KAHEAWA WIND POWER II
WIND ENERGY GENERATION FACILITY

HABITAT CONSERVATION PLAN

APPLICANT:
KAHEAWA WIND POWER II, LLC.
56 Honuhula Street
Kihei, Hawaii 96753

PREPARED BY:
SWCA Environmental Consultants
201 Merchant st, Suite 2310
Honolulu, HI 96813

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1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 SUMMARY

Kaheawa Wind Power II LLC ("KWP II LLC" or the "Applicant") proposes to construct and operate a new 21-megawatt (MW) wind energy generation facility near Kaheawa Pastures above Mā'alaea in the southwestern portion of the Island of Maui, Hawai'i. The proposed project, known as Kaheawa Wind Power II (KWP II), is situated on approximately 143 acres (58 ha) of State Conservation Land southeast of the existing First Wind 30-MW Kaheawa Wind Power (KWP) project (see Figures 1.1 and 1.2). KWP commenced operation in June 2006. Like the KWP project, KWP II would supply wind-generated electricity to Maui Electric Company Ltd. (MECO).

The project components of KWP II will 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
- one 5,000 ft^2 maintenance building next to the existing KWP O&M building
- Installation of a 60,000-gallon tank adjacent to the existing O&M building at KWP. If a tank is not installed, the proposed project would use bottled water and portable pumped toilets similar to the KWP facility.
- 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 kV transmission lines through the area
- a communications system of underground fiber optic cables connecting to the existing KWP communications tower
- One permanent meteorological tower and one guyed temporary 65-meter test tower erected prior to construction of the WTGs. The temporary tower will be removed within three months of completing construction.
- service roadways to connect the new WTGs and other facilities to the existing main access road serving KWP

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

For the past two years, the Applicant has 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 turbines. Because of the characteristics of the prevailing winds, constructability and other factors, the Applicant has determined that the "Downroad" area is the best site for the KWP II project. Under the selected layout, 14 WTGs would be constructed along the existing KWP access road below the existing WTGs (see Figure 1.3, and Figure 4.1).

Construction and operation of the KWP II project has 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 auricularis newelli*), nēnē or the Hawaiian goose (*Branta sandvicensis*), and Hawaiian hoary bat (*Lasiurus cinereus semotus*). 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. No other listed, proposed, or candidate species has been found or is known or expected to be present in the project area. 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 through on-site collisions could have been tending to eggs, nestlings or dependent fledglings, or 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 the eggs or dependent young. Loss of eggs or young would be "indirect take" attributable to the proposed project. Observed direct takes documented at the existing KWP facility include three Hawaiian petrels, nine nēnē and two Hawaiian hoary bats.

The Applicant is seeking an Incidental Take Permit (ITP) in accordance with Section 10(a)(1)(B) of the federal Endangered Species Act (ESA) of 1973, as amended, and an Incidental Take License (ITL) in accordance with Chapter 195-D, Hawai'i Revised Statutes. These permits are issued by the U.S. Fish and Wildlife Service (USFWS) and State Department of Land and Natural Resources (DLNR), respectively. The requested take for KWP II is summarized in the table below.

Table 1.1 Requested Take for KWP II at Tier 1 and Tier 2.

Common Name	Scientific Name	Tier	Annual Take Limit	Five Year Take Limit	Twenty Year Take Limit
'Ua'u (Hawaiian petrel)	*Pterodroma sandwichensis*	Tier 1	4 adults/ immatures and 3 chicks/eggs	8 adults/ immatures and 4 chicks/eggs	19 adults/ immatures and 9 chicks/eggs
		Tier 2	up to 8 adults/ immatures and 4 chicks/eggs	up to 16 adults/ immatures and 8 chicks/eggs	up to 29 adults/ immatures and 14 chicks/eggs
'A'o (Newell's shearwater)	*Puffinus auricularis newelli*	Tier 1	2 adults/ immatures and 2 chicks/eggs	2 adults/ immatures and 2 chicks/eggs	2 adults/ immatures and 2 chicks/eggs
		Tier 2	up to 5 adults/ immatures and 3 chicks/eggs	up to 5 adults/ immatures and 3 chicks/eggs	up to 5 adults/ immatures and 3 chicks/eggs
Nēnē (Hawaiian goose)	*Branta sandvicensis*	Tier 1	4 adults/ immatures and 1 fledgling	8 adults/ immatures and 1 fledgling	18 adults/immatures and 2-3 fledglings
		Tier 2	up to 6 adults/immatures and 1 fledgling	up to 12 adults/ immatures and 3 fledglings	up to 27 adults/ immatures and 3 fledglings
'Ōpe'ape'a (Hawaiian hoary bat)	*Lasiurus cinereus semotus*	Tier 1	4 adults/ immatures and 2 juveniles	6 adults/immatures and 3 juveniles	6 adults/immatures and 3 juveniles
		Tier 2	up to 9 adults/ immatures and 5 juveniles	up to 9 adults/ immatures and 5 juveniles	up to 9 adults/ immatures and 5 juveniles

This HCP 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 construction and operation of the proposed 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 is proposing are intended to increase knowledge of the species' biology and distribution, enhance populations, or restore degraded native habitat. Mitigation measures are required to provide a net benefit to the species as required under state law. Mitigation measures are briefly summarized in the table below for the Covered Species.

Table 1.2 Proposed Mitigation for Covered Species: Tier 1 and Tier 1I Take Scenarios.

Tier 1 mitigation	Tier 2
Hawaiian Petrel	
1. Implement a comprehensive plan for seabird colony management at Makamaka'ole, on West Maui near lower Kahakuloa Valley, that would include predator proof fencing an enclosure, eradication within the enclosures, social attraction and artificial burrows. The success of the social attraction project in establishing a breeding and growing colony will be determined after 5 years and if unsuccessful, additional measures will be implemented till mitigation is commensurate with the requested take. AND/OR 2. Participate in the management of the Hawaiian petrel colony breeding in the crater of Haleakalā in an approximately 220 ac (89 ha) area with approximately 100 burrows. This would include contributing to contracting the labor and purchasing 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. AND/OR 3. Provide support for colony-based protection and productivity enhancement for Hawaiian petrels at the ATST mitigation site after 2016 when ATST mitigation obligations are fulfilled.	Tier 1 mitigation may be adequate to offset Tier 2 levels of take, if additional mitigation is needed, management will be initiated, or if already initiated for Tier 1 mitigation expanded to an area known to be occupied by unprotected burrows.
Newell's Shearwater	
1. Implement a comprehensive plan for seabird colony management at Makamaka'ole, on West Maui near lower Kahakuloa Valley, that would include predator proof fencing an enclosure, eradication within the enclosures, social attraction and artificial burrows. The success of the social attraction project in establishing a breeding and growing colony will be determined after 5 years and if unsuccessful, additional measures will be implemented till mitigation is commensurate with the requested take. AND/OR 2. Implement predator exclosure and social attraction scenario at an alternative site in East Maui, or implement predator exclosure at an in-situ site at upper Kahakuloa or alternative site on East Maui, if deemed feasible. AND/OR 3. Provide support for colony-based protection and productivity enhancement, or social attraction and predator exclusion for Newell's shearwaters on Molokai or Lanai. .	Progress through Tier 1 mitigation alternatives, which were developed to offset Tier 1 and Tier 2 take. .

Nēnē	
1. Fund the building of a new release pen to accommodate spillover of nene from other pens or participate in the translocation of eggs, adults or family groups from Kaua'i. Additional funding for management of the new pen for the first five years will be provided regardless of take, this includes support for logistics, DOFAW staffing, predator control and vegetation management activities. Perform systematic visual observations of nēnē activity within KWP II site to document how nēnē use the project area following construction.	1. Extend management activities at pen constructed for Tier 1, including support for logistics, 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 vs. gulches) and elevational ranges at KWP II and vicinity to support Maui bat research. 1b. Restoration of bat habitat at an acreage commensurate with the requested take.	1a. Continue surveys to document bat occupancy at different habitat types (e.g., ridges vs. gulches) and elevational ranges at KWP II and vicinity to support Maui bat research. 1b. Restoration of additional bat habitat at an acreage commensurate with the requested take.

Figure 1.1 KWP II Project Location Map.

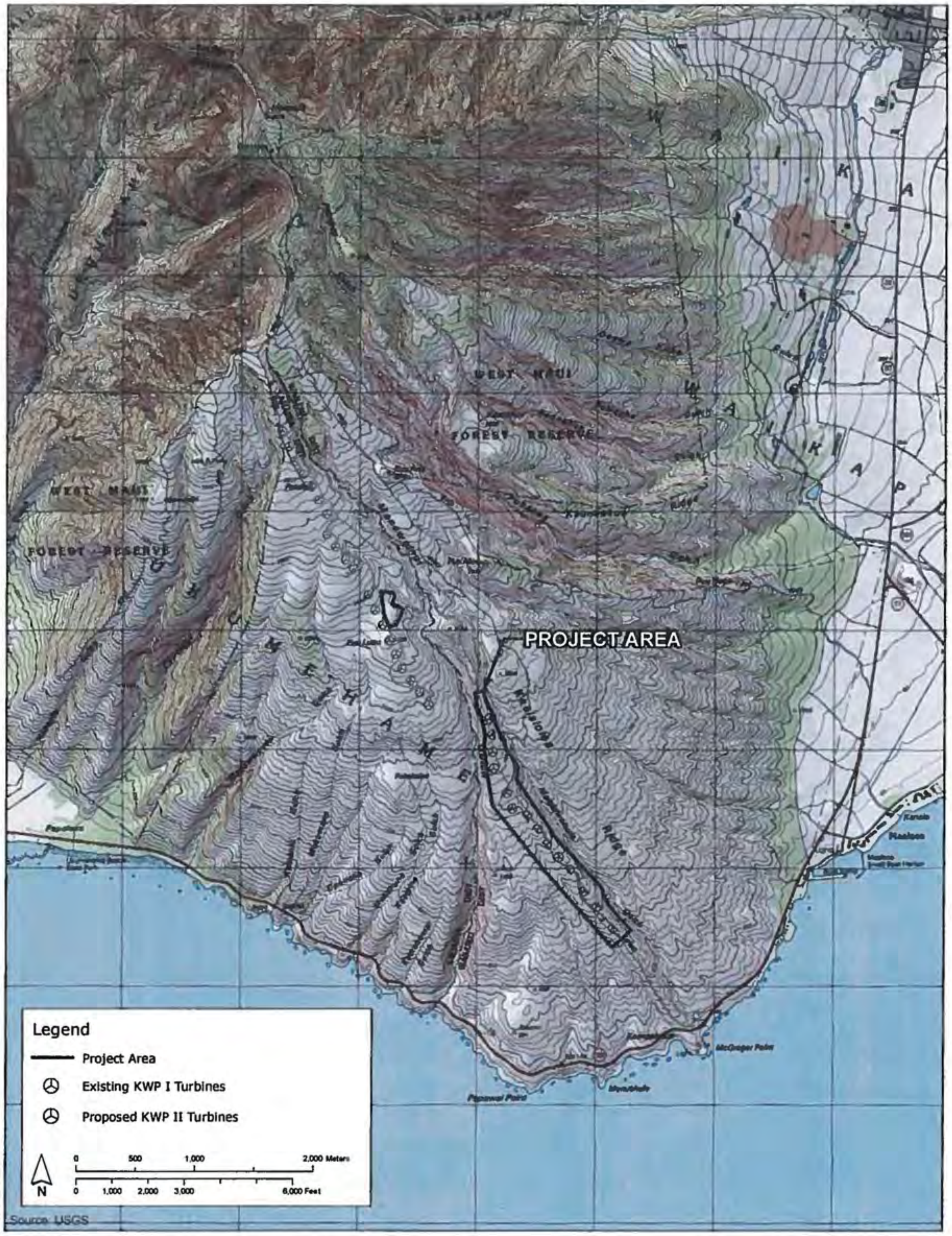


Figure 1.2 Map of the Vicinity of KWP II.

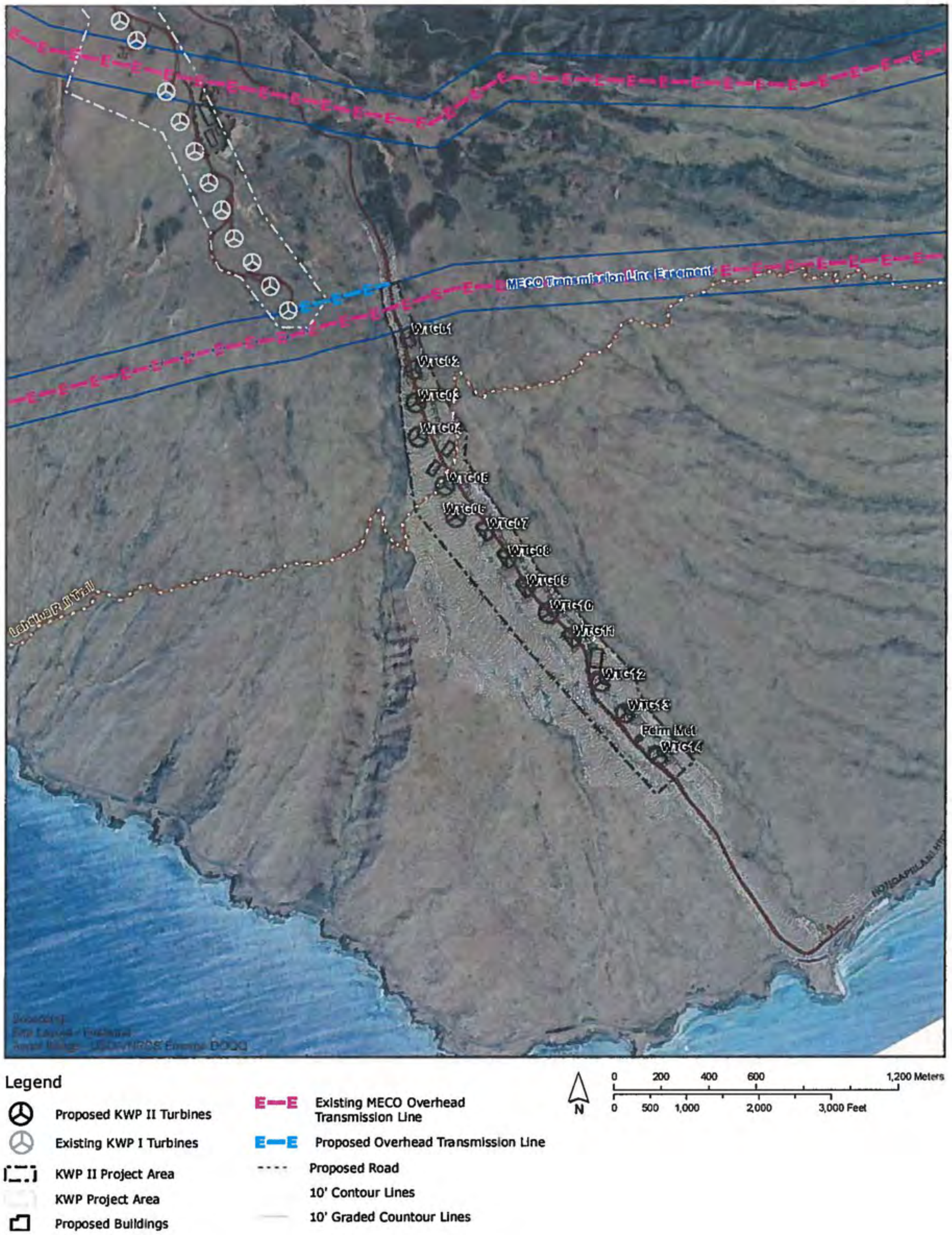


Figure 1.3 Site layout.

Additionally, the HCP outlines a monitoring protocol to determine the actual take of each species after the facility begins 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.

1.2 APPLICANT BACKGROUND

KWP II LLC was formed by Hawai'i Holdings LLC, which comprises two entities, First Wind and Makani Nui Associates, LLC. First Wind is a Boston-based wind energy company. Makani Nui Associates, LLC is a Maui-based partnership providing local resources for the project. KWP II LLC was created for the express purpose of developing a new wind generation facility adjacent to KWP. The principals of First Wind are among the country's leading wind power developers with extensive experience in financing, constructing, operating and managing large wind energy projects in the United States. First Wind has an extensive portfolio of wind energy generation facilities in operation or under development.

1.3 REGULATORY CONTEXT

1.3.1 Federal Endangered Species Act

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 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).

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. To apply for an ITP, an applicant must develop, fund and implement a USFWS-approved HCP to minimize and mitigate the effects of the incidental take. Such take may be permitted provided the following issuance criteria of ESA Section 10(a)(1)(B) and 50 CFR §17.22(b)(2) and 50 CFR §17.32(b)(2) are met:

- 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.

To obtain an ITP, an applicant must prepare a supporting HCP that provides the following information described in ESA Section 10(a)(2)(A) and 50 CFR 17.22(b)(1) and 50 CFR §17.32(b)(1):

- 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, 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 FR 35242) (USFWS and 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

Issuance of an ITP is a federal action subject to compliance with the National Environmental Policy Act (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 will prepare and provide for public review an Environmental Assessment (EA) to evaluate the potential environmental impacts of issuing an ITP and approving the implementation of the proposed KWP II HCP. The purpose of the EA is to determine if ITP issuance and HCP implementation will significantly affect the quality of the human environment. If the USFWS determines significant impacts are likely to occur, a comprehensive Environmental Impact Statement (EIS) for the proposed action will be prepared and distributed for public review; otherwise, a Finding of No Significant Impact (FONSI) will be issued. The USFWS will not make a decision on ITP issuance until after the NEPA process is complete.

1.3.3 Federal Migratory Bird Treaty Act

All three bird species addressed in this HCP are also protected under the Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC 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 MBTA provides no process for authorizing incidental take of MBTA-protected birds. However, if the HCP is approved and USFWS issues an ITP to the Applicant, the terms and conditions of that ITP will also constitute a Special Purpose Permit under 50 CFR §21.27 for the take of the Hawaiian petrel, Newell's shearwater, and nēnē under the MBTA. Therefore, subject to the terms and conditions to be specified in the ITP, if issued, any such take of the three listed bird species also will not be in violation of the MBTA. However, because the MBTA provides for no incidental take authorization, other MBTA-protected birds that are not protected by the ESA and that may be adversely affected by the proposed wind facility will not be covered by any take authorization.

To avoid and minimize impacts to MBTA-protected species, the KWP II project incorporates design and operational features based on the USFWS Interim Guidance on Avoiding and Minimizing Impacts to Wildlife from Wind Turbines (issued May 13, 2003). These 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 KWP II to avoid and minimize the potential for impacts to MBTA-protected species are detailed in Section 4.3. If take of any MBTA species occurs, these will be documented and reported in a similar fashion to that applied to any endangered or threatened species wildlife listed under the ESA.

1.3.4 Federal National Historic Preservation Act

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 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, 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)

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 Section 195D-2, 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; and
- 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 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; and
- 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, USGS, DLNR), and appropriate governmental and non-governmental 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 has met with the ESRC several times during the preparation of this HCP.

1.3.6 State Environmental Review: Chapter 343, Hawai'i Revised Statutes

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 Environmental Impact Statement (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* (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*, Kaheawa Wind Power II LLC will also comply with Chapter 343 for any actions conducted under this Habitat Conservation Plan as required by law.

1.4 PROJECT DESCRIPTION

1.4.1 Project Design and Components

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

Once all required land use approvals and environmental permits are granted, the Applicant will:

- Construct new internal service roads that connect the facility to the existing KWP access road.
- Install 14 General Electric (GE) 1.5-MW WTGs and supporting equipment. Each WTG will be set in a concrete foundation that is no more than 40 feet (12 m) × 40 feet in lateral directions. An additional 20-foot (6-m) wide cleared gravel perimeter will be provided around each foundation to facilitate access and maintenance. Table 1.3 lists other pertinent characteristics of the selected WTGs.
- Install an underground electrical collection network connecting all of the turbines, including excavation and burying of all wires and re-vegetation of the disturbed areas; a 1,225 foot (374 m) overhead collection line mounted on poles approximately 60-90 feet (18-25 m) above ground level will be required for crossing Manawainui Gulch.
- Construct a new electrical substation and install underground electrical power lines connecting the turbines with the new substation.
- Install interconnection facilities to connect the project to the existing MECO power transmission system.
- Construct a Battery Energy Storage System (BESS) adjacent to the substation to provide dispatchable energy under various operating conditions. This stored energy will be used to improve the ability of the MECO system to absorb additional as-available wind-generated resources.
- Construct a maintenance building to house operations personnel, equipment and facility spare parts.
- As KWP II will not directly connect to Maui's municipal water supply, KWP II LLC is considering installing a 60,000-gallon tank adjacent to the existing O&M building at KWP. This water would be used for non-potable bathroom plumbing, dust control, irrigating re-introduced native plants and emergency fire fighting. KWP II LLC estimates that daily water usage from the tank during normal operation will amount to about 250-450 gallons. If KWP II LLC does not install the tank, the proposed project would use bottled water and portable pumped toilets similar to the KWP facility (Planning Solutions, Inc. 2010); Potable water will be purchased and trucked up to the project area.
- Construct one permanent un-guyed met tower, a communications tower to support data gathering and control functions, and a temporary 213-foot (65-m) test tower prior to construction of the WTGs. The latter will be dismantled within three months of completion of construction.

Figure 1.3 provides a conceptual site plan showing the proposed locations of the above-mentioned facilities. Access to the site would be from Honoapi'ilani Highway (State Highway 30) via an existing State-owned road that was improved during construction of the KWP facility. Construction of the proposed facilities would disturb approximately 43 acres (17.4 ha) of land (i.e., approximately 30% of the leased area, Table 1.2); the remainder would remain undisturbed. The total "developed" area of the site, or the total area that would contain structures, hardened surfaces or roads is anticipated to be 39.2 acres (15.9 ha). The *Final KWP II EIS* for the project contains a detailed technical description of the infrastructure proposed for the project (Planning Solutions, Inc. 2010).

Table 1.3 Characteristics of 1.5-MW Wind Turbine Generators.

Power Generation	1.5 MW each
Tower Structure and Height	Tubular; 213 ft (65 m) tall
Rotor Diameter	231 ft (70 m)
Total Height (Tower + ½ Rotor)	328 ft (100 m)
Rotor Swept Area	50,130 ft^2 (4,657 m^2)
Rotor Speed	10-21 rpm (variable)
Wind Speed at Which Generator Starts	8 mph (13 kph)
Wind Speed at Which Generator Cuts Out	56 mph (90 kph)
Rated Wind Speed (Unit Reaches Maximum Output)	27 mph (43 kph)
Note: Based on GE Model 1.5se on 64.7 m tower.	
Source: Kaheawa Wind Power LLC (2004).	

Table 1.4 Area Occupied Project Components.

Project Component	Approximate Area Disturbed
	Alternative 1
14 WTG Foundations and Pads[1]	21 ac
Trenching for Underground Electrical Cables[2]	2 ac
Permanent Meteorological Tower[3]	0.2 ac
Maintenance Building, Substation, BESS	2 ac
Access Roads[4]	16 ac
Temporary Lay-Down Area[5]	2 ac
TOTAL	43 ac
(1) Each foundation occupies 2,500 ft^2; total disturbed area is 1.5 acres per turbine. (2) Trenches will be 2.0 ft (0.6 m) wide and 4.0 ft (1.2 m) deep and backfilled to finish grade. (3) The Proposed Action includes one met tower, while Alternative 2 proposes two met towers. (4) Estimate based on 36-ft wide (11-m) strip of "disturbance." (5) One construction lay-down area for equipment staging roughly 150 ft x 250 ft (46 x 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 would be kept to the minimum necessary for safety and operations. Lighting at the project would include that which is required by the Federal Aviation Administration (FAA) for aircraft safety. In March 2005, the existing KWP 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. KWP II LLC anticipates applying for a similarly reduced lighting plan for the KWP II project.

Other lighting would be 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 would consist of halogen flood lights that are shielded and/or directed downward. Lights would be 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 would likewise be turned off at the end of each work day (more detail is provided in Section 4.3.1).

Personnel would generally be present at the facility on a daily basis throughout project operation. They would 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 would include 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 may be conducted for fire prevention purposes at the direction of DLNR forestry officials, although any such work would first be reviewed and approved by USFWS and DLNR wildlife officials to ensure that it would not be expected to have any adverse impacts on any listed species.

The electrical power generated by KWP II would be 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 would be delivered from the proposed substation to the existing MECO 69kV (kilovolt) transmission line that passes directly through the southern end of the project area.

KWP II will implement a fire contingency plan as outlined in detail in the *Final KWP II EIS* for the project (Planning Solutions, Inc. 2010.) that closely follows the fire contingency plan developed for KWP (Fire Contingency Plan for CDUA MA-3103, 2005, Appendix 18).

1.4.2 Purpose and Need for KWP II Project

Maui presently depends heavily upon fossil fuels for its electrical energy needs. The purpose of the proposed KWP II project is to reduce that dependency by providing an alternative source that is renewable. As currently proposed, the project would provide 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 per month). By substituting a "local renewable" fuel source for imported fossil fuel, the project will help 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 proposed project would provide could reduce fossil fuel consumption by an estimated 138,000 barrels 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/barrel 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 $100,000,000. 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 barrels per year) would also benefit 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 will 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 kg) of carbon dioxide (CO_2) annually emitted into the atmosphere.
- Elimination of approximately 0.75 million pounds (0.34 million kg) of sulfur dioxide (SO_2) 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 megawatt-hours per year (MWh/year) is expected to be somewhat higher than the
[2] This estimate is based on the following: (a) Net capacity factor = 38%; (b) average heat rate for MECO-owned generation = 11,500 BTU/Net kWh; (c) BTU Savings = 803,905-1,148,436 MMBTU/yr (d) 5.821 MMBTU/BBL of distillate (diesel) fuel oil; and 21 MW installed capacity.

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

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 should result in reduced health costs and respiratory illnesses.

1.4.3 Project Schedule and Timeline

Construction of the project would likely occur as soon as practicable after all permits and authorizations have been obtained, and financing is completed. The turbines will become operational approximately six to nine months after the start of construction.

The life of the project is anticipated to be 20 years, after which time the Applicant would arrange either to extend the life of the project or remove the facilities. The continuance of the project's operation would be subject to a renewal of KWP II LLC's lease with 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 will require that the turbines and other structures be removed and the site remediated and stabilized.

1.4.4 List of Preparers

This 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 and 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 the Division of Forestry and Wildlife (DOFAW), James Kwon, Dawn Greenlee, Patrice Ashfield, and Jeff Newman of USFWS, as well as members of the ESRC are gratefully acknowledged.

2.0 DESCRIPTION OF THE HABITAT CONSERVATION PLAN

2.1 PURPOSE OF THIS HCP

The construction and operation of the KWP II wind energy generation facility could adversely impact four species protected under the ESA and HRS Chapter 195-D, and other Federal and State laws and regulations. These species are the Federally 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, or Hawaiian goose, 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 on-going 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 largely stem from loss of habitat.

Pursuant to ESA Section 10(a)(1)(B), as amended, and HRS Chapter 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 ITP and ITL, KWP II LLC will be authorized for the incidental take of the Covered Species in connection with the construction and operation of the proposed wind energy generation facility. The purpose of this HCP is to make supportable determinations as to the potential impact that the wind energy generation facility could have on each of the Covered Species; to discuss alternatives to the proposed facility and its design in terms of these impacts; to propose appropriate efforts to minimize, mitigate and monitor these potential 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 during this HCP'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, and in keeping with the project's other environmental benefits, the Applicant proposes to offset any impacts to the Covered Species and provide a net conservation benefit to these four species.

2.2 SCOPE AND TERM

This HCP seeks to offset the potential impact of the proposed wind energy generation facility on the Covered Species with measures that protect and perpetuate these species island-wide and statewide. The Applicant anticipates a 20-year project life, throughout which this HCP would be in effect. With monitoring and review by the USFWS and DLNR, the provisions for adaptive management will allow mitigation of project impacts to be adjusted appropriately. Accordingly, this HCP 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 will be coordinated with USFWS and DLNR, as further detailed in Chapter 7 – Implementation.

2.3 SURVEYS AND RESOURCES

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

- 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 environmental assessment documents previously prepared for the KWP facility. Information on endangered species occurrence in the project area and documented take at the KWP facility was obtained from various site-specific studies conducted prior to and since the KWP facility commenced operation. These sources include:
- Studies completed in support of the KWP HCP
- Annual reports documenting compliance with the HCP and status of ongoing take monitoring, research and mitigation at the KWP facility
- An invertebrate survey of the project area that Mike Severns conducted in September 2009 (Appendix 9 and 17) to investigate the status of protected Hawaiian snails (*Achatinella* spp.) and other native invertebrates in the project area
- Botanical survey of the proposed KWP II project area that Robert Hobdy conducted August 2009 and January 2010 (Appendix 7 and 15). The 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 *Final KWP II EIS* (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 (Appendix 3, 13, 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 (Appendix 21, 24, 25)

In addition to site-specific surveys, staff from KWP, USFWS and DLNR provided unpublished information, data and reports to ensure that all available resources could be considered and evaluated in the preparation of this HCP. Continued coordination with USFWS and DLNR biologists and KWP 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 *Final KWP II EIS* for the project (Planning Solutions, Inc. 2010).

