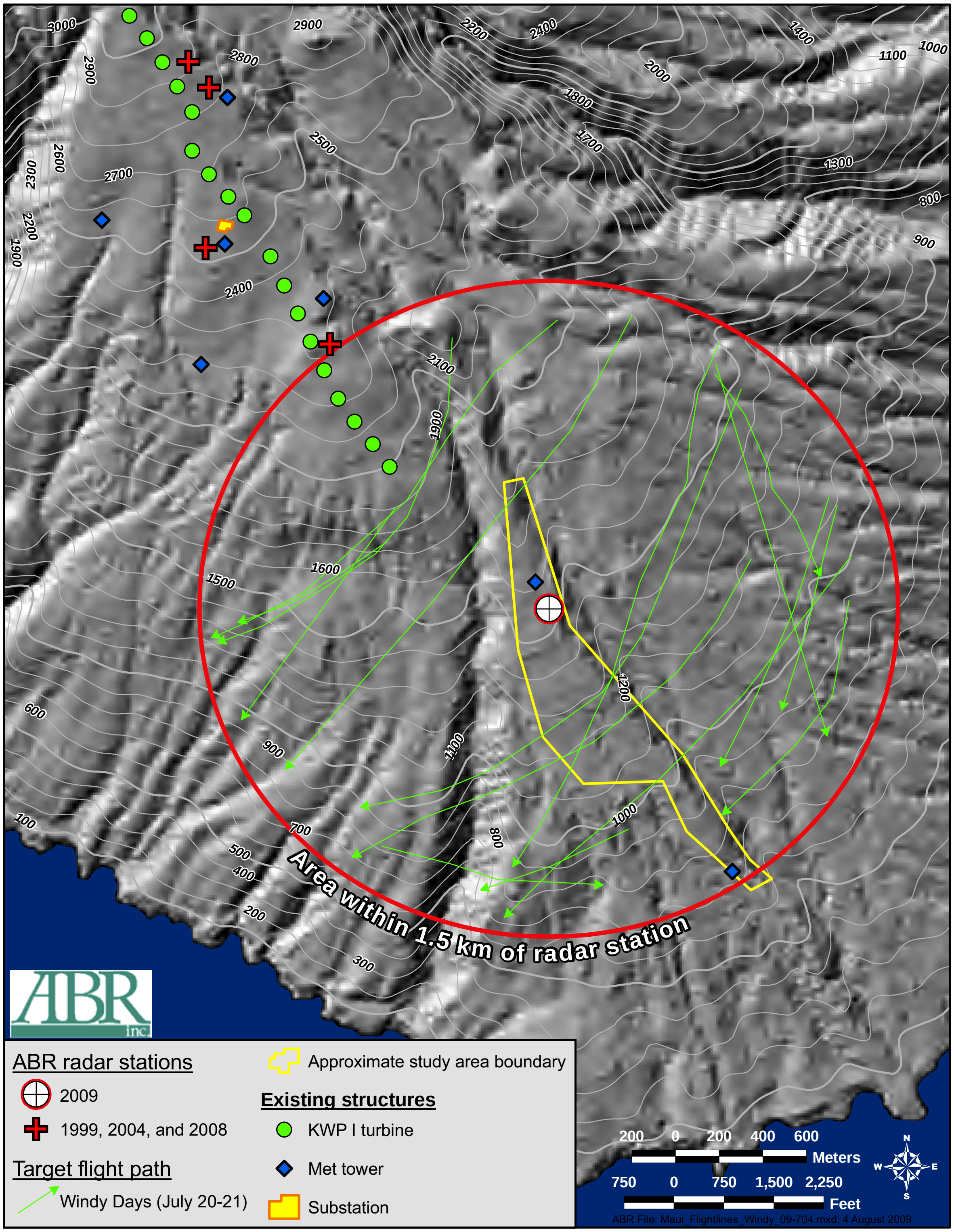


Figure 4. Location of flight paths of petrel-like radar targets observed during the strong wind conditions of 20–21 July 2009, at the KWP II Down-road Alternative wind energy facility, Maui, Hawaii.

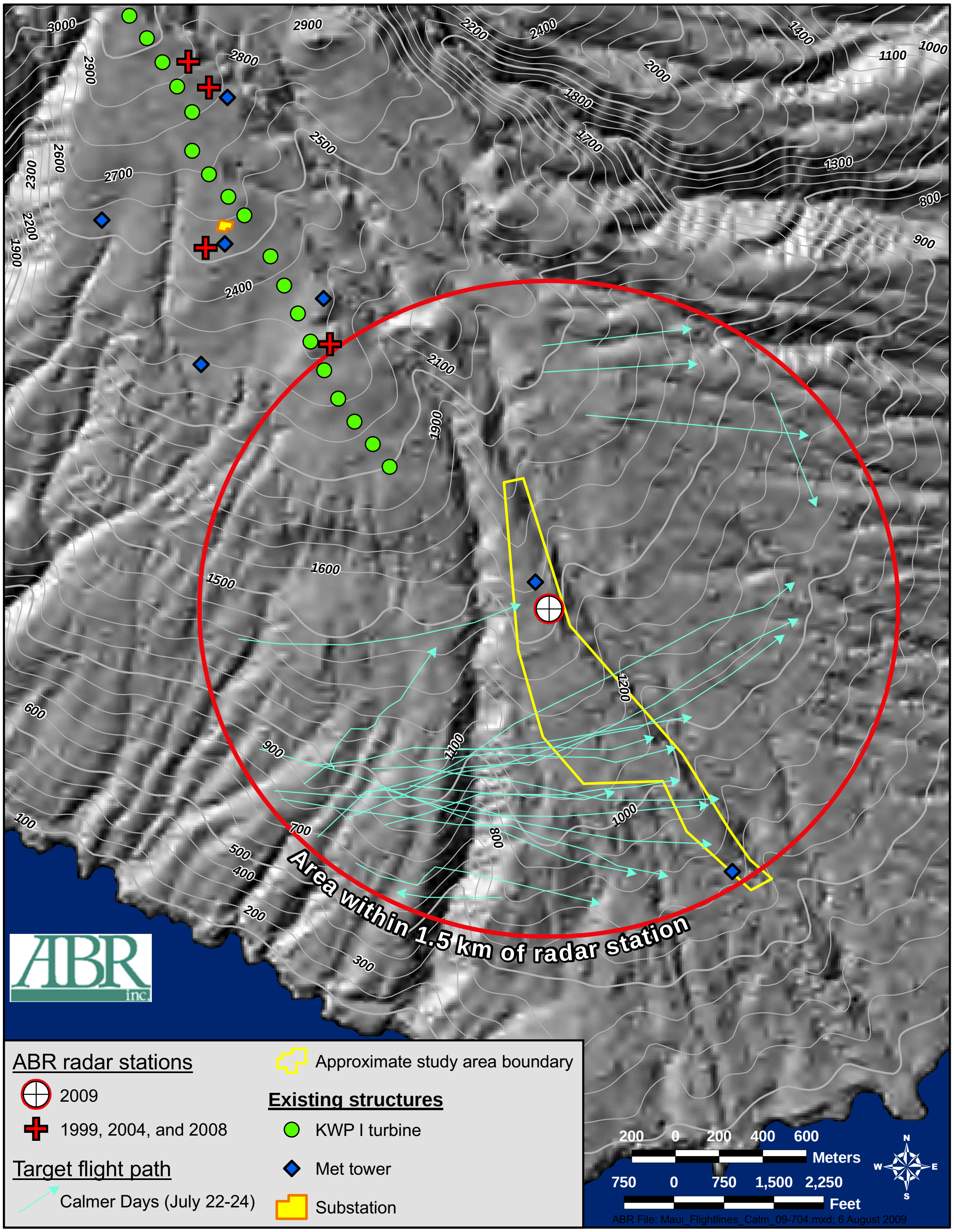


Figure 5. Location of flight paths of petrel-like radar targets observed during the light and variable wind conditions of 22–24 July 2009, at the KWP II Down-road Alternative wind energy facility, Maui, Hawaii.

Table 3. Estimated average exposure rates and fatality rates of Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at the proposed free-standing 65-m-tall met tower at the KWP II Down-road alternative wind-energy site, Maui, Hawaii, based on radar data collected in July 2009. Values of particular importance are in boxes.

Variable/parameter	HAPE	NESH
MOVEMENT RATE (MVR)		
A) Mean movement rate (targets/h)		
A1) Mean rate during nightly peak movement periods in spring/summer based on July 2009 data (targets/h)	1.776	1.776
A2) Mean rate during nightly peak movement periods in fall based on July 2009 data (targets/h)	1.776	1.776
B) Number of hours of evening and morning peak-period sampling	5	5
C) Mean number of targets during evening and morning peak-movement periods		
C1) Spring/summer (A1 * B)	8.88	8.88
C2) Fall (A2 * B)	8.88	8.88
D) Mean proportion of birds moving during off-peak h of night	0.126	0.126
E) Seasonal movement rate (targets/night) = ((C * D)+ C)		
e1) Spring/summer	10.0	10.0
e2) Fall	10.0	10.0
F) Mean number of birds/target	1.05	1.05
G) Estimated proportion of each species	0.60	0.40
H) Daily movement rate (birds/day =E*F*G)		
h1) Spring/summer	6.30	4.20
h2) Fall	6.30	4.20
I) Fatality domain (days/year)		
i1) Spring/summer	180	150
i2) Fall	75	60
J) Annual movement rate (birds/year; = ((H1*I1) + (H2*I2)), rounded to next whole number)	1,607	882
HORIZONTAL INTERACTION PROBABILITY (IPH)		
K) Maximal cross-sectional area of tower (side view =297 m²)	297.0	297.0
L) Cross-sectional sampling area of radar at or below 50 m tower height (= 3000 m * 65 m = 195,000 m²)	195000.000	195000.000
M) Average probability of radar target intersecting the met tower (= K/L, rounded to 8 decimal places)	0.00152308	0.00152308
VERTICAL INTERACTION PROBABILITY (IPV)		
N) Proportion of petrels flying ≤ tower height)	0.33	0.33
EXPOSURE INDEX (ER = MVR*IPH*IPV)		
O) Daily exposure index (birds/tower/day = H*M*N, rounded to 8 decimal places)		
O1) Spring/summer	0.00316612	0.00211075
O2) Fall	0.00316612	0.00211075
P) Annual exposure index (birds/tower/year = J*M*N, rounded to 8 decimal places)	0.80770292	0.44330677
FATALITY PROBABILITY (MP)		
Q) Probability of striking tower if in airspace	1.00	1.00
R) Probability of fatality if striking tower[1]	1.00	1.00
S) Probability of fatality if an interaction (= Q*R)	1.00000	1.00000
FATALITY INDEX (= ER*MP)		
T) Annual fatality rate with 90% exhibiting collision avoidance (birds/tower/year = P*S*0.1)	0.08077	0.04433
U) Annual fatality rate with 95% exhibiting collision avoidance (birds/tower/year = P*S*0.05)	0.04039	0.02217
V) Annual fatality rate with 99% exhibiting collision avoidance (birds/tower/year = P*S*0.01)	0.00808	0.00443

[1] Used 100% fatality probability due to ESA definition of "take", however actual probability of fatality with collision <100% (see methods).

annual fatality rate would be 0.229–3.043 Hawaiian Petrels/yr and 0.126–1.670 Newell's Shearwaters/yr for all 14 proposed wind turbines combined (Table 4). The cumulative annual fatalities at the one proposed met tower would be 0.008–0.081 Hawaiian Petrels/yr and 0.004–0.044 Newell's Shearwaters/yr (Table 4). We caution again, however, that the range of assumed avoidance rates of seabirds and turbines/towers (90–99%) is not fully supported by empirical data at this time.

DISCUSSION

MOVEMENT RATES AND FLIGHT BEHAVIOR

Within KWP, there has been some variation in mean movement rates among years and studies (Table 5), but all estimated rates have been low (i.e., between 0.5 and 1.8 targets/h). Thus, mean movement rates of Hawaiian Petrels recorded in the KWP study areas (i.e., ~1–2 targets/h; this study; Day and Cooper 1999, Cooper and Day 2004; Sanzenbacher and Cooper 2008, 2009) are much lower than those over the eastern and northern sides of Maui (Cooper and Day 2003).

Our limited data (i.e., five sampling nights) from the current study suggest that patterns of movement may have been affected by the wind regime. We found that shearwater/petrels mostly flew in an outbound movement towards the southwest during strong Trade Winds and flew inbound toward the east during light and variable winds (i.e., at wind speeds that apparently were below the cut-in speed of the KWP I turbines that were not spinning at the time). Our limited data also suggested that the passage rates might be higher over the lower (southern) end of the study area than elsewhere during calm conditions, though, again note that we only had two nights of sampling during strong winds and three nights during light winds. The flight directions of the targets observed during light winds suggest that they were birds approaching Maui from the west and "cutting the corner" of West Maui on their way to breeding colonies on Haleakala.

VISUAL OBSERVATIONS OF PETRELS AND SHEARWATERS

In total, we have had three visual observations of Hawaiian Petrels and two observations of unidentified shearwaters/petrels over the KWP study areas during 1999–2009 (Table 6; Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009; this study). The birds observed in the evening period were headed easterly or northeasterly, and the birds observed in the morning were heading southeasterly or southwesterly. These directions fit a pattern of inbound movements toward Haleakala in the evening and outbound movements from Haleakala and/or West Maui in the morning.

Flight altitudes of the two birds that we observed over the proposed turbine-string ridges were within turbine heights (i.e., one was at 40 m agl and the other was at 65 m agl; Table 6). The flight altitudes of the other three birds were much higher (i.e., 300–500 m agl), but they were measured over the valley to the east; hence, we not know what their flight altitudes were as they flew over the ridges on which the turbine strings lie. Thus, it is possible that visual altitude data is biased to detecting lower-flying birds, the very limited data that we have for known flight altitudes (n = 2) suggest that a substantial proportion of petrels may have flown within the turbine-height zone.

In our fatality models, we used the timing of inland flights at the nearby Ukumehame site from Cooper and Day (2003) to correct for proportions of targets that were Hawaiian Petrels and those that were Newell's Shearwaters; those data suggested that 60% of the targets were Hawaiian Petrels and 40% of the targets were Newell's Shearwaters. However, the timing of two of the three Hawaiian Petrels that we saw over the site (Table 6) occurred during the late evening, a period when Cooper and Day (2003) assumed that only Newell's Shearwaters would occur. Thus, these visual observations suggest the possibility that more than 60% of the radar targets we observed in the current study could have been Hawaiian Petrels. We do not recommend changing the relative proportions of Hawaiian Petrels vs. Newell's Shearwaters in the fatality model, however, unless further data are collected to confirm this pattern.

Table 4. Summary of exposure rates, fatality rates, and cumulative fatality rates for Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at wind turbines and meteorological (met) towers at the proposed KWP II Down-road Alternative wind-energy site, Maui, Hawaii, based on radar data collected in July 2009.

	Exposure rate/structure (birds/structure/yr)			Fatality rate/structure (birds/structure/yr)			Cumulative fatality rate (birds/yr)	
Structure type	HAPE	NESH	Avoidance rate	HAPE	NESH	No. structures	HAPE	NESH
GE 1.5 MW turbine	1.639 (min)	0.900 (min)	0.90 (min)	0.164	0.090	14.00	2.295	1.259
	11.148 (max)	6.119 (max)	0.90 (max)	0.217	0.119	14.00	3.043	1.670
			0.95 (min)	0.082	0.045	14.00	1.147	0.630
			0.95 (max)	0.109	0.060	14.00	1.522	0.835
			0.99 (min)	0.016	0.009	14.00	0.229	0.126
			0.99 (max)	0.022	0.012	14.00	0.304	0.167
65-m free-standing met tower	0.808	0.443	0.90	0.081	0.044	1.00	0.081	0.044
			0.95	0.040	0.022	1.00	0.040	0.022
			0.99	0.008	0.004	1.00	0.008	0.004

Table 5. Mean (± SE) movement rates of petrel-like targets measured with radar at the KWP wind-energy site and proposed KWP II wind-energy sites, Maui, Hawaii, during 1999–2009 studies.

		Movement rate (targets/h)		
Year	Site	Summer	Fall	Source
1999	KWP I	1.2 ± 0.3	–	Day and Cooper (1999)
2004	KWP I	–	1.0 ± 0.2	Cooper and Day (2004)
2008	KWP II	0.46 ± 0.15	0.09 ± 0.07	Sanzenbacher and Cooper (2008. 2009)
2009	KWP II Alternate	1.78 ± 0.14	–	current study

Table 6. Records of Hawaiian Petrels and unidentified shearwaters/petrels at the proposed KWP II wind-energy site and nearby KWP I wind-energy site, Maui, Hawaii, during 1999–2009 studies.

Date	Time	Species[1]	Number	Altitude (m agl)	Flight direction
28 May 1999	2150	HAPE	1	300[2]	NE
28 May 1999	0608	UNSP	2	500[2]	SE
12 October 2004	0608	HAPE	1	500[2]	SE
15 October 2004	0454	UNSP	1	65	SW
24 July 2009	2126	HAPE	1	40	E

[1] HAPE = Hawaiian Petrel; UNSP = unidentified shearwater/petrel.
[2] Flight altitude measured over the valley to east of the proposed turbine string ridge, not over the proposed turbine string ridge itself; measurements were done that way because that is where birds were first seen.

EXPOSURE RATES AND FATALITY ESTIMATES

We estimated that 2–12 Hawaiian Petrels and 1–7 Newell’s Shearwater would fly within the space occupied by each wind turbine in an average year and estimated that 1 Hawaiian Petrel and 1 Newell’s Shearwater would fly within the space occupied by the 65-m-high met tower in an average year (Table 4). We used these estimated exposure rates as a starting point for developing a complete avian risk assessment; however, we emphasize that it currently is unknown whether bird use (i.e., exposure) and fatality at windfarm structures are strongly correlated. For example, Cooper and Day (1998) found no relationship between movement rates and fatality rates of Hawaiian Petrels and Newell’s Shearwaters at powerlines on Kaua’i, indicating that other factors had a much greater effect on causing fatality than movement rates did. For example, other factors such as proximity to the ocean or poor weather could be more highly correlated with fatality rates than is bird abundance. As an example, collisions of Laysan Albatross with a large array of communication-tower antenna wires and guy wires adjacent to large, high-density albatross breeding colonies on Midway Atoll occurred at a far higher rate during periods of high winds, rain, and poor visibility than during periods of better weather: 838 (>25%) of the 2,901 birds killed during the study were killed during two storms (Fisher 1966). To determine which factors are most relevant, future studies that collect concurrent data on movement rates, weather, and fatality rates would be useful to begin to determine whether movement rates and/or weather conditions can be used to predict the likelihood of petrel fatalities at wind turbines and other structures across the entire proposed windfarm.

In addition, few data are available on the proportion of petrels and shearwaters that do not collide with wind turbines or met towers because of collision-avoidance behavior (i.e., birds that completely alter their flight paths horizontally and/or vertically to avoid flying through the space occupied by a turbine/tower). Clearly, the detection of wind turbines or other structures could result in collision-avoidance behavior by these birds and reduce the likelihood of collision. There also appear to be differences between petrels and shearwaters in their ability to avoid obstacles. For example, Cooper and Day (1998) indicated that Hawaiian Petrels have flight characteristics that make them more adept at avoiding powerlines than Newell’s Shearwaters, suggesting that Hawaiian Petrels might also be more likely to avoid collisions with other structures such as wind turbines. These authors also suggested that the tendency for Hawaiian Petrels to approach and leave nesting colonies primarily during crepuscular periods enables these birds to see and avoid structures (e.g., wind turbines) more easily than do Newell’s Shearwaters that approach and leave nesting colonies primarily during nocturnal periods.

Some collision-avoidance information is available on petrels and shearwaters from earlier work that we conducted on Kaua’i (Cooper and Day 1998; Day et al., *In review*). In summary, those data suggest that the behavioral-avoidance rate of Hawaiian Petrels and Newell’s Shearwaters near powerlines is high. For example, across all 207 Hawaiian Petrels observed flying within 150 m of transmission lines on Kauai, 40 exhibited behavioral responses; of those 40 birds that exhibited collision-avoidance responses, none (0%) collided with a transmission line. Thus, the collision-avoidance rate for Hawaiian Petrels was 100% (i.e., 40 of 40 interactions). Across all 392 Newell’s Shearwaters observed flying within 150 m of transmission lines, 29 exhibited behavioral responses; of those 29 birds that exhibited collision-avoidance responses, none (0%) collided with a transmission line. However, one Newell's Shearwater that did not exhibit a collision-avoidance response hit a transmission line. Thus, the collision-avoidance rate for Newell’s Shearwaters was 97% (i.e., 29 of 30 interactions).

There also is some information available on collision-avoidance of Hawaiian Petrels on Lana’i, where the behavior of petrels was studied as they approached large communication towers near the breeding colony (TetraTech 2008; Day et al., *In review*). In that study, all 20 (100%) of the Hawaiian Petrels seen on a collision-course toward communication towers exhibited avoidance behavior and avoided collision.

Additional data that provides some insight on collision-avoidance behavior of petrels and shearwaters at windfarm structures (e.g., wind turbines and met towers) are available from other studies associated with the operational KWP I wind facility. There was 1 Hawaiian Petrel fatality and 0 Newell’s Shearwater fatalities observed at the 20-turbines and three met towers in the first 3.5 years of operation (G. Spencer, FirstWind, pers. comm.). Calculations using data for scavenging bias and searcher efficiency collected at the KWP I wind facility indicate that the one observed fatality equates to a corrected direct take of 0.5 Hawaiian Petrels/yr and 0 Newell’s Shearwaters/yr (Kaheawa Wind Power LLC 2009, *in prep*). Cooper and Day (2004b) modeled seabird fatality for the KWP I wind turbines, based on movement rates from radar studies at the site (Day and Cooper 1999; Cooper and Day 2004a, 2004b), and estimated that the combined annual fatality of Hawaiian Petrels and Newell’s Shearwaters at the KWP I turbines would be ~3–18 birds/yr with a 50% avoidance rate, ~1–2 birds/yr with a 95% avoidance rate, and <1 bird/yr with a 99% avoidance rate. Thus, the fatality model that used a 99% avoidance value was a closer fit with the measured fatality rates than was the fatality models that used a 50% or 95% avoidance rate.

In summary, currently available data from Kaua’i, Lana’i, and Maui suggest that the avoidance rate of petrels and shearwaters at transmission lines and communications towers is high and approaches 100% (Day et al., *in review*). Data from the fatality searches at turbines and met towers on Maui are more difficult to interpret because they suggest high avoidance but are not a direct measure of avoidance; however those data also suggest that avoidance of those structures must be occurring because only one Hawaiian

Petrel has been found during regular fatality searches of those structures over a 3.5-year period. Thus, the overall body of evidence, while incomplete, is consistent with the hypothesis that the average avoidance rate of wind turbines and met towers is substantial and potentially is ≥95%. The ability of Hawaiian Petrels and Newell's Shearwater to detect and avoid most objects under low-light conditions makes sense from a life-history standpoint, in that they forage extensively at night and are adept at flying through forests near their nests during low light conditions.

In addition to the limited data available for Hawaiian Petrels and Newell's Shearwaters, there is evidence that many other species of birds detect and avoid structures (e.g., wind turbines, met towers) during low-light conditions (Winkelman 1995, Dirksen et al. 1998, Desholm and Kahlert 2005, Desholm et al. 2006). For example, seaducks in Europe have been found to detect and avoid wind turbines >95% of the time (Desholm 2006). Further, natural anti-collision behavior (especially alteration of flight directions) is seen in migrating Common and King eiders (*Somateria mollissima* and *S. fischeri*) approaching human-made structures in the Beaufort Sea off of Alaska (Day et al. 2005) and in diving ducks approaching offshore windfarms in Europe (Dirksen et al. 1998). Collision-avoidance rates around wind turbines are high for Common Eiders in the daytime (Desholm and Kahlert 2005), gulls (*Larus* spp.) in the daytime (>99%; Painter et al. 1999, cited in Chamberlain et al. 2006), Golden Eagles (*Aquila chrysaetos*) in the daytime (>99%; Madders 2004, cited in Chamberlain et al. 2006), American Kestrels (*Falco sparverius*) in the daytime (87%, Whitfield and Band [in prep.], cited in Chamberlain et al. 2005), and passerines during both the day and night (>99%; Winkelman 1992, cited in Chamberlain et al. 2006).

We agree with others (Chamberlain et al. 2006, Fox et al. 2006) that species-specific, weather-specific, and site-specific avoidance data are needed in models to estimate fatality rates accurately. However, the currently available avoidance data from Kaua'i and Lana'i for Hawaiian Petrels and Newell's Shearwaters and the petrel fatality data at KWP I wind turbines and met towers while incomplete, is consistent with the notion that a substantial proportion of petrels detect and avoid wind turbines, marked met towers, communication towers, and powerlines under normal ranges of weather conditions and visibility (but note that avoidance rates could be lower under inclement conditions). Until further petrel- and shearwater-specific data on the relationship between exposure and fatality rates are available for structures at windfarms, we continue to provide a range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance), along with a discussion of the body of evidence that, while incomplete at this time, is consistent with the notion that the average avoidance-rate value is substantial and potentially is ≥95%. With an assumption of a 95% avoidance rate, the estimated average annual take at the KWP II Downroad Alternative would be ≤0.1 Hawaiian Petrel/turbine/yr and ≤0.06 Newell's Shearwaters/turbine/yr and, for met towers, fatality would be 0.04 Hawaiian Petrel/tower/yr and 0.02 Newell's Shearwaters/tower/yr.

Other factors could affect our estimates of fatality in either a positive or a negative direction. One factor that would have created a positive bias was the inclusion of targets that were not petrels or shearwaters. Our visual observations of several other species with similar target characteristics to petrels (especially during crepuscular periods, when we could use binoculars) helped to minimize the inclusion of these non-target species, but it is possible (especially during nocturnal conditions) that some of our radar targets were other fast-flying species that were active during the sampling period (e.g., Pacific Golden-Plover [*Pluvialis fulva*]). A second positive bias in our fatality model is our simplistic assumption that movement rates of seabirds do not fall as individual fatalities occurred (i.e., we assumed sampling with replacement for fatalities). Given the low movement rates observed in this study, it is likely that the fatality of just a single bird would substantially reduce the average nightly movement rates. A third positive bias is the assumption that turbines are operating at maximal rotor speed; this assumption clearly is incorrect because of variability in winds, but using it results in maximal estimates of collision rates for birds flying through the turbine rotors.

There also are factors that could create a negative bias in our fatality estimates. One example would be if targets were missed because they flew within radar shadows. Because the sampling stations provided good coverage of the surrounding area, we believe that the proportion of targets that was missed because they passed through the entire area of coverage of the study area within a radar shadow was minimal.

A factor that could affect the predictive value of our fatality estimates in either direction is interannual variation in the number of birds visiting nesting colonies on Maui. Average hourly movement rates for the current study (= ~1.8 targets/h), from 2004 (summer = ~0.5 targets/h; fall = ~0.1 targets/h; Sanzenbacher and Cooper 2008, 2009), from summer 1999 (1.2 targets/h; Day and Cooper 1999), and from fall 2004 (1.0 targets/h; Cooper and Day 2004a) all suggest that rates are consistently low at the KWP project areas relative to other areas on Mauai, and that interannual variation in that overall level of bird use of the area is minimal. Some caution in extrapolation of movement rates across years is still warranted, however, because there are examples of other sites with high interannual variation in counts, such as the three sites on Kaua'i where counts were ~100–300 birds/hr lower (~four times lower) in fall 1992 than in fall 1993; the lower counts in 1992 were attributed to the effects of Hurricane Iniki (Day and Cooper 1995). Oceanographic factors (e.g., El Niño–Southern Oscillation events) also vary among years and are known to affect the distribution, abundance, and reproduction of seabirds (e.g., Ainley et al. 1994, Oedekoven et al. 2001). Another factor that could cause interannual variation in counts in either direction is overall population increases or declines. For example, there was a ~60% decline in radar counts on Kaua'i between 1993 and 1999–2001 that was attributed to population declines of Newell's Shearwaters (Day et al. 2003b).

CONCLUSIONS

We used our risk-assessment model to estimate the number of Hawaiian Petrels and Newell's Shearwaters that might be killed by collisions with wind turbines and met towers at the proposed KWP II Down-road Alternative facility. The model is affected by several input variables, including the collision-avoidance rate. The absence behavioral studies to fully quantify avoidance rates at wind turbines and met towers precludes determination of actual avoidance rates; however, a growing body of evidence suggests that a high percentage of petrels and shearwaters detect and avoid structures such as communication towers, transmission lines, and wind turbines (see above). We also suspect high rates of anti-collision behaviors because petrels must rely upon acute nocturnal vision for foraging and other flight activities under varying weather conditions. In conclusion, we believe that the proportion of petrels that would see and avoid proposed wind turbines at the KWP II Down-road Alternative will be high, but until studies are conducted to quantify avoidance behavior at wind turbines and met towers, we provide a range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance rates) along with a discussion of the body of evidence that is consistent with the hypothesis that the average avoidance-rate value is substantial and potentially ≥95%. With an assumption of 95% avoidance, the estimated average annual take at the proposed KWP II Down-road Alternative wind turbines would be ≤0.1 Hawaiian Petrel/turbine/yr and ≤0.06 Newell's Shearwaters/turbine/yr. The estimated average annual take at the proposed KWP II Down-road Alternative met tower (with an assumption of 95% avoidance) would be 0.04 Hawaiian Petrel/tower/yr and 0.02 Newell's Shearwaters/tower/yr.

LITERATURE CITED

Ainley, D. G., R. Podolsky, L. DeForest, and G. Spencer. 1997a. New insights into the status of the Hawaiian Petrel on Kauai. Colonial Waterbirds 20: 24–30.

Ainley, D. G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 1995. Kauai Endangered Seabird Study, Vol. 2: The ecology of Dark-rumped Petrels and Newell's Shearwaters on Kauai, Hawaii. Electric Power Research Institute, Palo Alto, CA. Final Report No. TR-105847-V2. 74 pp.

Ainley, D. G., W. J. Sydeman, S. A. Hatch, and U. W. Wilson. 1994. Seabird population trends along the west coast of North America: causes and extent of regional concordance. Studies in Avian Biology 15: 119–133.

Ainley, D. G., T. C. Telfer, and M. H. Reynolds. 1997b. Townsend's and Newell's Shearwater (*Puffinus auricularis*). *In* A. Poole and F. Gill, eds. The birds of North America, No. 297. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC. 20 pp.

American Ornithologists' Union. 1998. Check-list of North American birds. 7th ed. American Ornithologists' Union, Washington, DC. 829 pp.

Banko, W. E. 1980a. Part I. Population histories—species accounts. Sea birds: Hawaiian Dark-rumped Petrel ('Ua'u). Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Honolulu, HI. CPSU/UH Avian History Report 5B: History of Endemic Hawaiian Birds. 42 pp.

Banko, W. E. 1980b. Part I. Population histories—species accounts. Sea birds: Newell Shearwater ('A'o). Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Honolulu, HI. CPSU/UH Avian History Report 5B: History of Endemic Hawaiian Birds. 35 pp.

Brandt, C. A., J. K. Parrish, and C. N. Hodges. 1995. Predictive approaches to habitat quantification: Dark-rumped Petrels on Haleakala, Maui. Auk 112: 571–579.

Chamberlain, D. E., S. Freeman, M. R. Rehfisch, A. D. Fox, and M. Desholm. 2005. Appraisal of Scottish Natural Heritage's wind farm collision risk model and its application. British Trust for Ornithology, Norfolk, United Kingdom. Report No. 401. 51 pp.

Chamberlain, D. E., M. R. Rehfisch, A. D. Fox, M. Desholm, and S. J. Anthony. 2006. The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models. Ibis 148: 198–202.

Conant, S. 1980. Recent records of the 'Ua'u (Dark-rumped Petrel) and the 'A'o (Newell's Shearwater) in Hawaii. 'Elepaio 41: 11–13.

Cooper, B. A., and R. H. Day. 1995. Kauai Endangered Seabird Study, Vol. 1: Interactions of Dark-rumped Petrels and Newell's Shearwaters with utility structures on Kauai, Hawaii. Electric Power Research Institute, Palo Alto, CA. Final Report No. TR-105847-V1. 170 pp.

Cooper, B. A., and R. H. Day. 1998. Summer behavior and mortality of Dark-rumped Petrels and Newell's Shearwaters at power lines on Kauai. Colonial Waterbirds 21: 11–19.

Cooper, B. A., and R. H. Day. 2003. Movement of Hawaiian Petrels to inland breeding sites on Maui Island, Hawaii. Waterbirds 26: 62–71.

Cooper, B. A., and R. H. Day. 2004a. Results of endangered bird and bat surveys at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004. Unpublished report prepared for Kaheawa Windpower LLC, Makawao, HI, and UPC Wind Management LLC, Newton, MA, by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 16 pp.

Cooper, B. A., and R. H. Day. 2004b. Modeling annual seabird use and fatality at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004. Unpublished report prepared for Kaheawa Windpower LLC, Makawao, HI, and UPC Wind Management LLC, Newton, MA, by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 7 pp.

Cooper, B. A., R. H. Day, R. J. Ritchie, and C. L. Cranor. 1991. An improved marine radar system for studies of bird migration. Journal of Field Ornithology 62: 367–377.

Day, R. H., and B. A. Cooper. 1995. Patterns of movement of Dark-rumped Petrels and Newell's Shearwaters on Kauai. Condor 97: 1011–1027.

Day, R. H., and B. A. Cooper. 1999. Results of endangered bird and bat surveys at the proposed Kaheawa Pastures Windfarm on Maui Island, Hawaii, summer 1999. Unpublished report prepared for Zond Pacific, Wailuku, HI, by ABR, Inc., Fairbanks, AK, and Forest Grove, OR. 26 pp.

Day, R. H., and B. A. Cooper. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June 2002. Unpublished report prepared for National Park Service, Hawaii National Park, HI, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK, and Forest Grove, OR. 17 pp.

Day, R. H., B. A. Cooper, and R. J. Blaha. 2003a. Movement patterns of Hawaiian Petrels and Newell's Shearwaters on the island of Hawai'i. Pacific Science 57: 147–159.

Day, R. H., B. A. Cooper, T. J. Mabee, J. H. Plissner, P. M. Sanzenbacher, and A. Oller. In review. Collision-avoidance behavior of Hawaiian Petrels and Newell's Shearwaters in the Hawaiian Islands. Waterbirds.

Day, R. H., B. A. Cooper, and T. C. Telfer. 2003b. Decline of Newell's Shearwaters on Kauai, Hawaii. Auk 120: 669–679.

Day, R. H., A. K. Prichard, and J. R. Rose. 2005. Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001–2004. Unpublished final report prepared for BP Exploration (Alaska), Inc., Anchorage, AK, by ABR, Inc.—Environmental Research and Services, Fairbanks, AK. 142 pp.

Desholm, M. 2006. Wind farm related mortality among avian migrants. Ph.D. thesis, University of Copenhagen, Copenhagen, Denmark. 128 pp.

Desholm, M., A. D. Fox, P. D. L. Beasley, and J. Kahlert. 2006. Remote techniques for counting and estimating the number of bird-wind turbine collisions at sea: a review. Ibis: 148: 76–89.

Desholm, M. and J. Kahlert. 2005. Avian collision risk at an offshore windfarm. Biology Letters 1: 296–298.

Dirksen, S. E., A. L. Spaans, and J. Winden. 1998. Nocturnal collision risks with wind turbines in tidal and semi-offshore areas. Pp. 99–108 *In* Proceedings of International Workshop on Wind Energy and Landscape, Genua, 26–27 July 1997. Balkema, Rotterdam, The Netherlands.

First Wind. 2008. Kaheawa Pastures wind energy generation facility Habitat Conservation Plan: Year 2 HCP Implementation, July 2007–June 2008. Unpublished report prepared by First Wind, Newton, MA and Kaheawa Wind Power, Wailuku, HI. 26 pp. + appendices.

Fisher, H. I. 1966. Midway's deadly antennas. Audubon Magazine, July–August 1966. Pp. 220–223.

Fox, A. D., M. Desholm, J. Kahlert, T. K. Christensen, and I. K. Petersen. 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis 148: 129–144.

Gon, S. M., III. 1988. Observations of the 'Ua'u (Hawaiian Petrel) in the Hono O Pali Natural Area Reserve, Island of Kauai. 'Elepaio 48: 113.

Hirai, L. T. 1978a. Native birds of Lanai, Hawaii. Western Birds 9: 71–77.

Hirai, L. T. 1978b. Possible Dark-rumped Petrel colony on Lanai, Hawaii. 'Elepaio 38: 71–72.

Hodges, C. S. N. 1992. 'Ua'u observation at proposed site for antenna farm. Unpublished memorandum by Haleakala National Park, Makawao, HI, 2 pp.

Hu, D., C. Glidden, J. S. Lippert, L. Schnell, J. S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian Dark-rumped Petrels on Mauna Loa, Hawai'i. *In* J. M. Scott, S. Conant, and C. van Riper III, eds. Evolution, ecology, conservation, and management of Hawaiian birds: a vanishing avifauna. Studies in Avian Biology 22: 234–242.

Kaheawa Wind Power LLC. 2006. Kaheawa Pastures Wind Generation Facility Habitat Conservation Plan. Kaheawa Wind Power, LLC, Ukumehame, Maui, HI. 87 pp. + attachments.

Kaheawa Wind Power, LLC. 2009 (*in prep*). Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 3 Annual Report. First Wind Energy, LLC, Environmental Affairs, Newton, MA.

Mabee, T. J., J. H. Plissner, B. A. Cooper, and D. P. Young. 2006. Nocturnal bird migration over an Appalachian ridge at a proposed wind power project. Wildlife Society Bulletin 34: 682–690.

Nishibayashi, E. 1997. Downed wildlife surveys at six leeward West Maui monitoring towers. Unpublished report prepared for Zond Pacific, Wailuku, HI, by Eric Nishibayashi Biological Consulting, Kahului, HI. 10 pp.

Oedekoven, C. S., D. G. Ainley, and L. B. Spear. 2001. Variable responses of seabirds to change in marine climate: California Current, 1985–1994. Marine Ecology Progress Series 212: 265–281.

Podolsky, R., D. G. Ainley, G. Spencer, L. DeForest, and N. Nur. 1998. Mortality of Newell's Shearwaters caused by collisions with urban structures on Kauai. Colonial Waterbirds 21: 20–34.

Pyle, R. L. 1983. Hawaiian Islands Region (1 June–31 July 1983). American Birds 37: 1028–1029.

Pratt, T. K. 1988. Recent observations, March–May 1988. 'Elepaio 48: 65–66.

Reynolds, M. H., B. A. Cooper, and R. H. Day. 1997. Radar study of seabirds and bats on windward Hawaii. Pacific Science 51: 97–106.

Reynolds, M. H., and G. L. Richotte. 1997. Evidence of Newell's Shearwater breeding in Puna District, Hawaii. Journal of Field Ornithology 68: 26–32.

Richardson, F., and D. H. Woodside. 1954. Rediscovery of the nesting of the Dark-rumped Petrel in the Hawaiian Islands. Condor 56: 323–327.

Sanzenbacher, P. M., and B. A. Cooper. 2008. Radar and visual studies of seabirds at the KWP I and KWP II wind energy facilities, Maui Island, Hawaii: use of 2008 data to model annual collision fatalities at meteorological towers. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 21 pp.

Sanzenbacher, P. M., and B. A. Cooper. 2009. Radar and visual studies of seabirds at the KWP II wind energy facility, Maui Island, Hawaii: use of 2008 data to model annual collision fatalities at proposed wind turbines. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 20 pp.

Serventy, D. L., V. Serventy, and J. Warham. 1971. The handbook of Australian seabirds. A. H. and A. W. Reed, Sydney, Australia. 254 pp.

Shallenberger, R. J. 1974. Field notes. 'Elepaio 35: 18–20.

Simons, T. R. 1984. A population model of the endangered Hawaiian Dark-rumped Petrel. Journal of Wildlife Management 48: 1065–1076.

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

Simons, T. R., and C. N. Hodges. 1998. Dark-rumped Petrel (*Pterodroma phaeopygia*). *In* A. Poole and F. Gill, eds. The birds of North America, No. 345. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC. 24 pp.

Sincock, J. L., and G. E. Swedberg. 1969. Rediscovery of the nesting grounds of Newell's Manx Shearwater (*Puffinus puffinus newelli*), with initial observations. Condor 71: 69–71.

SPSS. 2005. SPSS for Windows, version 14.0. SPSS, Inc., Chicago, IL.

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin 15: 406–413.

TetraTech EC. 2008. Draft Habitat Conservation Plan for the construction and operation of Lanai met towers, Lanai, Hawaii (Revised February 8, 2008, TTEC-PTLD-2008-080). Unpublished report prepared by Tetratech EC, Honolulu, HI, for Castle and Cooke LLC, Lanai City, HI. 52 pp. + appendices. Available at: http://www.state.hi.us/dlnr/dofaw/pubs/Lana'i_Met_Towers_HCP.pdf.

USFWS (U.S. Fish & Wildlife Service). 2008. Midway Atoll National Wildlife Refuge. USFWS refuge website. Available at: http://www.fws.gov/midway/.

Warham, J. 1990. The petrels: their ecology and breeding systems. Academic Press. New York, NY. 440 pp.

Winkelman, J. E. 1995. Bird/wind turbine investigations in Europe. Pages 43–47 and 110–140 *in* LGL Ltd., ed. Proceedings of National Avian–Wind Power Planning Meeting I, Denver, CO. Available at: http://www.nationalwind.org/publications/wildlife/avian94/default.htm.

Appendix 4

Wildlife Education and Observation Program

Purpose	To educate project employees and other on-site personnel in the observation, identification and treatment of wildlife
Approach	In conjunction with regular assigned duties, all personnel will: - attend wildlife education briefings conducted in cooperation with DOFAW and USFWS; - monitor wildlife activity while on the site; - identify key species when possible (Hawaiian Petrel, Newell's Shearwater, Nene and Hawaiian Hoary Bat); - document specific observations with the filing of a Wildlife Observation Form; - identify, report and handle any downed wildlife in accordance with the Downed Wildlife Protocol, including filing a Downed Wildlife Monitoring Form – Incidence Report; - respond and treat wildlife appropriately under all circumstances.
Notes	All personnel will avoid approaching any wildlife other than downed wildlife; avoid any behavior that would startle or harass any wildlife; and not feed any wildlife.

Descriptions and Photographs
Follow

Hawaiian Petrel	
Description	16 inches, 36-inch wingspan. Head, wings and tail are sooty-colored, contrasting with slightly paler back. Forehead and underparts are white; tail is short. Feet are bi-colored pink and black. Downy chicks are charcoal gray.
Voice	Distinctive call heard at breeding colonies is a repeated moaning “ooh-ah-ooh.” At their burrows, birds also produce a variety of yaps, barks and squeals.
Habits	The Hawaiian Petrel is generally seen close to the main Hawaiian islands during breeding season; otherwise, it is a pelagic species. The flight is characterized by high, steeply-banked arcs and glides; the wings are long and narrow. Breeding extends from March to October. One white egg is laid within deep burrows or under rocks. Adults arrive in colonies well after dark. As the chicks develop, parental care becomes less frequent and adults leave the colony each year two to three weeks before the chicks. Adults feed on squid, fish and crustaceans, and pass food to chicks by regurgitation. Predation by introduced rats, cats and mongooses is a serious threat to this species.

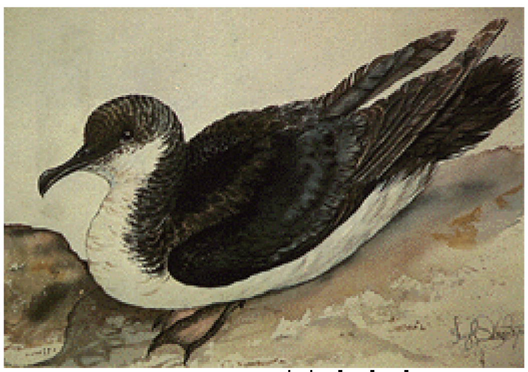
HNP/C. Hodges

HVNP/W. Banko

source: http://pacificislands.fws.gov/wesa/uau.html

source: http://www.birdinghawaii.co.uk/xHawaiianPetrel2.htm

Newell’s Shearwater	
Description	12 – 14 inches, 30 – 35-inch wingspan. Black above and white below. The white extends from the throat to the black undertail coverts. Sharp contrast of dorsal/ventral color is more distinct than in larger, more common Wedge-tailed Shearwater. Bill, legs and toes are dark; webbing between toes is pink.
Voice	Around nesting colony, a variable, jackass-like braying and crow-like calling.
Habits	The flight of the Newell’s Shearwater is characterized by rapid, stiff wingbeats and short glides. This species occurs in Hawaiian waters during the breeding season (April to November); it flies to nesting colonies only after dark, departing before dawn. Birds are highly vulnerable to predation by rats and cats. Many fledglings departing the colonies in late fall are attracted to urban lights and fall on highways or other brightly-lit areas.



Painting by Sheryl Ives Boynton

source: http://pacificislands.fws.gov/wesa/ao.html

source: http://audubon2.org/webapp/watchlist/viewSpecies.jsp?id=141

source: http://www.birdinghawaii.co.uk/XNewells2.htm

Nene	
Description	22 – 26 inches, sexes similar. A medium-sized goose with black head and nape that contrasts with yellow-buff cheek. Neck is also buffy but with dark brown furrows. Heavily barred gray-brown above; lighter barrel below. Bill and partially-webbed feet are black. Adults weigh approximately 4 pounds, males are larger.
Voice	Call is a loud "haw" or "haw-ah," resembling honking of the Canada Goose. Also gives a variety of muted calls, often resembling the "moo" of a cow.
Habits	Nene frequent scrubland, grassland, golf courses, and sparsely-vegetated slopes and, on Kaua`i, open lowland country. They feed on a variety of native and introduced plants. The breeding season extends from November to June. The nest is a down-lined bowl usually well-concealed under bushes; two to five white eggs are laid. Approximately 85 Nene have been released at Hanaula since 1995 as part of DOFAW's propagation and recovery program. Predation by introduced mongooses and feral cats on eggs, goslings and brooding adults inhibits population increases.

source: http://www.aloha-hawaii.com/hawaii/nene

source: http://www.50states.com/bird/nene.htm

source: http://www.thewildones.org/Animals/nene.html

source: http://www.coffeetimes.com/nene.htm

Hawaiian Hoary Bat	
Description	Weighs 5 to 8 ounces, has a 10.5 – 13.5-inch wingspan. Females are larger than males. It has a heavy fur coat that is brown and gray, and ears tinged with white, giving it a frosted or "hoary" look.
Voice	Like most insectivorous bats, this bat emits high frequency (ultrasonic) echolocation calls that detect its flying prey. These calls generally range from 15 – 30 KHz. Their lower frequency social calls may be audible to humans. These low frequency "chirps" are used to warn other bats away from their feeding territory.
Habits	The Hawaiian Hoary Bat is nocturnal to crepuscular and eats insects. Little is known about its biology, distribution, or habitat use on the Hawaiian islands, though it is thought to be most abundant on the Big Island. It occurs primarily below 4,000 feet elevation, although it commonly is seen at 7,000 to 8,000 feet on Hawai`i and at 10,000 feet on Haleakala. On Maui, this bat is believed to primarily occur in moist, forested areas. In spite of this preference, though, it has been seen in Lahaina and near Mopua, both of which are dry, and on the dry, treeless crest of Haleakala. During the day, this bat roosts in a variety of tree species and occasionally in rock crevices and buildings; it even has been recorded hanging from wire fences on Kaua`i and has been seen leaving and entering caves and lava tubes on Hawai`i.

source: http://pacificislands.fws.gov/wesa/hrybatindex.html

source: http://www.honoluluzoo.org/hawaiian_bat.htm

SAMPLE

Wildlife Education and Observation Program
KWP II
Observation Form

Observer's Name:			**Date:**	
Temperature:	**Wind Direction:**	**Wind Speed:**	**Precipitation:**	**Cloud Cover:**

Species Observed	
Location	
Proximity to Turbine	
Approximate Altitude	
Direction Traveling	
Other Species in Area	
Comments	

Appendix 5

Life History Information on

Newell's Shearwater (*Puffinus newelli*), Hawaiian Petrel (*Pterodroma sandwichensis*), Hawaiian Goose (*Branta sandvicensis*)
and
Hawaiian Hoary Bat (*Lasiurus cinereus semotus*)

Compiled by:
SWCA Environmental Consultants 201 Merchant Street, Suite 2310
Honolulu, HI 96813

1.1 INTRODUCTION

Demographic factors were used to assess indirect take and loss of productivity in section 5.0 (Potential Impacts) and 6.0 (Mitigation) of the HCP. Indirect take and loss of productivity are defined as follows:

> Indirect Take - These are individuals that suffer mortality as the result of a direct take of another individual. For example, the loss of a parent may also result in the loss of eggs or young.
>
> Loss of Productivity - Productivity can be assessed in terms of chicks or fledglings produced per breeding adult per year or the number of fledglings that survive to adulthood per breeding adult per year. When a direct take occurs, loss of productivity can occur between the time the direct take occurs and the time that mitigation is provided. Productivity may also be lost if a juvenile is used as a replacement for the take of a breeding age adult. Factors that need to be taken into consideration when accounting for loss of productivity include demographic factors such as the age and sex of the individuals taken, the time of year the take occurs, and the type of mitigation provided.

Demographic factors for each species covered by the HCP were determined using existing literature. Preference was given to life history information available from Hawai‘i, followed by information available for the same species on the North American continent or other areas of the world. If specific information was lacking for any species, life history information for a closely related species was used as a surrogate.

The life history information for the Newell’s shearwater (*Puffinus newelli*), Hawaiian petrel (*Pterodroma sandwichensis*), Hawaiian goose (*Branta sandvicensis*) and Hawaiian hoary bat (*Lasiurus cinereus semotus*) follow in the sections below.

1.2 Seabirds

1.2.1 Newell’s Shearwater

The following demographic factors and assumptions (from Ainley et al. 1997 and as otherwise noted) were used to assess indirect take and loss of productivity of the Newell’s shearwater.

Breeding Season: The breeding season lasts from June to October each year.

Age at First Breeding: Assumed age 6.

Adults Breeding/Year: On the basis of estimates made by Telfer (1986), incidence of non- breeding is high for Newell’s Shearwater on Kaua‘i. Only 46% of pairs that actively use a burrow actually breed in a given year (range 30–62 %, n = 5 yr, 36–47 burrows monitored/yr).

Reproductive Success: 66.0% ± 6.4 SD (range 49–75) of nests in which eggs are laid fledge young. Manx Shearwater populations have similar fledging rates (Brooke 1990). For the purposes of the HCP, a 70% average fledging rate is assumed.

Survival: Annual adult survivorship of Newell’s Shearwater was estimated to be 0.904 ± 0.017 SE, on the basis of allometric equation relating survivorship to body mass in procellariiforms. This figure approximates that estimated for Manx Shearwater by more conventional means (Brooke 1990). For the purposes of the HCP, it is assumed that 50% of fledged young survive to breeding age.

Number of Broods: One per year.

Clutch Size: One.

Relative Productivity of Males vs. Females: Relative productivity of males and females is assumed to be similar, as with the Hawaiian petrel described below. For the purposes of estimating lost productivity and indirect take, it is assumed that males and females each contribute 50% towards indirect take and the average annual productivity.

1.2.2 Hawaiian Petrel

The following demographic factors and assumptions (from Simons and Hodges 1998 and as otherwise noted) were used to assess indirect take and loss of productivity of the Hawaiian petrel:

Breeding Season: The breeding season lasts from May to October each year.

Age at First Breeding: Unknown, but population data suggests breeding starts at age 5-6. Age 5 is assumed for purposes of estimating indirect take and lost productivity.

Adults Breeding/Year: Estimated at 89%.

Reproductive Success: Estimates of annual reproductive success (chicks fledged/eggs laid) at Haleakala, Maui from 1979–1981 (Simons 1985) and 1993 (Hodges 1994) averaged 63.4 % ± 16.0 SD (range 38–82, n = 128). For the purpose of the HCP, the average annual reproductive success of 70% is assumed.

Survival: In an analysis of life history by Simons (1984), survival to breeding age was estimated to be 27%. For the purpose of the HCP, it is assumed that 30% of fledged young survive to breeding age. Yearly adult survivorship was estimated to be 93%.

Number of Broods: One per year.

Clutch Size: One.

Relative Productivity of Males vs. Females: Breeding Hawaiian petrels are apparently monogamous and show a high degree of mate fidelity over subsequent years. Pairs may exhibit courtship behavior that may last one or more seasons prior to breeding. Thus the loss of a male could cause a breeding hiatus for a female even if in pre-breeding condition. Both males and females incubate eggs and provide food for nestlings. For the purposes of estimating lost productivity and indirect take, it is assumed that males and females each contribute equally towards indirect take and the average annual productivity.

Sex Ratio: Similar adult male and female survival rates in related species (Warham 1996) suggest a balanced sex ratio, but no published data is available.

Based on these assumptions the following approach is proposed for adjusting each take of a Hawaiian Petrel or Newell's Shearwater that occurs to account for lost productivity:

1. No adjustment if in-kind mitigation (i.e., replacement with same-age individual) occurs during same year as take.

2. Increase mitigation for each year that replacement lags behind. Compound adjustments

annually to account for lost productivity of offspring. Loss of productivity accrual ends for an adult take once an adult replaces it. If fledglings are used to replace adult take the adult take continues to accrue loss of productivity until the fledglings survive and mature to reproduce. A fledgling that could have been produced from an adult take can be directly replaced by a fledgling produced through mitigation.

3. Replacements that occur in advance of take may offset adjustments for lagging replacements as long as the advance replacement is in-kind or survival to adult age is accounted for when fledglings are intended to replace adults.

4. Lagging and advanced replacements may result from, (a) replacement with an individual from the same age class at a different time, (b) replacement with an individual from a different age class during the same year as take, or (c) replacement with an individual from a different age class at a different time.

1.2 Hawaiian Goose, Nēnē

Adjustments to the take of Nene were developed based on the following demographic factors and assumptions (from Banko et al. 1999 and USFWS 2004 and as otherwise noted):

Breeding Season: The nēnē has an extended breeding season with eggs reported from all months except May, June, and July, although the majority of birds in the wild nest during the rainy (winter) season between October and March.

Age at First Breeding: Female nēnē mature at age three and males at age two. For the purposes of this HCP, it is assumed that both genders of nēnē mature at age three.

Adults Breeding/Year: Estimated at 60%.

Clutch Size: A clutch typically contains 3 to 5 eggs (mean 3.13 ± 1.07, range 1 to 6, n = 552 nests in the wild

Number of Broods: One per year.

Reproductive Success: During 4 seasons (1978–1981) mostly in highland habitat on Hawai‘i and Maui, eggs hatched in at least 36 % (n=50) of 140 observed breeding attempts, and goslings fledged in 7 % (n=10; Banko 1992). During 1994– 1996 at Hawai‘i Volcanoes National Park, eggs hatched in 58 % (21) of 36 nests with known outcomes, resulting in 42 goslings (2.0 goslings/successful pair) and 6 fledglings (0.29 fledgling/successful pair; Hu 1998). For the purposes of this HCP, it is assumed that adults have an average of 0.3 fledglings per pair.

Survival to breeding age: The mortality rate of captive-reared released goslings to Year 1 was reported to be 16.8% for females and 3% for males. For the purposes of this HCP, a conservative annual mortality rate of 20% is assumed for both genders of geese and this rate is assumed constant through maturity (age three).

Relative Productivity of Males vs. Females: Nēnē are highly territorial during the breeding season and males are likely to be defending nesting territories while the females are incubating. Family groups often forage together. For the purposes of estimating lost productivity and indirect take, it is assumed that males and females each contribute ~~equ~~ally towards indirect take and the average annual productivity.

Based on these assumptions the following adjustments are proposed for each take of a Nene to account for lost productivity:

Take of Gosling	Take of Immature/Juvenile (Post-fledging, pre-nesting)	Take of Adult
No adjustment if replacement gosling propagated in same year as take.	No adjustment if release of juvenile occurs same year as take.	Assume loss of 3 years productivity (conservative age to first breeding) if release of juvenile occurs concurrent with take.
Increase replacement ratio by 10 % for each year release lags behind take.	Increase replacement ratio by 10 % for each year release lags behind take.	Assume loss of 10 % productivity per year, compounded annually to account for productivity of offspring.
Replacements that occur in advance of take may offset adjustments for lagging replacements.	Replacements that occur in advance of take may offset adjustments for lagging replacements.	Replacements that occur in advance of take may offset adjustments for lagging replacements.
Compound annually to account for productivity of offspring.	Compound annually to account for productivity of offspring.	Adjust for assumed 90 % survival to adulthood of released juvenile birds.

1.3 Hawaiian Hoary Bat

Little life history information exists for the hoary bat (*Lasiurus cinereus cinereus*) found on continental America. Because these bats are migratory, do not hibernate and are not colonial, they are difficult to study. Even less life history information is available for the Hawaiian hoary bat. Hence, adjustments to the take of the Hawaiian hoary bat to account for lost productivity were developed based on the following demographic factors and assumptions using information from the hoary bat from continental America or other bat species when necessary:

Breeding Season: The pregnancy and lactating period for the female Hawaiian hoary bat occurs from April to August each year. The breeding lasts approximately four months, with a three month gestation period followed by parental care of one month (NatureServe 2008).

Age at First Breeding: Hoary bats on the continental US breed at age one (Gannon 2003, Koehler and Barclay 2000)

Adults Breeding/Year: Estimated at 100% for colonial bats (Gannon 2003), no data available for the hoary bat. Adults breeding/year is assumed to be 100 % for the Hawaiian hoary bat for purposes of this HCP.

Reproductive Success: A study following young of the hoary bat in Manitoba, Canada records that 23 out of 25 young fledged, resulting in a reproductive success of 92% (Koehler and Barclay 2000). Reproductive success is typically high for bats as they have a life history strategy where they have few young, low reproductive rates and are long lived compared to mammals of equivalent size (Kunz et al. 2005).

Survival to breeding age: No data exists for the Hawaiian hoary bat or the hoary bat on the American continent. However, survival is low for female little brown bats (*Myotis lucifugus* 20.4-47.2%) and female big brown bats (*Eptesicus fuscus*, 10.5-31.9%, Humphrey 1982). Survival rates of Hawaiian hoary bats probably approximate those of the big brown bat more closely than the little brown bat, given that they similar life history strategies such foliage roosting and the ability to commonly have two young at a time. The survival rate of Hawaiian hoary bats is estimated to be 30%.

Number of Broods: One per year.

Litter Size: Both Bogan (1972) and Koehler and Barclay (2000) in separate observations record that 6 females located before parturition gave birth to a total of 11 young, resulting in an average litter size of 1.83.

Relative Productivity of Males vs. Females: Male hoary bats only contribute sperm to the breeding process. Females are solely responsible caring and feeding the young till fledging. For the purposes of estimating indirect take, it is assumed that males contribute nothing to indirect take and females 100%.

Sex Ratio: Sex ratios of Hawaiian hoary bats inferred from samples obtained during different seasons indicate that during the pre-pregnancy and breeding season (April to August), sex ratios in the lowlands are approximately 1:1. During the post-lactation period (September to December) the sex ratio of females to males in the lowlands increases to 4:1 (Menard 2001). Sex of each take will be determined genetically if not clearly determined visually.

LITERATURE CITED

Ainley, D.G., T.C. Telfer, and M.H. Reynolds. 1997. Townsend's and Newell's Shearwater (*Puffinus auricularis*). In: The Birds of North America, No. 297. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Arroyo, B.E., T. DeCornulier and V. Bretagnolle. 2000. Sex and Age Determination of Short-eared Owl Nestlings. The Condor 102: 216-219

Banko. W.E. 1987. Historical synthesis of recent endemic Hawaiian birds. Part I. Population histories - species accounts, freshwater birds: Hawaiian Gallinule, 'Alae –'ula. Cooperative National Park Resources studies unit, University of Hawaii at Manoa, CPSU/UH Avian History report No. 12.

Banko, P.C. 1992. Constraints on productivity of wild Nene or Hawaiian Geese *Branta sandvicensis*. Wildfowl 43: 99–106.

Banko, P.C., J.M. Black, and W.E. Banko. 1999. Hawaiian Goose (Nene). The Birds of North America, No. 434, A. Poole and F. Gill (editors). The Birds of North America, Inc., Philadelphia, PA.

Bannor, B.K. and E. Kiviat. 2002. Common Moorhen (*Gallinula chloropus*). In: The Birds of North America, No. 685. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Bogan M.A. 1972. : Observations on paturition and development in the hoary bat *Lasiurus cinereus* Journal of Mammalogy 53(3):611-614

Brisbin, Jr., I.L., H.D. Pratt, and T.B. Mowbray. 2002. American Coot (*Fulica Americana*) and Hawaiian Coot (*Fulica alai*). In: The Birds of North America, No. 697. (A. Poole and F. Gill, eds.). Philadelphia, PA.

Brooke M. 1990. The Manx shearwater. London: Poyser.

Browne, R.A., C.R. Griffin, P.R. Chang, M. Hubley, and A.E. Martin. 1993. Genetic divergence among populations of the Hawaiian Duck, Laysan Duck, and Mallard. Auk

110:49-56.

Byrd, G.V., R.A. Coleman, R.J. Shallenberger and C.S. Arume. 1985. Notes on the Breeding Biology of the Hawaiian Race of the American Coot. ‘Elepaio 45: 57–63.

Chang, P.R. 1990. Strategies for Managing Endangered Waterbirds on Hawaiian National Wildlife Refuges. M.S. thesis, Univ. of Massachusetts.

Coleman, R.A. 1981. The Reproductive Biology of the Hawaiian Subspecies of the Black-necked Stilt, *Himantopus mexicanus knudseni*. Ph.D. diss., Pennsylvania State Univ., University Park.

Davies J.M. and M. Restani. 2006. Survival and Movements of Juvenile Burrowing Owls During the Post Fledgling Period. The Condor 108:282-219

Drilling, N., R. Titman and F. Mckinney. 2002. Mallard (*Anas platyrhynchos*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.eres.library.manoa.hawaii.edu/bna/species/658 doi:10.2173/bna.658

Engilis, Jr., A., K.J. Uyehara, and J.G. Giffin. 2002. Hawaiian Duck (*Anas wyvilliana*). In: The Birds of North America, No. 694. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Engilis, Jr., A. and T.K. Pratt. 1993. Status and Population Trends of Hawaii’s Native Waterbirds, 1977-1987. Wilson Bulletin 105:142-158.

Gannon W.L. 2003.Bats pp 56-74 in Feldhamer G.A. Thompson B.C. and Chapman J.A. (eds) Wild Mammals of North America: Biology, Management, and Conservation. John Hokins University Press, Baltimore

Haug, E.A., B.A. Millsap and M.S. Martell. 1993. Burrowing Owl (Athene cunicularia), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu.eres.library.manoa.hawaii.edu/bna/species/061doi:10.2173/bna.6 1

Hodges, C.S. 1994. Effects of Introduced Predators on the Survival and Fledging Success of the Endangered Hawaiian Dark-rumped Petrel (*Pterodroma phaeo-pygia sandwichensis*). M.S. thesis, Univ. of Washington, Seattle.

Hu, D. E.. 1998. Causes of endangerment and extinction in Hawaiian birds. Ph.D. diss., Univ. of California, Davis.

Humphrey 1982. Bats, Vespertilionidae and Molossidae. Pp 52-70 in Chapman J.A. and Feldhamer G.A. (eds) Wild mammals of North America: Biology, management, and economics. John Hopkins University Press, Baltimore

Johnson, D. H., and A. B. Sargeant. 1977. Impact of red fox predation on the sex ratio of prairie mallards. U.S. Fish and Wildl. Serv. Wildl. Res. Rep. 6. 56pp.

Kaheawa Wind Power, LLC. 2006. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan. Ukumehame, Maui, Hawai‘i.

Koehler and Barclay 2000. Post-natal growth and breeding biology of the hoary bat (*Lasiurus cinereus*) Journal of Mammalogy 81(1): 234-244

Kunz, T.H., E.B. Arnett. B. M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, and J.M. Szewczak. 2007. Assessing impacts of wind-energy development on nocturnally active birds and bats: A guidance document. Journal of Wildlife Management 71: 2449–2486.

McRae 1996 Family values: costs and benefits of communal nesting in the Moorhen. Animal Behavior. 52: 225–245.

Menard, T. 2001. Activity Patters of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) in Relation to Reproductive Time Periods. Masters thesis, Univ. of Hawaii, Hawaii.

Nagata, S.E. 1983. Status of the Hawaiian Gallinule on Lotus Farms and a Marsh on Oahu, Hawaii. M.Sc. Thesis, Colorado State University, Fort Collins, Colorado.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: December 24, 2008).

Ohde, B.R., R. A. Bishop, J. J. Dinsmore. 1984. Mallard Reproduction in Relation to Sex Ratios. The Journal of Wildlife Management 47(1):118-126

Polhemus, J.T. and D.G. Smith. 2005. Update on Nesting Activity and Habitat Utilization by Native Waterbirds at the Hamakua Marsh State Wildlife Sanctuary, Kailua, Oʻahu. Elepaio 65(3):17-21

Reed, J.M., C.S. Elphick, and L.W. Oring. 1998. Life-history and Viability Analysis of the Endangered Hawaiian Stilt. Biological Conservation 84:35-45.

Robinson, J.A., J.M. Reed, J.P. Skorupa, and L.W. Oring. 1999. Black-necked Stilt (*Himantopus mexicanus*). In The Birds of North America, No. 449. (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Simons, T. R. 1984. A Population Model of the Endangered Hawaiian Dark-rumped Petrel. J. Wildl. Mgmt. 48(4) 1065-1076. Simon and Hodges 1998.

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

Simons, T. R., and C. N. Hodges. 1998. Dark-rumped Petrel (*Pterodroma phaeopygia*). In The Birds of North America, No. 345 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Telfer, T.C., J.L. Sincock, G.V. Byrd, and J.R. Reed. 1987. Attraction of Hawaiian Seabirds to Lights: Conservation Efforts and Effects of Moon Phase. Wildlife Society Bulletin 15:406–413.

U.S. Fish and Wildlife Service. 2004. Draft Revised Recovery Plan for the Nēnē or Hawaiian Goose (*Branta sandvicensis*). U.S. Fish and Wildlife Service, Portland, OR. 148 + xi pp.

USFWS. 2005a. Draft Revised Recovery Plan for Hawaiian Waterbirds, Second Draft of Second Revision. U.S. Fish and Wildlife Service, Portland, OR.

Warham 1996. The behaviour, population biology and physiology of the petrels. London: Academic Press.

Wiggins, D.A., D.W. Holt and S.M. Leasure. 2006. Short-eared Owl (*Asio flammeus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology;

Retrieved from the Birds of North America Online:
http://bna.birds.cornell.edu.eres.library.manoa.hawaii.edu/bna/species/062doi:10.2173/bna.6 2

Funding Matrix- KWP II

	Item / Activity	One-time Cost	Annual Cost	Years 1-5	Remaining 15 Years	20-year Permit Duration
General Measures	Preconstruction surveys for nene and nests	$5,000				$5,000
	Daily search and documentation of nene and nests during construction	$25,000				$25,000
	Invasive species avoidance and minimization	$30,000	$5,000	$50,000	$15,000	$95,000
	Wildlife Education and Observation Program (WEOP)		$1,500	$7,500	$25,000	$32,500
	Hawaiian short-eared owl mitigation	$25,000				$25,000
	Sub-Total	**$85,000**	**$6,500**	**$57,500**	**$40,000**	**$182,500**
Minimization Tier 2 Rates of Take	Radar studies to characterize seabird interactions at facility				$50,000	$50,000
	Increased site-specific bat studies using enhanced audio-visual technologies to characterize activity levels and document bat interactions at facility		$10,000	$50,000	$50,000	$100,000
	Sub-Total	**$0**	**$10,000**	**$50,000**	**$100,000**	**$150,000**
Seabird mitigation (Tier 1)	Makamakaole fencing and social attraction option	$300,000		$100,000	$600,000	$1,000,000
	Exploring Maui mitigation alternatives KWPII portion			$56,000		$56,000
	Subtotal	**$300,000**	**$0**	**$156,000**	**$600,000**	**$1,056,000**
Tier 2 (NESH), or insufficient credit accrual at Tier 1.	Alt 2a Increase seabird colony size and productivity within fenced area, habitat enhancement and social attraction	$50,000	$10,000	$50,000	$150,000	$250,000
	Alt 2b Project at scale similar to Alt 1 at alternative location on Maui	$390,000	$0	$0	$0	$390,000
	Alt 2c: In situ predator proof fence in West Maui	$220,760	$36,642	$36,642	$549,623	$807,024
	Maximum sub-total	**$390,000**	**$36,642**	**$36,642**	**$549,623**	**$807,024**
Additional Measures for Tier 2 rates of take (HAPE)	Increased mitigation efforts at the same site or mitgation at another seabird site		$30,000	$150,000	$100,000	$250,000
	Sub-Total	**$0**	**$30,000**	**$150,000**	**$100,000**	**$250,000**
Lower rates of Take	Same as Baseline					
Nene Mitigation (Tier 1)	Staffing for monitoring and predator trapping at nesting locations on Maui			$162,500	$237,500	$400,000
	Sub-Total	**$0**	**$0**	**$162,500**	**$237,500**	**$400,000**

Additional Measures	Systematic observations of nene at the KWP II site		$2,000	$10,000	$30,000	$40,000
	Sub-Total	**$0**	**$2,000**	**$10,000**	**$30,000**	**$40,000**
Tier 2	Staffing for monitoring and predator trapping at nesting locations on Maui				$150,000	$150,000
	Sub-Total	**$0**	**$0**	**$0**	**$150,000**	**$150,000**
Tier 3	Staffing for monitoring and predator trapping at nesting locations on Maui	$0			$300,000	$300,000
	Sub-Total	**$0**	**$0**	**$0**	**$300,000**	**$300,000**
Lower rates of take	Same as Tier 1					
Additional Measures if Hanaula population declines or reintroduction efforts fail	New release pen if required	$150,000				$150,000
	Partial purchase of truck	$10,000				$10,000
	Staffing for on-site monitoring		$20,000	$80,000		$80,000
	Helicopter transport of nene to release site		$2,000	$6,000		$6,000
	Sub-Total	**$160,000**	**$22,000**	**$86,000**	**$0**	**$246,000**
Bat mitigation (Tier 1)	Management			$250,000		**$250,000**
	Bat monitoring at KWP II and vicinity for 5 years		$12,500	$25,000	$37,500	$62,500
	Sub-Total	**$0**	**$12,500**	**$275,000**	**$37,500**	**$312,500**
Tier 2	Increased management			$125,000		$125,000
	Increased site-specific bat studies using enhanced audio-visual technologies to characterize activity levels and document bat interactions at facility	$50,000	$10,000		$50,000	$100,000
	Sub-Total	**$50,000**	**$10,000**	**$125,000**	**$50,000**	**$225,000**
Tier 3	Research				$950,000	$950,000
	Sub-Total	**$0**	**$0**	**$0**	**$950,000**	**$950,000**
Tier 4	Land Protection	$0	$0	$0	$450,000	$450,000
	Sub-Total	**$0**	**$0**	**$0**	**$450,000**	**$450,000**
Measures for Lower Rates of Take	Same as Baseline					
Downed Wildlife Monitoring	Downed wildlife monitoring, oversight and reporting			$525,000	$1,050,000	$1,575,000
	3rd party Proctoring of Searcher Efficiency Trials and QA/QC of take calculations and reporting.			$53,000		$53,000

	Sub-Total	$0	$0	$578,000	$1,050,000	$1,628,000
State Compliance Monitoring	Sub-Total	$0	$12,000	$60,000	$180,000	$240,000
3rd Party Monitoring Contingency	Sub-Total	$0	$0	$525,000	$1,050,000	$1,575,000

Estimated Project Sub-Totals

	Item / Activity	One time Cost	Years 1-5	Remaining 15 Years	20-year Permit Duration
Tier 1	Minimization and General Measures	$85,000	$57,500	$40,000	$182,500
	Seabird Mitigation (Maximum)	$300,000	$156,000	$600,000	$1,056,000
	Nene Mitigation	$0	$172,500	$267,500	$440,000
	Hawaiian Hoary Bat	$0	$275,000	$37,500	$312,500
	Sub-Total	$385,000	$661,000	$945,000	$1,991,000
Tier 2	Minimization	$0	$50,000	$100,000	$150,000
	Seabird Mitigation (Maximum)	$390,000	$186,642	$649,623	$1,057,024
	Nene Mitigation	$0	$0	$150,000	$150,000
	Hawaiian Hoary Bat	$50,000	$125,000	$50,000	$225,000
	Sub-Total	$440,000	$361,642	$949,623	$1,582,024
Tier 3	Nene Mitigation	$0	$0	$300,000	$300,000
	Hawaiian Hoary Bat	$0	$0	$950,000	$950,000
	Sub-Total	$0	$0	$1,250,000	$1,250,000
Tier 4	Hawaiian Hoary Bat	$0	$0	$450,000	$450,000
	Sub-Total	$0	$0	$450,000	$450,000
Contingency Measures	Contingency Measures if Hanaula Nene Population exhibits failure	$160,000	$86,000	$0	$246,000
	3rd Party Monitoring Contingency	$0	$525,000	$1,050,000	$1,575,000
	Sub-Total	$160,000	$611,000	$1,050,000	$1,821,000
Other	Downed Wildlife Monitoring	$0	$578,000	$1,050,000	$1,628,000
	State Compliance Monitoring	$0	$60,000	$180,000	$240,000
	Sub-Total	$0	$638,000	$1,230,000	$1,868,000

Total Including Maximum Cost for Tier 1 Mitigation	$1,991,000
Total Tier 1 + Contingency Measures + Other	$5,680,000
Total for Tier 1+ Tier 2 Take Level of Mitigation+ Contingency Measures+ Other	$7,262,024
Total for Tier 1+ Tier 2+Tier 3+Tier 4 Take Level of Mitigation+ Contingency Measures+ Other	$8,962,024

Appendix 7

BOTANICAL RESOURCES SURVEY

for the

KAHEAWA PASTURES ENERGY PROJECT

UKUMEHAME, MAUI, HAWAII

by

ROBERT W. HOBDY
ENVIRONMENTAL CONSULTANT
Kokomo, Maui
August 2009

Prepared for:
First Wind Energy, LLC

BOTANICAL RESOURCES SURVEY
Kaheawa Pastures Wind Energy Project

INTRODUCTION

The Kaheawa Pastures Wind Energy Project area lies on lower Kealaloloa Ridge on the southern tip of West Maui between Manawainui Gulch on the west and Malalowaia'ole Gulch on the east. The project area is approximately 276 acres in size TMK (2) 3-6-01:14 (por.). This study has been initiated by First Wind Energy LLC to assess the botanical resources in the area in fulfillment of environmental requirements of the planning process.

SITE DESCRIPTION

Kealaloloa Ridge is a very evenly sloping ridge descending from Hanaula Peak to the sea at a 16% grade. Vegetation is mostly open windblown grasslands with scattered shrubs and trees in gullies. Soils are exclusively characterized as Rocklands (rRK) by the National Resource Conservation Service (Foote et al, 1972). This substrate consists of thin soils formed from gray trachyte lavas of the Honolua Series which overlay the foundational lavas of the West Maui volcano. These lavas weather to platy gray blocks that extend across the entire ridge. This area is quite arid with annual rainfall totaling only about 12 to 20 inches per year (Armstrong, 1983).

BIOLOGICAL HISTORY

In pre-contact times this part of the mountain slope was entirely covered with native vegetation of low stature with dry grass and shrub lands and with a few trees in the gullies. The Hawaiians made some uses of forest resources here and had a cross-island trail cresting the ridge at 1600 ft. elevation. This trail was upgraded during the mid-1800s and used as a horse trail to Lahaina. It was resurrected to use in recent years and is the present Lahaina Pali Trail.

Cattle ranching began in the late 1800s and continued for over 100 years. During this time the grazing animals consumed most of the native vegetation which was gradually replaced by hardy weed species.

During the 1950s high voltage power lines were installed across the mountain along with access roads through this area. Increased traffic brought more disturbances and weeds. Fires became more frequent, further eliminating remnant native vegetation.

With the cessation of cattle grazing a number of grass and weed species have proliferated, creating a heightened fire hazard. Large fires have swept across the mountain consuming thousands of acres including the entire project area several times.

DESCRIPTION OF THE VEGETATION

The vegetation within the project area is a diverse array of grasses and low shrubs with a scattering of small trees in gullies. The most abundant species is buffelgrass (*Cenchrus ciliaris*) which has proliferated following the fires. Also common are Natal redtop (*Melinis repens*), ‘ilima (*Sida fallax*), ‘uhaloa (*Waltheria indica*), lesser snapdragon (*Antirrhinum orontium*) and Jamaica vervain (*Stachytarpheta jamaicensis*). A total of 62 species were recorded during the survey.

Fifteen species of native plants were found on the project area: kumuniu (*Doryopteris decipiens*), (*Cyperus phleoides* var *phleoides*) no common name, kalamalö (*Eragrostis deflexa*), ‘äheahea (*Chenopodium oahuense*), nehe (*Lipochaeta lobata* var. *lobata*), nehe (*Melanthera lavarum*), puakala (*Argemone glauca*), ‘akia (*Wikstroemia oahuensis*), pili grass (*Heteropogon contortus*), koali awahia (*Ipomoea indica*), ‘ilima, ‘uhaloa, naio (*Myoporum sandwicense*), ‘ulei (*Osteomeles anthyllidifoli*a) and ‘a’ali’i (*Dodonaea viscosa*). The remaining 47 plant species were non-native grasses, shrubs and trees.

SURVEY OBJECTIVES

This report summarizes the findings of a botanical survey of the Kaheawa Pastures Wind Energy Project which was conducted in August, 2009.
The objectives of the survey were to:

1. Document what plant species occur on the property or may likely occur in the existing habitat.

2. Document the status and abundance of each species.

3. Determine the presence or likely occurrence of any native plant species, particularly any that are federally listed as Threatened or Endangered. If such occur, identify what features of the habitat may be essential for these species.

4. Determine if the project area contains any special habitats which if lost or altered might result in a significant negative impact on the flora in this part of the island.

5. Note which aspects of the proposed development pose significant concerns for plants and recommend measures that would mitigate or avoid these problems.

SURVEY METHODS

The entire project area was surveyed on foot. Areas on rocky gully slopes and the steep cliffs at the edges of the two large bordering gulches were examined more intensively as these were the places where the most native plants survived both the grazing of cattle and the effects of wildfires. Notes were made on plant species, distribution and abundance as well as on terrain and substrate.

PLANT SPECIES LIST

Following is a checklist of all those vascular plant species inventoried during the field studies. Plant families are arranged alphabetically within three groups: Ferns, Monocots and Dicots. Taxonomy and nomenclature of the ferns are in accordance with Palmer (2003) and the flowering plants are in accordance with Wagner et al. (1999) and Staples and Herbst (2005).

For each species, the following information is provided:

1. Scientific name with author citation

2. Common English or Hawaiian name.

3. Bio-geographical status. The following symbols are used:

   endemic = native only to the Hawaiian Islands; not naturally occurring anywhere else in the world.
   indigenous = native to the Hawaiian Islands and also to one or more other geographic area(s).
   Polynesian introduction = plants introduced to Hawai'i in the course of Polynesian migrations and prior to western contact.
   non-native = all those plants brought to the islands intentionally or accidentally after western contact.

4. Abundance of each species within the project area:

   abundant = forming a major part of the vegetation within the project area.
   common = widely scattered throughout the area or locally abundant within a portion of it.
   uncommon = scattered sparsely throughout the area or occurring in a few small patches.
   rare = only a few isolated individuals within the project area.

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
FERNS			
NEPHROLEPIDACEAE (Sword Fern Family)			
Nephrolepis brownii (Desv.) Hovencamp & Miyam.	Asian sword fern	non-native	rare
PTERIDACEAE (Brake Fern Family)			
Doryopteris decipiens (Hook.) J.Sm.	kumuniu	endemic	rare
Pityrogramma austroamericana Domin	gold fern	non-native	rare
MONOCOTS			
CYPERACEAE (Sedge Family)			
Cyperus phleoides Nees ex Kunth subsp. *phleoides*	-----------------	endemic	rare
POACEAE (Grass Family)			
Andropogon virginicus L.	broomsedge	non-native	rare
Cenchrus ciliaris L.	buffelgrass	non-native	abundant
Cynodon dactylon (L.) Pers.	Bermuda grass	non-native	rare
Eragrostis deflexa Hitchc.	kalamalö	endemic	rare
Heteropogon contortus (L.) P. Beauv. ex Roem & Schult.	pili grass	indigenous	uncommon
Melinis minutiflora P. Beauv.	molasses grass	non-native	rare
Melinis repens (Willd.) Zizka	Natal red-top	non-native	common
Panicum maximum Jacq.	Guinea grass	non-native	rare
Sporobolus africanus (Poir.) Robyns & Tournay	smutgrass	non-native	rare
DICOTS			
AMARANTHACEAE (Amaranth Family)			
Amaranthus spinosus L.	spiny amaranth	non-native	rare
Amaranthus viridis L.	slender amaranth	non-native	rare
Atriplex semibaccata R. Br.	Australian saltbush	non-native	rare
Chenopodium murale L.	'äheahea	non-native	rare

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
Chenopodium oahuense (Meyen) Aellen	'äheahea	endemic	rare
APOCYNACEAE (Dogbane Family)			
Calotropis procera (Aiton) W.T. Aiton	small crown flower	non-native	rare
ASTERACEAE (Sunflower Family)			
Conyza bonariensis (L.) Cronq.	hairy horseweed	non-native	uncommon
Emilia fosbergii Nicolson	red pualele	non-native	uncommon
Lactuca sativa L.	prickly lettuce	non-native	rare
Lipochaeta lobata (Gaud.) DC. var. lobata	nehe	endemic	rare
Melanthera lavarum (Gaud.) Wagner & Rob.	nehe	endemic	uncommon
Senecio madagascariensis Poir.	fireweed	non-native	rare
Sonchus oleraceus L.	pualele	non-native	rare
Tridax procumbens L.	coat buttons	non-native	uncommon
Xanthium strumarium L.	kikania	non-native	rare
Zinnia peruviana L.	zinnia	non-native	rare
BRASSICACEAE (Mustard Family)			
Sisymbrium altissimum L.	tumble mustard	non-native	uncommon
CACTACEAE (Cactus Family)			
Opuntia ficus-indica (L.) Mill.	panini	non-native	rare
CONVOLVULACAE (Morning Glory Family)			
Ipomoea indica (J. Burm.) Merr.	koali awahia	indigenous	rare
EUPHORBIACEAE (Spurge Family)			
Chamaesyce hirta (L.) Millsp.	hairy spurge	non-native	rare
FABACEAE (Pea Family)			
Acacia farnesiana (L.) Willd.	klu	non-native	rare
Chamaecrista nictitans (L.) Moench	partridge pea	non-native	uncommon
Crotalaria incana L.	fuzzy rattlepod	non-native	uncommon

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
Desmanthus pernambucanus (L.) Thellung	slender mimosa	non-native	uncommon
Desmodium incanum DC.	kaimi clover	non-native	rare
Desmodium tortuosum (Sw.) DC.	Florida beggarweed	non-native	rare
Indigofera suffruticosa Mill.	'inikö	non-native	uncommon
Leucaena leucocephala (Lam.) de Wit	koa haole	non-native	uncommon
Macroptilium lathryroides (L.) Urb.	wild bean	non-native	uncommon
Pithecellobium dulce (Roxb.) Benth.	'opiuma	non-native	rare
Prosopis pallida (Humb. & Bonpl. ex Willd.) Kunth	kiawe	non-native	uncommon
GENTIANACEAE (Gentian Family)			
Centaurium erythraea Raf.	bitter herb	non-native	rare
LAMIACEAE (Mint Family)			
Leonotis nepetifolia (L.) R. Br.	lion's ear	non-native	rare
MALVACEAE (Mallow Family)			
Abutilon incanum (Link) Sweet	hoary abutilon	non-native	rare
Sida fallax Walp.	'ilima	indigenous	common
Waltheria indica L.	'uhaloa	indigenous	common
MYOPORACEAE (Myoporum Family)			
Myoporum sandwicense A. Gray	naio	indigenous	rare
PAPAVERACEAE (Poppy Family)			
Argemone glauca (Nutt. ex Prain) Pope	puakala	endemic	rare
PLANTAGINACEAE (Plantain Family)			
Antirrhinum orontium L.	lesser snapdragon	non-native	common
Plantago lanceolata L.	narrow-leaved plantain	non-native	uncommon
PORTULACACEAE (Purslane Family)			
Portulaca oleracea L.	pigweed	non-native	rare

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
Portulaca pilosa L.	------------------	non-native	rare
PROTEACEAE (Protea Family)			
Grevillea robusta A. Cunn. ex R. Br.	silk oak	non-native	rare
ROSACEAE (Rose Family)			
Osteomeles anthyllidifolia	ūlei	indigenous	uncommon
SAPINDACEAE (Soapberry Family)			
Dodonaea viscosa Jacq.	'a'ali'i	indigenous	uncommon
SOLANACEAE (Nightshade Family)			
Solanum lycopersicum L.	cherry tomato	non-native	rare
THYMELAEACEAE ('Akia Family)			
Wikstroemia oahuensis (A. Gray) Rock	'akia	endemic	rare
VERBENACEAE (Verbena Family)			
Lantana camara L.	lantana	non-native	uncommon
Stachytarpheta jamaicensis (L.) Vahl.	Jamaica vervain	non-native	common

DISCUSSION

The construction of additional wind turbines will require the development of additional access roads and the clearing and leveling of construction pads within the 276 acre project area. This will result in the loss of vegetation where these occur. The area in general has experienced a dramatic loss of native plant communities over the last century and there is concern that further losses of rare species and special habitats be avoided. The proposed project was analyzed with these concerns in mind.

Of the 15 native plant species identified on the property none were found to be federally listed as Threatened or Endangered species (USFWS, 2009), nor were any found that are candidates for such status. All but two are widespread and fairly common in Hawaii. (*Lipocheata lobata*) has one Endangered variety from Oahu and one commoner variety (L.I. *var lobata*) known from Niihau, O'ahu and West Maui. The one found in the project area is the commoner variety that has no federal status. (*Eragrostis deflexa*) is a native grass that was presumed to be extinct in the early 1990s. Recent collections, some quite extensive, from West Maui, Lana'i and Kaho'olawe, however, have been identified as (*Eragrostis deflexa*) and this species is not likely to be listed as Endangered. Six populations of this grass were found within the project area along the rocky edges of the two large gulches.

Of the 15 native plant species found in the project area were most prevalent in the rocky habitat bordering Manawainui and Malalowaia'ole Gulches. This is due to the fact that these area were less accessible to grazing cattle over the years, and to the fact that these rather barren, rocky area are less susceptible to the effects of fires. The three hardiest native species 'ilima, 'uhaloa and 'a'ali'i that are more prevalent on the flatter grassy ridge tops, are the most likely to be impacted by road construction and the leveling of tower pads. These are three of the commonest native dryland plants in all of Hawaii.

It is likely that periodic fires will continue to be a problem into the forseeable future. The area has been nearly completely overtaken by buffelgrass, a highly flammable, fire-adapted species that is quick to recover following wildfires. Meanwhile, each fire destroys more and more of even the hardiest native plants. Unless land management practices change dramatically across this dry mountain slope, little improvement in this prognosis is likely.

Previous botanical surveys on this southern tip for West Maui have identified a few Endangered species growing in gulches about two miles upslope of this project area. This area is remote from these populations and is in a habitat completely unsuitable for their growth and survival. This project is not expected to negatively impact any of these species.

Due to the general condition of the habitat and the specific lack of any environmentally sensitive native plant species or habitats on or near the project area, the proposed development work is not expected to result in any significant negative impact on the botanical resources in this part of Maui.

RECOMMENDATIONS

The quality of the roads created will have a long term effect on surrounding habitat. Poorly engineered roads in this entire project area quickly erode causing downslope disturbances from moving water and road materials. They have the added effect of necessitating frequent maintenance work resulting in further disturbances. It is recommended that the road surfaces be crowned and rolled with stable material, and that swales, drains and culverts be engineered to channel water from the roadway quickly and effectively.

It is desirable that the incidence of wildfires be minimized because of their devastating long term effects on native plant resources. Fuels in this area are highly flammable. One way to minimize fire here is to limit human access along the road corridor to only those with management or other legitimate functions.

Literature Cited

Armstrong, R. W. (ed.) 1983. Atlas of Hawaii. (2nd. ed.) University of Hawaii Press.

Foote, D.E. , E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. U.S. Dept. of Agriculture, Soil Conservation Service. Washington, D.C.

Palmer, D.D. 2003 Hawai'i's Ferns and Fern Allies. University of Hawaii Press, Honolulu.

Staples, G.W. and D.R. Herbst. 2005. A Tropical Garden Flora, Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and Plants. 50 CFR 17.11 & 17.12

Wagner, W. L., D.R. Herbst, and S. H. Sohmer. 1999. Manual of the flowering plants of Hawai'i. Univ. of Hawai'i Press and Bishop Museum Press. Honolulu.

Appendix 8

KAHEAWA WIND POWER II:
POST-CONSTRUCTION REVEGETATION/RESTORATION PLAN

April 2010

I. Introduction

Kaheawa Wind Power II, LLC (KWP II) proposes to construct and operate a new 21-megawatt (MW) wind energy generation facility at Kaheawa Pastures above Māʽalaea in the southwestern portion of the Island of Maui, Hawaiʽi. The proposed project is situated on approximately 143 acres (58 ha) of State Conservation District Land southeast of the existing 30-MW Kaheawa Wind Power (KWP) project operated and owned by Kaheawa Wind Power LLC (KWP LLC) (KWP II 2009). The proposed project location is referred to as the Downroad Siting Area (Planning Solutions, Inc. 2009).

The area to be disturbed during construction of the KWP II facility is former pasture that was converted from native plant communities well over 100 years ago, and is currently dominated by a mixture of native and non-native grasses and low shrubs with scattered small trees. The area is prone to periodic wildfires, which suppress native plants and favor the spread of non-native, fire-tolerant grasses. Several native plant species are widely scattered throughout the project area, mixed among the non-native grasses (Hobdy 2009b). Native plants are more prevalent at higher elevations of Kaheawa Pastures and in the rocky habitat bordering Manawainui and Malalowaiaole Gulches (Hobdy 2009a, 2009b, 2010).

Construction of the proposed KWP II facility will disturb approximately 43 ac (17 ha) of land. Approximately one third of the disturbed area will be revegetated upon completion of earthwork. Areas suitable for stabilization by revegetation include cut and fill slopes and road cuts. Turbine pads, as well as some portion of the road cuts, will be stabilized with hard materials (e.g., rip-rap and compacted gravel) rather than vegetation in order to ensure stability or increase searchability of turbine plots for downed wildlife.

This plan describes the goals, methods, monitoring, and success criteria for revegetation of areas temporarily disturbed during the construction of KWP II. This plan is intended to meet the dual goals of 1) stabilizing disturbed areas immediately following construction, and 2) re-introducing and establishing several native plant species throughout the site as a longer-term effort. Most elements of this plan involve the application of Best Management Practices (BMPs) and are derived from experiences and lessons learned at the adjacent KWP project site, which underwent construction in early 2006, and which has a comparable plant ecological history.

II. Existing Conditions

The proposed KWP II project area is located in an area known locally as Kaheawa Pastures, on the southern slope of the West Maui Mountains between 695 and 1,825 ft elevation (212 and 556 m). The project area is approximately 4 miles (6.4 km) mauka (inland) of McGregor Point. It is located in the General subzone of the State Conservation District to the southeast of the existing 30-MW KWP facility along the existing access road (Downroad Siting Area). Kealaloloa Ridge, situated immediately northeast of Malalowaiaole Gulch, separates the project area from the isthmus of Maui to the east.

Average annual rainfall at the proposed project area ranges from less than 15 inches (38 cm) per year at the Honoapiʽilani Highway/site access road intersection to slightly over 40 inches (102 cm) per year at the uppermost portion of the existing wind facility (3,200 ft or 975 m). Most of the rainfall occurs during winter months (80+ percent from November through April).

Botanical surveys of the proposed KWP II area were conducted by Robert Hobdy in August 2009 and January 2010. The vegetation is mostly grasses and low-growing shrubs, with occasional small trees in the wetter gullies. The most abundant species in the project area is non-native buffelgrass (*Cenchrus ciliaris*), which proliferated after the fires in 1999 (Hobdy 2009a). Hobdy identified a total of 24 plants native to the Hawaiian Islands, which are widely scattered throughout the area. No state or federally threatened, endangered, or candidate species were found during his surveys.

III. Background of Revegetation Efforts at KWP

Because of the proximity and similarity of the landscape at the two facilities, the proposed KWP II facility will rely heavily on the lessons learned at KWP. The amended Conservation District Use Permit (CDUP MA-3103) granted to KWP by the Board of Land and Natural Resources (BLNR) on 24 June 2005 contained the following conditions related to revegetation:

20. *"All cleared areas shall be revegetated in a manner consistent with other permit conditions, with specific consideration given to the fire contingency plan and the Habitat Conservation Plan. Any necessary revegetation shall be completed within thirty days of the completion of specific project components that resulted in ground clearing, using native species found in the area;"*

37. *"The applicant shall ensure that operations and maintenance staff do not damage native plants. If construction or operation required the removal of native plants, the plants will be removed, relocated and replanted. The applicant shall pay for the cost of this effort;"*

38. *"The applicant shall work with plant experts to introduce appropriate native plant species back into the Kaheawa Pastures;"*

Similar conditions were required in the National Pollutant Discharge Elimination System (NPDES) General Permit for the KWP project area:

- *"Temporary soil stabilization with appropriate vegetation will be applied to areas remaining unfinished for more than 30 days; and*

- *Permanent soil stabilization will be applied as soon as practical after final grading. Contractor will coordinate with the Department of Land and Natural Resources (DLNR) regarding selection of appropriate vegetation as a condition of the Conservation District Use Permit."*

After extensive research and efforts at seeking source materials, KWP biologists concluded that establishing vegetation within 30 days by seeding with native species (per Condition 20) was not feasible due to the unavailability of native species in sufficient commercial quantities. Currently, the Hawai'i Department of Transportation is working with the Federal Highway Administration on a three-year research project to develop native grass mixes and hydro-seeding techniques for use on civil projects in Hawai'i (Dacus, pers. comm.). However, techniques have not yet been developed in Hawai'i for hydro-seeding or broadcasting with native seed mixes on a large scale.

In the *Response to October 27, 2005 Letter Regarding the Establishment of Stabilizing Vegetation Cover for Erosion and Sediment Control Related to Wind Farm Access Road Construction*, the State of Hawai'i Department of Land and Natural Resources (DLNR) authorized KWP's request to apply commercially available annual ryegrass (*Lolium multiflorum*) in order to comply with permit conditions of the CDUP and the NPDES permit, given the following conditions:

1. *"The permittee shall acquire commercial quantities of native pili grass bundles or other native species as soon as possible to substitute the annual rye; and*

2. *The permittee is responsible for controlling the annual rye if it starts invading adjacent State lands."*

KWP subsequently established a conservation partnership with the USDA/NRCS to obtain native pili grass (*Heteropogon contortus*) from the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) Plant Materials Center on Moloka'i. This partnership resulted in field trials to test the ability to establish pili grass at KWP using seed and bales. Following several treatments, it was determined that while it is possible to establish pili grass in limited quantities, and over several months, it probably cannot be expected to meet rapid, site-wide ground cover re-establishment requirements.

Following the trials with pili grass, KWP petitioned DLNR and the Office of Conservation of Coastal Lands (OCCL) to consider allowing manual application and hydro-seeding with a grass seed mixture to accomplish site revegetation goals. DLNR officials in the Division of Forestry and Wildlife (DOFAW) provided comments on this proposal, citing that annual ryegrass is expected to die off and provide a more suitable environment for recruitment by adjacent species. DOFAW expressed interest in limiting the amount of emergent grass in the immediate vicinity of turbines, a recommendation intended to minimize the attraction of Nēnē, which are common in the area and browse on a wide range of emergent vegetation types. KWP biologists have documented that Nēnē are prevalent in the area and currently use the areas in proximity to the existing turbines on a regular (i.e., almost daily) basis. Thus, revegetating bare areas with grasses is not expected to pose an additional risk of bird collisions.

At the same time, KWP biologists have had considerable success at re-introducing native plants grown in the nursery at various locations throughout the site, including along cut and fill slopes and other open earth portions of the roadsides and turbine pads. Although these plantings do not provide a uniform stabilizing cover *per se*, it does appear that they will, over several seasons, come to dominate the areas treated. Between July 2007 and June 2008, approximately 7,500 young a‘ali‘i (*Dodonaea viscosa*) were propagated from seed collected at Kaheawa and planted along cut and fill slopes and other open earth portions of the roadsides and turbine pads. An intensive outplanting effort comprising nearly 16,000 individual plants of several key native species occurred during the winter and spring of 2009 at KWP.

IV. Revegetation Goals

The goals of the revegetation plan for KWP II are based on the relevant CDUP and NPDES permit conditions for KWP, as well as experiences and lessons learned at KWP.

The proposed revegetation strategy for KWP II has two goals:

1. Address the immediate requirement of stabilizing exposed soils following construction activities at KWP II, in accordance with erosion and sedimentation control BMPs and NPDES stormwater discharge permitting requirements; and

2. Re-introduce native plant species in selected areas throughout the site over several years, with the goal of re-establishing native plant species in areas that have been overgrown with non-native species for a century or more.

V. Revegetation Methods

KWP II biologists will work alongside the DLNR-DOFAW specialists to ensure that revegetation methods consider and incorporate all wildlife, forestry, fire, and rangeland concerns and are in alignment with the management provisions of the Conservation District. All revegetation material brought to the project area (e.g. seed mixes, sand, gravel, rock, and mulch) will be certified as weed free by the Hawai‘i Department of Agriculture (HDOA) prior to entering the project area.

KWP II will work with construction contractors to ensure that slopes are not excessively compacted so as to inhibit establishment of vegetation. No other site preparation (e.g. weeding, adding soil amendments, etc.) is anticipated to be necessary prior to revegetation.

<u>Hydroseeding (*Goal 1*):</u>

KWP II biologists propose to hydroseed disturbed areas along the edges of turbine pads and along road cuts and fill slopes with annual ryegrass to establish an initial cover of vegetation after ground shaping and grading activities have been completed (Figure 1). Annual ryegrass was selected for erosion control because it provides rapid initial vegetation cover and forms an extensive, dense root system (Valenzuela and Smith 2002). This species is expected to gradually die back and allow natural recruitment of neighboring species or species present in the seed bank (DOFAW, personal communication). Hydroseeding with annual ryegrass will require supplemental irrigation for a 90-day period and monitoring to ensure establishment of stabilizing cover.

Erosion Mats and Hard Materials (*Goal 1*):

Excessively steep areas may require additional erosion control to achieve the immediate goal of stabilizing exposed soils and preventing erosion. For example, certain sections of the site may require the use of organic coir or jute mats and/or coir logs to reduce water flow velocity and capture sediments and seed material during periods of seasonal rainfall. The mats or logs will be secured in place along steep fill slopes and grades to provide temporary erosion control during the initial establishment period and further contribute to ground cover establishment. In addition, some portion of the disturbed area (particularly the turbine pads) will be stabilized with hard materials (e.g., rip-rap, compacted gravel) rather than vegetation in order to ensure stability and facilitate monitoring of turbine plots for downed wildlife. The use of these materials will be evaluated in consultation with DLNR and the U.S. Fish and Wildlife Service (USFWS), and implemented according to site-specific considerations.

Outplanting (*Goal 2*):

To accomplish the long-term goal, KWP II biologists propose to re-introduce native plants in discrete locations over several years, with the intent of eventually re-establishing some of the key elements of the plant communities that historically existed on the site (Figure 2). This phase will involve collecting native seeds and cuttings in the area, propagating these species at local nurseries, and subsequently outplanting these species at the site.

Native species that may potentially be used during this phase include ‘a‘ali‘i (*Dodonaea viscosa*), pili grass (*Heteropogon contortus*), ‘ūlei (*Osteomeles anthyllidifolia*), and ‘ilima (*Sida fallax*). These relatively fast-growing and easily propagated species provide excellent root structure for maintaining surface substrate retention, as well as provide a native seed source for the project area. Pili grass and ‘a‘ali‘i are particularly appropriate for Kaheawa Pastures because these species area among the few native Hawaiian plants shown to be fire tolerant (Tunison et al. 1994, Loh et al. 2009).

The specific species, sizes, densities, and location of native outplantings will be determined based on site-specific factors such as slope, erosion potential, and substrate. Due to physical constraints of the site (i.e. the presence of surface bedrock material), KWP II LLC may concentrate native outplants outside of the area disturbed during construction (i.e. near the pu‘u). This location will be determined in consultation with DLNR, USFWS, and a revegetation/restoration specialist.

Because this phase will occur after the immediate revegetation phase, many of these plantings will be installed in or adjacent to areas that were previously stabilized with the annual ryegrass mixture and temporary measures (e.g., coir mats and logs). In certain cases, it may be necessary to remove or control undesirable non-native species, either manually or with the assistance of an approved herbicide. Any use of herbicides will be done only in consultation with DLNR, and only in accordance with applicable restrictions on handling and use.

KWP II biologists plan to approach this phase of the site revegetation plan in a manner that emulates the successful native plant reintroduction efforts at KWP. KWP II will work in collaboration with KWP to share resources and coordinate logistics.

VI. Timeline

Construction of the access roads and turbine foundations is anticipated to begin shortly after issuance of the Federal Incidental Take Permit (ITP) and State Incidental Take License (ITL). Revegetation of temporarily disturbed area with annual ryegrass will begin as soon as possible immediately after construction of the access roads and turbine foundations. Outplanting with native species will occur during the first several years of the project. Some species will be outplanted immediately after hydroseeding with annual ryegrass to take advantage of irrigation.

VII. Monitoring and Success Criteria

Regular irrigation and monitoring will be necessary at KWP II to ensure that immediate revegetation measures are successful. Young grasses and seedlings are especially vulnerable to root damage in the absence of rain or watering. All hydroseeded areas will be monitored and irrigated for a 90-day period following hydroseeding. The revegetation/restoration contractor shall provide sufficient irrigation during this period to assure adequate survival.

This phase of the project will be considered successful if it can be demonstrated that >75% of the bare areas, fill slopes, and road cut segments that receive treatment have established cover within one year following treatment. If initial applications appear to be only partially successful, subsequent hand and/or hydro-seeding applications or additional temporary measures (e.g., matting or logs) may be installed to ensure adequate coverage and erosion control.

The longer term revegetation efforts at KWP II are expected to be very successful given the success at KWP. A well-established seed collection and propagation program exists in cooperation with local nurseries, other native plant specialists, contract landscape specialists, and volunteers. Plants will be outplanted and maintained, monitored, and documented using resources available at KWP II and in collaboration with community and conservation groups. This effort will be considered to be successful if a minimum of 5,000 individual plants are installed during the first three years following construction, with an average survival rate of greater than 75% (i.e., a minimum of 3,750 surviving plants), for all plants one year after installation, as determined by representative sampling of planted areas. If mortality exceeds 25%, replacement plantings will be installed as needed to achieve the 75% minimum.

VIII. Literature Cited

Hobdy, R.W. 2009a. Biological Resources Survey for the Kaheawa Pastures Energy Project, Ukumehame, Maui, Hawaii. Prepared for First Wind Energy, LLC. August 2009.

Hobdy, R.W. 2009b. Post-Fire Botanical Survey and Assessment. Kaheawa Wind Power II, Ukumehame, Maui, Hawaii. Prepared for Kaheawa Wind Power II LLC. January 2009.

Hobdy, R.W. 2010. Biological Resources Survey, Kaheawa Wind Energy Project 2 (KWP 2), Kaheawa, Maui, Hawaii. Prepared for First Wind Energy, LLC.

Kaheawa Wind Power II, LLC (KWP II). 2009. Draft HCP for KWP II.

Loh, R., A. Ainsworth, T. Tunison, and C. D'Antonio. 2009. Testing native species response to fire – a first step towards building fire resilient native plant communities at Hawai'i Volcanoes National Park. Pacific Cooperative Studies Unit Technical Report #167.

Planning Solutions, Inc. 2009b. Revised Draft Environmental Impact Statement Kaheawa Wind Power II Wind Energy Generation Facility, Ukumehame, Maui, Hawaii.

Tunison, J.T., J.A.K. Leialoha, R.K. Loh, L.W. Pratt, and P.K. Higashino. 1994. Fire effects in the coastal lowlands, Hawai'i Volcanoes National Park. Technical Report 88. Cooperative Parks Resources Studies Unit. University of Hawai'i, Honolulu.

Valenzuela, H. and J. Smith. 2002. Green Manure Crops: Annual Ryegrass. College of Tropical Agriculture and Human Resources (CTAHR).

Figure 1. Mechanized hydroseeding along a bare road cut during immediate site revegetation and soil stabilization efforts following construction at KWP.

Figure 2. Several native plant species successfully outplanted at KWP as part of long-term revegetation efforts.

Appendix 9

An Assessment of Hawaiian Native Molluscan Fauna of the lower Kaheawa Pasture, West Maui, Hawai‘i

TMK (2) 3-6-01 : 14

Prepared for

First Wind
85 Wells Avenue, Suite 305
Newton, Massachusetts 02459

Prepared by

Mike Severns
3415 Kehala Drive
Kihei, Hawai‘i, 96753

September, 2009

Introduction:

The terrestrial molluscan fauna of Hawai‘i is in a state of catastrophic decline in which hundreds of species and an endemic family are in danger of extinction. Hawai‘i’s molluscs evolved in isolation with an ecological naivety that has left them extremely vulnerable to environmental change, and a low fecundity that has not allowed them to recover from the pressures exerted by introduced predators. During the late 20th century perhaps as many as two-thirds of the living species described in the 19th and early 20th centuries became rare or extinct.

This survey was commissioned by First Wind to determine if any species of native Hawaiian snails, particularly those species listed by federal or state agencies as threatened, endangered, or of substantial conservation concern, remain within or along the borders of the lower Kaheawa Pasture, and if so what steps should be taken to insure their continued survival.

During the survey rock talus and grasses were searched for living snails, and soil samples were screened for living and dead snails to 1 mm in diameter. Two species of extant snails were located representing two families – one, an undescribed species of Vertiginidae, the other a species of Succinidae.

Site Description:

The lower Kaheawa Pasture lies in the Lahaina District in the ahupua‘a of Ukumehame and is defined by the upper reaches of Manawainui Gulch on the southwest and by Malalowaia‘ole Gulch on the north. The area surveyed was located between these two gulches and consisted of a gently undulating pasture with a slight slope of 17 degrees and the upper edges of the gulches themselves. The elevation range was approximately 258 - 577 meters. Much of the pasture was burned in 2006 in the most recent of many wind-driven fires that consumed the vegetation on the gulch slopes and the flat, grass-covered pasture.

Remnants of an old road snake up the pasture on the southwest side of the First Wind access road which lies to the north of the approximate center of much of the survey area. Along the upper edges of the gulches that define the survey area are periodic rock outcroppings, low rock cliffs and rock talus, the latter being generally overgrown with taller grass than that seen in the pasture. These talus areas are of particular interest because they form good dryland snail habitat as well as offer the potential to find semi-fossil snail shells, which might indicate the presence of species not encountered alive during the survey or species that may have existed in the survey area prior to the activity of First Wind.

At the time of the survey the top of the pasture was covered with a knee-high grass and sporadic woody shrubs, many of which were blackened and appeared to be recovering from the last fire in 2006. The substrate is a hard packed sun-dried soil covered with loose rocks. Occasional rock outcroppings are scattered throughout the pasture and appear to be remnants of the volcanic flows that cap what is now the ridge.

Biological History and Potential:

Prior to European contact much of the pasture was probably covered in woody shrubs and trees of the Hawaiian low elevation dryland forest; grasses; and occasional ferns, with the horizontally growing uluhe fern probably being found in the highest elevation surveyed. Little or no habitat would have been available for arboreal snails; however, ground-dwelling snails were found in similar dryland habitats statewide and some are still extant in other such areas on Maui.

There is no record of land snails having been found in the area of the survey; however, based on previous collections of Hawaiian dryland snails, species of the following four families might have been present at one time.

Species of the family Succinidae are known from similar dryland habitat on the lower western slopes of Haleakala; a species of Endodontidae is known from fresh dead shells collected in a small gulch on the Lahaina side of West Maui several miles from the survey area; species of ground-dwelling Achatinellidae are known to exist at the base of grasses on some of the dry, remnant islands of the northwestern Hawaiian chain and were no doubt found in similar habitat throughout the Hawaiian Islands; and species of Vertiginidae are known to have inhabited grass and leaf litter in dryland areas throughout the island chain.

An extensive search of the literature, however, showed no indication that species from these families have ever been collected from the survey area. If snails had been collected in the survey area they were probably species already known to early collectors from other areas and thus were not considered of interest.

Survey Objectives:

This survey and report were initiated out of concern that there may be native snail populations within, or reasonably close to, the lower Kaheawa Pasture region and proposed Kaheawa Wind Power facility. The objectives were to determine if any native land snail species were present in the survey area, to identify them and to try to determine their habitat. Another objective was to look for semi-fossil shells protected beneath rocks or buried in the soil, which could indicate what species might have been present in the area at one time.

Habitat Requirements:

The habitats preferred by the Hawaiian lowland molluscan fauna are determined by available vegetation and moisture. Considering the sparse vegetation and dry conditions of the survey area the search for living land snails was restricted to rock talus, rock cliffs and other rocky features scattered in the pasture where the roots of grasses help maintain moisture beneath the rocks and deep in cracks. This kind of habitat is common along the upper edges of the defining gulches but uncommon in the open pasture.

Method:

A preliminary examination and initial survey of the area showed that the best habitat existed along the edge of the gulch on the windward side of the survey area. A series of stations was established based on available habitat along the upper edge of the gulch and a transect determined by the elevational contour of each station was followed horizontally across the pasture, as Hawaiian snails are known to be sensitive to elevation on the steep slopes of West Maui.

Species Discovered:

Of the four potential families expected to be found in the survey area, two families had living representatives and two families did not. As expected, both species were found in protected, moist habitat beneath rocks.

The Succinid, ***Succinea mauiensis*** Ancey, 1889, is present throughout the pasture within undisturbed rock outcroppings where it attaches to the moist undersides of closely-packed rocks or in the root mat of grasses beneath the rocks. It was not found beneath the loose surface rocks which litter the pasture but have no root mat.

This species is known to have a wide range in dry habitat on East and West Maui. The ***S. mauiensis*** present in the survey area were uncommon in the pasture compared to the upper edges of the gulches. One live specimen was collected and preserved in an RNA/Later solution for further study, and dead specimens were collected when encountered for identification purposes.

In addition to the Succinid, an undescribed species of Vertiginidae of the genus ***Nesopupa*** was discovered in similar habitat. This new species was seen in only one location along the upper edge of Malalowaia‘ole Gulch at an elevation of 446 meters and represents a fifth species of the genus to be found on Maui.

After the initial discovery of the first specimen a one-square-meter area was examined closely on two occasions. A total of 9 *Nesopupa* specimens were collected including four fresh fragments, four intact dead shells and one live specimen. The live specimen was collected for descriptive purposes. One other live specimen was noted and left.

Conservation Relevance:

In general dryland species appear to have an advantage in surviving the introduced predatory snails which have devastated the native molluscan fauna because their preferred habitat is too dry for these predators to survive. In addition, the habitat of the two living species found within the survey area has proven to be resilient, as it has apparently survived 100 years of grazing cattle and periodic fires.

Discussion:

Finding lowland snails in the survey area was not a surprise, though finding an undescribed species of ***Nesopupa*** was, and indicated that the area has never been thoroughly explored for Hawaiian snails.

The two species found in the survey area are numerous when located. Thus, there is reason to believe that both species may exist in similar habitats beyond the boundaries of the property surveyed on neighboring ridges and in neighboring gulches.

Of the two species located during the survey, only ***Succinea mauiensis*** is found in the area proposed to be developed, and then only in several rock outcroppings associated with small ravines scattered within the pasture. The undescribed ***Nesopupa sp.*** is found in an area not scheduled to be developed.

For these reasons careful planning and caution should suffice to protect these species. In fact, they may eventually prosper as the use of the pasture becomes stabilized, is protected more vigorously from fires and is regulated by First Wind.

The attention First Wind has given to this important but devastated aspect of Hawaiian biology is commendable, but it appears that years of abuse of the land prior to First Wind has destroyed much of the habitat available to these snails, reducing the potential habitat for living snails to islands of rock outcroppings. More than 99% of the land within the survey area is now completely devoid of snails and their habitat.

Conclusion:

First Wind has shown by this survey that the degradation of an area through decades of grazing and periodic fires was no reason to ignore the possibility that endemic Hawaiian snails and their micro-habitat might yet survive. This prudence has not only demonstrated snails can and do survive in extreme conditions, but that new species may yet be discovered where least expected, adding more to our knowledge of this fragile fauna.

GPS Coordinates:

GPS coordinates are given here for the five stations along Malalowaiaʻole Gulch and the species found at each.

20˚48.224 – 156˚32.409 No snails present. Elevation 577 meters.
20˚47.706 – 156˚32.145 ***Nesopupa n. sp.*** and ***Succinea mauiensis*** Ancey, 1889. Elevation 446 meters.
20˚47.537 – 156˚31.996 ***Succinea mauiensis*** Ancey, 1889. Elevation 350 meters.
20˚47.335 – 156˚31.855 No snails present. Elevation 282 meters.
20˚47.275 – 156˚31.832 meters. ***Succinea mauiensis*** Ancey, 1889. Elevation 256 meters.

Species Analysis:

Family Succinidae
Succinea mauiensis Ancey, 1889 was compared with an image of a specimen from the Museum of Comparative Zoology at Harvard, MCZ# 039616 (possible lectotype).

Family Vertiginidae
Nesopupa n. sp. was compared with the following Nesopupa which represent all the known species from Maui, Kaho‘olawe, Lana‘i and Moloka‘i.

Nesopupa (Nesopupilla) baldwini Ancey, 1904
1.2 mm. Maui. MCZ 078790 Paratype.

Nesopupa (Nesopupilla) baldwini lanaiensis Pilsbry & Cooke, 1920
1.6 mm. Lana‘i. MCZ 078778 Paratype.

Nesopupa (Nesopupilla) baldwini subcostata Pilsbry & Cooke, 1920
1.5 mm. Moloka‘i. MCZ 180174.

Nesopupa (Infranesopupa) bishopi Cooke & Pilsbry, 1920
2.15 mm. Maui. BPBM 12465 Holotype.

Nesopupa (Nesopupilla) dispersa Cooke & Pilsbry, 1920
1.4 mm. Kaho‘olawe. MCZ 078785 Paratype.

Nesopupa (Infranesopupa) dubitabilis Cooke & Pilsbry, 1920
1.2 mm. Moloka‘i. MCZ 078797 Paratype.

Nesopupa (Limbatipupa) newcombi (Pfeiffer, 1853)
1.3 mm. Lana‘i. MCZ 045244 Lectotype.

Nesopupa (Limbatipupa) newcombi seminulum (Boettger, 1881)
1.2 mm. Moloka‘i. MCZ 180179.

Nesopupa (Infranesopupa) limatula Cooke & Pilsbry, 1920
1 mm. Maui. ANSP 44692 Paratype.

Nesopupa (Limbatipupa) singularis Cooke & Pilsbry, 1920
1.0 mm. Maui. ANSP 44697.

Nesopupa (Nesodagys) wesleyana rhadina Cooke & Pilsbry, 1920
2 mm. Moloka‘i. MCZ 078793 Paratype.

References:

Severns, Mike. In press. *An Illustrated Catalog of the Shelled Molluscan Fauna of the Hawaiian Islands, Marine and Land*. Conchbooks Publishers. Maizer Str. 25, D-55546, Hackenheim, Germany. Estimated 800 pages in two volumes. Estimated publication November 2009.

Appendix 10

Calculating Total Direct Take

Monitoring efforts at KWP II as prescribed in the KWP II HCP will result in identification of "observed" mortality, which is a statistical sampling of all mortality directly attributable to project operations. Identifying the total mortality (or "total direct take") requires accounting for individuals that may be killed by collision with project components but that are not found by searchers for various reasons, including heavy vegetation cover and scavenging. The calculation for estimating total direct take is:

Total Direct Take = Observed Direct Take + Unobserved Direct Take

Searcher efficiency (SEEF) trials and scavenger trials are conducted to arrive at estimates of unobserved direct take (See Appendix 2). SEEF trials measure how effective searchers are in finding carcasses within the search areas and scavenger trials measure the length of time carcasses remain in the field before being removed by scavengers. Scavenger trials are often used to determine the frequency at which turbines and met towers can be searched to maximize the likelihood of searchers detecting carcasses while maintaining a cost-effective survey schedule. Factors to be considered for SEEF trials and scavenger trials for KWP II include season, carcass size, and vegetation type.

Numerous estimators have been developed for the calculation of unobserved direct take. The variables these estimators often include are SEEF, search intervals, and carcass retention rates within the search intervals. Newer estimators are frequently incremental improvements over older estimators as biases and deficiencies of each estimator become clearer as data accumulates. KWP II, LLC examined three estimators, Shoenfeld (2004), Jain (2007), and Huso (2008), in the development of the calculation to be used for determination of total direct take for its project.

The estimators are presented below:

Estimator by Shoenfeld (2004)

$$m = \left(\frac{N * I * C}{k * t * p}\right)\left(\frac{e^{I/t} - 1 + p}{e^{I/t} - 1}\right)$$

N= total number of turbines
I = interval between searches in days
C = total number of carcasses detected for the period of study (total direct take)
k= number of turbines sampled
t = mean carcass removal time in days
p = searcher efficiency (proportion of carcasses found)
e = natural log

Shoenfeld (2004) and its derivatives were found to bias total direct take calculations low as carcass retention rates (t) increased, particularly when search intervals (I) were small (Smallwood 2007, Huso 2008a, b). The weakness of the estimator resulted from the t/I not being a good estimate of scavenger efficiency (or proportion of carcasses remaining) and this bias also became more pronounced as searcher efficiency (p) became low (Huso 2008a, b).

Estimator by Jain (2007)

$$'C = \frac{\mathbf{C}}{\mathbf{S_c \times S_e \times P_s}}$$

'C = total number of carcasses for the period of study (total direct take)

C = number of carcasses found

S_c = scavenger efficiency (proportion of carcasses remaining)

S_e = searcher efficiency (proportion of carcasses found)

P_s = proportion of towers searched

Jain (2007) tried to avoid the bias present in the Shoenfeld (2004) estimator by directly incorporating scavenger efficiency or proportion of carcasses remaining (S_e) into his proposed estimator. Jain (2007) assumed that carcasses had equal probability of occurring on any day between search intervals, thus the average number of days a carcass was present was half the number of days between searches and S_e was determined empirically in scavenger trials for a specified time period (in this case half the search interval). This method proposed for determining S_e is fairly simplistic as scavenger efficiency is non-linear but approximates a logarithmic function (Smallwood 2007). Methods to estimate S_e have subsequently been improved on by Huso (2008a, b).

Estimator by Huso (2008)

$$\hat{m}_{ij} = \frac{c_{ij}}{\hat{r}_{ij}\hat{p}_{ij}\hat{e}_{ij}}$$

$\mathbf{m_{ij}}$ = estimated total direct take at turbine *i* over interval *j*

$\mathbf{c_{ij}}$ = observed direct take

$\mathbf{r_{ij}}$ = estimated proportion of carcasses remaining after scavenging

$\mathbf{p_{ij}}$ = estimated searcher efficiency (proportion of carcasses found)

$\mathbf{e_{ij}}$ = effective search interval

The recently introduced estimator by Huso (2008a, b) has several improvements over the previous two estimators. For estimating the scavenger efficiency or the proportion of carcasses remaining within a specified search interval (r_{ij}), Huso (2008a, b) accounts for the logarithmic nature of carcass removal, and also accounts for the removal of older carcasses over time while newer carcasses are being simultaneously deposited during the search interval. Huso (2008) has further developed methods to determine effective search intervals (e_{ij}) for cases where search intervals are much longer than the estimated carcass retention times (i.e. carcasses deposited early on in the search interval are 99% removed by scavengers before the subsequent search). Simulations run to determine the degree of bias for the different estimators has shown that the Huso (2008a, b) estimator is the least susceptible to bias over a wide range of values for each variable and is currently the most precise of the commonly used estimators (Huso 2008a, b).

Estimating Total Direct Take at KWP II

In the light of the recent improvements to estimators for calculating total direct take, KWP II, LLC proposes to apply the Huso (2008a, b) estimator to the monitoring protocol proposed for KWP II in Appendix 2. Three factors will be considered for scavenger trials and SEEF trials - season, carcass size, and vegetation type. The values obtained from the scavenger and SEEF trials will then be applied to the Huso (2008a, b) estimator using the following protocol:

1. Determine proportion of different vegetation types (bare ground, grass) under all turbines combined for search area less than 75% turbine height. Please see Appendix 2 for the definition of search areas.

2. Conduct SEEF trials for each vegetation type. Calculate variances for SEEF trials for each vegetation type per season. Conduct statistical tests to determine if searcher efficiency varies with vegetation type. Pool SEEF values for vegetation types that are not significantly different.

3. Determine mean carcass removal time for each vegetation type. Calculate variances for carcass removal time for each vegetation type per season. Conduct statistical tests to determine if carcass removal rates vary with vegetation type. Pool carcass removal rates for vegetation types that are not significantly different.

4. Determine effective search interval for each carcass size for each vegetation type.

5. Apply values to Huso (2008a, b) formula for 75% search areas (see example).

6. Methods to determine variances and confidence intervals for total direct take are currently being developed by M. Huso (Huso 2008a, Huso pers. comm.). When such methods become available, KWP II will apply confidence intervals to the estimated total direct take.

An example of using Huso (2008) to calculate total direct take of a medium-sized bird (Hawaiian petrel) for one season (Summer and Fall combined, June - November) is presented. For illustrative purposes, an observed take of two petrels within the 75% search area. The theoretical search protocol is as follows:

All 14 turbines on site will be searched weekly (7-day intervals) to 75% turbine height.

Example of Calculation of Direct Take Using Huso (2009) for Hawaiian Petrel in Summer

Main equation

$$\hat{m}_{ij} = \frac{c_{ij}}{\hat{r}_{ij}\hat{p}_{ij}\hat{e}_{ij}}$$

Eq 1

$$If\ \ f(x) = \lambda e^{-\lambda x};\ S(x) = e^{-\lambda x}$$

Eq 2

$$d_{99} = \min(\ x : S(x) = 0.01, I),\ \hat{e} = \frac{d_{99}}{I}$$

Eq 3

$$\hat{\lambda} = 1/\bar{t};$$

Eq 4

$$\hat{r} = \frac{\int_0^{d_{99}} e^{-\lambda x}dx}{d_{99}} = \frac{(1-e^{-\lambda d_{99}})}{\lambda d_{99}}$$

m_{ij}	estimated mortality
r_{ij}	estimated proportion of carcasses remaining after scavenging
p_{ij}	estimated searcher efficiency
c_{ij}	observed take
I	search interval
e_{ij}	effective search interval
d_{99}	days to 99% of carcasses removed
t	mean carcass retention time (scavengers)

Example of Calculation of Direct Take Using Huso (2009) for Hawaiian Petrel in Summer

Season	Winter		
Search area	**75% turbine height**		
Vegetation type	**bare ground**	**grass**	**unsearchable**
Proportion	0.75	0.20	0.05
Petrel Size (SEEF) likelihood of detection (p_{ij})	1.00	0.81	
Mean Carcass removal time (t) (days)	11	11	
No of carcasses (c_{ij})	1	1	
λ (Eq3)	0.09	0.09	
d_{99}	49.28	49.28	
I	7	7	
d_{99} (Eq 2 applied)	7	7	
e_{ij}	1	1	
Eq4			
λd_{99}	0.63	0.63	
r_{ij}	0.74	0.74	
m_{ij}	1.34	1.66	
total mortality	3.01		
total mortaity including unsearchable areas (= total mortality + (total mortality x 0.05))	3.16		

References:

Huso M. 2008a. Estimators of wildlife fatality: a critical examination of methods in Proceedings of the NWCC Wind Wildlife Research Meeting VII. Milwaukee, WI October 28-29, 2008. Prepared for the Wildlife Workgroup of the National Wind Coordinating Collaborative by RESOLVE, Inc., Washington, DC, Susan Savitt Schwartz, ed. 116 pp...................................

Huso 2008b. Estimators of wildlife fatality: a critical examination of methods PowerPoint Presentation. Available at: http://www.nationalwind.org/pdf/HusoManuela.pdf

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual Report for the Maple Ridge Wind Power Project Postconstruction Bird and Bat Fatality Study – 2006. Final Report. Curry and Kerlinger, LLC.

Shoenfeld, P. 2004. Suggestions regarding avian mortality extrapolation. Prepared for the Mountaineer Wind Energy Center Technical Review Committee

Smallwood, K. S. 2007. Estimating wind turbine-caused bird mortality. Journal of Wildlife Management 71:(8)2781–2791.

Appendix 11

Seabird Mitigation:

Makamakaʻole Seabird Mitigation and Management Plan (with KWP and KWP II)

Calendar Year	Task/Item	By	Estimated Cost ($1,000s)	Project Share	
				KWP	KWP II
2011	• Permit application review and processing • Solicit bids/select contractor • Follow-up reconnaissance/construction planning	Project Staff/ Consultant	50	25	25
2012	• Fence construction • Intensive predator trapping/bait boxes • Social attraction and artificial burrows • Monitoring • Field investigation for contingencies	Project Staff/ Interns	260	130	130
2013	• Continue bait boxes • Social attraction and artificial burrows • Monitoring • Field investigation for contingencies	Project Staff/ Interns	48	24	24
2014	• Inspections (fence/predator) • Bait boxes • Social attraction and artificial burrows • Monitoring • Field investigation for contingencies	Project Staff/ Interns	48	24	24
2015	• Inspections (fence/predator) • Bait boxes • Social attraction and artificial burrows • Monitoring • Field investigation for contingencies	Project Staff/ Interns	48	24	24
2016	• Inspections (fence/predator) • Bait boxes • Social attraction and artificial burrows • Monitoring • Field investigation for contingencies • Assessment of first five years, projection of expected credit accrual	Project Staff/ Interns	48	24	24
2017-2031 *(KWP permit expires 2026)*	• Social attraction continues • Inspections (fence/predator) • Bait boxes • $30,000/yr for 15 years	Project Staff/ Interns	450	225	225
		Totals	**952**	**476**	**476**

Seabird Mitigation Alternative :
Multi-Project Plan for Hawaiian Petrel at Haleakala National Park and Newell's Shearwater on Maui/Molokai/Lanai

Calendar Year	Task/Item	By	Estimated Cost ($1,000s)	Project Share	
				KWP	KWP II
2017	• If Makamaka`ole is not meeting mitigation goals proceed with Haleakala/alternative Maui/Molokai/Lanai options • Haleakala Petrel Colony: o Coordinate with National Park Service, define Haleakala colony management area, prepare draft plan, submit for agency review o Execute necessary agreements with NPS, obtain necessary permits and authorizations • Newell's Shearwater: o Fence construction o Intensive predator trapping/bait boxes o Social attraction and artificial burrows o Monitoring	Project Staff/ Consultant Support	334	167	167
2018	• Haleakala Petrel Colony: o Complete final plan, complete permits, authorizations and agreements o Solicit resumes/select field staff, procure equipment and materials o Lay out management area and trapping array o Commence trapping in accordance with approved plan • Newell's Shearwater: o Continue trapping and baiting o Social attraction and artificial burrows o Monitoring	Project Staff/Consultant Support	60	30	30
2019	• Haleakala Petrel Colony: o Continue trapping in accordance with approved plan o Work out bugs in program • Newell's Shearwater: o Inspections (fence/predator) o Trapping and baiting o Social attraction and artificial burrows o Monitoring	Project Staff/ Interns	60	30	30
2020	• Haleakala Petrel Colony: o Continue trapping in accordance with approved plan • Newell's shearwater: o Inspections (fence/predator) o Trapping and baiting o Social attraction and artificial burrows o Monitoring	Project Staff/ Interns	60	30	30

2021	• <u>Haleakala Petrel Colony</u>:
	  ○ Continue trapping in accordance with approved plan
	• <u>Newell's shearwater</u>:
	  ○ Inspections (fence/predator)
	  ○ Trapping and baiting
	  ○ Social attraction and artificial burrows
	  ○ Monitoring
	  ○ Assessment of first five years, projection of expected credit accrual
		Project Staff/ Interns	60	30	30

2017-2031 *(KWP permit expires 2026)*	• <u>Haleakala Petrel Colony</u>:
	  ○ Continue trapping @ $30K/yr for 8 yrs in accordance with approved plan (assumes 8 add'l years needed to fulfill mitigation obligations)
	• <u>Newell's shearwater</u>:
	  ○ Continue trapping/mgmt @ $30K/yr for 11 yrs in accordance with approved plan
		Project Staff/ Interns	570	285	285

		Totals	**1145**	**572**	**572**

Appendix 12

Kaheawa Wind Power II
Habitat Conservation Plan

Construction Phase Nēnē and Nest Survey Protocol

INTRODUCTION

Surveys for nēnē and nēnē nests will be conducted by a qualified biologist, ornithologist, field ecologist or similarly experienced professional, prior to any clearing, grading, selected drill-and-shoot dense substrate fracturing, or construction of project roadways, turbines and accessory facilities. These surveys will be conducted as avoidance and minimization measures as prescribed in the project's Habitat Conservation Plan and are a requirement of the Conservation District Use Permit issued to Kaheawa Wind Power II (KWP II) by the DLNR.

Section 9 of the Endangered Species Act (ESA) prohibits the "take" of any endangered or threatened species of fish or wildlife listed under the ESA. Under the ESA, the term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect species listed as endangered or threatened, or to attempt to engage in any such conduct. "Harm" in the definition of "take" in the ESA means an act which actually kills or injures wildlife, and may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). "Harass" in the definition of take in the ESA means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering (50 CFR 17.3).

Section 195D-4, Hawai`i Revised Statutes, states that any endangered or threatened species of fish or wildlife recognized by the ESA shall be so deemed by State statute. Like the ESA, the "take" of such endangered or threatened species is prohibited [Section 195D-4(e)]. The definition of "take" in Section 195D-2 mirrors the definition of the ESA: "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect endangered or threatened species of aquatic life or wildlife...or to attempt to engage in any such conduct."

The nēnē nesting season typically begins in October and ends in April. Although nēnē are not believed to use the KWP II project area as preferred nesting habitat, they may still be present in the project area during the nesting and non-nesting season. Therefore, construction activities occurring from May through September would typically be the least likely to encounter nēnē nesting in the project vicinity.

FIELD METHODS

Timing Surveys for Optimal Reliability

Surveys to identify nēnē or nēnē nests in project construction areas should be conducted in a timeframe as close as possible to anticipated construction activities in order for the survey to accurately represent the occurrence of birds or newly established nests in proximity to these areas. Because nēnē are mobile and have the ability to readily move among different portions of the project area, the reliability of a survey depends largely on it being performed immediately before construction activities are expected to commence.

The timing and protocol for conducting pre-construction surveys during the nesting season will be confirmed through consultation with DOFAW and USFWS prior to surveys being conducted to ensure that there is confidence in the survey methods and results such that the subsequent proposed construction activity can be safely undertaken.

DOFAW and Kaheawa Wind Power biologists have agreed to work in close collaboration during construction phase nēnē monitoring at KWP II.

Search Area

The area surveyed for Nene presence or nesting activity should cover the entire area where such construction activity will occur, and will extend a distance of 100-200 meters (328-656 feet) further on either side of these areas, depending on the specific type of construction activity being performed. For example, if roadway construction on a turn will involve cut-and-fill in an area that is 50 feet wide, this area plus 100 meters on either side must be searched. Similarly, if drill-and-shoot charge detonations are required to loosen dense rock and substrate prior to excavation, the area that will be searched may extend 200 meters. The size of the search area on any given day will depend on which areas are planned for construction activities and what specific construction activities are planned, while spacing and configuration of transects will be dependent upon topography and vegetation in the area, and subject to the surveyor's qualified opinion..

Construction Monitoring

KWP II will provide a biologist who will inspect areas of proposed active construction for evidence of nests, adult birds and/or young, for a period leading up to and immediately prior (same day) to construction work proceeding. During the nesting period, once an area is searched and determined to be "cleared" (of nene nests and or family groups with un-flighted goslings), KWP II biologists may, where practicable and warranted, place a temporary orange construction fence or similar barrier at the edge of the surveyed area to designate the limits of the area that has been "cleared". This temporary fence material may be moved and re-used as surveying and construction proceeds, but will not be left in the field indefinitely.

If nests or birds are found, the discovery protocol provided in the following section will be followed.

DISCOVERY PROTOCOL

Discovery During Clearing Surveys

Should any nēnē or nests be found during a survey, DOFAW and USFWS will be contacted and will advise the on-site biologist in-charge of monitoring at KWP II how to proceed, on a case-by-case basis, depending on the location and status of the birds or nest. It is important to note the case-by-case nature of this protocol, as there are many factors that DOFAW, USFWS, and KWP II will consider if birds and/or nests are discovered in the project area, including: topography and terrain; vegetation and adjacent habitat; recent weather; proximity to proposed construction activity; status of nest and eggs and the age, health and behavior of goslings and/or adults.

If a nest is found during pre-construction clearing surveys, the following measures will likely be required, in varying degrees:

- Construction will likely be prohibited from commencing within a certain perimeter of the nest for an appropriate period of time;
- Subsequent monitoring of the nest may be required to ensure that the nest, eggs, chicks and adults are not disturbed by project activities nearby and elsewhere;
- Temporary fencing or other protection barrier, where specifically warranted may be required to protect the nest from nearby activity; or the nest may be relocated by agency officials.

DOFAW and USFWS will likewise advise KWP II on appropriate measures to avoid any inadvertent harm or harassment of non-nesting birds, family groups, and individuals or flocks that are discovered during the clearing surveys.

Discovery During Construction

Even with timely surveys, it is possible that construction activities could encounter birds or nests that were not discovered during an initial clearing survey. If a nest or evidence of nēnē nesting activity is discovered during construction, all work in the vicinity of the discovery shall cease immediately and DOFAW and USFWS shall be contacted.

Thereafter, the same case-by-case protocol as described in the section above (Discovery During Clearing Surveys) will be followed. Construction may be allowed to resume in adjacent areas beyond the established nest protection bufferbuffer if agreed by DLNR, USFWS, and KWP II that such activity is not expected to result in adverse impacts or disturbance; temporary fencing, other protective barrier, or suitable marking strategy may be required along with subsequent monitoring; or, the nest may be relocated by agency officials.

Education

DOFAW and Kaheawa Wind Power II have agreed that it would be beneficial to coordinate pre-construction educational and training sessions with all construction workers, inspectors, and site managers to provide information about nēnē , with an emphasis on their nesting and foraging habits, general disposition and behavior, and overall ecology in the Kaheawa Pastures region. Kaheawa Wind Power II is also implementing a Wildlife Education and Observation Program (WEOP) under the HCP that ensures each individual contractor and their designees are provided with the necessary information on the occurrence and behavior, guidelines for reporting observations and occurrences of birds around work areas and roads of nēnē while working and traveling I

REPORTING

Kaheawa Wind Power II will present written results of daily surveys performed throughout the construction phase of the project to DOFAW and USFWS on a weekly and as-requested basis to ensure steady and useful exchange of information on the status of monitoring efforts and levels of nēnē interaction with construction activities. A final report summaring the results of construction phase nēnē monitoring will be prepared and presented to DOFAW and USFWS when construction activities are complete.

Appendix 13

RADAR AND VISUAL STUDIES OF SEABIRDS AT THE PROPOSED KWP II DOWN-ROAD ALTERNATIVE WIND ENERGY FACILITY, MAUI ISLAND, HAWAII, FALL 2009

BRIAN A. COOPER

PETER M. SANZENBACHER

ROBERT H. DAY

PREPARED FOR

FIRSTWIND, LLC
NEWTON, MA

PREPARED BY

ABR, INC.—ENVIRONMENTAL RESEARCH & SERVICES
FOREST GROVE, OREGON ♦ FAIRBANKS, ALASKA

RADAR AND VISUAL STUDIES OF SEABIRDS AT THE PROPOSED KWP II DOWN-ROAD ALTERNATIVE WIND ENERGY FACILITY, MAUI ISLAND, HAWAII, FALL 2009

FINAL REPORT

Prepared for

FIRSTWIND, LLC
85 Wells Avenue, Suite 305
Newton, MA 02459-3210

Prepared by

Brian A. Cooper and Peter M. Sanzenbacher
ABR, Inc.—Environmental Research & Services
P.O. Box 249
Forest Grove, OR 97116-0249

and

Robert H. Day
ABR, Inc.—Environmental Research & Services
P.O. Box 80410
Fairbanks, AK 99708-0410

April 2010

EXECUTIVE SUMMARY

- We used radar and audiovisual methods to collect data on movements of endangered Hawaiian Petrels (*Pterodroma sandwichensis*) and threatened Newell's (Townsend's) Shearwaters (*Puffinus auricularis newelli*) at the proposed Kaheawa Wind Power II Down-road Alternative (KWP II) wind energy generation facility, on Maui Island during fall 2009. We conducted evening and morning surveys during 25–29 October 2009.
- The objectives of the study were to: (1) document movement rates of Hawaiian Petrels and Newell's Shearwaters at the proposed KWP II facility; (2) estimate the daily number of petrels/shearwaters that fly within areas that would be occupied by wind turbines and a meteorological (met) tower at the proposed facility; and (3) estimate annual fatality rates of petrels/shearwaters at proposed turbines and a met tower.
- We recorded 24 radar targets that fit our criteria for petrels and shearwaters.
- The mean movement rate across all nights was 1.16 ± 0.17 targets/h. After adjusting our sampling results for hours of the night that we did not sample (i.e., non-peak periods), we estimated a mean movement rate of 6.5 petrel-like/shearwater-like targets/night during fall 2009.
- No Hawaiian Petrels or Newell's Shearwaters were detected by visual observers. We also did not visually observe any Hawaiian Hoary Bats, but had one auditory detection on the evening of 27 October.
- To determine the risk of collision-caused mortality, we used petrel/shearwater movement rates observed on radar in summer and fall 2009, petrel/shearwater flight altitudes from previous studies, and dimensions and characteristics of the proposed turbines and met towers to generate an estimate of exposure risk. We then applied estimates of the fatality probability (i.e., the probability of collision with a portion of the turbine or tower and dying while in the airspace occupied by the structure) and a range of estimated avoidance probabilities (i.e., the probability that a bird will detect and avoid entering the airspace containing the turbine or tower) to this estimate of exposure to calculate annual fatality rates that could be expected at the proposed turbines and met tower.
- We estimated that 2–11 Hawaiian Petrels and 1–6 Newell's Shearwater fly within the space occupied by each wind turbine in an average year and estimated that 1 Hawaiian Petrel and 1 Newell's Shearwater fly within the space occupied by the 65-m-high met tower in an average year. Note that all these calculations are exposure rates and, thus, include an unknown proportion of birds that would detect and avoid the turbines and met towers. Hence, exposure rates estimate how many times/year a petrel or shearwater would be exposed to wind turbines or met towers and not necessarily the number that actually would collide with those structures.
- We provide a range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance rates) along with a discussion of the body of evidence that is consistent with the hypothesis that the average avoidance-rate value is substantial and potentially ≥95%. With an assumption of ≥95% avoidance, the estimated average annual number of fatalities at the proposed KWP II wind turbines would be 0.015–0.098 Hawaiian Petrel/turbine/yr and 0.008–0.054 Newell's Shearwaters/turbine/yr. The estimated average annual number of fatalities at the proposed KWP II met tower (with an assumption of ≥95% avoidance) would be 0.007–0.036 Hawaiian Petrel/tower/yr and 0.004–0.020 Newell's Shearwaters/tower/yr.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

We thank First Wind for funding this study and for providing the ornithological radar used for sampling. We thank Greg Spencer and Dave Cowan (First Wind) for help with logistics and thank Greg Spencer, Bob Roy, and Ian Bordenave (First Wind) for their assistance with the visual sampling. At ABR, Rich Blaha and Dorte Dissing produced study figures and Alice Stickney and Pam Odom assisted with report production.

INTRODUCTION

First Wind, LLC, formerly UPC Wind Management, LLC, operates the 30-MW Kaheawa Pastures Wind Energy Generation Facility, referred to as Kaheawa Wind Power I (KWP I), on the island of Maui (Figure 1). A new wind project adjacent to the existing facility is being considered for development by First Wind and will be operated as Kaheawa Wind Power II (i.e., the KWP II Down-road Alternative [KWP II]). Two federally-listed seabird species occur on Maui: the endangered Hawaiian Petrel (*Pterodroma sandwichensis*; Hawaiian name ’Ua’u) and the threatened Newell’s (Townsend’s) Shearwater (*Puffinus auricularis newelli*; Hawaiian name ’A’o). Ornithological radar and night-vision techniques have been shown to be successful in assessing numbers and movement rates of these petrels and shearwaters on the Hawaiian Islands (e.g., Kaua’i [Cooper and Day 1995, 1998; Day and Cooper 1995, Day et al. 2003b], Maui [Cooper and Day 2003], Moloka’i [Day and Cooper 2002], and Hawai’i [Day et al. 2003a]). Previous radar and visual studies documented the presence of petrel/shearwater targets, including visual observations of Hawaiian Petrels, in the vicinity of the existing KWP I project site (Day and Cooper 1999, Cooper and Day 2004a). These data were used to model the potential number of annual fatalities at the KWP I development (Cooper and Day 2004b). In addition, radar studies were conducted in 2008 (Sanzenbacher and Cooper 2008, 2009) to model the potential number of fatalities in a nearby portion of a previous KWP II site that was located just upslope of the KWP II Down-road alternative.

The currently operational KWP I windfarm consists of an articulated row of 20 1.5-MW turbines (GE 1.5se) with a hub height of ~55 m and a rotor diameter of 70.5 m, plus one 30-m-high, guyed NRG monopole meteorological (met) tower and two 55-m-high, guyed lattice met towers (Figure 2). The proposed KWP II project would consist of ~14 additional 1.5-MW turbines (GE 1.5se), each with a hub height of ~65 m and a rotor diameter of 70.5 m, plus one 65-m-high, free-standing met tower.