3.1 LOCATION AND VICINITY

The proposed KWP II project is located on the southwestern slopes of the West Maui Mountains. The lowest of the proposed WTGs is approximately 0.8 miles inland from Honoapi'ilani 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 five miles (8 km) to the southwest, and Mā'alaea, 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

The proposed KWP II project area is in the General subzone of the State Conservation District as established and regulated by Chapter 205, Hawai'i Revised Statutes. Lands within the Conservation District are typically used for protecting watershed areas, preserving scenic and historic resources, and providing forest, park and beach reserves [subsection 205-2(e) HRS]. The entire project area is owned by the State of Hawai'i. 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

The proposed WTGs would be constructed on the lower part of a broad interfluve between Manawainui Gulch on the west and Malalowaia'ole Gulch on the east. The proposed baseyard (substation, battery energy storage system 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 Malalowaia'ole Gulch and separates the proposed facilities from the isthmus of Maui to the east. The gulches are steep and rocky. Several small pu'u are present in the area, including Pu'u Lū'au, 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 (1.2-1.5 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, Pu'uhele, lies approximately 1.6 miles (2.5 km) north of Mā'alaea along the road to Wailuku. There are no known unique or unusual geologic resources or conditions in the area.

3.4 SOILS

Soils in the area where the proposed WTGs would be constructed are exclusively characterized as rock lands (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. 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 proposed KWP II project area.

Table 3.1 Characteristics of Soil Types within the Project Area

Soil Type	Slope (%)	Permeability	Runoff	Erosion Hazard	Land Uses
Nā'iwa 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, urban development
Source: General Soil Survey of Hawai'i, Foote et al. 1972 (U.S. Soil Conservation Service).					

3.5 HYDROLOGY AND WATER RESOURCES

Average annual rainfall in the general project area ranges from less than 15 inches (38 cm) per year at the Honoapi'ilani Highway/site access road intersection to slightly over 40 inches (102 cm) per year at the uppermost of the existing KWP 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 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 wind farm. There are no wetlands or other aquatic habitats (Hobdy 2004a, 2004b, 2006a, 2006b, and 2009). No perennial streams flow through the area, though storm runoff is present in Malalowaiaole Gulch just to the east of the proposed WTGs during rainy periods. On-site drainage is in a southeasterly direction toward Malalowaiaole Gulch and the Pacific Ocean.

The State of Hawai'i Commission on Water Resource Management (Letter from CWRM to Perry White, dated March 14, 2008) has determined that Manawainui Gulch does not have sufficient water to support instream 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 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 State of Hawai'i Water Use Commission). 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 non-potable groundwater.

3.6 TERRESTRIAL FLORA

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 shrublands 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 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 (Appendix 9 and 15, Table 3.2). No State or Federally 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, Lāna'i, Moloka'i, and Kaho'olawe. 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 Malalowaia'ole 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 6-10 ft (2-3 m) in size.

The vegetation in the KWP II 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*), 'ilima (*Sida fallax*), 'uhaloa (*Waltheria indica*), lesser snapdragon (*Antirrhinum orontium*), and Jamaican vervain (*Stachytarpheta jamaicensis*). In the two small areas of the existing KWP area proposed to be developed under Alternative 1 and within the proposed trenching corridor, the most common species include molasses grass (*Melinis minutiflora*), 'ūlei (*Osteomeles anthyllidifolia*), lantana (*Lantana camara*), natal redtop, and 'a'ali'i (*Dodonaea viscosa*).

Of the 24 native plant species documented on-site, 15 are endemic and nine are indigenous to the Hawaiian Islands (Table 3.2). The botanical surveys indicate that native plant species are most prevalent in the rocky habitat bordering Manawainui and Malalowaia'ole Gulches (Hobdy 2009a). These habitats are the most protected from grazing and fire. The three hardiest species 'ilima, 'uhaloa and 'a'ali'i are also present on the flatter grassy ridge tops. 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 Lāna'i, but is common in West Maui (Hobdy 2010).

Table 3.2 Native Hawaiian Plants Observed in the KWP II Project Area by Hobdy (2009).

Scientific Name	Common Name	Status[1]	Abundance (at site)[2]
FERNS			
DENNSTAEDTIACEAE (Bracken Family)			
Pterididum 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	'āheahea	E	rare
ASTERACEAE (Sun Flower Family)			
Bidens micrantha subsp. *micrantha* Gaud.	ko'oko'olau	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)			

Scientific Name	Common Name	Status[1]	Abundance (at site)[2]
Chamaesyce celastroides (Boiss.) Croizat & Degener var. *amplectens* (Sherff) Degner and I. Degener	'akoko	E	uncommon
GOODENIACEAE (Goodenia Family)			
Scaevola gaudichaudii Hooker and Arnott	naupaka kuahiwi	E	rare
MALVACEAE (Mallow Family)			
Sida fallax Walp.	'ilima	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	'ōhi'a	E	uncommon
Metrosideros polymorpha Gaud. var. *incana* (H. Lev.) St. John	'ōhi'a	E	rare
PAPAVERACEAE (Poppy Family)			
Argemone glauca (Nutt. ex Prain) Pope	puakala	E	rare
ROSACEAE (Rose Family)			
Osteomeles anthyllidifolia (Sm.) Lindl.	'ūlei	I	uncommon
SANTALACEAE (Sandalwood Family)			
Santalum ellipticum Gaud.	'iliahialo'e	E	rare
SAPINDACEAE (Soapberry Family)			
Dodonaea viscosa Jacq.	'a'ali'i	I	uncommon
STERCULIACEAE (Cacao Family)			
Waltheria indica L.	'uhaloa	I	common
THYMELAEACEAE ('Akia Family)			
Wikstroemia oahuensis (A. Gray) Rock.	'akia	E	rare

(1) E= endemic (native only Hawai'i); I= indigenous (native to Hawai'i and elsewhere).

(2) Common= widely scatted throughout or locally abundant; uncommon= scattered sparsely throughout or occurring in a few small patches; rare= only a few isolated individuals.

Source: Hodby 2009a, b, 2010.

3.6.1. Plant Sanctuaries, Critical Habitats and Plants of Interest in the Vicinity of KWP II

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 facility, specifically within Manawainui Gulch, Pāpalaua Gulch, and Kealaloloa Ridge (including the Manawainui Plant Sanctuary). The endangered species include *Remya mauiensis*, 'iliahi (*Santalum freycinetianum* var. *lanaiense*), *Diellia erecta*, pauoa (*Ctenitis squamigera*), *Cystopteris douglasii*, *Cyanea obtuse*, ha'iwale (*Cyrtandra oxybapha*), *Schiedea pubescens*, ko'oko'olau (*Bidens campylotheca* subsp. *pentamera*) and koki'o 'ula'ula (*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

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

No Federally listed species of snails were found in a recent molluscan survey conducted at the KWP II area (Severns 2009, Appendix 9). One native species of snail was found, *Succinea mauiensis* (Family: Succinidae). *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.

Succinea 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 biologists for the KWP II area (Table 3.3). Two other introduced species documented by Nishibayashi (1997, 1998) in the KWP area could also occur at the KWP II area. The two species are the northern cardinal (*Cardiinalis cardinalis*) and the house finch (*Carpodacus mexicanus*). Two native or endemic species occur on site, the endangered nēnē (*Branta sandvicensis*) and the Hawaiian short-eared owl (*Asio flammeus sandwichensis*). The indigenous white-tailed tropicbird has been observed flying overhead (*Phaethon lepturus*) 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. 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 four 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 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.

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 (*Asio flammeus flammeus*) 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 (*Phaethon lepturus*) are sometimes seen near the project area by KWP 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 as of November 2011. One fatality of a great frigate bird 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.

Based upon information provided by Maui DLNR staff and KWP biologists, mammals occurring in the vicinity of the project area 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 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 Biologists (2006 to present).

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 Oahu)
Tyto alba	Barn owl	I (MBTA)
Alauda arvensis	Eurasian skylark	I (MBTA)
Acridotheres tristis	Common myna	I
Lonchura punctulata	Nutmeg manakin	I

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

3.8 LISTED WILDLIFE SPECIES

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 are the only two that likely use the habitats in the project area. Nēnē are known to be resident in the project area and acoustic bat detectors stationed in the KWP and KWP II project areas have recorded low levels of bat activity that may be seasonal. 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.

As at KWP, the proposed WTGs and met towers associated with the KWP II project would potentially 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).

Scientific Name	Common, Hawaiian Name(s)	Date Listed	Status
Birds			
Puffinus auricularis newelli	Newell's shearwater, 'a'o	10/28/1975	T
Pterodroma sandwichensis	Hawaiian petrel, 'ua'u	3/11/1967	E
Branta sandvicensis	Hawaiian goose, nēnē	3/11/1967	E
Mammals			
Lasiurus cinereus semotus	Hawaiian hoary bat, 'ōpe'ape'a	10/13/1970	E

3.8.1 Hawaiian Petrel

3.8.1.1 Population, Biology and Distribution of the Hawaiian Petrel

Hawaiian petrel was once abundant on all main Hawaiian Islands except Ni'ihau (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, Hawai'i, Kaua'i and Lāna'i (Richardson and Woodside 1954; Simons and Hodges 1998; Telfer et al. 1987). Radar studies conducted in 2002 also suggest that breeding may occur on Moloka'i (Day and Cooper 2002). It is believed that breeding no longer occurs on O'ahu (Harrison 1990).

Survey work at a recently re-discovered Hawaiian petrel colony on Lāna'i, 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, b). Radar counts of petrels on the perimeter of Maui and recent colony detections by KWP 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 non-breeding 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 two-week foraging expeditions (Adams 2008).

Hawaiian petrels are active in their nesting colonies for about eight 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 2,500 meters (8,200 ft). 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 'ōhi'a with uluhe understory as those found on Kaua'i (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 six and may not breed every year, but pre-breeding and non-breeding 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 ranges 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 to have collided with WTGs, hve been recorded at KWP 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 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 6.3.1.1). 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.; see 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 elevation. The highest densities of nests (15-30 burrows per hectare) 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).

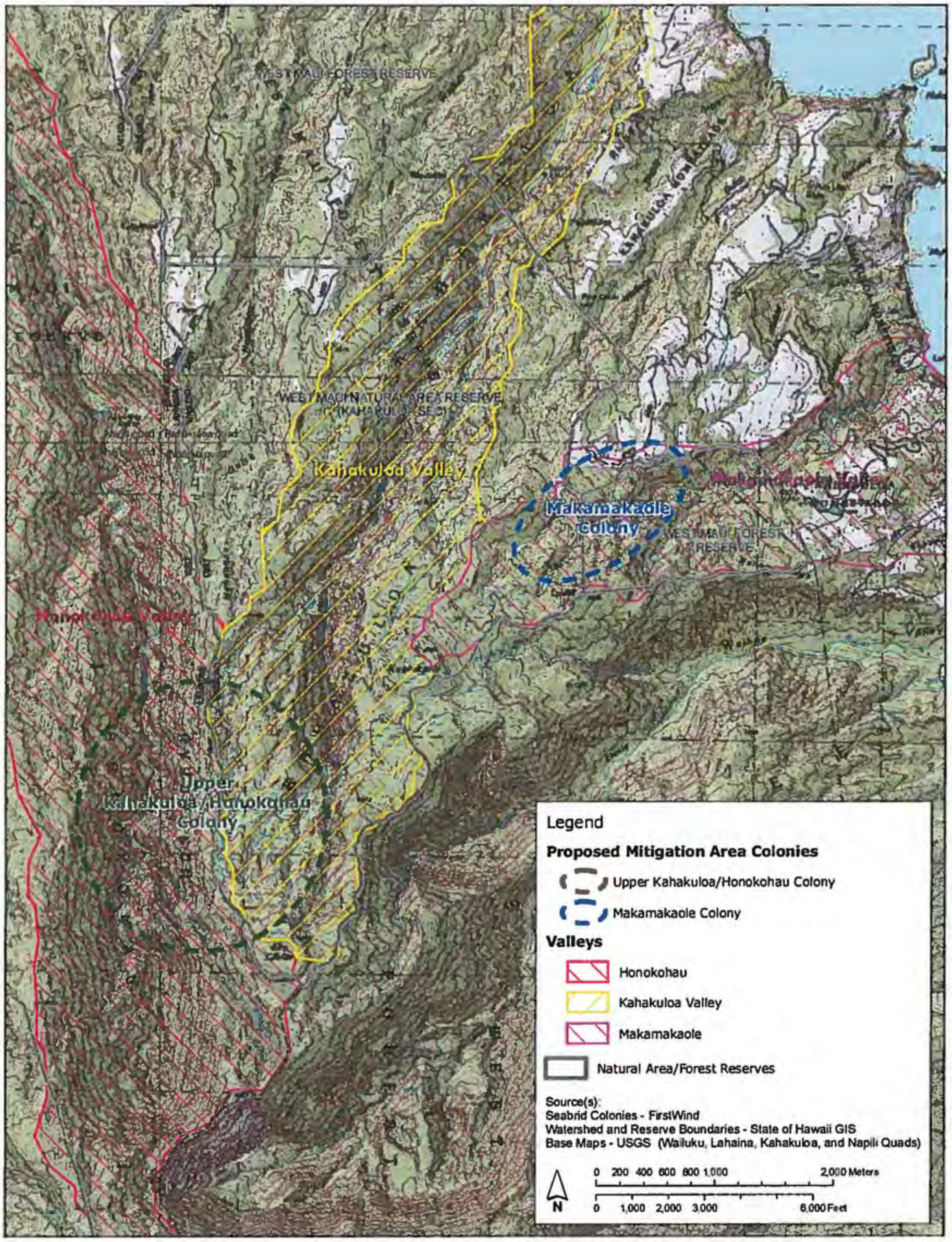


Figure 3.1 Seabird Colonies and Seabird Congregation Areas on West Maui.

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. 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 over the last 10 years (Figure 3.2a). However, when comparing passage rates over other areas and islands of Hawai'i, passage rates over the KWP and KWP II project area are lower than the mean rate measured for West Maui (8.7 ± 3.9 targets/hr Fig. 3.2a), East Maui (52.8 ±16.6 targets/hr, 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/hr, Day and Cooper 2001).

3.8.2 Newell's Shearwater

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

The Newell's shearwater is an endemic Hawaiian sub-species 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. 2003a). 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. 2003a) 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) above mean sea level, 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 six years of age, after which breeding pairs produce one egg in a given year. A high rate of non-breeding 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

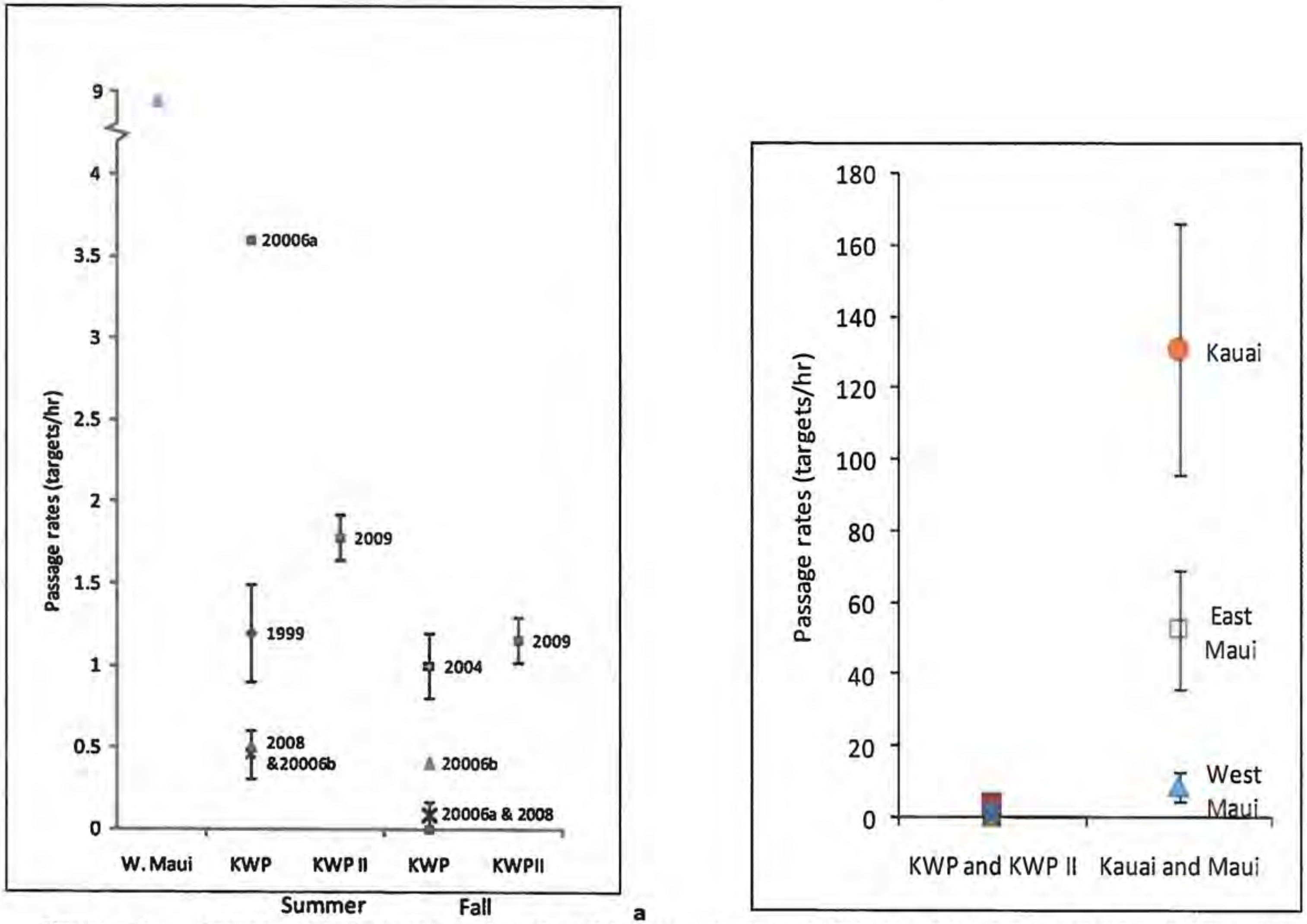


Figure 3.2 Comparison of passage rates of seabirds over KWP and KWP II with (a) West Maui and (b) East Maui and Kaua'i. Error bars are SE. Data points are labeled with the year the surveys were conducted. 2006 had two survey locations at KWP.

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. Pairs produce one egg, and 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. 2003a). 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 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 proposed 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 over the last 10 years (Figure 3.2a). However, when comparing passage rates over other areas and islands of Hawai'i, passage rates over the KWP and KWP II project area are lower than the mean rate measured for West Maui (8.7 ± 3.9 targets/hr, Figure 3.2a), East Maui (52.8 ±16.6 targets/hr, 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/hr; Day and Cooper 2001).

3.8.3 Nēnē

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 reduced 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, and Kaua'i. The USFWS estimated that in the early part of this decade, the nēnē population numbered 1,300 individuals (USFWS 2004a). 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 Kaheawa Pastures project area. Since 1994, 104 nēnē have been released at Hana'ula, compared with 18 at Haleakalā (USFWS 2004a).

KWP has worked with Maui DOFAW and USFWS to establish a new nēnē release pen on land owned by Haleakalā Ranch in East Maui. Nēnē will be released at this pen (total release numbers to be determined) for a period of 10 to 20 years in fulfillment of the KWP HCP mitigation program for nēnē.

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 one to two 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, shrubland 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 habitats. 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, and inbreeding depression (USFWS, unpubl.; USFWS 2004a). 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 and 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, unpubl.). A lack of adequate food and water supplies also seems to be a limiting factor in Hawai'i Volcanoes National Park (USFWS 2004a).

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.

Nine nēnē fatalities have been observed since the beginning of operations at KWP in 2006 (Kaheawa Wind Power LLC 2008b, 2009). Section 5.2.4.1 provides additional information concerning these fatalities.

3.8.3.3 Occurrence of Nēnē in West Maui and the Project Area

The Hana'ula release pen is located near the upper end of the existing KWP project area, approximately 1,800 feet (550 m) from the nearest KWP wind turbine. A number of nēnē from the Hana'ula release site have remained as residents within or near the KWP project area. Little is known about the exact distribution and movements of the birds released at the Hana'ula 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 is estimated at 106 birds (DOFAW 2009). This population is monitored under the KWP HCP and survey effort is now well coordinated between DOFAW and KWP biologists.

In 1998, four goslings were successfully fledged from the first nest reported in the area since reintroduction began (DOFAW 2000). As of this report date, monitoring studies at KWP have resulted in discovery of a few nēnē nests in the vicinity. One successful nest was discovered in 2007 about 330 feet (100 m) to the west of turbine WTG-15. Spencer (pers. comm.) reported that most nesting activity is observed well to the west and southwest of the KWP area but seldom, if ever, within the KWP II area.

Nēnē presence and nesting behavior have been monitored regularly in the KWP project area prior to and after commencing operation of KWP. Data collected from incidental surveys and the WEOP program (December 2006–June 2009), have provided information about nēnē distribution and behavior at KWP and KWP II. Monitoring of nēnē during the construction period at KWP (January to June 2006) also documented nēnē use of the KWP area and Downroad KWP II area. Both these data sets combined provide over 800 observations (n = 820 individuals) on nēnē distribution and span over three and a half years[3]. Results show that nēnē are seen almost twice as frequently (n = 532 individuals) at the KWP 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 64kV overhead transmission route crossing (Mile Marker 2.25). The birds periodically use the area for browsing and socializing (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 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 wind facility. Surveys were conducted in the mornings (6-10 a.m.), afternoons (10 a.m.–2 p.m.) and evenings (2 p.m.–6 p.m.). Systematic surveys show that flight activity did not vary with time of day (range = 0.29 – 0.38 flocks in flight/hr; $X^2 = 0.464$, $df = 2$, $p = 0.79$).

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

3 To standardize effort spent surveying both KWP 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 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.

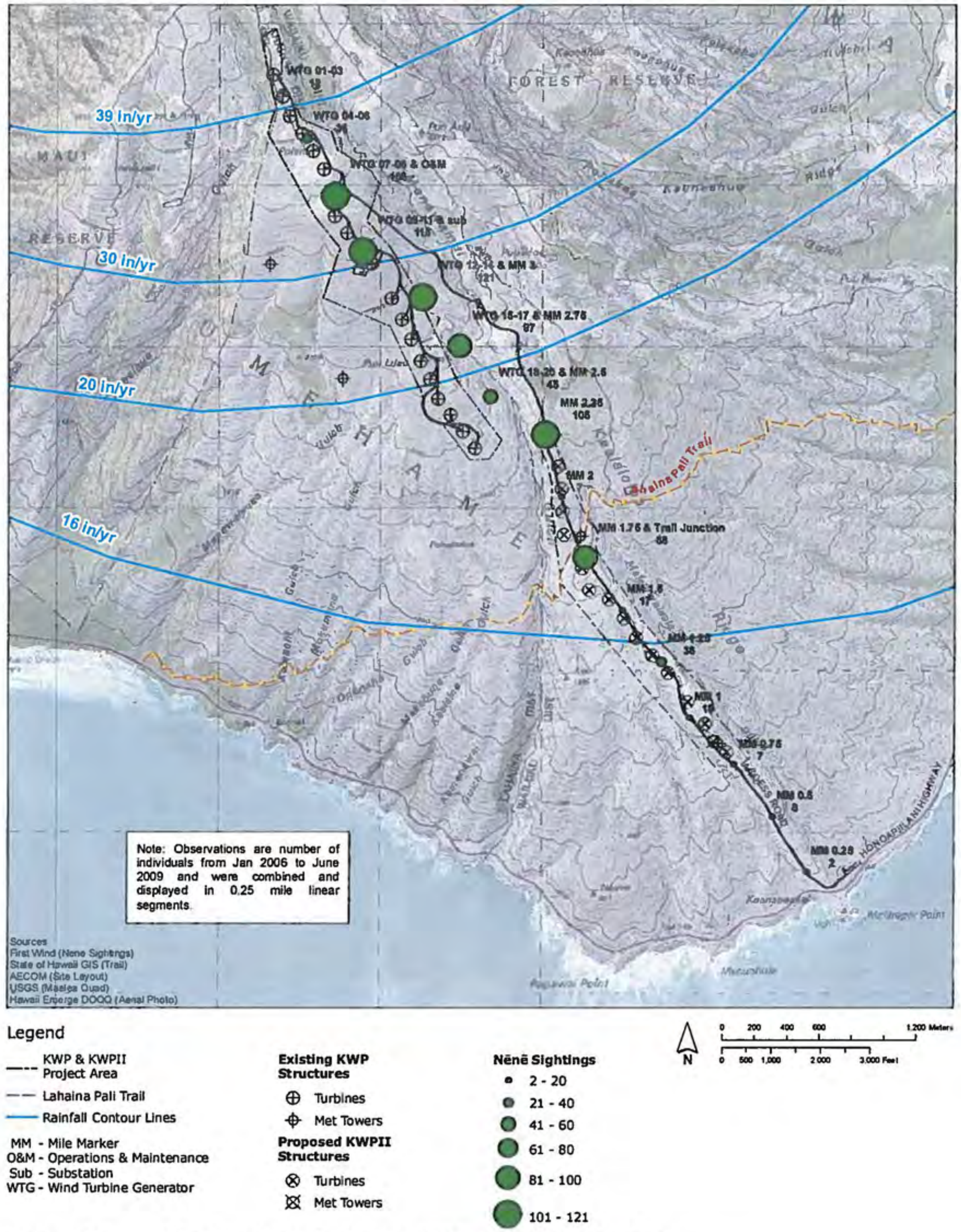


Figure 3.3 Distribution of nēnē at KWP and KWP II areas.

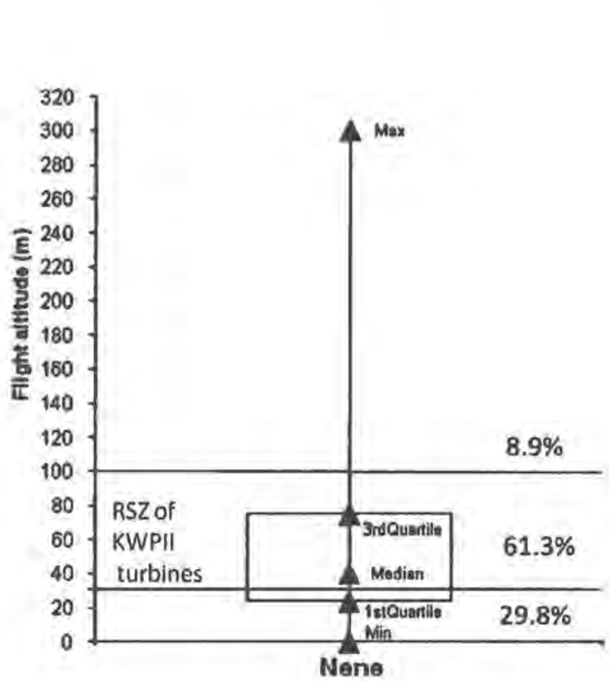


Figure 3.4 Flight altitudes of nēnē from WEOP and systematic observations (n=97), imposed on the RSZ of turbines at KWP II. Percentages on the right are the percentages of nēnē flights expected to occur at, below and above the RSZ.

Two of the documented nēnē fatalities at KWP were closely correlated with abrupt and severe shifts in weather that may have reduced their visual acuity and compromised their maneuvering abilities. Weather conditions at the higher elevations of KWP can change rapidly. As turbine towers at KWP II will be 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, 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. Applying nēnē behavioral observation at KWP 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 turbines, fewer nēnē flocks will fly within the RSZ of the KWP II turbines (61% vs. 66%) and the flight avoidance behavior observed at KWP is expected to further lower the risk of take at KWP II. The greater visibility on site due to the lower elevation, and due to the decrease in the frequency and extent of cloud cover of KWP II, could also potentially decrease the risk of turbine collision for nēnē.

3.8.4 Hawaiian Hoary Bat

3.8.4.1 Population, Biology and Distribution of the Hawaiian Hoary Bat

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 population estimates or information exist for this subspecies. Population estimates for all islands in the state in the recent past have ranged from hundreds to a few thousand bats (Menard 2001). 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).

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*), and fern clumps; they are also suspected to roost in eucalyptus (*Eucalyptus* spp.) and Sugi pine (*Cyrptomeria japonica*) stands. The species is rarely observed using lava tubes, cracks in rocks, or man-made structures for roosting. While roosting during the day, Hawaiian hoary bat are solitary, although mothers and pups roost together (USFWS 1998).

Preliminary study of a small sample of Hawaiian hoary bats (n=18) on the Island of Hawai'i have estimated short term (1-2 weeks) core range habitat sizes of 84.3 ac (34.1 ha; n=14) for males and 41.2 ac (16.7 ha; n=11) for a female bat (Bonaccorso, F. 2011. pers. comm. (USGS. May 3, 2011). 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, forest edge or road and a typical feeding range stretches around 300 yds (275 m). Bats will spend 20 to 30 mins hunting in a feeding range before moving on to another (Bonaccorso 2011).

It is thought that breeding occurs primarily between April and August. Breeding has only been documented on the islands of Hawai'i and Kaua'i (Baldwin 1950; Kepler and Scott 1990; Menard 2001). It is not known whether bats observed on other islands breed locally or only visit these islands during non-breeding periods. Seasonal changes in the abundance of Hawaiian hoary bats at different elevations indicate that altitudinal migrations occur on the Island of Hawai'i. 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). They appear to prefer moths ranging between 0.60 and 0.89 inches (16 to 20 mm) in size (Bellwood and Fullard 1984; Fullard 2001). Prey is located using echolocation. Water courses and edges (e.g., coastlines and 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).

3.8.4.2 Current Threats to the Hawaiian Hoary Bat

The availability of roosting sites is believed to be a major limitation in many bat species. 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).