ABR conducted additional radar and visual studies on Maui in July 2009 (Cooper and Day 2009) and fall 2009 (this study) with a specific focus on an area proposed for the KWP II facility. The objectives of the studies were to: (1) document movement rates of Hawaiian Petrels and Newell’s Shearwaters at the proposed KWP II facility; (2) estimate the daily number of petrels/shearwaters that fly within areas that would be occupied by wind turbines or met towers at the proposed facility; and (3) estimate annual fatality rates of petrels/shearwaters at the proposed turbines and meteorological (met) tower.

Background

Two seabird species that are protected under the Endangered Species Act (ESA) are likely and/or known to occur in the KWP II project area: the endangered Hawaiian Petrel and the threatened Newell’s (Townsend’s) Shearwater. The Hawaiian Petrel and the Newell’s Shearwater are forms of tropical Pacific species that nest only on the Hawaiian Islands (American Ornithologists’ Union 1998). Both species are Hawaiian endemics whose populations have declined significantly in historical times: they formerly nested widely over all of the Main Islands but now are restricted in most cases to scattered colonies in more inaccessible locations (Ainley et al. 1997b, Simons and Hodges 1998). The one exception is Kaua’i Island, where colonies still are widespread and populations are substantial in size. Of note, Kaua’i (along with Lana’i) also has no introduced Indian Mongooses (*Herpestes auropunctatus*) which prey on these seabirds.

The Hawaiian Petrel nests primarily on Maui (Richardson and Woodside 1954, Banko 1980a; Simons 1984, 1985; Simons and Hodges 1998, Cooper and Day 2003), Kaua’i (Telfer et al. 1987, Gon 1988, Day and Cooper 1995; Ainley et al. 1995, 1997a, 1997b; Day et al. 2003a), Hawai’i (Banko 1980a, Conant 1980, Hu et al. 2001, Day et al. 2003a), Lana’i (Shallenberger 1974; Hirai 1978a, 1978b; Conant 1980; G. Spencer and J. Penniman, pers. comm.), and Moloka’i (Simons and Hodges 1998, Day and Cooper 2002). On Maui, these petrels are known to nest on Haleakala Crater (Brandt et al. 1995, Simons and Hodges 1998) and are believed to nest in West Maui (Cooper and Day 2003, Kaheawa Wind Power 2009), with recent observations of birds calling and exhibiting aerial displays consistent with breeding

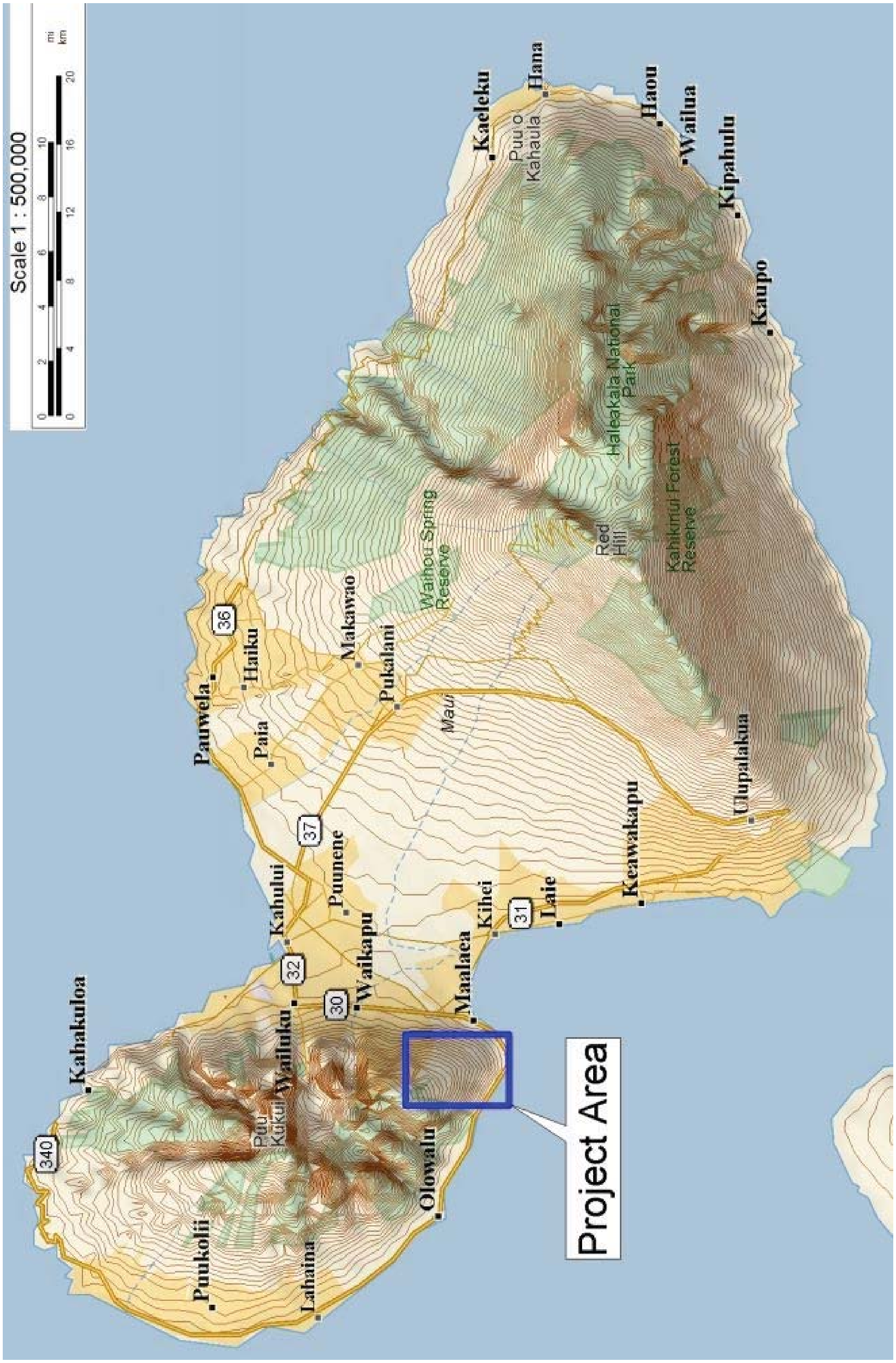


Figure 1. Maui Island, Hawaii, with approximate location of the Kaheawa Pastures Wind Energy Facilities (KWP I and KWP II).

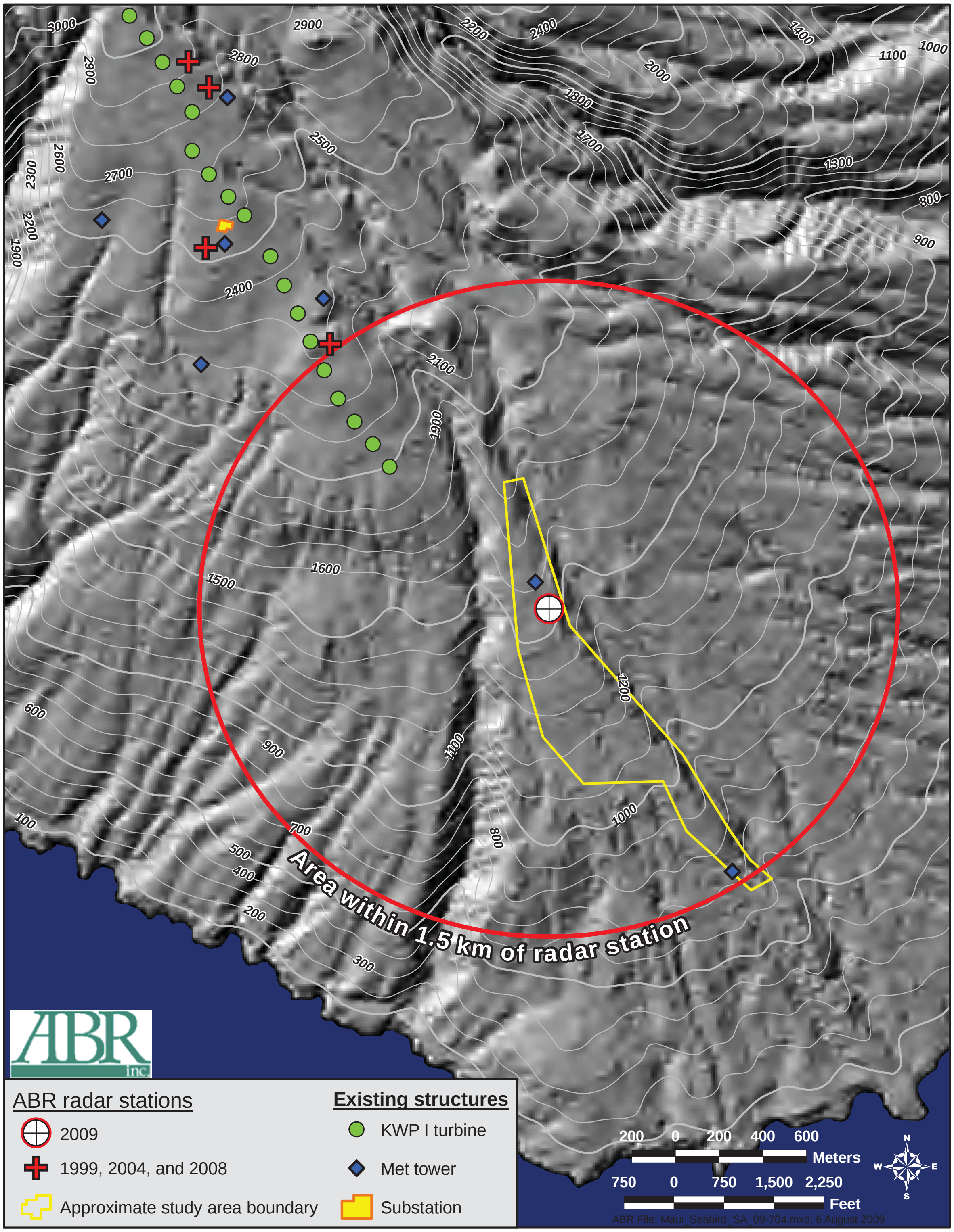


Figure 2. Location of 2009 radar sampling stations relative to sampling stations from previous studies (Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009) and areas under consideration for siting of wind turbines at the proposed KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii.

behavior, despite the minimal historical evidence and introduction of Indian Mongoose on Maui. For example, on 16 June 1999, a Hawaiian Petrel was heard calling from a bed of uluhe ferns (*Dicranopteris linearis*) at 3,300 ft (~1,000 m) elevation in the Kapunakea Preserve, which lies on the northwestern slope of the West Maui Natural Area Reserve (A. Lyons, *fide* C. Bailey). In addition, recent observations of consistent calling from a single location suggests that there is another small colony of Hawaiian Petrels in the West Maui Mountains ~14 km north of the KWP project areas (G. Spencer, First Wind, pers. comm.). On the other hand, daily movement rates of Hawaiian Petrels near KWP I and II (i.e., on the southern slope of the West Maui Mountains; Day and Cooper 1999, Cooper and Day 2004a, Sanzenbacher and Cooper 2008 and 2009) are much lower than those over the eastern and northern sides of Maui (Cooper and Day 2003), suggesting that few birds use that area.

Newell's Shearwaters nest on several of the main Hawaiian Islands, with the largest numbers clearly occurring on Kaua'i (Telfer et al. 1987, Day and Cooper 1995; Ainley et al. 1995, 1997b; Day et al. 2003b). These birds also nest on Hawai'i (Reynolds and Richotte 1997, Reynolds et al. 1997, Day et al. 2003a), almost certainly nest on Moloka'i (Pratt 1988, Day and Cooper 2002), and may still nest on Oahu (Sincock and Swedberg 1969, Banko 1980b, Conant 1980, Pyle 1983; but see Ainley et al. 1997b). On Maui, recent auditory observations suggest that a small colony of Newell's Shearwaters is present in the West Maui Mountains ~14 km north of the KWP project areas (G. Spencer, First Wind, pers. comm.), matching a prediction of their occurrence there by Cooper and Day (2003). Newell's Shearwaters typically nest on steep slopes that are vegetated by uluhe fern undergrowth and scattered o'hia trees (*Metrosideros polymorpha*).

There is interest in studying these two species because of concerns regarding collisions with structures such as met towers and turbines. To date, there has been only one documented fatality of a single Hawaiian Petrel and zero Newell's Shearwaters during the past four years at KWP (G. Spencer, First Wind, pers. comm.). In addition, zero fatalities of either species were observed at six met towers that were monitored on the island of Lana'i during 2008 (TetraTech 2008a). Though several additional entities operate other wind turbine and/or met tower facilities within the Hawaiian Islands, it is unknown whether these other facilities have incurred take of either species. Hence, there still are not enough reported studies of adequate duration or geographic scope to answer the question definitively of whether these species are prone to collisions at wind turbines and met towers. There has, however, been well-documented petrel and shearwater mortality because of collisions with other human-made objects (e.g., transmission lines, communication towers) on Kaua'i (Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998) and Maui (Hodges 1992), and there have been collision-caused fatalities of other seabirds at other Hawaiian Islands (Fisher 1966).

STUDY AREA

The operational KWP I windfarm and proposed KWP II expansion are located on the southern slope of the West Maui Mountains, in an area called Kaheawa Pastures (Figure 1). These sites lie on a moderately sloping portion of West Maui Mountain, ~1–6 km inland from McGregor Point. Vegetation at the site consists of non-native grasslands at lower elevations and a mixture of grasslands and scattered shrubs at moderate to higher elevations. Although the KWP II area consists of a dry Mediterranean habitat, vegetation becomes much wetter upland, toward the summit of West Maui Mountain. Presumably, vegetation communities also are dominated by native species in these higher, wetter areas. These upland habitats may provide suitable nesting habitat for Newell's Shearwaters, based on our experience on Kaua'i and other sites. In addition to the vegetation, the steepness of the land at higher elevations on West Maui Mountain also suggests that suitable nesting habitat exists for Hawaiian Petrels, as it does on Haleakala (Brandt et al. 1995), Kaua'i (Telfer, pers. comm.), and Lana'i (Hirai 1978b).

In previous studies at the KWP I and KWP II sites (Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009; Cooper and Day 2009), sampling was conducted at four other stations; however, for the current study, we established a new sampling station with a focus on providing maximal radar coverage of potential siting areas for the proposed KWP II Down-road Alternative development (Figure 2). The study area is situated in lower elevations slightly to the east and south of the existing KWP I turbine string, and our 2009 sampling station was located adjacent to the existing KWP I access road, just south of the Lahaina Pali trail (20° 47'52.6" N, 156° 32'16.5" W; elevation ~490 m).

METHODS

We used marine radar and visual equipment to collect data on the movements, flight behaviors, and flight altitudes of petrels and shearwaters at a single sampling station during fall (25–29 October) 2009 (Table 1). The daily sampling effort consisted of 3 h each evening (1800–2100 h) and 2 h each morning (0430–0630 h). These sampling periods were selected to correspond to the evening and morning peaks of movement of petrels and shearwaters, as described near breeding colonies on Kaua'i (Day and Cooper 1995). During sampling, we collected radar and audiovisual data concurrently so the radar operator could help the audiovisual observer locate birds for species identification and data collection. In return, the audiovisual observer provided information to the radar operator on the identity and flight altitude of individual targets (whenever possible). For the purpose of recording data, a calendar day began at 0700 and ended at 0659 the following morning; that way, an evening and the following morning were classified as occurring on the same day.

The ornithological radar used in this study was a Furuno (Model FCR-1510) X-band radar transmitting at 9.410 GHz through a slotted wave guide with a peak power output of 12 kW; a similar radar unit is described in Cooper et al. (1991) and Mabee et al. (2006). The antenna face was tilted upward by ~10°, and we operated the radar at a range setting of 1.5 km and a pulse-length of 0.07 μsec.

Issues associated with radar sampling include ground clutter and shadow zones. Whenever

Table 1. Sampling dates and number of inbound and outbound seabird radar targets and number of audiovisual observations of species of interest observed at the proposed KWP II Down-road Alternative (KWP II) wind-energy site, Maui Island, Hawaii, October 2009.

			Number of radar targets			
Date	Site	Period	Inbound[1]	Outbound[1]	Total	Number of audio-visual Detections[2]
25 Oct	Lower KWP	Eve	0	1	1	1 SEOW
		Morn	3	0	3	0
26 Oct	Lower KWP	Eve	1	1	2	0
		Morn	2	1	3	2 NENE
27 Oct	Lower KWP	Eve	2	0	2	1 PGPL, 1 HOBA (acoustic)
		Morn	5	0	5	0
28 Oct	Lower KWP	Eve	2	0	2	4 SEOW
		Morn	1	0	1	1 SEOW
29 Oct	Lower KWP	Eve	2	2	4	1 BAOW
		Morn	1	0	1	0
TOTAL		Eve	7	4	11	
		Morn	12	1	13	
		Total	19	5	24	

[1] Flight direction categories for inbound and outbound categories included all birds flying toward/away from either the colonies located on west Maui (north of the study site) or colonies located on Haleakala (i.e., Inbound = 316–135° and Outbound = 136–315°).

[2] NENE = Nene; HOBA = Hoary Bat; SEOW = Short-eared Owl; BAOW = Barn Owl: PGPL = Pacific Golden-plover.

energy is reflected from the ground, surrounding vegetation and other objects around the radar unit, a ground-clutter echo that can obscure targets of interest (i.e., birds) appears on the radar's display screen. Shadow zones are areas of the screen where birds can fly at an altitude that potentially would put them behind a hill or row of vegetation where they could not be detected because the radar operates only on line-of-sight. We attempted to minimize ground clutter and shadow zones during the selection of radar sampling stations; various structures and landscape features visible on radar indicated that our sampling stations provided good coverage of the study area.

We sampled for six 25-min sessions during each evening and for four 25-min sessions each morning (Table 1). Each 25-min sampling session was separated by a 5-min break for collecting weather data. To help eliminate non-target species, we collected data only for those targets that met a suite of selection criteria, following methods developed by Day and Cooper (1995), that included appropriate flight characteristics and flight speeds (≥30 mi/h [≥50 km/h]). We also removed radar targets identified by flight characteristics or visual observers as being of other bird species.

We conducted audiovisual sampling for birds and bats concurrently with the radar sampling to help identify targets observed on radar and to obtain flight-altitude information. During this sampling, we used 10X binoculars during crepuscular periods and Generation 3 night-vision goggles (Model ATN-PVS7; American Technologies Network Corporation, San Francisco, CA) during nocturnal periods. The magnification of the night-vision goggles was 1X, and their performance was enhanced with the use of a 3-million-Cp floodlight that was fitted with an IR filter to avoid blinding and/or attracting birds. Audiovisual observations were conducted within 25 m of the radar to facilitate coordination between observers, and we also listened for petrel and shearwater vocalizations. In addition, we opportunistically used an Anabat SDI ultrasonic detector (Titley Electronics) to listen for bat vocalizations in the immediate vicinity during our sampling.

Before each 25-min sampling session, we also collected environmental and weather data, including:

- wind speed (to the nearest 1.6 km/h [1 mi/h]);
- wind direction (to the nearest 1°);
- percent cloud cover (to the nearest 5%);
- cloud ceiling height, in meters above ground level (agl; in several height categories);
- visibility (maximal distance we could see, in categories);
- light condition (daylight, crepuscular, or nocturnal, and with or without precipitation)
- precipitation type; and
- moon phase/position (lunar phase and whether the moon was above or below the horizon in the night sky).

For each appropriate radar target, we recorded the following data:

- species (if identified by visual observer);
- number of birds (if identified by visual observer);
- time;
- direction of flight (to the nearest 1°);
- cardinal transect crossed (000°, 090°, 180°, or 270°);
- tangential range (the minimal perpendicular distance to the target when it passed closest to the radar; used in reconstructing actual flight paths, if necessary);
- flight behavior (straight, erratic, circling);
- velocity (to the nearest 5 mi/h [8 km/h]); and
- flight altitude (meters agl, if identified by visual observer).

For each bird (or bat) recorded during audiovisual sampling, we recorded:

- time;
- species (to the lowest practical taxonomic unit [e.g., Hawaiian Petrel, unidentified petrel/shearwater]);
- number of individuals composing each target;
- ordinal flight direction (000°, 045°, 090°, 135°, 180°, 225°, 270°, 315°); and
- flight altitude (meters agl).

For any birds heard but not observed, we recorded species, number of calls, direction of calls, and approximate distance.

DATA ANALYSIS

We entered all radar and visual data into Microsoft Excel databases. Data files were checked visually for errors after each night's sampling, then were checked electronically for irregularities at the end of the field season, prior to data analyses. In addition, radar data were filtered to remove non-target species, and only known petrel/shearwater targets or unknown targets with appropriate characteristics (i.e., target size, flight characteristics, and airspeeds ≥30 mi/h) were included in data analyses. Airspeeds were calculated by correcting observed target flight speeds (groundspeeds) for speed and relative direction of wind, as measured each half-hour at the radar station (Mabee et al. 2006).

We tabulated counts of numbers of radar targets of petrels and shearwaters recorded during each sampling session, then converted those counts to estimates of movement rates of birds (radar targets/h), based on the number of minutes sampled. Only 25 min of sampling time was lost to rain or other factors during the fall sampling period; we standardized estimates by actual minutes of sampling effort each half hour. We used all of the estimated movement rates across sampling sessions at a station to calculate the mean ± 1 standard error (SE) nightly movement rate of petrels and shearwaters by station and pooled data across nights to derive an overall hourly movement rate for the study.

We also classified general flight directions of each radar target as inbound or outbound and summarized those directional categories by station, date, and time period. To categorize the general flight direction of each target, we defined an inbound flight as a radar target flying toward 316–135° (i.e., toward breeding colonies in the West Maui Mountains or on Haleakala) and classified targets flying in the opposite directions (i.e., toward 136–315°) as outbound targets.

MODELING FATALITY RATES

The risk-assessment technique that we have developed involves the use of radar data for estimating the fatality rates for petrels and shearwaters near structures in the Hawaiian Islands. This modeling technique uses the radar data on seasonal movement rates to estimate numbers of birds flying over the area of interest (sampling station) across a 255-d year (for Hawaiian Petrels) or a 210-d year (for Newell's Shearwater) when breeding birds are present on the island. The model then uses information on the physical characteristics of the structures (e.g., wind turbines or met towers) themselves to estimate horizontal and vertical interaction probabilities and combines these interaction probabilities with the movement rates to generate exposure rates (Figure 3). These rates represent the estimated numbers of petrels/shearwaters that pass within the airspace occupied by a proposed wind turbine or within the airspace occupied by a met tower and its associated guy wires each year. We then combine these exposure rates with (1) the probability that an interaction results in fatality, and (2) the probability that birds detect structures and avoid interactions, to estimate fatality rates.

We calculate an exposure rate by multiplying the seabird movement rate observed on radar by horizontal- and vertical-interaction probabilities. The movement rate is an estimate of the average number of birds passing in the vicinity of the proposed turbines/towers in a day, as indicated by numbers of targets on the radar screen and the mean flock size/target. It is generated from the radar data by: (1) multiplying the average movement rates by 5.0 h to estimate the number of targets moving over the radar site in the first 3 h and last 2 h of the night (i.e., during the peak movement periods of petrel/shearwaters); (2) adjusting the sum of those evening and morning counts to account for the estimated percentage of

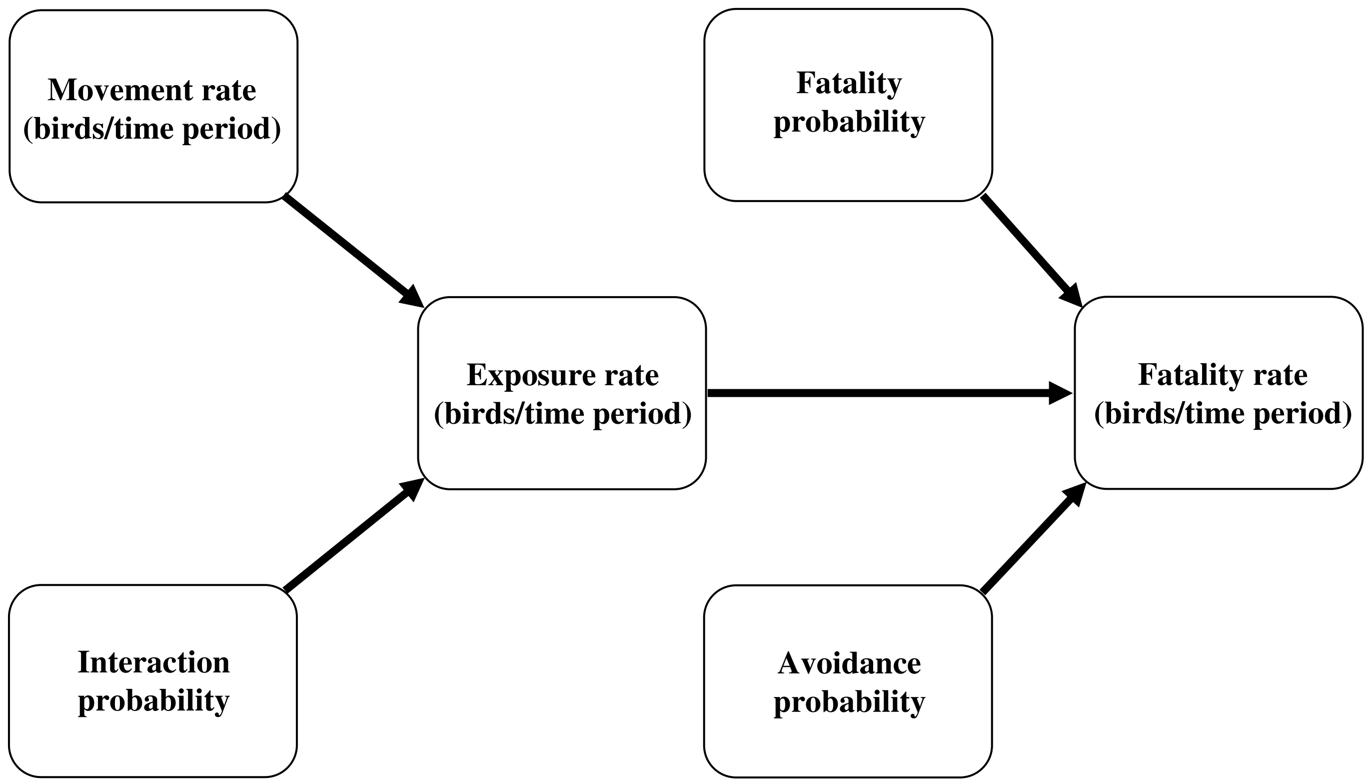


Figure 3. Major variables used in estimating possible fatalities of Hawaiian Petrels and Newell's Shearwaters at wind turbines at the proposed KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii. See Tables 2 and 3 for details on calculations.

movement that occurs during the middle of the night (when we did not sample); and (3) multiplying that total number of targets/night by the mean number of seabirds/target to generate an estimate of the number of petrel/shearwaters passing in the vicinity of the proposed met towers/turbines during an average day.

We used the radar-based movement data from our summer 2009 (Cooper and Day 2009) and fall studies (this study) at the proposed KWP II development to estimate seabird movement-rates and assumed that those rates represented average rates observed in an average year. We used data from all-night sampling sessions on Kaua'i (Day and Cooper 1995) to estimate movement rates occurring during the hours between our evening and morning sampling periods. These data suggested that an additional 12.6% of the total combined evening inbound movements and outbound morning movements occurred between the evening and morning peak-movement periods (Day and Cooper, unpubl. data). We also corrected the number of targets for flock size: mean flock sizes of petrels and shearwaters combined in Hawai'i are 1.05 ± SE 0.01 birds/flock (n = 2,062 flocks; Day and Cooper, unpubl. data). In addition, we used the timing of inland flights at the nearby Ukumehame site from Cooper and Day (2003) to correct for proportions of targets that were Hawaiian Petrels and those that were Newell's Shearwaters; those data suggested that 60% of the targets were Hawaiian Petrels and 40% of the targets were Newell's Shearwaters.

The number of petrels visiting breeding colonies generally tends to decline from summer to fall because attendance at colonies by nonbreeders and failed breeders declines as chick-rearing progresses (Serventy et al. 1971, Warham 1990, Ainley et al. 1997b, Simons and Hodges 1998). Thus, we split the 255-d breeding season for Hawaiian Petrels (Simons and Hodges 1998) and 210-d breeding season for Newell's Shearwaters (Ainley et al. 1997b) into a spring/summer period of 180 days and 150 days for petrels and shearwaters, respectively and a fall period of 75 days and 60 days for petrels and shearwaters, respectively. We corrected the summer 2009 (from Cooper and Day 2009) and fall 2009 seasonal estimates of nightly movement rates by the numbers of days for the spring/summer and fall seasons, to generate estimates of movements for each season and species. We assume that the sum of these two estimates represents estimated movement rates for an entire breeding season (i.e., an average year).

Because the resulting estimate of the number of birds/yr is not an integer, we then round it upward to the next whole number to generate an estimate of the average number of birds passing within 1.5 km of the radar site during a year. This rounding technique results in slightly-inflated fatality estimates, but we choose to take a conservative approach in these studies associated with endangered species.

INTERACTION PROBABILITIES

Horizontal

Interaction probabilities consist of horizontal and vertical components. The horizontal-interaction probability is the probability that a bird seen on radar will pass through or over the airspace occupied by a met tower or turbine located somewhere on the radar screen. This probability is calculated from information on the two-dimensional area (side view) of the tower/turbine and the two-dimensional area sampled by the radar screen to determine the interaction probability. The 65-m, free-standing met-tower system consists of a central lattice tower without any supporting guy wires. The tower is 65 m high with a width at the base of ~6 m and a width at the top of ~0.5 m. The proposed wind turbines have ~65-m monopole towers and 35.25-m-long blades. Two calculations of area were made for turbines because of the large differences in area of the structure that depended on the orientation of the blades relative to the flight path of an approaching bird: a minimal area occupied by each proposed turbine if a bird approaches it from the side (i.e., side profile) and a maximal area occupied by each turbine if a bird approaches it from the front (i.e., front profile, including the rotor-swept area). The ensuing ratio of cross-sectional area of the proposed tower/turbine to the cross-sectional area sampled by the radar (1.5 km) indicates the probability of interacting with (i.e., flying over or through the airspace occupied by) the proposed tower or turbine.

Vertical

The vertical-interaction probability is the probability that a bird seen on radar will be flying at an altitude low enough that it might pass through the airspace occupied by a proposed met tower/turbine located somewhere on the radar screen. This probability is calculated from data on flight altitudes and from information on the proposed turbine heights. We used data from throughout the Hawaiian Islands (*n* = 2,010 birds; Cooper and Day, unpubl. data) to calculate the percentage of petrels/shearwaters with flight altitudes at or below the maximal height of the turbines (i.e., 51.0% ≤100 m agl) and met towers (i.e., 33.0% ≤65 m agl). We would have preferred to use flight-altitude data from the project area for the flight-altitude computations, but adequate sample sizes do not currently exist to do so.

FATALITY RATES

The annual estimated fatality rate is calculated as the product of: (1) the exposure rate (i.e., the number of birds that might fly within the airspace occupied by a tower/turbine); (2) the fatality probability (i.e., the probability of collision with a portion of the tower/turbine and dying while in the airspace occupied by the structure); and (3) the avoidance probability (i.e., the probability that a bird will detect and avoid entering the airspace containing the tower/turbine). The annual fatality rate is generated as an estimate of the number of birds killed/yr as a result of collisions with the tower/turbine, based on a 255-d breeding season for Hawaiian Petrels and a 210-d breeding season for Newell's Shearwaters.

Fatality Probability

The estimate of the fatality-probability portion of the fatality rate formula is derived as the product of: (1) the probability of dying if a bird collides with a tower/turbine; and (2) the probability of colliding with a turbine if the bird enters the airspace occupied by the structure (i.e., are there gaps big enough for birds to fly through the structure without hitting any part of it). Because any collision with a wind turbine or tower falls under the ESA definition of "take" we used an estimate of 100% for the first fatality-probability parameter. Note that the actual probability of fatality resulting from a collision is less than 100% because of the potential for a bird to hit a turbine component and not die (e.g., a bird could brush a wingtip but avoid injury/death). The second probability (i.e., striking the structure) needs to be calculated differently for met towers and turbines. In the met-tower design, the tower frame is a lattice structure, so we conservatively estimated the probability of hitting the tower if the bird enters the airspace at 100%. Similarly, a bird approaching a wind turbine from the side has essentially a 100% probability of getting hit by a blade; in contrast, a bird approaching from the back or front of a turbine may pass through the rotor-swept area without colliding with a blade, if it is flying fast enough. We calculated the probability of collision for the "frontal" bird approach based upon the length of a petrel (43 cm; Simons and Hodges 1998); the average groundspeed of petrels on Maui (mean velocity = 42.5 mi/h; *n* = 347 probable petrel targets; Cooper and Day, unpubl. data) and the time that it would take a 43-cm-long petrel to travel completely through a 2-m-wide turbine blade spinning at its maximal rotor speed (22 revolutions/min); also see Tucker (1996). These calculations indicated that 19.5% of the disk of the rotor-swept area would be occupied by a blade sometime during the length of time (i.e., 0.13 sec) that it would take a petrel to fly completely past a rotor blade (i.e., to fly 2.43 m).

Avoidance Probability

The final parameter is the avoidance probability, which is the probability that a bird will see the turbine and change flight direction, flight altitude, or both, so that it completely avoids flying through the space occupied by a met tower/turbine. Because avoidance probabilities are largely unknown, we present fatality estimates for a range of probabilities of collision avoidance by these birds by assuming that 90%, 95%, or 99% of all petrels or shearwaters flying near a tower/turbine structure will detect and avoid it. See discussion for explanation of avoidance rates used.

RESULTS

VISUAL OBSERVATIONS

No Hawaiian Petrels or Newell's Shearwaters were detected by visual observers (Table 1). We did have numerous observations of Short-eared Owls (*Asio flammeus sandwichensis;* Pueo), one Barn Owl (*Tyto alba*), a flock of two Nene (*Branta sandvicensis*) at 0612 h on 26 October, and one Pacific Golden-Plover (*Pluvialis fulva*) at 1812 h on 27 October. No Hawaiian Hoary Bats (*Lasiurus cinereus semotus*; 'Ope'ape'a) were seen, but one was detected on the ultrasonic device on the evening of 27 October.

MOVEMENT RATES

We recorded 24 radar targets during 25.0 h of sampling in fall 2009 that fit our criteria for petrels and shearwaters (Table 1). Passage rates were similar between the evening and morning: 11 (46%) of the 24 targets were recorded during the evening sampling period. Mean nightly movement rates during fall 2009 were 1.16 ± 0.17 targets/h. After adjusting our sampling results for hours of the night that we did not sample (i.e., non-peak periods), we estimated a mean movement rate of 6.5 petrel-like targets/night during fall 2009 (Table 2).

Flight paths generally were similar between evening and morning, with widely dispersed movements across the entire proposed wind facility (Table 1; Figures 4 and 5). The majority of targets were heading toward the general direction of breeding colonies on Haleakala—not West Maui Mountain.

EXPOSURE RATES

The exposure rate is calculated as the product of three variables: annual movement rate, horizontal-interaction probability, and vertical-interaction probability. As such, it is an estimate of the number of birds flying in the vicinity of the wind turbine/met tower (i.e., crossing the radar screen) that could fly in a horizontal location and at a low-enough altitude that they could interact with a tower/turbine. Based on our summer and fall 2009 movement rate data, we estimate that ~1,443 Hawaiian Petrels and 795 Newell's Shearwaters pass over the 1.5-km-radius radar sampling area in an average year (including birds at all altitudes; Tables 2 and 3). To generate annual exposure rates of birds exposed to each turbine or met tower (e.g., bird passes/tower/yr), we then multiplied the annual movement rate by the horizontal-interaction probability and the vertical-interaction probability. By applying those proportions to our data (and rounding up to the nearest whole number), we estimate that 2–11 Hawaiian Petrels and 1–6 Newell's Shearwater fly within the space occupied by each wind turbine in an average year (Tables 2 and 4) and estimate that 1 Hawaiian Petrel and 1 Newell's Shearwater fly within the space occupied by the 65-m-high met tower in an average year (Tables 3 and 4). Note that all these calculations are exposure rates and, thus, include an unknown proportion of birds that would detect and avoid the turbines and met towers. Hence, exposure rates estimate how many times/year a petrel or shearwater would be exposed to wind turbines or met towers and not necessarily the number that actually would collide with those structures.

FATALITY MODELING

The individual steps and estimates involved in calculating fatality rates are shown in Table 2 (turbines) and Table 3 (met tower). We speculate that the proportions of birds that detect and avoid turbines and towers is substantial (see Discussion), but limited petrel- or shearwater-specific data are available to use for an estimate of the avoidance rates for those types of structures. Because it is necessary to estimate the fatality of petrels and shearwaters at the proposed project, however, we assumed that 90%, 95%, or 99% of all birds will be able to detect and avoid the towers and turbines. If we also assume that 100% of the birds colliding with a turbine/tower die (although see above), the annual fatality rates are 0.015–0.195 Hawaiian Petrel/turbine/yr and 0.008–0.108 Newell's Shearwaters/turbine/year (Table 2). For the 65-m met tower, we estimate a fatality rate of 0.007–0.073 Hawaiian Petrel/tower/yr and 0.004–0.040 Newell's Shearwaters/tower/year (Table 3). For cumulative annual fatalities, the annual fatality rate would be 0.206–2.733 Hawaiian Petrels/yr and 0.114–1.506 Newell's Shearwaters/yr for all 14 proposed wind turbines combined (Table 4). The cumulative annual fatalities at the one proposed met tower would be 0.007–0.073 Hawaiian Petrels/yr and 0.004–0.040 Newell's Shearwaters/yr (Table 4). We caution

Table 2. Estimated average exposure rates and fatality rates of Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at GE 1.5se wind turbines at the proposed KWP II Down-road Alternative (KWP II) wind-energy site, Maui, Hawaii, based on radar data collected in July and October 2009. Values of particular importance are in boxes.

Variable/parameter	HAPE		NESH	
	Minimum	Maximum	Minimum	Maximum
MOVEMENT RATE (MVR)				
A) Mean movement rate (targets/h)				
A1) Mean rate during nightly peak movement periods in spring/summer based on July 2009 data (targets/h)	1.776	1.776	1.776	1.776
A2) Mean rate during nightly peak movement periods in fall based on October 2009 data (targets/h)	1.161	1.161	1.161	1.161
B) Number of hours of evening and morning peak-period sampling	5	5	5	5
C) Mean number of targets during evening and morning peak-movement periods				
C1) Spring/summer (A1*B)	8.88	8.88	8.88	8.88
C2) Fall (A2*B)	5.805	5.805	5.805	5.805
D) Mean proportion of birds moving during off-peak h of night	0.126	0.126	0.126	0.126
E) Seasonal movement rate (targets/night) = ((C*D)+ C)				
E1) Spring/summer	10.0	10.0	10.0	10.0
E2) Fall	6.5	6.5	6.5	6.5
F) Mean number of birds/target	1.05	1.05	1.05	1.05
G) Estimated proportion of each species	0.60	0.60	0.40	0.40
H) Daily movement rate (bird passes/day =E*F*G)				
H1) Spring/summer	6.30	6.30	4.20	4.20
H2) Fall	4.12	4.12	2.75	2.75
I) Fatality domain (days/year)				
I1) Spring/summer	180	180	150	150
I2) Fall	75	75	60	60
J) Annual movement rate (bird passes/year; = ((H1*I1) + (H2*I2)), rounded to next whole number)	1,443	1,443	795	795
HORIZONTAL INTERACTION PROBABILITY (IPH)				
K) Turbine height (m)	100	100	100	100
L) Blade radius (m)	35.25	35.25	35.25	35.25
M) Height below blade (m)	29.5	29.5	29.5	29.5
N) Front to back width (m)	6	6	6	6
O) Minimal side profile area (m^2) = (K*N)	600		600	
P) Maximal front profile area (m^2) = (M*N) + (π x L^2)		4081		4081
Q) Cross-sectional sampling area of radar at or below 100 m turbine height (= 3,000 m * 100 m = 300,000 m^2)	300,000.0	300,000.0	300,000.0	300,000.0
R) Minimal horizontal interaction probability (= O/Q)	0.00200000		0.00200000	
S) Maximal horizontal interaction probability (= P/Q)		0.01360211		0.01360211
VERTICAL INTERACTION PROBABILITY (IPV)				
T) Proportion of petrels flying ≤ turbine height)	0.51	0.51	0.51	0.51

Table 2. Continued.

Variable/parameter	HAPE Minimum	HAPE Maximum	NESH Minimum	NESH Maximum
EXPOSURE INDEX (ER = MVR*IPH*IPV)				
U) Daily exposure index (bird passes/turbine/day = H*(R or S)*T, rounded to 8 decimal places)				
U1) Spring/summer	0.00642528	0.04369870	0.00428352	0.02913247
U2) Fall	0.00420031	0.02856655	0.00280021	0.01904437
V) Annual exposure index (bird passes/turbine/year = J*(R or S)*T, rounded to 8 decimal places	1.47186000	10.01020412	0.81090000	5.51497732
FATALITY PROBABILITY (MP)				
W) Probability of striking turbine if in airspace on a side approach	1.00		1.00	
X) Probability of striking turbine if in airspace on frontal approach		0.20		0.20
Y) Probability of fatality if striking turbine[1]	1.00	1.00	1.00	1.00
Z1) Probability of fatality if an interaction on side approach (= W*Y)	1.00000		1.00000	
Z2) Probability of fatality if an interaction on frontal approach (= X*Y)		0.19500		0.19500
FATALITY INDEX (= ER*MP)				
Annual fatality rate with 90% exhibiting collision avoidance (birds/turbine/year = V*(Z1 or Z2)*0.1)	0.14719	0.19520	0.08109	0.10754
Annual fatality rate with 95% exhibiting collision avoidance (birds/turbine/year =V*(Z1 or Z2)*0.05)	0.07359	0.09760	0.04055	0.05377
Annual fatality rate with 99% exhibiting collision avoidance (birds/turbine/year =V*(Z1 or Z2)*0.01)	0.01472	0.01952	0.00811	0.01075

[1] Used 100% fatality probability due to ESA definition of “take”; however, actual probability of fatality with collision <100% (see methods).

again, however, that the range of assumed avoidance rates of seabirds and turbines/towers (90–99%) is not fully supported by empirical data at this time.

DISCUSSION

MOVEMENT RATES AND FLIGHT BEHAVIOR

Within KWP, there has been some variation in mean movement rates among years and studies (Table 5), but all estimated rates have been low (i.e., between 0.5 and 1.8 targets/h). Thus, mean movement rates of Hawaiian Petrels recorded in the KWP study areas (i.e., ~1–2 targets/h; this study; Day and Cooper 1999, Cooper and Day 2004; Sanzenbacher and Cooper 2008, 2009; Cooper and Day 2009) all are much lower than those over the eastern and northern sides of Maui (Cooper and Day 2003).

Our limited data in summer (i.e., five sampling nights; Cooper and Day 2009) suggested that patterns of movement may have been affected by the wind regime. For instance, in summer we found that shearwater/petrels mostly flew in an outbound movement towards the southwest during strong Trade Winds and flew inbound toward the east during light and variable winds. Further, those limited data also suggested that summer passage rates might be higher over the lower (southern) end of the study area than elsewhere during calm conditions, though, again note that we only had two nights of sampling during strong winds and three nights during light winds.

We did not experience any high wind conditions during fall; average wind speeds ranged between 0–8 mph. Thus, we did not have high wind conditions for comparison to summer movement patterns under those conditions, but during the low wind conditions, we did observe similar directionality as in summer, with most birds

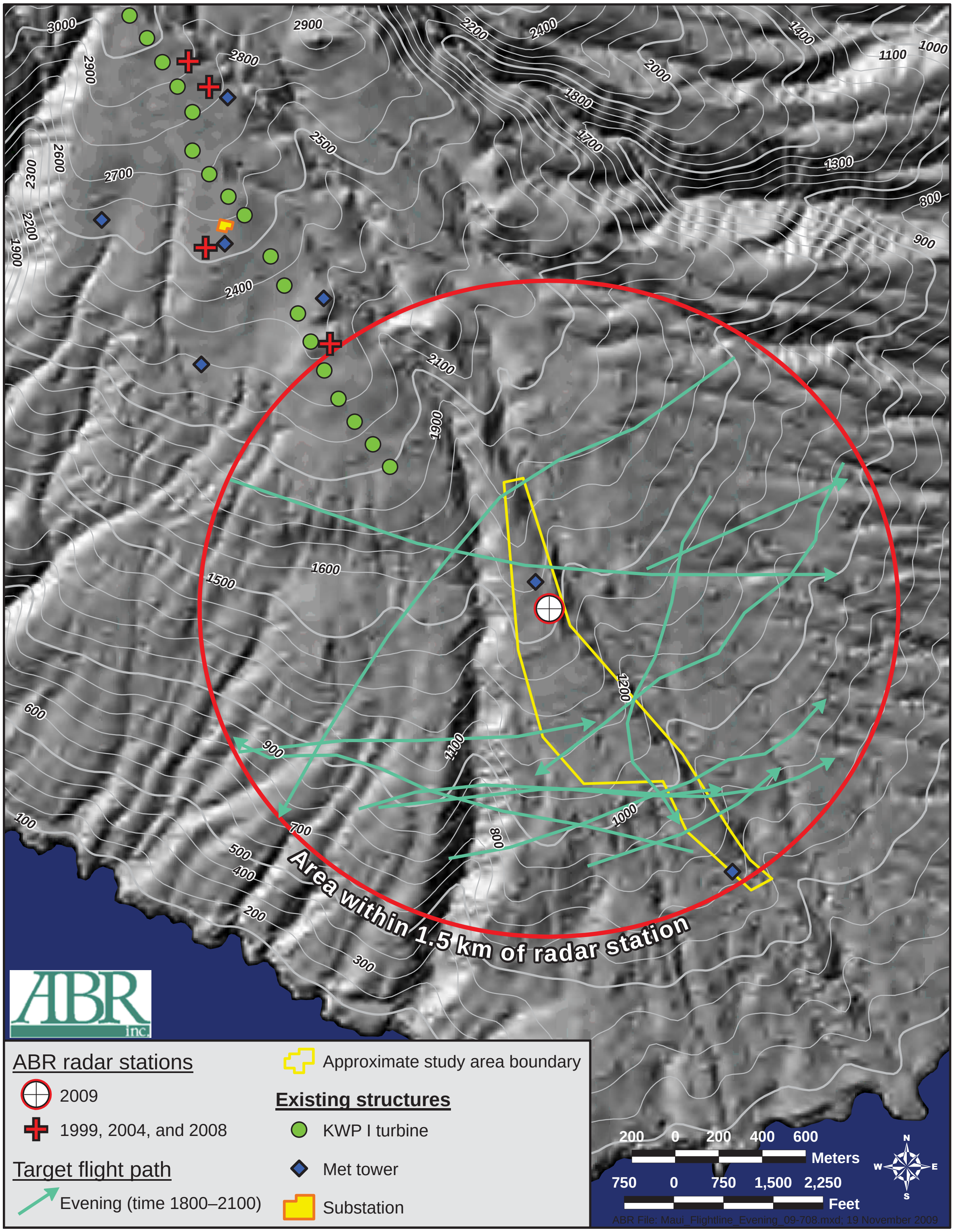


Figure 4. Location of flight paths of petrel-like radar targets observed during the evening sampling period (1800–2100 h) in October 2009 at the KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii.

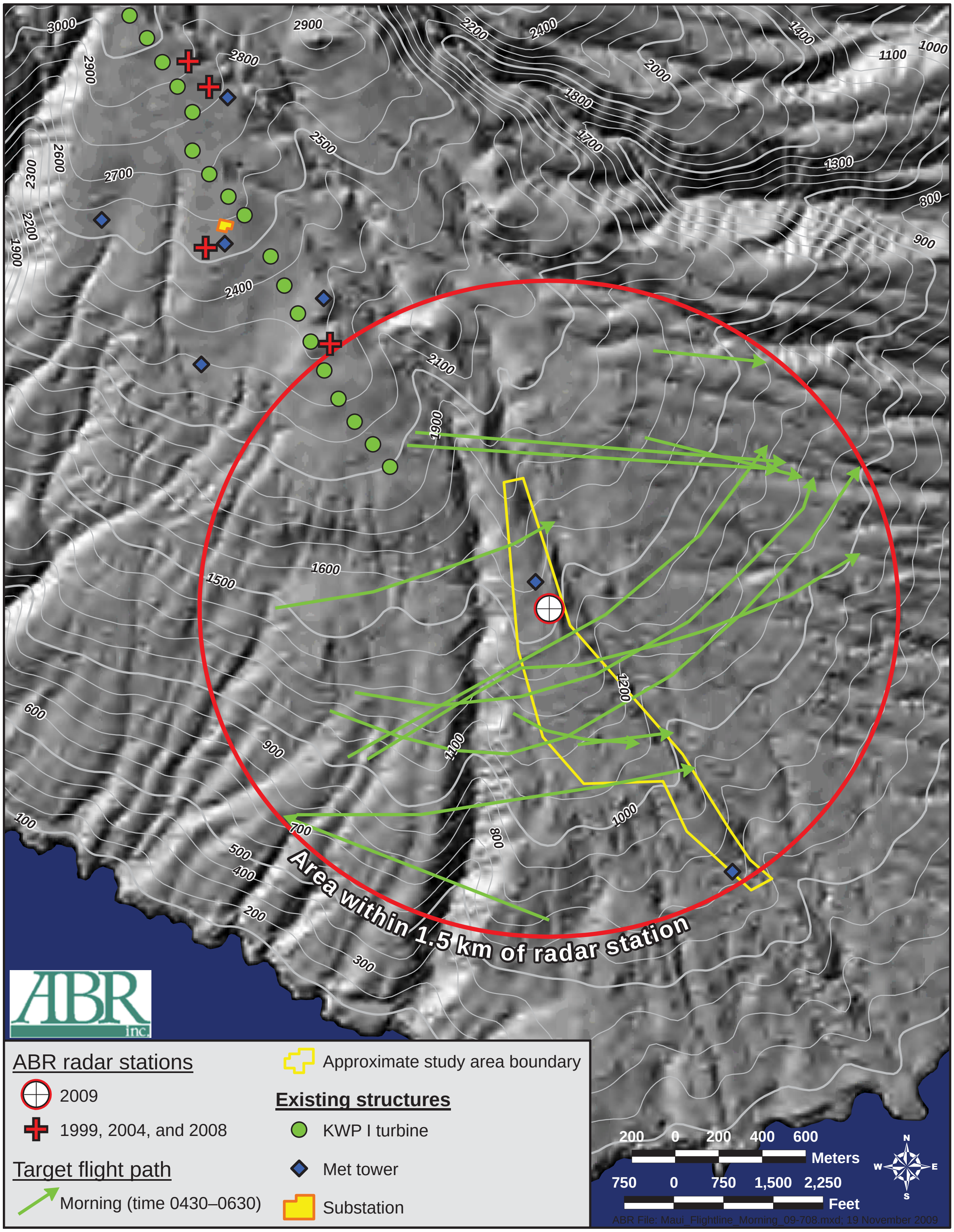


Figure 5. Location of flight paths of petrel-like radar targets observed during the morning sampling period (0430–0630 h) in October 2009 at the KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii.

Table 3. Estimated average exposure rates and fatality rates of Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at the proposed free-standing 65-m-tall met tower at the KWP II Down-road Alternative (KWP II) wind-energy site, Maui, Hawaii, based on radar data collected in July and October 2009. Values of particular importance are in boxes.

Variable/parameter	HAPE	NESH
MOVEMENT RATE (MVR)		
A) Mean movement rate (targets/h)		
A1) Mean rate during nightly peak movement periods in spring/summer based on July 2009 data (targets/h)	1.776	1.776
A2) Mean rate during nightly peak movement periods in fall based on October 2009 data (targets/h)	1.161	1.161
B) Number of hours of evening and morning peak-period sampling	5	5
C) Mean number of targets during evening and morning peak-movement periods		
C1) Spring/summer (A1 * B)	8.88	8.88
C2) Fall (A2 * B)	5.805	5.805
D) Mean proportion of birds moving during off-peak h of night	0.126	0.126
E) Seasonal movement rate (targets/night) = ((C * D)+ C)		
E1) Spring/summer	10.0	10.0
E2) Fall	6.5	6.5
F) Mean number of birds/target	1.05	1.05
G) Estimated proportion of each species	0.60	0.40
H) Daily movement rate (bird passes/day =E*F*G)		
H1) Spring/summer	6.30	4.20
H2) Fall	4.12	2.75
I) Fatality domain (days/year)		
I1) Spring/summer	180	150
I2) Fall	75	60
J) Annual movement rate (bird passes/year; = ((H1*I1) + (H2*I2)), rounded to next whole number)	1,443	795
HORIZONTAL INTERACTION PROBABILITY (IPH)		
K) Maximal cross-sectional area of tower (side view = 297 m²)	297.0	297.0
L) Cross-sectional sampling area of radar at or below 65 m tower height (= 3,000 m * 65 m = 195,000 m²)	195,000.000	195,000.000
M) Average probability of radar target intersecting the met tower (= K/L, rounded to 8 decimal places)	0.00152308	0.00152308
VERTICAL INTERACTION PROBABILITY (IPV)		
N) Proportion of petrels flying ≤ tower height)	0.33	0.33
EXPOSURE INDEX (ER = MVR*IPH*IPV)		
O) Daily exposure index (bird passes/tower/day = H*M*N, rounded to 8 decimal places)		
O1) Spring/summer	0.00316612	0.00211075
O2) Fall	0.00206975	0.00137983
P) Annual exposure index (bird passes/tower/year = J*M*N, rounded to 8 decimal places)	0.72527400	0.39957923
FATALITY PROBABILITY (MP)		
Q) Probability of striking tower if in airspace	1.00	1.00
R) Probability of fatality if striking tower[1]	1.00	1.00
S) Probability of fatality if an interaction (= Q*R)	1.00000	1.00000
FATALITY INDEX (= ER*MP)		
T) Annual fatality rate with 90% exhibiting collision avoidance (birds/tower/year = P*S*0.1)	0.07253	0.03996
U) Annual fatality rate with 95% exhibiting collision avoidance (birds/tower/year = P*S*0.05)	0.03626	0.01998
V) Annual fatality rate with 99% exhibiting collision avoidance (birds/tower/year = P*S*0.01)	0.00725	0.00400

[1] Used 100% fatality probability due to ESA definition of "take", however actual probability of fatality with collision <100% (see methods).

Table 4. Summary of exposure rates, fatality rates, and cumulative fatality rates for Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at wind turbines and meteorological (met) towers at the proposed KWP II Down-road Alternative (KWP II) wind-energy site, Maui, Hawaii, based on radar data collected in July and October 2009

	Exposure rate/structure (bird passes/structure/yr)			Fatality rate/structure (birds/structure/yr)			Cumulative fatality rate (birds/yr)	
Structure type	HAPE	NESH	Avoidance rate	HAPE	NESH	No. structures	HAPE	NESH
GE 1.5 MW turbine	1.472 (min)	0.811 (min)	0.90 (min)	0.147	0.081	14.00	2.061	1.135
	10.010 (max)	5.515 (max)	0.90 (max)	0.195	0.108	14.00	2.733	1.506
			0.95 (min)	0.074	0.041	14.00	1.030	0.568
			0.95 (max)	0.098	0.054	14.00	1.366	0.753
			0.99 (min)	0.015	0.008	14.00	0.206	0.114
			0.99 (max)	0.020	0.011	14.00	0.273	0.151
65-m free-standing met tower	0.725	0.400	0.90	0.073	0.040	1.00	0.073	0.040
			0.95	0.036	0.020	1.00	0.036	0.020
			0.99	0.007	0.004	1.00	0.007	0.004

Table 5. Mean (± SE) movement rates of petrel-like targets measured with radar at the KWP wind-energy site and proposed KWP II wind-energy sites, Maui, Hawaii, during 1999–2009 studies.

Year	Site	Movement rate (targets/h) Summer	Movement rate (targets/h) Fall	Source
1999	KWP I	1.2 ± 0.3	–	Day and Cooper (1999)
2004	KWP I	–	1.0 ± 0.2	Cooper and Day (2004)
2008	KWP II	0.46 ± 0.15	0.09 ± 0.07	Sanzenbacher and Cooper (2008. 2009)
2009	KWP II	1.78 ± 0.14	1.16 ± 0.17	Cooper and Day (2009); current study

flying inbound towards the east. In contrast, we did not see as strong a pattern of higher passage rates over the lower (southern) end of the study during fall as in summer. Thus, the consistent flight directions of the targets observed during light winds in summer and fall suggest that they were birds approaching Maui from the west and "cutting the corner" of West Maui on their way to breeding colonies on Haleakala, but it is unknown whether the lower, southern half of the study area consistently has higher passage rates than the northern half during low wind conditions.

VISUAL OBSERVATIONS OF PETRELS AND SHEARWATERS

In total, we have had three visual observations of Hawaiian Petrels and two observations of unidentified shearwaters/petrels over the KWP study areas during 1999–2009 (Table 6; Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009; this study). The birds observed in the evening period were headed easterly or northeasterly, and the birds observed in the morning were heading southeasterly or southwesterly. These directions fit a pattern of inbound movements toward Haleakala in the evening and outbound movements from Haleakala and/or West Maui in the morning.

Flight altitudes of the two birds that we observed over the proposed turbine-string ridges were within turbine heights (i.e., one was at 40 m agl and the other was at 65 m agl; Table 6). The flight altitudes of the other three birds were much higher (i.e., 300–500 m agl), but they were measured over the valley to the east; hence, we do not know what their flight altitudes were as they flew over the ridges on which the turbine strings lie. Thus, the very limited data that we have for known flight altitudes at this site (n = 2) suggests that at least some petrels flew within the turbine-height zone.

In our fatality models, we used the timing of inland flights at the nearby Ukumehame site from Cooper and Day (2003) to correct for proportions of targets that were Hawaiian Petrels and those that were Newell's Shearwaters; those data suggested that 60% of the targets were Hawaiian Petrels and 40% of the targets were Newell's Shearwaters. However, the timing of two of the three Hawaiian Petrels that we saw over the site (Table 6) occurred during the late evening, a period when Cooper and Day (2003) assumed that only Newell's Shearwaters would occur. These visual observations suggest the possibility that more than 60% of the radar targets we observed in the current study could have been Hawaiian Petrels. We do not recommend changing the relative proportions of Hawaiian Petrels vs. Newell's Shearwaters used for the fatality model, however, unless further data are collected to confirm this pattern.

EXPOSURE RATES AND FATALITY ESTIMATES

We estimated that 2–11 Hawaiian Petrels and 1–6 Newell's Shearwater would fly within the space occupied by each wind turbine in an average

Table 6. Records of visual observations of Hawaiian Petrels and unidentified shearwaters/petrels at the proposed KWP II wind-energy site and nearby KWP I wind-energy site, Maui, Hawaii, during 1999–2009 studies.

Date	Time	Species[1]	Number	Altitude (m agl)	Flight direction
28 May 1999	2150	HAPE	1	300[2]	NE
28 May 1999	0608	UNSP	2	500[2]	SE
12 October 2004	0608	HAPE	1	500[2]	SE
15 October 2004	0454	UNSP	1	65	SW
24 July 2009	2126	HAPE	1	40	E

[1] HAPE = Hawaiian Petrel; UNSP = unidentified shearwater/petrel.
[2] Flight altitude measured over the valley to east of the proposed turbine string ridge, not over the proposed turbine string ridge itself; measurements were done that way because that is where birds were first seen.

year and estimated that 1 Hawaiian Petrel and 1 Newell's Shearwater would fly within the space occupied by the 65-m-high met tower in an average year (Table 4). We used these estimated exposure rates as a starting point for developing a complete avian risk assessment; however, we emphasize that it currently is unknown whether bird use (i.e., exposure) and fatality at windfarm structures are strongly correlated. For example, Cooper and Day (1998) found no relationship between movement rates and fatality rates of Hawaiian Petrels and Newell's Shearwaters at powerlines on Kaua'i, indicating that other factors had a much greater effect on causing fatality than movement rates did. For example, other factors such as proximity to the ocean or poor weather could be more highly correlated with fatality rates than is bird abundance. As an example, collisions of Laysan Albatross with a large array of communication-tower antenna wires and guy wires adjacent to large, high-density albatross breeding colonies on Midway Atoll occurred at a far higher rate during periods of high winds, rain, and poor visibility than during periods of better weather: 838 (>25%) of the 2,901 birds killed during the study were killed during two storms (Fisher 1966). To determine which factors are most relevant, future studies that collect concurrent data on movement rates, weather, and fatality rates would be useful to begin to determine whether movement rates and/or weather conditions can be used to predict the likelihood of petrel fatalities at wind turbines and other structures across the entire proposed windfarm.

In addition, few data are available on the proportion of petrels and shearwaters that do not collide with wind turbines or met towers because of collision-avoidance behavior (i.e., birds that completely alter their flight paths horizontally and/or vertically to avoid flying through the space occupied by a turbine/tower). Clearly, the detection of wind turbines or other structures could result in collision-avoidance behavior by these birds and reduce the likelihood of collision. There also appear to be differences between petrels and shearwaters in their ability to avoid obstacles. For example, Cooper and Day (1998) indicated that Hawaiian Petrels have flight characteristics that make them more adept at avoiding powerlines than Newell's Shearwaters, suggesting that Hawaiian Petrels might also be more likely to avoid collisions with other structures such as wind turbines. These authors also suggested that the tendency for Hawaiian Petrels to approach and leave nesting colonies primarily during crepuscular periods enables these birds to see and avoid structures (e.g., wind turbines) more easily than do Newell's Shearwaters that approach and leave nesting colonies primarily during nocturnal periods.

Some collision-avoidance information is available on petrels and shearwaters from earlier work that we conducted on Kaua'i (Cooper and Day 1998; Day et al., *In prep*). In summary, those data suggest that the behavioral-avoidance rate of Hawaiian Petrels and Newell's Shearwaters near powerlines is high. For example, across all 207 Hawaiian Petrels observed flying within 150 m of transmission lines on Kauai, 40 exhibited behavioral responses; of those 40 birds that exhibited collision-avoidance responses, none (0%) collided with a transmission line. Thus, the collision-avoidance rate for Hawaiian Petrels was 100% (i.e., 40 of 40 interactions). Across all 392 Newell’s Shearwaters observed flying within 150 m of transmission lines, 29 exhibited behavioral responses; of those 29 birds that exhibited collision-avoidance responses, none (0%) collided with a transmission line. However, one Newell's Shearwater that did not exhibit a collision-avoidance response hit a transmission line. Thus, the collision-avoidance rate for Newell’s Shearwaters was 97% (i.e., 29 of 30 interactions).

There also is some information available on collision-avoidance of Hawaiian Petrels on Lana’i, where the behavior of petrels was studied as they approached large communication towers near the breeding colony (TetraTech 2008b; Day et al., *In prep*). In those studies, all 26 (100%) of the Hawaiian Petrels seen on a collision-course toward communication towers exhibited avoidance behavior and avoided collision. In addition, zero fatalities of Hawaiian Petrels were observed at six met towers that were monitored on the island of Lana’i during 2008 (TetraTech 2008a).

Additional data that provides some insight on collision-avoidance behavior of petrels and shearwaters at windfarm structures (e.g., wind turbines and met towers) are available from other studies associated with the operational KWP I wind facility. There was 1 Hawaiian Petrel fatality and 0 Newell’s Shearwater fatalities observed at the 20-turbines and three met towers in the first ~four years of operation (G. Spencer, First Wind, pers. comm.). Calculations using data for scavenging bias and searcher efficiency collected at the KWP I wind facility indicate that the one observed fatality equates to a corrected direct take of 0.5 Hawaiian Petrels/yr and 0 Newell’s Shearwaters/yr (Kaheawa Wind Power LLC 2009, *in prep*). Cooper and Day (2004b) modeled seabird fatality for the KWP I wind turbines, based on movement rates from radar studies at the site (Day and Cooper 1999; Cooper and Day 2004a, 2004b), and estimated that the combined annual fatality of Hawaiian Petrels and Newell’s Shearwaters at the KWP I turbines would be ~3–18 birds/yr with a 50% avoidance rate, ~1–2 birds/yr with a 95% avoidance rate, and <1 bird/yr with a 99% avoidance rate. Thus, the fatality model that used a 99% avoidance value was a closer fit with the measured fatality rates than was the fatality models that used a 50% or 95% avoidance rate.

In summary, currently available data from Kaua’i, Lana’i, and Maui suggest that the avoidance rate of petrels and shearwaters at transmission lines and communications towers is high and approaches 100% (Day et al., *in prep*). Data from the fatality searches at turbines and met towers on Maui are more difficult to interpret because they suggest high avoidance but are not a direct measure of avoidance; however those data also suggest that avoidance of those structures must be occurring because only one Hawaiian Petrel has been found during regular fatality searches of those structures over a four-year period. Thus, the overall body of evidence, while incomplete, is consistent with the hypothesis that the average avoidance rate of wind turbines and met towers is substantial and potentially is ≥95%. The ability of Hawaiian Petrels and Newell’s Shearwater to detect and avoid most objects under low-light conditions makes sense from a life-history standpoint, in that they forage extensively at night and are adept at flying through forests near their nests during low light conditions (Ainley et al. 1997b, Simons and Hodges 1998).

In addition to the limited data available for Hawaiian Petrels and Newell’s Shearwaters, there is evidence that many other species of birds detect and avoid structures (e.g., wind turbines, met towers) during low-light conditions (Winkelman 1995, Dirksen et al. 1998, Desholm and Kahlert 2005, Desholm et al. 2006). For example, seaducks in Europe have been found to detect and avoid wind turbines >95% of the time (Desholm 2006). Further, natural anti-collision behavior (especially alteration of flight directions) is seen in migrating Common and King eiders (*Somateria mollissima* and *S. fischeri*) approaching human-made structures in the Beaufort Sea off of Alaska (Day et al. 2005) and in diving ducks approaching offshore windfarms in Europe (Dirksen et al. 1998). Collision-avoidance rates around wind turbines are high for Common Eiders in the daytime (Desholm and Kahlert 2005), Common Terns (*Sterna hirundo*) and Sandwich Terns (*Sterna* *sandvicensis*) during the daytime (>99%, Everaert and Stienen 2007), gulls (*Larus* spp.) in the daytime (>99%; Painter et al. 1999, cited in Chamberlain et al. 2006), Golden Eagles (*Aquila chrysaetos*) in the daytime (>99%; Madders 2004, cited in Chamberlain et al. 2006), American Kestrels (*Falco sparverius*) in the daytime (87%, Whitfield and Band [in prep.], cited in Chamberlain et al. 2005), and passerines during both the day and night (>99%; Winkelman 1992, cited in Chamberlain et al. 2006).

We agree with others (Chamberlain et al. 2006, Fox et al. 2006) that species-specific, weather-specific, and site-specific avoidance data are needed in models to estimate fatality rates accurately. However, the currently available avoidance data from Kaua'i and Lana'i for Hawaiian Petrels and Newell's Shearwaters and the petrel fatality data at KWP I wind turbines and met towers while limited, is consistent with the notion that a substantial proportion of petrels detect and avoid wind turbines, marked met towers, communication towers, and powerlines. Until further petrel- and shearwater-specific data on the relationship between exposure and fatality rates are available for structures at windfarms, we continue to provide a range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance), along with a discussion of the body of evidence that, while incomplete at this time, is consistent with the notion that the average avoidance-rate value is substantial and potentially is ≥95%. With an assumption of a 95% avoidance rate, the estimated average annual fatality rate at the KWP II would be ≤0.10 Hawaiian Petrel/turbine/yr and ≤0.05 Newell's Shearwaters/turbine/yr and, for met towers, the average annual fatality rate would be 0.04 Hawaiian Petrel/tower/yr and 0.02 Newell's Shearwaters/tower/yr.

Other factors could affect our estimates of fatality in either a positive or a negative direction. One factor that would have created a positive bias was the inclusion of targets that were not petrels or shearwaters. Our visual observations of several other species with similar target characteristics to petrels (especially during crepuscular periods, when we could use binoculars) helped to minimize the inclusion of these non-target species, but it is likely (especially during nocturnal conditions) that some of our radar targets were other fast-flying species that were active during the sampling period (e.g., Pacific Golden-Plover). A second positive bias in our fatality model is our simplistic assumption that movement rates of seabirds do not fall as individual fatalities occurred (i.e., we assumed sampling with replacement for fatalities). Given the low movement rates observed in this study, it is likely that the fatality of just a single bird would substantially reduce the average nightly movement rates. A third positive bias is the assumption that turbines are operating at maximal rotor speed; this assumption clearly is incorrect because of variability in winds, but using it results in maximal estimates of collision rates for birds flying through the turbine rotors.

There also are factors that could create a negative bias in our fatality estimates. One example would be if targets were missed because they flew within radar shadows. Because the sampling stations provided good coverage of the surrounding area, we believe that the proportion of targets that was missed because they passed through the entire area of coverage of the study area within a radar shadow was minimal.

A factor that could affect the predictive value of our fatality estimates in either direction is interannual variation in the number of birds visiting nesting colonies on Maui. The average hourly movement rates in summer (~1.8 targets/h), and fall (~1.2 targets/h) 2009 were slightly higher than rates from previous years (Table 5). However, all those studies suggest that rates are consistently low at the KWP project areas relative to other areas on Maui, and that interannual variation in the overall level of bird use of the area is minimal (i.e., < 1 target/h difference among studies). Some caution in extrapolation of movement rates across years is still warranted, however, because there are examples of other sites with high interannual variation in counts, such as the three sites on Kaua'i where counts were ~100–300 birds/hr lower (~four times lower) in fall 1992 than in fall 1993; the lower counts in 1992 were attributed to the effects of Hurricane Iniki (Day and Cooper 1995). Oceanographic factors (e.g., El Niño–Southern Oscillation events) also vary among years and are known to affect the distribution, abundance, and reproduction of seabirds (e.g., Ainley et al. 1994, Oedekoven et al.

2001). There was a moderate El Niño–Southern Oscillation event that began in April 2009 and was still developing when our summer study occurred in July 2009 (NOAA 2009). We speculate that it is unlikely that El Niño-related oceanographic effects were large enough by July 2009 to have significantly affected seabird movement rates during our summer study period, but it is possible that fall rates could have been affected (however, note that this is unlikely, given that fall 2009 rates were higher than rates in both fall 2004 and fall 2008; Table 5). Another factor that could cause interannual variation in counts in either direction is overall population increases or declines. For example, there was a ~60% decline in radar counts on Kaua'i between 1993 and 1999–2001 that was attributed to population declines of Newell's Shearwaters (Day et al. 2003b).

CONCLUSIONS

We used our risk-assessment model to estimate the number of Hawaiian Petrels and Newell's Shearwaters that might be killed by collisions with wind turbines and met towers at the proposed KWP II facility. The model is affected by several input variables, including the collision-avoidance rate. The absence of behavioral studies to fully quantify avoidance rates at wind turbines and met towers precludes determination of actual avoidance rates; however, a growing body of evidence suggests that a high percentage of petrels and shearwaters detect and avoid structures such as communication towers, transmission lines, and wind turbines (see above). We also suspect high rates of anti-collision behaviors because petrels must rely upon acute nocturnal vision for foraging and other flight activities under varying weather conditions. In conclusion, we believe that the proportion of petrels that would see and avoid proposed wind turbines at the KWP II will be high, but until studies are conducted to quantify avoidance behavior at wind turbines and met towers, we provide a range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance rates) along with a discussion of the body of evidence that is consistent with the hypothesis that the average avoidance-rate value is substantial and potentially ≥95%. With an assumption of ≥95% avoidance, the estimated average annual number of fatalities at the proposed KWP II wind turbines would be 0.015–0.098 Hawaiian Petrel/turbine/yr and 0.008–0.054 Newell's Shearwaters/turbine/yr. The estimated average annual number of fatalities at the proposed KWP II met tower (with an assumption of ≥95% avoidance) would be 0.007–0.036 Hawaiian Petrel/tower/yr and 0.004–0.020 Newell's Shearwaters/tower/yr.