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). Most mortality has been detected 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. Currently, it is not known if Hawaiian hoary bats are equally susceptible to turbine collisions during their altitudinal migrations as hoary bats are during their migrations in the continental U.S. To At the Kaheawa Wind Power facility on Maui, two Hawaiian hoary bat fatalities have been observed since the start of project operations. The fatalities occurred in September 2008 and April 2011.

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).

Hawaiian hoary bats are not expected to breed or roost in the project area due to the lack of trees in the grassland dominated landscape. Bats are likely to be using the KWP II area for foraging only.

Since the HCP for KWP was approved and the existing facilities began operation in the summer of 2006, KWP has carried out regular bat monitoring in accordance with the provisions of its HCP. The results of these observations as summarized below have greatly increased the information that is available on the presence of the Hawaiian hoary bat at Kaheawa Pastures and confirm that the species is present in low numbers in the KWP project area. Due to their proximity to each other and some similarities in habitat structure at KWP and KWP II, it is expected that bat activity at KWP II will likely be comparable.

Visual Surveys for Flying Bats at KWP. In accordance with the provisions of the KWP HCP, KWP biologists carried out regular crepuscular and nocturnal surveys aimed at recording bat activity at Kaheawa Pastures from June 2006 through June 2007. During this period, KWP biologists performed 32 surveys totaling nearly 116 hours of observation effort in and around the KWP site and adjacent countryside. Initially, surveys were conducted in the vicinity of each of the wind turbines on the site; however, the survey area was extended to include some of the adjacent gulches (Kaheawa Wind Power LLC 2007). The sites were surveyed during winter and spring seasons and under a range of weather and survey conditions. Though there often appeared to be abundant aerial insect prey and favorable wind conditions for flight in the sheltered gulch areas (and occasionally on the plateaus), no positive observations of Hawaiian hoary bats were made during either survey period (Kaheawa Wind Power LLC 2007, 2008a). Two separate bat sightings were reported by contractors between July 2007 and June 2008. One observation occurred on the access road below the Pali Trail on February 20, 2008 and the other at the Operations and Maintenance building on April 5, 2008 (Kaheawa Wind Power LLC 2008b; Appendix 4). KWP biologists conducted interviews and in both cases identification of these individuals could not be confirmed, but these sightings are consistent with other confirmed records of occurrence in the project area.

Visual Surveys for Downed Bats. KWP biologists also looked for bats as part of their year-round monitoring aimed at documenting all downed (i.e., injured or dead) Covered Species in the project area. On September 26, 2008, a single dead bat was found near WTG 8. Injuries to the bat suggested it had died of physical trauma, presumably having collided with a turbine rotor or the tower. The second downed bat was found in April 2011.

Acoustic Monitoring of Bat Activity at KWP. Since August 2008, four to eight Anabat detectors (Titley Electronics, NSW, Australia) have been deployed at various locations in Kaheawa Pastures (Figure 3.5; Kaheawa Wind Power LLC 2009). Bat detectors were placed from ground level to 15 ft. (4.6 m). On average Anabat detectors are considered to have a detection radius of approximately 98 ft. (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 Hawai'i, the primary goal of these detectors was to determine bat absence/presence in the area and subsequently quantify bat activity if detected. These detectors do not document bat activity in the rotor swept zone which typically begins at heights above 98 ft (30 m). Surveys conducted at wind farms in the continental U.S. typically exhibit notably higher frequencies of detection of migratory tree-roosting bat from detectors placed at tree height (<20 m or 66 ft) versus those placed within the rotor swept zone (RSZ) (>40 m or 131 ft), 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 the 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 Hawai'i. Most other studies typically only sample for migratory tree-roosting bats during the migration period, these data provide good information on the causes of bat mortality during migration, but may be less applicable to Hawai'i. During the fall migration season, Baerwald and Barclay (2009) documented that hoary bats are more active at 30m (98 ft) 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 and KWP II, bat call sequences were mostly detected between the months of May and November (Table 3.5; Figure 3.5).

Thirty-nine bat passes, were recorded by the four to seven detectors over the sampling period from August 2008 to June 2010 (see Table 3.5 for data and definitions). This equates to a detection rate of 0.011 passes/detector/night (39 bat passes/3436 detector nights). This is less than 2% of the detection rates measured during a study being conducted by U.S. Geological Survey (USGS) at Hakalau National Wildlife Refuge on the Island of Hawai'i (0.66 bat passes/detector/night) (Bonaccorso, unpub. 2008).

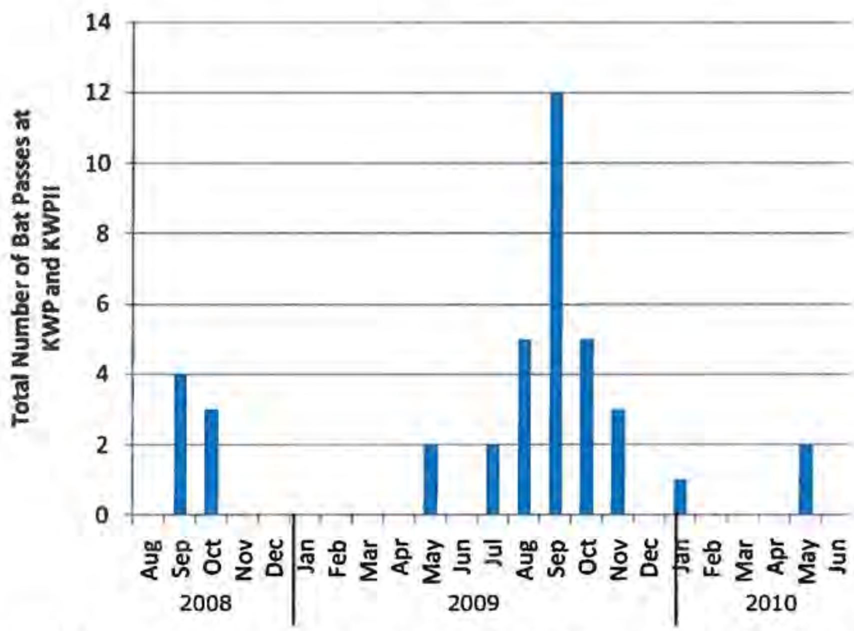


Figure 3.5 **Temporal Distribution of Anabat Detections at KWP and KWP II from August 2008 to June 2010.**

Table 3.5 Results of Acoustical Bat Monitoring at KWP.

Detector ID #	Location	Survey dates	Operation Days	Total Passes	Total Detection Rate
1	KWP I	08/08/08-11/11/08	86	2	***0.02***
2	KWP I	08/08/08-11/05/08	86	3	***0.03***
3	KWP I	08/07/08-11/05/08	82	2	***0.02***
4	KWP I	08/07/08-11/12/08	89	0	0.00
5	KWP I	11/12/08-04/07/09	138	0	0.00
6	KWP I	11/12/08-04/15/09	138	0	0.00
7	KWP I	11/14/08-04/16/09	159	0	0.00
8	KWP I	11/14/08-04/04/09	72	0	0.00
9	KWP I	04/28/09-05/27/10	343	1	0.00
10	KWP I	05/17/09-06/30/10	394	12	***0.03***
11	KWP I	05/07/09-05/27/10	307	0	0.00
12	KWP I	04/28/09-05/27/10	366	4	***0.01***
13	KWP I	06/02/09-05/27/10	324	1	0.00
14	KWP II	06/03/09-06/30/10	375	12	***0.03***
15	KWP II	06/03/09-05/27/10	314	2	***0.01***
16	KWP I	06/03/09-10/23/09	66	0	0.00
17	KWP I	06/24/10-06/30/10	7	0	0.00
18	KWP II	05/27/10-06/30/10	35	0	0.00
19	KWP I	06/27/10-06/30/10	5	0	0.00
20	KWP II	05/27/10-06/30/10	16	0	0.00
21	KWP II	05/28/10-06/30/10	34	0	0.00
		Total detector nights	**3,436**		
		Total passes	**39**		
		Overall detection rate	**0.011**		

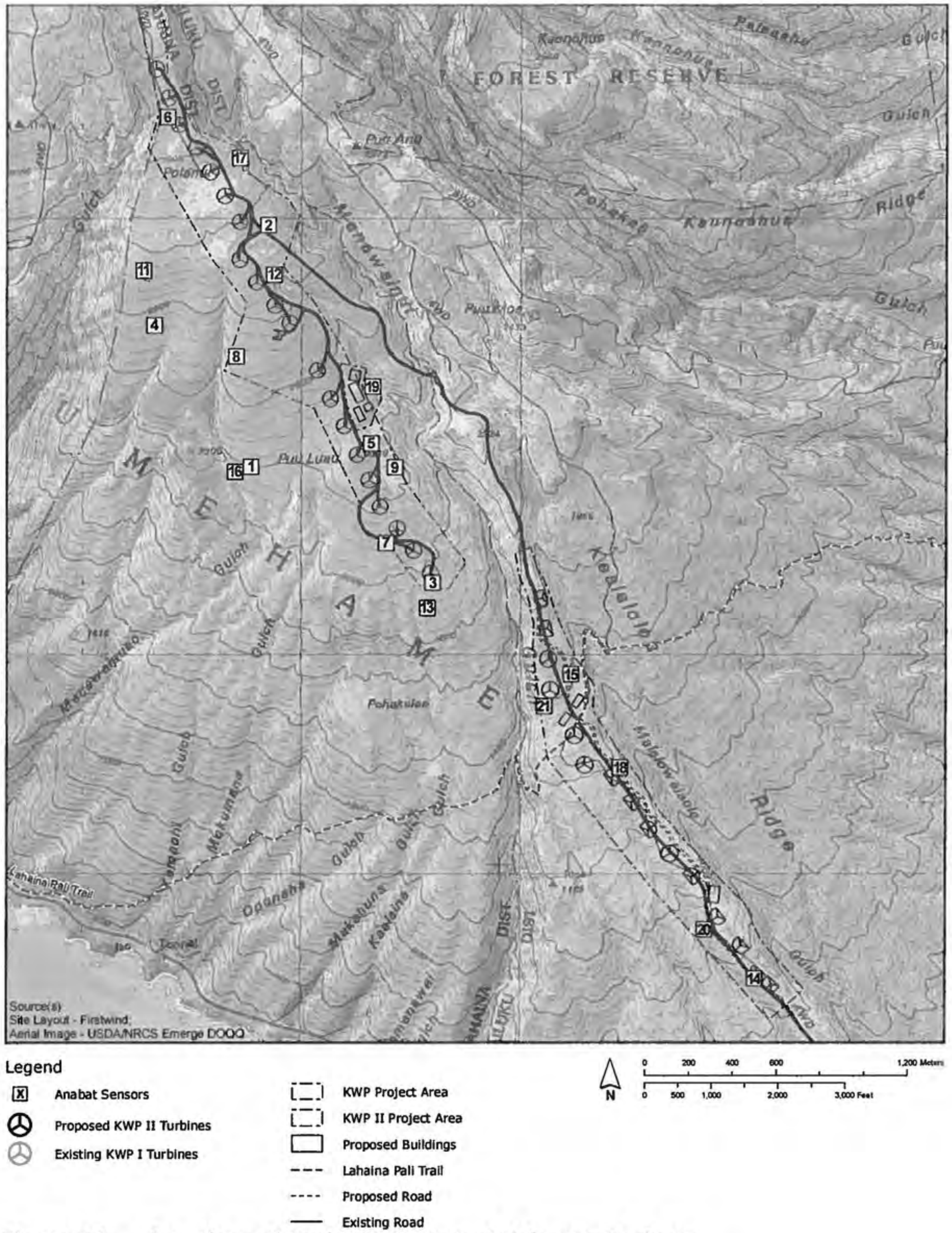


Figure 3.6 Locations of Anabat Detectors at Kaheawa Pastures.

4.0 BIOLOGICAL GOALS AND OBJECTIVES

4.1 GENERAL

KWP II LLC has worked cooperatively with USFWS and 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 to 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 to:

- 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 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

The proposed project design was described in Section 1.4. Before evaluating the potential impacts of the proposed project, and before discussing measures to avoid and minimize potential impacts, it is helpful to understand how the project area and design were ultimately chosen over other possible alternatives.

4.2.1 No-Action Alternative: "No Build"

The "no-action" alternative is a "no build" alternative that would mean a commercial wind energy generation facility would not be constructed and operated by KWP II LLC at this location on Maui. KWP II LLC is a business entity created for this sole purpose, with a majority partner that is a leader in the wind power industry – so a "no build" alternative is contrary to the Applicant's fundamental purpose and objective. The "no build" scenario also fails to serve the purpose, intent, and requirements of Act 95 (S.B. 2474, S.D. 3, H.D. 2, signed by Governor Linda Lingle on June 2, 2004), which establishes renewable energy portfolio standards for Hawai'i's electric utilities. Act 95 requires each electric utility to establish a renewable portfolio standard of 8% by the end of 2005, 10% by the end of 2010, 15% by the end of 2015, and 20% by the end of 2020. The "no build" alternative, then, does not support the State's desire to develop viable renewable energy sources, as well as MECO's obligation to meet these milestones, and KWP II LLC's business plan to contribute to these goals.

The no-build scenario would result in no take of the Covered Species and no implementation of any mitigation measures. There would be no changes to the site or to existing habitats, nor any potential for collision with wind turbines or project infrastructure. However, without the proposed mitigation measures, there would be no contributions to recovery efforts, and no further study or habitat protection funded by the project. In view of the fact that these are expected to provide a net benefit to the species, the "no-build" scenario does not have any positive effect on the species.

Lastly, the "no build" scenario would maintain the status quo of Maui's electric energy production, its dependence on imported oil along with the emissions thereof. The broad economic and environmental benefits of a commercial wind energy generation facility would be foregone.

4.2.2 Alternate Project Location

Few other sites on Maui have as robust and reliable a wind regime as Kaheawa Pastures. In addition, the site's proximity to KWP allows the proposed new facilities to share infrastructure such as the main access road, some equipment storage and parts and, to a smaller extent, personnel with the KWP project. KWP II LLC and KWP would enter into a formal agreement to allow the sharing of these resources. Other wind-rich sites on Maui are located in areas that lack adequate transmission capability, are closer to/more visible from populated areas, or have other constraints. Because of the ability to share resources with KWP, other things being equal, the Applicant believes that building a facility with similar production capability at another site would result in greater costs and environmental impacts than building in the proposed location.

Moreover, other sites suitable for wind development on Maui present comparable challenges in terms of topography, visibility, natural resources, and sensitive flora and fauna without having comparable benefits. Operation of the existing KWP has produced data pertaining to the Covered Species at the proposed location which has been used to more accurately estimate levels of take for each Covered Species at the proposed KWP II site. At an alternate location, the species vulnerable to take by a proposed wind facility may be different from the Covered Species in this HCP. The levels of take for those species also may change at an alternate project location, depending on movement rates and the potential level of interaction of each species with the wind facility. These take levels would have to be determined from wildlife surveys and other existing information, but would not have the benefit of long-term data that is available for the proposed location.

Therefore, the Applicant has concluded that the proposed project location is superior to the alternatives that are available for its project.

4.2.3 Alternate WTG Locations at Kaheawa Pastures

KWP II LLC initially considered three potential WTG siting areas (Upwind, Downwind/Downstring, and Downroad) at Kaheawa Pastures. The Upwind and Downwind/Downstring siting areas are at similar elevation to KWP but the Downroad area (proposed site) is at a lower elevation. KWP II LLC used ground-truthing and meteorological data to identify individual WTG locations. The siting areas are shown on Figure 4.1 along with the existing KWP and proposed KWP II WTG layouts. All three potential WTG siting areas are within the same general area, and the same Covered Species would have potential to be impacted regardless of the site chosen. The greater visual impacts and logistical challenges of developing on new ridgeline led KWP II LLC to eliminate the Upwind site from further consideration. Initial impact analyses led KWP II LLC to conclude that use of the Downwind/Downstring site was likely to cause greater impacts to Covered Species or their habitats than was use of the Downroad site (proposed site). Measurements of passage rates of seabirds at lower elevations have shown that passage rates are generally similar to those previously recorded at higher elevations at KWP (see Figure 3.2a). Due to the similarity of habitat, bats are also expected to be infrequently present Downroad as they are at KWP. Nēnē are less frequently seen at lower elevations, thus use of the lower elevation Downroad site is likely to have a smaller impact on the resident nēnē population than higher elevation sites (Upwind and Downwind/Downstring). The following sub-sections outline the reasons the Upwind and Downwind/Downstring siting areas were eliminated and explain the criteria the Applicant used for micro-siting individual WTGs within the Downroad site.

4.2.3.1 Upwind Siting Area

The Upwind siting area that was considered is located on the east side of the existing main access road approximately 2,000 feet (610 m) to the east (i.e., on the Central Valley side) of the KWP turbines. Preliminary analyses indicated this area could accommodate up to 15 WTGs. However, the Upwind area possesses several drawbacks. Constructing turbines in this area would require the Applicant to lease additional land (up to an additional 250 acres) and to construct an access road across the intervening gulch and onto a second, presently undeveloped ridgeline. A new overhead collection line would be required to connect the turbines with the electrical substation and existing MECO power transmission system. Visual simulations also indicated that turbines placed in this area would be much more visible to surrounding communities than the other locations considered. Finally, existing information and reconnaissance of the area suggested that the distribution of Covered Species was not likely to be significantly different at the Upwind site.

4.2.3.2 Downwind/Downstring Siting Area

The Downwind/Downstring siting area is located approximately south-west of the existing KWP facility, along the same ridgeline. Preliminary analyses indicated that the Downwind/Downstring area could accommodate up to 14 WTGs. Though feasible, construction of the facility would have required almost one and a half times the earthwork to put in the required road network for access to project components than at the proposed site (Downroad). This would have resulted in greater ground disturbance, potential for erosion, and the need for revegetation. Nēnē are twice as likely to be found at higher elevations consistent with existing KWP and Downwind/Downstring areas (see Section 3.8.3.3, Figure 3.3) than at the proposed lower elevation Downroad site, likely due to the proximity of better nesting and foraging habitat in the Downwind/Downstring areas. Consequently, risk of nēnē collision with turbines is probably also greater at the Downwind/Downstring area than at the proposed site.

Impacts to seabirds at the Downroad site are anticipated to be generally similar to those modeled Downwind/Downstring, as passage rates at these two elevations are similar (Section 3.8.1.4). However, the Downwind/Downroad alternative would require up to three permanent met towers, as opposed to one at the proposed site, which would create additional collision hazards for seabirds and nēnē. Bats were expected to be impacted to the same degree at both sites due to similarities in terrain and available habitat (Section 3.8.4.3). One positive feature of the Downwind/Downstring alternative was the smaller visual impact it would present to the residents of Maui. However, when weighed against the greater impacts of this alternative to several Covered Species, particularly nēnē, the Downwind/Downstring alternative was less favored than the proposed alternative.

4.2.3.3 Individual WTG Locations at Kaheawa Pastures

The Applicant considered several factors in narrowing down suitable locations for individual WTG installation at the KWP II facility. These included the viability of the wind resource, proximity and orientation to the existing KWP turbines (which can affect the efficiency and output of the facility), visibility to the Maui community, presence of sensitive resources (e.g., native flora and fauna, cultural features, aesthetic, etc.), and constructability (i.e., site topography, geological features, and extent of road building required).

Observed conditions at KWP, as well as meteorological data collection and ground surveys in the KWP II project area helped to support the micro-siting of WTGs within the preferred Downroad siting area. The Applicant also used these factors for early elimination of potential turbine siting areas. For example, the area north (mauka) of the KWP site was not seriously considered for placement of WTGs because it supports a greater representation of native biota and lacks the wind resource of the Downwind/Downstring and Downroad siting areas.

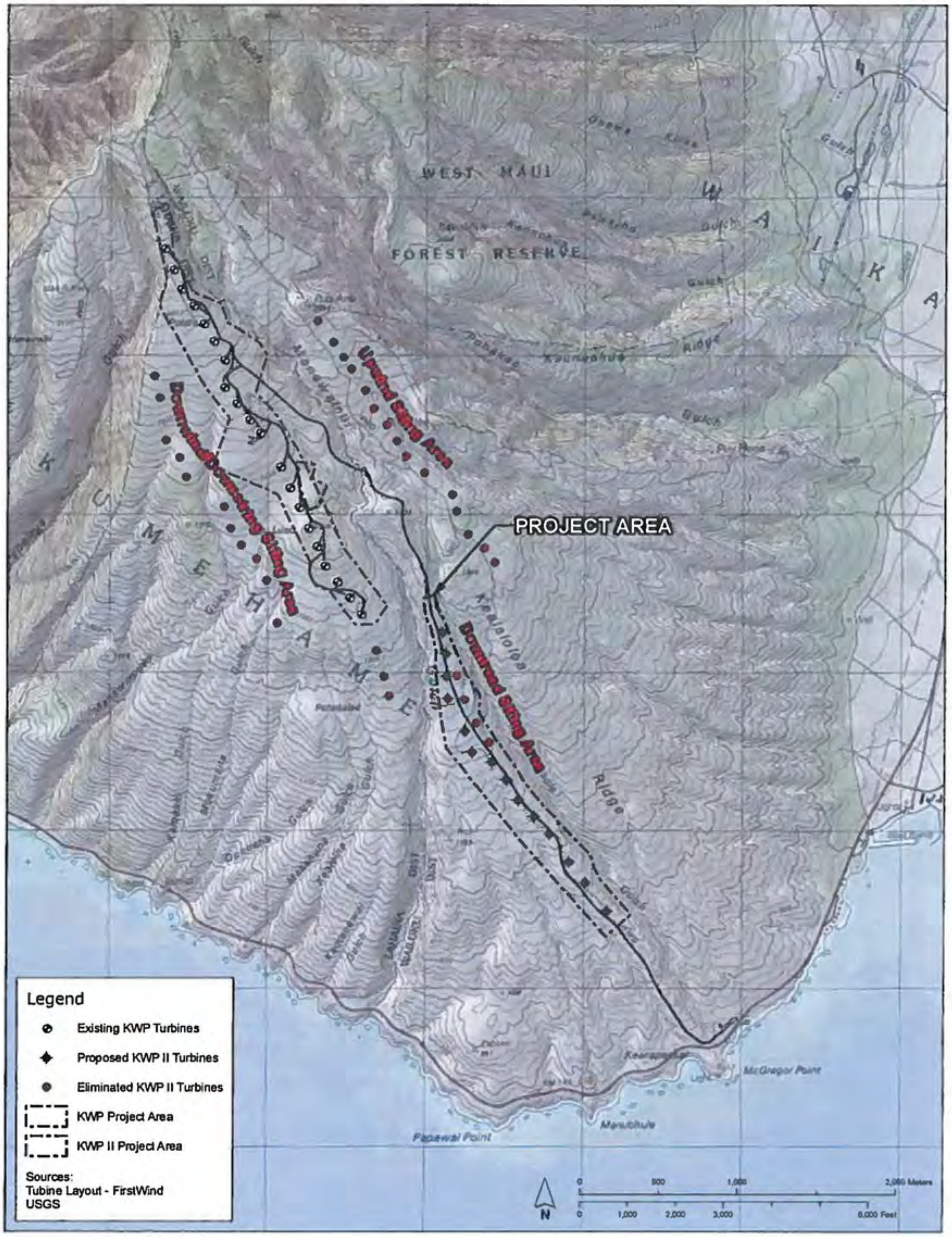


Figure 4.1 Siting Areas Eliminated from Further Consideration.

4.2.4 Greater or Fewer Number of WTGs

The *EA/EISPN* for the project identified a range of possible generating capacities for KWP II, from 10.5 MW (in accordance with the capacity identified in the latest MECO Integrated Resource Management Plan [IRP-3] as being appropriate for development by 2011) to 30 MW. Feedback on the *EA/EISPN*, analyses of the wind and meteorological data that KWP II LLC has collected, and the fixed cost of the required battery storage facilities have led the Applicant to select 21 MW as the appropriate capacity for the facility. The following discussions describe the reasons why the Applicant has decided not to consider alternatives that involve a greater or lesser generating capacity than the proposed 21-MW facility.

4.2.4.1 Reduced Scale Project (<21 MW)

MECO submitted its IRP-3 to the State of Hawai'i Public Utilities Commission on April 30, 2007. This plan calls for the addition of another 10.5 MW of as-available wind generating capacity in 2011 (the output of seven 1.5-MW machines of the type that the Applicant is proposing to use). The limited amount of new wind generating capacity that is identified in the IRP-3 is largely a function of MECO's assessment of its ability to integrate electricity from a variable source, such as wind into the island-wide system. The Applicant does not believe that the potential revenue from such a limited generating capacity justifies the cost of developing the needed support infrastructure.

Moreover, discussions that have occurred between MECO and potential wind energy developers since the IRP-3 was prepared indicate that MECO is now willing to attempt to integrate more than 10.5 MW of wind generating capacity into its system so long as it is accompanied by provisions which buffer MECO's system against short-term fluctuations.[4]

KWP II LLC believes that reducing the capacity of the facility below 21 MW would decrease the benefits of further wind power development without providing off-setting environmental benefits. Moreover, lowering the number of WTGs would not produce a proportional reduction in the cost of the support facilities and permitting. This, combined with the high fixed costs of transportation, logistics, mobilization, and other factors mean that the cost per MW of capacity increases as the number of turbines decreases. Although a reduced scale project from 14 to seven (7) turbines likely would reduce the risk of adverse impacts to the Covered Species, the reduction in biological impacts is not sufficient to overcome the economic and logistical considerations. For these reasons, the Applicant believes it is financially infeasible to consider constructing a facility with fewer than 14 1.5-MW WTGs.[5]

4.2.4.2 Increased Scale Project (>21 MW)

Sufficient space is available to construct at least 14 additional WTGs in the Kaheawa Pastures area. However, to engineer a successful utility integration design, KWP II LLC does not propose installing more than 14 1.5-MW WTGs in the project area at this time. Moreover, an increase in the number of turbines will proportionately increase impacts on the Covered Species.

4.2.5 Turbine Design and Size

The KWP facility installed GE 1.5-MW WTGs. These have proven to be a good match for the wind regime at Kaheawa Pastures. These WTGs are sufficiently large to take advantage of economies of scale and the higher wind speeds that are present at heights above those that can be reached by smaller/lower wind turbine generators, yet they are considerably shorter and less massive than the larger WTGs that are now being put into service in some areas.[6]

[4] The exact magnitude and nature of the buffer that is needed to protect MECO's system is the subject of ongoing discussions between MECO and potential wind developers, including KWP II LLC.

[5] The announced size (40 MW of installed capacity) of a proposed Shell Wind Energy project on Maui is almost twice that of KWP II, suggesting that these economic limitations are not unique to KWP II LLC.

[6] Examples include GE's 2.5-MW series and 3.6-MW machines (which have overall heights reaching up to 500 feet) and the 3.0-MW Vestas V90, whose overall height is about the same as that of the large GE Unit.

The Applicant is proposing to also use GE 1.5-MW turbines, which will be nearly identical in appearance to those present at KWP, though about 33 feet (10 m) taller in overall height due to manufacturer's design changes.[7] Using the same type of WTGs for KWP II as have been used at KWP will help ensure visual and logistical continuity for the facilities at Kaheawa Pastures. This would decrease the overall visual impact of the facilities and streamline the delivery and exchange of parts between them.[8]

Economic analyses performed by the Applicant indicate that the 1.5-MW GE turbines are likely to be the most cost-effective choice for this location. Finally, it is believed the GE 1.5-MW turbines can meet the requirements that MECO is likely to set on the basis of the Interconnect Requirement Study that it will conduct as part of the Power Purchase Agreement negotiations.

4.3 AVOIDANCE AND MINIMIZATION OF IMPACTS

4.3.1 Site-Specific Project Design Considerations

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 by making the turbines less attractive, more visible, and/or more likely to be avoided by birds and bats. These measures include:

- 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 (11-20 rpm) 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 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 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 will be fitted with marker balls to increase visibility. All overhead collection lines will be 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 will be 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) will be used (APLIC 2006). Any jumper wires will be insulated.
- Placement of the overhead power collection line will be as close to the existing MECO transmission line as practicable (see 1.3). These lines will 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

[7] GE has modified its Model 1.5se design since KWP was constructed. The new design has a tower height of 212 feet and the same rotor diameter (231 feet), for a total height of 328 feet. In comparison, the total height of the existing GE 1.5se turbines at KWP I is 296 feet (90 m).

[8] Because the ownership of KWP II is different from that of KWP, the exchange/sharing of parts and services would be done on a commercial basis, but the co-location of the two sets of wind generators and support equipment will greatly facilitate this and will reduce overall costs.

presented. Marker balls, which will be present on both lines, should increase their visibility to Covered Species and minimize 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 operations and maintenance building and substation, using fixtures that will be 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 should be employed where feasible to minimize the risk of unintended light emissions. These three lighting measures will be used not only to minimize impacts to wildlife, but also to reduce the visual impact as viewed from local communities at night.
- Conducting pre-construction surveys for nēnē and their nests prior to roadway and site clearing and construction to identify and avoid harming or harassing (as defined under the ESA) any active nests, eggs, young, or adults; an improved survey protocol based on the successful model implemented at KWP will be used for this HCP (Appendix 12).
- 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 will be immediately notified and construction activities will be modified or curtailed until appropriate measures are implemented, with approval of DLNR and USFWS, which will reduce or eliminate adverse risk to nēnē or their nests (Appendix 12).
- Clearing of trees above 15 ft in height for construction between June 1 and September 15 will not occur as it is the period when non-volent Hawaiian hoary bat juveniles may occur in the project area.
- Low wind speed curtailment will be implemented once the project is 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 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% 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.

  Therefore, low wind speed curtailment will be implemented at night by raising the cut-in speed of the project's wind turbines to 5m/s. Bat activity has been consistently documented during months of May to November from 1900 – 0600 hrs (see Section 3.8.4.3). However, the two fatalities that were observed at KWP occurred in April and September; bats can therefore be expected to be at the KWPII in April as well. Thus for KWPII the curtailment will initially occur between the months of April and November. Curtailment will be extended if fatalities are found outside the initial proposed curtailment period with approval of USFWS and DLNR. Curtailment may also be modified with the approval of DOFAW and 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 10 mph will also be enforced to reduce possible vehicular collisions with nēnē and the Hawaiian short-eared owl.

4.3.2 USFWS Guidelines

While wind energy has been utilized for centuries, it has expanded rapidly rather recently in the U.S. 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 below 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).

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 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 HCP. The proposed KWP II project minimizes habitat disturbance by sharing key infrastructure with KWP 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 area). 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.

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed KWP II Facility
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, 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, Hawaiian short-eared owls at KWP II are expected to be observed occasionally flying over grasslands of the proposed wind farm, but at low risk of collision with the turbines and associated structures (see Section 3.7).
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 storm water 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 five 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 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. Re-vegetation 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.

USFWS Interim Voluntary Guidelines Site Development Recommendations	Proposed KWP II Facility
Use tubular supports with pointed tops rather than lattice supports to minimize bird perching and nesting opportunities. Avoid placing external ladders and platforms on tubular towers to minimize perching and nesting. Avoid use of guy wires for turbine or met tower supports. All existing guy wires should be marked with recommended bird deterrent devices (APLIC 1994).	This recommendation has been, and will continue to be followed. Tubular towers are being utilized for turbines. The permanent met tower will be unguyed.
If taller turbines (top of the rotor-swept area is >199 feet above ground level) require lights for aviation safety, the minimum amount of pilot warning and obstruction avoidance lighting specified by the Federal Aviation Administration (FAA) should be used (FAA 2000). Unless otherwise requested by the FAA, only white strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. Solid red or pulsating red incandescent lights should not be used, as they appear to attract night-migrating birds at a much higher rate than white strobe lights.	KWP II LLC has received approval from the FAA to apply a minimal lighting scheme. Only 4 WTGs and the met tower will be fitted with synchronized red lights, as opposed to all WTGs. Other on-site lighting will be minimal, shielded and used infrequently.
Where the height of the rotor-swept area produces a high risk for wildlife, adjust tower height where feasible to reduce the risk of strikes.	This recommendation is generally not applicable in that the risk of strikes is not demonstrably related to the height of the rotor-swept area. However, the proposed 65-meter towers are the shortest that GE produces for its 1.5 MW machines.
Where feasible, place electric power lines underground or on the surface as insulated, shielded wire to avoid electrocution of birds. Use recommendations of the Avian Power Line Interaction Committee (APLIC 1994, 1996, 2006) for any required aboveground lines, transformers or conductors.	This recommendation is being followed; all new power lines will be placed underground where feasible. APLIC guidelines for overhead collection lines have been followed.
High seasonal concentrations of birds may cause problems in some areas. If, however, power generation is critical in these areas, an average of three years monitoring data (e.g., acoustic, radar, infrared or observational) should be collected and used to determine peak use dates for specific sites. Where feasible, turbines should be shut down during periods when birds are highly concentrated at those sites.	This recommendation is not applicable as there is no documented seasonal concentration of birds. Though seabirds have been documented passing through the area, their numbers are low compared to other locations on Maui. Nēnē are present on site year round (Section 3.8.3.3) and flight activity does not vary with time of day. Furthermore, results of on-going acoustic monitoring of bats at KWP and KWP II indicate low-level bat activity on site between April to November and no almost no activity between December to March (Figure 3.5).
When upgrading or retrofitting turbines, follow the above guidelines as closely as possible. If studies indicate high mortality at specific older turbines, retrofitting or relocating is highly recommended.	This recommendation is not applicable to the current project as it will be a new facility.

5.0 ASSESSMENT OF POTENTIAL IMPACTS

5.1 ASSESSMENT OF POTENTIAL IMPACTS TO COVERED SPECIES

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, b).

5.1.2 Impacts to Birds

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 U.S., 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, powerlines, smokestacks, vehicles, cat predation, pesticides and hunting (Podolsky et al. 1998; Erickson et al. 2001; Martin and Padding 2002; Woodlot Alternatives, Inc. 2003; Federal Register 2004; Mineau 2005). Mortality from these other sources is many orders of magnitude higher than that which occurs at wind facilities.

5.1.3 Impacts to Bats

The number of bat fatalities at wind energy facilities has often exceeded the number of avian fatalities. Studies in the continental U.S. 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 (range 15.54 – 69.6 bats per turbine) in certain areas of the eastern U.S. (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 U.S. where fatalities are highest are primarily located along forested ridge tops 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 U.S. (83.2%) are members of migratory tree-roosting species. Hoary bats, of which the Hawaiian hoary bat is a non-migratory (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, man-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). However, 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.

5.2 ESTIMATING PROJECT-RELATED IMPACTS

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. However, post-construction monitoring to document downed wildlife has been conducted at the KWP facility since operations began in June 2006 (Kaheawa Wind Power 2008b, 2008c) and suggests that avian mortality resulting from the proposed KWP II project may occur at a lower rate than has occurred at facilities in the continental U.S. This information is based upon the best available insight 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 project. No Covered Species were found downed or dead during the first year of construction and operation of the KWP project (Kaheawa Wind Power 2007a, 2007b). From the second to fifth years of monitoring, KWP documented observed direct take of three listed species: three adult Hawaiian petrels, nine full-grown nēnē, and two Hawaiian hoary bats (Kaheawa Wind Power 2008b, 2008c, 2009). Other documented fatalities include six white-tailed tropic birds, two short-eared owls, one great frigate bird, 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. .

Construction and operation of the KWP II project would create 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. Estimating the potential for each Covered Species to collide with these project components (i.e., "direct take") was done using the results of the on-site surveys, information about the proposed project design, and the results of post-construction monitoring at the adjacent KWP facility. The fatality estimates for the Covered Species at KWP II considered the species occurrence at KWPII compared to KWP and the average annual rate of take of that species known to be occurring at KWP.

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. Loss of eggs or young would be "indirect take" attributable to the proposed project. Methods for determining indirect take are described in detail in Section 5.2.1.

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 (Monitoring), the "total direct take" attributed to the KWP II project will be the sum of observed direct take (actual individuals found during post-construction monitoring) and unobserved direct take based on searcher efficiency and scavenging trial results. The latter will account for individuals that may be killed by collision with project components but that are not found by searchers for various reasons, including vegetation cover and scavenging. 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 searcher efficiency and scavenging rates) is provided in Section 7.2 and Appendix 2.

Sections 5.2.2 through 5.2.5 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 adults 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 2x). 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 two years, because it cannot be known if or in what years 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 1rate. 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 one-year, 5-year, and 20-year Tier 1 limits could be considered a "Tier 2" rate. However, 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 one-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.

5.2.1 Indirect Take

For the purposes of this HCP, an assessment of indirect take will be 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 bat each have a well-defined breeding season. For these three species, breeding status will be assigned following the general principles identified below:

- If an adult is found during breeding season, and if an estimate of the average breeding rate of the species (percent of adult population breeding in 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 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.
- If an adult is found outside of the breeding season, the adult will be assumed to have been non-breeding.
- Immatures will be assumed to be non-breeding regardless of season.
- If age cannot be determined, an individual will be assumed to have been an adult of breeding age.

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 non-breeding.
- Immatures will be assumed to be non-breeding 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 non-breeding periods they remain at sea. Hawaiian hoary bats may preferentially reside at higher elevations during non-breeding 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 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 is 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.

5.2.2 Hawaiian Petrel

5.2.2.1 Risk of Hawaiian Petrel Collision with WTGs

KWP is the only operating wind energy generating facility in Hawai'i where potential mortality of Hawaiian petrels and Newell's shearwaters is consistently being studied. KWP 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 eight-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 project area. KWP 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) report is provided as Appendix 3 and 13. The passage rates from the summer and fall studies were 116-148% higher than that previously documented at KWP. For take estimates, it is assumed that the passage rates over KWP II are 1.3 times that over KWP.

The total direct take of Hawaiian petrels at KWP after 5.33 years of operation is 4.96 birds. The average annual total direct take of Hawaiian petrels at KWP 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 KWPII for all project components (primarily turbines and met towers) is calculated based on the average rate of take per turbine at KWP, 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 passage rate = 0.86 birds/year).

5.2.2.2 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). However, the construction phase is expected to last six to eight months, with cranes on-site for only three to four 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 onsite.

A crane will permanently be available for KWP II (probably shared with KWP) 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.

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 ft. (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 powerlines 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 or 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).

5.2.2.3 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 non-breeding 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 5.2 below, indirect take would be assessed at the rate of 0.89 eggs per adult taken between May and July, 0.66 chicks per adult 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 7).

Table 5.2 Calculation of Indirect Take for Hawaiian Petrel

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	August	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

5.2.2.4 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 multi-year 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 five 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 (nine months long) was used to determine the expected amount of indirect take. For example, for a total direct take of 8 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 5.3). Table 5.3 shows the expected distribution of direct take over the breeding season and the indirect take that would be subsequently assessed (derived from Table 5.2) for the **Tier 1** requested take levels.

Table 5.3 Allocation of Indirect Take for Hawaiian Petrel for the Requested Tier 1 Level of Take

Hawaiian petrel	Adult (March-April)	Adult (May-Aug)	Adult (Aug)	Adult (Sept)	Adult (Oct)	Fledgling (Nov)	Total
Direct take	5	6	2	2	2	2	19
Indirect take	0.00	5.3	1.3	2.00	1.00	0.00	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 chicks /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 non-breeding 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 proposed 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.

5.2.3 Newell's Shearwater

5.2.3.1 Risk of Newell's Shearwater Collision with WTGs

No take of Newell's shearwater has been documented at KWP since the start of project operations (KWP LLC 2011). This would result in a projected 20-year take of zero at KWPII if the same method for calculating take for Hawaiian petrels (Section 5.2.2.1) is applied t 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 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 are likely to be Hawaiian petrels with possibly only 10%

Newell's shearwaters (Cooper et al. 2011, Appendix 2.3). 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 KWPII, 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.

5.2.3.2 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 onsite. 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 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 ft (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 powerlines 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 birds/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 birds in 20 years (1 bird/9= 0.1 birds). 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 shearwaters/year.

5.2.3.3 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 non-breeding 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 5.4 below, indirect take would be assessed at the rate of 0.46 eggs or chicks 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 7).

Table 5.4. Calculation of Indirect Take for Newell's Shearwater

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	--	0.00
Adult	Jun-Aug	1	0.46	1.0	0.46 eggs/chicks
Adult	Sept-Oct	1	1	1.0	1 chick
Adult	Nov-May	--	0.00	--	0.00
Immature	All year	--	0.00	--	0.00

5.2.3.4 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 birds/year (0.1 adults/year + (1 chicks/year x 0.1) = 0.2 birds/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 one-year, 5-year and 20-year limits are identical.

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 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 (eight 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 5.5 shows the possible distribution of direct take over the breeding season and the indirect take that would be subsequently assessed (derived from Table 5.2) for the **Tier 1** requested take levels.

Table 5.5 Allocation of Indirect Take for Newell's Shearwater for Tier 1 Requested Take Levels

Newell's shearwater	Adult (April-May)	Adult (June-Aug)	Adult (Sept-Oct)	Fledgling (Nov)	Total
Direct take	0	1	1	0	2
Indirect	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 adults/immatures and 0.1 chicks/eggs 0.2 birds/year
20-year project life	2 adults/immatures 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

One-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). However, radar studies and population modeling have indicated that the population of Newell's shearwater is likely on a decline, especially on Kaua'i (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 birds/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 6.3) 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.

5.2.4 Nēnē

Past surveys and extensive monitoring prior to and during the five-year operation of KWP have established that a population of nēnē occurs in the general project area of KWP and KWP II (Day and Cooper 1999; Cooper and Day 2004; Kaheawa Wind Power 2007a, 2007b, 2008b, 2008c). DOFAW operation of the captive release and reintroduction pen at Hana'ula, near the upper end of the KWP 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 current population is estimated at 106 birds (DOFAW 2009). Observations at KWP confirm that nēnē are resident in and around the KWP and KWP II area. At KWP, birds are on the ground browsing, socializing, nesting, and using habitat and terrain features for cover. Nēnē are not expected to nest at the KWP II Downroad area owing to a lack of suitable nesting habitat (see Section 3.8.3.3 and 5.2.4.2). Nēnē commonly fly at altitudes that are within the RSZ of the KWP and proposed KWP II WTGs, with most birds observed during daylight and crepuscular periods.

5.2.4.1 Nēnē Collision Risk and Avoidance Behavior

Nēnē at KWP are commonly observed displaying avoidance behavior and maneuverability in the vicinity of project structures and moving rotors (Spencer pers. comm.; Kaheawa Wind Power 2008b, 2008c). While this indicates that the geese generally see and avoid the WTGs, nine nēnē mortalities from wind turbine collisions have been observed since June 2006, when the 20 KWP WTGs became operational. The first incident in October, 2007 occurred during an ordinary period of strong trade winds. The second and third incidents were closely correlated with abrupt changes in local weather that included increases in local wind speeds and cloud cover associated with large scale weather events that may have significantly reduced visibility of the WTGs. This suggests that nēnē may be more vulnerable to collisions with turbines, met towers, and other structures during periods of strong winds and low visibility. Circumstances surrounding the fourth fatality are unknown; the carcass was in an advanced stage of deterioration by the time it was discovered. Five observed mortalities occurred in 2011, largely attributed to the increased number of nēnē present at one particular site where hydroseeding had taken place.

After adjusting the observed direct take at KWP for the effects of searcher efficiency and carcass removal by scavengers, the estimated total direct take at this facility after five years of operation has been 12.8 birds (Appendix 16). However, the take has not been evenly distributed over the years, 2011 was an abnormally high year for nēnē take with more than twice the take of any of the previous years (Table 5.6). This has been attributed to the hydroseeding of a work area at KWP which attracted nēnē to feed in this area which resulted in a greater number of collisions with the turbines in 2011. No future hydroseeding is expected in the coming years and based on the consequences observed, other alternatives will be implemented if erosion control is needed, to avoid attracting nēnē to the project area.

Table 5.6 Estimated Total Direct Take for Nēnē at KWP.

Year	2007	2008	2009	2010	2011
Adjusted Direct Take for Nene	0	3.1	1.2	1.2	7.3

Consequently, to calculate the expected rate of take at KWPII, the average rate of take at KWP is calculated based only on years 2007 – 2010. The total adjusted direct take for 2007-2010 is 5.5 birds over 4 years, or 1.4 birds/year or 0.07 birds/turbine at KWP. As nēnē are encountered less frequently the KWP II area than at KWP (35% of all nēnē sightings have been made in the Downroad area vs. 65% of sightings at KWP, see Section 3.8.3.3), the risk of nēnē colliding with the turbines is assumed to be 0.54 (=35/65) times the risk at KWP per turbine. This results in an expected mortality of 0.04 birds/turbine/year or 0.5 birds/year for all 14 turbines combined at KWPII.

In addition to collisions with WTGs, some potential exists for nēnē to collide with the temporary and permanent met towers and construction equipment, such as cranes during the construction phase of the project. To date, no nēnē have been found to have collided with met towers at KWP. Potential for the birds to collide with met towers is 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.

No nēnē collided with any cranes during the construction phase of that project. As discussed for the two seabird species, the one permanently stationed crane is not expected to pose a collision threat to the nēnē because it is expected to be used during the daytime and stored in a horizontal position at ground level when not in use. Nēnē should also be able to avoid collisions with the overhead collection lines while flying and the new collection lines will be strung with marker balls to increase their visibility. No nēne collisions with the overhead lines already on site have been documented thus far. Because nēnē are comparatively large birds, the potential for construction or maintenance vehicles to strike downed nēnē is considered to be negligible because of the proposed staff training measures and project road speed limit of 10 mph.

Concerns that immediate revegetation measures conducted on site may present foraging opportunities for nēnē, thereby attracting nēnē to the vicinity of the turbines, have arisen during discussions with DLNR and USFWS. However, based on observations by KWP biologists, nēnē are attracted to grass used in immediate revegetation mainly during the early emergent phase of growth and hence revegetation measures will be a source of attraction for only a short period of time. Nēnē in flight have also been documented to exhibit avoidance behavior around turbines (Kaheawa Wind Power 2008b, 2008c), hence the risk to nēnē due to attraction resulting from revegetation with grasses is considered minimal.

Based on the above, it is estimated the total proposed KWP II project would result in an average direct take of 0.5 nēnē/year.

5.2.4.2 Ground Displacement of Nēnē

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 proposed 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 five years of KWP operations, KWP and DOFAW biologists have observed nēnē using portions of the combined KWP and KWP II area and, at KWP, successfully nesting within and adjacent to the project area. Nēnē are frequently seen at KWP 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 and KWP II project areas and observation of patterns of habitat usage by nēnē at KWP 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 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 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 area, with lower elevations of the KWP II area receiving as much as 20" less rainfall than the upper parts of KWP (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 'ilima (*Sida fallax*), ulei (*Osteomeles anthyllidifolia*) and pili (*Heteropogon contortus*), and nēnē are known to shelter or nest under 'a'ali'i (*Dodonaea viscosa*). 'Ilima, is widely scattered throughout the KWP II area, but of very short stature; pili and ulei, are scattered sparsely throughout the area or occur only in a few small patches (Hobdy 2009b, 2010). 'Ilima is one of the most common native dryland plants in all of Hawai'i (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. However, 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).

'A'ali'i 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 ft.-long corridor and nēnē food plants that may be impacted include naupaka kuahiwi (*Scaevola gaudichaudii,* pukiawe (*Leptecophylla tameiameiae*) and 'ilima (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 two 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, ilima and 'ōhi'a (*Metrosideros polymorpha*) 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). 'A'ali'i 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.

5.2.4.3 Indirect Take of Nēnē

It is assumed that adult nēnē are most likely to collide with turbines and associated structures during non-breeding periods (May through July) or at the end of their breeding period when the adults and young may travel as family groups. Nēnē are highly territorial during the breeding season (Banko et al. 1999) and males are likely to be defending nesting territories while the females are incubating. Upon hatching, both parents would be attending to heavily dependent young; adult nēnē also molt while in the latter part of their breeding period and are therefore flightless for four to six weeks (USFWS 2004a). These adults attain their flight feathers at about the same time as their goslings (USFWS 2004a). Consequently, such birds are more likely to be in flight within KWP II only when goslings have already fledged.

Indirect take to account for loss of dependent young will be assessed for adult nēnē only when mortality occurs during the breeding season (August to April). Adults found during the months of October through March will be 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) will be assumed to have had a 25% chance of breeding. Male and female nēnē care for their young fairly equally, so indirect take would be assessed equally to the direct take of any male or female adult nēnē found during the breeding season. Because breeding nēnē are not expected to collide with WTGs prior to the fledging of their young, it is assumed that the number of young possibly affected by loss of an adult would be 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 5.7 below, the amount of indirect take that would be 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 would be 0.04 (life history data presented can be found in Appendix 7).

Table 5.7 Calculation of Indirect Take of Nēnē

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	0.60	0.5	0.09
Adult, any gender	April, Aug and Sep	0.3	0.25	0.5	0.04
Adult, any gender	May–July	--	0.00	--	0.00
Immature	All year	--	0.00	--	0.00

5.2.4.4. Estimating Total Take for Nēnē

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 birds or essentially one bird per year. This is based on the expected rate of 0.5 adults/year with assessment for indirect take (0.5 + (0.09 fledglings/year x 0.5) = 0.55).

The DLNR and 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 searcher efficiency 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 one and a half 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 will be assumed that all birds taken through "unobserved direct take" will be of 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 one-month incubation period followed by parental care for 3.5 months; 4.5/12 = 0.375).

Consequently, following the above table, indirect take will be assessed to nēnē lost through "unobserved direct take" at the rate of 0.06 fledglings/nēnē (0.3 x 0.375 x 0.50 = 0.0563).
In addition to the annual rate of take, a 5-year and 20-year take limit based on the expected multi-year 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 five 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 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	0.5 adults/immatures and 0.05 fledglings	0.55 birds/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 2-3 fledglings	

Tier 2 Take Rate

One-year period	>4-6 adults/immatures and >1 fledgling
5-year period	>8-12 adults/immatures and >2-3 fledglings
20-year period	>18–27 adults/immatures and >2-3 fledglings

The most current statewide population estimate for nēnē is between 1,300 and 1,500 individuals, with 315 birds occurring on Maui (DOFAW, unpubl.). For the entire population statewide, the Tier 1 rate (1.05 birds/yr) and Tier 2 rate of take (1.5 birds/yr) requested for nēnē over the 20-year period represents a take of 0.08% and 0.12% of the population per year. In the unlikely event that all the requested take were to occur at once, it will impact roughly 1.62% (Tier 1) and 2.31% (Tier 2) of the species' population, respectively. This is not expected to cause a decline in the status of the species. For the island of Maui, the Tier 1 rate of take represents 0.3% of the island's population per year and the Tier 2 rate represents 0.5% of the island's population per year. In the unlikely event that all the requested take were to occur at once, it will impact roughly 15.56% of the island's population at Tier 1 and the Tier 2 rate represents 22.22% of the island's population. Should take occur at Tier 2 levels and persist indefinitely, this could result in a decline of the local population that has been established in the vicinity of the Hana'ula release pen. However, when considered in light of the proposed mitigation, Tier 1 and Tier 2 mitigation are expected to exceed the requested take at the required tier well before the end of the permit term and for this reason, no significant adverse impacts to the species' overall populations are anticipated.

5.2.5 Hawaiian Hoary Bat

Low rates of activity by Hawaiian hoary bats have been measured at KWP (see Section 3.8.4.3). The lack of visual observations and low recorded activity levels at KWP suggest that only a small number of bats utilize the general area. Bats are not expected to breed or roost at KWP II due to the lack of trees. Due to the similarity in terrain between KWP and KWP II, the estimated mortality at KWP II is expected to be similar to the mortality rates at the existing KWP site. Hawaiian hoary bats breed from 0 to 4,200 feet (1280 m) in elevation (Menard 2001), so it is possible that volent juveniles occur in the project area in the latter portion of the breeding season.

5.2.5.1 Collision Risk and Other Potential Causes of Take at KWP II

The potential for take of the Hawaiian hoary bat is believed to be very low based on the surveys that have been conducted at the KWP and KWP II project areas, 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. However, the occurrence of at least a few individuals in the project area has been documented, and two observed fatalities have been recorded at the KWP facility over five years of project operation.

The two fatalities recorded at KWP equate to a total direct take of 6 bats after adjustments for unobserved take, resulting in an average of 1.2 bats/year for KWP or 0.06 bats/turbine/year (Kaheawa Wind Power 2011, Appendix 16). Extrapolating this rate to KWP II results in an average direct take of 0.84 bats/year for all 14 turbines at KWP II.

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 non-operational 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 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.

5.2.5.2 Indirect Take

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. However given the lack of empirical data and for the purposes of the HCP, it is assumed that levels of bat activity on site remain constant throughout the year. Consequently, adult bats are considered to have equal potential to collide with turbines throughout the year and regardless of breeding status.

Hawaiian hoary bats breed between April and August (Menard 2001). Females are solely responsible for the care and feeding of young, and twin pups are typically born each year, although single pups sometimes occur. To date, no breeding records for Hawaiian hoary bat exist for Maui, however, any female bats directly taken from April through August will be examined and, if determined to be lactating, indirect take will be assessed. 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. The rate at which indirect take will be assessed for lactating female bats found during the months of April through August is 1.8 juveniles per adult female as indicated in Table 6-14 below (life history data presented can be found in Appendix 5).

Table 5.8 Calculating Indirect Take for the Hawaiian Hoary Bat.

Hawaiian hoary bat	Season/ Breeding Condition	Average no. of juveniles per pair (A)	Likelihood of breeding (B)	Parental contribution (C)	Indirect take (A*B*C)
Female	Lactating	1.8	1.0	1.00	1.80
Female	Not lactating	--	0.0	--	0.00
Male	All year	--	0.0	0.00	0.00
Immature	All year	--	0.0	--	0.00

5.2.5.3 Estimating Total Take for the Hawaiian Hoary Bat

As indicated, the average rate of direct take of Hawaiian hoary bats as a result of project operations is expected to be 0.84 bats/yr. The implementation of low wind speed curtailment is anticipated to further reduce take by at an average of70% (Arnett et al. 2009, 2010), thus the expected take is0.25 bats/yr. Indirect take associated with this level of direct take would result in a maximum of 0.45 juveniles per year (=0.25 x 1.8) resulting in a total adjusted take of 0.70 bats/year or essentially one bat per 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 ESRC have recommended that annual take limits allow for 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 will lead to an assessment of total direct take for that year of greater than one likely to be rounded up to four bats (based on expected results from take monitoring and expected subsequent adjustments for searcher efficiency and scavenging rates). Existing literature on adjusting total direct take for bats suggests that a ratio of one observed take to three unobserved takes is not unreasonable and may be conservative (e.g., Arnett 2005; Jain et al. 2007; Fiedler et al. 2007).

While the other bats taken under these scenarios would be assumed and, therefore, of unknown age or gender, for the purposes of this HCP it will be assumed that all Hawaiian hoary bats taken through "unobserved direct take" will be adults and will have a 50% chance of having been female (based on the sex ratio of males to females during the breeding season). In addition, because bats most likely would be flying through the project area from April through November, spanning a period of eight months, the likelihood of a female bat having dependent young is assumed to be 13%. This is based on the information that Hawaiian hoary bats have one brood a year, and are expected to have dependent young one month out of the eight months (parental care of one month after birth; NatureServe 2008) present on site. Further, parental care is limited to a period June through September. Consequently, indirect take will be assessed to bats lost through "unobserved direct take" at the rate of 0.1 juveniles/bat (0.5 x 0.13 x 1.8 = 0.12).

As an example, indirect take assessed to a total direct take of 4 bats (1 observed direct take + 3 unobserved direct takes) is assumed to be no more than 2.1 juveniles. Consequently, the Applicant suggests the ITP and ITL should allow for a total direct take of up to four adult or volent juvenile Hawaiian hoary bats and the indirect take of up to two dependent juvenile bats for any given year for the duration of the project. A 5-year and 20-year take limit based on the expected multi-year 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 five 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 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 adults and 0.45 juveniles	0.70 bats/year
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	4 adults/immatures and 2 juveniles	6 bats/year
Five-year limit of take	6 adults/immatures and 3 juveniles	
20-year limit	6 adults/immatures and 3 juveniles	

Tier 2 Take Rate

One-year period	5-9 adults/immatures and 3-5 juveniles
5-year period	7-9 adults/immatures and 3-5 juveniles
20-year period	7-9 adults/immatures and 3-5 juveniles

The most recent population estimates for Hawaiian hoary bat have ranged from several hundred to several thousand (Tomich 1969; Menard 2001). The Recovery Plan for the Hawaiian Hoary Bat (USFWS 1998) 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." Although overall numbers of Hawaiian hoary bats are believed to be low, they are thought to occur in the greatest numbers on the islands of Hawai'i and Kaua'i (Menard 2001).

It is difficult to gauge the effect that take of Hawaiian hoary bat resulting from the proposed project may have on the population of this species because its population is not known. The identified Tier 1 level of take is low and so it seems unlikely that take at this rate would result in a significant impact on the overall population of the Hawaiian hoary bat. Tier 2 levels of take may begin to impact the Maui population, if the population is very small, although this seems unlikely to occur given the relatively low habitat availability on the site and low activity levels. In any case, such take would not likely impact the status of the species on other islands where populations are assumed to be more robust. The Applicant's proposed mitigation for the anticipated take (see Section 6.5) will contribute to restoration of native bat habitat and should result in an overall net conservation benefit for the species.

5.3 CUMULATIVE IMPACTS

The only other wind project that has been proposed on Maui is the 21 MW Auwahi Wind Farm at 'Ulupalakua Ranch located on the leeward slope of Haleakalā on the southern coast of East Maui. A Draft EIS was released for this project in February 2011 (Tetra Tech EC, Inc. 2011a) and Auwahi Wind Energy LLC prepared a Draft HCP in June 2011 (Tetra Tech EC, Inc. 2011b) to obtain an ITP and ITL. 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: the Hawaiian hoary bat, Hawaiian petrel, nēnē, and Blackburn's sphinx moth. Mitigation measures to compensate for the take of these Covered Species at the proposed Auwahi Wind Farm have been developed in cooperation with USFWS, DOFAW, and the ESRC. If the project is ultimately approved, there is a potential for cumulative impacts to these species.

The proposed construction and operation of the Advanced Technology Solar Telescope (ATST) at the Haleakalā High Altitude Observatory Site has the potential to impact the endangered Hawaiian petrel. The National Science Foundation 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 six-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 of 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 this HCP, KWP II will ensure 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 Covered Species has been authorized on O'ahu, Maui and Kaua'i through several HCPs and Safe Harbor Agreements (SHAs) (Table 5.9). Under a Safe Harbor Agreement, property owners voluntarily undertake management activities on their property to enhance, restore or maintain habitat benefiting species listed under the ESA. These agreements assure property owners they will not be subjected to increased property use restrictions if their efforts attract listed species to their property or increase the numbers or distribution of listed species already on their property. The USFWS issues the Applicant an "enhancement of survival" permit which authorizes any necessary future incidental take through Section 10(a)(1)(A) of the ESA. Accordingly, all impacts associated with these Section 10 permits have been mitigated.