LITERATURE CITED

Ainley, D. G., R. Podolsky, L. DeForest, and G. Spencer. 1997a. New insights into the status of the Hawaiian Petrel on Kauai. Colonial Waterbirds 20: 24–30.

Ainley, D. G., R. Podolsky, L. DeForest, G. Spencer, and N. Nur. 1995. Kauai Endangered Seabird Study, Vol. 2: The ecology of Dark-rumped Petrels and Newell's Shearwaters on Kauai, Hawaii. Electric Power Research Institute, Palo Alto, CA. Final Report No. TR-105847-V2. 74 pp.

Ainley, D. G., W. J. Sydeman, S. A. Hatch, and U. W. Wilson. 1994. Seabird population trends along the west coast of North America: causes and extent of regional concordance. Studies in Avian Biology 15: 119–133.

Ainley, D. G., T. C. Telfer, and M. H. Reynolds. 1997b. Townsend's and Newell's Shearwater (*Puffinus auricularis*). *In* A. Poole and F. Gill, eds. The birds of North America, No. 297. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC. 20 pp.

American Ornithologists' Union. 1998. Check-list of North American birds. 7th ed. American Ornithologists' Union, Washington, DC. 829 pp.

Banko, W. E. 1980a. Part I. Population histories—species accounts. Sea birds: Hawaiian Dark-rumped Petrel ('Ua'u). Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Honolulu, HI. CPSU/UH Avian History Report 5B: History of Endemic Hawaiian Birds. 42 pp.

Banko, W. E. 1980b. Part I. Population histories—species accounts. Sea birds: Newell Shearwater ('A'o). Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Honolulu, HI. CPSU/UH Avian History Report 5B: History of Endemic Hawaiian Birds. 35 pp.

Brandt, C. A., J. K. Parrish, and C. N. Hodges. 1995. Predictive approaches to habitat quantification: Dark-rumped Petrels on Haleakala, Maui. Auk 112: 571–579.

Chamberlain, D. E., S. Freeman, M. R. Rehfisch, A. D. Fox, and M. Desholm. 2005. Appraisal of Scottish Natural Heritage's wind farm collision risk model and its application. British Trust for Ornithology, Norfolk, United Kingdom. Report No. 401. 51 pp.

Chamberlain, D. E., M. R. Rehfisch, A. D. Fox, M. Desholm, and S. J. Anthony. 2006. The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models. Ibis 148: 198–202.

Conant, S. 1980. Recent records of the 'Ua'u (Dark-rumped Petrel) and the 'A'o (Newell's Shearwater) in Hawaii. 'Elepaio 41: 11–13.

Cooper, B. A., and R. H. Day. 1995. Kauai Endangered Seabird Study, Vol. 1: Interactions of Dark-rumped Petrels and Newell's Shearwaters with utility structures on Kauai, Hawaii. Electric Power Research Institute, Palo Alto, CA. Final Report No. TR-105847-V1. 170 pp.

Cooper, B. A., and R. H. Day. 1998. Summer behavior and mortality of Dark-rumped Petrels and Newell's Shearwaters at power lines on Kauai. Colonial Waterbirds 21: 11–19.

Cooper, B. A., and R. H. Day. 2003. Movement of Hawaiian Petrels to inland breeding sites on Maui Island, Hawaii. Waterbirds 26: 62–71.

Cooper, B. A., and R. H. Day. 2004a. Results of endangered bird and bat surveys at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004. Unpublished report prepared for Kaheawa Windpower LLC, Makawao, HI, and UPC Wind Management LLC, Newton, MA, by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 16 pp.

Cooper, B. A., and R. H. Day. 2004b. Modeling annual seabird use and fatality at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004. Unpublished report prepared for Kaheawa Windpower LLC, Makawao, HI, and UPC Wind Management LLC, Newton, MA, by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 7 pp.

Cooper, B. A., and R. H. Day. 2009. Radar and visual studies of seabirds at the proposed KWP II Down-road Alternative wind energy facility, Maui Island, Hawaii, summer 2009. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 25 pp.

Cooper, B. A., R. H. Day, R. J. Ritchie, and C. L. Cranor. 1991. An improved marine radar system for studies of bird migration. Journal of Field Ornithology 62: 367–377.

Day, R. H., and B. A. Cooper. 1995. Patterns of movement of Dark-rumped Petrels and Newell's Shearwaters on Kauai. Condor 97: 1011–1027.

Day, R. H., and B. A. Cooper. 1999. Results of endangered bird and bat surveys at the proposed Kaheawa Pastures Windfarm on Maui Island, Hawaii, summer 1999. Unpublished report prepared for Zond Pacific, Wailuku, HI, by ABR, Inc., Fairbanks, AK, and Forest Grove, OR. 26 pp.

Day, R. H., and B. A. Cooper. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June 2002. Unpublished report prepared for National Park Service, Hawaii National Park, HI, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK, and Forest Grove, OR. 17 pp.

Day, R. H., B. A. Cooper, and R. J. Blaha. 2003a. Movement patterns of Hawaiian Petrels and Newell's Shearwaters on the island of Hawai'i. Pacific Science 57: 147–159.

Day, R. H., B. A. Cooper, T. J. Mabee, J. H. Plissner, P. M. Sanzenbacher, and A. Oller. In prep. Collision-avoidance behavior of Hawaiian Petrels and Newell's Shearwaters in the Hawaiian Islands. Journal of Field Ornithology.

Day, R. H., B. A. Cooper, and T. C. Telfer. 2003b. Decline of Newell's Shearwaters on Kauai, Hawaii. Auk 120: 669–679.

Day, R. H., A. K. Prichard, and J. R. Rose. 2005. Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001–2004. Unpublished final report prepared for BP Exploration (Alaska), Inc., Anchorage, AK, by ABR, Inc.—Environmental Research and Services, Fairbanks, AK. 142 pp.

Desholm, M. 2006. Wind farm related mortality among avian migrants. Ph.D. thesis, University of Copenhagen, Copenhagen, Denmark. 128 pp.

Desholm, M., A. D. Fox, P. D. L. Beasley, and J. Kahlert. 2006. Remote techniques for counting and estimating the number of bird-wind turbine collisions at sea: a review. Ibis: 148: 76–89.

Desholm, M. and J. Kahlert. 2005. Avian collision risk at an offshore windfarm. Biology Letters 1: 296–298.

Dirksen, S. E., A. L. Spaans, and J. Winden. 1998. Nocturnal collision risks with wind turbines in tidal and semi-offshore areas. Pp. 99–108 *In* Proceedings of International Workshop on Wind Energy and Landscape, Genua, 26–27 July 1997. Balkema, Rotterdam, The Netherlands.

Everaert, M. and E. W. M. Stienen. 2007. Impact of wind turbines on birds in Zeebrugge (Belgium). Biodivers. Conserv. 16: 3345–2259.

First Wind. 2008. Kaheawa Pastures wind energy generation facility Habitat Conservation Plan: Year 2 HCP Implementation, July, 2007 – June, 2008. Unpublished report prepared by First Wind, Newton, MA and Kaheawa Wind Power, Wailuku, HI. 26 pp. + appendices.

Fisher, H. I. 1966. Midway's deadly antennas. Audubon Magazine, July-August 1966. Pp. 220–223.

Fox, A. D., M. Desholm, J. Kahlert, T. K. Christensen, and I. K. Petersen. 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis 148: 129–144.

Gon, S. M., III. 1988. Observations of the 'Ua'u (Hawaiian Petrel) in the Hono O Pali Natural Area Reserve, Island of Kauai. 'Elepaio 48: 113.

Hirai, L. T. 1978a. Native birds of Lanai, Hawaii. Western Birds 9: 71–77.

Hirai, L. T. 1978b. Possible Dark-rumped Petrel colony on Lanai, Hawaii. 'Elepaio 38: 71–72.

Hodges, C. S. N. 1992. 'Ua'u observation at proposed site for antenna farm. Unpublished memorandum by Haleakala National Park, Makawao, HI, 2 pp.

Hu, D., C. Glidden, J. S. Lippert, L. Schnell, J. S. MacIvor, and J. Meisler. 2001. Habitat use and limiting factors in a population of Hawaiian Dark-rumped Petrels on Mauna Loa, Hawai'i. *In* J. M. Scott, S. Conant, and C. van Riper III, eds. Evolution, ecology, conservation, and management of Hawaiian birds: a vanishing avifauna. Studies in Avian Biology 22:234–242.

Kaheawa Wind Power LLC. 2006. Kaheawa Pastures Wind Generation Facility Habitat Conservation Plan. Kaheawa Wind Power, LLC, Ukumehame, Maui, HI. 87 pp. + attachments.

Kaheawa Wind Power, LLC. 2009 (*in prep*). Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 3 Annual Report. FirstWind Energy, LLC, Environmental Affairs, Newton, MA.

Mabee, T. J., J. H. Plissner, B. A. Cooper, and D. P. Young. 2006. Nocturnal bird migration over an Appalachian ridge at a proposed wind power project. Wildlife Society Bulletin 34: 682–690.

Nishibayashi, E. 1997. Downed wildlife surveys at six leeward West Maui monitoring towers. Unpublished report prepared for Zond Pacific, Wailuku, HI, by Eric Nishibayashi Biological Consulting, Kahului, HI. 10 pp.

NOAA 2009. National Climatic Data Center El Niño and La Niña website. [http://www.ncdc.noaa.gov/oa/climate/elnino/elnino.html]

Oedekoven, C. S., D. G. Ainley, and L. B. Spear. 2001. Variable responses of seabirds to change in marine climate: California Current, 1985–1994. Marine Ecology Progress Series 212: 265–281.

Podolsky, R., D. G. Ainley, G. Spencer, L. DeForest, and N. Nur. 1998. Mortality of Newell's Shearwaters caused by collisions with urban structures on Kauai. Colonial Waterbirds 21: 20–34.

Pyle, R. L. 1983. Hawaiian Islands Region (1 June–31 July 1983). American Birds 37: 1028–1029.

Pratt, T. K. 1988. Recent observations, March–May 1988. 'Elepaio 48: 65–66.

Reynolds, M. H., B. A. Cooper, and R. H. Day. 1997. Radar study of seabirds and bats on windward Hawaii. Pacific Science 51: 97–106.

Reynolds, M. H., and G. L. Richotte. 1997. Evidence of Newell's Shearwater breeding in Puna District, Hawaii. Journal of Field Ornithology 68: 26–32.

Richardson, F., and D. H. Woodside. 1954. Rediscovery of the nesting of the Dark-rumped Petrel in the Hawaiian Islands. Condor 56: 323–327.

Sanzenbacher, P. M., and B. A. Cooper. 2008. Radar and visual studies of seabirds at the KWP I and KWP II wind energy facilities, Maui Island, Hawaii: use of 2008 data to model annual collision fatalities at meteorological towers. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 21 pp.

Sanzenbacher, P. M., and B. A. Cooper. 2009. Radar and visual studies of seabirds at the KWP II wind energy facility, Maui Island, Hawaii: use of 2008 data to model annual collision fatalities at proposed wind turbines. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 20 pp.

Serventy, D. L., V. Serventy, and J. Warham. 1971. The handbook of Australian seabirds. A. H. and A. W. Reed, Sydney, Australia. 254 pp.

Shallenberger, R. J. 1974. Field notes. 'Elepaio 35: 18–20.

Simons, T. R. 1984. A population model of the endangered Hawaiian Dark-rumped Petrel. Journal of Wildlife Management 48: 1065–1076.

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

Simons, T. R., and C. N. Hodges. 1998. Dark-rumped Petrel (*Pterodroma phaeopygia*). *In* A. Poole and F. Gill, eds. The birds of North America, No. 345. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC. 24 pp.

Sincock, J. L., and G. E. Swedberg. 1969. Rediscovery of the nesting grounds of Newell's Manx Shearwater (*Puffinus puffinus newelli*), with initial observations. Condor 71: 69–71.

SPSS. 2005. SPSS for Windows, version 14.0. SPSS, Inc., Chicago, IL.

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin 15: 406–413.

TetraTech EC. 2008a. Lanai Met Towers 2008 Annual Report. Unpublished report prepared by Tetratech EC, Portland, OR, for Castle and Cooke LLC, Lanai City, HI. 14 pp. + appendices. [http://hawaii.gov/dlnr/dofaw/annual-reports/fy2008/Lanai-MT-HCP-2008-Annual-Rpt-9.19.08.pdf]

TetraTech EC. 2008b. Draft Habitat Conservation Plan for the construction and operation of Lanai met towers, Lanai, Hawaii (Revised February 8, 2008, TTEC-PTLD-2008-080). Unpublished report prepared by Tetratech EC, Honolulu, HI, for Castle and Cooke LLC, Lanai City, HI. 52 pp. + appendices. [http://www.state.hi.us/dlnr/dofaw/pubs/Lana'i_Met_Towers_HCP.pdf]

USFWS (U.S. Fish & Wildlife Service). 2008. Midway Atoll National Wildlife Refuge. USFWS refuge website. [http://www.fws.gov/midway/]

Warham, J. 1990. The petrels: their ecology and breeding systems. Academic Press. New York, NY. 440 pp.

Winkelman, J. E. 1995. Bird/wind turbine investigations in Europe. Pages 43–47 and 110–140 *in* LGL Ltd., ed. Proceedings of National Avian–Wind Power Planning Meeting I, Denver, CO. [http://www.nationalwind.org/publications/wildlife/avian94/default.htm]

Appendix 14

Downed Wildlife Protocol

Kaheawa Wind Power II

Habitat Conservation Plan

Purpose	To identify and document any wildlife injury or fatality incident that involves Covered and MBTA Species at the Kaheawa Wind Power II site incidental to and during regular monitoring.
Applicability	This protocol applies to all employees of Kaheawa Wind Power II and its affiliates, and extends to all consultants, contractors, or other personnel who work on the site.
Covered Species	Covered Species include the federally *endangered* Hawaiian Petrel, Hawaiian goose, Hawaiian Hoary Bat, and the federally *threatened* Newell's Shearwater. MBTA species include all species covered under the provisions of the federal Migratory Bird Treaty Act.
Overall Approach	Downed wildlife may be located during the course of regular monitoring or opportunistically during routine site work. In addition to the project's monitoring program, which is a component of the project's Habitat Conservation Plan, project consultants and personnel will routinely look for and exhibit awareness of the potential to encounter downed wildlife when working at individual turbine sites, when traveling along site roads by vehicle, and when traveling the site on foot. Should any downed wildlife be found or reported, the responsible party (Senior Wildlife Biologist, Site Compliance Officer, or their official designee) shall contact Maui DLNR Forestry and Wildlife Division and USFWS immediately to initiate response coordination: Maui Wildlife Program Manager at 808-873-3510 (John Medeiros) or 808-873-3502 (Fern Duvall). USFWS Wildlife Biologist at 808-792-9433 (James Kwon) A written report that provides documentation and details of the incident will be submitted to DLNR/DOFAW and USFWS within 3 business days following the incident. All downed wildlife will be left in place until agency personnel arrive or unless directed by USFWS or DLNR personnel. Injured wildlife may require, if instructed directly by DLNR or USFWS, that the responsible party transport the downed individual in an appropriate container (e.g. ventilated pet carrier) either to a qualified veterinarian or other facility specified by DLNR or USFWS, as described below, as soon as possible and appropriate (e.g., if the individual is alive, it shall be transported immediately). The responsible party will also complete a Downed Wildlife Monitoring Form and an official Incident Report will be submitted to DLNR and USFWS within 3 business days following the incident.
Facility Information	TBD Phone:
Kaheawa Wind Power II Contact Information	Gregory Spencer, Senior Wildlife Biologist Phone: (808) 298-5097

Kaheawa Wind Power II, LLC

Habitat Conservation Plan – Downed Wildlife Incident Documentation Form

SAMPLE

Observer Name:	
Date:	
Species (common name):	
Time Observed (HST):	
Time Initially Reported (HST):	
Time Responders Arrive (HST):	
Location:	
GPS Coordinates (specify units and datum):	
Date Last Surveyed:	
Distance to Base of nearest WTG:	
Bearing from Base of nearest WTG:	
Ground Cover Type:	
Wind Direction and Speed (mph):	
Cloud Cover (%):	
Cloud Deck (magl):	
Precipitation:	
Temperature (^{o}F):	

Condition of Specimen:
Probable Cause of Injuries and Supportive Evidence:
Action Taken:

Appendix 15

BIOLOGICAL RESOURCES SURVEY

KAHEAWA WIND ENERGY PROJECT 2 (KWP2)

KAHEAWA, MAUI, HAWAII

by

ROBERT W. HOBDY
ENVIRONMENTAL CONSULTANT
Kokomo, Maui
January 2010

Prepared for: FIRST WIND ENERGY, LLC

INTRODUCTION

Kaheawa Wind Energy Project 2 (KWP2) lies on Kaheawa Ridge on the southern tip of West Maui just west of Manawainui Gulch between the elevations of 1,800 feet and 2,700 feet. This project consists of one approximately 1,500 ft. long corridor for the installation of an underground cable system and two small areas where project related structures are planned. This study has been intiated by First Wind Energy LLC to assess the botanical resources of the project area in fulfillment of environmental requirements of the planning process.

SITE DESCRIPTION

Kaheawa Ridge has moderately sloping terrain that descends to the sea at a roughly 16% grade. Vegetation is mostly grasslands and low shrubby cover with a few small scattered trees. Soils are characterized as Oli Silty Clay Loam, 10 – 30% slopes (OMB), which is a moderately deep soil formed from volcanic ash, as well as Rocklands (rRK) which are broken and uneven and with some eroded areas (Foote et al, 1972). This area is often windy, and has an annual rainfall that averages 30 inches to 40 inches with the bulk falling during the winter months (Armstrong, 1983).

BIOLOGICAL HISTORY

In pre-contact times this part of the mountain slope was entirely covered with native vegetation of low stature with dry grass and shrub lands and with a few trees in the gullies. The Hawaiians made some uses of forest resources here and had a cross-island trail cresting the ridge at 1600 ft. elevation. This trail was upgraded during the mid-1800s and used as a horse trail to Lahaina. It was resurrected to use in recent years and is the present Lahaina Pali Trail.

Cattle ranching began in the late 1800s and continued for over 100 years. During this time the grazing animals consumed much of the native vegetation which was gradually replaced by hardy weed species.

During the 1950s high voltage power lines were installed across the mountain along with access roads through this area. Increased traffic brought more disturbances and weeds. Fires became more frequent, further eliminating remnant native vegetation.

With the cessation of cattle grazing a number of grass and weed species have proliferated, creating a heightened fire hazard. Large fires have swept across the mountain consuming thousands of acres including the entire project area several times.

DESCRIPTION OF VEGETATION

The vegetation within the project area is a diverse array of grasses and low shrubs with a scattering of small trees. Five species are common throughout: molasses grass (*Melinis minutiflora*), Natal redtop (*Melinis repens*), u'ulei (*Osteomeles anthyllidifolia*), 'a'ali'i (*Dodonaea viscosa*) and lantana (*Lantana camara*). A total of 57 species were recorded during the survey.

Sixteen species of native plants were found in the project area: they include the u'ulei and 'a'ali'i as well as (*Carex wahuensis* subsp. *wahuensis*) no common name, ko'oko'olau (*Bidens micrantha* subsp. *micrantha*), naupaka kuahiwi (*Scaevola gaudichaudii*), 'akoko (*Chamaesyce celastroides* var. *amplectens*), 'öhi'a (*Metrosideros polymorpha* vars. *Glaberrima* and *incana*), 'iliahi alo'e (*Santalum ellipticum*), kilau (*Pteridium aquilinum* var. *decompositum*), koali awahia (*Ipomoea indica*), pükiawe (*Leptecophylla tameiameiae*), 'ilima (*Sida fallax*), 'uhaloa (*Waltheria indica*) and huehue (*Osteomeles anthyllidifolia*). The remaining 41 plant species were non-native grasses, shrubs and trees.

SURVEY OBJECTIVES

This report summarizes the findings of a botanical survey of the Kaheawa Pastures Wind Energy Project which was conducted in January 2010.
The objectives of the survey were to:

1. Document what plant species occur on the property or may likely occur in the existing habitat.

2. Document the status and abundance of each species.

3. Determine the presence or likely occurrence of any native plant species, particularly any that are federally listed as Threatened or Endangered. If such occur, identify what features of the habitat may be essential for these species.

4. Determine if the project area contains any special habitats which if lost or altered might result in a significant negative impact on the flora in this part of the island.

5. Note which aspects of the proposed development pose significant concerns for plants and recommend measures that would mitigate or avoid these problems.

SURVEY METHODS

The entire project area was surveyed on foot. Areas on rocky gully slopes were examined more intensively as these were the places where the most native plants survived both the grazing of cattle and the effects of wildfires. Notes were made on plant species, distribution and abundance as well as on terrain and substrate.

PLANT SPECIES LIST

Following is a checklist of all those vascular plant species inventoried during the field studies. Plant families are arranged alphabetically within three groups: Ferns, Monocots and Dicots. Taxonomy and nomenclature of the ferns are in accordance with Palmer (2003) and the flowering plants are in accordance with Wagner et al. (1999) and Staples and Herbst (2005).

For each species, the following information is provided:

1. Scientific name with author citation

2. Common English or Hawaiian name.

3. Bio-geographical status. The following symbols are used:

   endemic = native only to the Hawaiian Islands; not naturally occurring anywhere else in the world.

   indigenous = native to the Hawaiian Islands and also to one or more other geographic area(s).

   Polynesian introduction = plants introduced to Hawai'i in the course of Polynesian migrations and prior to western contact.

   non-native = all those plants brought to the islands intentionally or accidentally after western contact.

4. Abundance of each species within the project area:

   abundant = forming a major part of the vegetation within the project area.

   common = widely scattered throughout the area or locally abundant within a portion of it.

   uncommon = scattered sparsely throughout the area or occurring in a few small patches.

   rare = only a few isolated individuals within the project area.

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
FERNS			
DENNSTAEDTIACEAE (Bracken Family)			
Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) R.M. Tryon	*kilau*	endemic	rare
MONOCOTS			
CYPERACEAE (Sedge Family)			
Carex wahuensis C.A. Meyen subsp. *wahuensis*	----------------	endemic	uncommon
POACEAE (Grass Family)			
Bothriochloa barbinodis (Lag.) Herter	fuzzy top	non-native	rare
Bothriochloa pertusa (L.) A. Camus	pitted beardgrass	non-native	uncommon
Cynodon dactylon (L.) Pers.	Bermuda grass	non-native	rare
Digitaria insularis (L.) Mez ex Ekman	sourgrass	non-native	rare
Hyparrhenia rufa (Nees) Stapf	thatching grass	non-native	uncommon
Melinis minutiflora P. Beauv.	molasses grass	non-native	common
Melinis repens (Willd.) Zizka	Natal red top	non-native	common
Panicum maximum Jacq.	Guinea grass	non-native	rare
Paspalum dilalatum Poir.	Dallis grass	non-native	rare
Pennisetum clandestinum Chiov.	Kikuyu grass	non-native	rare
Sprorobolus africanus (Poir.) Robyns & Tournay	smutgrass	non-native	uncommon
DICOTS			
ANACARDIACEAE (Mango Family)			
Schinus terebinthifolius Raddi	Christmas berry	non-native	uncommon
ASTERACEAE (Sunflower Family)			
Acanthospermum australe (Loefl.) Kuntze	spiny bur	non-native	rare
Bidens micrantha Gaud.	*ko'oko'olau*	endemic	uncommon
Cirsium vulgare (Savi) Ten.	bull thistle	non-native	rare
Conyza bonariensis (L.) Cronq.	hairy horseweed	non-native	uncommon
Emilia fosbergii Nicolson	red pualele	non-native	rare
Heterotheca grandiflora Nutt.	telegraph weed	non-native	rare
Hypochoeris radicata L.	gosmore	non-native	rare
Senecio madagascariensis Poir.	fireweed	non-native	uncommon
BRASSICACEAE (Mustard Family)			
Lepidium virginicum L.	pepperwort	non-native	rare
Sisymbrium altissimum L.	tumble mustard	non-native	rare
CACTACEAE (Cactus Family)			
Opuntia ficus-indica (L.) Mill.	*panini*	non-native	rare
CASUARINACEAE (She-oak Family)			
Casuarina equisetifolia L.	common ironwood	non-native	rare

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
Casuarina glauca Sieber ex Spreng	longleaf ironwood	non-native	uncommon
CONVOLVULACEAE (Morning Glory Family)			
Ipomoea indica (J. Burm.) Merr.	*koali awahia*	inidgenous	rare
ERICACEAE (Heath Family)			
Leptecophylla tameiameiae (Cham. & Schlect.) C.M. Weiller	*pükiawe*	indigenous	uncommon
EUPHORBIACEAE (Spurge Family)			
Chamaesyce celastroides (Boiss.) Croizat & Degener var. *amplectens* (Sherff) Degner & I. Degener	*'akoko*	endemic	uncommon
FABACEAE (Pea Family)			
Acacia farnesiana (L.) Willd.	klu	non-native	rare
Chamaecrista nictitans (L.) Willd.	partridge pea	non-native	uncommon
Indigofera suffruticosa Mill.	'*inikö*	non-native	rare
Leucaena leucocephala (Lam.) de Wit	*koa haole*	non-native	rare
Macroptilium lathyroides (L.) Urb.	wild bean	non-native	rare
Neonotonia wightii (Wight & Arnott) Lackey	glycine	non-native	rare
GOODENIACEAE (Goodenia Family)			
Scaevola gaudichaudii Hooker & Arnott	*naupaka kuahiwi*	endemic	rare
MALVACEAE (Mallow Family)			
Malvastrum cormandelianum (L.) Garcke	false mallow	non-native	rare
Sida fallax Walp.	'*ilima*	indigenous	uncommon
Triumfetta semitriloba Jacq.	Sacramento bur	non-native	uncommon
Waltheria indica L.	'*uhaloa*	indigenous	uncommon
MENISPERMACEAE (Moonseed Family)			
Cocculus orbiculatus (L.) DC.	*huehue*	indgenous	rare
MYRTACEAE (Myrtle Family)			
Metrosideros polymorpha Gaud. var. *glaberrima* (H.Lev.) St. John	'*öhi'a*	endemic	uncommon
Metrosideros polymorpha Gaud. var. *incana* (H. Lev.) St. John	'*öhi'a*	endemic	rare
Psidium guajava L.	common guava	non-native	rare
OXALIDACEAE (Wood Sorrel Family)			
Oxalis corniculata L.	yellow wood sorrel	Polynesian	rare
PLANTAGINACEAE (Plantain Family)			
Plantago lanceolata L.	narrow-leaved plantain	non-native	uncommon
POLYGALACEAE (Milkwort Family)			
Polygala paniculata L.	milkwort	non-native	rare

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
PROTEACEAE (Protea Family)			
Grevillea robusta A. Cunn. ex R. Br.	silk oak	non-native	rare
ROSACEAE (Rose Family)			
Osteomeles anthyllidifolia (Sm.) Lindl.	u'ulei	indigenous	common
SANTALACEAE (Sandalwood Family)			
Santalum ellipticum Gaud.	'iliahialo'e	endemic	rare
SAPINDACEAE (Soapberry Family)			
Dodonaea viscosa Jacq.	'a'ali'i	indigenous	common
SOLANACEAE (Nightshade Family)			
Solanum linnaeanum Hepper & P. Jaeger	apple of Sodom	non-native	rare
THYMELAEACEAE ('Akia Family)			
Wikstroemia oahuensis (A.Gray) Rock	'akia	endemic	uncommon
VERBENACEAE (Verbena Family)			
Lantana camara L.	lantana	non-native	common
Stachytarpheta jamaicensis (L.) Vahl	Jamaica vervain	non-native	uncommon
Verbena littoralis Kunth	ha'uōwi	non-native	rare

DISCUSSION

The excavation of a 1,500 foot long trench in which to install an underground electrical transmission cable will result in the loss of some native vegetation within a narrow corridor between turbines 12 through 20. Much less native vegetation will be impacted by the construction of additional project structures at a proposed substation near turbine 12 and an extension to the office building at the project baseyard, as these two sites are nearly entirely covered with non-native grasses. None-the-less, the area in general has experienced a dramatic loss of native plant communities over the last century and there is concern that further losses of rare species and special habitats be avoided. The proposed project was analyzed with these concerns in mind.

Of the 16 native plant species identified within the project area none were found to be federally listed as Threatened or Endangered species (USFWS, 2009), nor were any found that are candidates for such status. All but one of these native species are common throughout the state. One, *Bidens micrantha*, is found only on Maui and Lanai but is quite common in West Maui.

Most of these native plants are in low shrubland communities that are most prevalent on rocky slopes on the West side of Manawainui Gulch. This is due to the fact that these areas were less accessible to grazing cattle over the years and because these rather barren, rocky slopes are less susceptible to fires. While a few of the native shrubland communities within the project corridor have a variety of native species, none can be considered special habitats or associated with a rare or protected species.

It is likely that periodic fires will continue to be a problem into the forseeable future. The area has been nearly completely overtaken by molasses grass, a highly flammable, fire-adapted species that is quick to recover following wildfires. Meanwhile, each fire destroys more and more of even the hardiest native plants. Unless land management practices change dramatically across this dry mountain slope, little improvement in this prognosis is likely.

Previous botanical surveys on this southern tip for West Maui have identified a few Endangered species growing in gulches about a mile upslope of this project area. This area is remote from these populations and is in a habitat completely unsuitable for their growth and survival. This project is not expected to negatively impact any of these species.

Due to the general condition of the habitat and the specific lack of any environmentally sensitive native plant species or habitats on or near the project area, the proposed development work is not expected to result in any significant negative impact on the botanical resources in this part of Maui.

RECOMMENDATIONS

Sensitivity toward the remnant native plant communities on the steeper slopes should be exercised in selecting the route for the underground cable. The gentler slope near the edge of the ridgetop would be preferable.

It is recommended that some of the native plant species found in this area be used to revegetate berms and banks resulting from construction activities.

Literature Cited

Armstrong, R. W. (ed.) 1983. Atlas of Hawaii. (2nd. ed.) University of Hawaii Press.

Foote, D.E. , E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. U.S. Dept. of Agriculture, Soil Conservation Service. Washington, D.C.

Palmer, D.D. 2003 Hawai'i's Ferns and Fern Allies. University of Hawaii Press, Honolulu.

Staples, G.W. and D.R. Herbst. 2005. A Tropical Garden Flora, Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press.

U.S. Fish and Wildlife Service. 1999. Endangered and threatened wildlife and Plants. 50 CFR 17.11 & 17.12

Wagner, W. L., D.R. Herbst, and S. H. Sohmer. 1999. Manual of the flowering plants of Hawai'i. Univ. of Hawai'i Press and Bishop Museum Press. Honolulu.

Appendix 16

Calculation of Total Direct Take at Kaheawa Wind Power

The following are excerpts from the Kaheawa Wind Power Year 3 Annual Report:

"As presented in Section V of the HCP, the principle components that go into estimating the Adjusted Take are, a) Observed Direct Take, b) Unobserved Direct Take, c) Indirect Take, and d) Loss of Productivity. The SEEF and Carcass Removal results are used to estimate the Unobserved Direct Take (UDT). To calculate adjusted estimates of the number of Hawaiian Hoary Bat and Nene fatalities that may have occurred at KWP during the present reporting period, we used an estimator, *m*, as proposed by Shoefeld (2004) and Kerns and Kerlinger (2003) to estimate fatality rates using the formula:

$$m = \left(\frac{N * I * C}{k * t * p}\right)\left(\frac{e^{I/t} - 1 + p}{e^{I/t} - 1}\right)$$

where *I* represents the number of days between plot searches (search interval), *N* is equal to the number of turbine search plots, *k* is the number of plots searched (in the case of KWP, *N* and *k* are the same value), *t* is the mean carcass retention time, *p* is used to represent the detection probability (searcher efficiency), $e^{I/t}$ is an exponential value, and *C* is the actual number of carcasses observed (ODT) during downed wildlife monitoring."

Example from KWP Year 3 Annual Report

<u>Hawaiian Hoary Bat</u>

Observed Direct Take (C) = 1
Total Search Plots (N) = 20
Number of Plots Searched (k) = 20
Search Interval (I) = 7.6
Carcass Retention Time (t) = 10
Carcass Detection Probability (p) = 0.58
Natural Log ($e^{t/I}$) = 2.138276

$$m = \left(\frac{N * I * C}{k * t * p}\right)\left(\frac{e^{I/t} - 1 + p}{e^{I/t} - 1}\right)$$

m = 1.978

The total adjusted direct take at KWP is presented below in Table 1.

Table 1. Total Adjusted Direct Take for KWP

	Total direct take	Yearly average
Hawaiian Goose*	**5.50**	**1.37**
Hawaiian Petrel	**4.96**	**0.93**
Newell's Shearwater	**0**	**0**
Hawaiian Hoary Bat	**6**	**1.2**

***Years 1-4 only**

Appendix 17

An Assessment of Native Hawaiian Molluscan Fauna
Kaheeawa Pastures, West Maui, Hawaii

Kaheawa Wind Power II: Part 2

TMK 4-8-001:001 and 3-6-001:014

Prepared for

First Wind
179 Lincoln Street, Suite 500
Boston, Massachusetts 02111

Prepared by

Mike Severns
3415 Kehala Drive
Kihei, Hawaii, 96753

January, 2010

Introduction:

The terrestrial molluscan fauna of Hawai‘i is in a state of catastrophic decline in which hundreds of species and an endemic family are in danger of extinction. Hawai‘i’s molluscs evolved in isolation with an ecological naivety that has left them extremely vulnerable to environmental change, and a low fecundity that has not allowed them to recover from the pressures exerted by introduced predators. During the late 20th century perhaps as many as two-thirds of the living species described in the 19th and early 20th centuries became rare or extinct.

This survey was commissioned by Kaheawa Wind Power II (KWP II) to determine if any species of native Hawaiian snails, particularly those species federally and state listed as threatened, endangered or of substantial conservation concern occur within the proposed underground collection system routing, BESS and sub-station enclosures, expanded Operations and Maintenance facilities, and proposed water storage tank, and if so what steps could be taken to ensure their continued survival.

Survey Objectives:

This survey and report were initiated out of concern that there may be native snail populations within the proposed KWP II underground collection system routing, BESS and sub-station enclosures, expanded Operations and Maintenance, and water storage tank facilities. The objectives were to determine if any native land snail species were present in these proposed project areas, to identify them and to determine their habitat. Another objective was to look for semi-fossil shells protected beneath rocks or buried in the soil, which could indicate what species might have been present in the area in recent years, and thus may still be present.

Site Description:

The survey area was restricted to the eastern side of the lower portion of the Kaheawa Pastures within the existing Kaheawa Wind Power (KWP) leased area. The survey encompassed a 750-meter-long by 50-meter-wide corridor beginning at turbine number 20 at approximately 546 meters and extending uphill parallel to the western edge of Manawainui Gulch and bordering the existing KWP string road to turbine 12. It also included a proposed building expansion site measuring 18 by 24 meters which is beside an existing structure housing offices and equipment (Operations and Maintenance facility) and a section of pasture to the east of the present Operations and Maintenance facility where a water storage tank is proposed.

Kaheawa Pasture lies in the Lahaina District in the ahupua‘a of Ukumehame. It is defined by the upper reaches of Papalaua Gulch and its tributaries on the west and by Manawainui Gulch to the east and south. Much of the pasture was burned in 2006 in the most recent of many wind-driven fires to pass through the area.

Within the survey area there are areas of fire-stunted, native shrubs and some native and introduced grasses. A very shallow layer of leaf litter was found beneath the shrubs which rested on a layer of burnt plant material presumably from the last fire. A couple of small stands of ironwood trees found within the survey area blanket the ground with their needles preventing the growth of other plants resulting in very poor snail habitat.

When exposed, much of the stratigraphy is relatively constant in appearance with a brown layer of recent soil resting on a layer of hard-packed reddish-brown soil-like material. The upper layer was the most likely to contain evidence of snails in the form of semi-fossil shells of recent species; however none were found.

Though naturally occurring rock formations were abundant, they rested on the hard-packed ground mentioned above with pockets of ash in the cracks between the rocks. Very seldom did grass root-mats of any substantial depth form around or beneath the rocks. This grass root-mat and rock combination provides good snail habitat and can protect small snails living deep in the grass root-mat from fast-moving fires which sweep across the rocks burning exposed grass leaves, but not the root-mat.

Biological History:

[The following paragraphs are copied from my first assessment of the Kaheawa Pastures in January 2009. They are repeated here because the area of this survey is adjacent to and part of the original Kaheawa Pastures which was surveyed in January, 2009.]

Prior to European contact much of the pasture was probably blanketed by the horizontally-growing uluhe fern with scattered trees, predominantly ohia (*Metrosideros polymorpha*), as on the nearby ridges today.

Uluhe fern often acts as a fringe forest plant on mountain slopes and ridge tops. It is intermediate between the forest and the lowland vegetation and is often the dominant plant in that role. Because of the steep inclination of the ridges of West Maui’s lee side, uluhe forms an obvious broken line of bright green on the ridge backs beneath the forest. Its regularity in elevation and growth patterns permits a reasonable expectancy from one ridge to the next at the same elevation. Thus by comparing nearby ridges of similar elevation to the Kaheawa Pastures survey area it is possible to imagine what the vegetation of the pasture may have looked like in the past.

Since West Maui is heavily eroded into distinct ridges separated by deep valleys, populations of species living on the ridge tops are isolated and develop characteristics in shape and color that are unique to each population. Thus, if snails had existed in the Kaheawa Pastures they would have had distinct characteristics and would have been interesting to early collectors as subspecies. An intensive search of the collecting data showed that all of the collected variations of arboreal snail species that I would have expected to find in the survey area had data indicating their origin, but none of that data mentions Kaheawa Pastures or Ukumehame.

The nearest location for which snail collecting data exist is along the ridge overlooking Ukumehame Valley on the trail leading to the reservoir at Hanaʻula, parallel to but at a higher elevation than the Kaheawa Pastures. There, *Partulina fusoidea* was collected and still exists today. It was described in 1855 by Newcomb.

Knowing that collections were made on an adjacent and parallel ridge on the Wailuku side of the survey area in 1855, and that in 1978 semi-fossil *Partulina* were found in the soil along the Wailuku edge of that adjacent pasture at the elevation of the upper survey area, I would expect a subspecies or variation of that species to have lived in the area that the Kaheawa Pastures occupies today. Having no collecting data nor specimens whose location is unaccounted for and could be attributed to the Kaheawa Pastures suggests that the Kaheawa Pastures was unproductive for snail hunters before 1855.

One explanation for the lack of specimens is that the pastoral history of the pasture predates the study of snails in the area. The snail fauna of the pasture can be inferred from surrounding areas, but without living snails or fossil snail deposits it will not be possible to know what the pasture was like prior to what is known historically and what is there today.

Habitat Requirements for Ground dwelling Snails:

The habitats preferred by ground-dwelling snails are a moist environment beneath rocks and rock talus, often associated with the root-mats of grasses; in the leaf litter beneath trees and shrubs, and in thick mosses growing on the ground, on trees and among rocks.

Conservation Relevance:

It is highly unlikely that native snails, including those which receive protection under state or federal endangered species laws will be found in the Kaheawa Pastures. However, all of the native Hawaiian land snails should be considered rare and treated as such if discovered, with particular attention given to their habitat.

Discussion:

Since all of the habitats expected to be occupied by ground-dwelling snails are seriously degraded or non-existent within the surveyed area and since there is no habitat for arboreal snails, it is highly unlikely that living snails exist within the surveyed area.

The attention First Wind and Kaheawa Wind Power II has given to this important but devastated aspect of Hawaiian biology is commendable, but it appears that years of abuse of the land, along with tell-tale hints of pastoral use pointing back to before the 1850's, seem to have reduced the capacity of the area to support living snails.

Conclusion:

During the survey the leaves, bark and leaf litter beneath shrubs were searched. In addition, grass root-mats among and beneath rock talus and other naturally occurring rock formations were also searched for evidence of snails. The limited amount of moss was examined, and exposed ground was searched for fresh and dead shells. No snail shells, fossil or extant, native or introduced, were found.

After the meticulous search described, my assessment is that there are no living snails, native or introduced, within the area surveyed.

References:

Severns, Mike. In press. *An Illustrated Catalog of the Shelled Molluscan Fauna of the Hawaiian Islands, Marine and Land*. Conchbooks Publishers. Maizer Str. 25, D-55546, Hackenheim, Germany. Estimated 800 pages in two volumes. Estimated publication May, 2010.

Appendix 18

COPY

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

ROBERT K. MASUDA
DEPUTY DIRECTOR - LAND

DEAN NAKANO
ACTING DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

Division of Forestry and Wildlife
1151 Punchbowl Street, Rm. 325
Honolulu, HI 96734

June 17, 2005

Kaheawa Wind Power, LLC
Attn: Mike Gresham/Michelle McClean
1043 Makawao Avenue, Ste. 208
Makawao, HI 96768

SUBJECT: Fire Contingency Plan for CDUA MA-3103

Attached please find the approved fire contingency plan for CDUA MA-3103. Should you have any specific questions to the plan, please feel free to call Maui Branch Division of Forestry and Wildlife at 984-8100.

Very truly yours,

Wayne F. Ching
State Protection Forester
Fire Management

attachment

CDUA NO. MA-3103

Division of Forestry and Wildlife
CONSERVATION DISTRICT USE APPLICATION
Fire Contingency Plan

This plan is to be used for the construction of a project within a conservation district. In developing a plan, it is important to: 1) know what activities might start a fire, 2) analyze the fire prevention actions which can minimize the chance of starting a fire, and 3) know what action to take and whom to call in case of a fire.

I. NAME: Kaheawa Wind Power, LLC
attn: Mike Gresham or Michele McLean

ADDRESS: 1043 Makawao Avenue
Suite 208
Makawao, Hawai`i 96768

TELEPHONE: 808-298-1055 (M. Gresham) or 808-572-3011, x. 208 (M. McLean)
808-572-8378 (facsimile)

II. LOCATION:

Island: Maui

Tax Map Key: 4-8-001: 001 (site) and 3-6-001: 014 (access roadway)

Fire Station Name/Number Closest to Project: Wailuku Station (243-7569)
Kihei Station (879-2741)

Miles from Fire Station: Approximately 10 miles from Wailuku Station
Approximately 12 miles from Kihei Station
(both measurements to project access roadway entrance at the existing highway)

III. APPROVED USE:

The approved use of the site is the construction and operation of a 30-megawatt wind energy generation facility (also known as a "wind farm"). Project components include grading and improving approximately 1.7 miles of the existing 4-wheel-drive roadway beginning at the Honoapiilani Highway entrance; clearing, grading and improving approximately 1.9 miles of a new access roadway to the site and approximately 1.75 miles of intra-site roadway; construction and operation of 20 wind turbines on concrete foundations; construction and use of an operations and maintenance (O&M) facility; construction and operation of an electrical gathering system to transmit energy from individual turbines to the project substation; and construction and use of an electrical substation and interconnection facilities (to transmit electrical energy to Maui Electric Company's transmission lines).

IV. POTENTIAL IGNITION SOURCE(S) OF ACCIDENTAL FIRES DURING THE CONSTRUCTION OF THE PROJECT:

During construction of the project, ignition sources for accidental fires would include errant sparks from a variety of vehicles, equipment and tools, and wrongly discarded matches and cigarette butts.

During operation of the project, the same potential ignition sources exist, though overall risk exposure is significantly more limited due to lower volume of concurrent work ongoing at the project site. Additional theoretical operational ignition sources would include the electrical components of the individual wind turbine generators and energized substation/interconnection facilities equipment.

V. DESCRIBE THE TYPE OF FIREFIGHTING RESOURCES AVAILABLE:

The most important preventive resource will be education of all on-site contractors and personnel and proper maintenance of all vehicles, equipment, tools and turbine hardware.

During construction, firefighting resources will include the provision of fire extinguishers in all construction vehicles and trailers, as well as the provision of shovels and water-filled backpack pumps which shall be readily accessible during construction activities. Additionally, during some periods of construction, earthmoving equipment will be present on-site that could assist in creating fire breaks. Lastly, large quantities of water will be utilized on-site for road construction, concrete batching, re-vegetation efforts and erosion control – when available, this water could also be used for firefighting purposes. Should this water be provided by a water truck, it will be fitted with a hose and cannon to be used for fire protection.

During all phases of the project, basic on-site fire-fighting resources will include fire extinguishers in the O&M facility, at the substation, and in all project vehicles, and shovels and backpack pumps in the O&M facility and maintenance vehicles.

VI. DESCRIBE THE ACCESSIBILITY OF THE PROJECT SITE FOR FIRE EMERGENCY RESPONSE VEHICLES:

The project consists of access roadways and a wind turbine site. The existing access roadway is a very difficult four-wheel-drive jeep trail, but site access will be significantly improved and extended for the access of the project's construction vehicles and equipment deliveries – including multi-axle trailers with gross weights in excess of 150,000 pounds. Construction will begin at the bottom (makai) of the road, and move upward (mauka) to the wind turbine site. As the road is improved, access for fire emergency response vehicles will be greatly improved compared to access existent today.

The applicant will meet with appropriate personnel from the County of Maui Department of Fire Control before construction begins, and again after the access roadways have been improved, to assist the Department in its fire response knowledge base.

VII. DESCRIBE, IF APPLICABLE, ANY FIRE PLAN THAT WILL APPLY TO THE COMPLETED PROJECT:

Existing vegetation in the project area consists of low brush and grass and, as such, is anticipated to be subject to relatively fast-moving fires of modest intensity and duration. During and after construction, vegetation in the immediate vicinity of project components will be appropriately maintained (cut or cleared). Cleared areas around each wind turbine, the O&M facility, and the substation/interconnection facility will be covered with gravel to assist in fire prevention and to form fuel breaks around individual project components. Specifically, a minimum 30-foot cleared (i.e., no vegetation) buffer will be provided around the O&M facility and substation/interconnection facility, while a minimum 20-foot cleared buffer will be provided around each wind turbine's concrete footprint. Should these buffers be determined by State forestry and/or County fire personnel to be inadequate, they will be increased as warranted.

Additional theoretical fire breaks/fuel breaks will be formed by project roadways running along the turbine array and from the highway to the project site. Areas that will be cleared during construction will be promptly re-vegetated with existing vegetation or otherwise appropriate plants that both (a) present limited hazards from a fire control perspective and (b) are non-attractions for wildlife.

Ongoing operation and maintenance of the completed project will involve routine checks of electrical connections, wash schedule for substation equipment (if indicated by detailed design), and periodic infrared reconnaissance of electrical components.

As referenced in Section V above, all project vehicles will carry fire extinguishers as a first response methodology. Additional on-site fire suppression equipment and supplies may be stocked in project warehouse facilities depending upon need assessment to be conducted as project design and operational plans are completed.

VIII. OTHER COMMENTS:

Wind energy generation facilities are unlikely to be the cause of a fire or wildfire. In the applicant's experience with such facilities domestically and worldwide, the turbine generators and related electrical interconnection have never been a source or cause of fire. The facility is also unlikely to be seriously impacted by a wildfire that occurs on or spreads to the site. The towers supporting the turbines are of ¾-inch plate steel, mounted on concrete foundations; the interconnecting electrical systems are below ground; and the O&M facility will be of noncombustible construction and exterior finishes (the building permit for the O&M facility will be reviewed by the County of Maui Department of Fire Control). Damage from fire could occur to the on-site substation and would potentially disrupt the facility's provision of electricity to Maui Electric, though it would not jeopardize Maui Electric's ability to provide electricity services to its customers.

On-site vegetation management will require ongoing coordination with State forestry and wildlife officials to ensure that (a) appropriate fire control efforts are implemented due to factors such as weather conditions; (b) the site does not introduce nesting, foraging or other attractions to wildlife, particularly endangered, threatened or protected species; and (c) the project infrastructure and operations are reasonably protected. Similarly, as weather conditions or other factors may dictate, Kaheawa Wind Power will work with State forestry and wildlife officials, as well as County fire personnel, during project construction and operation to implement fire prevention or control measures as the need may so arise (e.g., creating fire breaks near the Manawainui Plant Sanctuary located along the mauka portion of the subject property and turbine array).

During all phases of project construction and operation, contractors and employees will be made aware of fire prevention protocols, including failsafe methods to contact the Department of Fire Control and 911 for emergency response. The applicant will work with State and County officials to ensure that emergency response personnel have appropriate access to the site.

Lastly, Kaheawa Wind Power is aware that it may be financially liable for fire suppression efforts in the event of any fire that is caused by its project activities, and pledges its full cooperation in both fire suppression efforts and subsequent investigations. In the event of a fire in the project vicinity, project maintenance records will be made available to fire investigators.

APPROVED:

Glenn H. Shishido

for Branch Manager, DOFAW Maui

CONCUR:

Paul J Conry

Administrator, DOFAW

Appendix 19

Timetable for Implementation of HCP Requirements and Reporting Requirements

Species	Annual commitment ($)	Time of payment/execution	Length of commitment	Purpose	Relevant HCP text
Hawaiian petrel					
Alternative 1	in house	within the first year of project operation	duration to be determined based on results	social attraction project at Makamakaole	see Appendix 11, 27, 6.3.1.3 and 6.3.1.5 for Baseline Mitigation
Other Alternatives	in house	within the first year of project operation or after 5 years if social attraction at Makamakaole is deemed inadequate	duration to be determined based on results	petrel mitigation at Haleakala	see Appendix 11, 6.3.1.6 and 6.3.2.2 Other Alternatives for Baseline Mitigation
	in house	after 2016	duration to be determined based on results	petrel mitigation at ATST site	see Appendix 11, 6.3.1.6 and 6.3.2.1 Other Alternatives for Baseline Mitigation
Newell's shearwater					
Alternative 1	in house	within the first year of project operation	duration to be determined based on results	social attraction project at Makamakaole	see Appendix 11, 27, 6.3.1.3 and 6.3.1.5 for Baseline Mitigation
Additional Measures	in house	Within the first year of project operation	5 years	Reseach and development of plan for alternatives	see Appendix 11, 27, 6.3.1.3 and 6.3.1.7 for Baseline Mitigation
Other Alternatives	in house	year 6	duration to be determined based on results	Social attraction or in-situ protection at alternative site on Maui	see Appendix 11, 27, 6.3.2.6 and 6.3.2.2 for Alternatives to Baseline Mitigation
	In House	year 6	duration to be determined based on results	In-situ protection or social attraction at an alternative site on Molokai or Lanai	see 6.3.2.6 and 6.3.2.2 for Alternatives to Baseline Mitigation

Species	Annual commitment ($)	Time of payment/execution	Length of commitment	Purpose	Relevant HCP text
Bats	in-house		Year 1 to 2, 5, 10, 15	survey for bats within and in vicinity of KWPII	Surveys will be conducted during years when systematic fatality monitoring is conducted, (i.e., during the first two years and at five year intervals thereafter, or as otherwise determined under the Adaptive Management provisions), to allow observed activity levels to be correlated with any take that is observed.
	in-house		Year 1 to 2, 5, 10, 15	bat interaction research	KWPII will survey for bat activity near turbine locations for the first two years of operation using acoustic bat detectors. Surveys will be conducted during years when systematic fatality monitoring is conducted (see Appendix 2 and Section 7.2.1). …. The use of additional techniques and technologies will also be considered.
	variable	within 60 days of the commercial operation date and before June of each subsequent year	20 years	bat management	Recommendations by USFWS and DOFAW for mitigation for the Hawaiian hoary bat have consisted of habitat restoration to improve or provide additional roosting, breeding and foraging habitat.
Hawaiian short-eared owl	25,000	within 60 days of the commercial operation date	one time	research and/or rehabilitation	KWPII will contribute a total of $25,000 to appropriate programs or facilities such as the Hawaii Wildlife Center, to support owl research and rehabilitation

Species	Annual commitment ($)	Time of payment/execution	Length of commitment	Purpose	Relevant HCP text
Nene*					
Nene management at release pen	in-house		Preconstruction and construction	Nene nest surveys	Surveys will be performed in areas to be cleared for project construction to ensure that no active nēnē nests would be disturbed or destroyed by vegetation clearing activities;
	up to $158,209	before June 2015 or earlier with 6 months notification from DOFAW.	one-time	staffing at release pen	Mitigation for KWPII will consist of providing funding to DOFAW to build an additional release pen and five years of funding for conducting predator control, vegetation management and monitoring at the additional pen beginning in 2016.
	$30,000	by June 2015 and before June of each subsequent year	Year 4-8	staffing at release pen	
Additional measures independent of alternative chosen	in-house		Year 1	Weekly systematic nene observations	a wildlife biologist will make systematic visual observations of nēnē activity from representative locations within the KWP II project area during the first year of project operation

* please see HCP for other backup scenarios - Section 6.4.5 includes contingencies for additional nene pens

Appendix 20

DRAFT
IMPLEMENTING AGREEMENT
KAHEAWA WIND POWER II WIND ENERGY GENERATION FACILITY
September__, 2010

1.0 PARTIES

The parties to this Implementing Agreement (Agreement) are Kaheawa Wind Power II, LLC, a Delaware limited liability company (Permittee); the United States Fish and Wildlife Service (Service) and the State of Hawai`i (State) Department of Land and Natural Resources (DLNR) through its Division of Forestry and Wildlife (DOFAW).

2.0 RECITALS AND PURPOSES

2.1 Recitals. The parties have entered into this Agreement in consideration of the following facts:

(a) The Kaheawa Wind Power II Energy Generation Facility (Project) project site has been determined to provide, or potentially provide, habitat for the following four (4) listed species: the endangered Hawaiian Petrel (*Pterodroma sandwichensis*), the threatened Newell's (Townsend's) Shearwater (*Puffinus auricularis newelli*), the endangered Nene (*Branta sandvicensis*), and the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*); and

(b) The Permittee has developed a series of measures, described in the Habitat Conservation Plan (HCP), to minimize, mitigate and monitor, to the maximum extent practicable, the effects of take of Covered Species incidental to Permittee's Covered Activities.

2.2 Purposes. The purposes of this Agreement are:

(a) To ensure implementation of each of the terms of the HCP and provide benefit to the Covered Species;

(b) To describe remedies and recourse in the event that any party should fail to perform its obligations as set forth in this Agreement; and

(c) To provide assurances to Permittee that as long as the terms of the HCP, the Incidental Take Permit (Permit), the Incidental Take License (ITL) , and this Agreement are met, no additional mitigation will be required of Permittee with respect to Covered Species except as provided for in this Agreement or required by law and/or applicable regulations.

3.0 DEFINITIONS

The following terms as used in this Agreement will have the meanings set forth below. Terms used in this Agreement and specifically defined in the Endangered Species Act (ESA) or in regulations adopted by the Service or DLNR shall have the same meaning as in those implementing regulations, unless this Agreement expressly provides otherwise.

3.1 **"Adaptive Management"** means a flexible approach to the long-term management of the fish, wildlife and habitat resources of the project area that is directed over time by the results of ongoing monitoring activities and other information.

3.2 **"Changed Circumstances"** means changes in circumstances affecting a Covered Species or the geographic area covered by the HCP that can reasonably be anticipated by the parties to the HCP and that can reasonably be planned for in the HCP (e.g. the listing of a new species, or a fire or other natural catastrophic event in areas prone to such event). Changed Circumstances and the planned responses to those circumstances are described in Chapter 7("Implementation") of the HCP. Changed Circumstances are not Unforeseen Circumstances.

3.3 **"Covered Activities"** means certain activities carried out by Permittee on Covered Lands that may result in incidental take of Covered Species. Covered Activities means the following activities, provided that these activities are otherwise lawful: construction and operation of 14 wind turbine generators (model GE 1.5 MW, manufactured by General Electric, each capable of generating 1.5 megawatts, and each having a 213-foot tower and 231-foot diameter rotors); construction and use of new internal service roads connecting the project site to the existing Kaheawa Wind Project (KWP) access road; installation of an underground electrical network connecting all turbines; construction and use of an overhead powerline connect the turbines across the gulch; construction and use of an electrical substation and connection of the substation to the new turbines and to the existing MECO power transmission lines; construction and use of a Battery Energy Storage System (BESS) adjacent to the substation; construction and use of an operations and maintenance building; installation of an above-ground water storage tank; erection and use of one (1) permanent meteorological tower and one temporary test tower onsite to monitor and transmit wind data; construction and use of one (1) communications tower; use of an access roadway to the project site; maintenance of all of the aforementioned and related infrastructure; site visits by appointment for public education and outreach; and management of on-site vegetation in coordination with wildlife and forestry officials.

3.4 **"Covered Species"** means the following species, each of which the HCP addresses in a manner sufficient to meet all of the criteria for issuing an incidental take permit under ESA Section 10(a)(1)(B) and an incidental take license under Chapter 195D Hawai`i Revised Statutes (HRS): the endangered Hawaiian Petrel (*Pterodroma sandwichensis*), the threatened Newell's (Townsend's) Shearwater (*Puffinus auricularis newelli*), the endangered Nene (*Brunta sandvicensis*), and the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus).*

3.5 **"HCP"** means the Habitat Conservation Plan prepared by Permittee for the Project.

3.6 "ITL" means the Incidental Take License (ITL) issued by DLNR to Permittee pursuant to Chapter 195D HRS, for take incidental to Covered Activities relating to the Project as it may be amended from time to time.

3.7 **"Listed Species"** means a species (including a subspecies, or a distinct population segment of a vertebrate species) that is listed as endangered or threatened under the ESA and/or under Chapter 195D-4 HRS.

3.8 **"Permit"** means the incidental take permit issued by the Service to Permittee pursuant to ESA Section 10(a)(1)(B) for take incidental to Covered Activities relating to the Project, as it may be amended from time to time.

3.9 **"Permittee"** means Kaheawa Wind Power II, LLC, a Delaware limited liability company.

3.10 **"Plan Area"** means the lands upon which the permit authorizes incidental take of Covered Species and the lands to which the HCP's conservation and mitigation measures apply. These lands are described in Section 1.4 of the HCP.

3.11 **"Take"** means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any listed or unlisted Covered Species. Harm means an act that actually kills or injures a member of a Covered Species, including an act that causes significant habitat modification or degradation where it actually kills or injures a member of a Covered Species by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

3.12 **"Unforeseen Circumstances"** means changes in circumstances affecting a species or geographic area covered by a conservation plan that could not have been reasonably anticipated by Permittee, the nService and/or DLNR at the time of the HCP's negotiation and development, and that result in a substantial and adverse change in the status of the Covered Species.

3.13 **"Unlisted Species"** means a species (including a subspecies, or a distinct population segment of a vertebrate species) that is not listed as endangered or threatened under the ESA or State law, including proposed, candidate and other species.

4.0 OBLIGATIONS OF THE PARTIES

4.1 Obligations of Permittee.

4.1.1 General

(a) Chapter 5 of the HCP identifies impacts to Covered Species from Covered Activities. As identified in Chapter 5 of the HCP, the Permittee is to perform measures to avoid, minimize and monitor those impacts to Covered Species during the Covered Activities. In addition, as identified in Chapters 5 and 6 of the HCP, the Permittee will undertake mitigation measures and implement a monitoring program in order to assure that potential effects on Covered Species are mitigated so as to achieve a net recovery benefit. As identified in Chapter 6 of the HCP, the Permittee will engage in monitoring and adaptive management. The

Permittee's activities under the HCP will be subject to Service and DLNR review and approval as described in the HCP.

(b) The Permittee will fully and faithfully perform all obligations assigned to it under this Agreement, the ITL, the Permit and the HCP.

(c) Funding for implementation of the HCP shall be included as an annual operating expense of the Project Assurances that adequate funding will be available to support the proposed monitoring and mitigation measures will be provided by Permittee in the form of a bond, letter of credit (LC) or similar instrument (the "Surety") naming the Service and/or DLNR as the beneficiary. Permittee will provide a Surety in the amount of $500,000 to secure the obligation to fund implementation of the HCP. The Surety will have a term of one year, and will be automatically renewed prior to expiration, unless it is determined to no longer be necessary by the Service and DLNR. The Service and/or DLNR may draw upon the surety to fund or otherwise pay for any outstanding mitigation obligations of the Project only in the event that Permittee fails to fund or otherwise pay for the proposed monitoring and mitigation measures when required under the HCP or in the event that Permittee is bankrupt.

(e) Permittee will establish an additional letter of credit or other credit support in the amount of $335,000 in order to support the three (3) contingency funds specific for each of the Covered Species in Chapter 3.8 of the HCP. The separate amounts of the three (3) contingency funds are as follows: $160,000 for the Seabird Contingency Fund; $100,000 for the Nene Contingency Fund; and $75,000 for the Hawaiian Hoary Bat Contingency Fund. The amount of the letter of credit or other credit support will increase at 2.5% annually over the term of the HCP. If contingency funds are used, the amount of the bond would be reduced accordingly, and the net amount would continue to increase at a 2.5% annual rate.

4.2 Obligations of Service and DLNR. Upon execution of this Agreement by all parties, and satisfaction of all other applicable legal requirements, the Service will issue Permittee a Permit under ESA Section 10(a)(1)(B), and DLNR will issue Permittee an ITL under Chapter 195D HRS, authorizing incidental take by Permittee of each Covered Species resulting from Covered Activities on Covered Lands.

4.2.1 Permit and ITL coverage. The Permit and ITL will identify all Covered Species. The Permit and ITL will take effect for Covered Species at the time the Permit and ITL are issued, respectively.

4.2.2 "No surprises" assurances. Provided that Permittee has complied with its obligations under the HCP, this Agreement, the Permit and the ITL I (including any provisions for changed circumstances, adaptive management, or any other contingency measures provided for in the HCP), the Service and/or DLNR can require Permittee to provide mitigation beyond that provided for in the HCP only under Unforeseen Circumstances, and only in accordance with the "No Surprises" requirements set forth in Section 7.6 of the HCP.

4.3 Interim obligations upon a finding of Unforeseen Circumstances. If the Service and/or DLNR make a finding of Unforeseen Circumstances, during the period necessary to determine the nature and location of additional or modified mitigation, Permittee will avoid contributing to appreciably reducing the likelihood of the survival and recovery of the affected species.

5.0 INCORPORATION OF HCP

The HCP and each of its provisions are intended to be, and by this reference are incorporated herein. In the event of any direct contradiction between the terms of this Agreement and the HCP, the terms of this Agreement will control. In all other cases, the terms of this Agreement and the terms of the HCP will be interpreted to be supplementary to each other.

6.0 MONITORING AND REPORTING

6.1 Planned period reports. As described in the HCP, Permittee will submit periodic reports describing its activities and results of the monitoring program provided for in the HCP.

6.2 Other reports. Permittee will provide, within 30 days of being requested by the Service and/or DLNR, any additional information in its possession or control related to implementation of the HCP that is requested by the Service and/or DLNR for the purpose of assessing whether the terms and conditions of the Permit, the ITL and the HCP, including the HCP's adaptive management plan, are being fully implemented.

6.3 Certification of reports. All reports will include the following certification from a responsible company official who supervised or directed preparation of the report:

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

6.4 Monitoring by Service/DLNR. The Service and/or DLNR may conduct inspections and monitoring in connection with the Permit and ITL, respectively, in accordance with the ESA and Chapter 195D HRS and any regulations adopted under those statutes.

7.0 CHANGED CIRCUMSTANCES

7.1 General

(a) Section 7.6 of the HCP identifies Changed Circumstances. The Permittee shall carry out the responses identified in that section, including coordination with the Service and DLNR and other agencies as appropriate.

(b) The Parties acknowledge that, notwithstanding the assurances provided by Section 4.2 herein, future modifications to mitigation that are specifically contemplated under the

HCP and this Agreement may require adjustments in the mitigation program set forth in the HCP as of the effective date, including Adaptive Management changes in the Plan Area. Such changes are part of the operating conservation program, and do not violate the assurances of Section 4.2. In particular, mitigation actions related to Changed Circumstances and to changes in mitigation deriving from Adaptive Management of the Plan Area remain the responsibility of the Permittee in accordance with the responsibilities under the HCP and this Agreement and do not violate the assurances of Section 4.2. Notwithstanding the foregoing, the Parties further acknowledge that such modifications to the mitigation program described in the HCP shall not require funding in addition to that set forth in the HCP.

7.2 Notification of Changed and Unforeseen Circumstances

7.2.1 Permittee-initiated response to Changed Circumstances. Permittee will give notice to the Serviceand DLNR within seven (7) days after learning that any of the Changed Circumstances listed in Section 7.5 of the HCP has occurred. As soon as practicable thereafter, but no later than 30 days after learning of the Changed Circumstances, Permittee will modify its activities in the manner described in Section 7.5 of the HCP to the extent necessary to mitigate the effects of the Changed Circumstances on Covered Species, and will report to the Serviceand DLNR on its actions. Permittee will make such modifications without awaiting notice by the Service and/or DLNR.

7.2.2 Service/DLNR-initiated response to Changed Circumstances. If the Service and/or DLNR determine that Changed Circumstances have occurred and that Permittee has not responded in accordance with Section 7.5 of the HCP, the Service and/or DLNR will so notify Permittee and will direct Permittee to make the required changes. Within 30 days after receiving such notice, Permittee will make the required changes and report to the Serviceand/or DLNR on its actions. Such changes are provided for in the HCP, and hence do not constitute Unforeseen Circumstances or require amendment of the Permit, ITL or HCP.

7.3 Listing of species that are not Covered Species.

(a) The Parties acknowledge that the HCP covers four (4) species listed as endangered or threatened under the ESA and/or State law which have been found or are likely to be found in the Plan Area. The Parties further acknowledge that the HCP, this Agreement, the Permit and the ITL do not authorize any take, or violation of the ESA or State law, with respect to species other than Covered Species that are listed as endangered or threatened, or with respect to species that are listed subsequent to the Effective Date. When and if a species that is not a Covered Species is listed under the ESA or State law,or a Listed Species other than a Covered Species in the Plan Area is found to be affected by the Project, the Parties shall follow the procedures of this Section including, if necessary, amendments to the Permit and/or ITL.

(b) If a species that is not included as a Covered Species in the HCP is proposed for listing under the ESA or State law during the term of this Agreement, including a proposal for listing on an emergency basis, and the Service and/or DLNR determine that the species may be affected by the Covered Activities, the Service and/or DLNR shall notify the Permittee of the proposed listing as early as feasible. Similarly, the Service and/or DLNR shall notify the Permittees if other Listed Species are found to be present in the Plan Area.

(c) The Permittee shall evaluate the potential effect of the Covered Activities on the species identified in paragraphs (a) and (b) above, based on the HCP, the information developed through the ongoing management of the Plan Area and other relevant information, and the Permittee shall inform the Serviceand/or DLNR in writing of its determination with regard to such potential effect.

(d) If the Permittee notifies the Service and/or DLNR that the Covered Activities may affect the species, or if the Service and/or DLNR disagree with the Permittee's determination that the Covered Activities will not affect the species, the Parties shall meet and confer in order to develop an appropriate response.

(e) If the Service and/or DLNR determine, after consultation with the Permittee, that feasible modifications in the Adaptive Management program or minor adjustments in the Covered Activities can be used to assure that the Covered Activities remaining compliance with the ESA and Chapter 195D HRS, the Permittee will implement those changes and no amendment to the HCP, this Agreement, the Permit or the ITL will be necessary. If the Service and/or DLNR determines after consultation with Permittee that more substantial modifications are necessary in order to remain in compliance with the ESA and Chapter 195D HRS, such modification may be made by minor modifications pursuant to Section 12.1 of this Agreement or by standard amendment pursuant to Section 12.2 of this Agreement.

8.0 ADAPTIVE MANAGEMENT

8.1 Adaptive management. Parties will implement the adaptive management provisions in Section 7.3 of the HCP when changes in management practices are necessary to remain in compliance with the ESA and Chapter 195D HRS, to achieve the HCP's biological goals and objectives or to respond to monitoring results or new scientific information as provided for in the HCP.

8.2 Service/DLNR-initiated adaptive management. If the Serviceand/or DLNR determine that one or more of the adaptive management provisions in the HCP have been triggered and that Permittee has not changed its management practices in accordance with Section 7.3 of the HCP, the Service and/or DLNR will so notify Permittee and will direct Permittee to make the required changes. Within 30 days after receiving such notice, Permittee will make the required changes and report to the Service and/or DLNR on its actions. Such changes are provided for in the HCP, and hence do not constitute Unforeseen Circumstances or require amendment of the Permit, the ITL or HCP, except as provided in this section.

8.3 No reduction in conservation benefit. Permittee will not implement adaptive management changes that may result in less mitigation than provided for Covered Species under the original terms of the HCP, unless the Service and/or DLNR first provide written approval. The amount of money spent on mitigation may be less than the estimated amounts included in Appendix 6 of the HCP, provided the mitigation is sufficient to provide a net conservation benefit to the species. Permittee may propose any such adaptive management changes by notice to the Service and/or DLNR, specifying the adaptive management modifications proposed, the basis for them, including supporting data, and the anticipated effects on Covered Species, and other environmental impacts. Within 120 days of receiving such notice, the Service and/or

DLNR will either approve the proposed adaptive management changes, approve them as modified by the Service and/or DLNR, or notify Permittee that the proposed changes constitute permit amendments that must be reviewed under Section 12.2 of this Agreement.

8.4 No increase in take. This section does not authorize any modifications that would result in an increase in the amount and nature of take, or increase the impacts of take, of Covered Species beyond that analyzed under the original HCP and any amendments thereto. Any such modification must be reviewed as a permit amendment under Section 12.2 of this Agreement.

9.0 FUNDING

Permittee warrants that it has, and will expend, such funds as may be necessary to fulfill its obligations under the HCP. Permittee will promptly notify the Service and/or DLNR of any material change in Permittee's financial ability to fulfill its obligations. In addition to providing any such notice, Permittee will provide the Service and DLNR with a copy of its annual report each year of the Permit and ITL, or with such other reasonably available financial information that the Parties agree will provide adequate evidence of Permittee's ability to fulfill its obligations.

10.0 EFFECTIVE DATE AND TERM

10.1 Effective date and term of the Agreement. This Agreement and the HCP will become effective on the date that the Service and DLNR issue the respective permits. This Agreement, the HCP, the Permit and ITL will remain in effect for a period of twenty (20) years from issuance of each original permit, except as provided below.

10.2 Permit suspension or revocation. The Service and DLNR may suspend or revoke the respective permits for cause in accordance with the laws and regulations in force at the time of such suspension or revocation, except that the Service and/or DLNR may revoke their respective permits based on a determination that the continuation of the permitted activity would be likely to jeopardize the continued existence of the Covered Species only if the Service and/or DLNR have not been successful in remedying the situation in a timely fashion through other means.

10.3 Relinquishment of the permits.

10.3.1 Generally. Permittee may relinquish the Permit and the ITL in accordance with the regulations of the Service and DLNR in force on the date of such relinquishment. Notwithstanding relinquishment of the permits, Permittee will be required to provide post-relinquishment mitigation for any take of Covered Species that the Service and/or DLNR determine will not have been fully mitigated under the HCP by the time of relinquishment. Permittee's obligations under the HCP and this Agreement will continue until the Service and/or DLNR notify Permittee that no post-relinquishment mitigation is required, or that all post-relinquishment mitigation required by the Service and/or DLNR is completed. Unless the Parties agree otherwise, the Service and/or DLNR may not require more mitigation than would have been provided if Permittee had carried out the full term of the HCP.