Table 5.9 Take authorizations for the four Covered Species on Maui, Kaua'i, and O'ahu.

Permittee	Permit Duration	Location	Species Covered	No. of Permitted Take Over Permit Duration
Habitat Conservation Plan Permits				
Kaheawa Pastures Wind Energy Facility	01/30/2006-01/30/2026	Mā'alaea, Maui	Hawaiian hoary bat	20
			Hawaiian goose	60
			Hawaiian petrel	40
			Newell's shearwater	40
Advanced Technology Solar Telescope[a]	?	Haleakalā, Maui	Hawaiian petrel	35
Kahuku Wind Power	05/27/2010-05/27/2030	Kahuku, O'ahu	Newell's shearwater	12
			Hawaiian petrel	8
			Hawaiian hoary bat	32
Kauai Island Utility Cooperative (KIUC)[b]	2011-2015	Kaua'i	Newell's shearwater	625 mortalities, 275 non-lethal
Safe Harbor Agreement Permits[c]				
USDA Farm Bill Conservation Programs [b]	09/12/2007-09/12/2017	Statewide	Hawaiian goose	Various
Pi'iholo Ranch	09/21/2004-09/21/2054	Makawao, Maui	Hawaiian goose	>0 [c]

[a] The state HRS Chapter 195-D ITL permit and federal ESA Section 10(a)(1)(B) permit are still pending.
[b] Only a federal ESA Section 10(a)(1)(B) permit has been issued for this project; however, a state HRS Chapter 195-D ITL is still pending.
[c] The SHA is expected to result in a net conservation benefit. Incidental take is authorized for all covered activities on the property under the ESA Section 10(a)(1)(A) and an HRS Chapter 195-D ITL.

5.3.1 Hawaiian Petrel

The only other authorized take of Hawaiian petrel on Maui is at the KWP facility. Since 2006, KWP LLC has documented three observed direct takes of adult Hawaiian petrels (Kaheawa Wind Power LLC 2008b; First Wind and KWP 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-ac 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

The only other authorized take of Newell's shearwater on Maui is at the KWP facility. To date, no take of Newell's shearwater have been observed at KWP. 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 (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 their 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 powerline 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 of breeding success of the seabirds. Research initiatives include a two-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

Authorized take of nēnē is documented at several locations on Maui (Table 5.9). Since 2006, KWP LLC has documented observed direct take of nine full-grown nēnē (Kaheawa Wind Power 2008b, 2009; First Wind and KWP LLC 2011). Since 2005, two nēnē fatalities have been documented at Pi'iholo Ranch, while 48 nēnē have been released at this site (DOFAW 2008). Take authorization for this species is being requested for the Auwahi Wind Farm due to the potential for colliding with WTGs and other project components. 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).

Proposed mitigation measures for nēnē at KWP II are expected to more than offset the anticipated take and will contribute to the species' recovery by providing a net conservation benefit, as required by State law. Similar offsets can be expected for the Auwahi Wind Farm, if constructed, based on the requirement under State law to provide an overall net environmental benefit for the species. Similar measures are expected for other developments on Maui with the potential to impact nēnē. Given the low expected rate of take at KWP II 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

The only other authorized take of Hawaiian hoary bat on Maui is at the KWP facility. Since 2006, KWP LLC has documented two observed direct takes of Hawaiian hoary bats (Kaheawa Wind Power LLC 2008b; First Wind and KWP LLC 2011). Take authorization for this species is being requested for the Auwahi Wind Farm due to the potential for colliding with WTGs and other project components. 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 nesting and roosting habitat.

On O'ahu, take of Hawaiian hoary bats has been authorized for the Kahuku Wind Power facility (Table 5.9). Mitigation for this project consists of funding for research followed by funding for appropriate management measures. Two other potential wind facilities - Na Pua Makani on O'ahu and Kauai Wind Power on Kaua'i – will likely also request take of Hawaiian hoary bats.

Because an accurate population estimate for this species is not available (see Section 3.8.4), it is difficult to gauge whether the take of Hawaiian hoary bat will result in a significant impact on the overall population. Research was the main component of Kaheawa Wind Power mitigation due to the need for research to help determine some basic life history parameters and identify effective management measures, which in turn will help guide future management and recovery efforts. Kahuku Wind Power and KWP II will mitigate for bats by restoring forest habitat to increase or improve bat foraging and roosting habitat. This is expected to increase survival and reproductive success commensurate with take and provide a net benefit to the species. Kawailoa Wind Power's proposed mitigation for the anticipated take of Hawaiian hoary bat will also contribute to restoration of native bat habitat (either wetland or forest) with a research component and are anticipated to have the same benefits. Similar mitigation measures are assumed for Na Pua Makani on O'ahu, Auwahi Wind Project on Maui and Kauai Wind Power on Kaua'i. Therefore, there is no anticipated cumulative impact to the Hawaiian hoary bat.

6.0 MITIGATION FOR POTENTIAL IMPACTS AND SELECTION OF MITIGATION MEASURES

The proposed mitigation program for KWP II was influenced greatly by the approved mitigation program for KWP and the data that has been collected by KWP biologists since operations commenced. In coordination with biologists from DLNR and USFWS, the Applicant will build upon the existing KWP 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.
- 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, though 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 proposed 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 Table 6.1. 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 DLNR. All mitigation measures chosen for the project will be subject to review by DLNR and 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, USFWS and DLNR. As discussed, the Covered Species considered to have potential to be incidentally taken during operation of the KWP II project include the Hawaiian petrel, Newell's shearwater, nēnē, and Hawaiian hoary bat. The mitigation proposed to compensate for impacts to these species is based on anticipated levels of incidental take as determined through on-site surveys, modeling, and the results of post-construction monitoring conducted at KWP.

Table 6.1 Proposed Mitigation for Covered Species: Tier 1 and Tier 2 Take Scenarios

Tier 1 mitigation	Tier 2
Hawaiian Petrel	
1. Implement a comprehensive plan for seabird colony management at Makamaka'ole, on West Maui near lower Kahakuloa Valley, that would include predator proof fencing an enclosure, eradication within the enclosures, social attraction and artificial burrows. The success of the social attraction project in establishing a breeding and growing colony will be determined after 5 years and if unsuccessful, additional measures will be implemented till mitigation is commensurate with the requested take. AND/OR 2. Participate in the management of the Hawaiian petrel colony breeding in the crater of Haleakalā in an approximately 220 ac (89 ha) area with approximately 100 burrows. This would include contributing to contracting the labor and purchasing 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. AND/OR 3. Provide support for colony-based protection and productivity enhancement for Hawaiian petrels at the ATST mitigation site after 2016 when ATST mitigation obligations are fulfilled.	Tier 1 mitigation may be adequate to offset Tier 2 levels of take, if additional mitigation is needed, management will be initiated, or if already initiated for Tier 1 mitigation expanded to an area known to be occupied by unprotected burrows
Newell's Shearwater	
1. Implement a comprehensive plan for seabird colony management at Makamaka'ole, on West Maui near lower Kahakuloa Valley, that would include predator proof fencing an enclosure, eradication within the enclosures, social attraction and artificial burrows. The success of the social attraction project in establishing a breeding and growing colony will be determined after 5 years and if unsuccessful, additional measures will be implemented till mitigation is commensurate with the requested take. AND/OR 2. Implement predator exclosure and social attraction scenario at an alternative site in East Maui, or implement predator exclosure at an in-situ site at upper Kahakuloa or alternative site on East Maui, if deemed feasible. AND/OR 3. Provide support for colony-based protection and productivity enhancement or social attraction and predator exclusion for Newell's shearwaters on Molokai or Lanai.	Progress through Tier 1 mitigation alternatives, which were developed to offset Tier 1 and Tier 2 take..

Nēnē	
1. Fund the building of a new release pen to accommodate spillover of nene from other pens or participate in the translocation of eggs, adults or family groups from Kauai. Additional funding for management of the new pen for the first five years will be provided regardless of take, this includes support for logistics, DOFAW staffing, predator control and vegetation management activities. Perform systematic visual observations of nēnē activity within KWP II site to document how nēnē use the project area following construction.	1. Extend management activities at pen constructed for Tier 1, including support for logistics, 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 vs. gulches) and elevational ranges at KWP II and vicinity to support Maui bat research. 1b. Restoration of bat habitat at an acreage commensurate with the requested take.	1a. Continue surveys to document bat occupancy at different habitat types (e.g., ridges vs. gulches) and elevational ranges at KWP II and vicinity to support Maui bat research. 1b. Restoration of additional bat habitat at an acreage commensurate with the requested take.

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. Later in the project, total adjusted take as estimated through post-construction monitoring will be used to determine which tier take is occurring at and the necessary levels of mitigation required to achieve mitigation success.

The proposed seabird and nēnē mitigation will include funding measures intended to increase populations of these species. Measures intended to increase seabird population sizes will generally be aimed at eliminating predation through exclusion and/or eradication of predators from a breeding area. Reducing or eradicating predators can dramatically increase adult and juvenile survival, leading to increased productivity, (e.g., Ebbert and Byrd 2002; Pascal et al. 2008; Hu et al. 2001; Hodges and Nagata 2001), thus compensating for any individuals that may be incidentally taken by the project.

The Applicant proposes to provide mitigation for nēnē primarily by improving survival and productivity of the existing nēnē populations at a release pen or at Hana'ula and the KWP project areas through predator control. This will enhance efforts to establish separate breeding populations on Maui as recommended by the Draft Revised Recovery Plan for the species (USFWS 2004a).

Proposed 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. Funding will also be 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 be 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 will be used to determine annually whether take is occurring at Tier 1 or Tier 2 rates. In general, mitigation efforts will be adjusted to compensate for the requested take at the required tier. The Applicant will promptly coordinate with USFWS and DLNR if Tier 2 rates of take are occurring in order to adjust mitigation efforts accordingly and, if five-year take limits are exceeded, to implement adaptive management measures. Sections 5.2.2.4, 5.2.3.4, 5.2.4.4, and 5.2.5.3 identify the rates of take that will be considered "Tier 2" for each species, as well as the amounts of time considered necessary to determine those rates. If Tier 2 mitigation is initiated, these mitigation measures will be completed, even if monitoring indicates that take has fallen back into Tier 1 levels.

6.1. WILDLIFE EDUCATION AND OBSERVATION PROGRAM

A wildlife education and observation program (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, on-going, 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 in 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.

6.2 DOWNED WILDLIFE PROTOCOL

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 USFWS and DLNR. This protocol was developed in cooperation with DLNR and 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 DLNR and the Fish and Wildlife Biologist at USFWS will be notified within 24 hours by phone and written notification will be provided within three 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 USFWS and DLNR to handle and salvage wildlife. Injured individuals or carcasses will be handled according to guidelines in Appendix 2 and 14 of the HCP.

6.3 PETRELS AND SHEARWATERS

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 (road-kills, collapsed burrows, 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 and 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 6.2.

Table 6.2 Comparison of Hawaiian Petrel Nesting Success (Percent Nests that Successfully Fledge a Chick) With and Without Predator Control.

Location	Year(s)	Nesting success (%)		Reference
		W/o predator control	W/ 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 play-backs of vocalizations of conspecifics. This technique has been shown to increase site prospecting, 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), and a large number of additional seabird species in New Zealand (Steve Sawyer pers. comm.).

6.3.1 Tier 1 Mitigation

The proposed Tier 1 mitigation for seabirds is designed to meet Tier 1 mitigation requirements for KWPII as well as KWPI per amendment submitted to DOFAW and 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 (i.e., social attraction) to draw birds to the fenced area. This social attraction project will be implemented at Makamaka'ole, West Maui (Figure 3.1, Appendix 22).

6.3.1.1 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), USGS (Josh Adams), and H.T Harvey and Associates (David Ainley). In 2010, after consultation with DOFAW and USFWS, First Wind carried out an assessment of the site to determine the extent of petrel activity. The 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 2011). 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. com.).

The Ecoworks team concluded that:

- Makamaka'ole 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 Kaua'i (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 four nights of visual observations in 2011, Hawaiian petrels continue to congregate in the airspace above Makamaka'ole Valley even though no active burrows were found.
- Hawaiian petrels travel up the Makamaka'ole Stream from the sea a historic staging area where aerial courtship is facilitated by updrafts created as winds collide with a 350 ft vertical rock face. Petrels do a considerable amount of aerial courting (pers.com Dr Nicholas Carlile), i.e., Grey-faced petrels at Nicks Head, Collared petrels at Waitambua, and Taiko at Awatotara Valley/Lower Tuku, New Zealand; it is also comparable to behavior observed at Haleakala and Lana'i adjacent to petrel breeding sites (David Ainley, pers.obs.).
- There is likely to be a remnant Hawaiian petrel colony somewhere in the Makamaka'ole – Kahakuloa watershed, highly likely to be several thousand ft above sea level and very difficult to access, manage or protect sufficiently.
- Some of these juvenile birds probably land at Makamaka'ole and begin to excavate burrows. However these birds are highly likely killed by mongoose or feral cat in a short time as their searching for cavities or suitable burrowing sites is quite noisy (David Ainley, pers. obs, Haleakala).
- A total of 11 mongoose were trapped in two traps during 12 trap nights using two traps 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 Makamaka'ole is extremely low.
- Based on the density of mongoose at lower elevations in Hawaii it is unlikely that predator control alone is going to be enough at lower altitudes (0-2,500 ft asl) to protect any nesting Hawaiian petrel or Newell's shearwater (Steve Sawyer & Tim Day, Xcluder pers. comm).

In addition to the conditions at the sites where remnant nesting locations in the Makamaka'ole-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 Carlile 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.

6.3.1.2 Newell's shearwater

Based on radar information and documented flight calls at Makamaka'ole and vicinity (see also Cooper & 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 & 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 Kaua'i. Maui SOS data indicate that Newell's shearwater fallout is decreasing, similar to the historic pattern on Kaua'i 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 the Natural Area Reserve System'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 have 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 Makamaka'ole relative to the upper Kahakuloa site, its demonstrated location within the suspected flight paths of Newell's shearwater (section 2.4.2), Makamaka'ole 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.

6.3.1.3 Hawaiian petrel and Newell's shearwater Passage Rates Over Makamaka'ole

Radar surveys were conducted at Makamaka'ole 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 Makamaka'ole 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.

Hawaiian petrels

Auditory and visual surveys have documented Hawaiian petrels circling over Makamaka'ole 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 mins 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 Haleakala (David Ainley pers. comm.).

Radar data collected at Makamaka'ole, 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 infra-red 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.). The population of Hawaiian petrel in the existing colony in the vicinity of Makamaka'ole 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 Makamaka'ole to support the number of immigrants needed for successful social attraction at the site.

Figure 6.1 Average Hawaiian Petrel Call Rates at Makamaka'ole, July 2010.

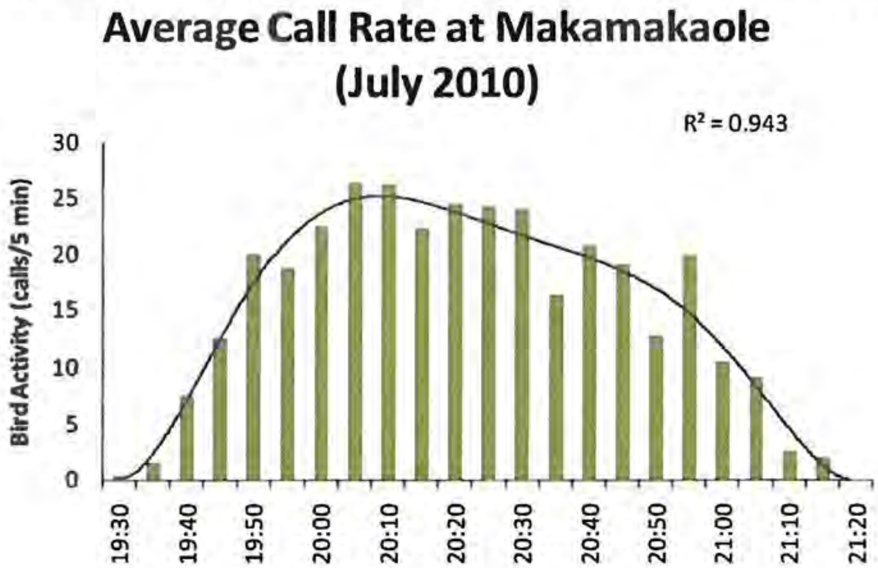


Table 6.3 Radar data from Makamaka'ole

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

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 & Day (2003) the radar detection rates of Newell's shearwaters and Hawaiian petrels are given for surveys conducted in June 2001 (Fig. 2.2). For the 6 sites around west Maui, detection ranged from 0.4 to 21 birds/hr, or 1 to 62 birds per night (data collected during first 3 hours of each night). Cooper & Day (2003) concluded that shearwaters and petrels may use specific 'corridors' for accessing their breeding colonies. It's 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 sure for Hawaiian Petrels based on their data around east Maui/Haleakala. For the section of the coast containing Makamaka'ole, detection ranged 5.6 to 21/hr. Total for 3 sites in that area ('Iao, Waihe'e, Kahakuloa) was 48 birds/hr (Newell's shearwaters in remainder of west Maui were negligible). Cooper & Day (2003) also concluded that any detections that occurred 60 min 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 (average of 30% for the 3 sites), then, the detection rate for Newell's shearwaters in the north-east portion of west Maui, in 2001, ranged from 2 to 7birds/hr or 6 to 21 Newell's shearwaters per night (bracketing Makamak'ole, between Kahakuloa and Waihe'e); or assuming that Newell's shearwaters detected at all 3 sites were all heading for the same colony, then 32 birds/hr or 96 birds in a night.

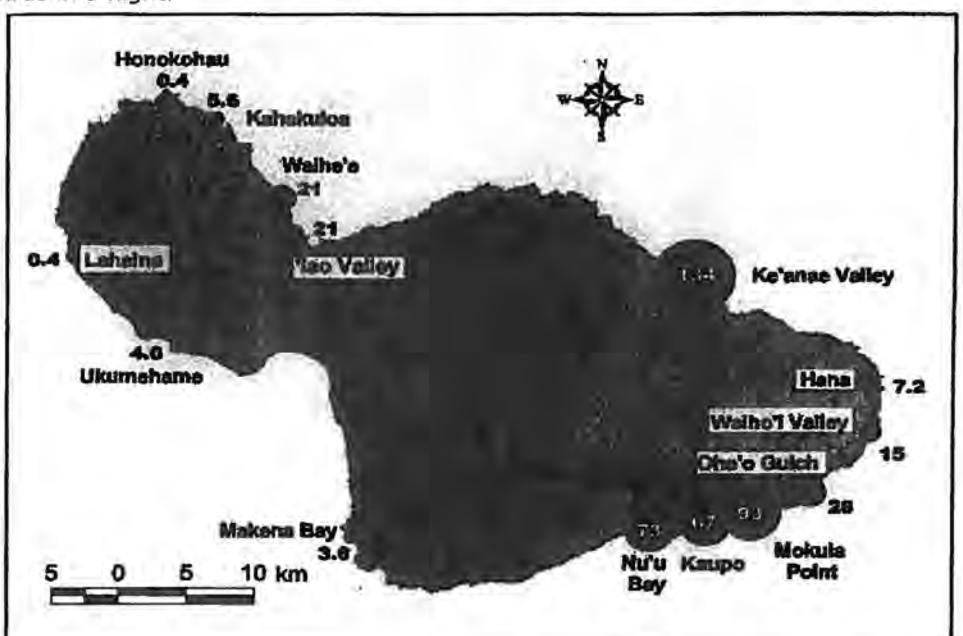


Figure 6.2 **From Cooper & Day (2003). Radar detection rates, birds/hr, for the first three hours of night on surveys conducted 7-21 June 2001.**

Based on work at Haleakala during 2008-11 (by Adams, Ainley et al. David Ainley pers. com.), it is known that Hawaiian petrels bring fresh food to their nestlings at all hours of the night, even up to 0430 (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 1/3 of what Cooper and Day (2003) thought were Newell's shearwaters actually were Hawaiian petrels (see their Figure 6.2). The detection of Newell's shearwaters in the north-east portion of west Maui in

2001 would therefore range 4-14 birds per night, bracketing Makamaka'ole, or 64 birds per night if Newell's shearwaters detected at the 3 NE west Maui sites were all headed for the same colony. Assuming that very few Newell's shearwaters arrived later than the first 3 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 NE west Maui each night in June 2001.

During detection surveys at Makamaka'ole in 2010-11, 1-3 Newell's Shearwaters were heard flying up slope during the first 3 hours of each night in June-July (this is not birds/hr); maximum was 13 vocal detections of Newell's Shearwaters in one night (FirstWind, unpubl. data). This is fewer by a third of what was detected by Cooper & Day (2003) 10 years earlier, 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 Pt NWR, at least one adult Newell's Shearwaters, 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 NE portion that contains Makamaka'ole.

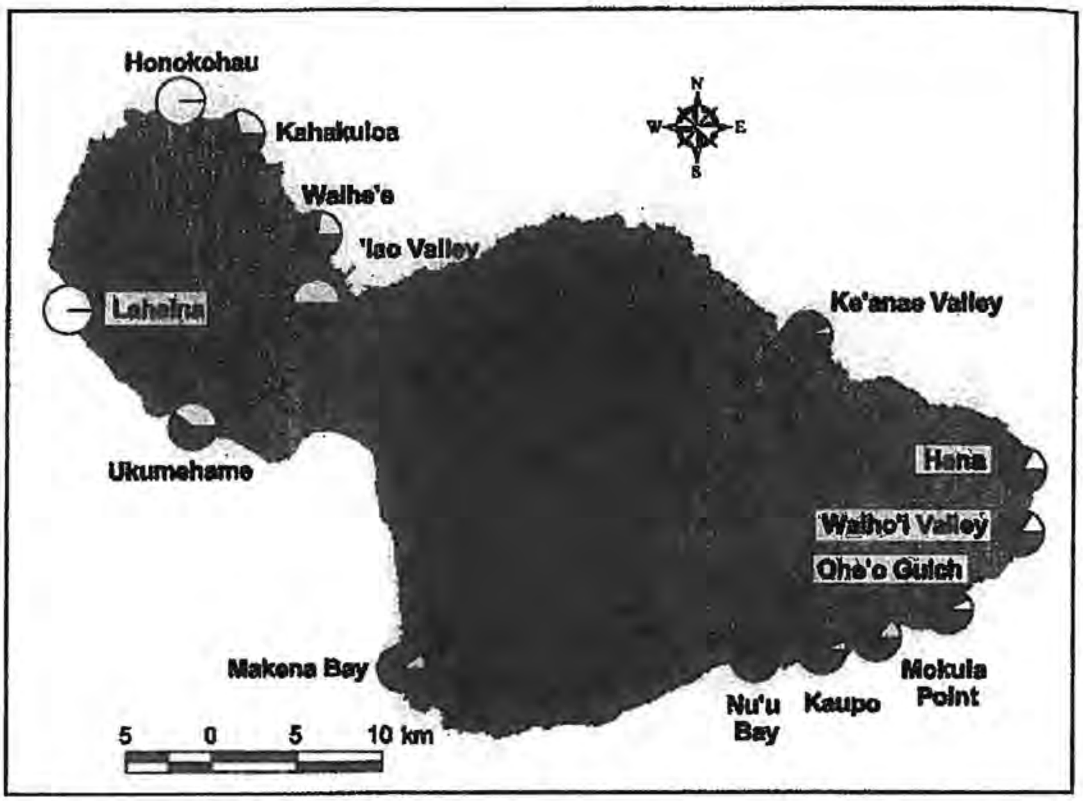


Figure 6.3 **From Cooper & Day (2003). Radar targets by species. Pie charts showing the proportion of Newell's Shearwaters (white) and Hawaiian Petrels (dark) thought to compose the targets detected by radar, 7-21 June 2001. Distinguishing Newell's Shearwaters from Hawaiian Petrels was done only under the assumption that detections after 60 min after sunset were Newell's Shearwaters.**

Table 6.4 Newell's Shearwater Auditory Data

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

A maximum of 13 individuals were recorded flying over Makamaka'ole during auditory point count observations in 2010. Newell's shearwaters were detected (based on auditory observations) eight days out of the 14 days that auditory point count surveys were made. Radar data at Makamaka'ole 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 Makamaka'ole to be good candidates to be immigrants to the social attraction site.

6.3.1.4 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 play-backs. 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 Kaua'i (Joyce et al. 2008; U.S. Fish and Wildlife 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 Hawaii's Comprehensive Wildlife Conservation Strategy, while protecting seabird populations and their breeding colonies remains an important management priority, re-establishing 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 loud speaker compared with only 16% nesting three or more meters 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 Carlile 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, Podloski and Kress 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 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 two years into the project (Kress 1990). At Nick's Head Peninsula, New Zealand calls of six pelagic seabird species were broadcast in 2005. After three years, grey-faced petrels (*Pterodroma macroptera*) 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, 2 fairy prions and 2 white-faced storm-petrels) (Miskelly et al. 2004). However, there were no breeding attempts after three 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 re-establish breeding colonies of Bulwer's petrels, which were extirpated from Midway Atoll by rats. This is currently also planned for Ka'ena Point, Oahu, 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.

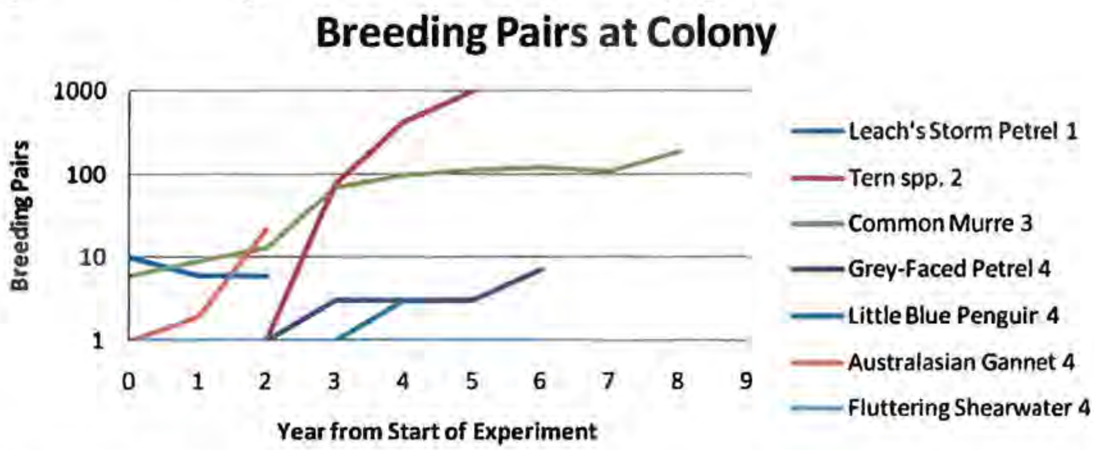
A fencing and social attraction approach at Makamaka'ole is expected to have a very high chance of success. The site is very accessible, being located within walking distance from the end of a road, and includes a range of topographical features and aspects, including slope, gullies, flat areas, ridges, 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 fence line 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 petrel transiting and even courting adjacent to the proposed attraction site indicate there is a significant source of birds that may be drawn in to 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 Hawaiian people 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).

6.3.1.5 Colony establishment and credit accrual

The rate of increase in colony size following re-establishment 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, subadult 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.

Figure 6.4 Colony attraction for social attraction projects.



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

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 KWPI and KWPII combined would not be reached during the 20 year license period (i.e., at least 1 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. However, mitigation accelerates with time, and net recovery benefit would be reached by year 24 for adults and year

25 for fledglings (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 KWPI and KWPII 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 five 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 (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 6.3.1.7 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-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 Kukui 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. 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 6.5 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

Newell's shearwater
Modeling by H.T. Harvey and associates (Appendix 25) based on published demographic parameters, data from social attraction projects referenced above, and a set of reasonable assumptions which are explained in Appendix 25, projects the presence of 6 active breeding burrows within the enclosure in 20 years. Tier 1 mitigation requirements for both KWPI and KWPII combined would be reached during the 20 year license period (i.e., at least 1 individual above the Tier 1 take level of 8 individuals, at least 4 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 five 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 (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 6.6).

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 selection of demographic parameters of the existing population of Newell's shearwaters on West Maui.

Table 6.6 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	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

6.3.1.6 Project design

An area has been identified for the construction of two approximately 5 ac 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 25 m grid of bait stations (Diphacinone), and a trapping program will be carried out within a 100 m 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 Makamaka'ole, Lana'ihale, and/or Haleakala 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 40 m 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).) 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 2). 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.

6.3.1.7 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 Makamakaole social attraction project does not produce the anticipated mitigation benefits, adaptive management at the Makamakaole 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 Makamaka'ole 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 Makamaka'ole social attraction project are not anticipated.

Throughout the first five years of social attraction at Makamaka'ole, management may be adapted to change methods, scale, or strategy at Makamaka'ole 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 6.7 Minimal number of breeding pairs occupying the enclosures after 5 years of social attraction to confirm meeting mitigation requirements.

Species	Number Needed to Offset KWPII Tier 1	Total Needed to Offset KWPII Tier 1 + KWPII Tier 2	Total Needed to Offset KWPI Tier 1	Total Needed to Offset KWPI Tiers I and 2
Newell's shearwater	1	2	1	2
Hawaiian petrel	1	2	1	2

If based on results achieved during years one through five, the success of the Makamaka'ole 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 KWPII Tier 1 take, KWPI's anticipated 20-year take levels, and KWPII's Tier 2 requested take level, if triggered, based on observed take) the Applicant will, in year six, 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. 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 Haleakala Crater Rim.
b) Implement predator control at Hawaiian petrel colony at the ATST mitigation site on Haleakala.

Newell's shearwater:

a) Install predator fencing and manage predators around a Newell's shearwater colony or colonies in West Maui or, if 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 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 Molokai or Lanai (see section 6.3.2.2).
d) If DOFAW and 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 Molokai or Lanai to ensure that the collective mitigation efforts result in successful achievement of mitigation goals for KWPII Tier 1 requested take in addition to KWPI's anticipated 20-year take levels and KWPII'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 towards 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 Kaua'i. 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 Makamaka'ole or alternative sites will be subject to approval by the agencies. Input will be sought from the Seabird Recovery Group for the State of Hawai'i. 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 DLNR and USFWS.

Newell's shearwater will not be a Covered Species in the HCP unless the USFWS and DLNR approve the requested reduction in Newell's shearwater take permitted at KWPI to a total take of 8 Newell's shearwater. 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.

6.3.2 Alternatives for Tier 1 Mitigation

Makamaka'ole is considered by DOFAW, 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 USFWS will determine the most appropriate alternative for mitigating the impacts of this project.

6.3.2.1 Alternatives for Hawaiian Petrel

If necessary to offset KWPI and KWPII Tier 1 take of the Hawaiian petrel, KWPII would augment the Makamaka'ole 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 participates in the management effort with KWP, 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 National Science Foundation has proposed six years of monitoring at a control site on Haleakala pursuant to their Advanced Technology Solar Telescope (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 and KWPII 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, DLNR, and USFWS.

The effort will, at minimum, include traps spaced 50 meters 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 non-breeding 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.

6.3.2.2 Alternatives for Newell's shearwater

As described above and discussed and agreed upon with the agencies, Makamaka'ole 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 Makamaka'ole-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 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 Makamaka'ole, 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, USFWS, and other subject specialists when applicable.

Table 6.8 Factors that will affect the feasibility of installing and maintaining a predator proof fence.

Feasibility criteria	
Burrows:	Enclosure needs to contain at least 8 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 meter 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 USFWS. It is likely that KWP II and KWP 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 Makamaka'ole social attraction site are insufficient, (see section 6.3.1.7) 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 Makamaka'ole social attraction project. The most likely sites may be on state land and TNC-managed land along the Ko'olau Gap, or Ke'anae Valley located north of Haleakala National Park, and on state land east of Haleakala 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 Makamaka'ole 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, DLNR and 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 KWPII, determine anticipated benefits of the Makamaka'ole social attraction project and any additional mitigation projects are not expected to offset KWPII's Tier 1 take, USFWS and DOFAW may direct KWPII 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 USFWS and DOFAW in coordination with KWPII, the landowner, and the contractor appointed to construct a possible fence. If DOFAW and 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 Moloka'i or Lana'i. During the first breeding season after the determination that mitigation requirements cannot be met through the proposed projects on Maui, KWPII will confirm a breeding site on south east Moloka'i 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 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 KWPII 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 Moloka'i or Lana'i 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 Moloka'i. If USFWS and DOFAW conclude that predator exclusion and management is not feasible at these sites on Moloka'i and Lana'i, and a social attraction project similar to that described for Makamaka'ole 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.

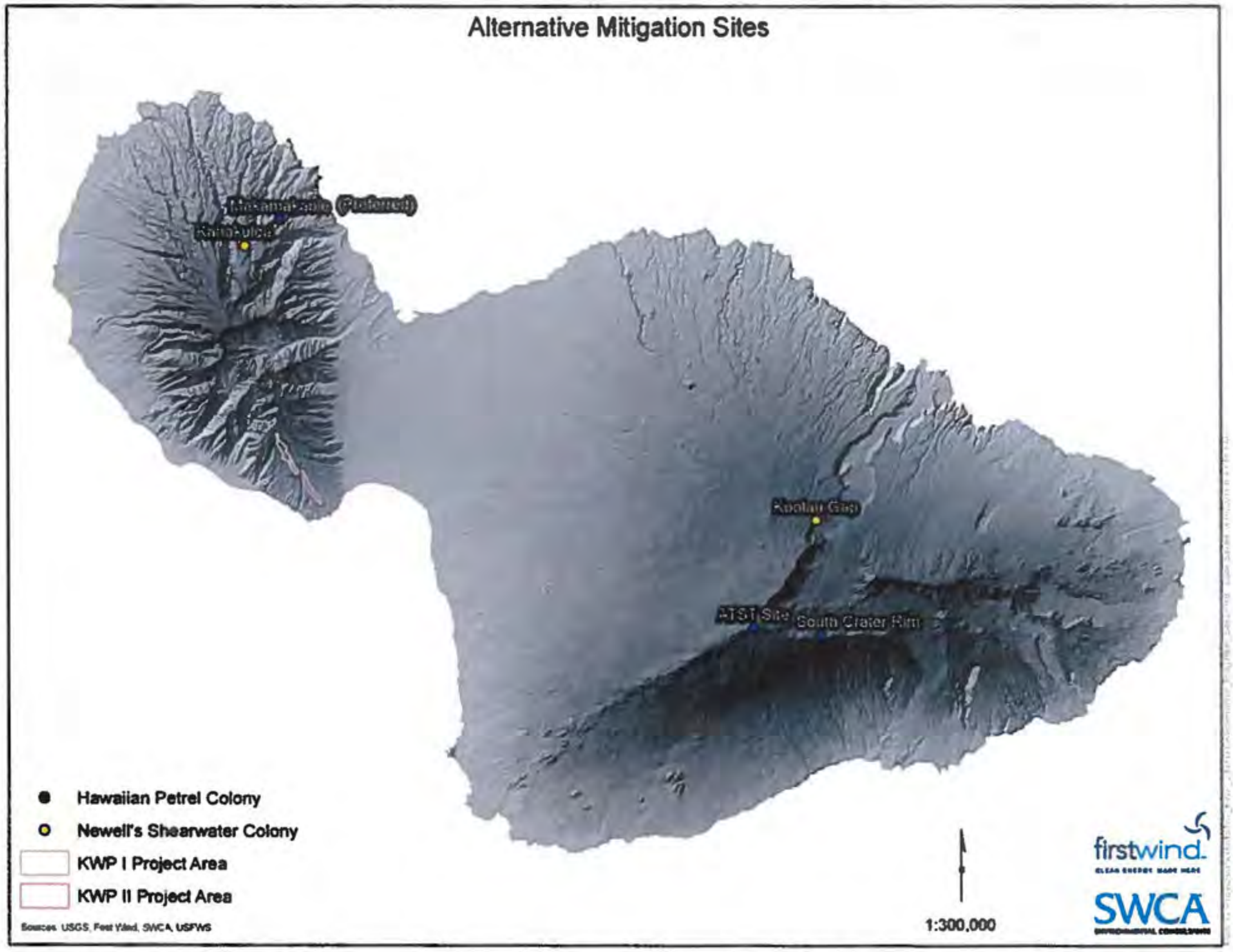


Figure 6.5 **Locations of alternative mitigation sites for Hawaiian petrel and Newell's shearwater.**

6.3.3 Mitigation for Tier 2 Rates of Take

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 KWPI and KWPII permit applications. The proposed Makamaka'ole social attraction mitigation project is expected to mitigate for all of the Tier 1 take of KWPI and KWPII, and at least a portion of the requested take under the Tier 2 of take. For Newell's shearwater the proposed mitigation project at Makamaka'ole 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 Makamaka'ole 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 Haleakala Crater Rim site, in conjunction with anticipated benefits at Makamaka'ole, 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 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 (ie in year 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 KWPI occurs on a bird by bird basis, rather than full implementation for whole tiers of take. If take occurs at Tier 2, the Applicant, USFWS, and 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 hectare (Hodges and Nagata 2001), and is largely unprotected from predators and experiencing a much lower level of breeding attempts and breeding success.

6.3.3.1 Haleakala 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 participates in the management effort with KWP, 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 meters 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 non-breeding 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.

The National Science Foundation has proposed six years of monitoring at a control site on Haleakala pursuant to their Advanced Technology Solar Telescope (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.

6.3.3.2 ATST Site

A 328 acre (133 ha) mitigation area is proposed for mitigation for Advanced Technology Solar Telescope (NSF 2010) may be used instead of or in addition to the additional Haleakala 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 Hawaii, 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 National Science Foundation (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.

6.3.4 Additional Research to Improve Avoidance and Minimization Measures for Tier 2

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 USFWS.

6.3.6 Measures of Success

Mitigation efforts provided by KWP II 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 (Appendix 24 and 25). A baseline scenario for birds breeding in an unprotected area is subtracted from a reasonable scenario within the enclosure (Table 6.5, 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 National Science Foundation has proposed six years of monitoring at a control site on Haleakala pursuant to their Advanced Technology Solar Telescope (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 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 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 will nonetheless be responsible for ensuring that the necessary conservation is provided.

6.4 NĒNĒ

KWP 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 HCP. Several provisions in the KWP 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"

6.4.1 Avoidance and Minimization Measures

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.

6.4.2 Tier 1 Mitigation

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 1995). 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, Hawai'i. Mongoose have also been documented causing significant nesting failures of wild nēnē on the Islands of Hawai'i 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 (Table 6.7).

Female nēnē mature at age three and males at age two (Banko et al. 1999). For the purposes of this HCP the take of a mature female will require accounting for two 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 Year 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 one year of loss of 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 goslings/individual/year (see Section 5.2.4.2). When adults are replaced by goslings loss of productivity will be assessed at an additional 0.09 fledglings for an adult male (one year loss of productivity) and 0.18 fledglings for an adult female (two 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 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 6.9 Fledgling requirement for Tier 1 take assuming same year replacement.

	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 of 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.

6.4.2.1 Preferred Tier 1 Mitigation Measure

On April 14th, 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 Kauai) to neighboring islands. This proclamation invoked provisions of Chapter 128, Hawaii Revised Statutes, and affirmed the State's responsibility to protect the health, safety, and welfare of the people and nene populations by mitigating potential bird-strikes with aircraft and enhancing the population of this federally listed Endangered Species on those designated neighboring islands.

The Department of Land and Natural Resources and Department of Transportation have been directed to develop and implement a five-year Nene Action Plan that will translocate and monitor the Kaua'i Lagoons nēnē population. According to the proclamation, "the five-year Nene 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 five years till June 2016. DOFAW anticipates that the translocated nene 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 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. The best location for release pen will be determined by DOFAW and 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 Puu 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. com.). 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 KWPII will be expected to accrue a minimum 42 fledglings after five 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 five 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 anticipated 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 five years of management is considered to be a very conservative estimate.

Table 6.9 Fledgling accrual for KWPII Tier 1 mitigation.

	Number of goslings					Total Accrual
No. goslings reared in pen (from 5 breeding pairs)	10	10	10	10	10	
No. fledge (90% of all goslings)	9.00	9.00	9.00	9.00	9.00	
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 five 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 on-going monitoring and best available science and implemented with approval of DLNR and USFWS.

After the Tier 1 mitigation obligations are met by KWPII, 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 USFWS and DLNR will direct the funds toward whatever management or management activity is deemed most appropriate at the time.

6.4.2.3 Additional Tier 1 Mitigation Measures

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 three hours (one 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.

6.4.3 Mitigation for Tier 2 Rates of Take

The Applicant will provide additional funding for three years as described in Section 6.4.2.1. Funding will be provided to DLNR to monitor the status of the nēnē population and conduct predator control at a chosen release pen. As Tier 1 mitigation is anticipated to be exceeded in five years, and as the Tier 2 is 1.5 times Tier 1 take (an additional request of nine adults), three years is anticipated be adequate to compensate for the additional take of nine adults. 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 6.4.2.1.

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 USFWS and DLNR will direct the funds toward whatever management or management activity is deemed most appropriate at the time.

Additionally, if monitoring after the first three 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. 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 measures to be undertaken will be determined based on data collected from the on-going monitoring and best available science and implemented with the approval of DLNR and USFWS.

After the Tier 2 mitigation obligations are met by KWPII, DOFAW will continue the long-term management of the release pen.

6.4.5 Additional Measures for the Protection of Nēnē

KWP II will fund the construction and operation of an additional nēnē release pen at an approximate cost of $150,000 and at a location to be determined by DLNR, and provide funding for a truck ($10,000), up to three years of staffing ($20,000 per year if either of the following occurs):

- The nēnē mitigation occurs at a site with a Safe Harbor Agreement which is terminated before the end of the terms of this HCP and the site returns to baseline conditions. The replacement pen will be established at a replacement site prior to the return of the original release site to baseline conditions. The birds present at the original release site will be translocated to the replacement site as needed.
- The nēnē population at Hana'ula (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 five-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 and KWP II, the cost of

construction and operation of the additional release pen will be shared between KWP II and KWP. The birds present at Hana'ula will be translocated to the replacement site as needed.

6.4.6 Measures of Success

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.

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

If mitigation efforts at the release pens do not exceed the baseline productivity or adult survival rates for two years running (to take into account possible annual variations), then adaptive management measures will be implemented. The magnitude and scope of these measures will be determined with approval of USFWS and DLNR and will be based upon monitoring data recorded at the mitigation site and best available science at that point in time.

Net benefit will also have been provided to the species these mitigation measures will 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. Thus, for example, 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 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 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 will nonetheless be responsible for ensuring that the necessary conservation is provided.

6.5 HAWAIIAN HOARY BAT

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. 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 6.5.1. 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 6.5.2). The estimated cost for each proposed measure is presented in Appendix 6.

6.5.1 Tier 1 Mitigation

Mitigation for the Hawaiian hoary bat by KWPII was developed through discussions with USFWS, DLNR, and bat experts at USGS, and involved identifying measures believed most likely to contribute to the recovery of the species. Based on the feedback received, KWP II proposes 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 DLNR, USFWS and ESRC in consultation with KWPII.

6.5.1.1 Bat Habitat Utilization at KWPII and Vicinity

The Applicant will continue to survey for and monitor Hawaiian hoary bats within and in the vicinity of the KWPII site. Surveys will be conducted during years when systematic fatality monitoring is conducted, (i.e., during the first three 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. 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 will also join the Hawai'i Bat Research Cooperative (HBRC) and as a contribution to the on-going research efforts in the state, will conduct its own surveys and monitoring at KWP II and the vicinity. Survey protocols will be developed prior to the start of project operations, in consultation with HBRC, with approval by USFWS and DLNR. Up to 12 Anabat detectors will be deployed at KWP II and the vicinity.

The goal of this research will be 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 will be an extension of a five-year survey already underway on the Island of Hawai'i and Kaua'i and another that will shortly commence on Maui.

6.5.1.2 Research on Bat Interactions with the Wind Facility

In conjunction with the study to determine habitat utilization by bats at KWPII and its vicinity, KWPII proposes to conduct 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. KWPII will survey for bat activity near turbine locations for the first three 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). USGS (HBRC) monitoring protocols will be used and adjusted if necessary. Thermal imaging or night vision technology will 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 will be analyzed in an effort to determine seasonal and daily peak bat

activity periods onsite, and comparison of data with pre-construction activity levels will help determine if bats are being attracted to the wind facility.

2. Incidental bat observations will be recorded under the WEOP (Section 6.1 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.

6.5.1.3 Implementation of Management Measures

The Tier 1 mitigation for bats is based on the recommendations received from USFWS and DOFAW in May 2011. 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. This dataset from a two-week tracking study indicates that the mean core area of rainforest habitat on the island of Hawai'i used by 14 male bats was 84.3 acres (34.1 hectares) per bat and the average size of the core area utilized by the 11 females in the dataset was 41.2 acres (16.7 ha) per bat. 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 6 adult bats and 3 juveniles (see Section 5.2.5.3) 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 50:50 adult sex ratio, the potential take of 7adults would result in the take of up to 4 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.

Assuming 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 (similar to the mainland subspecies), 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. . Additionally, benefits of restoration would presumably extend beyond the 20- year term of the ITP/ITL. Based on this assumption, the mitigation acreage required for 4 adult male bats is two male core areas totaling 168.6 acres (84.3 x 2 males = 168.6 ac). This area is also assumed to encompass the core areas of at least four female bats, and possibly up to eight female bats and therefore will also mitigate for any female bats taken.

Fencing of the Kahikinui Forest Reserve to exclude ungulates will enable the koa-ohia montane mesic forest to regenerate and is expected to create additional habitat for the Hawaiian hoary bat. If natural regeneration is less than or slower than expected, native plants will be outplanted to enhance the regeneration of the mesic forest to meet the criteria for successful restoration (Section 6.5.4). KWPII will contribute to 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 Hawaii 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. USFWS and DOFAW recommend that to offset the conservation shortfall associated with conducting mitigation on existing conservation land, the acreage managed in conservation areas be double that of privately owned land. This will require that KWPII restore 338 ac (168.6 x 2 = 338 ac) of land at Kahukinui.

KWPII will provide funding to DOFAW to fence and manage and monitor for bats at a distinct area within the Kahikinui project. A 338 ac subunit at Kahikinui has been identified as a suitable mitigation site (Figure 6.6). However, if sufficient partnerships can be secured to ensure management of the whole of Kahikinui, KWPII will contribute 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 fenceline throughout the remainder of the 20-year Permit period. The monitoring of bats at Kahikinui and the implementation of restoration actions will be the responsibility of DOFAW (based on criteria 3a-d in Section 6.5.4). However, KWPII 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. The location of the mitigation area may be modified with the approval of DOFAW and 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 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.

6.5.2 Mitigation for Tier 2 Rates of Take

6.5.2.1 Additional Research

KWPII will 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, KWPII will conduct supplemental investigations that may include but not be limited to:

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. using thermal imaging or night vision equipment to document bat behavior
4. use of telemetry to document home range size and habitat usage, and density/population estimation; if new technology is available to address these goals, they may be used with approval of USFWS and DOFAW instead of telemetry.
5. 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)

Other measures to reduce bat fatalities will be implemented as identified and feasible 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 KWPII with the concurrence of USFWS and DLNR.

6.5.2.2 Implementing Bat Habitat Management Measures

The Tier 2 requested take of 9 adult bats and 5 juveniles (see Section 5.2.5.3) equates to a total of 11 adults (with an estimated 30% survival rate of juveniles to adulthood; see Appendix 5 for life history information). Assuming a 50:50 adult sex ratio, the potential take of 11 adults would result in the take of up to 6 adult male bats. Tier 1 already mitigates for 4 male bats, therefore the requirement for Tier 2 mitigation is for two additional males above the Tier 1. Therefore, the recommended 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 (see Section 6.5.1.3 for details).

The Tier 2 mitigation site would be selected and a management plan would be completed for the site within the first five years of the permit term. Ungulate removal and forest restoration objectives used in Tier 1 would be applied, as adapted, with the approval of DOFAW and the Service, based on the best available information.

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.

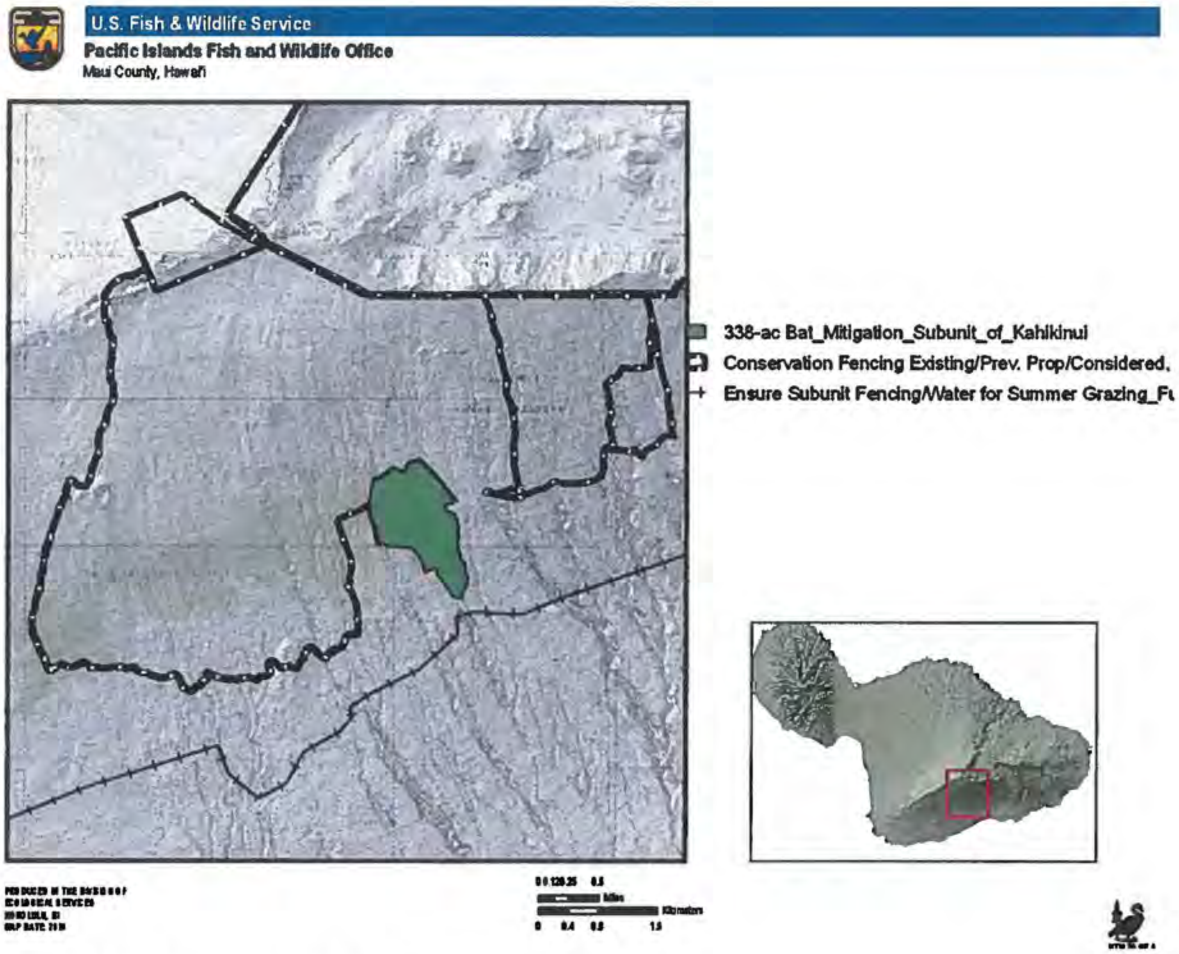


Figure 6.6 Possible Tier 1 Bat Mitigation Site

6.5.4 Measures of Success

The success of the mitigation efforts will be determined as follows:

1. Both components of on-site research into Hawaiian hoary bat habitat utilization and bat interaction with wind facilities will be considered successful if KWPII joins the HBRC and the specified survey and monitoring is carried out, including proper deployment and operation of bat detectors, data reduction and analysis, and reporting of findings to DLNR, USFWS and ESRC.
2. In the event that KWPII exceeds the Tier 1 rate of take measures to reduce bat fatalities will be considered successful if one or more causes can be identified and corrective measures are implemented that result in an estimated 50 percent or greater reduction in bat fatalities over previous levels when averaged over a five-year period.
3. Implementation of management measures will be considered successful if KWPII contributes 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 if a Tier 2 rate of take is identified, 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) is provided within six 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.
d.

And after 20 years

a. The cover of non-native species (excluding kikuyu grass) in the managed areas is less than 50%.
b. 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.
e. Restoration trials are implemented.
f. 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.

These criteria will be refined by DOFAW before management commences in the Kahikunui area.

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. 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 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 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 will nonetheless be responsible for ensuring that the necessary conservation is provided

6.6 MITIGATION FOR OTHER NATIVE SPECIES – THE HAWAIIAN SHORT-EARED OWL

Since the start of project operations at KWP 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 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 will consist of funding research and/or rehabilitation of injured owls. Therefore, within 60 days of the commercial operation date, KWP II will contribute 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 which will house 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 DLNR and 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 USFWS and 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.

6.7. RESTORATION OF VEGETATION AND PREVENTION OF SOIL EROSION

KWP II received approval of their CDUA (Appendix 1) from the Office of Conservation and Coastal Lands (OCCL) on 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 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 project site, which underwent construction in early 2006, and which has a comparable plant ecological history. KWP II 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.

6.7.1. Immediate Revegetation to Control Soil Erosion

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 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 die back and allow 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).

6.8 MANAGING INVASIVE SPECIES

KWP 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 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 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 Hawai'i 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.

6.9 ENHANCEMENT OF MID-ELEVATION NATIVE PLANT HABITAT

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 Mā'alaea 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) project area and both projects reside on Conservation District Land administered by the Hawaii Department of Land and Natural Resources (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 Malalowaiaole Gulches (Hobdy 2009a, 2009b).

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 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 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 a'ali'i (*Dodonaea viscosa*) were propagated from seed collected at the KWP 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. These efforts have enabled many disturbed areas to become re-established 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 re-introduce 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 '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 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 may propose to direct some native outplantings outside of the immediate project area (i.e. near the pu'u), 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 DLNR, 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 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 while incorporating the knowledge of past experience working in the region. KWP II will work in collaboration with KWP 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 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 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 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 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 onsite personnel are equipped and trained to suppress incipient fires. The KWP wildfire contingency plan (Appendix 18) ensures adequate response and suppression of potential wild fires. In addition, KWPII 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

The Applicant will administer this HCP under the direction of the USFWS and 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, USGS), private conservation organizations, conservation partnerships (e.g., Nēnē Recovery Action Group), consultants and academia. When appropriate, and as requested by USFWS and DLNR, HCP-related issues may be brought before the ESRC for formal consideration.

The Applicant will meet at least semi-annually with USFWS and DLNR. Additional meetings/conferences may be called by any of the parties at any time 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 DLNR may suspend or revoke their respective permits if Kaheawa Wind Power 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

Monitoring and reporting by the Applicant will address both compliance and effectiveness. Compliance monitoring will verify the Applicant's implementation of the HCP terms and conditions. Annual reports and other deliverables as described below will be provided to USFWS and DLNR to allow them to independently verify that the Applicant has performed all of the required activities and tasks on schedule. Monitoring will investigate the impacts of the authorized take and the success of the HCP's mitigation program. The monitoring will involve 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

The Applicant proposes to document 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 Hawai'i and the continental United States. Another alternative is for KWP II 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 will establish the monitoring protocol and provide personnel to conduct the monitoring. If the program is established, KWP II 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 will be 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 USFWS and DLNR will be developed with approval of DLNR and USFWS. Additional funds are provided in the event a third-party contractor is required for monitoring and will only be used for this purpose.

- Upon agency concurrence, carcass removal (i.e., scavenging) and searcher efficiency (SEEF) trials will be 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 will be classified according to structure (bare ground and mowed grass) and the vegetation types and their boundaries will be mapped at KWP II after construction. Carcass removal and SEEF trials will be conducted with sufficient replication to produce statistically reliable results. These results will provide a basis for estimating unobserved take (see Appendix 2 on the potential study design); the Applicant will cover all costs and responsibilities for acquiring carcasses for trials.
- Intensive searches will be conducted for the first three years under the direction of a qualified biologist, after which the approach may be reduced to a sampling method based on the results obtained up to that point, subject to the approval of DOFAW and USFWS. For example, systematic searches of 50% reduced effort could subsequently be conducted at five-year intervals and a further reduced but regular sampling method conducted during the interim years Any reduction in searcher effort will first be evaluated using data collected up to that point, and final decisions on searcher effort reduction will require the approval of DOFAW and USFWS, and ESRC, when applicable.
- The frequency of searches during the intensive search years will ensure that a variety of conditions are 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 will be documented in accordance with the WEOP and Downed Wildlife Protocol described in Section 6.1 and 6.2.
- Third party quality control of data analysis and the proctoring of SEEF trials will cost $30,000/yr during intensive monitoring years.
- Annually, on the anniversary of the start of operations, the USFWS and DOFAW will determine, 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. KWPII 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 356 days in length, during years six through 20.

7.2.2. Reporting

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 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, DLNR and USFWS will discuss possible adaptive management measures to address and correct the problem.

Semi-annual meetings with DLNR and 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 DLNR and USFWS as needed. In addition, should a take of a Covered Species occur, DLNR and USFWS will be notified within 24 hours by phone and an incident report will be filed within three (3) business days (Appendix 14).

Annual reports summarizing the results of each of the two years of intensive monitoring will be prepared and submitted to DLNR and 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 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 Program, 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 DLNR, to target areas or times of particular interest. A table summarizing the results of incidental observations will be submitted to DLNR and 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 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 USFWS and DLNR.

7.3 SUMMARY OF ADAPTIVE MANAGEMENT PROGRAM

According to USFWS policy (see 65 Fed. Reg. 35242 [June 1, 2000]), 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 on-going 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.

In the case of KWP II, some uncertainty exists in the proposed project, from estimated rates of take to the success of the proposed mitigation measures. Fortunately, because of the adjacent KWP project and the monitoring surveys that have been conducted since its turbines were erected in 2006, the level of uncertainty in the estimated rates of take is believed to be quite low. Similarly, there is reasonable basis for expecting the proposed mitigation measures to be successful, including a track record for successfully improving breeding success of seabirds through predator control and social attraction at colonies in Hawai'i and elsewhere, and a long history of nēnē releases on Maui and other islands. Nonetheless, uncertainties remain and, as a result, adaptive management provisions have been incorporated into this HCP.