10.3.2 Procedure for relinquishment. If Permittee elects to relinquish the Permit or the ITL before expiration of the full term of the HCP, Permittee will provide notice to the Service and/or DLNR at least 120 days prior to the planned relinquishment. Such notice will include a status report detailing the nature and amount of take of all Covered Species, the mitigation provided for those species prior to relinquishment, and the status of Permittee's compliance with all other terms of the HCP. Within 120 days after receiving a notice and status report meeting the requirements of this paragraph, the Service and/or DLNR will give notice to Permittee stating whether any post-relinquishment mitigation is required and, if so, the amount and terms of the mitigation, and the basis for the Service and/or DLNR conclusions. If the Service and/or DLNR determine that no post-relinquishment mitigation is required, all obligations assumed by the Parties under this Agreement will terminate upon the Service and/or DLNR issuance of such notice. If Permittee disagrees with the Service and/or DLNR determination, the Parties may choose to use the dispute resolution procedures described in Section 13 of this Agreement. Permittee will continue to carry out its obligations under the HCP until any such dispute is resolved. If the Parties are unable to agree, the Service and/or DLNR will have the final authority to determine whether Permittee is required to provide post-relinquishment mitigation.

10.3.3 Extension of the Permits. Upon agreement of the Parties and compliance with all applicable laws, the Permit and ITL may be extended beyond their initial terms under regulations of the Service and DLNR in force on the date of such extension. If Permittee desires to extend the Permit and ITL, it will so notify the Service and DLNR at least 180 days before the then-current terms are scheduled to expire. Extension of the Permit and ITL constitutes extension of the HCP and this Agreement for the same amount of time, subject to any modifications that the Service and DLNR may require at the time of extension.

11.0 LAND TRANSACTIONS

11.1 Acquisition of land by Permittee. Nothing in the agreement, the HCP, the Permit or the ITL limits Permittee's right to acquire additional lands. Any lands that may be acquired will not be covered by the Permit and ITL except upon amendment of the Permit and ITL as provided in Section 12.2 of this Agreement.

11.2 Disposal of land by Permittee. The Permit and ITL may be transferred in accordance with regulations in force at the time of transfer. Permittee's transfer of ownership or control of Covered Land will require prior approval by the Service and DLNR and an amendment of the Permit and ITL in accordance with Section 12.2 of the Agreement, except that transfers of Covered Lands may be processed as minor modifications in accordance with Section 12.1 of this Agreement if:

(a) The land will be transferred to an agency of the federal government and, prior to transfer, the Service and DLNR have determined that transfer will not compromise the effectiveness of the HCP based on adequate commitments by that agency regarding management of such land;

(b) The land will be transferred to a non-federal entity that has entered into an agreement acceptable to the Service and DLNR (e.g. an easement held by the County of Maui with the Service and DLNR as third-party beneficiaries) to ensure that the lands will be managed in such a manner and for such duration so as not to compromise the effectiveness of the HCP;

(c) The land will be transferred to a non-federal entity that, prior to completion of the land transaction, has agreed to be bound by the HCP as it applies to the transferred land and has obtained an incidental take permit/incidental take license following normal permit procedures covering all species then covered by the Permittee's Permit and ITL; or

(d) The Service and DLNR determine that the amount of land to be transferred will not have a material impact on the ability of the Permittee to comply with the requirements of the HCP and the terms and conditions of the Permit and ITL.

12.0 MODIFICATIONS AND AMENDMENTS

12.1 Minor modifications.

(a) Minor modifications to the HCP shall not require amendment of the Agreement, the Permit or the ITL.

(b) Minor modifications are modifications to the HCP of a minor or technical nature where the effect on Covered Species and levels of incidental take are not significantly different than those described in the HCP as originally adopted. Minor modifications to the HCP which would not require amendment of the Permit or ITL may include modifications that are minor in relation to the HCP and to which the Service and DLNR agree. They include, but are not limited to, corrections of typographic, grammatical, and similar editing errors that do not change the intended meaning; correction of any maps or exhibits to correct errors in mapping or to reflect previously approved changes in the Permit, ITL or HCP; and minor changes to survey, monitoring or reporting protocols. Any other modifications to the HCP will be processed as amendments in accordance with Section 12.2.

(c) Any Party may propose minor modification of the HCP or this Agreement by providing notice to all other Parties. Such notice shall include a statement of the reason for the proposed modification and an analysis of its environmental effect, including its effects on operations under the HCP and on Covered Species.

(d) The Parties will use best efforts to respond to proposed modifications within 60 days of receipt of such notice. Proposed modifications will become effective upon all other Parties' written approval. If, for any reason, a receiving Party objects to a proposed modification, it must be processed as an amendment of the Permit and ITL in accordance with subsection 12.2 of this section. The Service and DLNR will not propose or approve minor modifications to the HCP or this Agreement if the Service or DLNR determine that such modifications would result in (i) operations under the HCP that are significantly different from those analyzed in connection with the original HCP, (ii) adverse effects on the environment that are new or significantly different from those analyzed in connection with the original HCP, or (iii) additional take not analyzed in connection with the original HCP.

12.2 Standard Amendment

(a) Standard amendments to the HCP shall mean any amendments not treated as minor modifications. Standard amendments to the HCP shall require an amendment to this Agreement, the Permit and the ITL.

(b) The Parties anticipate that amendment of the Permit and ITL will be treated as original permit applications, pursuant to applicable legal requirements under the ESA and Chapter 195D HRS and applicable regulations. Such applications typically require submittal of a revised Habitat Conservation Plan, a complete permit application form with appropriate fees, a revised implementation agreement, and may require environmental review documents prepared in accordance with federal and State law. However, the Parties acknowledge that specific documentation requirements may vary based on the nature of the amendment.

13.0 REMEDIES, ENFORCEMENT AND DISPUTE RESOLUTION

13.1 In general. Except as set forth below, each Party shall have all remedies otherwise available to enforce the terms of this Agreement, the Permit, the ITL and the HCP.

13.2 No monetary damages. No Party shall be liable in damages to any other Party or other person for any breach of this Agreement, any performance or failure to perform a mandatory or discretionary obligation imposed by this Agreement or any other cause of action arising from this Agreement.

13.3 Injunctive and temporary relief. The Parties acknowledge that the Covered Species are unique and that therefore injunctive and temporary relief may be appropriate to ensure compliance with the terms of this Agreement.

13.4 Enforcement authority of the United States. Nothing contained in this agreement is intended to limit the authority of the United States government to seek civil or criminal penalties or otherwise fulfill its enforcement responsibilities under the ESA or other applicable law.

13.5 Dispute resolution. The Parties recognize that disputes concerning implementation of, compliance with, or termination of this Agreement, the HCP, the Permit and the ITL may arise from time to time. The Parties agree to work together in good faith to resolve such disputes, using the informal dispute resolution procedures set forth in this section, or such other procedures upon which the Parties may later agree. However, if at any time any Party determines that circumstances so warrant, it may seek any available remedy without waiting to complete the informal dispute resolution.

13.5.1 Informal dispute resolution process. Unless the Parties agree upon another dispute resolution process, or unless an aggrieved Party has initiated administrative proceedings or suit in federal or State court as provided in this section, the Parties may use the following process to attempt to resolve disputes:

(a) The aggrieved Party will notify the other Parties of the provision that may have been violated, the basis for contending that a violation has occurred, and the remedies it proposes to correct the alleged violation.

(b) The Party alleged to be in violation will have 30 days, or such other time as may be agreed, to respond. During this time it may seek clarification of the information provided in the initial notice. The aggrieved Party will use its best efforts to provide any information then available to it that may be responsive to such inquiries.

(c) Within thirty (30) days after such response was provided or was due, representatives of the Parties having authority to resolve the dispute will meet and negotiate in good faith toward a solution satisfactory to all Parties, or will establish a specific process and timetable to seek such a solution.

(d) If any issues cannot be resolved through such negotiations, the Parties will consider non-binding mediation and other alternative dispute resolution processes and, if a dispute resolution process is agreed upon, will make good faith efforts to resolve all remaining issues through that process.

14.0 MISCELLANEOUS PROVISIONS

14.1 No partnership. Neither this agreement nor the HCP shall make or be deemed to make any Party to this Agreement the agent for or the partner of any other Party.

14.2 Notices. Any notice permitted or required by this Agreement shall be in writing, delivered personally to the persons listed below, or shall be deemed given five (5) days after deposit in the United States mail, certified and postage prepaid, return receipt requested and addressed as follows, or at such other address as any Party may from time to time specify to the other Parties in writing. Notices may be delivered by facsimile or other electronic means, provided that they are also delivered personally or by certified mail. Notices shall be transmitted so that they are received within the specified deadlines.

Assistant Regional Director
U.S. Fish and Wildlife Service
911 N.E. 11th Ave.
Portland, Oregon 97232-4181
Telephone: 503-231-6159
Telefax: 503-231-2019

Chairman of the Board
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809
Telephone: 808-587-0400
Telefax: 808-587-0390

Kaheawa Wind Power II, LLC
1043 Makawao Avenue, Suite 208
Makawao, Hawaii 96768

Telephone: 808-572-3011
Telefax: 808-572-8378

14.3 Entire agreement. This Agreement, together with the HCP, the Permit and the ITL, constitutes the entire agreement among the Parties. It supersedes any and all other agreements, either oral or in writing, among the Parties with respect to the subject matter hereof and contains all of the covenants and agreements among them with respect to said matters, and each Party acknowledges that no representation, inducement, promise or agreement, oral or otherwise, has been made by any other Party or anyone acting on behalf of any other Party that is not embodied herein.

14.4 Elected officials not to benefit. No member of or delegate to Congress and no member of the Hawaii State Legislature shall be entitled to any share or part of this Agreement, or to any benefit that may arise from it.

14.5 Availability of funds. Nothing in this Agreement will be construed by the Parties to require the obligation, appropriation, or expenditure of any money from the U.S. Treasury or the State of Hawai`i. The Parties acknowledge that the Service and DLNR will not be required under this Agreement to expend any federal or State agency's appropriated funds unless and until an authorized official of that agency affirmatively acts to commit to such expenditures as evidenced in writing.

14.6 Duplicate originals. This Agreement may be executed in any number of duplicate originals. A complete original of this Agreement shall be maintained in the official records of each of the Parties hereto.

14.7 No third-party beneficiaries. Without limiting the applicability of rights granted to the public pursuant to the ESA or other federal law, or Chapter 195D HRS or any other state law, this Agreement shall not create any right or interest in the public, or any member thereof, as a third party beneficiary hereof, nor shall it authorize anyone not a Party to this Agreement to maintain a suit for personal injuries or damages pursuant to the provisions of this Agreement. The duties, obligations and responsibilities of the Parties to this Agreement with respect to third parties shall remain as imposed under existing law.

14.8 Relationship to other authorities. The terms of this Agreement shall be governed by and construed in accordance with the ESA, Chapter 195D HRS, and applicable federal and State law. In particular, nothing in this Agreement is intended to limit the authority of the Service and/or DLNR to seek penalties or otherwise fulfill their respective responsibilities under the ESA and Chapter 195D HRS. Moreover, nothing in this Agreement is intended to limit or diminish the legal obligations and responsibilities of the Service and/or DLNR as agencies of the federal and State government, respectively.

14.9 References to regulations. Any reference in this Agreement, the HCP, the Permit or the ITL to any regulation or rule of the Service and/or DLNR shall be deemed to be a reference to such regulation or rule in existence at the time an action is taken.

14.10 Applicable laws. All activities undertaken pursuant to this Agreement, the HCP, the Permit or the ITL must be in compliance with all applicable federal and State laws and regulations.

14.11 Successors and assigns; Assignment. This Agreement and each of its covenants and conditions shall be binding on and shall inure to the benefit of the Parties and their respective successors and assigns. Assignment or other transfer of the Permit and/or ITL shall be governed by the Service and/or DLNR regulations in force at the time of assignment or transfer. Permittee shall be entitled to assign this Agreement to an affiliate of Permittee and shall be entitled to collaterally assign this Agreement to any financing party or lender providing financing to the Project.

IN WITNESS WHEREOF, THE PARTIES HERETO have executed this Implementing Agreement to be in effect as of the later date that the Service or DLNR issues its Permit or ITL.

BY ____ Date____________

Deputy Regional Director
United States Fish and Wildlife Service
Portland, Oregon

BY ____ Date_____________

Chairman of the Board
Department of Land and Natural Resources
State of Hawai`i

BY ____ Date_____________

Evelyn Lim, Secretary
Kaheawa Wind Power II, LLC

Appendix 21

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

ADDENDUM 6: HAWAIIAN PETREL – REVISON OF POPULATION MODELING FOR SOUTH RIM OF HALEAKALA

DRAFT

Prepared by

H. T. HARVEY & ASSOCIATES

Prepared for

Greg Spencer
First Wind, Environmental Affairs
Kaheawa Wind Power, LLC
56 Honuhula Street
Kihei, Hawaii 96753

23 September 2011 Project No. 2936-03

TABLE OF CONTENTS

List of Figures:

List of Tables:

BACKGROUND

This addendum is a revisit of Hawaiian Petrel Population Modeling, Addendum 3 (HTH and PRBO 2011a), which focuses on an alternative mitigation option for a potential population at a colony located at the South Rim of Haleakala Volcano. The revision is necessary owing to new figures for the baseline and high rate of take at KWPI and II. This potential mitigation would be in the form of predator control rather than predator exclusion, and therefore the "mitigation scenario" defined for this exercise assumes a low predation level, analogous to that being attained currently by the National Park Service on the West Rim, and includes reductions to survival of ages 4 years and greater and to reproductive success when compared to the no predation mitigation scenario modeled in HTH and PRBO (2011b).

This addendum was written to focus and revise results from the modeling in Addendum 3 (HTH and PRBO 2011a) in response to requests from the United States Fish and Wildlife Service (USFWS) for clarity on how the proposed mitigation would meet their defined take levels, as well as a revision in the estimated take. In this document, we focus on specific model input values and rationale for these values, both for the current conditions, "full predation scenario" (i.e., what was formerly known as "baseline scenario"), and for the conditions that will exist after mitigation, "mitigation scenario" (i.e., formerly known as "reasonable starting point" scenario). The full predation scenario considers what happens in the colony under a high level of predation, and the mitigation scenario considers what happens in the colony once the mitigation is implemented. The terminology has been changed to reduce confusion over concepts as used by USFWS. In this document, we use the term "baseline take" to refer to the lower of two take levels defined by USFWS; to avoid confusion with the term "baseline scenario", which in previous addenda referred to current conditions during modeling, we now use the term "full predation scenario" instead.

We modeled a full predation scenario to represent existing conditions, and a low predation mitigation scenario to represent the mitigation area with predator control. The full predation scenario used the same values for survival and fecundity and assumptions as used for the full predation scenario in HTH and PRBO (2011b) (Table 11). The low predation mitigation scenario assumes a survival rate for ages 4 years and greater of 0.90 based on Simons (1984), which corresponds to a mild level of predation. For reference, a survival rate of 0.80 was assumed for ages 4 years and greater for the full predation scenario and a survival rate of 0.93 was assumed for the mitigation scenario with predator exclusion at Makamaka'ole (HTH and PRBO 2011b). Breeding probability for the mitigation scenario was 0.62 for ages 6 years and older, and assumed to be half as much for ages 4 and 5 years. Although some age 4 and 5 year birds breed, we assumed that their reproductive capability is much reduced, both in terms of breeding probability and reproductive success. Reproductive success was assumed to be 0.63 for ages 6 years and older, based on Hodges (1994) and Simons (1985). We assumed a reproductive success of 0.44 for ages 4 and 5 years, based on a ratio calculated using optimal observed reproductive success of ages 4 and 5 years (0.50, for fluttering shearwater, Bell et al. 2005) and ages 6 years and older (0.72 for no predation, see HTH and PRBO 2011c).

Table 11. Parameter values used in population model, full predation scenario (current conditions) vs. low predation scenario (mitigation colony), for Hawaiian petrel at Haleakala, South Rim.

Parameter	Value: Full predation	Value: Low predation	Source
Survival			
Annual age 0 survival	0.66	Same	Calculated using ratio of age 0 to 2 survival rates, based on Ainley et al. 2001
Annual age 1 survival	0.79	Same	Calculated using ratio of age 1 to 2 survival rates, based on Ainley et al. 2001
Annual age 2 survival	0.90	Same	Back-calculated to result in a fledgling to age 6 survival rate of 0.2689 (from Simons 1984)
Annual age 3 survival	0.90	Same	Assumed to be same as age 2 year survival rate (see HTH and PRBO 2011b)
Annual adult (>=4) survival	0.80	0.90	Simons 1984, high level of predation; Simons 1984, low level of predation
Fecundity			
Breeding probability (4, 5)	0.26	0.31	Assumed to be half the breeding probability of ages >=6
Breeding probability (>=6)	0.51	0.62	Hodges and Nagata 2001, no predator control (high level of predation); Hodges and Nagata 2001
Reproductive success (4, 5)	0.27	0.44	Calculated based on ratio of estimate of 0.5 for ages 4, 5 from Bell et al. 2005 to the estimate of 0.72 based on the literature and the assumed reproductive rate of 0.39 for ages >=6; Bell et al. 2005
Reproductive success (>=6)	0.39	0.63	Simons 1985, high predation; Hodges 1994, Simons 1985
Sex ratio	1:1	Same	Nur and Sydeman 1999; Simons 1985
Average age at first breeding	6	Same	Simons 1984
Maximum breeding age	36	Same	Simons 1984

POPULATION PROJECTION

Population projection results for the mitigation and full predation scenarios, where demographic variables reflected different levels of predation, showed that the initial number of active burrows required to meet baseline take levels (i.e., 42 individuals, including 28 adults) varied considerably (Figure 15, Appendix G). Results for the mitigation scenario indicated that protecting 83 active burrows would produce a net recovery benefit with respect to baseline take (i.e., at least 1 individual above the baseline take level of 42 individuals, at least 28 of which are adults) (Table 12). It would take 13 years to reach the mitigation target. To reach the mitigation target in as few as 5 years would require protection of 113 active burrows (Appendix G). To meet the baseline take level for adults, it would take considerably fewer burrows, 67, and this would be achieved by year 13 (Table 12). For fledglings, it would require 138 burrows, with take being exceeded in year 9.

The mitigation scenario requires considerably more burrows to meet high take levels of 40 adults and 20 fledglings. A net recovery benefit could be achieved by protecting 118 active burrows by year 12 (Figure 15, Appendix G). To reach the net recovery benefit in 5 years would require protection of 160 active burrows (Appendix G). For adults, it would require 95 active burrows, with take exceeded in year 14, and for fledglings, it would require 197 burrows, with take exceeded in year 9 (Table 12).

Table 12. Primary results of population modeling for the mitigation scenario of Hawaiian petrel at Haleakala, South Rim, with respect to baseline and high take levels. Baseline take level was defined by USFWS to be 28 adults and 14 fledglings; high take level was defined to be 40 adults and 20 fledglings.

Life stage	Baseline take		High take	
	# burrows	# years	# burrows	# years
Adult	67	13	95	14
Fledgling	138	9	197	9
Net recovery benefit (>1 individual above adult+fledge take, with adult take exceeded)	83	13	118	12

By observing the relationship between the initial number of active burrows and the number of years required to meet mitigation targets (Figure 15), we found that increasing the number of burrows becomes less and less effective at reducing the number of years once reaching a certain point. Increasing the number of burrows does allow for a shorter time to reach mitigation targets, however achieving a net recovery benefit prior to year 6 is difficult, because the differences between the population trajectories for mitigaton and full predation scenarios are much smaller in earlier years. Although time is really the driver here, we can use this relationship to assess the number of burrows where we are likely to gain the most benefit. A net recovery benefit can be achieved by year 7 with 99 burrows, but to get to 6 years, it would require at least 109 burrows; in contrast, a gain of 2 years (year 13 to year 11) can be achieved by going from 83 to 84 burrows. The effect of increasing the number of burrows on reducing the time to achieve mitigation targets is much reduced beginning at about 86 burrows assuming a baseline take level or at about 122 burrows assuming a high take level. Increasing the number of burrows beyond these points has increasingly diminishing returns.

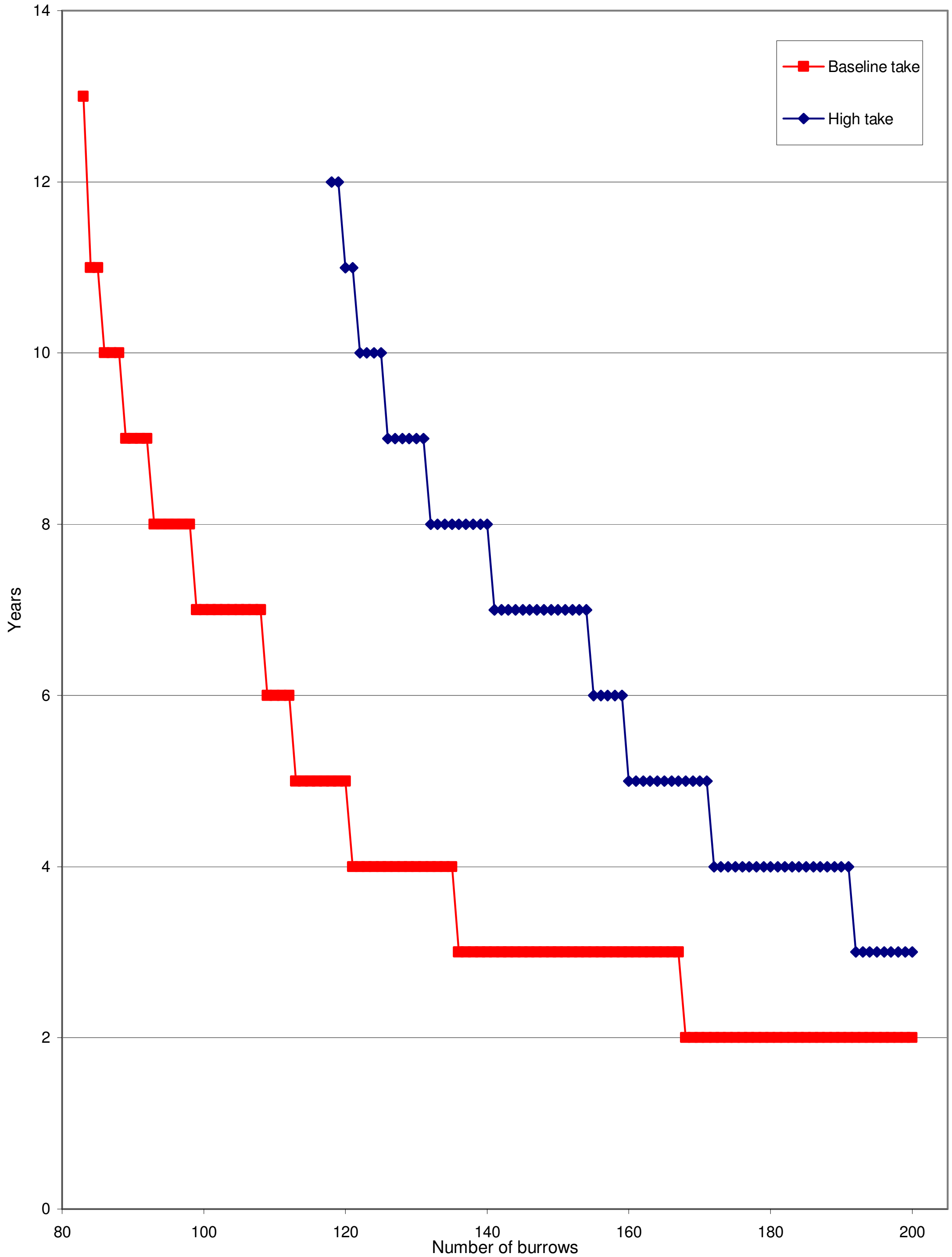


Figure 15. The number of years required to meet mitigation targets in relation to the initial number of active burrows of Hawaiian petrel for potential mitigation site, South Rim of Haleakala; baseline and high levels of take are as specified in the text.

REFERENCES

Ainley DG, R Podolsky, L Deforest, G Spencer, N Nur. 2001. The status and population trends of the Newell's Shearwater on Kaua'i: Insights from modeling. Studies in Avian Biology 22:108-123.

Bell M, BD Bell, EA Bell. 2005. Translocation of fluttering shearwater (*Puffinus gavia*) chicks to create a new colony. Notornis 52:11-15.

Hodges, CSN. 1994. Effects of introduced predators on the survival and fledgling success of the endangered Hawaiian dark-rumped petrel, *Pterodroma phaeopygia sandwichensis*. Forest Resources. Seattle, WA, University of Washington**:** 49.

Hodges CSN, RJ Nagata, Sr. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. Studies in Avian Biology 22:308-318.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011a. Addendum 3: Hawaiian petrel population modeling (Updated) – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011b. Addendum 5: Hawaiian petrel population modeling – growth of mitigation colony at Makamaka'ole, West Maui – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011c. Hawaiian petrel population modeling (Updated) – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

Nur N, WJ Sydeman. 1999. Demographic processes and population dynamic models of seabirds: Implications for conservation and restoration. Current Ornithology 15:149-188.

Simons TR. 1984. A population model of the endangered Hawaiian dark-rumped petrel. Journal of Wildlife Management 48(4):1065-1076.

Simons TR. 1985. Biology and behavior of the endangered Hawaiian dark-rumped Petrel. Condor 87:229-245.

APPENDIX G.
POPULATION MODELING RESULTS OF HAWAIIAN PETREL AT A POTENTIAL MITIGATION SITE, SOUTH RIM OF HALEAKALA

# Burrows	Baseline take	High take
83	13	NA
84	11	NA
85	11	NA
86	10	NA
87	10	NA
88	10	NA
89	9	NA
90	9	NA
91	9	NA
92	9	NA
93	8	NA
94	8	NA
95	8	NA
96	8	NA
97	8	NA
98	8	NA
99	7	NA
100	7	NA
101	7	NA
102	7	NA
103	7	NA
104	7	NA
105	7	NA
106	7	NA
107	7	NA
108	7	NA
109	6	NA
110	6	NA
111	6	NA
112	6	NA
113	5	NA
114	5	NA
115	5	NA
116	5	NA
117	5	NA
118	5	12
119	5	12
120	5	11
121	4	11
122	4	10
123	4	10
124	4	10
125	4	10
126	4	9
127	4	9
128	4	9
129	4	9

# Burrows	Baseline take	High take
130	4	9
131	4	9
132	4	8
133	4	8
134	4	8
135	4	8
136	3	8
137	3	8
138	3	8
139	3	8
140	3	8
141	3	7
142	3	7
143	3	7
144	3	7
145	3	7
146	3	7
147	3	7
148	3	7
149	3	7
150	3	7
151	3	7
152	3	7
153	3	7
154	3	7
155	3	6
156	3	6
157	3	6
158	3	6
159	3	6
160	3	5
161	3	5
162	3	5
163	3	5
164	3	5
165	3	5
166	3	5
167	3	5
168	2	5
169	2	5
170	2	5
171	2	5
172	2	4
173	2	4
174	2	4
175	2	4
176	2	4

# Burrows	Baseline take	High take
177	2	4
178	2	4
179	2	4
180	2	4
181	2	4
182	2	4
183	2	4
184	2	4
185	2	4
186	2	4
187	2	4
188	2	4
189	2	4
190	2	4
191	2	4
192	2	3
193	2	3
194	2	3
195	2	3
196	2	3
197	2	3
198	2	3
199	2	3
200	2	3

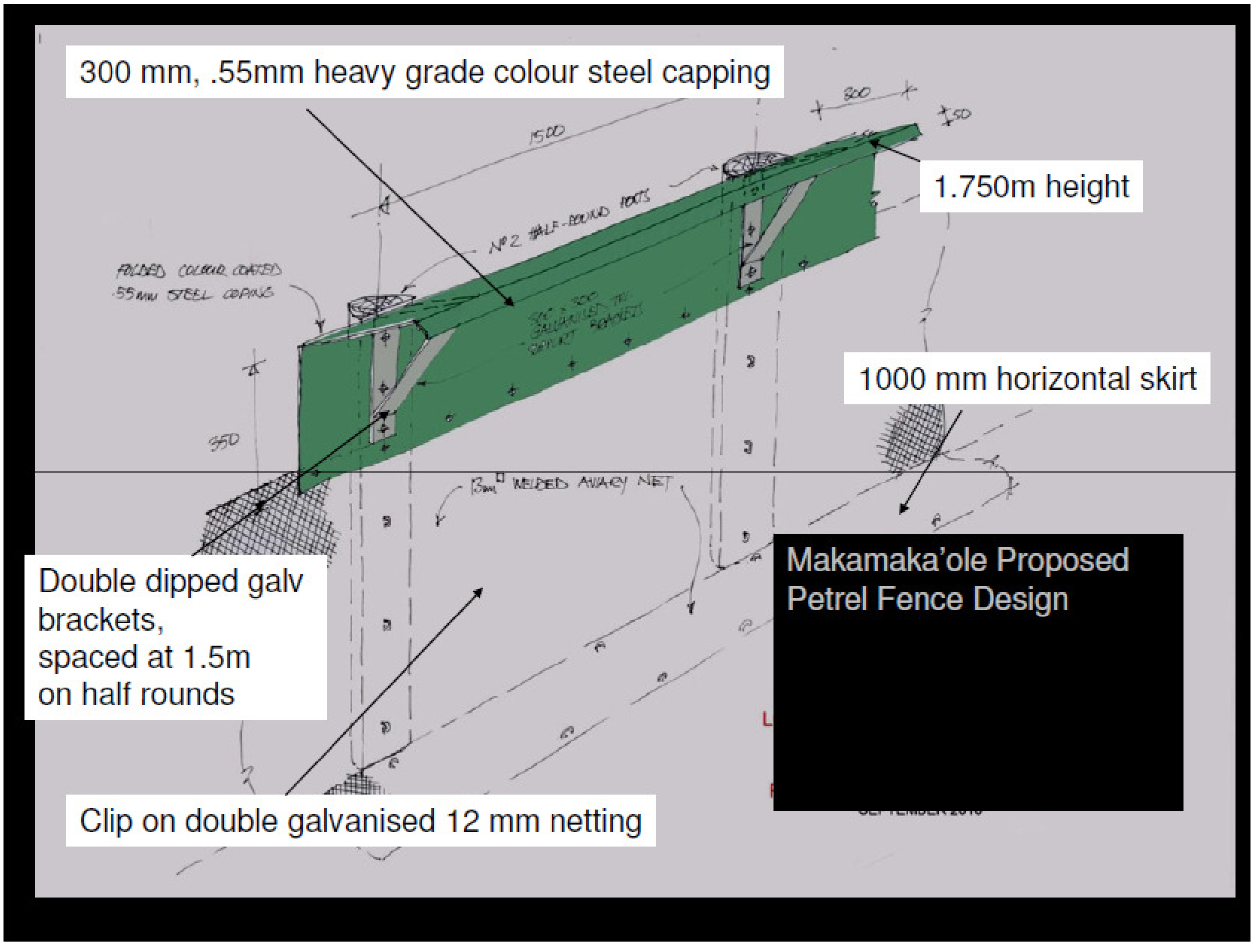
Appendix 22

Makamakaole draft mitigation design and timeline.

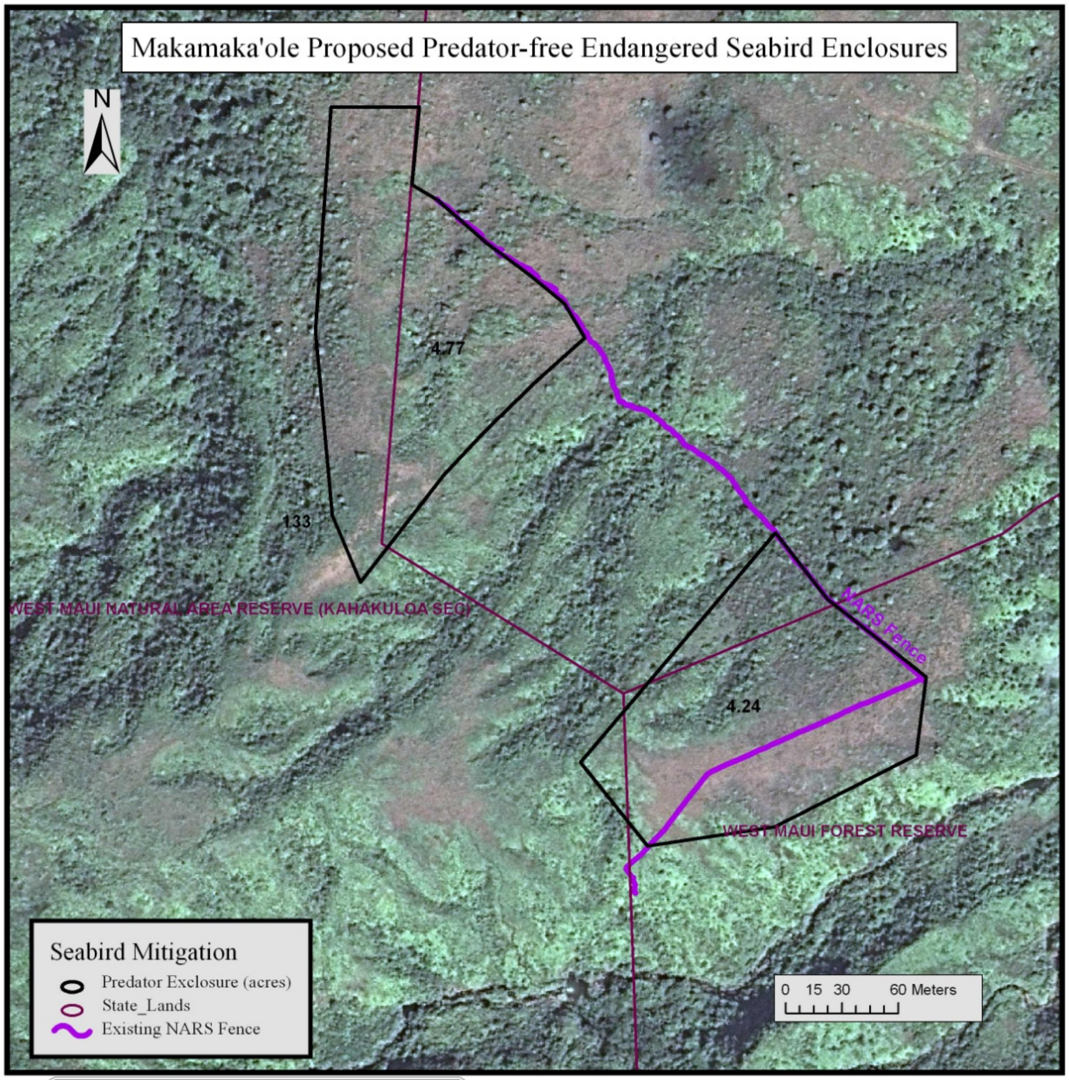
Draft Timeline

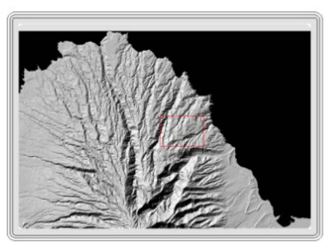
1. Delineate enclosure fence lines- Botanical and cultural surveys will be conducted to avoid sensitive resources along the fenceline and identify sensitive resources within the enclosure. The fence line will follow the terrain and be located below the tops of the ridges to maximize predator exclusion and minimize collision hazard for petrels – **November 2011**
2. Area around fenceline to be cleared with scrub bars- **December 2011**
3. Construction of fence lines with an estimated 4 weeks construction period, with a crew of 3, with a Team Leader from New Zealand. Fence equipment will be deployed by helicopter to both sites. Energiser & electric hotwires will be used to construct a pig fence 4 m from the enclosure-**mid January to mid February 2012**
4. Obtain high quality digital recording of Hawaiian petrel & Newell's shearwater vocalizations at Makamakaole. If not possible, vocalizations from Haleakala or alternate sites will be used **– by31st March 2012**
5. Ordering of digital acoustic units and speakers (already ordered) – **November 2011**.
6. Vertebrate Pest Eradication Program undertaken within both enclosures immediately after fences are completed, including Diphacinone bait boxes deployed in a 25 x 25 m grid (to control mouse populations inside enclosure), kill traps & bait for rats, conibear traps for feral cats & mongoose - **mid February 2012**
7. Control program commences outside both enclosures, using kill traps & bait for rats, conibear traps for feral cats & mongoose (conibears in plywood boxes). A Buffer zone trapping regime will be established within 1 kilometer radius of each enclosure. Trapping in the buffer zone will mainly be on the ridgelines where cat and mongoose scat have been detected (no cat or mongoose sign have been detected in the valleys and along streams) - **mid Feb-mid March 2012**
8. Acoustic system installed and activated once tracking tunnels, gnaw sticks and traps indicate no vertebrate pest species are present at all within enclosures (except for mice, see below) – **20th March 2012**
9. Tracking tunnel, gnaw stick monitoring presence/absence monitoring undertaken permanentlyfor first 12 months. Target mice only within enclosure at <2% -**15th March 2012-15th March 2013**
10. Quarterly rodent monitoring undertaken within and outside enclosure from Yr 2 on.
11. Radio collar tracking study of mongoose outside enclosure by trapping and tagging within the buffer zone to determine local home ranges – to be funded by First Wind.

Draft proposed fence design



Draft proposed location of enclosures





The actual shape of the enclosures will be determined by landscape features and in consultation with the Natural Area Reserve System. This map serves to illustrate their approximate location.

Appendix 23

AN EXAMINATION OF CURRENT INFORMATION REGARDING THE PROPORTIONS OF HAWAIIAN PETRELS VS. NEWELL'S SHEARWATERS FLYING OVER THE KWP WIND FACILITY ON MAUI

Prepared for

FIRST WIND
129 Middle Street
Portland, ME 04101

Prepared by

Brian A. Cooper and Peter M. Sanzenbacher
ABR, Inc.—Environmental Research & Services
P.O. Box 249
Forest Grove, OR 97116-0249

and

Robert H. Day
ABR, Inc.—Environmental Research & Services
P.O. Box 80410
Fairbanks, AK 99708-0410

31 May 2011

BACKGROUND

The KWP wind facility is located on West Maui, south of the West Maui Mountains (Figure 1). All seabird-fatality modeling efforts to date at the KWP site have assumed that the shearwater/petrel targets observed during radar studies are composed of 60% Hawaiian Petrels (HAPE) and 40% Newell's Shearwaters (NESH; Day and Cooper 1999; Cooper and Day 2004a, b; Sanzenbacher and Cooper 2008, 2009; Cooper and Day 2009; Cooper et al. 2010). The basis for that 60/40 split was the timing of inland flights at the nearby Ukumehame site (located on the shoreline ~5 km west of KWP; Cooper and Day 2003) that suggested that 60% of the targets

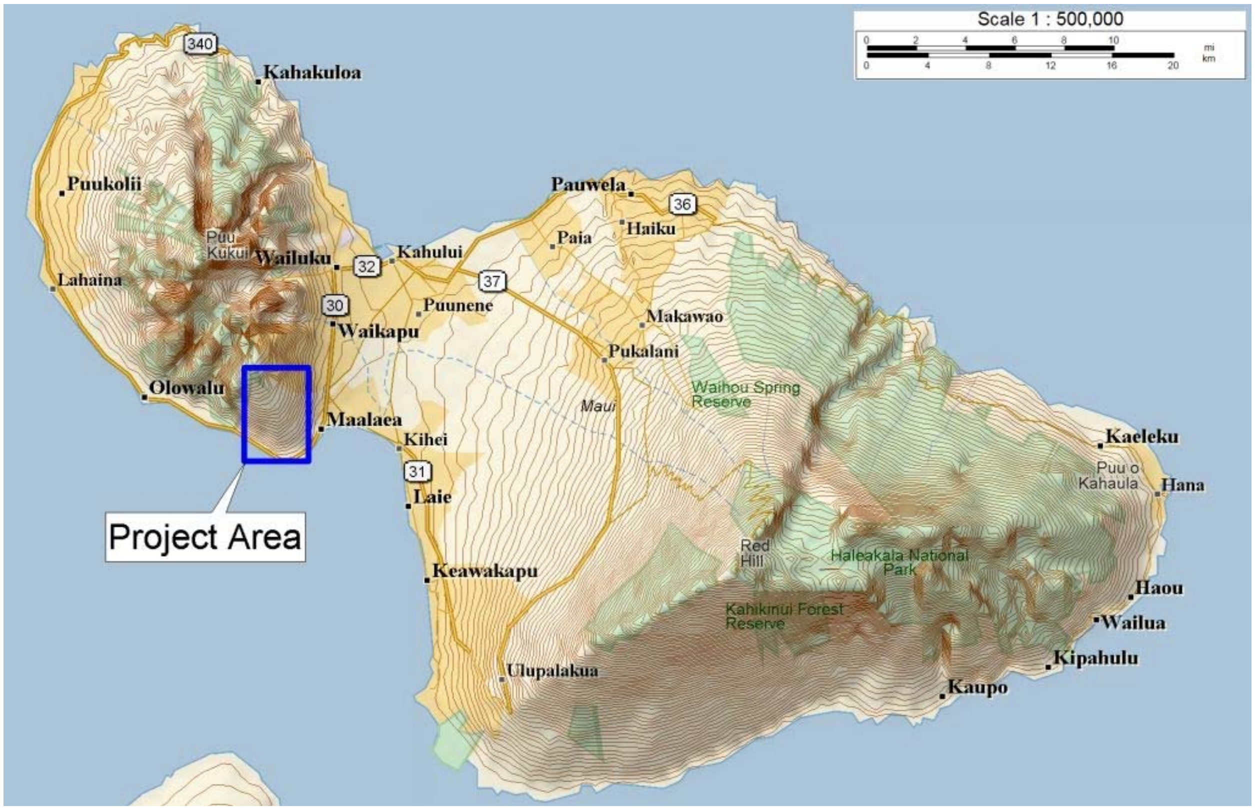


Figure 1. Map of the KWP project area and Maui Island.

were Hawaiian Petrels and 40% of the targets were Newell’s Shearwaters. Specifically, the Cooper and Day (2003) conclusion was based upon extensive visual data collected on Kauai (Day and Cooper 1995, Day et al. 2003; Day and Cooper, unpubl. data) indicating that HAPE inland movements on Kauai are essentially finished by 60 min past sunset, but that NESH inland flights begin at 30 min past sunset, overlapping with HAPE until 60 min past sunset, after which essentially all incoming birds are NESH. New information has come to light suggesting that a substantial proportion of HAPE at the KWP site also fly inland >60 min past sunset, suggesting that the composition of seabirds at the site may include more than 60% HAPE (i.e., <40% Newell’s Shearwaters). The purpose of this memo is to review pertinent information to determine if the 60/40 proportion for Hawaiian Petrel/Newell’s Shearwater should be modified and, if appropriate, to recommend a new proportion to be used for current and future fatality-modeling exercises.

SPECIES OBSERVED AT KWP TO DATE

Information on the species identified at the KWP site is limited but suggests that the proportion of HAPE/NESH is 100% HAPE and 0% NESH. For instance, all three of the seabirds identified to species during radar/visual studies at the site were HAPE (Table 1). Further, 1 HAPE and 0 NESH have been found during fatality surveys at KWP over the past ~5 years (G. Spencer, First Wind, pers. comm.). Lastly, one additional HAPE was found in 2006 on the inland side of transmission lines at the southern end of the KWP access road, near the Honoapi'ilani perimeter road (G. Spencer, First Wind, pers. comm.). Thus, the combined available species-specific records at or near the project area includes 5 HAPE and 0 NESH.

DISTRIBUTION AND ABUNDANCE OF HAPE AND NESH COLONIES ON MAUI

On Maui, HAPE are known to nest on Haleakala Crater (Brandt et al. 1995, Simons and Hodges 1998) and are believed to nest in West Maui (Cooper and Day 2003). For example, on 16 June 1999, a HAPE was heard calling from a bed of uluhe ferns (*Dicranopteris linearis*) at 3,300 ft (~1,000 m) elevation in the Kapunakea Preserve, which lies on the northwestern slope of the West Maui Natural Area Reserve (A. Lyons, *fide* C. Bailey) in the West Maui Mountains. In addition, recent observations of consistent calling from a single location suggests that there is at

Table 1. Records of all visual observations of Hawaiian Petrels, Newell's Shearwaters, and unidentified shearwaters/petrels at the proposed KWP II wind energy site and nearby KWP I wind energy site, Maui, Hawaii, during 1999–2009 radar studies.

Date	Time	Species[a]	Number	Altitude (m agl)	Flight direction
28 May 1999	2150[b]	HAPE	1	300[c]	NE
28 May 1999	0608	UNSP	2	500[c]	SE
12 October 2004	0608	HAPE	1	500[c]	SE
15 October 2004	0454	UNSP	1	65	SW
24 July 2009	2126[b]	HAPE	1	40	E

[a] HAPE = Hawaiian Petrel; UNSP = unidentified shearwater/petrel.
[b] Observation occurred in the evening, >60 min past sunset.
[c] Flight altitudes measured over the valley to east of the proposed turbine string ridge, not over the proposed turbine string ridge itself; measurements were done that way because that is where birds were first seen.

least one other small colony of HAPE in the West Maui Mountains ~12 km north of the KWP project area (G. Spencer, pers. comm.). The Maui population of HAPE is estimated to be at least ~1,800 birds (Simons 1984, 1985; Hodges 1994). In contrast to HAPE, NESH are rare on Maui (Ainley et al. 1997). The only suspected colonies of NESH are located on West Maui, where recent auditory observations suggest that a small colony occurs in the West Maui Mountains ~12 km north of the KWP project area in the upper reaches of the Kahakuloa drainage (G. Spencer, pers. comm.). This discovery of a colony matched a prediction of their occurrence there by Cooper and Day (2003), based on timing of movements on radar. Thus, there is an unknown, but low, number of NESH (<100 birds?) that are likely to occur on Maui and a known number of at least ~1,800 HAPE on Maui, suggesting that the proportion of HAPE to NESH island-wide is greater than 60%, and perhaps greater than 95% (i.e., ~1,800 HAPE and ~100 NESH would equate to 95% HAPE).

FALLOUT RECORDS OF HAPE AND NESH ON MAUI

Available fallout records of downed seabirds from the Hawaii Department of Fish and Wildlife (DOFAW) indicate that a total of 35 HAPE and 13 NESH have been found on Maui to date, with most of the birds being found in the valley between eastern and western Maui or on the western shore of Maui. (G. Spencer, pers. comm.). Thus, the proportion of HAPE/NESH fallout victims to date is 73% HAPE/27% NESH for the Island of Maui. An unknown proportion of these fallout victims may have been drawn in from the ocean and, hence, may not have been associated with colonies on Maui, so this proportion may not be indicative of the actual relative proportions of HAPE/NESH on Maui.

TIMING OF EVENING FLIGHTS

The basis for the 60/40 split for HAPE/NESH at KWP was the Cooper and Day (2003) data on the timing of inland flights at the nearby Ukumehame site. Their conclusions were based on the Kauai data that indicates HAPE inland movements are essentially finished by 60 min past sunset, but NESH inland flights begin at 30 min past sunset, overlapping with HAPE until 60 min past sunset, after which essentially all incoming birds on Kauai are NESH (Day and Cooper 1995, Day et al. 2003; Day and Cooper, unpubl. data). It was clear that some HAPE moved after complete darkness, but that number was swamped by the enormous numbers of NESH flying inland. Our visual observations of the two HAPE observed during evening hours at KWP suggest that a similar pattern of timing does not occur at KWP: both birds flew over KWP after 2100 h (Table 1), well into the period when essentially only NESH occur on Kauai. This later movement period for the two HAPE observed at KWP did, however, match well with what has been observed recently on Lanai, where HAPE exhibit substantial inland movements >60 min past sunset (Cooper et al. 2007 *in* TetraTech EC 2008). Hence, it is possible that the timing of movements may vary among islands for reasons that are poorly understood at this time.

We compared the percent of evening radar targets observed during each sampling session in Kauai during the summers of 1993, 1999, 2000, and 2011 combined (Day et al. 2003) with the percentages observed during spring and summer of 2007 at Lanai (where only HAPE and essentially no NESH are thought to occur; Cooper et al. 2007 *in* TetraTech EC 2008) and at the KWP wind energy site during the summers of 1999, 2008, and 2009 combined (Figure 2). Clearly, there is a marked difference in the timing pattern of evening flights between Kauai and the other two areas, with Lanai and KWP being very similar. Specifically, we observed a much greater proportion of targets after 2030 at KWP and Lanai than on Kauai. This difference alone suggests that the timing criteria used on Kauai to differentiate HAPE from NESH radar targets may not be appropriate to apply to KWP data (or Lanai data).

In summary, the available information suggests that the use of the proportion of radar targets observed beyond 60 min past sunset to calculate the proportion of NESH probably is not an accurate approach to determining that proportion at KWP. Further, because we have visual observations of HAPE after 2100 and because the pattern of movements at KWP matches up so well with that on Lanai (where only HAPE are believed to occur), those data also suggest that far more than 60% of the radar targets we observed at KWP could have been Hawaiian Petrels.

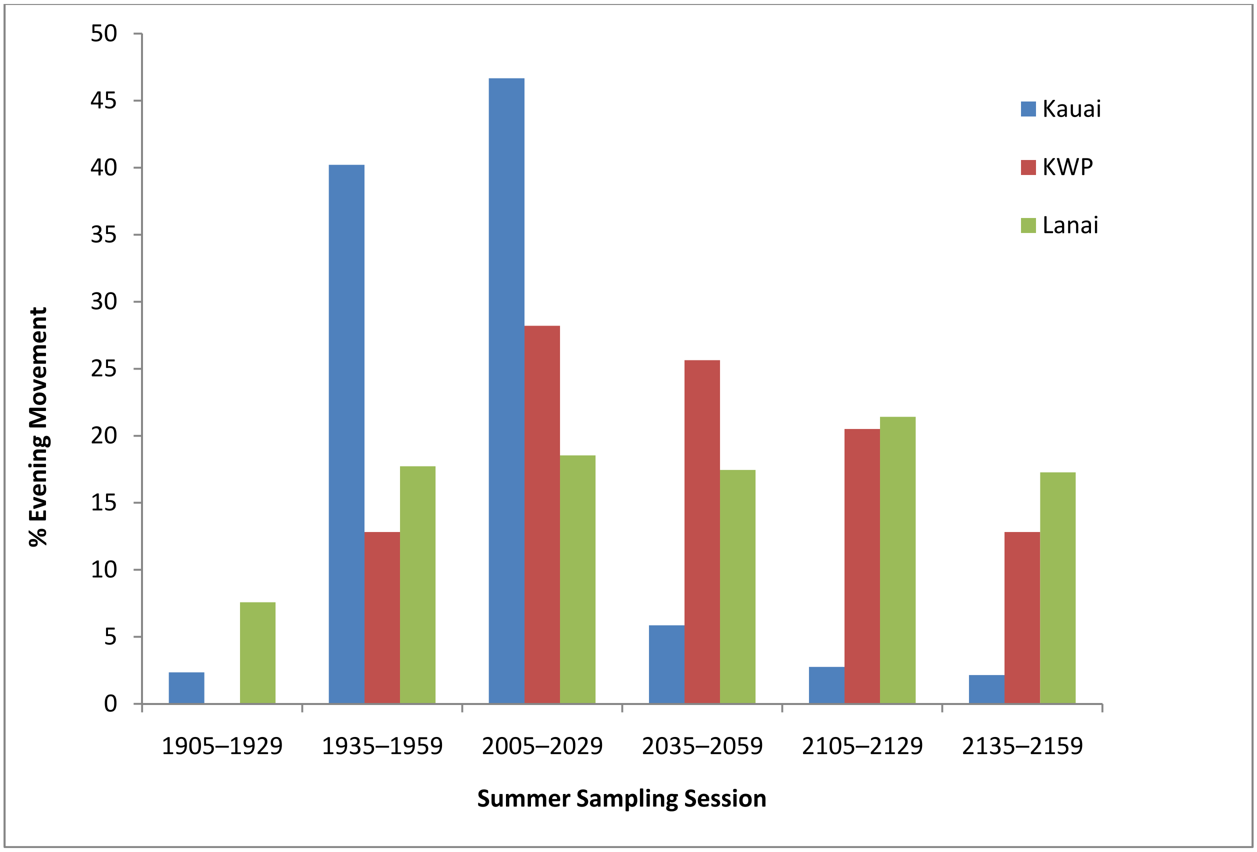


Figure 2. Percent of evening radar targets observed during each sampling session in Kauai during the summers of 1993, 1999, 2000, and 2011 combined (Day et al. 2003), at the KWP wind energy site, Maui, during the summers of 1999, 2008, and 2009 (Day and Cooper 1999; Sanzenbacher and Cooper 2008, 2009; Cooper and Day 2009), and in Lanai during spring/summer 2007 (Cooper et al. 2007 *in* TetraTech EC 2008b). The first session started near sunset, the second session included some evening twilight, and the last four sessions occurred after it became completely dark. Day et al. (2003) found that, on Kauai, only HAPE were flying during the first session, that both HAPE and NESH were flying during the second session, and that essentially only NESH were flying in the final four sessions.

IMPLICATIONS OF FLIGHT-DIRECTION DATA

There have been three visual observations of HAPE and two observations of unidentified shearwaters/petrels over the KWP study areas during 1999–2009 (Table 1; Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009). The two birds observed in the evening period were flying east or northeast, and the three birds observed in the morning were flying southeast or southwest. These flight directions fit a pattern of inbound movements toward Haleakala (i.e., movement across the southern part of the island by late-arriving birds heading to the colonies on Haleakala) in the evening and outbound movements from colonies on both Haleakala and West Maui in the morning.

In general, the radar data collected at KWP during 1999–2009 exhibited the same pattern in flight directions as the visual data from KWP. Over 80% of all radar targets at KWP were heading east, southeast, south, or southwest and only 2% were heading north (i.e., toward the direction of the suspected NESH colony in the West Maui mountains; Table 2). There are no known colonies of NESH on Maui to the northeast, east, or southeast of KWP, and it is likely that there are both NESH and HAPE colonies in the West Maui Mountains to the north of KWP. If one assumed that (1) half of the birds flying toward or away from the West Maui Mountains (i.e., flying north or south) were HAPE and half were NESH and (2) all birds headed toward or away from East Maui (i.e., flying northeast, east, southeast, southwest, west, or northwest) were HAPE, then ~89% of the radar targets observed during 1999–2009 would have been HAPE and ~11% would have been NESH.

In addition to observations at KWP, there are recent visual and radar data available from the suspected NESH colony in the upper Kahakuloa drainage on the northern side of the West Maui Mountains, north of KWP (G. Spencer, pers. comm.). Those data, along with radar data collected along the northern coast of West Maui (Cooper and Day 2003) suggest that most HAPE and NESH in northern West Maui access their colonies along valleys from the northern, rather than southern, coast of Maui. Thus, those data suggest that NESH on their way to the suspected Kahakuloa colony probably do not pass over KWP.

Table 2. Flight directions of all petrel/shearwater-like seabird radar targets observed at the proposed KWP II wind energy site and nearby KWP I wind energy site, Maui, Hawaii, during 1999–2009 radar studies during evening (Even) sampling hours, morning (Morn) sampling hours, and all sampling hours combined (Total).

Flight direction		Number and percent of targets					
Direction	Degree	Eve	Eve %	Morn	Morn %	Total	Total %
N	338–022	4	3.8	0	0.0	4	2.4
NE	023–067	10	9.5	4	6.5	14	8.4
E	068–112	20	19.0	14	22.6	34	20.4
SE	113–157	12	11.4	11	17.7	23	13.8
S	158–202	17	16.2	17	27.4	34	20.4
SW	203–247	34	32.4	11	17.7	45	26.9
W	248–292	4	3.8	5	8.1	9	5.4
NW	293–337	4	3.8	0	0.0	4	2.4
Total		105		62		167	

CONCLUSIONS

We made a thorough examination of currently available information, and the overall weight-of-evidence suggests that the method devised on Kauai that uses time of day to separate HAPE from NESH radar targets is not valid for the KWP site and, further, that the proportion of HAPE at KWP is likely to be much higher than 60%. Determining the exact proportion of HAPE at KWP is difficult without further visual observations at the site; however, while it is impossible to state with certainty that no NESH fly over KWP, we think that it is justified to raise the estimated proportion of HAPE at KWP from 60% to ~90% based upon the following information: (1) The observed proportion of HAPE/NESH at KWP to date is 100%/0% (n = 5 birds); (2) The literature suggests that at least ~1,800 HAPE occur on Maui, but there are only scattered reports of low numbers of NESH on Maui. Thus, there is an unknown, but very low, number of NESH (<100 birds?) that might occur on Maui and a known number of ~1,800 HAPE on Maui, suggesting that the proportion of HAPE to NESH island-wide may be greater than 95% (i.e., ~1,800 HAPE and ~100 NESH); (3) The ratio of HAPE/NESH in the available seabird fallout data for Maui is 73% HAPE/27% NESH; (4) The timing of movements of radar targets observed at KWP matches fairly closely with the timing of radar targets observed at Lanai (where essentially only HAPE occur), indicating that the proportion of HAPE also could be very high at KWP; and (5) If one assumed that half of the birds flying toward or away from the West Maui Mountains were HAPE and half were NESH (based upon observations of low numbers of both species in that area) and that all birds headed toward or away from East Maui were HAPE (based upon the known occurrence of HAPE but not NESH on East Maui), then ~89% of the radar targets we observed during 1999–2009 would have been HAPE and ~11% would have been NESH. Thus, taking the average of the percentages of HAPE listed in points #1, 2, 3, and 5 (i.e., 100%, 95%, 73%, and 89%), we get an average proportion of ~90% HAPE/10% NESH. Again, the exact proportion of HAPE at KWP remains unknown, but, based upon a thorough review of the available evidence, we believe that it would be more appropriate for future modeling exercises to operate under the assumption that the proportion of HAPE is much higher than 60% and suggest that using a 90% assumption (i.e., a 90%/10% HAPE/NESH ratio) would improve the accuracy of fatality-modeling calculations at KWP.

LITERATURE CITED

Ainley, D. G., T. C. Telfer, and M. H. Reynolds. 1997. Townsend's and Newell's Shearwater (Puffinus auricularis). *In* A. Poole and F. Gill, eds. The birds of North America, No. 297. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC. 20 pp.

Brandt, C. A., J. K. Parrish, and C. N. Hodges. 1995. Predictive approaches to habitat quantification: Dark-rumped Petrels on Haleakala, Maui. Auk 112: 571–579.

Cooper, B. A., and R. H. Day. 1995. Kauai Endangered Seabird Study, Vol. 1: Interactions of Dark-rumped Petrels and Newell's Shearwaters with utility structures on Kauai, Hawaii. Electric Power Research Institute, Palo Alto, CA. Final Report No. TR-105847-V1. 170 pp.

Cooper, B. A., and R. H. Day. 1998. Summer behavior and mortality of Dark-rumped Petrels and Newell's Shearwaters at power lines on Kauai. Colonial Waterbirds 21: 11–19.

Cooper, B. A., and R. H. Day. 2003. Movement of Hawaiian Petrels to inland breeding sites on Maui Island, Hawaii. Waterbirds 26: 62–71.

Cooper, B. A., and R. H. Day. 2004a. Results of endangered bird and bat surveys at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004. Unpublished report prepared for Kaheawa Windpower LLC, Makawao, HI, and UPC Wind Management LLC, Newton, MA, by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 16 pp.

Cooper, B. A., and R. H. Day. 2004b. Modeling annual seabird use and fatality at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004. Unpublished report prepared for Kaheawa Windpower LLC, Makawao, HI, and UPC Wind Management LLC, Newton, MA, by ABR, Inc., Forest Grove, OR, and Fairbanks, AK. 7 pp.

Cooper, B. A., and R. H. Day. 2009. Radar and visual studies of seabirds at the proposed KWP II Down-road Alternative wind energy facility, Maui Island, Hawaii, summer 2009. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 25 pp.

Cooper, B. A., R. H. Day, and J. H. Plissner. 2007. Radar and audio-visual studies of Hawaiian Petrels near proposed meteorological towers and wind turbines on northwestern Lanai Island, May-July 2007. Unpublished report prepared for KC Environmental, Inc., Makawao, HI, and TetraTech EC, Portland, OR, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR, and Fairbanks, AK. 44 pp.

Cooper, B. A., R. H. Day, and P. M. Sanzenbacher. 2010. Radar and visual studies of seabirds at the proposed KWP II Down-road Alternative wind energy facility, Maui Island, Hawaii, fall 2009. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 26 pp.

Day, R. H., and B. A. Cooper. 1995. Patterns of movement of Dark-rumped Petrels and Newell's Shearwaters on Kauai. Condor 97: 1011–1027.

Day, R. H., and B. A. Cooper. 1999. Results of endangered bird and bat surveys at the proposed Kaheawa Pastures Windfarm on Maui Island, Hawaii, summer 1999. Unpublished report prepared for Zond Pacific, Wailuku, HI, by ABR, Inc., Fairbanks, AK, and Forest Grove, OR. 26 pp.

Day, R. H., B. A. Cooper, and T. C. Telfer. 2003. Decline of Newell's Shearwaters on Kauai, Hawaii. Auk 120: 669–679.

First Wind. 2008. Kaheawa Pastures wind energy generation facility Habitat Conservation Plan: Year 2 HCP Implementation, July, 2007–June, 2008. Unpublished report prepared by First Wind, Newton, MA and Kaheawa Wind Power, Wailuku, HI. 26 pp. + appendices.

Hodges, C. S. N. 1992. ‘Ua’u observation at proposed site for antenna farm. Unpublished memorandum by Haleakala National Park, Makawao, HI. 2 pp.

Kaheawa Wind Power LLC. 2006. Kaheawa Pastures Wind Generation Facility, Habitat Conservation Plan. Kaheawa Wind Power, LLC, Ukumehame, Maui, HI. 87 pp. + attachments.

Kaheawa Wind Power, LLC. 2009. Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 3 Annual Report. FirstWind Energy, LLC, Environmental Affairs, Newton, MA.

Sanzenbacher, P. M., and B. A. Cooper. 2008. Radar and visual studies of seabirds at the KWP I and KWP II wind energy facilities, Maui Island, Hawaii: use of 2008 data to model annual collision fatalities at meteorological towers. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 21 pp.

Sanzenbacher, P. M., and B. A. Cooper. 2009. Radar and visual studies of seabirds at the KWP II wind energy facility, Maui Island, Hawaii: use of 2008 data to model annual collision fatalities at proposed wind turbines. Unpublished report prepared for FirstWind, Newton, MA, by ABR, Inc.—Environmental Research & Services, Forest Grove, OR. 20 pp.

Simons, T. R. 1984. A population model of the endangered Hawaiian Dark-rumped Petrel. Journal of Wildlife Management 48: 1065–1076.

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

Simons, T. R., and C. N. Hodges. 1998. Dark-rumped Petrel (Pterodroma phaeopygia). *In* A. Poole and F. Gill, eds. The birds of North America, No. 345. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC. 24 pp.

Telfer, T. C., J. L. Sincock, G. V. Byrd, and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin 15:406–413.

TetraTech EC. 2008. Draft Habitat Conservation Plan for the construction and operation of Lanai met towers, Lanai, Hawaii (Revised February 8, 2008, TTEC-PTLD-2008-080). Unpublished report prepared by Tetratech EC, Honolulu, HI, for Castle and Cooke LLC, Lanai City, HI. 52 pp. + appendices. <http://www.state.hi.us/dlnr/dofaw/pubs/Lana'i_Met_Towers_HCP.pdf>

Appendix 24

ADDENDUM 5: HAWAIIAN PETREL POPULATION MODELING – GROWTH OF MITIGATION COLONY AT MAKAMAKA'OLE, WEST MAUI

DRAFT

Prepared by

H. T. HARVEY & ASSOCIATES

Prepared for

Greg Spencer
First Wind, Environmental Affairs
Kaheawa Wind Power, LLC
56 Honuhula Street
Kihei, Hawaii 96753

21 September 2011 Project No. 2936-03

TABLE OF CONTENTS

List of Figures:

List of Tables:

BACKGROUND

To date, there have been several documents detailing the population modeling for Hawaiian petrel on Maui with respect to estimating results of take at KWPI and II (HTH and PRBO 2011a, b, c, d, e). This addendum was written to focus and revise results from the modeling in Addendum 4 in response to requests from the United States Fish and Wildlife Service (USFWS) for clarity on how the proposed mitigation would meet their defined take levels, as well as a revision in the estimated take. The background on the social attraction option and rationale for why we think this would be an effective approach is presented in HTH and PRBO (2011e). In this document, we focus on specific model input values and rationale for these values, both for the currently existing conditions, "full predation scenario" (i.e., what was formerly known as "baseline scenario"), and for the conditions that will exist after mitigation, "mitigation scenario" (i.e., formerly known as "reasonable starting point" scenario) is implemented. The full predation scenario models what happens in the existing population (colony) without mitigation being instituted, and the mitigation scenario models what happens in the population, composed of both the mitigation colony and the existing colony, upon implementation of the mitigation (colony established using social attraction). The terminology has been changed to reduce confusion over concepts as used by USFWS. In this document, we use the term "baseline take" to refer to the lower of two take levels defined by USFWS; to avoid confusion with the term "baseline scenario", which in previous addenda referred to existing conditions during modeling, we now use the term "full predation scenario" instead.

In other species of procellarids observed in New Zealand, the rate of increase in colony size in both translocation and social attraction scenarios appears to be somewhat rapid, once breeding begins. With respect to translocations of fluttering shearwaters and common diving petrels, the increase in the number of breeding pairs from year 6 to year 10 was rapid (Bell et al. 2005, Miskelly and Taylor 2004); in social attraction experiments of fluttering shearwaters, similar patterns occurred, except that by borrowing pre-breeders initial breeding started sooner (Steve Sawyer, pers. comm.). After the relatively rapid initial increase in breeding pairs, it would be expected that growth rate would eventually decrease, upon becoming self sustaining without lots of new immigrants. However, the New Zealand experiments have not lasted long enough to observe such a later pattern. We assumed a rate of social attraction of immigrants based on Bell et al. (2005), who in the early years of their experiment documented 8 of 40 adults caught at the colony site as immigrants, or 20%. We believe this to be a conservative value, as other studies such as Miskelly and Taylor (2004) on common diving petrels suggest that over half of a socially attracted colony could consist of immigrants within the first several years of re-establishment. In addition, we assumed for Hawaiian petrel that the transition from social attraction to a self-sustaining colony occurs at 25 breeding pairs.

For simplicity of the modeling, we assume a fraction of the total population breeds based on the stable age structure resulting from modeling of the current conditions (i.e., the full predation scenario). We also assumed an initial population of 600 pairs of adults in the existing colony in the vicinity of Makamaka'ole. This is a crude estimate based on the fact that 50-70 Hawaiian petrels at times have been heard/seen circling and calling (including pair formation flights) in the valley next to the proposed site of the Makamaka'ole mitigation colony (predator exclosure). We assumed that the birds cavorting are equivalent to ~10% of what to expect as colony size (N. Holmes, pers. comm.).

Any ground and burrow nesting birds in west Maui would be and have been subject to intense predation by cats, mongoose and rats. During work at Makamaka'ole in July-Aug 2011, 11 mongoose were trapped in 12 days using two traps; only predated carcasses of Hawaiian petrels and deserted burrows thus far have been found in the lower Makamaka'ole area over which the petrels circle at night (First Wind, unpubl. data). According to the NARS management plan (NARS 1989), mongoose tracks have been found on the Puu Kiki Trail well above Makamaka'ole (2980 ft and higher), and rat sign to as high as 4200 ft on west Maui (more or less the summit). Cats and rats occur at the summit of Haleakala (10,029 ft) and mongoose at high altitude as well; thus, there is reason to believe that these predators are likely widespread on west Maui, which is half that altitude.

For the full predation scenario, which reflects what is happening at the existing colony, we assumed model input values based on our previous modeling exercises, but made important adjustments to a few. First, for the full predation scenario (current conditions on west Maui), we assumed an annual adult survival rate (ages 4 and older) of 0.80 (Simons 1984) (Table 9). Annual survival rates for juveniles were calculated based on an assumed fledging to age 6 survival rate of 0.2689, an agreed-upon (with USFWS) conservative rate from Addendum 1 (HTH and PRBO 2011b). Because we reduced the assumed survival rates for ages 4 and 5 years, this had the effect of slightly increasing survival rates for ages 0 – 3 years, in order for fledgling to adult survival rate to match that used in Simons (1984).

Table 9. Parameter values used in the population model, existing colony (full predation) and mitigation colony (no predation), for Hawaiian petrel at Makamaka'ole.

Parameter	Value		Source
	Existing colony	Mitigation colony	
Survival			
Annual age 0 survival	0.66	Same	Calculated using ratio of age 0 to 2 survival rates, based on Ainley et al. 2001
Annual age 1 survival	0.79	Same	Calculated using ratio of age 1 to 2 survival rates, based on Ainley et al. 2001
Annual age 2 survival	0.90	Same	Back-calculated to result in a fledgling to age 6 survival rate of 0.2689 (from Simons 1984)
Annual age 3 survival	0.90	Same	Assumed to be same as age 2 year survival rate (see HTH and PRBO 2011b)
Annual adult (>=4) survival	0.80	0.93	Simons 1984, high level of predation; no predation could be as high as 0.94, see HTH and PRBO 2011a for explanation
Fecundity			
Breeding probability	0.51	0.89	Hodges and Nagata 2001, no predator control (high level of predation); Simons 1985, no predation
Reproductive success (4, 5)	0.27	0.50	Calculated based on ratio of estimate of 0.5 for ages 4, 5 from Bell et al. 2005 to the estimate of 0.72 based on the literature and the assumed reproductive rate of 0.39 for ages >=6; Bell et al. 2005
Reproductive success (>=6)	0.39	0.72	Simons 1985, for high predation; see HTH and PRBO 2011a for explanation regarding no predation scenario
Sex ratio	1:1	Same	Nur and Sydeman 1999; Simons 1985
Age at first breeding	6	Same	Simons 1984
Maximum breeding age	36	Same	Simons 1984

For values related to fecundity in the existing colony, we assumed different values for both breeding probability and reproductive success than previously used (Table 9). We assumed a breeding probability of 0.51 based on Hodges and Nagata (2001), whose estimates were for the South Rim of Haleakala, where there was no predator control, and a reproductive success of 0.39 for ages 6 years and older based on Simons (1985), observed under a high level of predation at Haleakala. The breeding probability of 0.51 is reasonable, because this rate has been measured in the field with appreciable sample sizes and numbers of years. Likewise, reproductive success as low as 0.27 has been reported by Hodges and Nagata (2001) at the South Rim with no predator control, therefore, the value of 0.39 would be considered conservative (in terms of quantifying a net recovery benefit). In addition, we assumed a lower reproductive success for ages 4 and 5 years, based on the ratio of observed rates for fluttering shearwater (as high as 0.50, Bell et al. 2005) to the assumed rate of 0.72 for ages 6 years and older under the no predation scenario (observed by Simons (1984), among nests that did not suffer predation). This rate has been found in other petrels, as noted in some of our earlier reports (HTH and PRBO 2011a). We applied this ratio to the reproductive success of 0.39 to obtain a reproductive success of 0.27 for ages 4 and 5 years.

The mitigation scenario considers birds in both the existing colony (as potential emigrants) and the mitigation colony. Survival and reproductive values for the existing colony under the mitigation scenario are the same as those used for the existing colony in the full predation scenario, and those of the mitigation colony are those experienced by petrels under no predation pressure. In this paragraph, we only describe values for the mitigation (social attraction) colony. Survival rates for ages 4 years and older were assumed to be 0.93 (see HTH and PRBO 2011a) (Table 9). Survival rates for juveniles are assumed to be unaffected by predation, so there is no change to these rates when compared to the existing colony. With respect to fecundity, we assumed a breeding probability of 0.89, based on Simons (1985) for no predation, and a reproductive success of 0.5 for ages 4 and 5 years based on fluttering shearwater (Bell et al. 2005), and 0.72 for ages 6 years and older (see HTH and PRBO 2011a). Because the social attraction is bringing immigrants from the existing colony, we assumed that breeding would begin within two years, as was true with grey-faced petrel in a social attraction project in NZ (S. Sawyer, pers. comm.).

POPULATION PROJECTION: ACHIEVING MITIGATION TARGETS

Population projections showed that the mitigation scenario would make steady progress towards reaching mitigation targets for the baseline take level (Table 10, Figure 12, Appendix F). This was calculated by comparing the decreasing trend of the existing colony under the full predation scenario to the combined effect of the decreasing trend of the existing colony in conjunction with the increasing trend of the mitigation colony under the mitigation scenario (Figure 12). The baseline take level is the lower of two possible take levels defined by USFWS, and was previously referred to as the "low take level" in Addendum 4 (HTH and PRBO 2011e). USFWS has now defined the baseline take level to be 28 adults and 14 fledglings; the "high take level" was defined by USFWS to be 40 adults and 20 fledglings. Although net recovery would not be reached during the 20 year license period (i.e., at least 1 individual above the baseline take level of 42 individuals, at least 28 of which are adults, and assuming that the permitted take is actually realized and requiring mitigation), considerable progress would be made, especially for adults. Although the mitigation targets would not be exceeded within the license period, 67% and 65% of adult and fledgling baseline take would be met, respectively. However, mitigation accelerates with time, and net recovery benefit would be reached not long after, i.e. in year 24 (Appendix F). The baseline take would be met by year 24 for adults and year 25 for fledglings (Table 10).

The mitigation scenario would also make progress towards the high take level. The high take level was defined by USFWS as 40 adults and 20 fledglings, and reflects a worst case that is well beyond what is expected. For both adults and fledglings, the mitigation scenario would provide 47% and 45% of required adults and fledglings, respectively, by year 20 (Table 10). A net recovery benefit would be reached within a reasonable time frame beyond the license period (again, because mitigation accelerates), by year 28 (Appendix F). The mitigation targets would be reached by year 28 for adults, and year 33 for fledglings (Table 10).

Table 10. Primary results of population modeling for the mitigation scenario of Hawaiian petrel at Makamaka'ole with respect to baseline and high take levels. Baseline take level was defined by USFWS to be 28 adults and 14 fledglings; high take level was defined to be 40 adults and 20 fledglings.

Life stage	Additional burrows by year 20	Take level	Year mitigation target reached	% of mitigation target in year 20
Adult	9	Baseline (28)	Year 24	0.67
		High (40)	Year 28	0.47
Fledgling	na	Baseline (14)	Year 25	0.65
		High (20)	Year 33	0.45

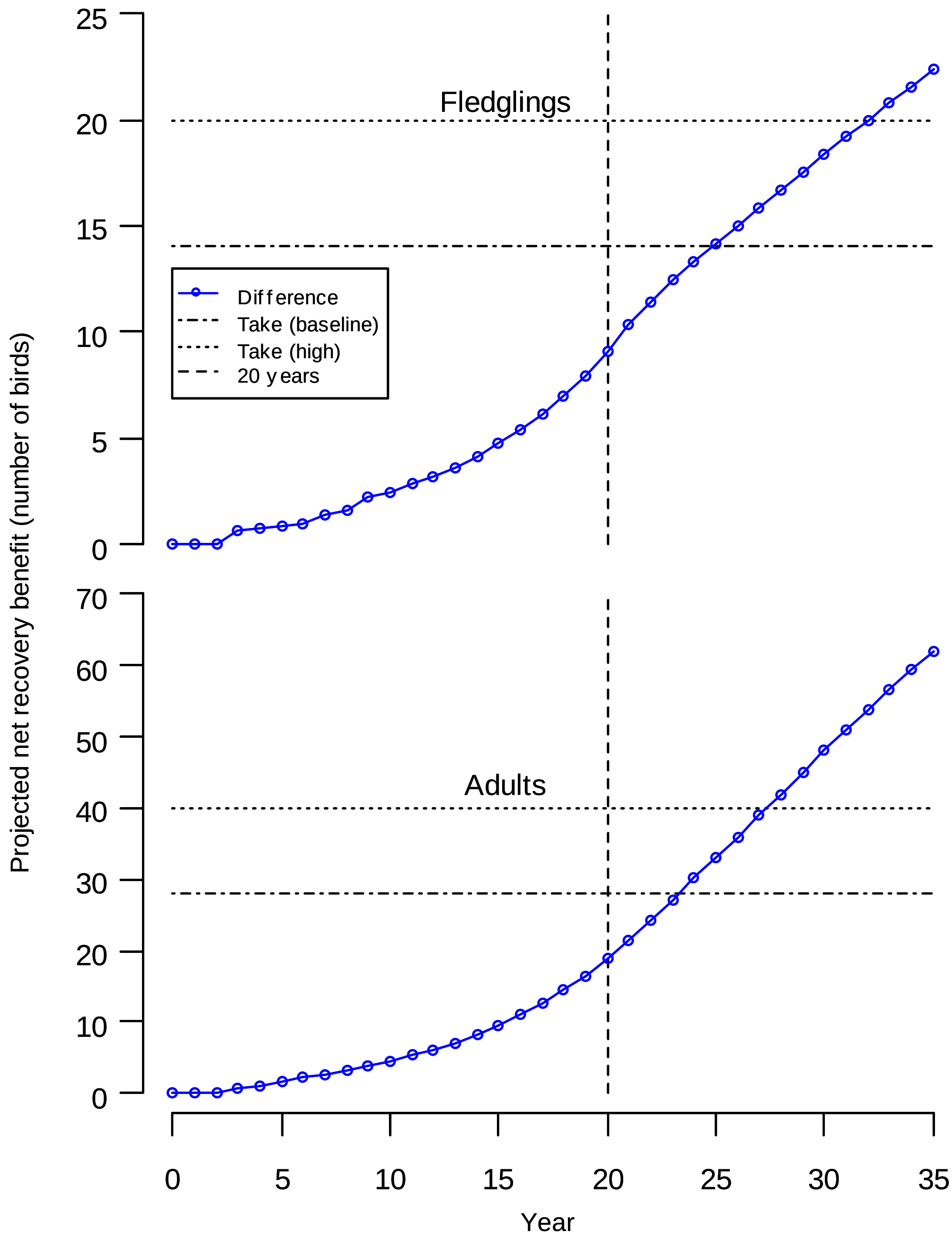


Figure 12. Difference between full predation scenario (existing colony) and mitigation scenario (mitigation and existing colony combined) for Hawaiian Petrel breeding adults and fledglings, Makamaka'ole, assuming that the social attraction mitigation project is implemented. Vertical line indicates the end of the 20-year license period.

Predator-free burrows, including 50 artificial ones, would be provided under the mitigation scenario, compared to the full predation scenario, where predation would remain rampant in the existing colony. Under the mitigation scenario, at year 20, there would be 14 active burrows at the mitigation colony and only 21 active burrows remaining at the existing colony (results not shown). By year 20, there would be a 35% increase in active burrows (35 active burrows overall in both the existing and mitigation colonies) compared to the full predation scenario, in which there would be no mitigation (26 active burrows at the existing colony).

EXTINCTION OF THE EXISTING COLONY AS THE MITIGATION COLONY GROWS

Projected number of birds for the existing colony without mitigation (i.e., full predation scenario) show a decreasing trend with time until extinction (defined as <10 breeding pairs, when stochastic processes can lead to complete loss of all individuals in the population; Figure 13). Modeling results show that adding mitigation (i.e., mitigation scenario, social attraction to a predator free colony), despite an initially decreasing trend, will eventually reverse the decreasing trend for the population as a whole by year 27 (Figure 13). For the existing colony without mitigation, the trend leads to extinction () by year 27. In contrast, the population with mitigation never reaches extinction levels.

Within the mitigation colony itself, the trend is clearly an increasing one, with a larger rate of increase occurring after year 10 (Figure 14). By year 20, we would expect 16 nesting pairs of adults in the mitigation colony, and by year 50, 58 nesting pairs of adults.

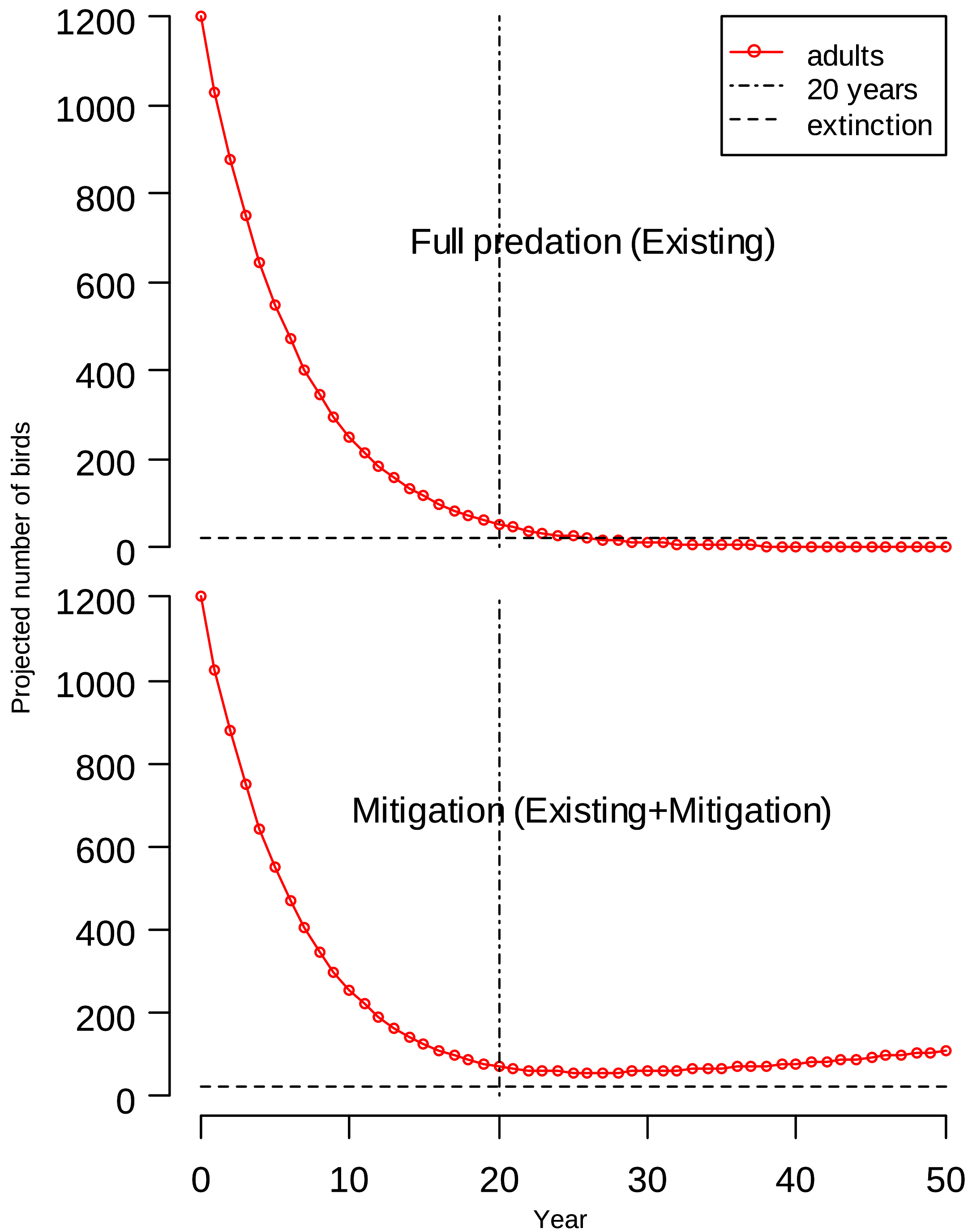


Figure 13. Projected number of Hawaiian Petrels, by life stage, for the overall population under full predation (no mitigation) and mitigation (no predation) scenarios, Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period, and the horizontal line indicates the threshold for extinction (10 breeding pairs), which is only reached in the existing colony (full predation).

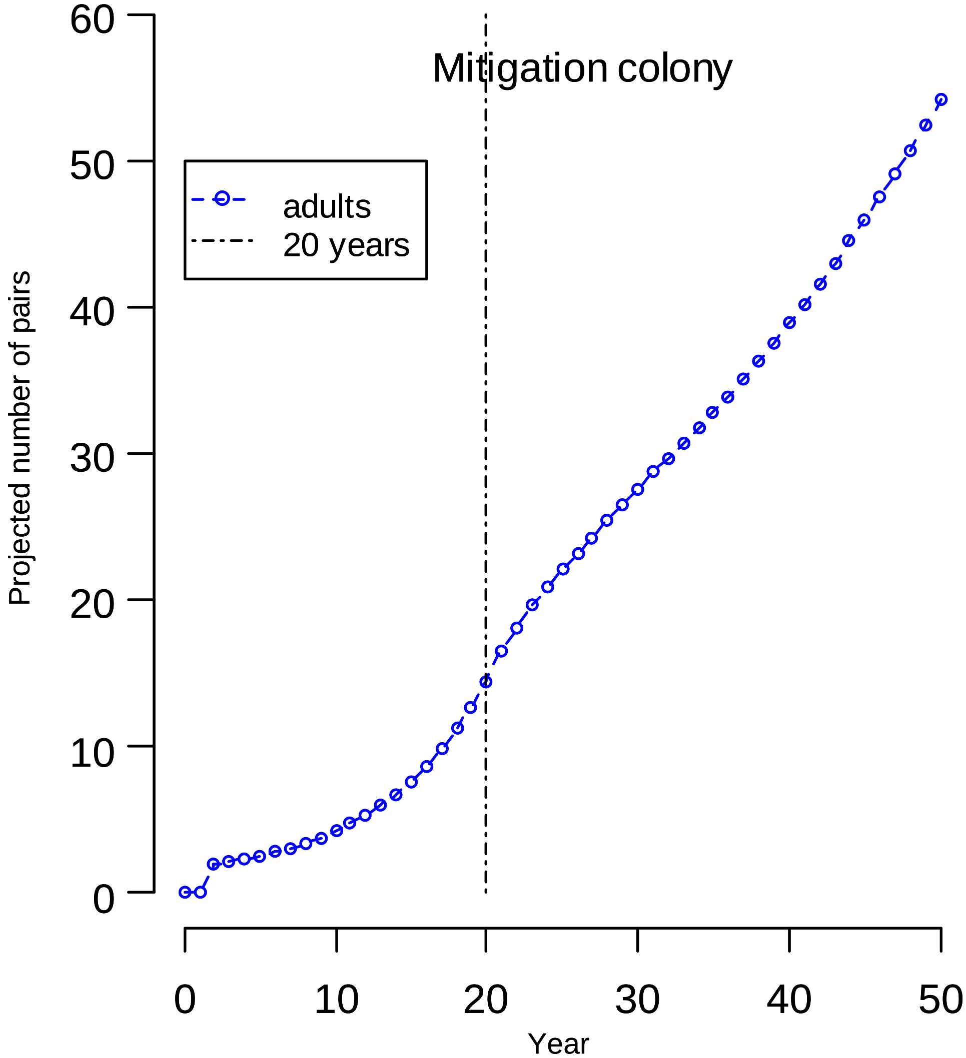


Figure 14. Projected number of Hawaiian petrel adults for mitigation colony (social attraction), Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period.

CONCLUSION

This addendum presents a more concise version of the modeling results for the purpose of evaluation by USFWS than what was contained in previous modeling efforts for Hawaiian petrel. We still agree with the conclusions from the previous addendum (HTH and PRBO 2011e). As was stated in Addendum 4 (HTH and PRBO 2011e), we believe that the social attraction mitigation, even with conservative values, provides a viable way by which to meet mitigation targets within a reasonable timeframe. Model results suggest that substantial progress can be made toward take levels, with the baseline level of take for fledglings and adults being met a few years after the 20-year license period under the proposed mitigation.

Most importantly, our modeling efforts suggest that under the current conditions, the population will likely be nearing extinction within the timeframe of the license period. Modeling results from the social attraction option, and the experience with similar projects in New Zealand, show that it may be possible to reverse the trend, if this option is implemented soon.

REFERENCES

Ainley DG, R Podolsky, L Deforest, G Spencer, N Nur. 2001. The status and population trends of the Newell's Shearwater on Kaua'i: Insights from modeling. Studies in Avian Biology 22:108-123.

Bell M, BD Bell, EA Bell. 2005. Translocation of fluttering shearwater (*Puffinus gavia*) chicks to create a new colony. Notornis 52:11-15.

Hodges CSN, RJ Nagata, Sr. 2001. Effects of predator control on the survival and breeding success of the endangered Hawaiian dark-rumped petrel. Studies in Avian Biology 22:308-318.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011a. Hawaiian petrel population modeling (Updated) – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011b. Addendum 1: Hawaiian petrel population modeling (Updated) – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011c. Addendum 2: Hawaiian petrel population modeling – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011d. Addendum 3: Hawaiian petrel population modeling – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011e. Addendum 4: Hawaiian petrel population modeling – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

Miskelly CM, GA Taylor. 2004. Establishment of a colony of common diving petrels (*Pelecanoides urinatrix*) by chick transfers and acoustic attraction. Emu 104:205-211.

[NARS] Natural Area Reserve System. 1989. West Maui Natural Area Reserve Management Plan. Technical report. Honolulu (HI): State of Hawaii, Department of Land and Natural Resources.

Nur N, WJ Sydeman. 1999. Demographic processes and population dynamic models of seabirds: Implications for conservation and restoration. Current Ornithology 15:149-188.

Simons TR. 1984. A population model of the endangered Hawaiian dark-rumped petrel. Journal of Wildlife Management 48(4):1065-1076.

Simons TR. 1985. Biology and behavior of the endangered Hawaiian dark-rumped Petrel. Condor 87:229-245.

APPENDIX F.
POPULATION MODELING RESULTS OF HAWAIIAN PETREL AT A POTENTIAL MITIGATION SITE, MAKAMAKA'OLE (WEST MAUI) – SOCIAL ATTRACTION

Table F1. Number of Hawaiian petrel individuals projected per year and differences between no predation and predation scenarios, based on 600 pairs of breeding adults in the existing colony at year 0, and high predation level in the existing colony.

					# Greater than Baseline Scenario			
Scenario	Year	Adults	Juveniles	Fledglings	Adults	Juveniles	Fledglings	Total
Baseline	0	1200.0	613.2	129.1				
	1	1026.3	524.5	110.4				
	2	877.7	448.5	94.4				
	3	750.7	383.6	80.8				
	4	642.0	328.1	69.1				
	5	549.1	280.6	59.1				
	6	469.6	240.0	50.5				
	7	401.6	205.2	43.2				
	8	343.5	175.5	36.9				
	9	293.7	150.1	31.6				
	10	251.2	128.4	27.0				
	11	214.8	109.8	23.1				
	12	183.7	93.9	19.8				
	13	157.1	80.3	16.9				
	14	134.4	68.7	14.5				
	15	114.9	58.7	12.4				
	16	98.3	50.2	10.6				
	17	84.1	43.0	9.0				
	18	71.9	36.7	7.7				
	19	61.5	31.4	6.6				
	20	52.6	26.9	5.7				
	21	45.0	23.0	4.8				
	22	38.5	19.7	4.1				
	23	32.9	16.8	3.5				
	24	28.1	14.4	3.0				
	25	24.1	12.3	2.6				
	26	20.6	10.5	2.2				
	27	17.6	9.0	1.9				
	28	15.1	7.7	1.6				
	29	12.9	6.6	1.4				
	30	11.0	5.6	1.2				
	31	9.4	4.8	1.0				
	32	8.1	4.1	0.9				
	33	6.9	3.5	0.7				
	34	5.9	3.0	0.6				
	35	5.0	2.6	0.5				
	36	4.3	2.2	0.5				
	37	3.7	1.9	0.4				
	38	3.2	1.6	0.3				
	39	2.7	1.4	0.3				
	40	2.3	1.2	0.2				
	41	2.0	1.0	0.2				
	42	1.7	0.9	0.2				
	43	1.4	0.7	0.2				
	44	1.2	0.6	0.1				

Table F1. Number of Hawaiian petrel individuals projected per year and differences between no predation and predation scenarios, based on 600 pairs of breeding adults in the existing colony at year 0, and high predation level in the existing colony.

					# Greater than Baseline Scenario			
Scenario	Year	Adults	Juveniles	Fledglings	Adults	Juveniles	Fledglings	Total
Baseline	45	1.1	0.5	0.1				
	46	0.9	0.5	0.1				
	47	0.8	0.4	0.1				
	48	0.7	0.3	0.1				
	49	0.6	0.3	0.1				
	50	0.5	0.2	0.1				
Reasonable	0	1200.0	613.2	129.1	0.0	0.0	0.0	0.0
	1	1026.3	524.5	110.4	0.0	0.0	0.0	0.0
	2	877.7	448.5	94.4	0.0	0.0	0.0	0.0
	3	751.2	384.3	81.4	0.6	0.7	0.6	1.3
	4	643.1	329.3	69.8	1.1	1.2	0.7	2.3
	5	550.7	282.3	59.9	1.7	1.7	0.8	3.4
	6	471.8	242.2	51.5	2.2	2.2	0.9	4.4
	7	404.3	208.4	44.6	2.7	3.1	1.4	5.8
	8	346.6	179.5	38.5	3.1	4.0	1.6	7.2
	9	297.6	155.3	33.8	3.8	5.2	2.2	9.0
	10	255.7	134.7	29.5	4.5	6.3	2.5	10.8
	11	220.1	117.3	25.9	5.3	7.5	2.8	12.7
	12	189.8	102.7	23.0	6.1	8.8	3.2	14.8
	13	164.2	90.4	20.6	7.1	10.1	3.6	17.2
	14	142.5	80.3	18.6	8.1	11.7	4.2	19.8
	15	124.4	72.0	17.1	9.5	13.3	4.7	22.8
	16	109.3	65.4	16.0	11.0	15.1	5.4	26.1
	17	96.7	60.2	15.2	12.6	17.2	6.2	29.8
	18	86.3	56.4	14.7	14.4	19.6	7.0	34.0
	19	78.0	53.8	14.6	16.5	22.3	8.0	38.8
	20	71.4	52.3	14.7	18.8	25.4	9.1	44.2
	21	66.4	51.9	15.2	21.4	28.9	10.3	50.4
	22	62.7	52.2	15.6	24.3	32.5	11.4	56.8
	23	60.1	52.9	16.0	27.2	36.1	12.4	63.3
	24	58.2	53.9	16.3	30.1	39.6	13.3	69.7
	25	57.1	55.3	16.8	33.0	43.0	14.2	76.0
	26	56.5	56.7	17.2	35.9	46.2	15.0	82.1
	27	56.5	58.3	17.8	38.9	49.3	15.9	88.3
	28	57.0	60.0	18.4	42.0	52.3	16.7	94.3
	29	57.9	61.8	19.0	45.0	55.2	17.6	100.2
	30	59.0	63.7	19.6	48.0	58.1	18.4	106.1
	31	60.3	65.7	20.2	50.9	60.9	19.2	111.8
	32	61.8	67.8	20.8	53.7	63.7	20.0	117.5
	33	63.4	70.0	21.5	56.5	66.5	20.8	123.0
	34	65.2	72.3	22.2	59.3	69.3	21.6	128.6
	35	67.1	74.6	22.9	62.1	72.1	22.4	134.1
	36	69.2	77.1	23.7	64.9	74.9	23.2	139.7
	37	71.3	79.6	24.5	67.7	77.7	24.1	145.4

Table F1. Number of Hawaiian petrel individuals projected per year and differences between no predation and predation scenarios, based on 600 pairs of breeding adults in the existing colony at year 0, and high predation level in the existing colony.

					# Greater than Baseline Scenario			
Scenario	Year	Adults	Juveniles	Fledglings	Adults	Juveniles	Fledglings	Total
Reasonable	38	73.6	82.3	25.3	70.5	80.7	25.0	151.1
	39	76.0	85.1	26.2	73.3	83.7	25.9	157.0
	40	78.5	87.9	27.1	76.1	86.8	26.8	162.9
	41	81.0	90.9	28.0	79.0	89.9	27.8	168.9
	42	83.7	94.0	29.0	82.0	93.1	28.8	175.1
	43	86.5	97.2	29.9	85.0	96.4	29.8	181.5
	44	89.3	100.5	30.9	88.1	99.8	30.8	187.9
	45	92.3	103.9	32.0	91.2	103.3	31.9	194.5
	46	95.3	107.4	33.0	94.4	106.9	33.0	201.3
	47	98.4	111.0	34.1	97.7	110.6	34.1	208.2
	48	101.6	114.7	35.3	101.0	114.3	35.2	215.3
	49	104.9	118.5	36.4	104.4	118.2	36.4	222.5
	50	108.3	122.4	37.6	107.8	122.1	37.6	229.9

Appendix 25

ADDENDUM 4: NEWELL'S SHEARWATER POPULATION MODELING – GROWTH OF MITIGATION COLONY AT MAKAMAKA'OLE, WEST MAUI AND GROWTH IN A POSSIBLE PROJECT IN EAST MAUI

FINAL

Prepared by

H. T. HARVEY & ASSOCIATES

Prepared for

Greg Spencer
First Wind, Environmental Affairs
Kaheawa Wind Power, LLC
56 Honuhula Street
Kihei, Hawaii 96753

04 October 2011 Project No. 2936-03

983 University Ave, Bldg D • Los Gatos, CA 95032 • Ph: 408.458.3200 • F: 408.458.3210

TABLE OF CONTENTS

List of Figures:

List of Tables:

BACKGROUND

Recently, we developed several documents detailing the population modeling for Newell's shearwater on Maui with respect to estimating mitigation for take at KWP I and II (HTH and PRBO 2011a, b, c, d). This addendum was written to focus and revise results from the modeling in Addendums 2 and 3 in response to requests from the United States Fish and Wildlife Service (USFWS) for clarity on how the proposed mitigation would meet their defined take levels. The background on the social attraction option and rationale for why we think this would be an effective approach is presented in HTH and PRBO (2011c, d). In this document, we focus on specific model input values and rationale for these values, both for the existing conditions, "full predation scenario" (i.e., what was formerly known as "baseline scenario"), and for conditions that will exist upon initiation of mitigation, "mitigation scenario" (i.e., formerly known as "reasonable starting point" scenario). The full predation scenario considers what happens in the existing colony, and the mitigation scenario considers what happens in both the mitigation colony and the existing colony once the mitigation is implemented. The terminology has been changed to reduce confusion over concepts as used by USFWS. In this document, we use the term "baseline take" to refer to the lower of two take levels defined by USFWS; to avoid confusion with the term "baseline scenario", which in previous addenda referred to current conditions during modeling, we now use the term "full predation scenario" instead.

In other species of procellarids observed in New Zealand, the rate of increase in colony size in both translocation and social attraction scenarios appears to be somewhat rapid, once breeding begins. "Somewhat rapid" is a relative term, acknowledging that the life-history strategies of procellarids, being K-selected, do not allow for the sort of increase one could expect from, for example, game birds, which can breed at one year of age and tend to lay relatively large numbers of eggs. The proposed project is one of social attraction only, but with respect to translocations of fluttering shearwater and common diving petrel, Bell et al. (2005) and Miskelly and Taylor (2004) observed that the increase in the number of breeding pairs from year 6 to year 10 was rapid; in social attraction experiments of fluttering shearwaters, similar patterns occurred, except that by borrowing pre-breeders from the existing population, initial breeding started sooner in the new colony (Steve Sawyer, pers. comm.). After the relatively rapid initial increase in breeding pairs as a result of immigration, it would be expected that growth rate would eventually decrease, with the population becoming self-sustaining without lots of new immigrants. However, the New Zealand experiments have not yet lasted long enough to observe a self-sustaining population. We assumed a rate of social attraction of immigrants based on Bell et al. (2005), who in the early years of their experiment documented 8 of 40 adults caught at the translocation colony site as immigrants, or 20%. We believe this to be a conservative value, as other studies such as Miskelly and Taylor (2004) suggest that over half of a socially attracted colony could consist of immigrants within the first several years of re-establishment. Initially, a social attraction colony, without translocation, would be composed entirely of immigrants. Finally, we assumed that the transition from social attraction to a self-sustaining colony occurs at 25 breeding pairs.

For simplicity of the modeling, we assume a fraction of the total population breeds based on the stable age structure resulting from the full predation scenario. We also assumed an initial population of 40 pairs of adults in the existing colony in the vicinity of Makamaka'ole; this was a minimum estimate based on several bits of information. 1) The Cooper and Day (2003) radar survey from 6 locations around west Maui in 2001 detected just 51 seabird targets/hr (for first 3 hrs of the night = 153 detections); almost all the detections were in the portion of west Maui that contains Makamaka'ole. Based on time of night (well after sundown), these authors thought that an average 30% were Newell's shearwaters, or ~45 Newell's shearwaters per night. Subsequently it has been found that Hawaiian petrels come ashore throughout the night and, thus, this Newell's shearwater estimate is overly generous; thus, we decreased the Newell's estimate a further 20% to ~35 Newell's per night visiting west Maui. 2) The usual traffic of calling Newell's shearwater up slope through the Makamaka'ole Valley is 1-3 per night (high count 13) during the last few years. 3) A survey of Kahakuloa by G. Spencer in 2007 detected calls of 20-30 birds, but a survey in 2011 of the same area detected none. Finally, 4) based on studies on Kauai (B. Zaun, pers.comm.), it is known that one member of each Newell's pair visits its chick each night. Therefore, the number of burrows is equivalent to the number of birds flying inland in the early evening, less than 100, but at least 40 for west Maui.

The full predation scenario is justified for current conditions in the existing colony. Any ground and burrow nesting birds in west Maui would be and have been subject to intense predation by cats, mongoose and rats. During work at Makamaka'ole in July-Aug 2011, 11 mongoose were trapped in 12 days using two traps; only predated carcasses of Hawaiian petrels and deserted burrows thus far have been found in the lower Makamaka'ole area (First Wind, unpubl. data). According to the NARS management plan (NARS 1989), mongoose tracks have been found on the Puu Kiki Trail well above Makamaka'ole (2980 ft and higher), and rat sign to as high as 4200 ft on west Maui (more or less the summit). Cats and rats occur at the summit of Haleakala (10,029 ft) and mongoose at high altitude as well; thus, there is reason to believe that these predators are likely widespread on west Maui, whose altitude is half that of Haleakala.

In order to determine the net benefit of the mitigation, in comparison to estimated take at KWP I and II, we evaluated trends in the overall population. We compared the mitigation scenario, which includes both the migitation colony and the existing colony acting synergistically, to a full predation scenario that only includes the existing colony.

For the mitigation colony (mitigation scenario only), adult and juvenile survival for the mitigation colony were the same as those defined in previous addenda for scenarios with no predation (HTH and PRBO 2011a,b), with the exception of age 0 survival, which was increased due to changes in our perception of potential fallout mortality. Previously, we had modeled low fallout mortality for all scenarios, however, based on recently available data from the Maui SOS program, it appears that the effect of fallout on Newell's shearwater is negligible given so few Newell's shearwaters are found by the program (see HTH and PRBO 2011c). Therefore, we assumed no fallout mortality for the scenarios modeled in this addendum, increasing age 0 survival to 0.654 (stable population value, as described in Griesemer and Holmes 2010). We also used the maximum adult survival rate that has been determined for the closely related Manx shearwater, 0.93 (Schreiber and Burger 2001).

Fecundity rates in the mitigation colony were primarily based on Griesemer and Holmes (2010), with some important adjustments to account for social attraction. Breeding probability for the mitigation colony was 0.5 for ages 6 years and older, and assumed to be half as much for ages 3, 4, and 5 years. Although we assumed an average age at first breeding to be 6 years (Ainley et al. 2001), it is possible for shearwaters to begin breeding as early as age 3 (e.g., for Manx Shearwater, see Brooke 1990). Although ages 3, 4 and 5 year birds can sometimes breed, we assumed that their reproductive capability is much reduced, both in terms of breeding probability and reproductive success. For ages 6 years and older, we assumed a reproductive success of 0.4 for years 2 – 5 (i.e., the first four years of breeding) based on a slight reduction from the full predation scenario (which was 0.45), a medium level of reproductive success (0.55) for years 6 and 7, and a maximum of 0.70 (Griesemer and Holmes 2010) for years 8 and above. Rates were based on previously defined scenarios assuming varying levels of predation (HTH and PRBO 2011a,b), as well as information from the very well studied Manx shearwater (Brooke 1990). Such a gradual increase in success is consistent with increased proficiency as seabirds gain experience, and as seen for fluttering shearwater (Bell et al. 2005) and Manx shearwater (Brooke 1990). For ages 3, 4, and 5 years, we scaled the reproductive rates downwards, based on a ratio calculated using optimal observed reproductive success of ages 4 and 5 years (0.50, for fluttering shearwater, Bell et al. 2005) and ages 6 years and older (0.70, based on Griesemer and Holmes 2010).

We assumed 2 breeding pairs to start, as an initial value for the number of breeders at the first breeding occasion. This was consistent with what was found for fluttering shearwaters and common diving petrels in their first year of breeding at a new colony, following social attraction.

Table 7. Parameter values used in the population model, existing colony (full predation and mitigation scenarios) and mitigation colony (mitigation scenario only), for Newell's shearwater at Makamaka'ole.

Parameter	Value		Source
	Existing colony	Mitigation colony	
Survival			
Annual age 0 survival	0.654	Same	Greisemer and Holmes (2010)
Annual age 1 survival	0.780	Same	Greisemer and Holmes (2010)
Annual age 2 survival	0.815	0.890	Greisemer and Holmes (2010), high predation; Greisemer and Holmes (2010), no predation
Annual age 3 survival	0.830	0.905	Greisemer and Holmes (2010), high predation; Greisemer and Holmes (2010), no predation
Annual age 4 and 5 survival	0.770	0.920	Ainley et al. (2001), Griesemer and Holmes (2010); assumed same survival as for ages 6 and older under no predation
Annual adult (>=6) survival	0.877	0.930	Ainley et al. (1995), Griesemer and Holmes (2010), high predation; Schreiber and Burger (2001), Manx shearwater
Fecundity			
Breeding probability (3, 4, 5)	0.25	0.4	Assumed to be half of breeding probability for ages 6 years and older
Breeding probability (>=6)	0.5	0.8	Griesemer and Holmes (2010), high predation; Griesemer and Holmes (2010), no predation
Reproductive success (3, 4, 5)	0.21	0.29, 0.39, 0.50	Calculated based on ratio of estimate of 0.5 for ages 4, 5 from Bell et al. 2005 to the estimate of 0.7 based on Griesemer and Holmes (2010); Bell et al. (2005), gradual increase from year 2 to 8 (see HTH and PRBO 2011c)
Reproductive success (>=6)	0.30	0.4, 0.55, 0.70	Griesemer and Holmes (2010), high predation; Griesemer and Holmes (2010), low predation, gradual increase from year 2 to 8 (see HTH and PRBO 2011c)
Sex ratio	1:1	Same	Nur and Sydeman 1999
Average age at first breeding	6	Same	Ainley et al. 2001
Maximum breeding age	36	Same	Ainley et al. 2001

The existing colony was modeled for both the full predation and mitigation scenarios. For each scenario, we modeled the existing colony, assuming no fallout mortality and no powerline strike mortality but full predation (see HTH and PRBO 2011c for explanation). Model input values for survival and fecundity were based primarily on values from Griesemer and Holmes (2010) for a high predation level, but included some important adjustments (described below).

Breeding probability for the full predation scenario was the same as that from Griesemer and Holmes (2010) for a high predation level, and were averages given the absence of actual age-specific data; assuming a high predation level, the reduction from a stable population with breeding probability of 0.80 (used by Ainley et al. 2001 for their stable population model) was assumed to be -0.30, resulting in a breeding probability of 0.50. We assumed that the breeding probability of ages 3, 4, and 5 years would be half the value (0.25) of age 6 years and older. Griesemer and Holmes (2010) noted that their assumed reductions in breeding probability due to medium (-0.20) and high (-0.30) predation levels resulted in a breeding probability that was similar to the observed breeding probability in a population experiencing moderate predation (0.55 breeding probability, from Ainley et al. (2001)). Reproductive success was adjusted by the same reduction used in Griesemer and Holmes (2010) for their high predation model, -0.4, but the stable population value of 0.7 based on Ainley et al. (2001) was used instead (see HTH and PRBO 2011a for detail), resulting in reproductive success of 0.3. For ages 3, 4, and 5 years, we scaled the reproductive rates down from 0.30 to 0.21, based on a ratio calculated using optimal observed reproductive success of ages 4 and 5 years (0.50, for fluttering shearwater, Bell et al. 2005) and ages 6 years and older (0.70, based on Griesemer and Holmes 2010).

Parameterization of survival rates for the full predation scenario was based on information for fledgling to adult survival from Ainley et al. (2001) and annual adult survival rates from Griesemer and Holmes (2010). We used the same survival rates for ages 0, 1, and 2 years as Griesemer and Holmes (2010) for their high predation, no fallout mortality model; however, the survival rates for ages 3, 4, 5 and 6+ differed.

Survival rates for the full predation scenario for ages 0 through 2 years were based on values identified by Griesemer and Holmes (2010) for a population experiencing high predation, without powerline or fallout mortality (see HTH and PRBO 2011b for further detail). Griesemer and Holmes (2010) assumed that the survival rates for ages 0 and 1 were the same as those from a stable population, 0.654 and 0.780, respectively, and would remain unchanged under various predation levels. The survival rate for age 2 years was based on reductions from a stable population (survival rate of 0.89) based on Griesemer and Holmes (2010). The stable population survival rate was adjusted by -0.075 for a high predation level, resulting in a survival rate of 0.815 for age 2 years.

The calculation of survival rates for ages 3, 4, and 5 years at the high predation level followed the approach used by Ainley et al. (2001), as described in HTH and PRBO (2011a). We used the reduction for high predation based on Griesemer and Holmes (2010), -0.15, but assumed a stable population value of 0.92 based on Griesemer and

Holmes (2010), resulting in a survival rate of 0.77. These age classes would dominate those birds that are prospecting for new nest sites and for mates. They would be even more vulnerable to ground predators than nest-holding adults, which don't spend much time at all on the surface; adults typically arrive on a given night and immediately disappear into their cavities rather than scampering around, rustling the vegetation, and attempting to dig beneath roots and rocks.

The calculation of survival rate for ages 6 years and older for the high predation level followed the approach as described by HTH and PRBO (2011a), adjusting survival rate based on the observed predation rate from Ainley et al. (1995). Their data indicate that predation rates could be as high as 0.05 (based on observed mortality of age 2+ years) and even higher in some years. We made an adjustment to the stable population value based on a reduction in survival commensurate with an assumed 0.05 predation mortality; we reduced the stable population value of survival from Griesemer and Holmes (2010) (0.92) by 0.043 to obtain a survival rate of 0.877 for ages 6 years and older.

POPULATION PROJECTION: ACHIEVING MITIGATION TARGETS

Population projections showed that the mitigation scenario would make steady progress towards reaching mitigation targets for the baseline take level (Table 8, Figure 19, Appendix F). This was calculated by comparing the decreasing trend of the existing colony under the full predation scenario to the combined effect of the decreasing fate of the existing colony in conjunction with the increasing trend of the mitigation colony under the mitigation scenario, as shown in Figure 19. USFWS defined the baseline take level to be 4 adults and 4 fledglings; the "high take level" was defined to be 10 adults and 6 fledglings. Net recovery would be reached during the 20 year license period (i.e., at least 1 individual above the baseline take level of 8 individuals, at least 4 of which are adults, and assuming that the permitted take is actually realized and requiring mitigation), by year 16 (Table 8). The mitigation target for adults would be reached in year 13. For fledglings, the mitigation target would not be reached (4 fledglings), however 90% of baseline take would be met by the end of the license period. However, mitigation accelerates with time, and the baseline take would be met by year 23 for fledglings (Table 8).

The mitigation scenario would also make progress towards the high take level. The high take level was defined by USFWS as 10 adults and 6 fledglings, and reflects a worst case that is beyond what is expected. For both adults and fledglings, the mitigation scenario would provide 93% and 60% of required adults and fledglings, respectively, by year 20 (Table 8). A net recovery benefit would be reached shortly after the license period ends (again, because mitigation accelerates), by year 26 (Table 8). The mitigation targets would be reached by year 22 for adults, and year 35 for fledglings (Table 8).

Table 8. Primary results of population modeling for the mitigation scenario of Newell's shearwater at Makamaka'ole with respect to baseline and high take levels. Baseline take level was defined by USFWS to be 4 adults and 4 fledglings; high take level was defined to be 10 adults and 6 fledglings.

Life stage	Additional burrows by year 20	Take level	Year mitigation target reached	% of mitigation target in year 20
Adult	5	Baseline (4)	Year 13	>100%
		High (10)	Year 22	93%
Fledgling	na	Baseline (4)	Year 23	90%
		High (6)	Year 35	60%
Adult + Fledgling	na	Baseline (≥9, ≥4 adults)	Year 16	>100%
		High (≥17, ≥10 adults)	Year 26	76%

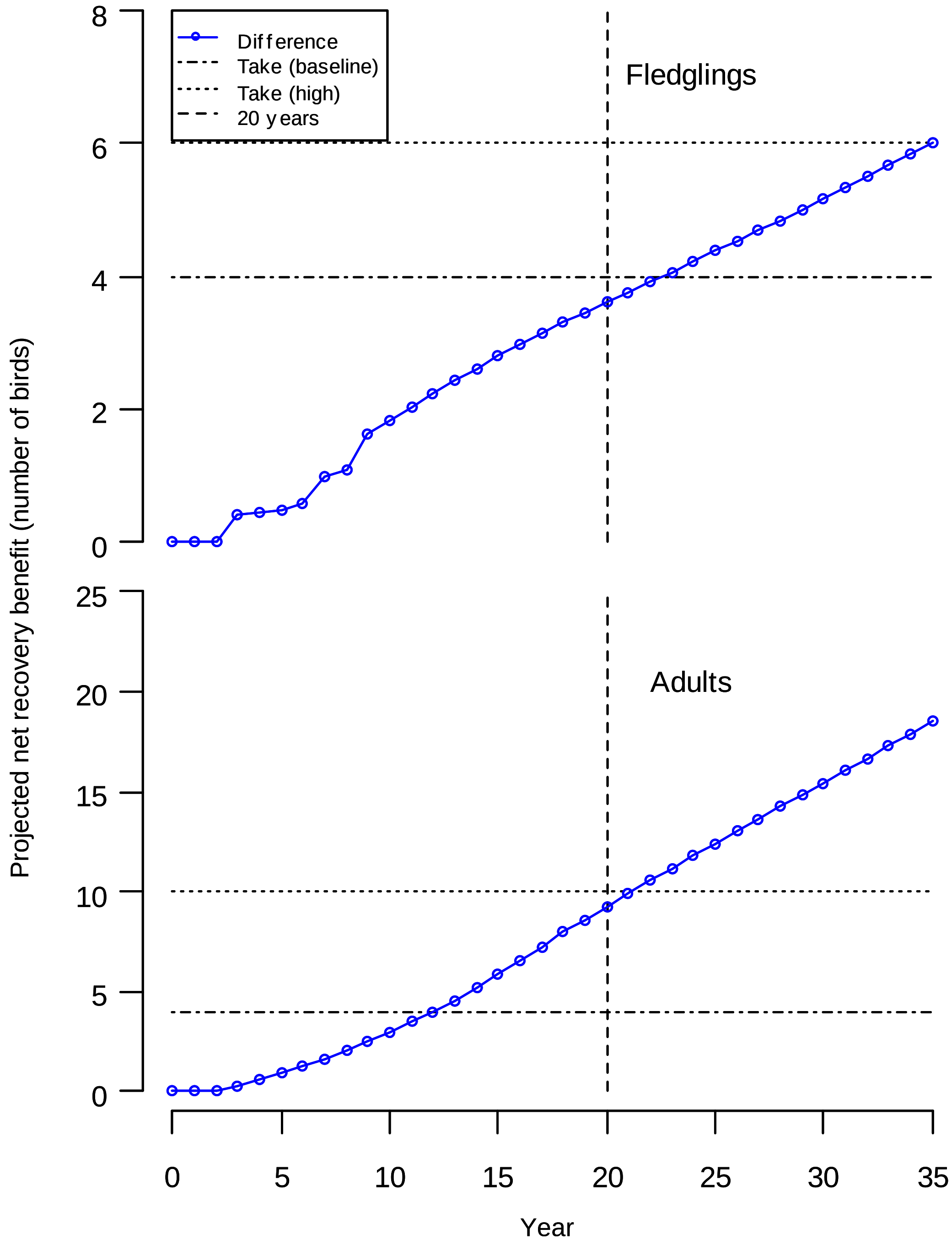


Figure 19. Difference between full predation scenario (existing colony) and mitigation scenario (mitigation and existing colony combined) for Newell's shearwater breeding adults and fledglings, Makamaka'ole, assuming that the social attraction mitigation project is implemented. Vertical line indicates the end of the 20-year license period.

We also evaluated a potential alternative project in East Maui that would be very similar to the proposed project in west Maui, with complete predator exclusion. The potential site could be located, within flyways, along Koolau Gap on state and The Nature Conservancy land, or another area east of the Park, also on state land. This project would only be triggered if the social attraction at Makamaka'ole, west Maui, is not successful owing to too few birds to attract to the area and the project falls short for the mitigation requirements. From Cooper and Day (2003), our calculations indicate that combined Newell's shearwater and Hawaiian Petrel movement rate over Kaenae (below Koolau Gap) would be less than Kahakuloa (near Makamaka'ole): ~6.7 birds/h. This is determined as follows: Cooper and Day (2003) report Newell's shearwaters to be 5% of targets at Kaenae, so 0.05*134=6.7 birds/h. From this, only 20% of these are likely to be Newell's shearwater, so 1.3 birds/h * 3h (the length of the Cooper and Day (2003) survey period each night, i.e., when most birds would have flown inland) = 4 birds per night flying inland; an estimate of breeding pairs would then be <100 but perhaps 40, assuming a two week period. Therefore, it appears that the situation there would be somewhat similar to that at Makamaka'ole, although likely worse, as the Koolau Gap Newell's shearwater location (vocalizations heard a few years ago) had no evidence of Newell's shearwater this past year. Results for the modeling were the same as for west Maui, given an assumed initial population of 40 breeding pairs (Figure 20).

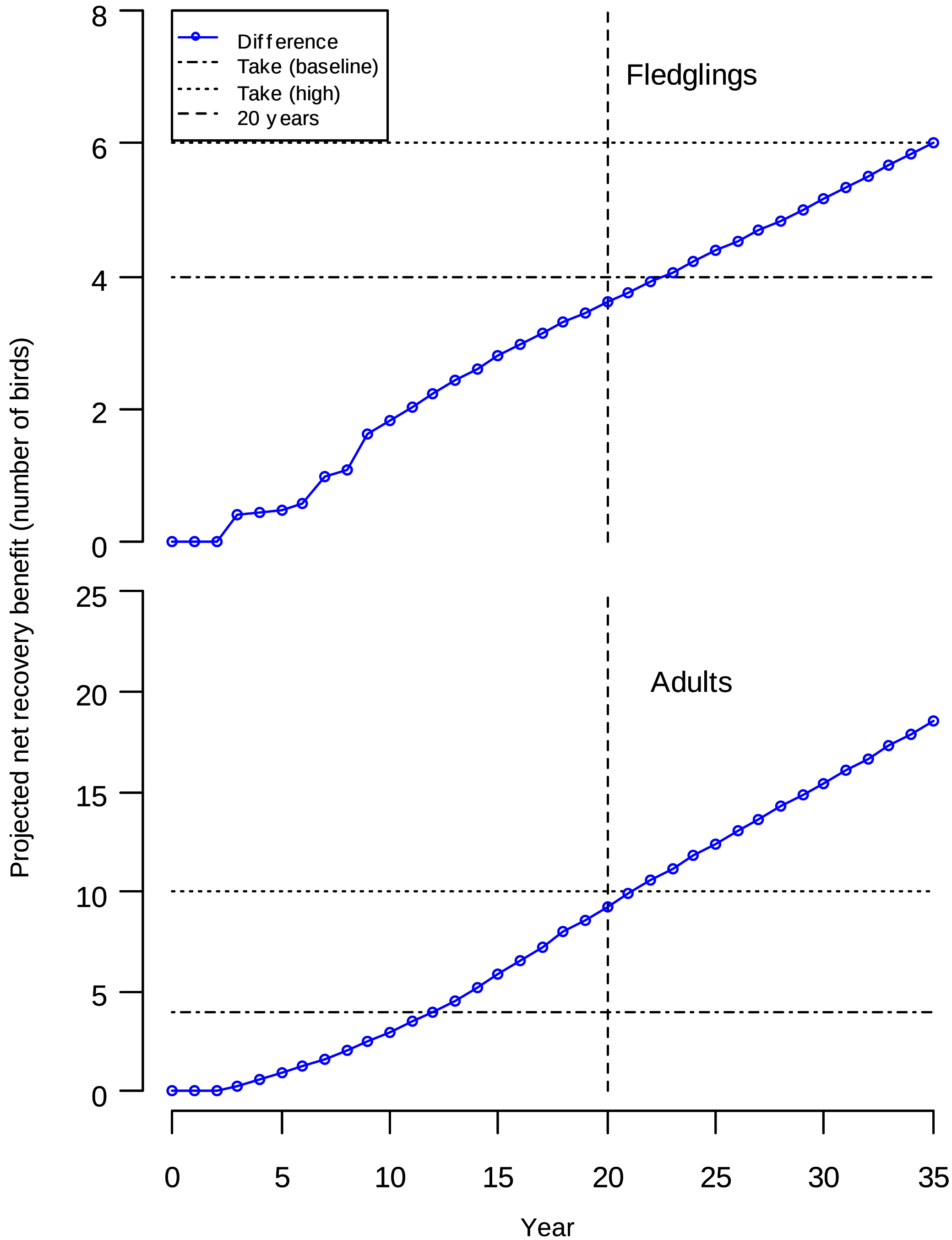


Figure 20. Difference between full predation scenario (existing colony) and mitigation scenario (mitigation and existing colony combined) for Newell's shearwater breeding adults and fledglings, east Maui, assuming that the social attraction mitigation project is implemented. Vertical line indicates the end of the 20-year license period.

Predator-free burrows, including 50 artificial ones, would be provided under the mitigation scenario, compared to the full predation scenario, where predation would remain rampant in the existing colony. Under the mitigation scenario, at year 20, there would be 6 active burrows at the mitigation colony and only 2 active burrows remaining at the existing colony (results not shown). By year 20, there would be over twice as many active burrows (8 active burrows overall in both the existing and mitigation colonies) compared to the full predation scenario, in which there would be no mitigation (3 active burrows at the existing colony).

EXTINCTION OF THE EXISTING COLONY AS THE MITIGATION COLONY GROWS

The projected number of birds for the existing colony without mitigation (i.e., full predation scenario) shows a rapidly decreasing trend with time (Figure 21). Both scenarios lead to extinction (defined as <10 breeding pairs), although the modeling results show that adding mitigation (i.e., mitigation scenario, social attraction to a predator free colony), despite an initially decreasing trend, could eventually reverse the decreasing trend for the population as a whole by year 22, if the population does not lose all its members before that (Figure 21). The designation of 10 breeding pairs as on the verge of extinction is somewhat arbitrary, though we believe that a population this small would certainly be vulnerable to any stochastic processes that lead to decreased survival or reproductive success, and could result in a loss of all the individuals from the population. For the existing colony without mitigation, the trend leads to extinction by year 11 (Figure 21), with fewer than 2 adults by year 29. In contrast, under the mitigation scenario, the population decreases to 15 adults before the decreasing trend reverses, and the population, assuming stochastic factors don't completely eliminate it, exceeds 20 adults by year 37.

Within the mitigation colony itself, the trend is clearly an increasing one, with a stronger rate of increase beginning in about year 5 (Figure 22). By year 20, we would expect 6 nesting pairs of adults in the mitigation colony, and by year 50, 14 nesting pairs of adults.

A major caveat to the modeling is that uncertainty in model parameter values may also add to the uncertainty regarding risk of extinction. For instance, under the given values for the full predation scenario for Newell's shearwater, the population has been modeled to decrease at a rate that is slightly slower than that for Hawaiian petrel. However observations seem to indicate that Newell's shearwater is actually declining more quickly than Hawaiian petrel on west Maui. Less is known about the population parameters for Newell's shearwater, and therefore the population projections based on these values are also less certain.

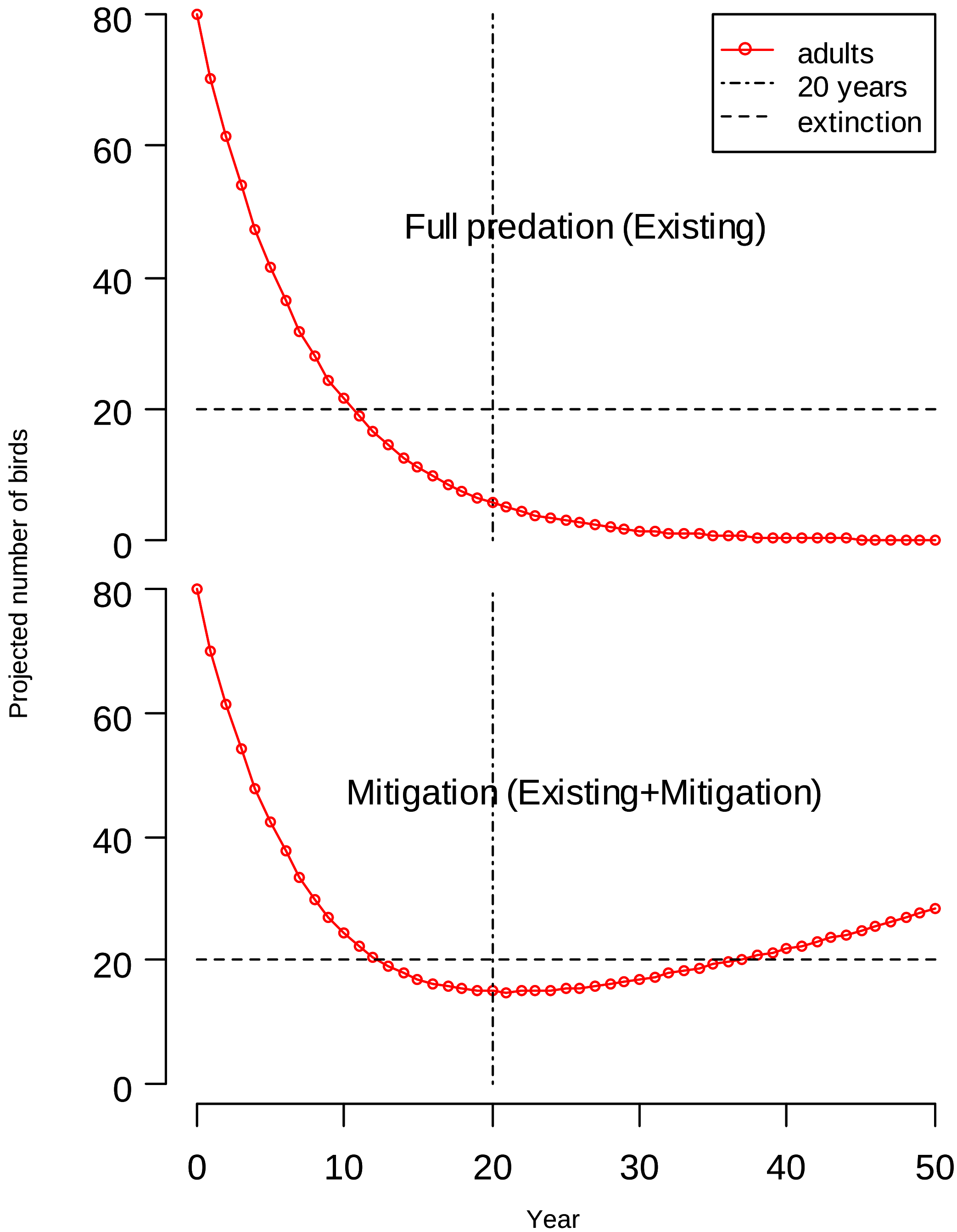


Figure 21. Projected number of Newell's shearwaters, by life stage, for the overall population under full predation (no mitigation) and mitigation (no predation) scenarios, Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period, and the horizontal line indicates the threshold for extinction (10 breeding pairs), which is only reached under full predation.

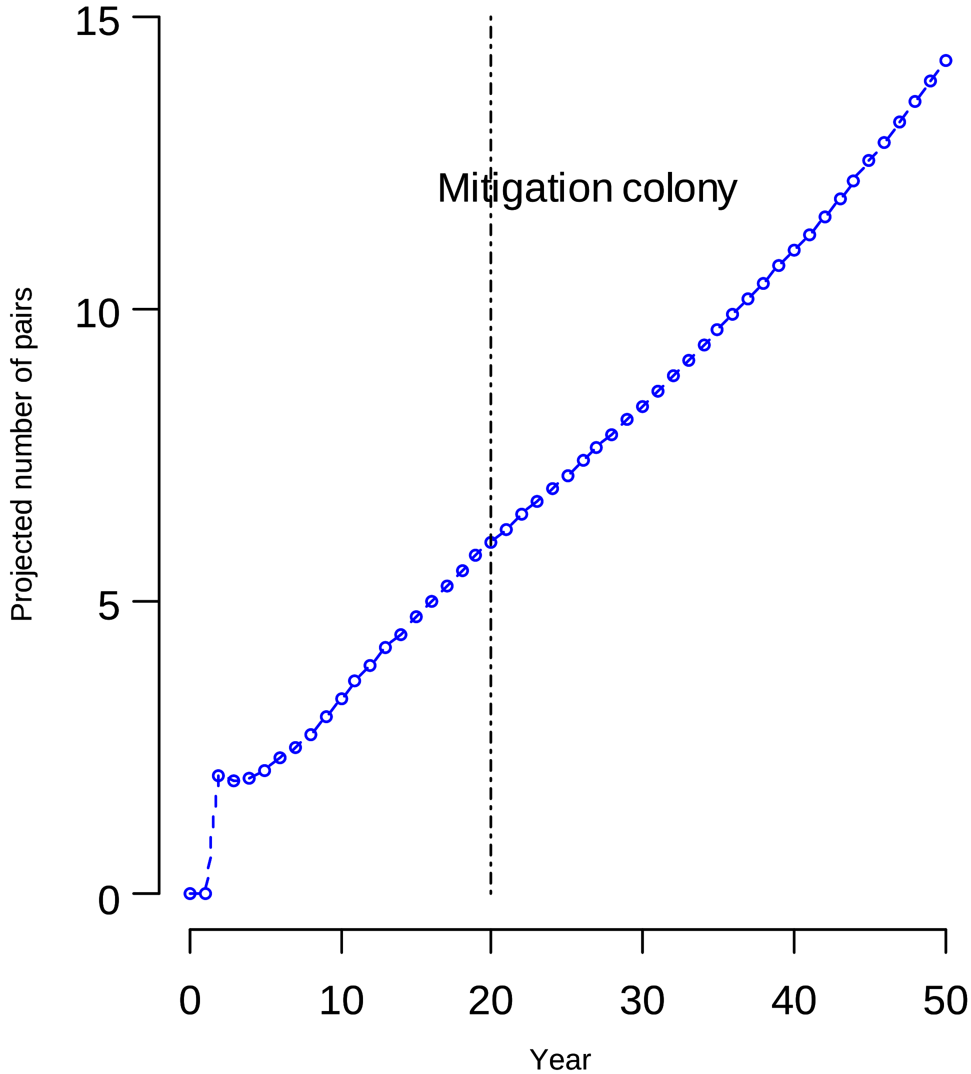


Figure 22. Projected number of Newell's shearwater adults for mitigation colony (social attraction), Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period.

CONCLUSION

This addendum presents a more concise version of the modeling results for the purpose of evaluation by USFWS than what was contained in previous modeling efforts for Newell's shearwater. We still agree with the conclusions from the previous addenda (HTH and PRBO 2011c, d). As was stated in Addenda 2 and 3 (HTH and PRBO 2011c, d), we believe that the social attraction mitigation provides a viable way by which to meet mitigation targets within a reasonable timeframe. Model results suggest that substantial progress can be made toward take levels, with the baseline level of take for adults being met within the 20-year license period, and within a few years of the 20-year license period for fledglings under the proposed mitigation.

Most importantly, our modeling efforts suggest that under the current conditions, the west Maui population may become extinct within the timeframe of the license period, especially if this project is not undertaken in the very immediate future. Modeling results from the social attraction option, and the experience with similar projects in New Zealand, show that it may be possible to reverse the trend, if this option is implemented soon. Some additional recovery efforts should also be made to decrease the risk of complete loss of all individuals due to stochastic events.

REFERENCES

Ainley DG, R Podolsky, L de Forest, G Spencer, N Nur. 1995. Kauai endangered seabird study - Volume 2. The ecology of dark-rumped petrels and Newell’s shearwater on the island of Kauai, Hawaii. Palo Alto (CA): Electric Power Reserach Institute.

Ainley DG, R Podolsky, L de Forest, G Spencer, N Nur. 2001. The status and population trends of the Newell's Shearwater on Kaua'i: Insights from modeling. Studies in Avian Biology 22:108-123.

Bell M, BD Bell, EA Bell. 2005. Translocation of fluttering shearwater (*Puffinus gavia*) chicks to create a new colony. Notornis 52:11-15.

Brooke, M. 1990. The Manx Shearwater. T & AD Poyser, Academic Press, Ltd, London.

Cooper BA, RH Day. 2003. Movement of the Hawaiian petrel to inland breeding sites on Maui island, Hawai’i. Waterbirds 26:62-71.

Griesemer AM, ND Holmes. 2010. Newell’s shearwater population modeling for HCP and recovery planning – Draft. University of Hawaii and State of Hawaii.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011a. Newell’s Shearwater population modeling – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011b. Addendum 1: Newell’s Shearwater population modeling – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011c. Addendum 2: Newell’s Shearwater population modeling – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

[HTH] H. T. Harvey & Associates, [PRBO] PRBO Conservation Science. 2011d. Addendum 3: Newell’s Shearwater population modeling: modeling the hypothetical rate of extinction of the last remaining Newell’s shearwaters in West Maui – Final. Kihei (HI): First Wind, Environmental Affairs, Kaheawa Wind Power, LLC.

Miskelly CM, GA Taylor. 2004. Establishment of a colony of common diving petrels (*Pelecanoides urinatrix*) by chick transfers and acoustic attraction. Emu 104: 205-211.

[NARS] Natural Area Reserve System. 1989. West Maui Natural Area Reserve Management Plan. Technical report. Honolulu (HI): State of Hawaii, Department of Land and Natural Resources.

Nur N, WJ Sydeman. 1999. Demographic processes and population dynamic models of seabirds: Implications for conservation and restoration. Current Ornithology 15:149-188.

Schreiber EA, J Burger. 2001. Biology of marine birds. Boca Raton (FL): CRC Press.

APPENDIX F.
POPULATION MODELING RESULTS OF NEWELL'S SHEARWATER PETREL AT A POTENTIAL MITIGATION SITE, MAKAMAKA'OLE (WEST MAUI) – SOCIAL ATTRACTION

Table F1. Number of Newell's shearwater individuals projected per year and differences between mitigation and full predation scenarios, based on 40 nesting pairs in the existing colony and high predation level in existing colony.

					# Greater than Baseline Scenario			
Scenario	Year	Adults	Juveniles	Fledglings	Adults	Juveniles	Fledglings	Total
Baseline	0	80.0	24.9	6.2				
	1	70.2	21.9	5.4				
	2	61.5	19.2	4.7				
	3	53.9	16.8	4.2				
	4	47.3	14.7	3.6				
	5	41.5	12.9	3.2				
	6	36.4	11.3	2.8				
	7	31.9	9.9	2.5				
	8	28.0	8.7	2.2				
	9	24.5	7.6	1.9				
	10	21.5	6.7	1.7				
	11	18.9	5.9	1.5				
	12	16.5	5.2	1.3				
	13	14.5	4.5	1.1				
	14	12.7	4.0	1.0				
	15	11.1	3.5	0.9				
	16	9.8	3.0	0.8				
	17	8.6	2.7	0.7				
	18	7.5	2.3	0.6				
	19	6.6	2.1	0.5				
	20	5.8	1.8	0.4				
	21	5.1	1.6	0.4				
	22	4.4	1.4	0.3				
	23	3.9	1.2	0.3				
	24	3.4	1.1	0.3				
	25	3.0	0.9	0.2				
	26	2.6	0.8	0.2				
	27	2.3	0.7	0.2				
	28	2.0	0.6	0.2				
	29	1.8	0.6	0.1				
	30	1.6	0.5	0.1				
	31	1.4	0.4	0.1				
	32	1.2	0.4	0.1				
	33	1.0	0.3	0.1				
	34	0.9	0.3	0.1				
	35	0.8	0.3	0.1				
	36	0.7	0.2	0.1				
	37	0.6	0.2	0.0				
	38	0.5	0.2	0.0				
	39	0.5	0.1	0.0				
	40	0.4	0.1	0.0				
	41	0.4	0.1	0.0				
	42	0.3	0.1	0.0				
	43	0.3	0.1	0.0				
	44	0.2	0.1	0.0				

Table F1. Number of Newell's shearwater individuals projected per year and differences between mitigation and full predation scenarios, based on 40 nesting pairs in the existing colony and high predation level in existing colony.

					# Greater than Baseline Scenario			
Scenario	Year	Adults	Juveniles	Fledglings	Adults	Juveniles	Fledglings	Total
Baseline	45	0.2	0.1	0.0				
	46	0.2	0.1	0.0				
	47	0.2	0.1	0.0				
	48	0.1	0.0	0.0				
	49	0.1	0.0	0.0				
	50	0.1	0.0	0.0				
Reasonable	0	80.0	24.9	6.2	0.0	0.0	0.0	0.0
	1	70.2	21.9	5.4	0.0	0.0	0.0	0.0
	2	61.5	19.2	4.7	0.0	0.0	0.0	0.0
	3	54.2	17.4	4.6	0.3	0.6	0.4	0.8
	4	47.8	15.7	4.1	0.5	1.0	0.4	1.5
	5	42.4	14.3	3.7	0.9	1.3	0.5	2.2
	6	37.6	13.0	3.4	1.3	1.6	0.6	2.9
	7	33.5	12.3	3.4	1.6	2.3	1.0	4.0
	8	30.0	11.7	3.2	2.0	3.0	1.1	4.9
	9	27.0	11.5	3.5	2.5	3.9	1.6	6.4
	10	24.5	11.5	3.5	3.0	4.8	1.8	7.7
	11	22.3	11.5	3.5	3.5	5.7	2.0	9.1
	12	20.5	11.7	3.5	4.0	6.6	2.2	10.5
	13	19.1	11.9	3.5	4.6	7.4	2.4	11.9
	14	17.9	12.1	3.6	5.1	8.1	2.6	13.3
	15	17.0	12.2	3.7	5.9	8.8	2.8	14.6
	16	16.3	12.4	3.7	6.6	9.4	3.0	15.9
	17	15.8	12.6	3.8	7.3	9.9	3.1	17.2
	18	15.5	12.8	3.9	7.9	10.5	3.3	18.4
	19	15.2	13.1	4.0	8.6	11.0	3.5	19.6
	20	15.0	13.4	4.1	9.3	11.6	3.6	20.8
	21	15.0	13.7	4.2	9.9	12.1	3.8	22.0
	22	15.0	14.0	4.3	10.5	12.6	3.9	23.1
	23	15.1	14.3	4.4	11.2	13.1	4.1	24.3
	24	15.2	14.7	4.5	11.8	13.6	4.2	25.4
	25	15.4	15.1	4.6	12.4	14.1	4.4	26.5
	26	15.6	15.5	4.7	13.0	14.6	4.5	27.7
	27	15.9	15.9	4.9	13.6	15.2	4.7	28.8
	28	16.3	16.3	5.0	14.2	15.7	4.8	29.9
	29	16.6	16.8	5.1	14.8	16.2	5.0	31.0
	30	17.0	17.2	5.3	15.4	16.7	5.2	32.2
	31	17.4	17.7	5.4	16.1	17.3	5.3	33.3
	32	17.9	18.2	5.6	16.7	17.8	5.5	34.5
	33	18.3	18.7	5.8	17.3	18.4	5.7	35.7
	34	18.8	19.3	5.9	17.9	19.0	5.8	36.9
	35	19.3	19.8	6.1	18.5	19.6	6.0	38.0
	36	19.8	20.4	6.2	19.1	20.1	6.2	39.2
	37	20.3	20.9	6.4	19.7	20.7	6.4	40.4

Table F1. Number of Newell's shearwater individuals projected per year and differences between mitigation and full predation scenarios, based on 40 nesting pairs in the existing colony and high predation level in existing colony.

					# Greater than Baseline Scenario			
Scenario	Year	Adults	Juveniles	Fledglings	Adults	Juveniles	Fledglings	Total
Reasonable	38	20.8	21.5	6.6	20.3	21.3	6.5	41.6
	39	21.4	22.1	6.8	20.9	21.9	6.7	42.8
	40	21.9	22.6	6.9	21.5	22.5	6.9	44.0
	41	22.5	23.2	7.1	22.1	23.1	7.1	45.2
	42	23.1	23.8	7.3	22.8	23.7	7.3	46.5
	43	23.7	24.5	7.5	23.4	24.4	7.5	47.8
	44	24.3	25.1	7.7	24.1	25.0	7.7	49.1
	45	25.0	25.8	7.9	24.7	25.7	7.9	50.4
	46	25.6	26.5	8.1	25.4	26.4	8.1	51.8
	47	26.3	27.1	8.3	26.1	27.1	8.3	53.2
	48	27.0	27.9	8.5	26.8	27.8	8.5	54.6
	49	27.7	28.6	8.8	27.6	28.6	8.7	56.1
	50	28.4	29.3	9.0	28.3	29.3	9.0	57.6

Appendix 26

Triggers and Timelines for Tier 2 Mitigation and Mitigation Contingencies.