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 through the seabird modeling and results of mortality monitoring performed to date at the KWP facility. 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

USFWS and 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 seabird and nēnē mitigation efforts is intended to inform the Applicant, USFWS, and 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 USFWS and DLNR, develop and implement a revised mitigation strategy intended to meet the project mitigation requirements.

If the take of any of the Covered Species exceeds that authorized by the ITP and ITL at the Tier 1 level, but remains within the range identified in Section 5.0 as the Tier 2 rate for that species, the Applicant will increase the mitigation effort for that species as prescribed in Section 6.0. As an adaptive management process, the Applicant will also promptly discuss this situation with USFWS and 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, and to identify whether mitigation performed to date has compensated for the Tier 2 rate of take, or whether changes in mitigation are needed to compensate for the Tier 2 rate of take. The Applicant may also consider whether changes in operational practices are needed to reduce levels of take. Any changes to the mitigation efforts would be made only with the concurrence of the Applicant, USFWS and DLNR.

7.4 FUNDING

The HCP includes a habitat conservation program with measures that KWP II will undertake 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 will provide the required conservation (monitoring, minimization, and mitigation) measures in full, even if the actual costs are greater than anticipated. For example, although the overall expenditures at the Tier 1 tier is not expected to exceed a total of $3.16 million, 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 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 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 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 will be 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 will operate 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 Power Purchase Agreement (PPA) with HECO, 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 will require 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 Kaheawa Wind Power II 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 from the Hawaii Department of Land and Natural Resources. 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 Conservation District Use Permit (CDUP) for KWP II, issued by the Hawaii 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/re-vegetating the site within 12 months. The decommissioning obligation for KWP II is secured with a LC of $1.4 million.

Additional assurance that adequate funding will be available to support the proposed monitoring and mitigation measures will be provided by Kaheawa Wind Power II in the form of a bond, letter of credit (LC) or similar instrument naming the DLNR as beneficiary. The LC will be in the amount of $1 million, which will be 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 amount of the LC is based on the estimated costs of mitigation obligations, as follows: Tier 1 mitigation for all Covered Species is expected be completed by Year 20, and it is unlikely that Tier 2 mitigation for any of the Covered Species will be triggered before Year 5. Therefore the amount of the LC covers the cost of Tier 1 mitigation, from Year 1-20, less the one-time costs that will be committed before commercial operations. After Year 5, the LC will cover the cost of Tier 2 mitigation in the unlikely event that all Covered Species are in Tier 2. The LC will be automatically renewed prior to expiration, unless it is determined to no longer be necessary by the USFWS and DLNR. As beneficiary, DLNR will have the ability to draw upon the LC to fund any outstanding mitigation obligations of the project.

KWPII funding assurance of $1,000,000 will be secured in a form approved by the USFWS and DLNR within 30 days of KWPII Permit issuance. KWPII Newell's shearwater take requested will be limited to the Tier 1 take level until KWPII LLC secures, in a form approved by the USFWS and DLNR, a total of $1,554,590, or less with approval of USFWS and DLNR, in funding assurance for the KWPII project, in addition to the seabird mitigation funding already in place pursuant to the KWPI HCP. The KWPII Newell's shearwater take level requested will increase to the Tier 2 level when the KWPII funding assurances are increased to $1,554,590, or with approval of USFWS and DLNR, an amount commensurate with the anticipated remaining mitigation need for this species. KWPII will secure the additional funding assurance within two years of KWPII Permit (License) issuance or within one month of a detected take of Newell's shearwater at KWPII, whichever is sooner.

7.5 CHANGED CIRCUMSTANCES

The HCP process allows for acknowledgement 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 that can be anticipated are not unforeseen circumstances, as described below.

Changed circumstances that may affect the implementation of the HCP include, but are not limited to:

1) Global Climate Change Significantly and Negatively Alters Status of the Covered Species.

   Global climate change within the life of the project (20 years) has some limited potential to alter the current distribution of vegetation communities utilized by the Covered Species through region-wide changes in weather patterns, sea level, average temperature and levels of precipitation (IPCC 2007). In some instances, climate change may also cause populations of Covered Species to decline. Covered seabird species are likely to be affected through changes in the distribution of their food resources at sea and possible changes in the vegetation at their preferred nesting habitats. The distribution of nēnē native food resources, particularly at high elevations, may change if climate change alters the range of native plants that they utilize. Nēnē, however, are also able to use a wide variety of non-native food resources. Hawaiian hoary bats are not expected to be affected by any changes in climate over the life of the project due to their ability to utilize non-native habitats which are unlikely to decrease in availability during that time frame.

   With climate change, hurricanes or storms may occur with greater intensity (Webster et al. 2005; U.S. Climate Change Science Program 2009), which would increase the risk of damage to established mitigation sites. This is discussed in Scenario 8 below. Sea level is predicted to rise approximately 1 m in Hawai'i by the end of the 21st century (Fletcher 2009). Given this, any rise in sea level experienced during the life of the project would likely be less than 1 m. As all the mitigation sites for the Covered Species are at or more than 1 m above sea level, these sites are unlikely to be impacted by sea level rise while the project is operational.

   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). Vegetation at the seabird or nēnē mitigation sites may change with decreased precipitation or increased temperatures; however, changes are expected to be small over the lifetime of the project. Should significant changes in vegetation be deemed to be occurring and demonstrated to affect the productivity of the Covered seabird species or nēnē, other mitigation sites will be considered for continued mitigation if deemed necessary and will be chosen with approval of USFWS and DLNR. In all cases, mitigation efforts will mitigate impacts of the requested take to the covered species to the maximum extent practicable and avoid jeopardy (unless agreed by all parties otherwise) with a net benefit provided to each Covered Species as required by State law.

   Any changes in the mitigation measures implemented for any of the Covered Species due to climate change will be performed under the budget established for mitigation expenses in this HCP, which includes the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

2) Listing of a new species.

   In the event that one or more species that occur on-site are listed pursuant to the ESA, the Applicant will evaluate the degree to which the species is (or are) at risk of being incidentally taken by project operations. If take of the species appears possible, the Applicant will then assess whether the mitigation measures already being implemented provide conservation benefits to the newly listed species and if any additional measures are needed to provide a net conservation benefit to the species. The Applicant would then seek coverage for the newly listed species under an amendment to the HCP if it is determined that the coverage would benefit both Kaheawa Wind Power II and the species.

3) Deleterious change in relative abundance of non-native plant species or ungulates occurring at the mitigation sites for Covered Species.

   Should the proportion or coverage of non-native plant species or ungulates increase at any mitigation site to a point where it is believed that this change is causing significant habitat degradation or loss of habitat for any of the Covered Species, thereby resulting in a measurable decline of the species at the site, the Applicant will consult with DLNR and USFWS to determine if measures to prevent the further spread of non-native plants or incursion of ungulates are available, practical and necessary. If no such measures are available, mitigation measures for the affected Covered Species may be implemented at another site as determined with DLNR and USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

4) Uluhe dieback at the seabird mitigation site.

   Observations of uluhe dieback were recorded in Hawai'i after the accidental introduction and spread of the two-spotted leafhopper (*Sophonia rufofascia*). Several studies implicate *Sophonia rufofascia* as the cause of uluhe dieback; however, there are indications that other factors (as yet unknown) are also required for dieback to occur (Follett et al. 2003). Should uluhe dieback occur at the seabird mitigation site, and then increase to the point where the dieback causes significant loss of habitat for seabirds, thereby resulting in a measurable decline of the species at the site, the Applicant will consult with DLNR and USFWS to determine if measures to prevent the further spread of the dieback are available, practical and necessary. If USFWs and DLNR determine that measures to prevent further spread of the dieback are not available, the Applicant will explore other measures available to re-create nesting habitat, such as the use of artificial burrows. The use of another seabird colony for the implementation of mitigation efforts may also be explored. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP, which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

5) 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 Makamaka'ole and/or any other seabird study areas, or if such changes affect monitoring or the success of mitigation, then the Applicant will consult with DLNR and USFWS to determine if measures to prevent further ingress of predators are necessary. Such measures may include more aggressive removal of predators and/or modification of mitigation actions. If USFWS and DLNR determine that no such measures are available, mitigation measures for seabirds may be implemented at another site as determined by DLNR and USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

6) The outbreak of disease affecting the Covered Species.

   Disease is considered one of the lesser threats to the persistence of the seabirds, nēnē and bats covered in the HCP. Newell's shearwater and Hawaiian petrel have not been documented to have disease outbreaks, although Newell's shearwater fledglings have been found with mild symptoms of avian pox (Ainley et al. 1997; Mitchell et al. 2005; Simons and Hodges 1998). Nēnē are not considered to be limited by disease, although omphalitis, an infection of the umbilical stump, has been found to cause mortality in both wild and captive nēnē goslings (USFWS 2004a). These geese have also been documented to have been infected with avian pox and avian malaria but no deaths have been attributed to either disease (USFWS 2004a). It is considered possible that the introduction of West Nile virus may affect the survival of nēnē (USFWS 2004a). It is currently not known if the Hawaiian hoary bat is susceptible to any diseases. Should the prevalence of disease increase dramatically and become identified as a major threat to the survival of any of the Covered Species by DLNR and USFWS, the Applicant will consult with DLNR and USFWS to determine if changes in monitoring, reporting or mitigation are necessary to provide assistance in documenting or reducing the impact of the disease. If USFWS and DLNR determine that no such measures are available, mitigation measures for the affected Covered Species may be implemented at another site as determined with DLNR and USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP, which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

7) Changes in the price of raw materials and labor.

   Annual reviews will be performed to analyze the costs in the previous year's budget for mitigation expenses and cumulative costs. Annual expenses for subsequent years will be adjusted to meet projected costs based on previous years' expenditures and cumulative spent to date.

8) Natural disasters, such as hurricanes, storms or fire of sufficient magnitude to significantly affect the Project site or mitigation sites for any of the Covered Species.

   Natural disasters, including wildfires regardless of origin, have potential to significantly affect the status of one or more of the Covered Species on Maui and, consequently, alter the relative importance of the incidental take of individuals. Such disasters could also greatly hinder or disrupt mitigation efforts.

   Seabirds, such as Newell's shearwater, have been shown to vacate nesting areas in response to approaching intense low-pressure areas. Thus, adults are unlikely to suffer significant mortality from hurricanes or other storm events. If a hurricane were to occur during the seabird nesting period (as did Hurricane 'Iniki in 1992), it might destroy eggs or chicks by uprooting trees or creating mudslides at the mitigation site. If necessary, the Applicant with approval of DLNR and USFWS will contribute to measures to rehabilitate seabird nesting habitat within seabird mitigation sites that are damaged during hurricanes or major storms as allowed by the mitigation budget established under the HCP. Possible contributions could include removing of debris, contribution to revegetation efforts or rehabilitation of injured Covered Species as deemed necessary. If the habitat destruction due to the hurricane or storm is so extensive as to render the mitigation site unsalvageable or is altered such that it is no longer utilized by nesting seabirds, any remaining mitigation will be carried out at another seabird nesting site chosen with approval ofb USFWS and DLNR. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP, which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

It is not known how nēnē or Hawaiian hoary bats respond to storms or hurricanes. Because these species are comparatively sedentary compared to the seabirds, it is presumed likely that individuals of these species would seek available shelter rather than flee when confronted by major storms. The Applicant may implement changes in monitoring, reporting or mitigation to help population recovery or contribute to rehabilitation of habitat for nēnē and/or Hawaiian hoary bat following a major storm, if deemed appropriate by DLNR and USFWS. If no such measures are available, mitigation measures for these Covered Species may be implemented at another site as determined with approval of DLNR and USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP, which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

Wildfires have occurred at the Project Site with some regularity, with the most recent fire at Kaheawa Pastures occurring in 2006 (Hobdy 2006, 2009). Fire could cause significant loss of foraging and roosting habitat for the population of nēnē currently established in the area. In the event of fire causing significant habitat degradation and loss of habitat for the nēnē, thereby resulting in a measurable decline of the species at the site, the Applicant may, with approval of DLNR and USFWS contribute habitat restoration measures which may consist of replanting or management of vegetation important for the persistence of the nēnē population and/or measures to prevent the spread of invasive plant species. Such measures and consequent changes in monitoring, reporting or mitigation deemed appropriate by DLNR and USFWS will be implemented if necessary. If no such measures are available, mitigation measures for the nēnē may be implemented at another site as determined with DLNR and USFWS. Any such measures and consequent changes in monitoring, reporting or mitigation as deemed appropriate by DLNR and USFWS will be implemented under the budget established for mitigation expenses in the HCP, which includes funding available for the tier of mitigation required and the Surety Letter of Credit if mitigation actions have not been fully achieved or unmitigated take remains.

The Applicant will report such changes as they occur and DLNR and 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 USFWS and 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

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, USFWS or 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, USFWS and 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, USFWS and 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 (Sec. 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) that may be conducted in the vicinity of the project as part of their mitigation requirements.

The USFWS and 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 DLNR will notify the Applicant in writing should the USFWS or DLNR believe that any unforeseen circumstance has arisen.

7.7 PERMIT DURATION AND AMENDMENTS

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 USFWS and 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 USFWS and 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 USFWS to obtain such other assurances as may be required that the HCP will be implemented.

8.0 CONCLUSION

KWP II LLC looks forward to working with the USFWS and DLNR throughout the approval and long-term implementation of the HCP 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

Adams, Josh. 2008. "Petrels in the Pacific: Tracking the Far-ranging Movements of Endangered 'Ua'u (Hawaiian Petrel)," U.S. Geological Survey, Western Ecological Research Center. www.microwavetelemetry.com/newsletters/spring_2007Page4.pdf

American Ornithologists' Union. 1998. *Check-list of North American Birds.* 7th ed. American Ornithologists' Union, Washington, DC. 829 pp.

Ainley, D.G., L. DeForest, N. Nur, R. Podolsky, G. Spencer, and T.C. Telfer. 1995. Status of the threatened Newell's Shearwater on Kaua'i: Will the population soon be endangered?

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, PA.

Ainley, D.G., R. Podolsky, L. DeForest, G. Spencer, and 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.

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. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas. http://www.batcon.org/windliterature

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. An annual report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas.

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.

APLIC (Avian Power Line Interaction Committee). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute. Washington, DC.

———. 1996. Suggested Practices for Raptor Protection on Power Lines. Edison Electric Institute/Raptor Research Foundation, Washington, DC. 128 pp.

———.1996 (reprinted 2000). Suggested practices for raptor protection on powerlines: the state of the art in 1996. Edison Electric Institute/Raptor Research Foundation, Washington, DC. 125 pp.

———. 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, DC and Sacramento, CA.

Baerwald, E.F., and R.M.R. Barclay. 2009. Geographic Variation in Activity and Fatality of Migratory Bats at Wind Energy Facilities. *Journal of Mammology* 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, H., and P.E. Baker. 1999. Nēnē gosling mortality in Haleakalā National Park, Maui, 1995/96 breeding season. Report to Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife. Unpublished document. 31 pp.

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. 255 pp.

———. 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, PA.

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 Behaviour 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 strom 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. Ope'ape'a – solving the puzzles of Hawaii's only bat. *Bats* 28(4):10-12.

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 Kaua'i. *Colonial Waterbirds* 21:11–19.

———. 2003. Movement of Hawaiian Petrels to inland breeding sites on Maui Island, Hawai'i. *Waterbirds* 26:62–71.

———. 2004. Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Wind Energy Facility on Maui Island, Hawai'i, Fall 2004. Prepared by ABR, Inc., Forest Grove, OR and Fairbanks, AK for Kaheawa Wind Power, LLC, Makawao, HI and UPC Wind Management, LLC, Newton, MA. 16 pp.

———. 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.

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.

Day, R.H., and B.A. Cooper. 1995. Patterns of movement of Dark-rumped Petrels and Newell's Shearwaters on Kaua'i. *The Condor* 97:1011–1027.

———. 1999. Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Windfarm on Maui Island, Hawai'i, Summer 1999. Prepared by ABR, Inc., Forest Grove, OR and Fairbanks, AK for Zond Pacific, Wailuku, HI. 26 pp.

———. 2001. Results of petrel and shearwater surveys on Kaua'i, June 2001. Unpublished report prepared for U.S. Fish and Wildlife Service, Honolulu, HI, by ABR, Inc., Fairbanks, AK, and Forest Grove, OR. 21 pp.

———. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June, 2002. Final report to the National Park Service, Hawaii National Park. ABR, Inc., Fairbanks, Alaska.

———. 2008. Interim Report: Oahu Radar & Audiovisual studies, Fall 2007 and Summer 2008. ABR, Inc. Environmental Research & Services.

Day, R.H., B.A. Cooper, and T.C. Telfer. 2003. Decline of Townsend's (Newell's) Shearwaters (*Puffinus auricularis newelli*) on Kaua'i, Hawai'i. *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: 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-Febuary 5, 2007, Kula Forest Reserve.

DOFAW (DLNR's Division of Forestry and Wildlife). 2000. Survey of the Nēnē population on Maui. *'Elepaio* 60:25-28.

———. 2009a. Annual report. Pittman-Robertson Non-game management grant. Nene Surveys.

Dobson A.F., and J. Madeiros. 2009. Threats facing Bermuda's breeding seabirds: measures to assist future breeding success. *Proceedings of the Fourth International Partners in Flight Conference Tundra to Tropics*, pp. 223-226.

Draft Habitat Conservation Plan or the Construction of the Advanced Technology Solar Telescope at the Haleakalā High Altitude Observatory Site Maui, Hawaii, 2010. 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, 2003. Resolve, Inc., Washington, DC. 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. National Wind Coordinating Committee Publication.

Federal Register. 2004. Incidental Take Permit and Habitat Conservation Plan for the Kaua'i Island Utility Cooperative, Hawai'i. *Federal Register* 69(135):42447-42449.

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. Tennessee Valley Authority, Knoxville. http://www.batcon.org/windliterature

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.

Fletcher C.H. 2009. Current Understanding of Global Sea-level Rise and Impacts in Hawai'i. Presentation by the Coastal Geology Group, accessible at: http://www.soest.hawaii.edu/coasts/sealevel/FletcherSeaLevel09_web.pps

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil Survey of the Islands of Kaua'i, O'ahu, Maui, Moloka'i, and Lana'i, State of Hawai'i. U.S. Department of Agriculture, Soil Conservation Service.

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., H. Diaz , 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.*

Gorresen, P.M., 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, 2008.

Griesemer AM, ND Holmes. 2010. Newell's shearwater population modeling for HCP and recovery planning – Draft. University of Hawaii and State of Hawaii.

Gummer, H. 2003. Chick translocation as a method of establishing new surface-nesting seabird colonies: a review. New Zealand Department of Conservation report. 40 pp.

Harrison, C. 1990. *Seabirds of Hawaii: Natural History and Conservation*. Ithaca: Cornell University Press.

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.

Hobdy, R.W. 2004a. Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Primary Route. Prepared for Kaheawa Wind Power, LLC. 18 pp.

———. 2004b. Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Alternate Route Section. Prepared for Kaheawa Wind Power, LLC. 11 pp.

———. 2006a. Botanical Resources Survey. Kaheawa Pastures Wind Energy Project II, Ukumehame, Maui, Hawaii. Prepared for Kaheawa Windpower, LLC.

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.

Day, R.H., and B.A. Cooper. 1995. Patterns of movement of Dark-rumped Petrels and Newell's Shearwaters on Kaua'i. *The Condor* 97:1011–1027.

———. 1999. Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Windfarm on Maui Island, Hawai'i, Summer 1999. Prepared by ABR, Inc., Forest Grove, OR and Fairbanks, AK for Zond Pacific, Wailuku, HI. 26 pp.

———. 2001. Results of petrel and shearwater surveys on Kaua'i, June 2001. Unpublished report prepared for U.S. Fish and Wildlife Service, Honolulu, HI, by ABR, Inc., Fairbanks, AK, and Forest Grove, OR. 21 pp.

———. 2002. Petrel and shearwater surveys near Kalaupapa, Molokai Island, June, 2002. Final report to the National Park Service, Hawaii National Park. ABR, Inc., Fairbanks, Alaska.

———. 2008. Interim Report: Oahu Radar & Audiovisual studies, Fall 2007 and Summer 2008. ABR, Inc. Environmental Research & Services.

Day, R.H., B.A. Cooper, and T.C. Telfer. 2003. Decline of Townsend's (Newell's) Shearwaters (*Puffinus auricularis newelli*) on Kaua'i, Hawai'i. *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: 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-Febuary 5, 2007, Kula Forest Reserve.

DOFAW (DLNR's Division of Forestry and Wildlife). 2000. Survey of the Nēnē population on Maui. *'Elepaio* 60:25-28.

———. 2009a. Annual report. Pittman-Robertson Non-game management grant. Nene Surveys.

Dobson A.F., and J. Madeiros. 2009. Threats facing Bermuda's breeding seabirds: measures to assist future breeding success. *Proceedings of the Fourth International Partners in Flight Conference Tundra to Tropics*, pp. 223-226.

Draft Habitat Conservation Plan or the Construction of the Advanced Technology Solar Telescope at the Haleakalā High Altitude Observatory Site Maui, Hawaii, 2010. 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, 2003. Resolve, Inc., Washington, DC. 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. National Wind Coordinating Committee Publication.

Federal Register. 2004. Incidental Take Permit and Habitat Conservation Plan for the Kaua'i Island Utility Cooperative, Hawai'i. *Federal Register* 69(135):42447-42449.

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. Tennessee Valley Authority, Knoxville. http://www.batcon.org/windliterature

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.

Fletcher C.H. 2009. Current Understanding of Global Sea-level Rise and Impacts in Hawai'i. Presentation by the Coastal Geology Group, accessible at: http://www.soest.hawaii.edu/coasts/sealevel/FletcherSeaLevel09_web.pps

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil Survey of the Islands of Kaua'i, O'ahu, Maui, Moloka'i, and Lana'i, State of Hawai'i. U.S. Department of Agriculture, Soil Conservation Service.

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., H. Diaz , 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.*

Gorresen, P.M., 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, 2008.

Griesemer AM, ND Holmes. 2010. Newell's shearwater population modeling for HCP and recovery planning – Draft. University of Hawaii and State of Hawaii.

Gummer, H. 2003. Chick translocation as a method of establishing new surface-nesting seabird colonies: a review. New Zealand Department of Conservation report. 40 pp.

Harrison, C. 1990. *Seabirds of Hawaii: Natural History and Conservation*. Ithaca: Cornell University Press.

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.

Hobdy, R.W. 2004a. Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Primary Route. Prepared for Kaheawa Wind Power, LLC. 18 pp.

———. 2004b. Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Alternate Route Section. Prepared for Kaheawa Wind Power, LLC. 11 pp.

———. 2006a. Botanical Resources Survey. Kaheawa Pastures Wind Energy Project II, Ukumehame, Maui, Hawaii. Prepared for Kaheawa Windpower, 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, Hawaii. 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, Univ. 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, Univ. 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-romped Petrels on Mauna Loa, Hawai'i. In *Ecology, conservation, and management of endemic Hawaiian birds: A vanishing avifauna*, edited by J.M. Scott, S. Conant, and C. van Riper III, pp. 234-242. *Studies in Avian Biology*, vol. 22.

Huso, M. 2008. Statistical properties of fatality estimators. Paper presented at NWCC Research Meeting, Milwaukee, Wisconsin. November 2008.

IPCC (Intergovernmental Panel on Climate Change). 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, UK and New York: Cambridge University Press.

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. Annual report prepared for PPM Energy and Horizon Energy, Curry and Kerlinger LLC, Cape May Point, New Jersey, USA. http://www.batcon.org/windliterature

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, by Western Ecosystems Technology, Inc.

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. 2005. A review of bat mortality at wind-energy developments in the United States. *Bat Research News* 46:45–49.

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. 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, HI.

———. 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, 43 pp.

———. 2007b. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan 2006 Annual Report Part 2, 52 pp.

———. 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, MA. 23 pp.

———. 2008c. Kaheawa Pastures Wind Energy Generation Facility, Habitat Conservation Plan: Year 2 Annual Report. First Wind Energy LLC, Environmental Affairs, Newton, MA. 26 pp.

———. 2009. Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Year 3 Annual Report. First Wind Energy LLC, Environmental Affairs, Newton, MA. 37 pp.

———. 2010. Kaheawa Pastures Wind Energy Facility, Habitat Conservation Plan: Year 4 Annual Report. First Wind Energy LLC, Environmental Affairs, Newton, MA. In prep.

Kear, J. and, A.J. Berger 1980. The Hawaiian goose: an experiment in conservation. Vermillion, SD: 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/ windliterature. 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 Frtercula 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-establishemnt of atlantic puffins (*Fratercula artica*) at a former breeding site int eh 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, DC.

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. United States Fish and Wildlife Service Division of Migratory Bird Management, Laurel, Maryland.

Menard, T. 2001. Activity Patters of the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) in Relation to Reproductive Time Periods. Master's thesis, Univ. 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, NZ, Department of Conservation.

Miskelly, C., G. Timlin, et al. (2004). "Common diving petrels (pelecanoides urinatrix) recolonise mana island." Notornis 51: 245-246.

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.

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, HI. Accessed August 21, 2008. http://www.state.hi.us/dlnr/dofaw/cwcs/index.html

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. 7 pp.

NatureServe. 2008. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available at: http://www.natureserve.org/explorer. Accessed: December 24, 2008.

Nishibayashi, E. 1997. Downed wildlife survey at six leeward West Maui wind monitoring towers. Unpublished report prepared for Zond Pacific, Inc., Wailuku, HI, by Eric Nishibayashi Biological Consulting, Kahului, HI. 11 pp.

———. 1998. Native bird activity at proposed access road. Unpublished report prepared for Zond Pacific, Inc., Wailuku, HI, by Eric Nishibayashi Biological Consulting, Kahului, HI.

NSF (National Science Foundation). 2010. Draft Habitat Conservation Plan or the Construction of the Advanced Technology Solar Telescope at the Haleakalā High Altitude Observatory Site Maui, Hawaii, 2010. 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, Hawaii.

Nur N, WJ Sydeman. 1999. Demographic processes and population dynamic models of seabirds: Implications for conservation and restoration. Current Ornithology 15:149-188.

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

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. 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, NY, National Audubon Society.

Podolsky, R. H. and S. W. Kress (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.

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.

Pratt, T.K. 1988. Recent observations, March-May 1988. *'Elepaio* 48:65–66.

Priddle, D. and N. Carlile 1995. "An artifiical nest box for burrow-nesting seabirds." Emu 95: 290-294.

Rechtman, R.B., J.R. Dudoit, and A.K. Dircks Ah Sam. October 2009. An Archaeological Inventory Survey for the Kaheawa Wind Power (KWP) 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.

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, MA. 28 pp.

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 EA, J Burger. 2001. Biology of marine birds. Boca Raton (FL): CRC Press

Severns, P.M. 2009. An Assessment of Hawaiian Native Molluscan Fauna Kaheawa Pastures, West Maui, Hawaii.

Simons T.R. 1983. Biology and conservation of the endangered Hawaiian dark-rumped petrel (*Pterodroma phaeophygia sandwichensis*). CPSU/UW 83-2, Summer 1983.

———. 1984. A population model of the endangered Hawaiian dark-rumped petrel. *J. Wildl. Mgmt.* 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. The Birds of North America, Inc., Philadelphia, PA.

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.

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, USA.

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. 234 p.

Taylor, G.A. 2000b. Action plan for seabird conservation in New Zealand. Part B: non-threatenedseabirds. *Threatened Species Occasional Publication 17*. Department of Conservation, Wellington, New Zealand. 199 pp.

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, HI.

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 & 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, Hawaii (Revised February 8, 2008, TTEC-PTLD-2008-080). Unpubl. report 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/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. 1969. *Mammals in Hawaii: A Synopsis and Notational Bibliography*. B.P. Bishop Museum, Honolulu, HI. Spec. Pub. 57. 238 pp.

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*.

USFWS. 1998. Recovery Plan for the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). U.S. Fish and Wildlife Service, Portland, OR. 50 pp.

———. 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, OR. 148 + xi pp.

———. 2004b. Interim Guidelines To Avoid and Minimize Wildlife Impacts From Wind Turbines. 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, OR.

Wagner, W.L., D.R. Herbst and S.H. Sohmer. 1999. Manual of the flowering plants of Hawai'i, Volumes I & II. Revised edition. University of Hawai'i Press: Honolulu, HI.

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* 64:151-52.

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.

Young, G.P. 2004. Letter to Michelle McLean dated 8 November 2004. Department of Army, Honolulu, HI.

Appendix 1

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
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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

LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

Office of Conservation and Coastal Lands
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

ALLAN A. SMITH
INTERIM CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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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.

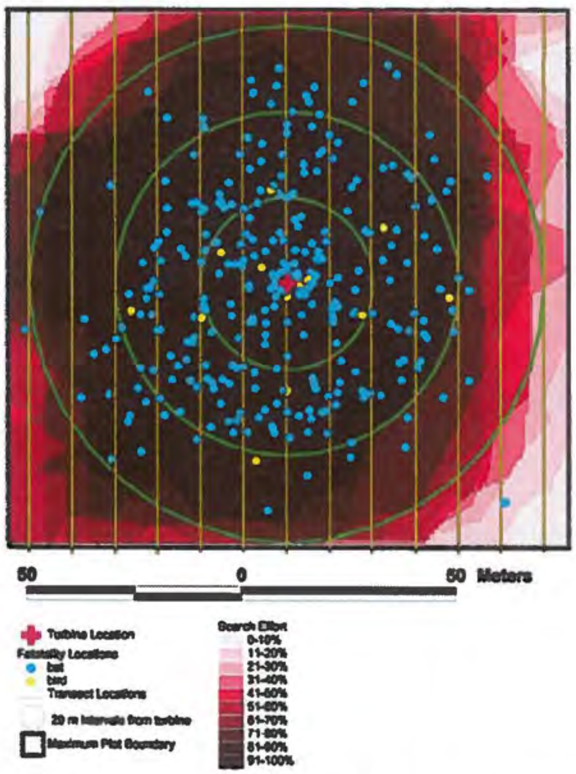


Figure 1a. Bat and bird fatalities (n=466 bats) at all turbines combined at Meyersdale Wind Energy Center in Pennsylvania, 2 August to 13 September 2004 (Arnett 2005). The maximum turbine height was 115 m.