Newell's Shearwater

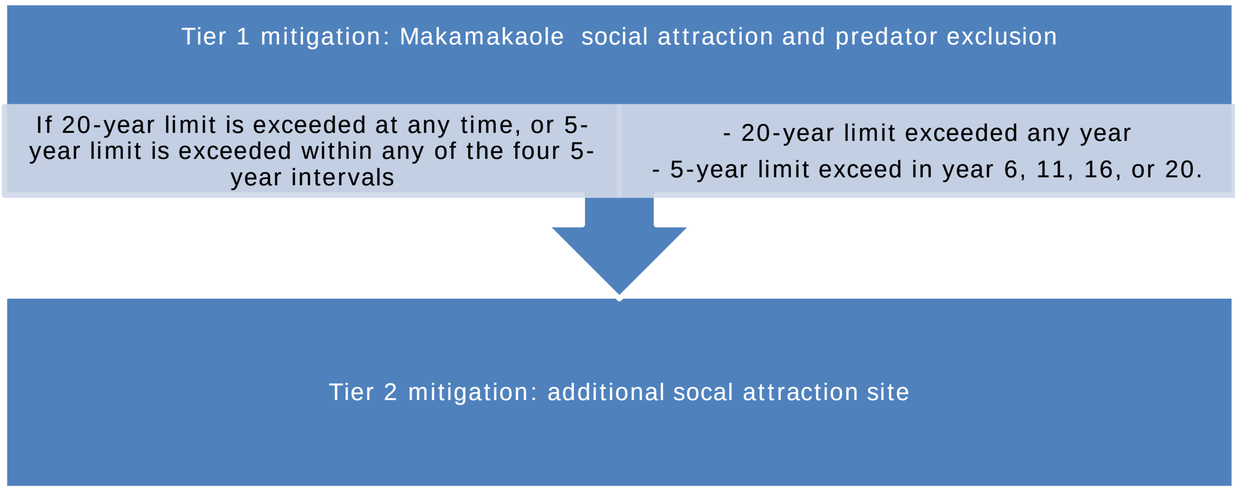


Figure 1: Triggers and timeline for Tier 2 mitigation for Newell's shearwater

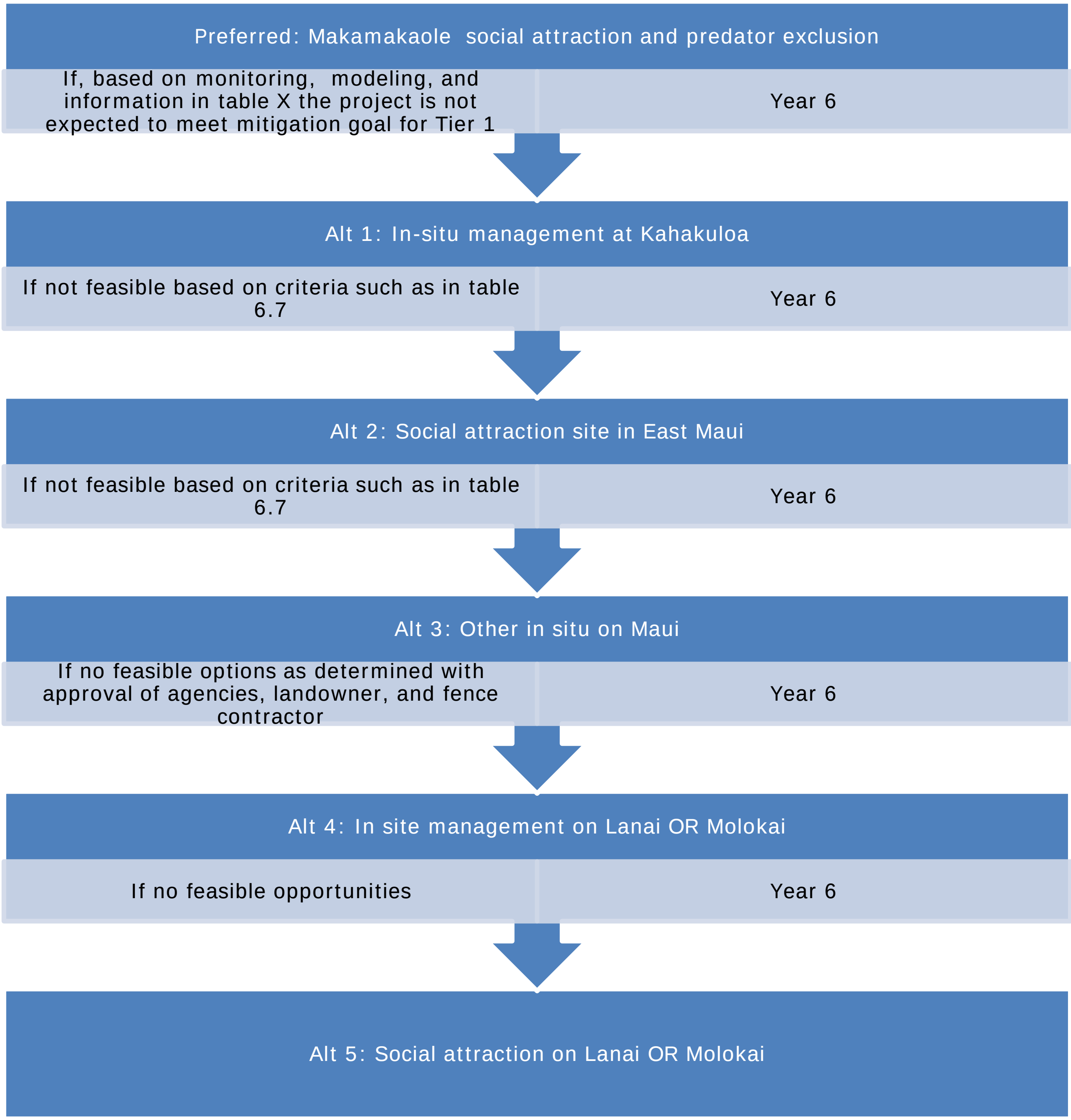


Figure 2: Triggers and timeline for mitigation contingencies for Newell's shearwater

Hawaiian Petrel

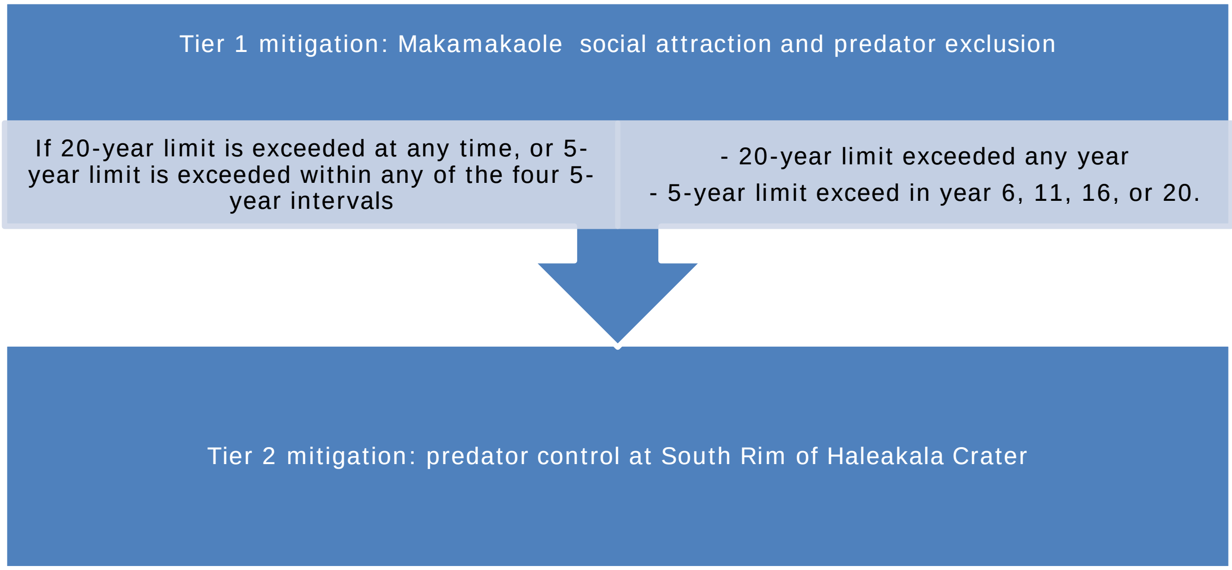


Figure 3: Triggers and timeline for Tier 2 mitigation for Hawiian petrel

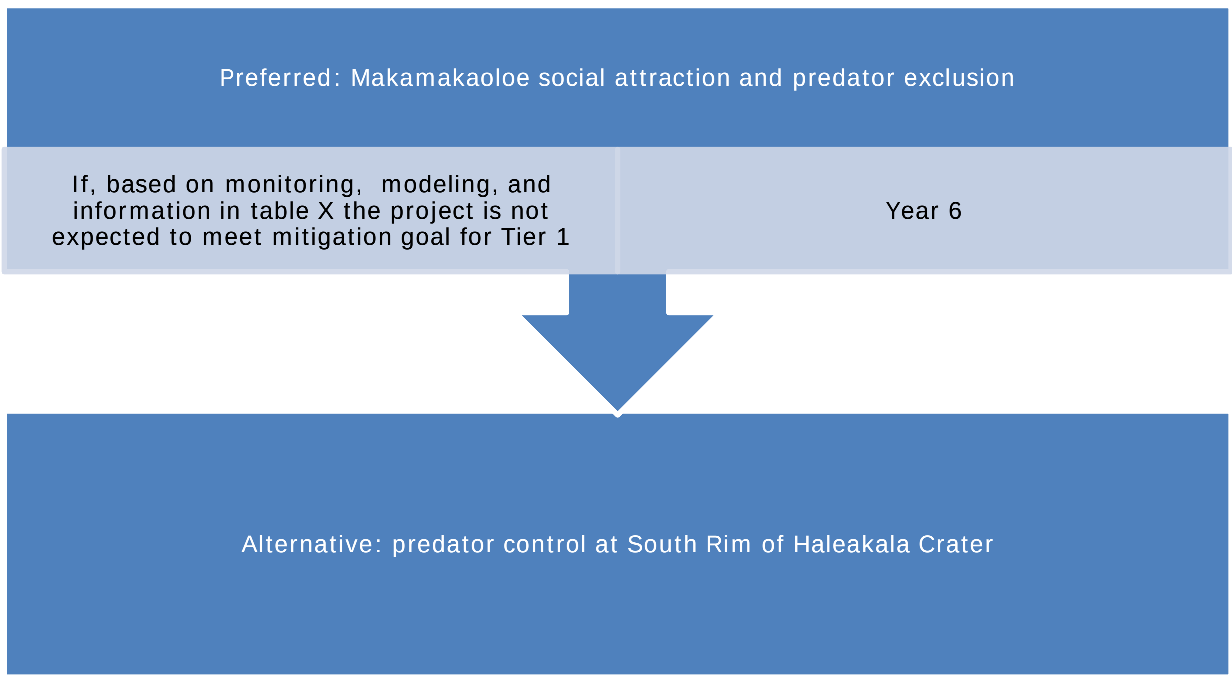


Figure 4: Triggers and timeline for mitigation contingencies for Hawaiian petrel

Nene

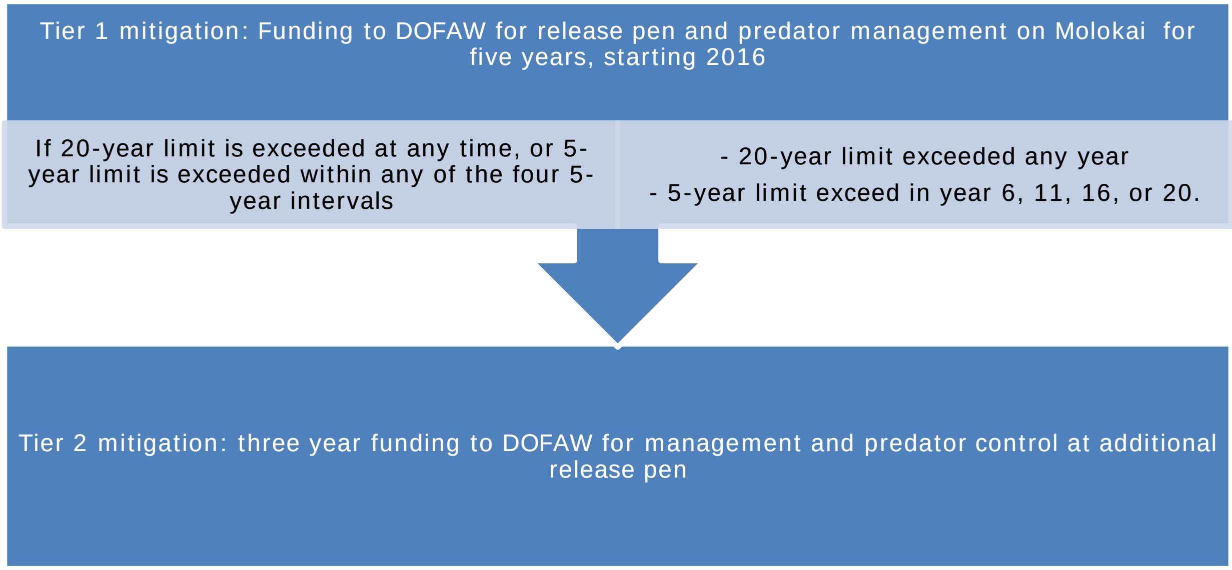


Figure 5: Triggers and timeline for Tier 2 mitigation for nene

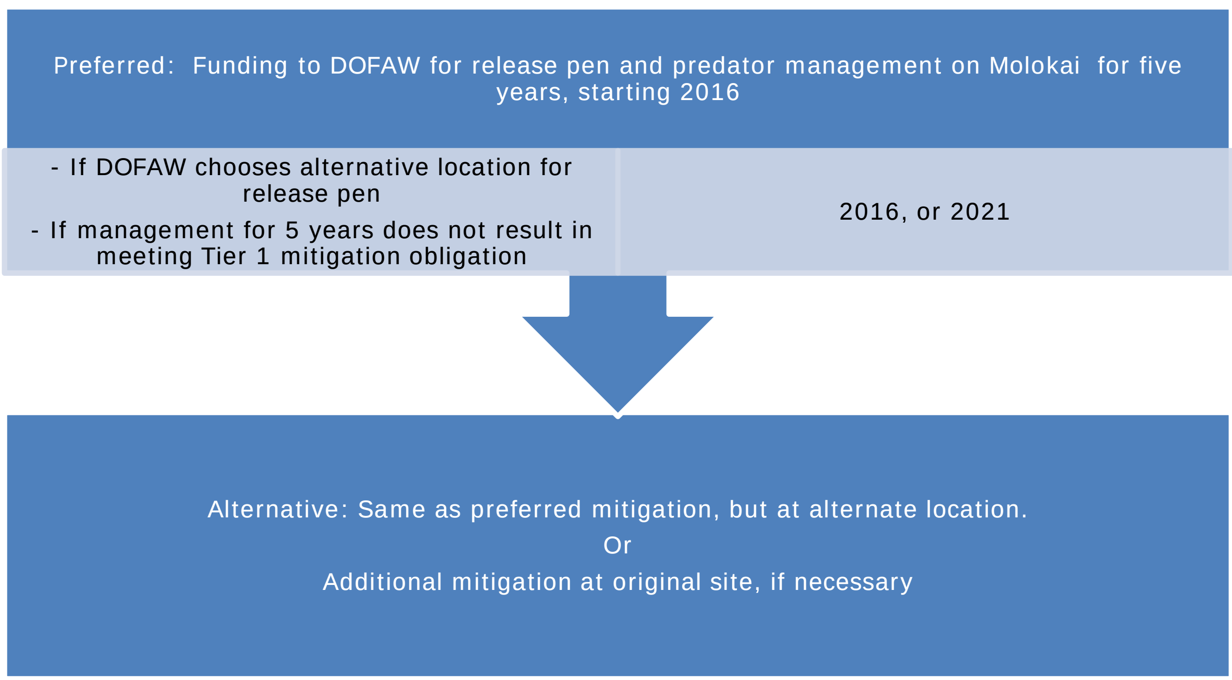


Figure 6: Triggers and timeline for mitigation contingencies for nene

Hawaiian Hoary Bat

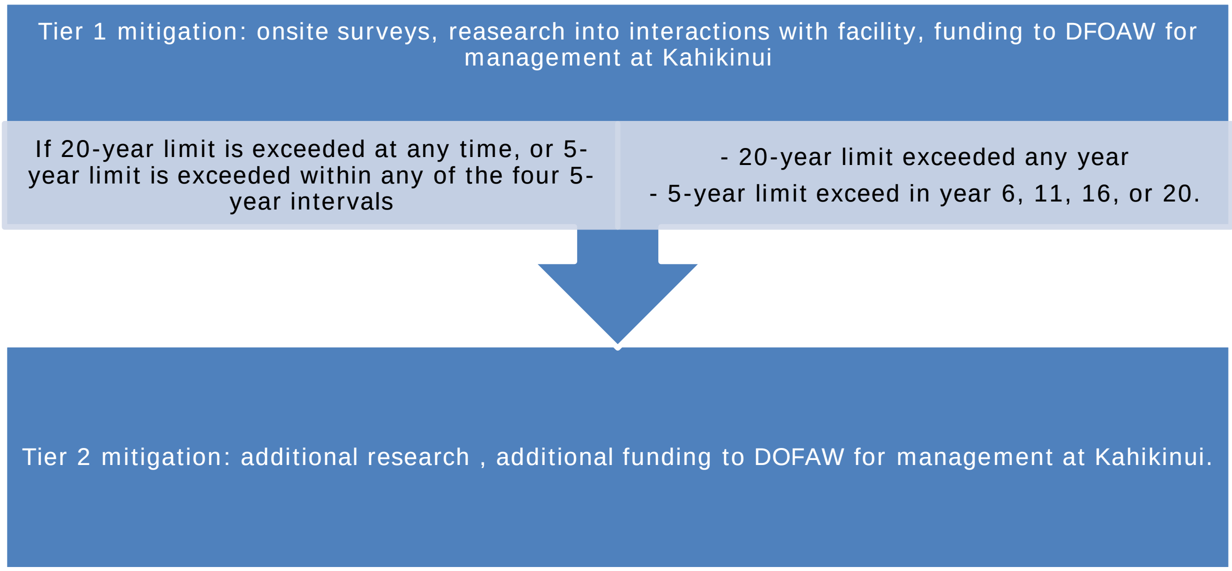


Figure 7: Triggers and timeline for Tier 2 mitigation for Hawaiian hoary bat

Appendix 27

Estimating Fatalities for Nēnē and the Hawaiian Hoary Bat at Kaheawa Wind Power II

<u>Nēnē</u>

Kaheawa Wind Power II (KWP II) estimated total nēnē fatalities from take observed during downed wildlife monitoring and projected an estimate for the 20-year permit period (Table 1) using the Evidence of Absence (EoA v2.06) software (Huso *et al*. 2015, Dalthorp *et al.* 2017). The actual period during which the turbines have been and will be operating is 19.5 years. Operations began in July 2012 and the permit term ends January 2032. All estimates for the "20-year permit period" are for 19.5 years.

The number of fatalities assumed to be observed for the remaining years of the permit is extrapolated by the EoA software from the actual take observed during six years of monitoring and adjusted for the reduced search area (began July 2015) defined in the long-term reduced monitoring protocol (see Appendix 28).

Biologists' intensive monitoring at KWP II (prior to July 2015) searched the areas around all turbines within circles centered on the WTG having a radius extending to 75m. Based on ballistics modeling Hull and Muir (2010) calculated that approximately 20% of the total fall distribution of large birds (nēnē) found around "small" turbines may fall *beyond* 75m. They considered turbines with a hub height of 65m to be a "small" turbine in their model; 75m and 97m were considered the distances within which 80% and 99%, respectively, of all large birds might fall around a "small" turbine.

Long-term monitoring (Appendix 28) will continue to the end of the permit period at the same reduced search area effort as began in July 2015. The reduced effort at KWP II consists of searching only the roads and graded pads that occur within a 70m radius circle centered on each turbine (Figure 1a and 1b). The portion of all nēnē fatalities from turbine strikes that could fall within the 70m circle is calculated based on the known fall distribution of all observed nēnē take at KWP I and KWP II (Figure 2). The KWP I and KWP II nacelle heights are 68 and 72m, respectively, and the maximum height of the rotor swept zone are 90 and 100m, respectively. Since these heights are similar all the observed nēnē take from both sites has been used in creating the fall distribution. We assume approximately 20% of nēnē may have fallen beyond 70m and therefore were not observed. To create a total fall distribution, we add six more nēnē beyond those observed within 70m: three at 71-80m, two at 81-90m, and one at 91-100m or approximately 20% more than the 30 observed nēnē used in creating the fall distribution. The fall distribution is assumed to be uniform around the turbine.

The area around the turbines within a 70m circle centered on each turbine that is graded road or turbine pads is calculated to include 83.3% of all nēnē carcasses expected to fall from turbine strikes (Figure 2). More birds are expected to and do fall closer to the WTG; the distribution of fatalities is not uniform, becoming less dense per acre as distance increases from the WTG. To determine the density-weighted proportion (DWP) of the total fall distribution, the 70m circle is divided into six circular adjacent bands around the WTG. The first, closest band encompasses the area from the WTG out to 20m radius and each band farther from the WTG has a 10m radius (Table 2). The total area in acres is calculated for each band and summed for all 14 turbines. The proportion of the total area in each band for each turbine that will be searched (roads and pads) is determined using ARCGIS (Table 2) and summed for all 14 turbines. The product of the portion of total area searched per band for all turbines and the expected portion of the total fatality distribution per band are determined for each band and the results summed for all six bands to derive the portion of the entire fall distribution searched across all turbines (Table 2). The reduced search area of roads and pads is estimated to encompass 36.4% of all nēnē fatalities that could occur from turbine strikes (Table 1).

For nēnē at KWP II SEEF is 100% with canine-assisted downed wildlife monitoring and average CARE is usually as long as the 28-day trials. In other words, the search conditions for nēnē at KWP II are nearly perfect, all nēnē falling in the searched area should be found. Therefore, if one nēnē is found in the formal search area we can assume that approximately two nēnē landed beyond the search area and were assumed to have not been found. There may or may not have been two additional nēnē killed but not found but we are assured (with 80% credibility) that no more than two nēnē were killed for everyone found. The actual observed nēnē fatalities found during the three-year intensive monitoring period was three and the actual observed nēnē fatalities found during the three-year reduced monitoring period was two. Since the proportion of the total fall distribution searched during intensive monitoring was 70% and the proportion during reduced searching was 36.4% we might expect an average of 1.5 nēnē observed during the three years of reduced searching (36.4%/70% * 3 observed nēnē = 1.56 observed nēnē).

Our estimation projecting take 14 years into the future assumes that the most recent SEEF and CARE values from 2018 continue to be similar for the remainder of the permit term. The SEEF values for nēnē on pads and roads may be higher than the overall SEEF observed during intensive monitoring when grass and shrubs of varying height were more likely to obscure areas searched.

With 80% credibility and five observed nēnē fatalities, no more than 43.0 nēnē would have been directly taken after 19.5 years (the operations period of the permit term of KWPII, Table 1); an average estimated annual direct take rate of 2.205 nēnē/year. If only 50% credibility level is chosen the total estimated direct take for the permit period is 35.8 adult nēnē.

Table 1. Input Parameters and Observed/Projected results for nēnē at KWPII.

Fiscal Year	% Year (*rho*)	Search Interval (*I*)	Carcass Count (*X*)	SEEF (*p*)			Persistence Distribution (CARE)				Spatial Coverage (*a*)	Probability of Detection (*g*)			Probability of Detection Beta Distribution (*B*)		M*
				found	placed	*k*	distribution	scale	95% CI for scale			*g*	min	max	*B*a	*B*b	
2013	1	7	**1**	6	9	1	Exponential	1000	45.9	237000	0.7	0.654	0.503	0.791	26.32	13.91	**3**
2014	1	7	**0**	5	5	1	Exponential	593	27.3	152000	0.7	0.653	0.474	0.812	18.94	10.05	**3**
2015	1	7	**2**	23	28	1	Exponential	1900	86.7	362000	0.7	0.681	0.583	0.771	62.81	29.46	**6**
2016	1	7	**1**	11	11	1	Exponential	844	38.7	207000	0.364	0.327	0.255	0.403	49.59	102.08	**9**
2017	1	7	**0**	12	12	1	Exponential	1280	58.7	434000	0.364	0.33	0.271	0.391	76.79	156.17	**10**
2018Q3	0.75	7	**1**	9	9	1	Exponential	796	36.5	195000	0.364	0.324	0.241	0.413	36.11	75.30	**13**
2018Q4	0.25											0.324	0.241	0.413	36.11	75.30	**13.4**
2019	1											0.324	0.241	0.413	36.11	75.30	**15.8**
2020	1											0.324	0.241	0.413	36.11	75.30	**18.2**
2021	1											0.324	0.241	0.413	36.11	75.30	**20.3**
2022	1											0.324	0.241	0.413	36.11	75.30	**22.6**
2023	1											0.324	0.241	0.413	36.11	75.30	**24.8**
2024	1											0.324	0.241	0.413	36.11	75.30	**26.9**
2025	1											0.324	0.241	0.413	36.11	75.30	**29.2**
2026	1											0.324	0.241	0.413	36.11	75.30	**31.2**
2027	1											0.324	0.241	0.413	36.11	75.30	**33.4**
2028	1											0.324	0.241	0.413	36.11	75.30	**35.5**
2029	1											0.324	0.241	0.413	36.11	75.30	**37.6**
2030	1											0.324	0.241	0.413	36.11	75.30	**39.7**
2031	1											0.324	0.241	0.413	36.11	75.30	**41.9**
Jan 2032	0.5											0.324	0.241	0.413	36.11	75.30	**43.0**

Table 2. Proportion of nēnē Expected to Fall within the Reduced Search Area

Distance Band (m)	Search Area Within Distance Band (m^2)*	Total Area of Distance Band (m^2)*	Proportion of Distance Band Searched (A)	Portion Birds Found Within Distance Band (B)	DWP of Distance Band (A x B)
20	17584	15745.8	0.895	0.167	0.149
30	21980	12284.1	0.559	0.194	0.109
40	30772	9141.1	0.297	0.278	0.083
50	39564	7621.3	0.193	0.056	0.011
60	48356	5914.9	0.122	0.056	0.007
70	57148	4491.8	0.079	0.083	0.007
			Totals	**0.833**	**0.364**

*ARCGIS derived

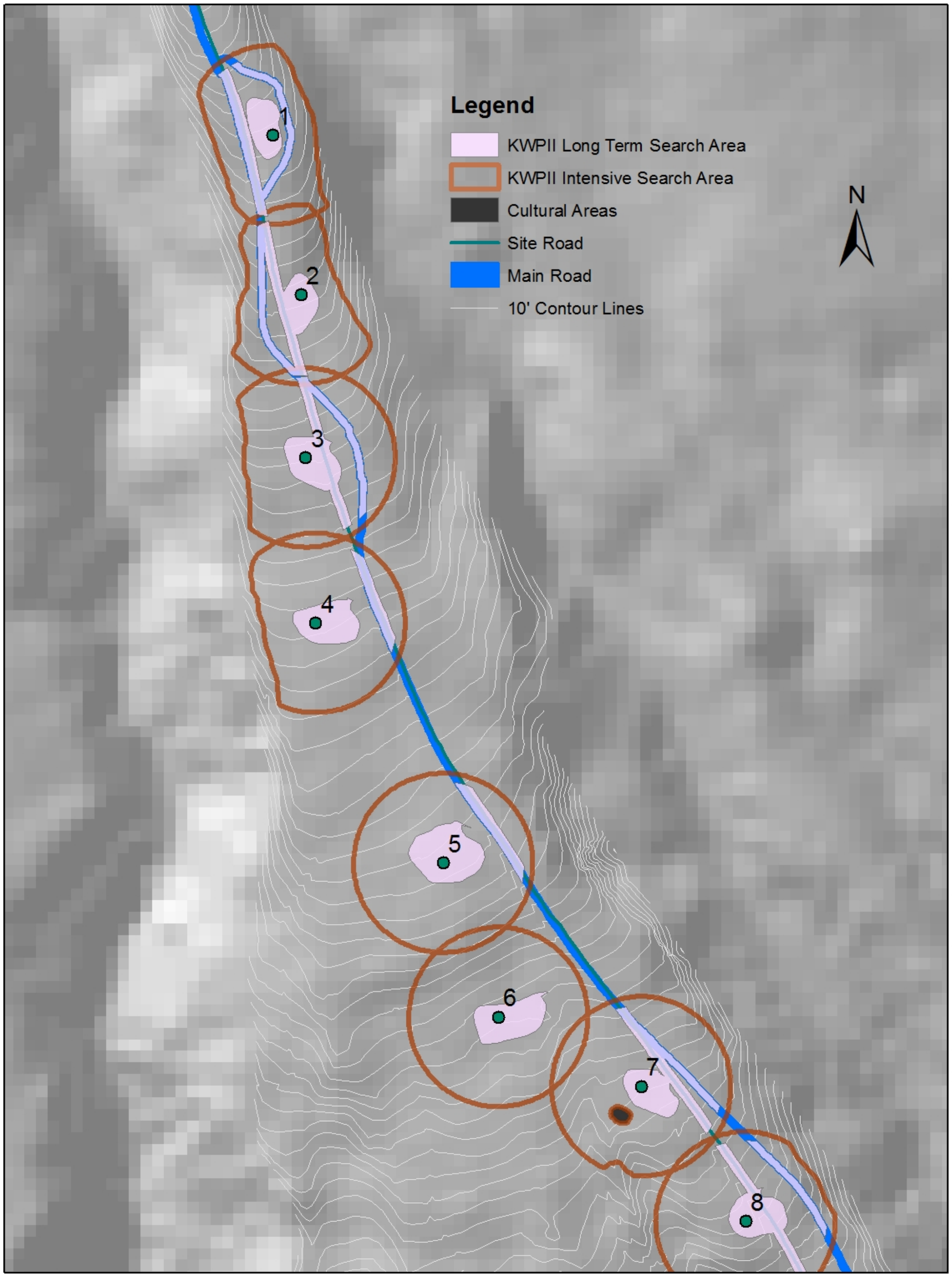


Figure 1a. Long Term Monitoring Search Area for KWPII (Turbines 1-7) with Roads and Pads Out to 70 m. Complete circles are 70 m radius.

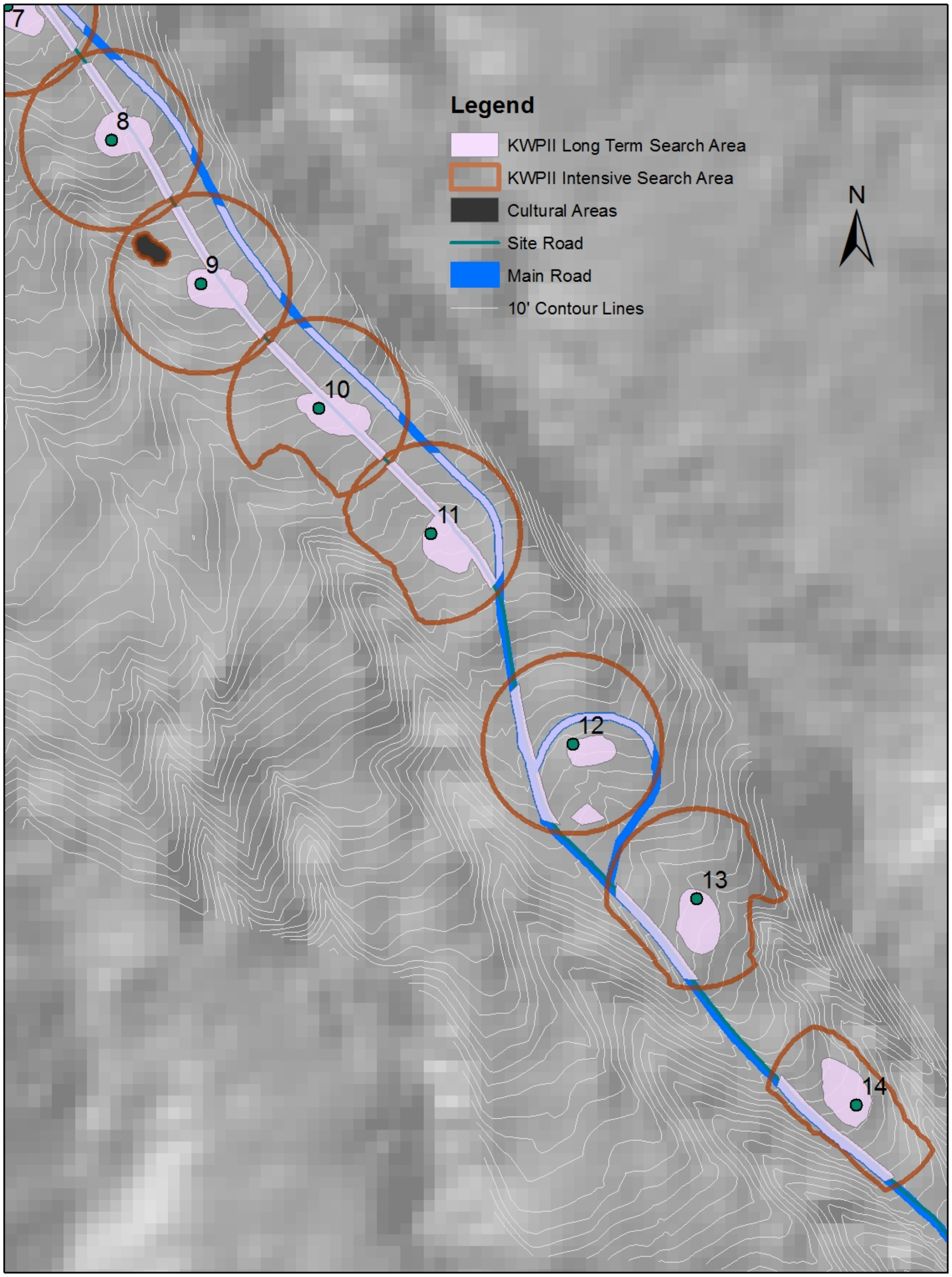


Figure 1b. Long Term Monitoring Search Area for KWPII (Turbines 8-14) with Roads and Pads Out to 70 m.

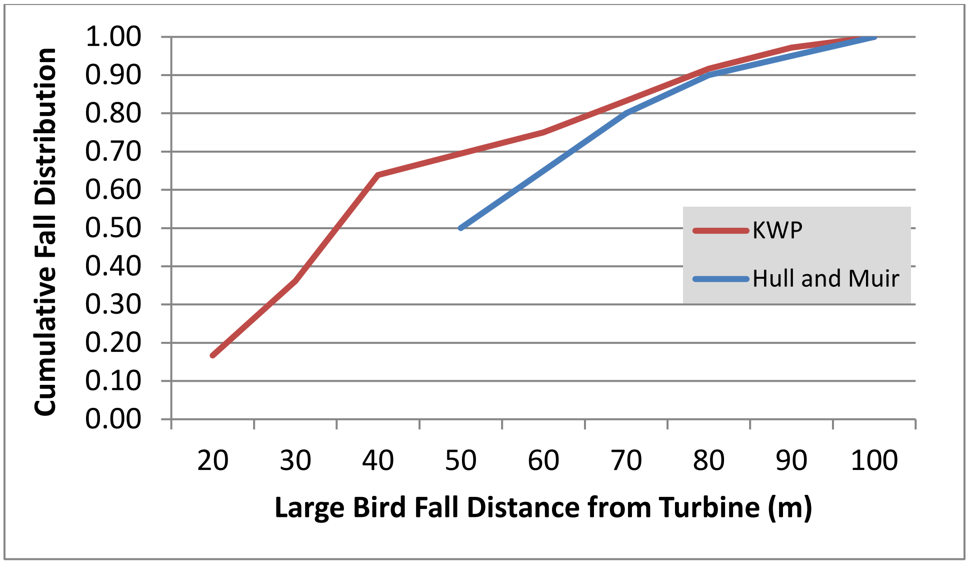


Figure 2. Cumulative Distribution of Large Birds' Distances from the Turbines at KWPI and KWPII (n = 30 observed nēnē between 0-70m radius and n = 6 hypothesized between 71-100m radius) and Hull and Muir (2010) large bird/small turbine ballistics model results.

Hawaiian Hoary Bat Fatality Rates

KWP II estimates total bat fatalities from take observed during monitoring and also projects an estimate for the 20-year permit period (Table 1) using the Evidence of Absence software (v2.06; Huso *et al*. 2015, Dalthorp *et al.* 2017). The actual period during which the turbines have been and will be operating is 19.5 years. Operations began in July 2012 and the permit term ends January 2032. All estimates for the "20-year permit period" are for 19.5 years.

The number of fatalities likely to be observed for the remaining years of the permit is extrapolated from the actual take observed at KWP I and KWP II during monitoring (12 years and 6 years, respectively) and adjusted for the reduced search area defined in the long-term reduced monitoring protocol that began July 2015 (see Appendix 28).

Biologists' intensive monitoring at KWP II searched the areas around all turbines within a circle centered on the WTG having a radius of 75m. Based on ballistics modeling Hull and Muir (2010) calculated that less than 1% of the total fall distribution of bats found around "small" turbines would fall beyond 75m. They considered turbines with a hub height of 65m to be a "small" turbine in their model; 32m and 45m were considered the distances within which 80% and 99%, respectively, of all bats might fall around a "small" turbine.

Long-term monitoring (Appendix 28) will continue to the end of the permit period at the same reduced search area effort as began in July 2015. The reduced effort at KWP II consists of searching only the roads and graded pads that occur within the 70m radius circle centered on each turbine (Figure 1a and 1b). The portion of all bat carcasses from turbine strikes that could fall within this 70m circle is calculated based on the known fall distribution of all observed bat take at KWP I and KWP II (Figure 3). Based on Hull and Muir (2010) ballistics modelling and observed carcasses we assume less than 1% of bats may have fallen beyond 70m. The KWP I and KWP II nacelle heights are 68 and 72m, respectively, and the maximum height of the rotor swept zone are 90 and 100m, respectively. Since these heights are similar all of the observed bat take from both sites has been used in creating the fall distribution. The fall distribution is assumed to be uniform around the turbine.

A 70m circle centered on each WTG is modeled to include 100% of all bat carcasses expected to fall from turbine strikes (Figure 3). More bats are expected to and do fall closer to the WTG and the distribution of fatalities is not uniform but is becoming less dense per acre as distance increases. To determine this density-weighted proportion (DWP) of the total fall distribution, the 70m circle is divided into six circular adjacent bands around the WTG. The first, closest band encompasses the area from the WTG out to 20m radius and each band farther from the WTG is 10m radius (Table 4). The total area in acres is calculated for each band and summed for all 14 turbines. The proportion of the total area in each band that is searched (roads and pads) is determined using ARCGIS (Table 4) and summed for all 14 turbines. The product of the portion of the total area actually searched per band area for all turbines and the expected portion of the total fatality distribution per band is determined for each band and the results summed for all six bands to derive the final portion of the entire fall distribution searched across all turbines (Table 4). The reduced search area of roads and pads is estimated to encompass 55.9% of all bat fatalities that could occur (Table 4). If the searching conditions were perfect (they are not) we would assume to find in the searched area half of all bats killed.

Our estimation projecting take 14 years into the future assumes that the most recent SEEF and CARE values from FY 2018 continue to be similar for the remainder of the permit term. The SEEF values for bats on pads and roads should be higher than the overall SEEF observed during intensive monitoring when grass and shrubs of varying height were more likely to obscure areas searched.

With 80% credibility, no more than 36.5 bats would have been directly taken after 19.5 years (the operations period of the 20-year permit term of KWPII, Table 1); an average estimated annual direct take rate of 1.87 bats/year. If only 50% credibility level is chosen the total estimated direct take for the permit period is 29.9 adult bats.

Table 3. Input Parameters and Observed/Projected Results for the Hawaiian Hoary Bat at KWPII.

Fiscal Year	% Year (rho)	Search Interval (*I*)	Carcass Count (*X*)	SEEF (*p*)			Persistence Distribution (CARE)					Spatial coverage (*a*)	Probability of Detection (*g*)			Probability of Detection Beta Distribution (*B*)		M*
				found	placed	*k*	distribution	shape	scale	95% CI for scale			*g*	min	max	*Ba*	*Bb*	
2013	1	7	**1**	8	19	0.7	LogNormal	0.613	2.138	1.629	2.647	1	0.443	0.241	0.656	9.080	11.412	**5**
2014	1	7	**2**	26	50	0.7	LogNormal	1.077	1.426	0.915	1.936	1	0.359	0.235	0.493	18.503	33.022	**12**
2015	1	7	**0**	21	56	0.7	Exponential	-	9.416	3.850	23.030	1	0.336	0.187	0.504	10.953	21.675	**12**
2016	1	7	**0**	34	42	1	LogNormal	9.214	2.589	1.056	4.122	0.559	0.362	0.27	0.46	35.087	61.842	**12**
2017	1	7	**0**	40	43	1	LogNormal	3.209	2.629	1.815	3.444	0.559	0.442	0.374	0.511	87.960	111.122	**12**
2018Q3	0.75	7	**0**	29	29	1	LogNormal	5.164	1.844	0.497	3.191	0.559	0.349	0.244	0.462	25.149	46.942	**12**
2018Q4	0.25												0.349	0.244	0.462	25.149	46.942	**12.4**
2019	1												0.349	0.244	0.462	25.149	46.942	**14.1**
2020	1												0.349	0.244	0.462	25.149	46.942	**15.7**
2021	1												0.349	0.244	0.462	25.149	46.942	**17.6**
2022	1												0.349	0.244	0.462	25.149	46.942	**19.5**
2023	1												0.349	0.244	0.462	25.149	46.942	**21.5**
2024	1												0.349	0.244	0.462	25.149	46.942	**23.2**
2025	1												0.349	0.244	0.462	25.149	46.942	**25**
2026	1												0.349	0.244	0.462	25.149	46.942	**26.7**
2027	1												0.349	0.244	0.462	25.149	46.942	**28.6**
2028	1												0.349	0.244	0.462	25.149	46.942	**30.4**
2029	1												0.349	0.244	0.462	25.149	46.942	**32.1**
2030	1												0.349	0.244	0.462	25.149	46.942	**34**
2031	1												0.349	0.244	0.462	25.149	46.942	**35.8**
Jan 2032	0.5												0.349	0.244	0.462	25.149	46.942	**36.5**

Table 4. Proportion of Hawaiian Hoary Bats Expected to Fall Within the Search Area

Distance Band	Area of Distance Band (m^2)*	Search Area Within Distance Band (m^2)*	Proportion of Distance Band Searched (A)	Portion Bats Found Within Distance Band (B)	DWP of Distance Band (A x B)
20	17584	15745.8	0.895	0.357	0.320
30	21980	12284.1	0.559	0.214	0.120
40	30772	9141.1	0.297	0.357	0.106
50	39564	7621.3	0.193	0.071	0.014
60	48356	5914.9	0.122	0.000	0.000
70	57148	4491.8	0.079	0.000	0.000
			Totals	**1.0**	**0.559**

* ARCGIS derived

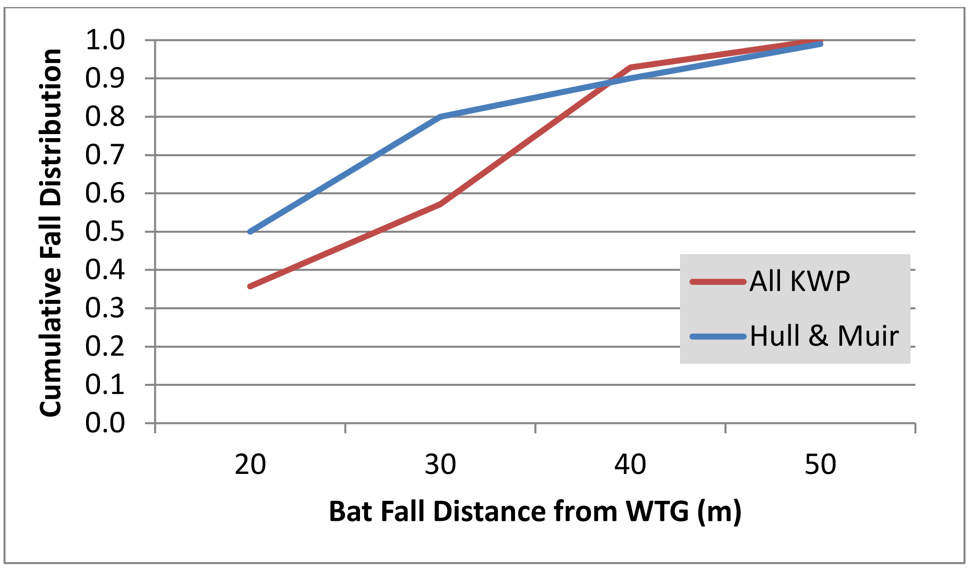


Figure 3. Cumulative Distribution of Bats' Distances from the Turbines at KWPI and KWPII (n=14) and Hull and Muir (2010) bat/small turbine ballistics model results.

References:

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

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

Dalthorp, D., M.M.P. Huso, and D. Dail. 2017. Evidence of absence (v 2.0) software user guide: U.S. Geological Survey Data Series 1055, 109p. https://doi.org/10.3133/ds1055 .

Appendix 28

KWPII - Long Term Monitoring Protocol

Summary of Intensive Monitoring Results to Date

KWPII has challenging search conditions due to rugged terrain and vegetation cover, and the use of canine assistance has until recently been restricted due to nēnē concerns. Canine assisted Downed Wildlife Monitoring began as trials in FY 2015 and had been integrated into weekly searches in FY 2016. Canine assisted monitoring will continue to the end of the 20-year permit term.

For KWPII the average observed annual take of nēnē and the Hawaiian hoary bat at KWPII was approximately one bird/year and one bat/year during intensive monitoring (Table 1 and Appendix 27). No take of Hawaiian petrels (HAPE) or Newell's shearwaters (NESH) have been documented at KWPII.

Carcass Retention (CARE) is measured in 28 day long trials. SEEF and CARE values reported include all data collected through June 30, 2015 (Table 1). Search interval has been approximately seven days at KWPII.

Table 1. Observed take, SEEF, and CARE for Nene, HAPE/NESH, and the Hawaiian hoary bat at KWPII.

<table>
<tr><th></th><th colspan="3">Nēnē</th><th colspan="3">HAPE/NESH</th><th colspan="3">Hawaiian Hoary Bat</th></tr>
<tr><td>Fiscal Year</td><td>Observed Take</td><td>Mean SEEF</td><td>Mean CARE (days)</td><td>Observed Take</td><td>Mean SEEF</td><td>Mean CARE (days)</td><td>Observed Take</td><td>Mean SEEF</td><td>Mean CARE (days)</td></tr>
<tr><td>2013</td><td>1</td><td>0.67</td><td>27</td><td>0</td><td>1.0</td><td>24</td><td>1</td><td>0.42</td><td>10</td></tr>
<tr><td>2014</td><td>0</td><td>1.0</td><td rowspan="2">28</td><td>0</td><td>0.64</td><td>28</td><td>2</td><td>0.52</td><td>6</td></tr>
<tr><td>2015</td><td>2</td><td>0.82</td><td>0</td><td>0.67</td><td>18</td><td>0</td><td>0.38</td><td>8</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

KWPII assumes that the observed take rate, fatality estimation and the variability in the environmental, ecological, and searching conditions that had been recorded during the three-year intensive monitoring period appropriately represents expected variation in the future.

Proposed Long Term Search Protocol

<u>Search Area</u>

KWPII proposes a long term monitoring protocol for the remaining years of the permit term. The searched area will consist of roads and graded pads that occur within a 70m radius circle centered on each WTG (Appendix 27). The area searched represents 34% and 56% of the expected total fall distribution of nēnē and bats (Appendix 27). Searches will continue to be conducted once a week. Visual searches are along approximately 6m wide parallel transects and canine assisted search patterns vary depending on wind direction and speed. Canine search tracks are recorded via GPS on a collar worn by the canine. Vegetation on pads and along roads will be managed to maximize searcher efficiency (i.e., eliminated or closely mowed). Exact GIS maps of the searched areas and the proportion of each 10 m wide band out to 70 m that the searched areas represent has been determined and is provided in Appendix 27.

CARE Trials

CARE trials will be conducted once every quarter and will include one medium and one large bird and at least five rats for each quarter trial with a minimum of four large and four medium birds and 20 rats per year. Predator trapping for scavengers may be implemented or intensified if carcass persistence averages less than seven days during a quarter trial.

SEEF Trials

SEEF trials will be conducted year round and will include a minimum of 40 rats (an average 10/quarter) and 10 medium and 10 large birds each year (between 2-3 birds of each bird size class each quarter).

References:

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

Appendix 29

KAHEAWA WIND POWER II

HAWAIIAN HOARY BAT MITIGATION PLAN

(for Tier 1 and Tier 2 KWP II Mitigation Fulfillment)

Applicant

Kaheawa Wind Power II, LLC
First Wind
56 Honuhula Street
Kihei, HI 96753

Prepared by

Hawai`i Department of Land & Natural Resources
Division of Forestry & Wildlife
1151 Punchbowl Street, Room 325
Honolulu, HI 96813

September 2014

Table of Contents

List of Tables

1.0 INTRODUCTION

The Hawaiian hoary bat is an endangered species found on all the Main Hawaiian Islands except Niʻihau. Current population estimates range from a few hundred to a few thousand, but the actual number remains essentially unknown. According to the state Comprehensive Wildlife Conservation Strategy (2005), primary threats include habitat loss (especially tree cover), pesticides, predation, and roost disturbance.

As per the mitigation requirements described in the Kaheawa Wind Power II (KWP II) Habitat Conservation Plan (HCP) (SWCA, 2011), Kaheawa Wind Power II, LLC (Kaheawa Wind) must provide funding for Tier 1 mitigation for the authorized take of 6 adult bats and 3 juveniles (see Section 5.2.5.3 of the HCP), which equates to a total of 7 adults (with an estimated 30% survival rate of juveniles to adulthood; see Appendix 5 of the HCP for life history information). According to the HCP, baseline mitigation must consist of, "implementation of bat habitat improvement measures to benefit bats as approved by DNLR, USFWS, and ESRC in consultation with KWP II."

The HCP specifies that, "one core area of 84.3 ac supports one male bat at a given time, and assuming that the lifespan of a Hawaiian hoary bat is approximately 10 years…then it could be assumed that one core area could be used by, or benefit, up to 2 male bats over the 20-year permit term… Based on this assumption, the mitigation area required for 4 adult male bats is two male core areas totaling 168.6 acres." Since the management is being conducted on State conservation lands, the required acreage is doubled, meaning 338 acres must be restored to mitigate for the requested Tier 1 take of bats at the KWP II facility at a cost of $250,000 ($126,260 Years 1-5, $123,740 Years 6-20). Mitigation measures must contribute to preserving or enhancing foraging and/or roosting habitat capable of supporting a commensurate number of bats to achieve the mitigation requirement.

As of February 26, 2014, adjusted take has reached the authorized Tier 2 level – 9 adult bats and 5 juveniles, equating to a total of 11 adults – requiring additional restoration of 84.3 ac of forest at Kahikinui or at another location on Maui at a cost of $125,000. Page 114 of the HCP states, "recommended [Tier 2] mitigation would consist of the additional restoration of 84.3 ac of forest at Kahikinui or at another location on Maui. If the acreage is required to be doubled because management is being conducted on State conservation land, KWPII will fund the management of 169 ac (84.3 x 2 = 169 ac) of land." However, per page 115 of the HCP, "if, at the time the Tier 2 level of take is triggered, new scientific information may indicate mitigation measures other than habitat restoration are more important or pressing for recovery of the Hawaiian hoary bat, KWPII may revise the Tier 2 mitigation plans with the approval of USFWS and DLNR."

Given that the cost for restoration and monitoring of the 340 acre unit exceeds the amount required to mitigate Tier 1 take levels, DOFAW and USFWS recommended that Kaheawa Wind direct Tier 2 mitigation funds toward the same 340 acre parcel to cover additional planting, as well as monitoring efforts which will occur in five year increments over the life of the project (Section 6.0). This plan therefore describes allocation of both Tier 1 and Tier 2 mitigations funds.

Currently, there are multiple ongoing restoration efforts being conducted at Kahikinui through various sources of funding, including funding from another First Wind development project – Kahuku Wind Power. In conjunction with these ongoing efforts, this document provides a description of the proposed allocation of the $375,000 in mitigation funds to fencing and restoring a 340 acre section of the Kahikinui Forest Reserve (FR) in order to achieve the mitigation goals described in the HCP.

2.0 OBJECTIVE

The objective of the mitigation effort is to implement measures that will not only mitigate for the permitted take, but provide a net benefit to the species by increasing population numbers of the Hawaiian hoary bat via the creation/restoration of available foraging and roosting habitat.

3.0 STUDY AREA

The proposed 340 acre project area is located between the 4,800 to 6,200 foot elevation contours in the Kahikinui FR (Mauka Unit). The upper reaches of this area are located just below the temperature inversion layer, which settles at about 6,500 feet in elevation. This is a koa-ohia montane mesic forest with an understory comprised of aʽaliʽi and other native plant species. Mesic forests are found in the transition zones between dry forest and rainforest in Hawaiʽi, receiving about 120-150 cm of annual precipitation. Mesic forests are home to a large number of endemic plant species and provide important ecosystem services in the form of habitat for native animal species and watershed protection. There is great potential for koa-ohia reforestation efforts in this wetter zone of the FR. Due to ungulate grazing and the lack of ungulate control in the area, the natural forest understory has been largely eliminated and replaced by non-native pasture grasses. However, gulches, intermittent stream beds, and other topographically protected areas still contain a diversity of native overstory tree species, understory plants, and native ferns.

Over time, restoration efforts are intended to increase native vegetation cover and provide a forest structure suitable for bat foraging, roosting and breeding. Additionally, the restoration of native forest within the parcel is expected to improve the functional connectivity of habitat within the Kahikinui area across the FR, Nakula Natural Area Reserve (NAR), and the adjacent Department of Hawaiian Home Lands (DHHL) lands.

4.0 PROPOSED MANAGEMENT ACTIONS

As mentioned above, multiple management efforts are occurring across the larger Kahikinui area, including efforts to control ungulates, restore and create native habitat, and increase native forest bird populations. The efforts funded by KWP II mitigation funds will contribute to a broader restoration and conservation management effort in the region, and will not only benefit the Hawaiian hoary bat, but other native plant and animal species as well. This collaborative, concentrated management approach increases the likelihood of success as compared to a similar project that might be isolated and surrounded by conflicting land uses.

The following measures will be implemented using funds provided by First Wind and other sources in a collective effort to improve native habitat.

4.1 Fencing

Approximately 2.8 miles of fence apron is currently being installed by DOFAW field crews, and is planned to be completed by July 2014.

Source: Partially funded by Capital Improvement Project funds and DOFAW Forestry operating funds

4.2 Ungulate Control

Following the completion of the fence apron (slated to be completed by July 2014), DOFAW Forestry staff will conduct ACETA (aerial capture, eradication, and tagging of animals) missions to dispatch all feral ungulates within the Nakula NAR and Kahikinui FR. These missions will be completed by December 2014. Subsequent missions will be conducted to ensure that these units remain at 'zero tolerance'. Monitoring of ungulate populations will occur at least quarterly to ensure that all ungulates were removed and no fence breaches occur.

Source & Cost: Ungulate control work will be funded by KWP II funds. ($16,000 – approx. 8 trips). Monitoring costs will be provided by the Forest Stewardship Special Fund.

4.3 Site Preparation – Soil Testing/Conditioning

Soil sampling to detect any nutrient deficiencies in the bare soil areas will be conducted from May to September 2014. Possible soil conditioning of nutrients to bare soil areas may be conducted to possibly increase outplanting survival rates within these nutrient depleted areas.

Source & Cost: Helicopter time for site prep work to be funded by KWPII funds.*

4.4 Plant Quality & Procurement

Based on bat recovery recommendations from Hawaiian hoary bat experts, koa and ohia were chosen as the forest canopy species of choice along with other native overstory species (pers. comm. Frank Bonaccorso & Chris Todd, March 2014). Other native tree species will be interspersed among the koa and ohia, along with a diverse understory of native species. Natural gullies and contours will serve as flight passage corridors, and 30 foot wide open spaces will be incorporated into the planting plan to connect the natural corridors and form an interconnected system to facilitate movement and foraging within the forest (pers. comm. Frank Bonaccorso, July 2014).

Source & Cost: Helicopter time, crew subsistence payments and plant purchase to be funded by KWP II funds and grant funds as detailed below.*

Initial actions for implementation starting January 2015 when precipitation increases:

a. 15' x 15' spacing; approximately 200 trees per acre (TPA)
b. 200 TPA x 300 acres = 60,000 seedlings at $3.00 per seedling
    1. 56,000 koa and ohia seedlings
    2. 4,000 seedlings of other native overstory species (kolea lau nui, sandalwood, olapa, ohe, etc.)
    3. 3 to 1 species ratio (koa to ohia)
c. Planting contractor at $500 per acre = $170,000 (*grant application in process)*
   Cost: $180,000 KWP II funds, $170,000 outside funding (price subject to change)

Subsequent actions beginning in January 2016:

a. Approximately 15,000 seedlings of understory plant species to be outplanted (pilo, aʻaliʻi, mamane, ferns, etc.)
   Cost: $45,000 (price subject to change)
b. Weed surveys and suppression to commence Year 2
   Cost: $50,000

**Total Helicopter time cost to be determined.*

Total funded by KWP II: $291,000 as listed here. However, these are preliminary estimates, and the total does not include all helicopter time or any monitoring costs.

5.0 SCHEDULE AND DURATION

Table 1 provides a tentative schedule for mitigation activities.

Table 1. Preliminary Schedule of Mitigation Activities.

Implementation Activities	FY 2014	Fiscal Year 2015				Fiscal Year 2016				Fiscal Year 2017				Entity Responsible
	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	
Fence Construction	XX	XX												DOFAW Maui Nui Branch
ACETA Activities	XX	XX	XX											DOFAW Maui Nui Branch
Soil Sampling and Conditioning	XX	XX												DOFAW to collect samples, NRCS or CTAHR to conduct analysis
Plant Procurement	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	Obtained from Native Nursery, LLC* by DOFAW
Initial Planting of Overstory Species			XX	XX			XX	XX				XX	XX	DOFAW Maui Nui Branch
Subsequent Planting of Understory Species							XX	XX	XX			XX	XX	DOFAW Maui Nui Branch

* DOFAW's current contract is with Native Nursery, LLC. However, this contract expires December 2014 and is currently out for bid.

6.0 MONITORING & MEASURES OF SUCCESS

According to the HCP (page 116) management measures will be considered successful if:

Prior to the start of management measures:

a. Ground and canopy cover at the mitigation site is measured.

After 6 years:

b. The fencing is completed.
c. The ungulates have been removed within the fenced area and the area is kept free of ungulates for the 20-year permit term.

After 20 years:

d. The cover of non-native species (excluding kikuyu grass) in the managed areas is less than 50%.
e. The mitigation area should have a canopy cover composed of dominant native tree species (particularly koa and ohia) that are representative of that habitat after 15 years of growth. According to Wagner *et al.* (1999), mature koa/ohia montane mesic forests "consist of open-to-closed uneven canopy of 35 m tall koa emergent above 25 m tall ohia." Therefore, there should be at least a 25% increase in canopy cover over original conditions throughout the mitigation area, and closed canopy areas should attain at least 60% canopy cover.
f. Restoration trials are implemented.
g. Radio-transmitter monitoring (or other measures as appropriate) is conducted every three to five years to detect changes in bat density and home range core area size as the site is restored.

Adaptive Management

The Annual Reports received in the Years 3 through 5 after the initial planting shall contain an evaluation of whether or not efforts are on track to reach the mitigation targets described above. If they are not on track, then DOFAW, USFWS, and Kaheawa Wind will discuss adaptive management measures to address the problem. Such measures could include additional planting, intensive management measures (*e.g.,* use of water absorbent gels) increased monitoring frequency, or other measures as deemed appropriate by all parties.

6.1 Forest Health Monitoring

Monitoring of ungulate populations, forest cover, and canopy structure will be conducted once per quarter by DOFAW Forestry staff and/or Leeward Haleakala Watershed

Restoration Partnership (LHWRP) staff. An Annual Report will be produced by DOFAW at the end of each fiscal year describing the activities that took place during the year (*e.g.*, fence construction/ incursions, weed control, bat detections, etc.), documenting the flora species present, status of ungulate populations, and a visual assessment of canopy cover and forest structure, with a quantitative scientific analysis of canopy cover completed if deemed necessary by field staff, DOFAW, and USFWS.

6.2 Bat Activity Level Monitoring

It was determined by USFWS and DOFAW, and agreed upon by Kaheawa Wind, that radio-transmitter monitoring to determine bat density would not be the most effective way to measure the success of the restoration activities at Kahikinui. Instead, it was determined that acoustic monitoring for bat activity levels would be a more appropriate approach. As of the writing of this plan, a study entitled Baseline Surveys for Two Wind Power Habitat Conservation Plans in the State of Hawaii is being conducted by USGS under Principal Investigator Frank Bonaccorso. This effort is funded by a Section 6 Cooperative Endangered Species Conservation Fund Habitat Conservation Planning Assistance Grant. The results of the study are expected in 2015, and will be used as the baseline bat activity level for Kahikinui.

Considering input from Mr. Bonaccorso (pers. comm., April 2014), it was determined by the agencies that subsequent monitoring efforts should occur at years 5, 10, 15, and 20 (measured after the start of habitat restoration activities), and should consist of 3-month continual sampling efforts in the same three months of each sampling year. Selection of the appropriate 3-month time period will be determined in collaboration with Mr. Bonaccorso based on the results of the USGS Baseline Surveys. A 5-year cycle of feedback will be very important in planning new restoration parcels for other mitigation activities in Kahikinui as well as for adaptive management of the current project.

Mr. Bonaccorso's suggested monitoring approach for 340 acres would employ at least four detection stations, but could potentially employ up to eight depending on the heterogeneity of the habitat (more heterogeneity would require more detectors). Based on the cost of this type of effort in 2014, it is estimated that each sampling effort will cost approximately $70,000. This is a rough figure that includes helicopter time, salaries for two field biologists for field data collection, data analysis and report preparation, inter-island travel costs of the two biologists, supplies, and contractor overhead and/or profit margin for a third-party contractor. This costing also assumes the permanent equipment (bat detectors) is already available for the project, otherwise this equipment will need to be purchased ($1,500 per bat detector station at 2014 prices).

Given that four monitoring efforts at a cost of $70,000 each cannot be supported by the budget for this project, the agencies will work to lower or supplement costs by:

a. Incorporating agency staff into monitoring efforts (*e.g.,* assisting with detector set up, downloading data from detectors, etc.);
b. Putting out a Request for Proposals to see if another qualified entity can provide similar services at a lower bid;
c. Seeking additional grant funding;
d. Pooling funding from current and future HCP mitigation efforts at Kahikinui; or
e. Other actions as deemed appropriate by the agencies and ITL Applicants.

It is understood that given the timeframe of this effort, it is not confirmed what entity or entities (agency or third party) will implement the monitoring efforts, and therefore a prescriptive scope of work is not laid out in this plan. The scope of work will be developed for the Year 5 monitoring effort, and will set the precedent for all subsequent monitoring. Protocols and equipment should remain identical in the Year 10, 15, and 20 sampling efforts to the extent practicable. Any amendments to the protocol/equipment must be justified by the entity carrying out the monitoring effort (*e.g.*, a particular brand of detector is no longer available), and must be taken into consideration during data analysis. A report will be produced at the conclusion of each monitoring season and will be reviewed by the agencies, Kaheawa Wind, and other bat experts as deemed appropriate to determine success of this project.

7.0 REFERENCES

DLNR. 2005. Hawaii's Comprehensive Wildlife Conservation Strategy. As submitted to the National Advisory Acceptance Team, October 1, 2005.

SWCA. 2011. Kaheawa Wind Power II Wind Energy Generation Facility Habitat Conservation Plan. Prepared for Kaheawa Wind Power II, LLC. December 2011.

Appendix 30

HAWAIIAN HOARY BAT CONSERVATION BIOLOGY: MOVEMENTS, ROOSTING BEHAVIOR, AND DIET

KWP II- Tier 3 Mitigation Plan

A Proposal Prepared for State of Hawaii Endangered Species Committee

Submitted: July, 2016

From: U. S. Geological Survey, Pacific Island Ecosystems Research Center

SUMMARY

This proposal is designed to advance understanding of key aspects of Hawaiian hoary bat (*Lasiurus cinereus semotus*) ecology and population biology listed as priority research goals both in the ESRC "Request for Proposals" and the USFWS 1998 Recovery Plan for the Hawaiian Hoary Bat. Central topics include: 1) seasonal and annual home range and movement patterns, 2) diet composition and food availability, 3) identifying habitats used for foraging roosting, and breeding, and 4) mother-pup demographics and predation at maternity roosts.

A key feature of our project will be deployment of a network of antennae masts wired to automated radio-telemetry systems supplemented by ground crew hand-held radio-telemetry that will provide coverage of a 1,500 km^2 area of eastern Hawaii Island to include native forests, agro-ecosystems, lava tubes, and urban/suburban landscapes from sea level to 3,500 m elevation, all in a region with previously demonstrated high presence levels for hoary bats. We plan to radio-tag 48 bats per year with a goal of 8 radio-tagged bats pulsed every two months over a three year period for a total of 144 tagged bats. The capture and release effort will provide opportunity to collect and bank skin, fecal, and hair samples for dietary analysis (this study), population genetics, and examination of pesticides and heavy metal accumulation in hoary bats (the latter two topics are proposed elsewhere by collaborative USGS teams). When possible, bats that are recaptured multiple times and identifiable from permanent wrist bands will become focal animals for tracking long term movements and monitoring site fidelity. We will also track bats to day roost trees and monitor bats with video, acoustic, and microclimate recording devices to study mother-pup behaviors and demographics through fledging. We will select among important bat foraging locations determined from radio-telemetry sites locations to sample insect diversity, abundance and biomass. Fecal pellets collected in this study from bat capture/release will be used in a meta-barcoding dietary study to identify and quantify insect prey items from matched barcodes in a reference library of insects we will compile to understand prey choice and seasonal movement patterns of the bat.

Major objectives in our study of Hawaiian hoary bats will document all the following points identified as Priority Objectives by the ESRC:

- foraging and home range size including winter and summer seasonal ranges over three annual cycles
- habitat use devoted to foraging, roosting, and breeding
- roost fidelity and roost tree geometry and characteristics
- mother-pup behavior and demographics through fledging at breeding roost trees
- quantitative diet analysis of insect prey selection and availability using molecular bar-coding techniques
- examination of the relationships between movement patterns and food availability
- insect prey-host plant associations providing guidance to wildlife managers for bat habitat restoration
- a tissue and fecal collection bank for genetic, dietary studies, and pesticide studies

Our research plan represents the largest sampling effort ever attempted to characterize Hawaiian hoary bat movement ecology and behavior through radio-telemetry. Only a single published radio-telemetry study of Hawaiian hoary bats spanning multiple years (Bonaccorso et al. 2015) exists and although informative about individual movements this study was limited to hand-held tracking in lowland areas and did not sample high elevation winter range of the bat. Our understanding of hoary bat spatial ecology will be vastly improved by successful completion of our

proposed objectives and will provide wildlife managers much more thorough home range estimates than those now existing.

The USGS and HCSU biologists available for this research project have unparalleled experience (over 125 years cumulative in Hawaii) in practicing field ecology throughout the ecosystems of Hawaii and specifically on the conservation biology of Hawaiian hoary bats. Furthermore, the USGS as an organization has an exceptional staff of field biologists at the Pacific Island Ecosystems Research Center (PIERC) at Kilauea Field Station and can call upon a national network of multi-disciplinary scientists for numerous specialized fields. USGS/PIERC ecologists and entomologists will lead the insect prey aspects of our study as well as providing expertise in the use of automated radio-telemetry arrays.

Information forthcoming from this study will provide wildlife managers key information, data, and maps for planning recovery of the Hawaiian hoary bat, as well as information that will better guide planning and implementation of current and future mitigation and management areas. Examples of new critical information expected as outcomes include first estimates of the size of the winter foraging range, survivorship of pups from birth to fledging, identification of predators of infant bats and other causes of mortality, and assessment of bat diet-insect prey base-host plant inter-relationships.

GOALS

The strategic goal is to provide strong multi-disciplinary sets of data showing the inter-relationships between daily and annual movement patterns, breeding biology, roosting biology, predation, and relationships of insect prey abundance, biomass, diversity, and distribution as drivers of hoary bat ecology. The information we gather will directly help managers make informed decisions assisting the recovery of Hawaiian hoary bats and for improved selection and design of bat mitigation reserves that will offer a balance of winter and summer habitat, foraging and roosting habitat, guidance on key plant species for propagation to benefit bats in restoration-mitigation areas, and potential precautions such as predator control that may be warranted.

Furthermore, tissue samples from bats captured for radio-telemetry will be banked for future use in population demographic studies and for study of heavy metal/pesticides accumulation both in hoary bats and lower levels of their food web as funds and partners become available.

OBJECTIVES

Major objectives in our study of Hawaiian hoary bats will document the following topics identified as Priority Objectives by the ESRC:

- foraging/home range size including winter and summer seasonal ranges over three annual cycles (ESRC Goal 1a, 1c)
- habitat use devoted to foraging, roosting, and breeding (ESRC 2a)
- roost fidelity and roost tree geometry and characteristics (2a)
- mother-pup demographics including predation/mortality at maternity roosts (1b, 2d)
- diet composition and insect prey availability (ESRC 2b)
- relationships of home range to food availability (ESRC 2b)

- prey-host plant associations (ESRC 2a, 2b, 4)
- tissue and fecal collections for presently proposed and future diet, population demographic, and pesticide/heavy metal studies (banking materials for ESRC 1d, 2b, 2c)

Each of the objectives when fulfilled will contribute to a more informed guidance toward mitigation strategies for the future selection, restoration and protection of natural reserve lands for the management to recovery of Hawaii hoary bats.

TASKS AND ACTIVITIES

- Capture and release – Hawaiian hoary bats will be captured with mist nets by an experienced and fully permitted group of bat ecologists having extensive experience in Hawaiian ecosystems. The use of social and foraging call playback will be used to enhance mist-net capture rates. Eastern Hawaii as proposed for our study is the best proven region in the state to capture large numbers of bats in order to produce robust data sets. Bats will be taken through a data collection protocol in less than 45 minutes and released at the capture site with radio-tags and individual wrist bands. Fecal pellets for dietary study will be collected from bats as expelled in soft cloth holding bags within the 45 minute handling protocol. Biological sampling of bat skin biopsies and hair clippings will be banked and available for complementary studies of bat genetics and pesticides.
- Radio-tagging – application of BD-2XC Holohil radio transmitters will be applied by a proven collar method for attachment of radios to small bats described in detail by Winkelmann *et al* (2003). Collars are designed to drop off bats soon after the 6 week battery life is expended via a cotton thread weak point in the collar. The BD-2XC offers a greatly extended battery life (John Edwards, Holohil Inc., personal communication) for tracking bats than previously employed by any study of Hawaiian hoary bats (6 week potential versus 13 days achieved previously).
- Banding—USFWS and DLNR permit approved plastic split rings color coded for individual visual identity will be used to identify bats both in hand and at roosts. Banding will permit long term identification of individuals upon recapture or at roost observations on a permanent basis long after radio-tags have ceased to function. Banding will be particularly important in our study of roost fidelity as well as providing some information on lifespan (banded hoary bats have been captured previously by us up to 4 years after banding).
- Radio-tracking—automated tracking using an array of elevated (mast) antennae/receiver systems will be deployed around eastern Hawaii to track movements in a 1500 km^2 area and supplemented with hand-held ground based tracking teams. Hand held tracking by humans in real time will permit homing to exact roost tree locations and visual observation of roosting bats essential for videography and acoustic monitoring of roosting bats. The automated tracking will provide minute by minute tracking of individuals and offers long distance tracking tens of miles beyond range of a ground based, hand held antennae. The antennae masts will be placed in the extensive study area to provide maximum line of sight coverage for effective triangulation of bat positions. The automated system will

rotate between up to 8 individual bats with a position triangulation recorded every minute during entire nights and hourly by daylight hours. This will make it possible to track individuals for up to 6 weeks on daily movements with a high probability of tracking some transition movements between summer and winter foraging ranges and for the first time make it possible to calculate true annual home ranges for the Hawaiian hoary bats. Our goal is to radio-tag and track eight individuals in each of six bimonthly periods throughout the year over a three year time-span. The telemetry combination of automated systems tracking from elevated antennae and ground based tracking will provide a very thorough monitoring of bat presence at day roosts and permit complimentary monitoring using video and acoustic apparatus in close proximity to day roosts thus providing details of roost fidelity, frequency of roost switching (multiple roost use), weather attributes confining bats to roosts or acceptable for foraging, predator presence, and mother-pup behaviors and demographics.

- Video monitoring—both thermal imaging and near infra-red cameras will be used to record bats at roosting trees to provided visual documentation of timing of roost departures and returns, observations of predators such as rats, owls or ants, and responses by bats, recordings of mother-pup interactions including times mothers are with pups during day roosting and intermittently between foraging bouts by the mother through the night.
- Acoustic Monitoring—will primarily be used in this study to record social calls of mother-pup communication and adult social communication in the vicinity of maternity roosts. We will use the latest available range of automated bat detector and ultrasonic microphones available from Wildlife Acoustics and Pedersen Electronik.
- Roost Tree Characterization—measurements will be taken of tree species, height, DBH, percent foliage cover, canopy geometry, bat perch height and position, slope aspect, and elevation among other attributes that may be deemed valuable.
- Prey Base—insects will be evaluated for biomass, abundance, and taxon diversity through light trap, malaise trap, sweep netting, and branch clipping collection techniques. Collections will be pulsed at two month intervals over two-years to provide insect phenology data as these prey items will have seasonal and spatial variation as aerial bat prey. Associations of insect communities on native Hawaiian plants potentially suitable for habitat restoration at bat mitigation sites will be evaluated. Insects will be identified by our staff entomologists using the extensive museum collections of USGS, USDA, and the Bishop Museum. Samples from the insect collections will be retained to provide tissue for expanding a bar code library for identification of insects in our dietary study as well as implementing a tissue bank for companion studies of heavy metal (eg. lead and mercury) and pesticide levels in Hawaiian hoary bats and insect prey tissues as such studies are funded and partners identified.
- Diet Analysis—fecal pellet samples will be collected during mist netting events, under bat roosts, and taken from our existing banked collections. Insect prey DNA inside the feces will be amplified using meta-barcoding techniques. A library of insect DNA barcode sequences will be generated from the most common prey base

insects including know agricultural pests collected from our study sites. Diet composition will be explored using bioinformatics techniques, through comparison of prey items barcoded in fecal matter to our reference library of local insects as well as publically available sequence data. Bat diet will be analyzed with respect to age, sex, season, and habitat. Important prey species will be linked to host plant associations as possible with emphasis on native plant community restoration.

OUTPUTS

Data outputs will include measurement of summer and winter foraging ranges (95% kernel) and core area (50% kernel), total home range and core area, habitat preferences for foraging and roosting, site fidelity for roosting and foraging core areas, weather correlates of flight activity, pup survivorship, description of mother-pup behavior, skin and ambient foliage temperatures of roosting bats, roost tree geometry, insect prey-base abundance, diversity, and biomass, insect-plant host associations for restoration of bat habitat, dietary contents of bat fecal pellets using molecular genetics. Biological samples from captured bats (tissue, fecal, hair) will directly contribute to our proposed and future studies which will analyze population genetics and demographics, diet composition, and prey selection. Biological samples from both hoary bat and insect tissue samples will be banked for possible pesticide and heavy metal analysis of the hoary bat food. Insect CO1 barcode sequences generated from the bat diet study will be an important contribution to entomological science in Hawaii, adding to the genetic data available for studies in Hawaiian biodiversity and ecological food webs.

OUTCOMES

While the USGS is a research agency, its project staff will be available to advise state, federal and private organizations about the applicability of data outputs in relation to bat ecology and behavior. We will do this through providing technical assistance by phone, in person conferences, presentations at scientific meetings, management workshops, technical reports, and publication of peer reviewed scientific publications. USGS and HCSU biologists will frequently present data at appropriate conferences such as the Hawaii Conservation Conference and the North American Symposium for Bat Research or at such relevant conferences as periodically are hosted in the State of Hawaii.

MATERIALS AND METHODS

Radio Tracking and Roost Monitoring

We propose a three year radio-telemetry study on the island of Hawaii with a study area spanning the Wailoa-Wailuku-Waikaumalo watersheds from near sea-level to montane sites at 3,500 m and including the northern slope of Mauna Loa that harbors important winter foraging habitat for Hawaiian hoary bats (Bonaccorso et al. 2016). USGS currently is using an automated telemetry system for tracking forest birds across difficult terrain in the Hakalau

Forest National Wildlife Refuge. We propose to supplement the existing network with seven additional masts that will expand coverage for the purpose of tracking of hoary bats across 1,500 km^2 of the island's windward region (Figure 1). Final locations for placement of telemetry masts will be based on local topography designed to maximize line-of-sight coverage as well as security from vandalism.

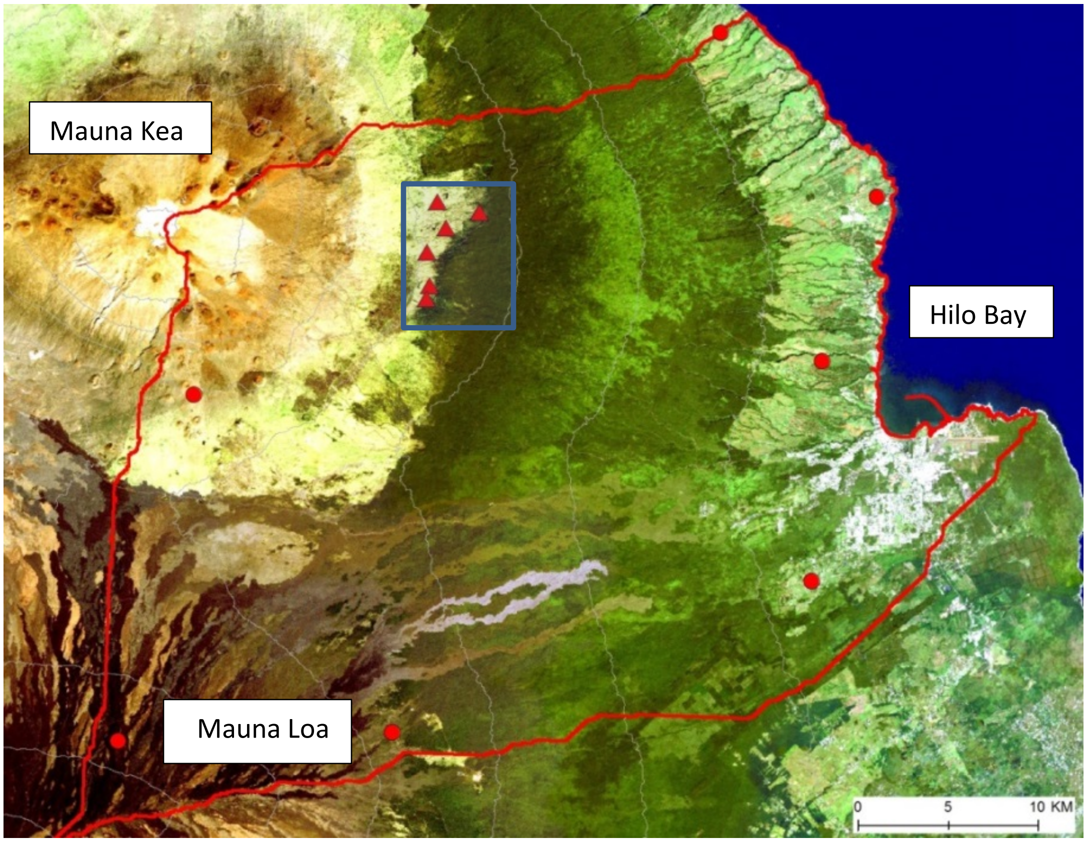


Figure 1. Map of proposed study on eastern Hawaii Island showing the existing Hakalau antennae array (rectangular blue outline enclosing red triangles) and approximate point locations for additional antennae (red dots).

Figure 2 Forty foot telemetry mast at Hakalau Forest NWR.

Bats will be captured by mist-netting following guidelines of the American Society of Mammalogists (Sikes et al. 2011). Our staff scientists hold current permits from USFWS, Hawaii DLNR, and University of Hawaii at Hilo IACUC that include all research protocols described in this proposal. Upon capture we will record sex, age class, morphology, and reproductive status. We will collect skin and hair tissue to bank for genetics and pesticide analysis. We will collect fecal pellets to bank for dietary analysis. Conducting this study in Eastern Hawaii offers the most dependable region known for hoary bat live capture. Nevertheless, the proposed study duration of three years will greatly enhance the opportunity to obtain statistically robust telemetry data on large numbers of bats.

Bats will be tagged with transmitters ≤5% body weight (Sikes et al. 2011) that operate continuously up to 40 days (BD-2XC model, Holohil Systems). Automatic Receiving Units (ARU; Orion model; Sigma Eight) will scan transmitter frequencies with 6 to 8 directional antennae while recording signal strength, date, and time used in combination with a network of 20 or 40 ft high antennae masts. Post-processing converts signal strengths into bearings and bat location is triangulated from multiple masts. Field testing has confirmed a reception potential of 30 km. Masts may be repositioned as needed to track long range bat movements.

Ground-crews will supplement the ARU system using hand-held receivers and directional yagi antennae to track bats to day roost locations and record fine-scale foraging movements from close range. Warbling (rapidly variable) versus steady signal strengths from radio transmitters will allow us to reconstruct flight and roost time budgets within each night.

Near-infrared and thermal videography will image roosting individuals, particularly recording mother-pup behavior and documenting pup survivorship. A Fluke Thermal Imaging Camera (FLUKE FLK-TIS75 30HZ Thermal Imager with IR-Fusion Technology, -20 °C to

550 °C, 320 x 240 Resolution, 30 Hz) will remotely measure bat skin temperature while roosting and temperature of surrounding foliage at the roost to track thermoregulatory patterns and the possible use of shallow torpor. Data loggers (iButton DS1921) also will record ambient temperature in roost trees.

Seasonal patterns in habitat use and movement patterns will be derived from the movement of successive individuals across a year to quantify composites of annual home range and population movements. Data will be analyzed with customized R software to determine spatial coordinates that will be mapped with ArcGIS to determine range size, elevation, and land-cover associations. Vegetation attributes of trees and stands used by bats as day roosts will be compared to randomly selected stands. Tree attributes will include species, diameter, height, roost aspect, elevation, and proximity to nearest road. Stand attributes will include land-cover class, composition of neighboring dominant tree species, canopy closure, and understory density. Roosts will be monitored with surveillance cameras to obtain information on predators, mother-pup behavior, frequency and duration of foraging bouts, time budgets and pup survivorship (Winchell and Kunz 1993). Acoustic sampling at roost sites will collect information on vocalization including mother-pup communication.

Home range – Bat locations from telemetry will be analyzed with kernel density estimators in the R package *adehabitat*. Brownian bridge movement modeling will predict trajectories of movement between successive locations (Horne et al. 2007).

Foraging habitat - Euclidean distance analysis will quantify habitat use (Conner and Plowman 2001) by comparing the mean distance of an individual's locations to each habitat type and the mean distance of a set of random locations to each habitat type. This analysis: 1) does not require explicit error modeling or equal sampling of individuals; 2) avoids habitat misclassification resulting from telemetry error; and 3) allows evaluation of surrounding habitat regardless if included within home range (Conner et al. 2003).

Roost selection and behavior – Logistic regression models will compare tree and stand characteristics at day roosts to randomly selected locations. An information theoretic model will rank variable importance. Descriptive statistics on behavior and body temperatures will be produced from video, thermal imaging, and acoustic recordings of mother-pup interactions at roosts. Generalized linear models will examine the proportion of the night which bats spend roosting and foraging, and its relationship to reproductive condition, regional weather conditions (temperature, precipitation, wind speed and barometric pressure), moon illumination and time of year (Anthony et al. 1981).

Insect Prey Base and Host Plant-Insect Associations

The abundance of nocturnal, flying insects that may act as prey for bats will be quantitatively assessed in the second and third years of radio-tracking after important foraging locations have been identified. Site selection for insect sampling will include low elevation rain forest, mid elevation rain forest, high elevation shrubland with lava tubes present, macadamia nut orchard, and a mixed agro-ecosystem with cattle because Todd (2012) identified insects associated with cattle in the bat's diet. We will use several standard entomological methods to assess insect diversity and abundance, including light traps, malaise traps, sweep nets, and lightly beating vegetation. Light traps utilize ultraviolet light to attract night-flying insects and are particularly effective at attracting moths and some beetles. Light traps utilize ultraviolet light to attract night-flying insects and are particularly effective at drawing moths and some beetles. Malaise traps are mesh, tent-like structures that intercept insects that fly close to the ground and trap a wide variety of insects but most effectively collect moths and flies. An insect net will be used to sweep grass and a beating stick and sheet will be used to dislodge and collect insects from shrubs and trees. The latter two methods will focus on collecting beetles and moth larvae (caterpillars) that can be projected as future prey in the adult moth. Collectively, these methods will sample the vast majority of the potential prey base. However, if diet analyses suggest that we are missing particular prey then we will adapt our sampling strategy to target those taxa (e.g. bark emergence traps aimed to collect bark beetles).

The bat prey base assessment will be conducted over five day periods at two month intervals at 5-6 sites within the study area (Figure 1). At each site, two light traps and two malaise traps will be operated; light traps will be operated 3-4 nights per month and malaise traps, which run continuously, will be serviced twice per month. For each of the most common species of grass, shrub and tree, 20 sweep-net or vegetation beating samples will be obtained during the sampling period. Regardless of abundance, we will sample mature specimens of the plant species that are currently being out-planted as part of the effort to restore native plants throughout the state (Table 1). All arthropods collected will be counted, weighed, and identified to species or to the greatest taxonomic precision practical.

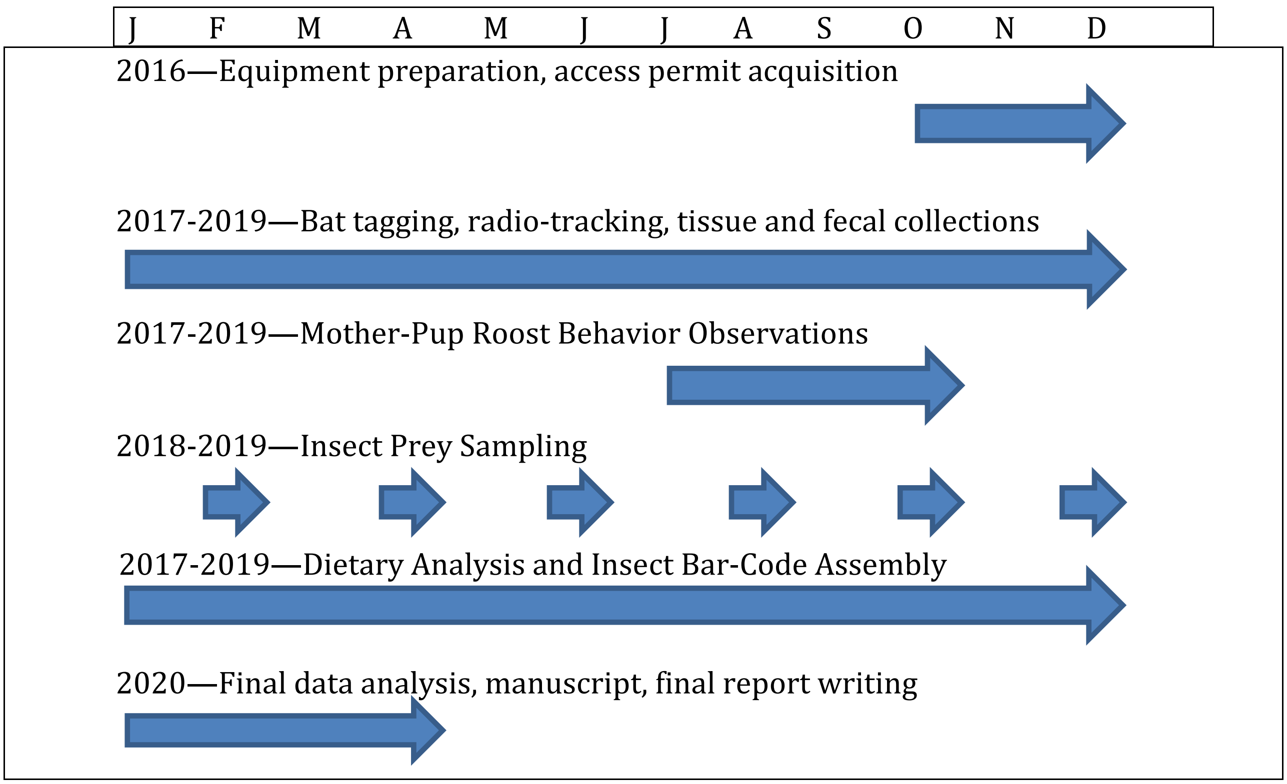
Insect Reference Library Barcoding and Hoary Bat Dietary Analysis

Detailed information on the insect prey taxa and relative compositions of prey within Hawaiian hoary bat diets are generally understated in previous studies concerning food habits and dietary needs for this endangered species. Past studies exploring the composition of hoary bat diet have relied on microscopy and dried collection comparison methods to determine the taxonomic identity and general abundance of insect prey items (Belwood & Fuller 1984, Jacobs 1999, Todd 2012, Valdez & Cryan 2013). These methods can limit or even bias the information gained since hard-bodied insects, such as beetles, are easier to recognize from fragments in the fecal matter than those with soft bodies, such as moths. New molecular genetics techniques are available that overcome many of the observational limitations in insect identification by using DNA barcoding (Clare 2014, Pompanon et al. 2012, Zeale et al. 2011) and have been successfully used on many bat species around the world including tree-roosting lasurine bats (Clare et al. 2009) and endangered bat species including the Ozark big-eared bat (Van Den Bussche et al. 2016). Specifically, the use of high throughput sequencing and meta-barcoding analyses of the mitochondrial cytochrome I gene (COI) of insects have aided in detecting the diversity and quantifying the relative contributions of insect taxa in bat diets across differing habitats, seasons, between the sexes, and prey selection (Bohmann et al. 2011, Burger et al 2013, Clare et al. 2014, Mata et al. 2016, and Vesterinen et al. 2013, 2016)

We will utilize meta-barcoding services and bioinformatics analysis at the University of Hawaii, to prepare and sequence thousands of insect CO1 barcodes from each individual fecal sample using high-throughput sequencing techniques. Barcodes generated from bat fecal pellets will be compared to a library of insect DNA barcodes sequences established from our insect sampling from the sites within our 1,500 km^2 field study area and publically available barcode databases (such as BOLD, www.barcodinglife.org). This reference library database will be based on the CO1 gene barcodes which has been cross-checked with local insect distribution and publically available data. Thus, we will identify insects consumed by bats to the most specific level of taxonomy possible, in many cases to species level. Our analysis will look for differences in diet for bats of differing sex, age class, season, foraging habitat and available prey.

TIMETABLE AND MILESTONES

Hoary Bat Research Timeline



PERMITS AND AUTHORIZATIONS

U. S. Geological Survey holds current research/take permits from U. S. Fish and Wildlife Service (Permit TE 003483-29) and Hawaii Department of Lands and Natural Resources (Permit WL-16-04), and additionally has an approved IACUC protocol approved by the University of Hawaii for vertebrate animal research. USGS has an excellent network of contacts with both private and public land stewards throughout the island of Hawaii that have frequently provided access to lands for bat research.

MONITORING AND EVALUATION

The project manager will closely supervise all aspects of research. Staff will have periodic meetings (usually quarterly) with the project manager and with supervisory directors of USGS and HCSU. Data downloads (e.g. telemetry data will be downloaded and reviewed frequently to better position tracking stations for focal animals) will be reviewed on weekly, monthly, bimonthly schedules as appropriate for specific analyses and cumulative data sets updated frequently. Project managers will employ adaptive management to improve and refine data collection with major reviews of success or weakness each year as the project proceeds. Annual reports will be provided to key wildlife management contacts (ESRC, DOFAW, USFWS) as well as oral reports or posters at the annual Hawaii Conservation Conference. Research staff will be available for phone consultations with wildlife managers when management issues arise in which new data inputs from the project may be helpful as updates.

ORGANIZATIONS

U. S. Geological Survey (USGS) is based at Kilauea Field Station inside Hawaii Volcanoes National Park and offers computer and research labs and a large multi-disciplinary staff of senior biologist researchers and technicians.

Hawaii Cooperative Studies Unit (HCSU) is based at the University of Hawaii at Hilo and offers research lab facilities and opportunities to collaborate with senior staff, technicians and students in the biological sciences.

LITERATURE CITED

Anthony, E. L. P., M. H. Stack, and T. H. Kunz. 1981. Night roosting and the nocturnal time budget of the little brown bat, *Myotis lucifugus*: effects of reproductive status, prey density and environmental conditions. Oecologia 51: 151-156.

Belwood, J. J., & Fullard, J. H. (1984). Echolocation and foraging behaviour in the Hawaiian hoary bat, *Lasiurus cinereus semotus*. *Canadian Journal of Zoology*, *62*(11), 2113-2120.

Bohmann, K., et al. 2011. Molecular diet analysis of two African Free-Tailed bats using high throughput sequencing. PLOS One. 6(6) ee 21441.

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: 64-71.

Bonaccorso, F. J., K. Montoya-Aiona, C. A. Pinzari, and C. M. Todd. 2016. Winter distribution and use of high elevation caves as foraging sites by the endangered Hawaiian hoary bat, *Lasiurus cinereus semotus*. Hawaii Cooperative Studies Unit, University of Hawaii at Hilo. Technical Report 67.

Burger, J., Murray, D., Craig, M., Haile, J., Houston, J., Stokes, V., and M. Bunce. 2013. Who's for dinner? High-throughput sequencing reveals bat dietary differentiation in a biodiversity hotspot where prey taxonomy is largely undescribed . Molecular Ecology. Doi: 10.111/mec.12531.

Burt, W. H. 1943. Territoriality and foraging range concepts as applied to mammals. J. Mammalogy 24: 346-352.

Clare, E., Fraser, E., Braid, H., Fenton, B., and P. Hebert. 2009. Species on the menu of a generalist predator, the eastern red bat (Lasiurus borealis): using a molecular approach to detect arthropod prey. Molecular Ecology. 18 2532-2542.

Clare, E., et al. 2014. The diet of Myotis lucifugus across Canada: assessing foraging quality and diet variability. Molecular Ecology. 23: 3618-3632.

Clare, E., 2014. Molecular detection of trophic interactions: emerging trends, distinct advantages, significant considerations and conservation applications. Evolutionary Applications, doi: 10.111/eva.12225.

Conner, L. M., and B. W. Plowman. 2001. Using Euclidean distances to assess non-random habitat use. Pp. in J. J. Millspaugh and J. M. Marzluff (Eds.) Radio tracking and animal populations. Academic Press, San Diego, CA. 474 pp.

Conner, L. M., M. D. Smith, and L. W. Burger. 2003. A comparison of distance-based and classification-based analyses of habitat use. Ecology 84: 526–531.

Horne, J. S., E. O. Garton, S. M. Krone, and J. S. Lewis. 2007. Analyzing animal movements using Brownian bridges. Ecology 88: 2354–2363.

Jacobs, D. S. 1992. Foraging behavior of the endangered Hawaiian hoary bat, *Lasiurus cinereus semotus*. Unpublished report to U. S. Fish and Wildlife Service.

Jacobs, D.. 1999. The diet of the insectivorous Hawaiian hoary bat (Lasiurus cinereus semotus). Canadian Journal of Zoology. 77: 1603-1607.

Mata, V.A., Amorim, F., Corley, M.F.V., McCracken, G.F., Rebelo, H., and P. Beja. 2016. Female dietary bias towards large migratory moths in the European free-tailed bat (*Tardaria teniotis*). Biology Letters. 12: 20150988. http://dx.doi.org/10.1098/rsbl.2015.0988.

Menard, T. 2001. Activity patterns of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) in relation to reproductive time periods. M.S. Thesis. University of Hawai'i, Honolulu.

Mitchell, C., C. Ogura, D.W. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. 2005. *Hawaii's Comprehensive Wildlife Conservation Strategy*. Department of Land and Natural Resources. Honolulu, Hawaiʻi.

Pompanon, F., Deagle, B.E., Symondson, W.O.C., Brown, D.S., Jarman, S.N., and P. Taberlet. 2012. Who is eating what: diet assessment using next generation sequencing? Molecular Ecology 21: 1931-1950. doi: 10.111/j.1365-294X.2011.05403.x.

Sikes, R. S., and Gannon, W. L. 2011. Guidelines of the American Society of Mammalogists for the use of wild mammals in research. Journal of Mammalogy, 92: 235-253.

Todd, C. M. 2012. Effects of prey abundance on seasonal movements of the Hawaiian hoary bat (Lasiurus cinereus semotus). Master's Thesis. Department of Tropical Conservation Biology and Environmental Science. University of Hawai`i at Hilo, Hi, 61pp.

U.S. Fish and Wildife Service.1998 Recovery plan for the Hawaiian Hoary Bat. USFWS, Portland, Oregon.

Valdez, E. W., & Cryan, P. M. 2013. Insect prey eaten by hoary bats (Lasiurus cinereus) prior to fatal collisions with wind turbines. Western North American Naturalist, 73(4), 516-524.

Van Den Bussche, R.A., Lee, D.N., Judkins, M.E., Dyer, J.E., Thompson, D.M., Stark, R.C., Puckette, W.L., and B. Fuller. 2016. Molecular dietary analysis of the endangered Ozark big-eared bat (Corynorhinus townsendii ingens). Acta Chiroptologica, 18(1): 181-1919. doi:10.3161/15081109ACC2016.18.1.008.

Vesterinen, E., Lilley, T., Laine, V., and N. Wahlberg. 2013. Next generation sequencing of fecal DNA reveals the dietary diversity of the widespread insectivorous predator Daubenton's bat (Myotis daubentonii) in Southwestern Finland. PLOS One. 8(11) e82168.

Vesterinen, E.J., Ruokolainen, L., Wahlberg, N., Peña, C., Roslin, T., Laine, V.N., Vasko, V., Sääksjärvi, I.E., Norrdahl, K. and Lilley, T.M., 2016. What you need is what you eat? Prey selection by the bat *Myotis daubentonii*. Molecular Ecology. 25:1581-1594. doi:10.1111/mec.13564.

Winchell, J. M., and T. H. Kunz. 1993. Sampling protocols for estimating time budgets of roosting bats. Canadian Journal of Zoology 71: 2244-2249.

Winkelmann, J. R., F. J. Bonaccorso, E. E. Goedeke, and L. J. Ballock. 2003. Home range and territoriality in the least blossom bat, *Marcroglossus minimus*, in Papua New Guinea. J. Mammalogy 84:561-570.

Zeale, M., Butlin, R., Barker, G, Less, D. and G. Jones. 2011. Taxon-specific PCR for DNA barcoding arthropod prey in bat feces. Molecular Ecology Resources. 11:236-244.

Appendix 31

A PROPOSAL SUBMITTED BY

UNIVERSITY OF HAWAII and

CENTER FOR CONSERVATION, RESEARCH AND TRAINING

TO:	Department of Land and Natural Resources/Forestry And Wildlife
PROJECT TITLE:	"Maui Nui Nene Monitoring and Predator Control Management"
PRINCIPAL INVESTIGATOR:	Dr. Kenneth Kaneshiro
DEPARTMENT:	Pacific Biosciences Research Center Center for Conservation Research and Training
PROJECT PERIOD:	February 1, 2019 – June 30, 2019
AMOUNT REQUESTED:	$43,520.00

AUTHORIZING UNIVERSITY
OFFICIAL: ___________________________DATE: _____________

Georgette Sakumoto
Office of Research Services
Phone: 808 956-4056
Email: gsakumoto@hawaii.edu

ADDRESS: University of Hawaii
Office of Research Services
2440 Campus Rd. Box 368
Honolulu, HI 96822

Please ensure that all correspondence regarding this application and project are a ddressed to the Office of Research Services

Maui Nui Nēnē Monitoring and Predator Control Management

Project Description

On January 5, 2012 the Board of Land and Natural Resources approved the Kaheawa Wind Power II Habitat Conservation Plan (HCP) and Incidental Take License (ITL). The ITL authorizes the incidental take of the Nēnē (*Branta sandvicensis*).

The project objective for Maui Nui Nēnē Monitoring and Predator Control Management is to assist in the recovery of the Nēnē (*Branta sandvicensis*). The primary objectives are to establish predator control and remove invasive vegetation in and around available open-top release pens (Pi'iholo Ranch, Haleakala Ranch, or a new pen not yet constructed on Molokai) in order to successfully produce as many Nēnē fledglings as is possible each season and ultimately meet KWP II's mitigation obligation for Nēnē.

Project Objectives and Tasks

- Establish and maintain trap lines. Traps or other methods will control rats, mongoose, cattle egrets, feral cats and dogs that may pose a threat to Nēnē and their nesting sites. No rodenticides will be used. Trapping protocols and control methods will follow state guidelines for humane treatment of animals. Trapping will be year-round. (See Figure's 1,2 and Table 1 for representations of the minimum trapping effort).

- Control alien plants using chemical and mechanical means, mow grass areas, and assist native vegetation restoration at this open-top release pen site. Herbicide application will follow state and federal use guidelines.

- General maintenance of the open-top release pens including maintenance of storage buildings, fence lines and water units.

- Monitor movements, nest success, distribution and survival of Nēnē at the open-top release sites. Keep records of individual birds sighted, GPS nest locations, and nesting activities and hatching and fledging success. Assist examinations, measurement and banding of unidentified birds. All birds will be banded if possible.

- At the Pi'iholo and Haleakala Ranch pen, the baseline number of fledglings (prior to any funding provided by KWP I or KWP II) is considered zero since all fledglings produced in the period covered by this proposal will be from actions funded under this proposal.

Reporting

Detailed records will be kept of:

1) each employee’s hours funded and tasks accomplished at each pen the funding supports;
2) adults present and band re-sightings;
3) nesting attempts, eggs laid and hatched, goslings produced and causes of death, and fledglings successfully produced;
4) trap location maps, trap types, trap days, and predator types and number removed;
5) number of nēnē banded.

Reports of the detailed records will be provided to KWP II at least quarterly and in an annual report submitted by July 15 each year. Employee hours worked, and tasks accomplished at each pen and current budget status/remaining will be provided at least quarterly and also annually.

An updated budget plan and SOW will be provided by May 1 of each year when funding is expected to be provided for the following state fiscal year. Once the updated budget and SOW is agreed to the MOU between KWP II and the state will be extended another year and funding promptly provided by KWP II to support the SOW for the next fiscal year.

Coordination

Coordinates with Maui Branch Nongame Biologist.

Personnel

UH/CCRT and sponsor will cooperate to assemble a staff to perform the project scope of work. The PI will have final discretion on the hiring, administrative management, and termination of CCRT project staff.

UH/CCRT and the sponsor will keep each other informed about changes in personnel, proposed hires, future funding, changes in the direction and anything else that might affect the functioning of the program.

Figure 1. Pi'iholo Ranch Pen: A one acre open-top release pen in Makawao, Maui.

Figure 2. The seventy trap locations of Tomahawk, Sherman, and A24 traps around and in Piiholo Ranch open-top release pen.

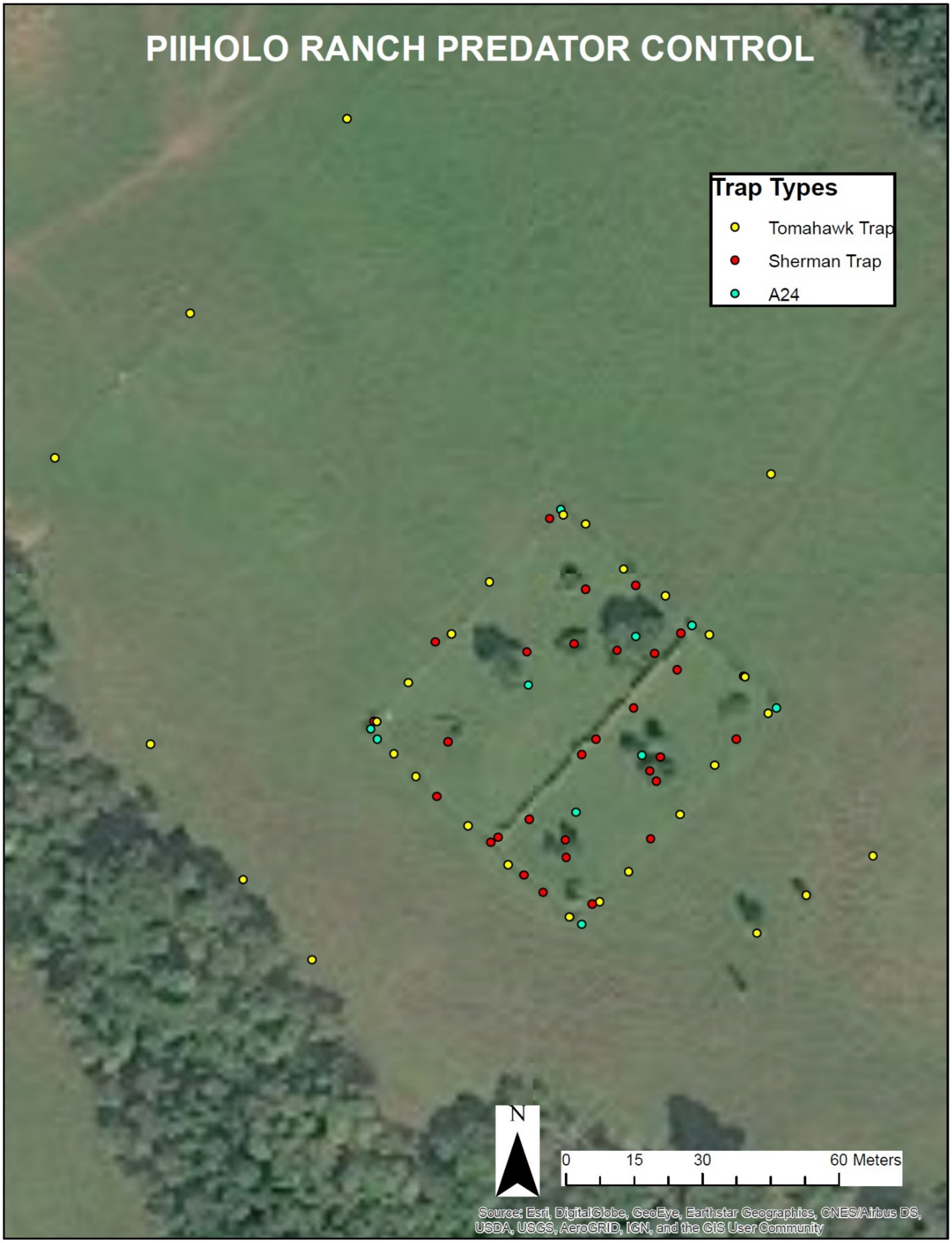

PIIHOLO RANCH PREDATOR CONTROL
Trap Types
Tomahawk Trap
Sherman Trap
A24
N
0
15
30
60 Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Table 2. Trap Types.

Trap Type	Trap Number	Target Predator	Trap Visit Frequency
Tomahawk Traps	30	Cats, Mongoose, & Rats	Year-round
Sherman Traps	30	Rats, Mice, and Mongoose	Year-round
A24s	10	Rats & Mice (Mongoose)	Year-round

Adaptive Management

1) Results of each year’s efforts will be reviewed annually by the USFWS, DLNR-DOFAW (Oahu and Maui) and by the ESRC at the annual HCP review.
2) Based on results and review, the agencies will provide suggested changes to the scope of work (if warranted). These could include increasing trap effort, changing trap types, increasing area to be managed (extending an existing pen), changing effort location (a different pen or consolidating efforts at one pen for both KWP I and KWP II or creating a new pen to attempt to manage and protect). Each change in management strategy will require a new budget projection and Scope of Work plan.

Success Metrics

1) At least five nēnē fledglings must be produced in state fiscal year 2019 to continue the SOW at Pi’iholo Ranch Pen. If less than five nēnē are produced at Pi’iholo any subsequent SOW will be conducted only at the Haleakala Ranch pen and/or at a new pen created elsewhere.
2) If only the Haleakala Ranch pen is used for both KWP I and KWP II nēnē mitigation a fenced extension may be considered to increase potential area protected and fledglings produced. The goal is to produce at least 12 nēnē fledglings per year for 14 years if only the Haleakala Ranch pen is used or 15 nēnē fledglings per year for 11 years if both Pi’iholo and Haleakala Ranch pens are funded.

Budget

Service Period: February 1, 2019 – June 30, 2019

Overhead Rate: 10% (UH - FY19)
5% (CCRT)

Funding Source: $43,520.00 Private: KWP II

Category	Description	FY 19 (2/1/19 - 6/30/19)
Salaries	Wildlife Field Asst. (2)	$28,840.00
Fringe	Wildlife Field Asst. (2)	$8,652.00
CCRT Admin		$2,072.00
Total Direct Costs		**$39,564.00**
UH Indirect Costs (10%)		$3,956.00
Total		**$43,520.00**

Appendix 32

FY 2017 –KAHIKINUI FOREST RESERVE MANAGEMENT
INITIATED FOR HAWAIIAN HOARY BAT MITIGATION for
Kaheawa Wind Power II, ISLAND OF MAUI

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

INTRODUCTION

Since June 4, 2014, the Division of Forestry and Wildlife (DOFAW) is actively managing 340 acres within the Kahikinui State Forest Reserve (SFR), and including ungulate eradication in the larger surrounding units of the Nakula Natural Area Reserve (NAR) and Kahikinui SFR. Kaheawa Wind Power II, per their Habitat Conservation Plan (HCP) and the requirement to mitigation for incidental take of the Hawaiian Hoary Bat, has provided some of the funding for this work. Maintaining "zero" tolerance for ungulate presence, restoring and creating native habitat, and increasing native bird and bat populations are some of the multiple management efforts that continue to be geared for this area. These management efforts continue to be conducted and managed primarily by Maui DOFAW staff.

OVERVIEW

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

Since the initial efforts to remove the feral ungulates in October 2014, staff members have continued to notice significant changes within the project area, as well as the surrounding Nakula NAR and Kahikinui SFR. There continues to be an increase in grass and native shrub growth and, more noticeably, a steady increase of bracken fern *(Pteridium aquilinum)* recruitment in the hardpan and gulch areas. Large sections of rock surface areas are being populated with these bracken ferns. As mentioned in last year's report and still holds true through this year, the most impressive change has been the increase in natural generation of native flora, specifically koa *(Acacia koa)* and pukiawe *(Styphelia tameiameiae)*; largely in part due to a viable seed bank and ungulate free environment. We continue to see an increase in game bird species presence and activity, as well as an increase in sightings of nene, all of which are positive improvements. There are currently 29 Hawaiian petrel *(Pterodroma sandwichensis)* burrows located and documented within the Nakula NAR/Kahikinui FR's ungulate proof fenced unit, as well as visual and acoustic confirmation of presence of Hawaiian hoary bats *(Lasiurus cinereus semotus)*. With the absence of feral ungulates, there are new issues that have risen and continue to threaten the restoration and reforestation efforts; most significantly, the threats of increased fuel loading and weed infestation. Plans to install firebreaks along the ungulate proof fenceline are scheduled for spring 2018. These issues are being addressed through various control and mitigation efforts, and continuous collaborations and discussions between agencies are on-going. In May 2016, DOFAW was awarded a USDA Forest Service State & Private Forestry (S&PF) grant that will help address some of the challenges identified in last fiscal year's end of year report.

ACTIVITIES & RESULTS

Fencing

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

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

Ungulate Control

During the reporting period for fiscal year 2017, a total of three aerial control missions (approximately 4.5 hours total flight time) were conducted by DOFAW staff resulting in 8 feral goats and 1 feral pig dispatched within the entire Nakula NAR and Kahikinui SFR unit. Since the initial mission completed in October 2014, DOFAW has dispatched 696 feral goats and 18 feral pigs within the fenced unit resulting in near "zero" presence and therefore has entered the "maintenance" phase of the animal removal project and will continue to conduct aerial surveys on a quarterly basis. To ensure 'zero' tolerance, a collared goat also referred to as a 'Judas' goat was placed within the unit in July 2016 to 'round up' any remaining goats, taking advantage of its natural instinct to socialize and congregate. As long as ungulates remain outside of the fenced unit, it is crucial to continue these survey missions.

Quarterly scheduled aerial control missions to monitor ungulate presence within the unit will continue in fiscal year 2018. Ungulates detected during subsequent monitoring flights will be dispatched accordingly in a timely manner through scheduled aerial control missions. New detections or ungulate ingress into this protected unit may, at any time, occur because of a fence break that may be caused by inclement weather, vandalism, normal wear and tear, etc. Per our DOFAW Forestry Program's fence maintenance protocol, personnel will continue to conduct regular scheduled fence checks throughout the year, as well as immediately following the onset of any strong weather disturbances that may pose a threat to the integrity of the fence.

Plant Quality and Procurement

The out-planting work for this reporting period covered approximately 27 acres of the 340 total acres of the project area. During this period, 12,988 native plant seedlings were out-planted, making the total number of native plant seedlings out-planted within the unit at approximately 55,000 since the initial reforestation efforts began. Another 20,000 seedlings were procured in fiscal year 2017 and will be planted in fiscal years 2018-19 to supplement and account for anticipated plant mortality due to various causes.

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

Site Preparation – Soil Testing/Conditioning

Several soil collections from various areas within the unit were conducted in July 2015 and samples were sent for analysis in August 2015. In general, the majority of the sites contain sufficient to high levels of pH and calcium, while showing deficiencies in potassium, phosphate, and magnesium. Recommendations on how to improve soil conditions have been noted for future field application use. Results are used to monitor the survivorship of out-planted seedlings and natural regenerated populations to determine if supplementing the soil conditions is necessary. Collecting and analyzing soil samples to evaluate deficiencies remain a priority and will aid in future reforestation and restoration efforts. Soil sampling is anticipated for fiscal year 2019 to evaluate how the area or soil conditions are changed or influenced by the increase of seedlings growing in the area.

Grass control treatments for site prep work within the 340 unit that were scheduled for fiscal year 2017 were completed on September 9, 2016. Approximately 50 acres were treated and portions of the treated area were out-planted in spring and summer of 2017 (Figure 1).

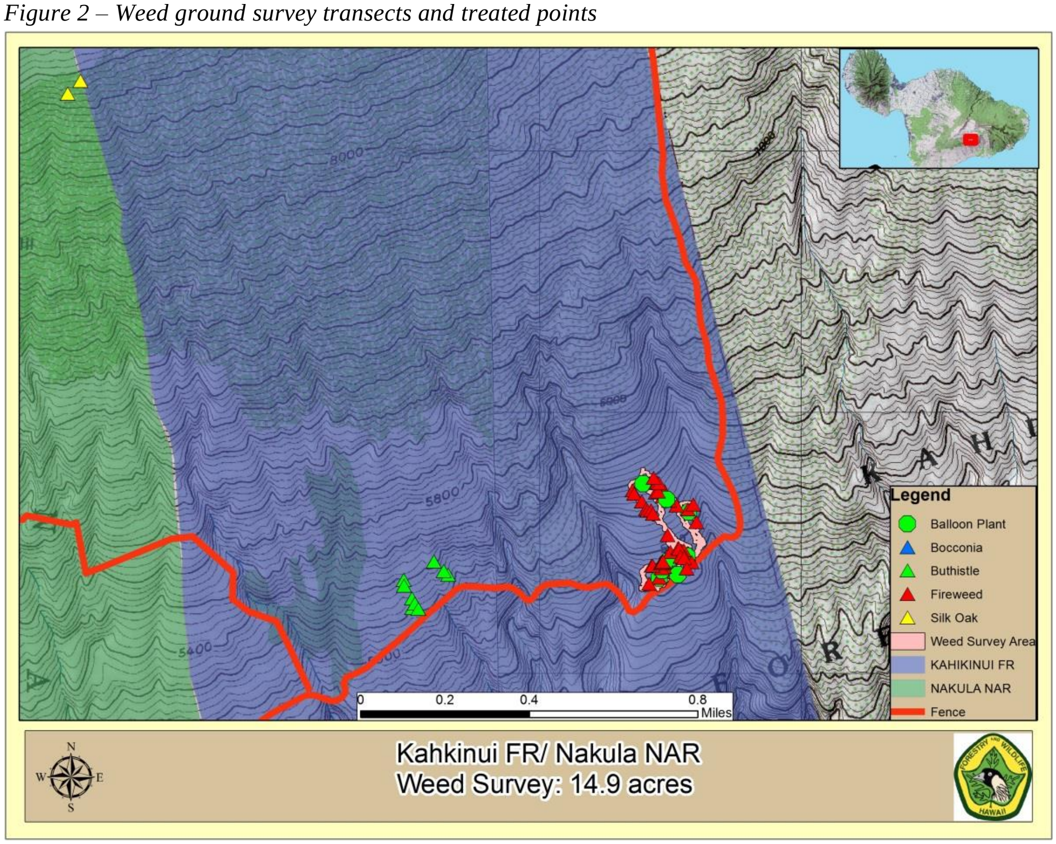
Figure 1 – Aerial view of the grass treatments in the Kahikinui FR project area (areas depicted in grey contrast above fenceline)

Weed Monitoring and Suppression

One aerial weed survey covering the entire Nakula NAR and Kahikinui SFR unit, as well as one ground survey targeting the 340 acre project area were conducted in fiscal year 2017. As in the previous year, the aerial survey focused primarily on Rapid Ohia Death (R.O.D). Fortunately, there were no visual signs or symptoms of the disease. Forestry personnel who are conducting aerial control missions within the unit continue to survey for weed species during their missions. Fireweed (*Senecio madagascariensis*), bull thistle (*Cirsium vulgare*) and balloon plant (Asclepias physocarpa) were sighted and documented across the lower elevations of the Nakula NAR and Kahikinui SFR.

The ground survey covered approximately 15 acres and targeted the southeastern portion of the project unit where the first phase of seedlings were out-planted (Figure 2). As a result, forestry program personnel detected and removed 2 mature silk oak trees *(Grevillea robusta)*, 10 mature balloon plants *(Asclepias physocarpa)*, 20 bull thistle plants *(Cirsium vulgare)*, and 520 fireweed plants *(Senecio madagascariensis)*.

Figure 2 – Weed ground survey transects and treated points



Partnering agencies will continue to work to monitor and control populations of bocconia *(Bocconia frutescens)* that are sited outside of the project area to prevent further spread into this unit. Subsequent weed surveys are scheduled for this area to ensure early detection and rapid response.

Table 1. Schedule of Mitigation Activities

Implementation Activities	Fiscal Year 2017				Entity Responsible	Total Cost
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr		
Fence Inspection	XX	XX	XX	XX	DOFAW Maui Nui Branch	*included into aerial control missions
Aerial Control Eradication and Tagging of Animals (ACETA) Activities			XX	XX	DOFAW Maui Nui Branch	**$7,500.00** *$7,500 paid by DOFAW
Soil Sampling and Conditioning	XX				*DOFAW Maui Nui Branch submitted to CTAHR for analysis in July 2016	**$15.00** *sampling fee by CTAHR paid with DOFAW funds
Plant Procurement			XX	XX	Obtained from Native Nursery, LLC by DOFAW	**$59,999.68** *procured approximately 20k seedlings paid by DOFAW fed grant
Planting of Overstory/Understory Species	XX	XX	XX	XX	DOFAW Maui Nui Branch	**$19,065.00** *costs included overstory/understory cost paid by DOFAW
Weed Surveys/Site Prep	XX	XX	XX	XX	DOFAW Maui Nui Branch	*weed surveys included into aerial control missions paid by DOFAW ***$2,665.00** for site prep paid by DOFAW
Survivorship Monitoring	XX		XX	XX	DOFAW Maui Nui Branch	**$8,608.00** *costs paid by DOFAW
Total						**$97,852.68**

MEASURES OF SUCCESS

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

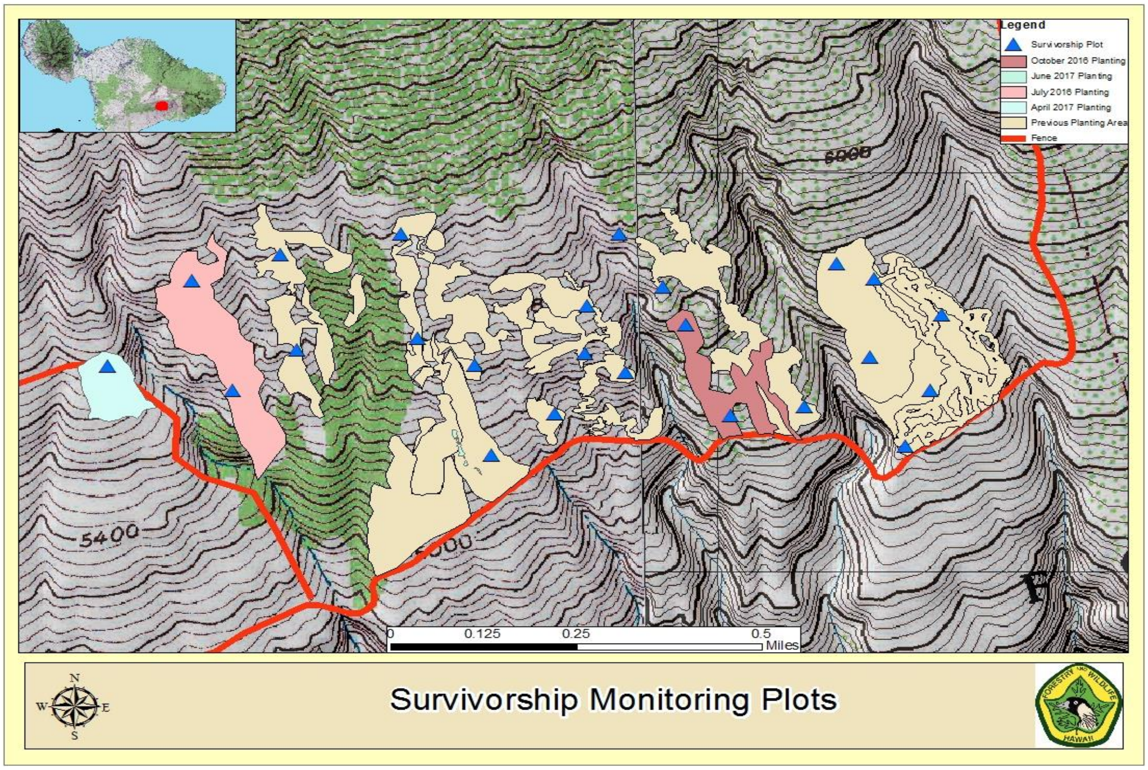
a. **Survivorship monitoring of out-planted seedlings.** Survivorship plots are randomly established throughout the planting area. Plot size is 1/10 acre with a radius of 37.2 feet from plot center. The vigor of the plot is noted on a scale from 1-3, where 1 is poor health and 3 is excellent health. A general survey of the top 3 dominant flora besides the planted trees within the plot is also recorded. Plots are scheduled to be revisited every six months. Forestry personnel have installed another 4 plots in addition to the existing 20 plots (11 grass, 3 rock/grass, 2 rock, 4 hardpan, and 4 herbicide treated) to date, covering all substrate and ground cover types (Figure 3). The results of these monitoring plots represent the average % of plants surviving per plot per ground type since initial out-planting. The monitoring and installation trips were completed on August 4, 2016, February 13, 2017, March 15, 2017 and June 15, 2017. The results are as follows:

   Grass average = 74.9%
   Grass/Rock average = 75.6%
   Rock average = 45.3%
   Dirt/Hardpan average = 40.7%
   Herbicide pretreated average = 87.3%

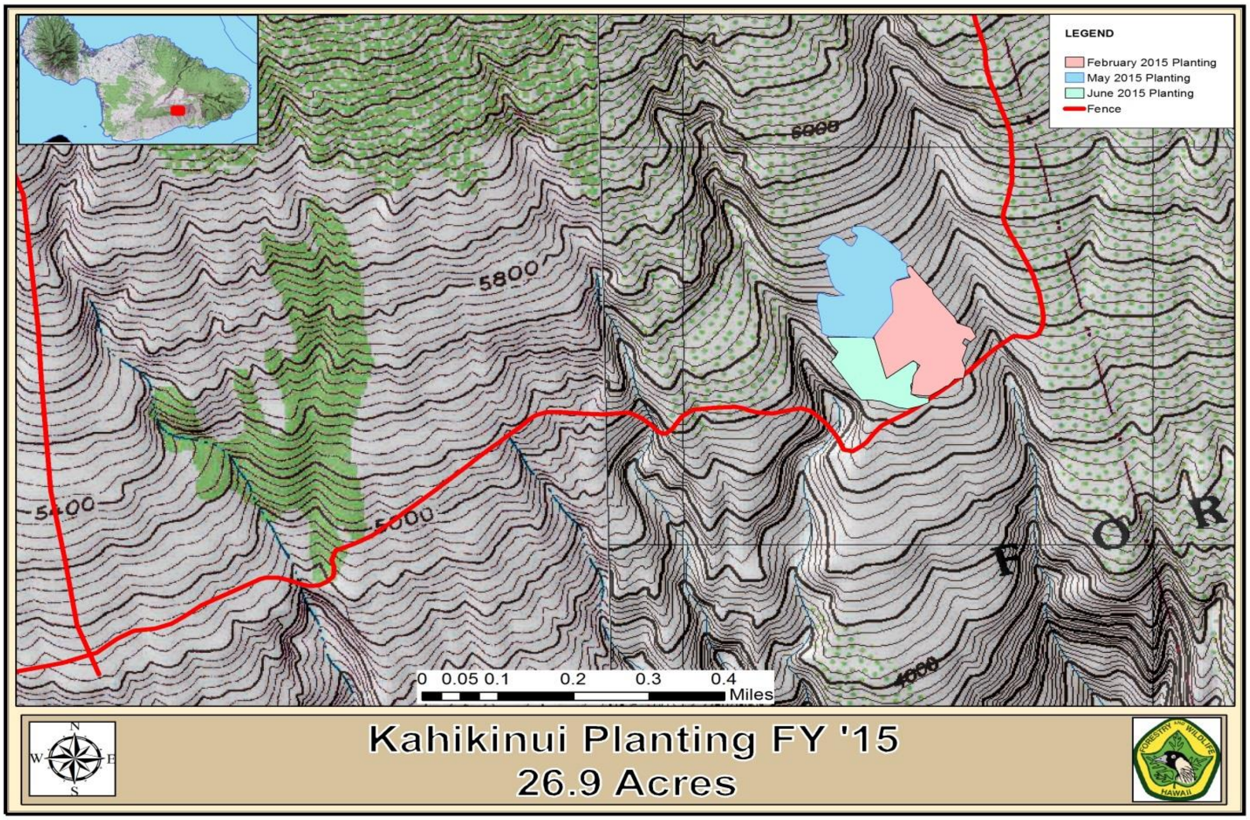
   By Species:
   Koa *(Acacia koa)* – 541/656 *overall yielding a 82.47% survival rate
   Aalii *(Dodonaea viscosa)* – 315/400 *overall yielding a 78.75% survival rate
   Pilo *(Cosprosma spp.)* **-** 41/42 *overall yielding a 97.62% survival rate
   Ohia *(Metrosideros polymorpha)* – 71/78 *overall yielding a 91.03% survival rate
   Mamane *(Sophora chrysophylla)* – 50/65 *overall yielding a 76.9*2% survival rate

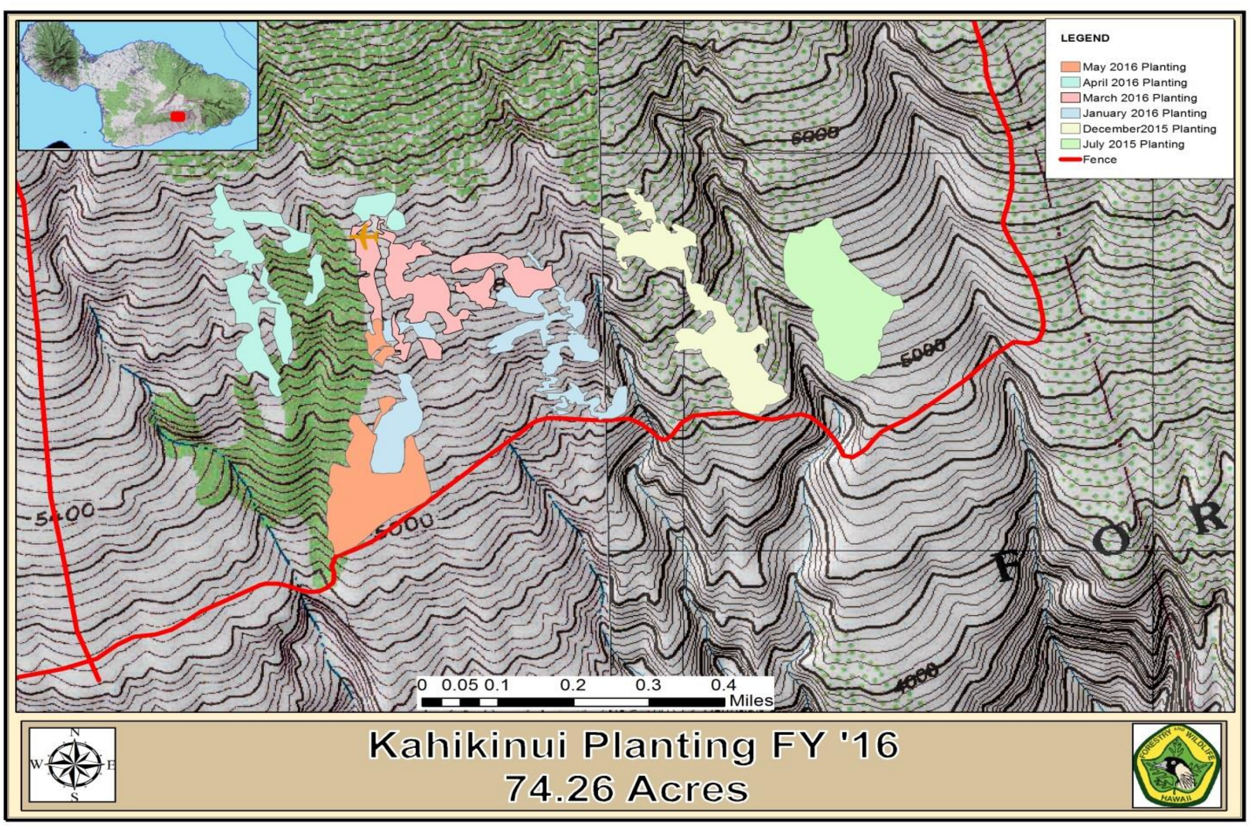
   **other plant species such as Osteomeles anthyllidifolia, Santalum freycinetianum, and Cheirodendron trigynum were not present in the random sample plots taken so far.*

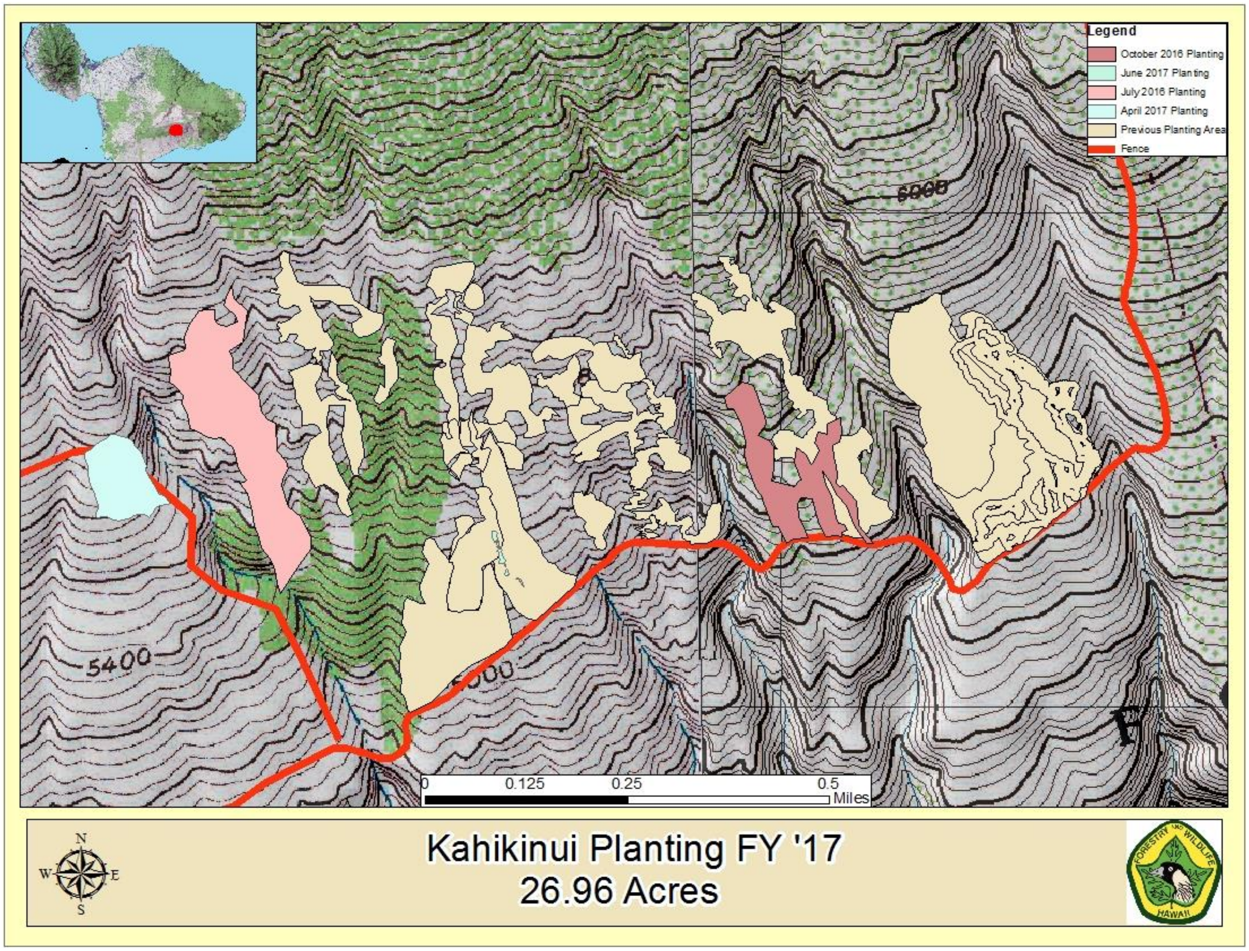
Figure 3 – Survivorship Monitoring Plot Locations



APPENDIX 1 – MAPS, LISTS & PHOTOS







Outplanting Taxon By Subunit

Subunits = <All>

From 1/1/2015 to 6/30/2017

Kahikinui-Nakula Units-Ka

Action = Plant

Taxon:	*Quantity:*
Acacia koa	32197
Argyroxiphium sandwicense	59
Cheirodendron trigynum sub	236
Coprosma ochracea	32
Coprosma waimeae	270
Deschampsia nubigena	1578
Dodonaea viscosa	10901
Metrosideros polymorpha	4133
Myrsine knudsenii	50
Osteomeles anthyllidifolia	161
Pisonia umbellifera	12
Santalum freycinetianum	15
Sophora chrysophylla	4776
Action Total Plants	54420
Polygon Total Plants	54420

Total all subunits	54420

Subunits = <All>

From 7/1/2016 to 6/19/2017

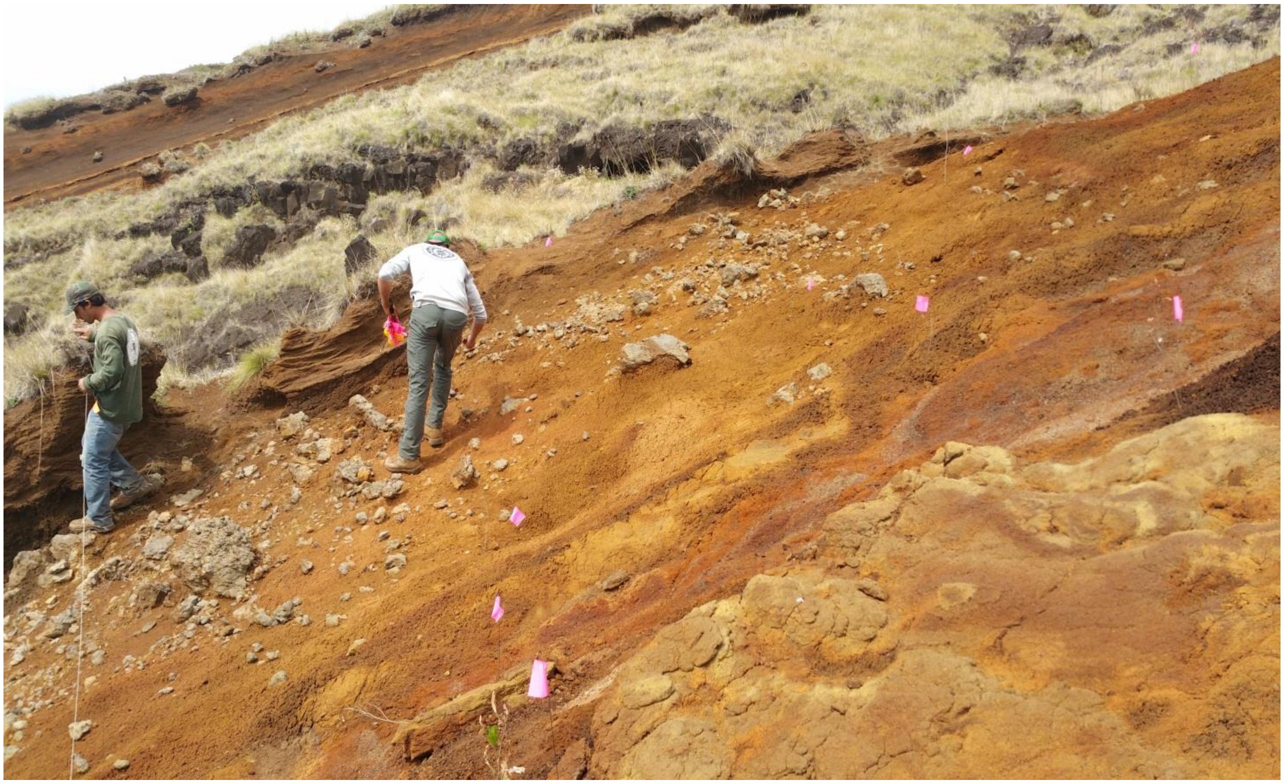
Kahikinui-Nakula Units-Ka

Action = Plant

Taxon:	***Quantity:***
Acacia koa	6785
Argyroxiphium sandwicense	59
Cheirodendron trigynum sub	145
Deschampsia nubigena	1578
Dodonaea viscosa	3809
Metrosideros polymorpha	350
Myrsine knudsenii	50
Pisonia umbellifera	12
Sophora chrysophylla	200
Action Total Plants	12988
Polygon Total Plants	12988
Total all subunits	12988

Temporary campsite located in the Kahikinui State Forest Reserve. View from project area looking makai with Pahihi Gulch in the background.

Acacia koa (koa) seedlings out-planted in the "hard pan" areas emerging above the non-native grass and bracken fern.



Forestry staff installing and monitoring survivorship plots in the "hard pan" areas.

Forestry staff using 5" blade auger machine to out-plant native seedlings in the project area

Natural regeneration of Acacia koa (koa) seedlings flourishing 8-12 months after removal of feral ungulates

Appendix 33

Low Wind Speed Curtailment Bat Mortality Rate Study Results

Region	Cut-in (m/s)	Full Feather	Treatment (LWSC m/s)	Average Reduction (%)	p Significant	Citation	Notes
Summerview Wind, Alberta	4.0	Yes	4.0	57	Yes	Baerwald *et al.* 2009	significance between control and each treatment, no difference between treatments
	4.0	No	5.5	60	Yes		no difference between feathering only and LWSC to 5.5 m/s w/out feathering
Wolfe Island Wind, Ontario	4.0	No	4.5	48	N/A	Stantec Consulting Ltd 2012	no statistical test, just averages, small sample size
	4.0	No	5.5	60	N/A		
Casselman Wind, PA	3.5	No	5.0	87	Yes	Arnett *et al.* 2009	no difference between treatments, 82% average for both treatments combined, small sample size
	3.5	No	6.5	74	Yes		
Casselman Wind, PA	3.5	No	5.0	68	Yes	Arnett *et al.* 2010	no difference between treatments, 72% average for both treatments combined, small sample size
	3.5	No	6.5	76	Yes		
Fowler Ridge Wind, IN	3.5	No	5.0	50	Yes	Good *et al.* 2011	significant 57.3% reduction between treatments
	3.5	No	6.5	78	Yes		
Fowler Ridge Wind, IN	3.5	Yes	3.5	36	Yes	Good *et al.* 2012	between treatments also significant
	3.5	Yes	4.5	57	Yes		
	3.5	Yes	5.5	73	Yes		
Fowler Ridge Wind, IN	3.5	Yes	5.0	84	Yes	Good *et al.* 2013	compared to Fowler Ridge 2010 without LWSC
Fowler Ridge Wind, IN	3.5	Yes	5.0	78	Yes	Good *et al.* 2015	
Fowler Ridge Wind, IN	3.5	Yes	5.0	71.8	Yes	Good *et al.* 2016	
Fowler Ridge Wind, IN	3.5	Yes	5.0	72.3	Yes	Good *et al.* 2017	
Fowler Ridge Wind, IN	3.5	Yes	5.0	66.3	Yes	Good *et al.* 2018	
Sheffield Wind, VT	4.0	Yes	6.0	62	Yes	Martin *et al.* 2017	combined 2012-2013, majority tree-roosting bats
Midwest US	3.5	No	4.5	47	Yes	Arnett *et al.* 2013	did not test 4.5 to 5.5 m/s between treatments
	3.5	No	5.5	72	Yes		
Pacific SW US	3.0	No	4.0	20	No	Arnett *et al.* 2013	4 hrs. from sunset only, low numbers of fatalities, 73.5 % Brazilian Freetail
	3.0	No	5.0	35	No		
	3.0	No	6.0	38	No		
	3.0	No	5.0	33	No		sunset to sunrise
Mt. Storm Wind, WV	4.0	Yes	4.0	72	Yes	Young *et al.* 2010	5 hrs. after sunset only
	4.0	Yes	4.0	50	Yes		5 hrs. before sunrise only
Mt. Storm Wind, WV	4.0	Yes	4.0	ND	No	Young *et al.* 2011	small sample size, winds high >6m/s
Beech Ridge Wind, WV	3.5	Yes	6.9	73	No	Tidhar *et al.* 2013	no control, compared to average of nearby windfarms, 89% less than WV average (with no LWSC)
Criterion Wind, MD	4.0	Yes	5.0	62	No	Young *et al.* 2013	compared to 2011 when blades not feathered, assumes conditions the same between years or turbines

Appendix 34

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.

<u>Fatality found outside of the designated reduced search area</u>
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.

<u>Fatality found outside of the designated "full" search area.</u>
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.