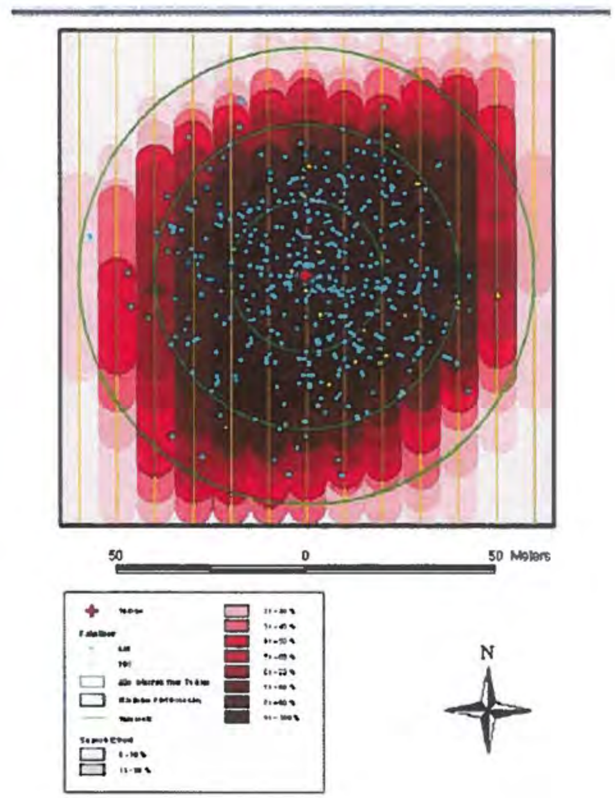
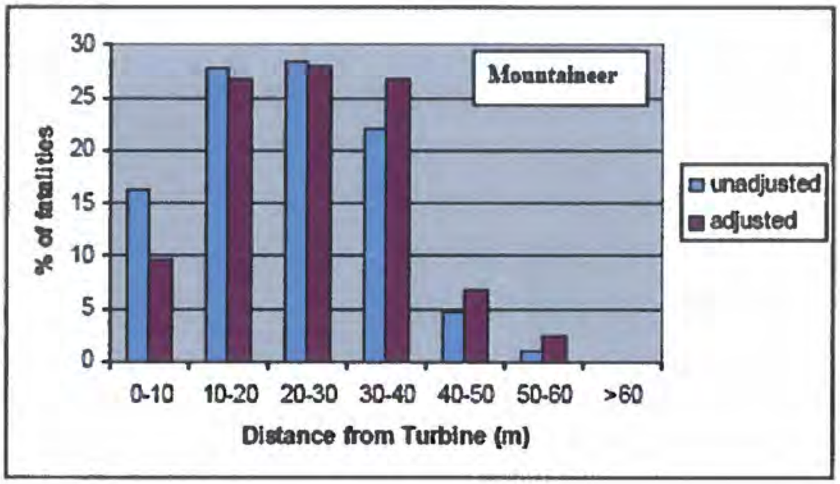


Figure 1b. Bat and bird fatalities (n=499 bats) at all turbines combined at Mountaineer Wind Energy Center in West Virginia, 31 August to 11 September 2004 (Arnett 2005). The maximum turbine height was 104.5 m.



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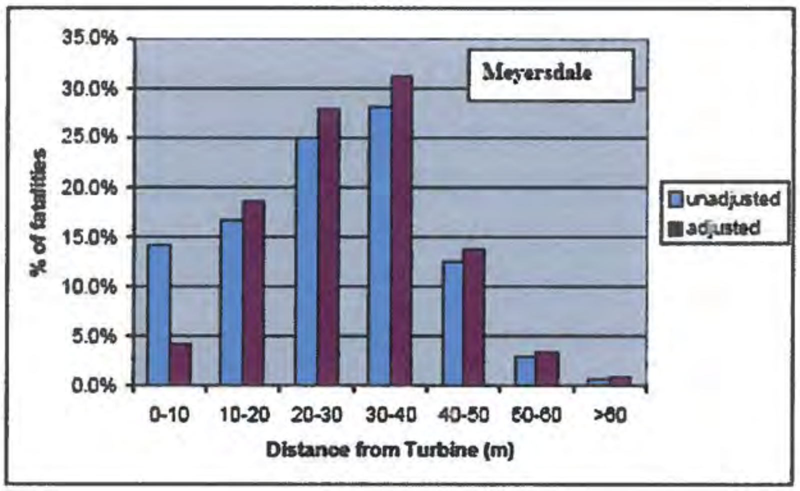
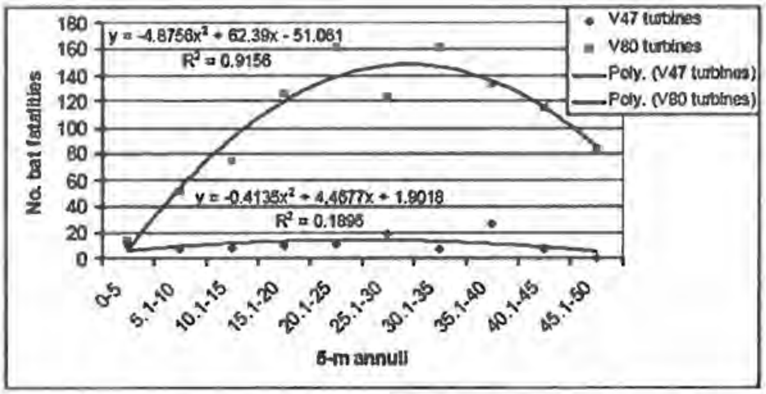


b

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.



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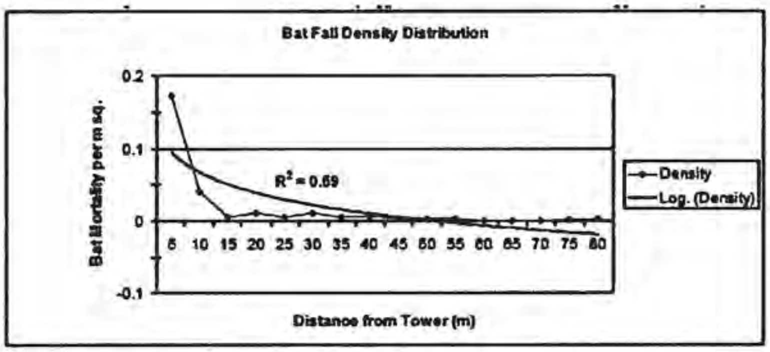

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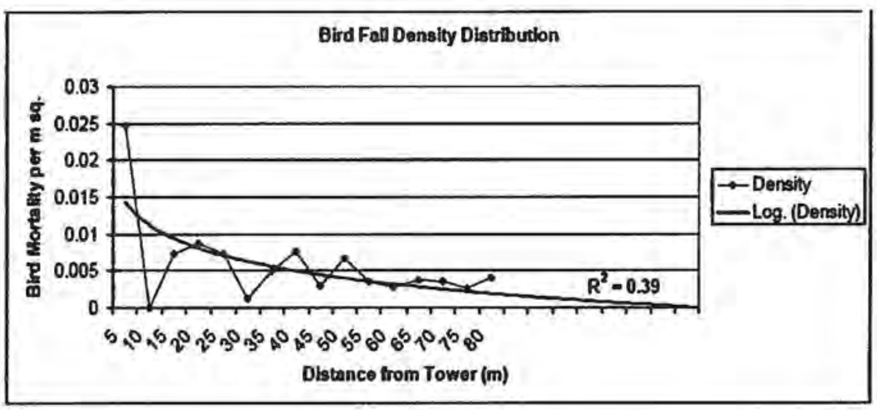

e

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

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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.

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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).

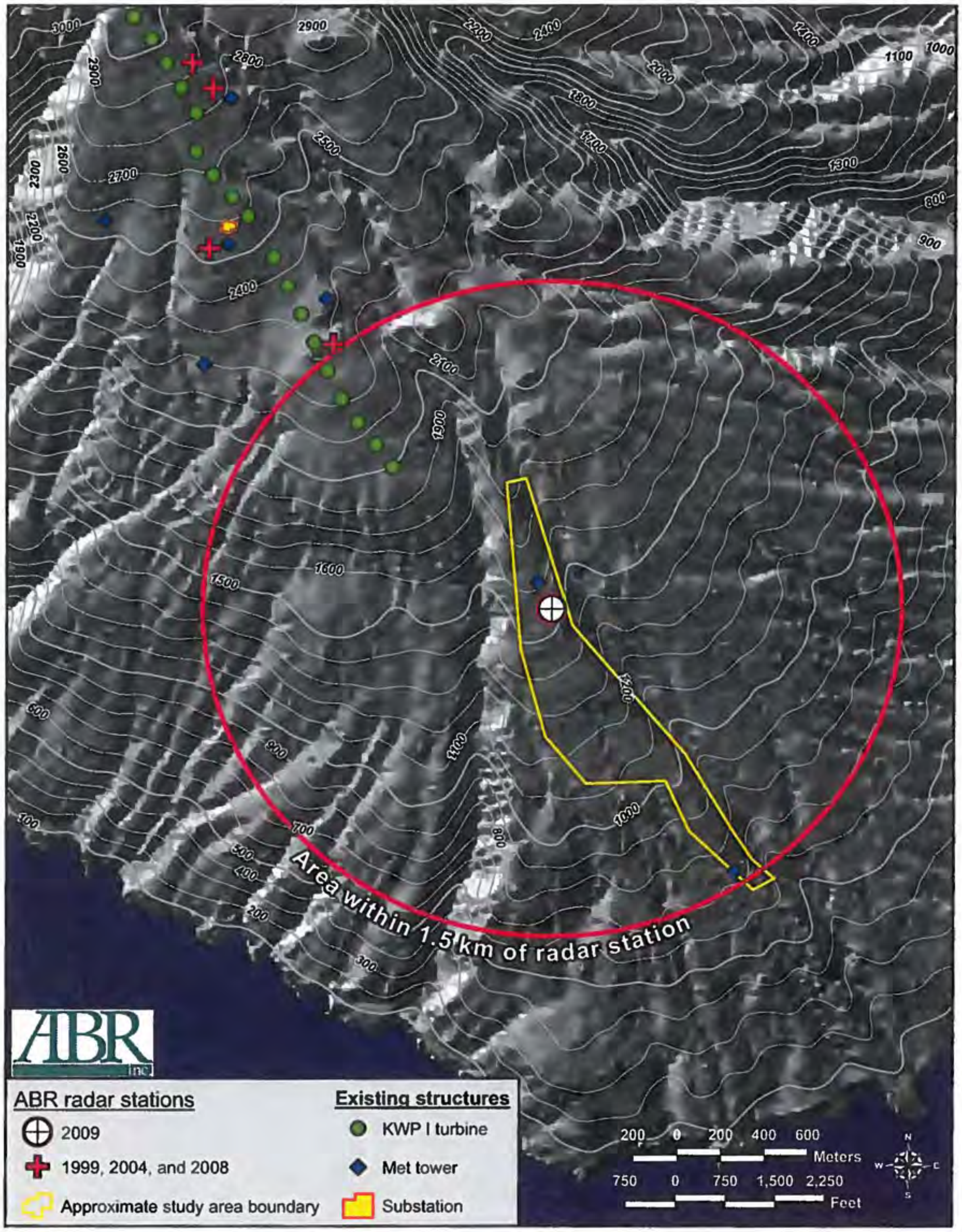


Figure 2. Location of 2009 radar sampling stations relative to sampling stations from previous studies (Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009) and areas under consideration for siting of wind turbines at the proposed KWP II Down-road Alternative wind energy facility, 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

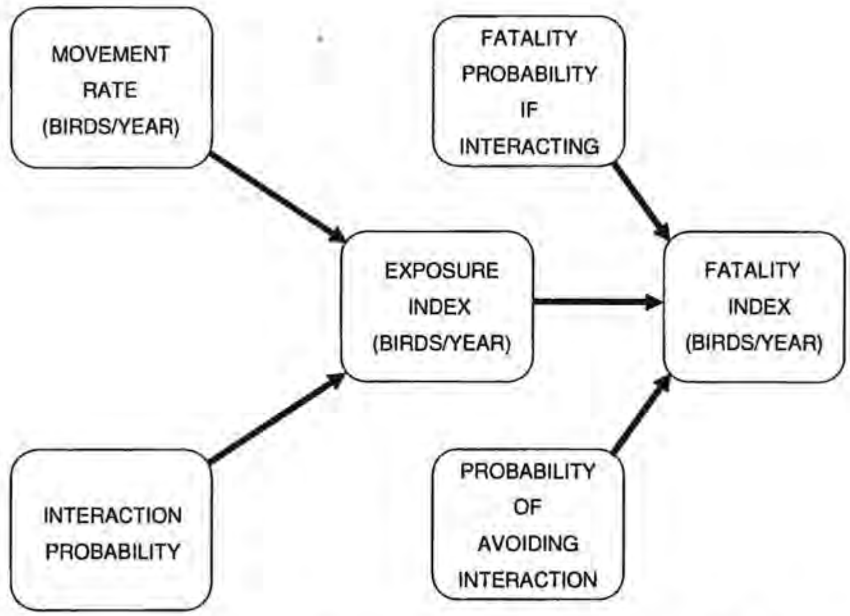


Figure 3. Major variables used in estimating possible fatalities of Hawaiian Petrels and Newell's Shearwaters at wind turbines at the proposed KWP II Down-wind Alternative wind energy facility, Maui, Hawaii. See Tables 2 and 3 for details on calculations.

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 Minimum	HAPE Maximum	NESH Minimum	NESH 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

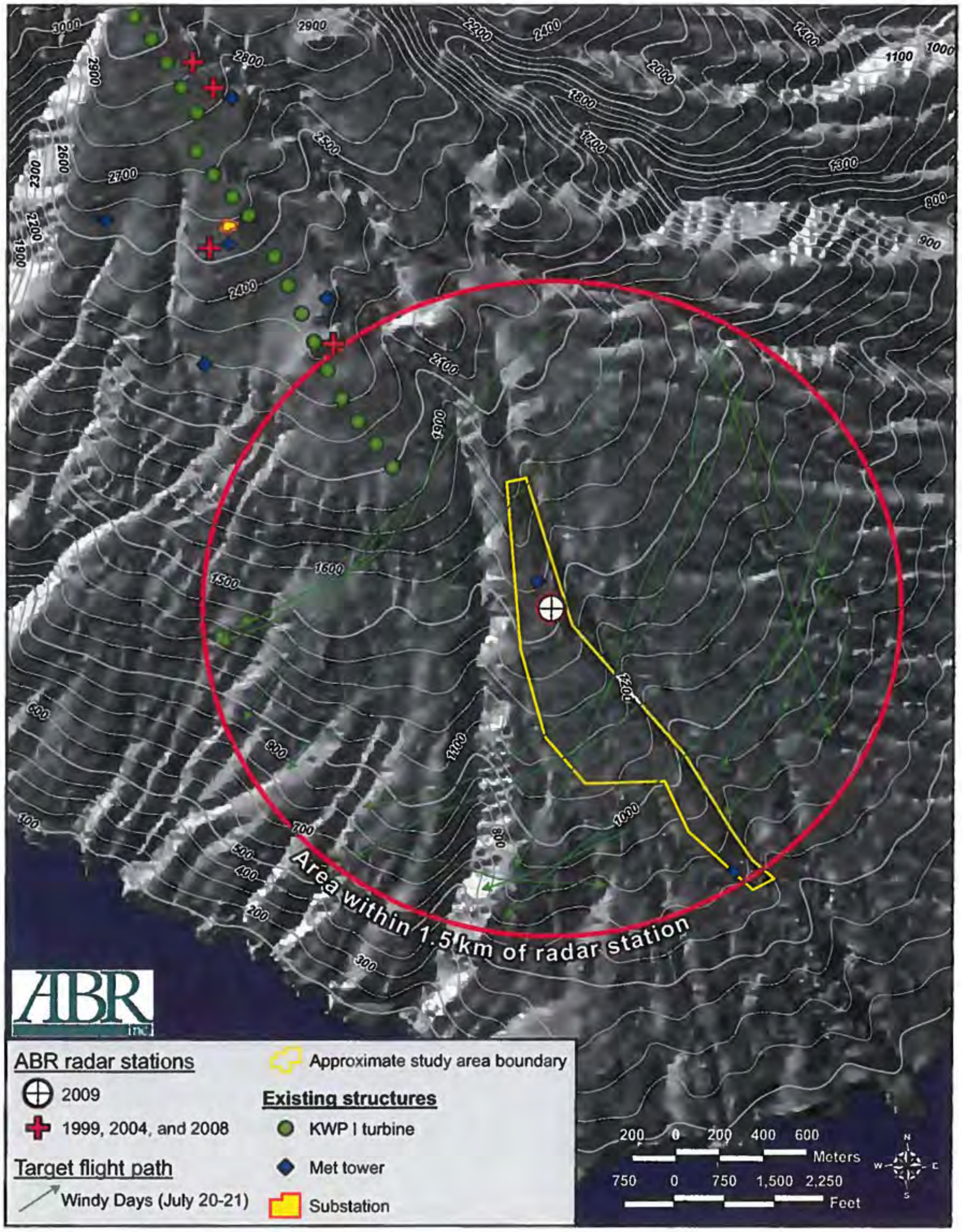


Figure 4. Location of flight paths of petrel-like radar targets observed during the strong wind conditions of 20–21 July 2009, at the KWP II Down-road Alternative wind energy facility, Maui, Hawaii.

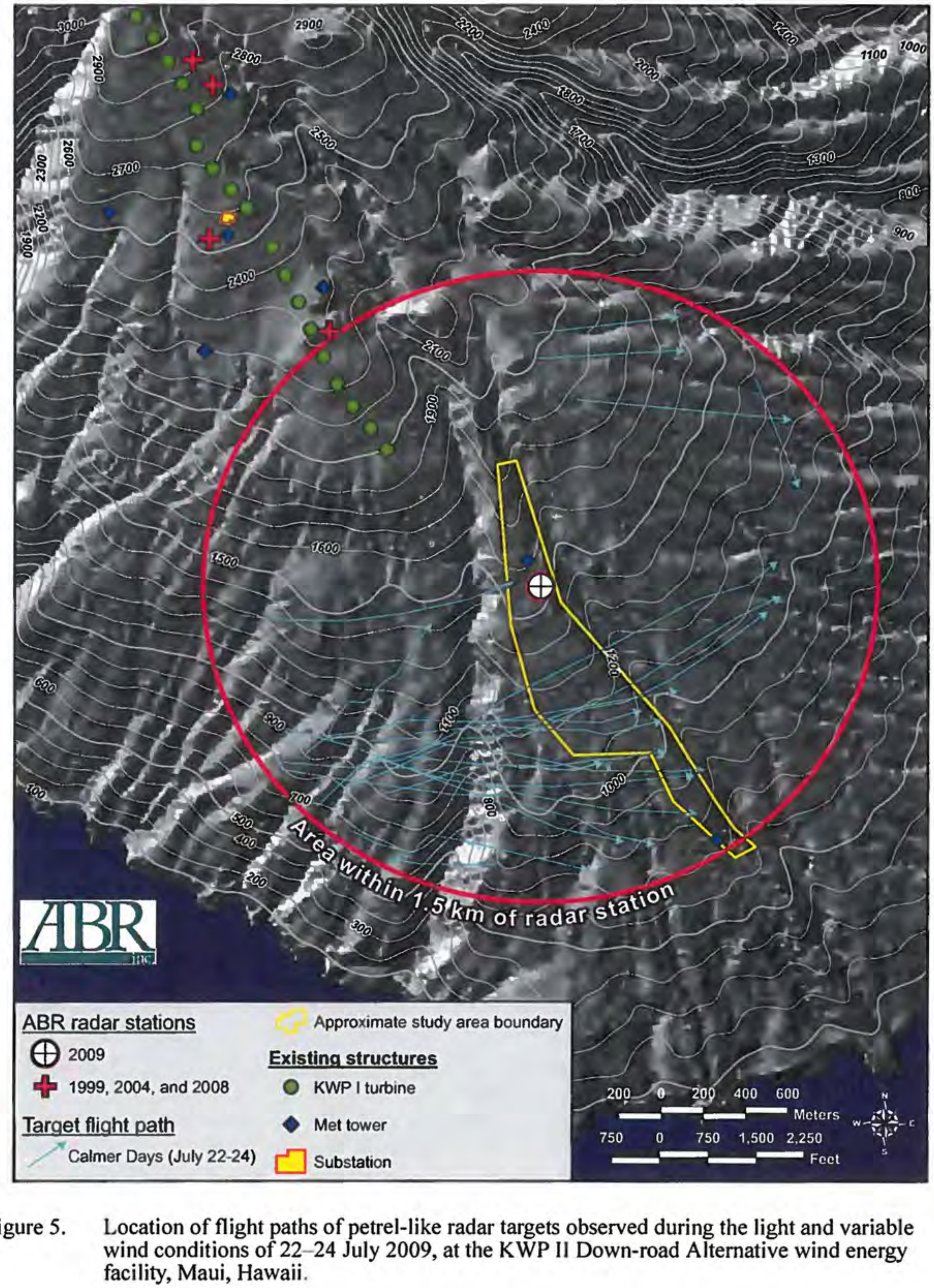


Figure 5. Location of flight paths of petrel-like radar targets observed during the light and variable wind conditions of 22–24 July 2009, at the KWP II Down-road Alternative wind energy facility, Maui, Hawaii.

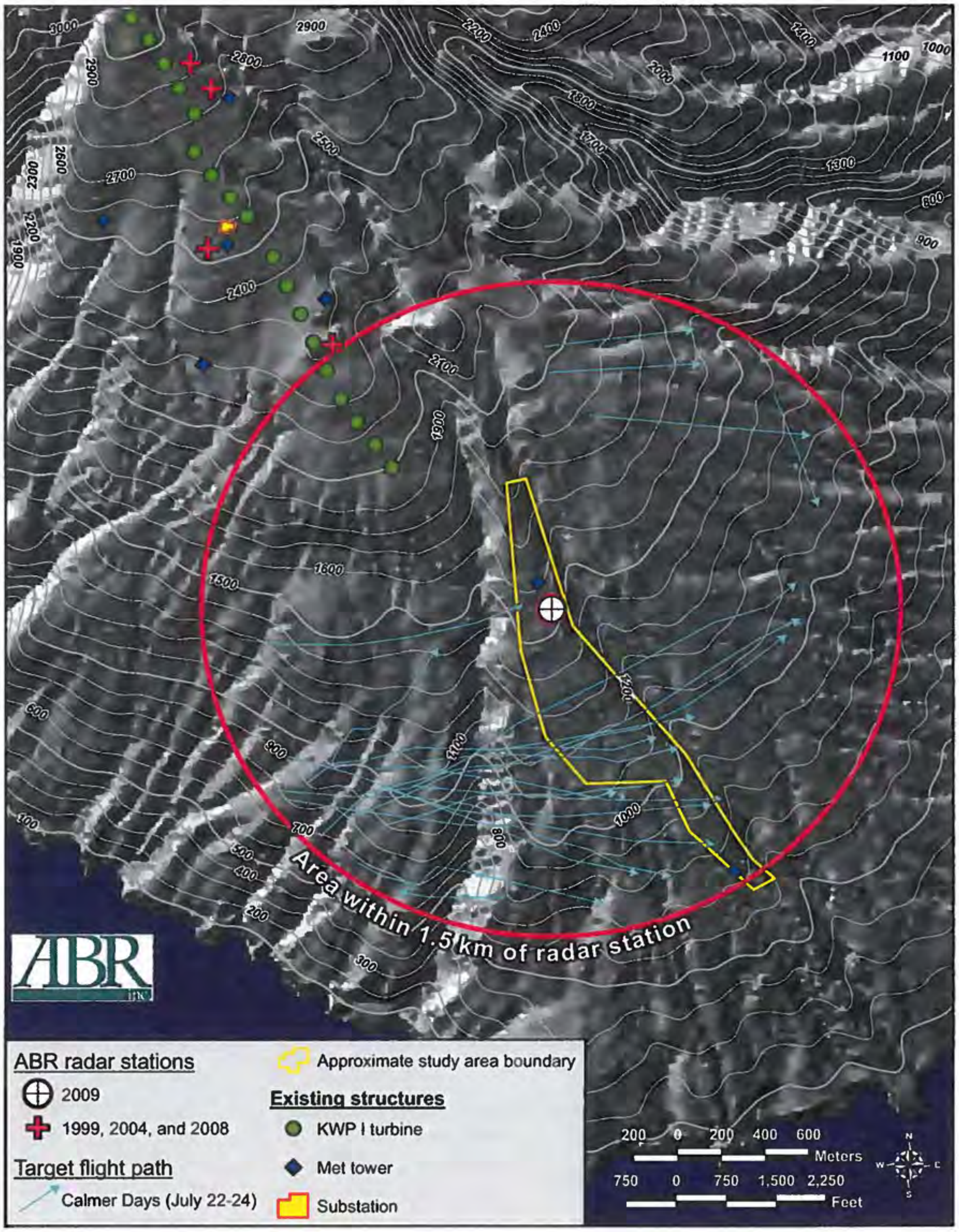


Figure 5. Location of flight paths of petrel-like radar targets observed during the light and variable wind conditions of 22–24 July 2009, at the KWP II Down-road Alternative wind energy facility, Maui, Hawaii.

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.

Year	Site	Movement rate (targets/h)		Source
		Summer	Fall	
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.

@Jack Jeffrey

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 auricularis 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

1.0 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 auricularis newelli*), Hawaiian petrel (*Pterodroma sandwichensis*), Hawaiian goose (*Branta sandvicensis*) and Hawaiian hoary bat (*Lasiurus cinereus semotus*) follow in the sections below.

1.1 Seabirds

1.1.1 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.

1.1.2 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 50% towards indirect take and the average annual productivity.

Sex Ratio: Similar adult male and female survival rates in related species (Warham 1996) suggests a balanced sex ratio, but no published data is available.

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 50% towards indirect take and the average annual productivity.

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 Augustr 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 beeding/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 parturation 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 inidirect 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).

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 paturation 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.61

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 Hokins 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, O'ahu. 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.62

Appendix 6

Funding Matrix
Kaheawa Wind Power II Habitat Conservation Plan

	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		**$10,000**	**$50,000**	**$100,000**	**$150,000**

	Item/Activity	One-Time Cost	Annual Cost	Years 1-5	Remaining 15 Years	20-Year Permit Duration
Seabird mitigation (Tier 1)	Alt. 1 - Makamakaole fencing and social attraction option	$121,000	$15,000	$75,000	$225,000	$421,000
	Exploring Maui mitigation alternatives KWPII portion			$88,800		$88,800
	Subtotal	**$121,000**	**$15,000**	**$163,800**	**$225,000**	**$509,800**
Additional Measures for Tier 2 rates of take (NESH), or insufficient credit accrual at Alt 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	$157,300	$19,500	$97,500	$292,500	$547,300
	Alt 2c: In situ predator proof fence in West Maui *	$220,760	$36,642	$36,642	$549,623	$807,024
	Maximum sub-total	**$220,760**	**$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		**$30,000**	**$150,000**	**$100,000**	**$250,000**
Lower rates of Take	Same as Baseline					

	Item/Activity	One-Time Cost	Annual Cost	Years 1-5	Remaining 15 Years	20-Year Permit Duration
Nene Mitigation (Tier 1)						
Tier 1 (Preferred) Alternative 1	Construction of release pen and staffing for monitoring and predator trapping at pen	$158,290	$30,000		$240,000	$398,290
	Sub-Total	**$158,290**	**$30,000**		**$240,000**	**$398,290**
Additional Measures for Tier 1	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 Take Alternative 1	Staffing for monitoring and predator trapping at pen		$30,000		$150,000	$150,000
	Sub-Total		**$30,000**		**$150,000**	**$150,000**
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**		**$246,000**

	Item/Activity	One-Time Cost	Annual Cost	Years 1-5	Remaining 15 Years	20-Year Permit Duration
Bat mitigation (Tier 1)	Funding for management		variable	$126,260	$123,740	$250,000
	Bat monitoring at KWP II and vicinity for 5 years		$12,500	$25,000	$37,500	$62,500
	Sub-Total		**$12,500**	**$151,260**	**$161,240**	**$312,500**
Measures for Tier 2 rates of take	Funding for increased management		variable		$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**		**$175,000**	**$225,000**
Measures for Lower Rates of Take	Same as Baseline					
Downed Wildlife Monitoring	Downed wildlife searches by 2 FTE trained technicians and partial cost of Senior Biologist, includes Scavenger Removal Trials by staff and preparation of quarterly and annual reports..		$130,000.0	$520,000.0	$780,000.0	$1,300,000.0
	3rd party Proctoring of Searcher Efficiency Trials and QA/QC of take calculations and reporting.		$30,000	$60,000	$60,000	$120,000.0
	Sub-Total		**$160,000**	**$580,000**	**$840,000**	**$1,420,000**
State Compliance Monitoring	**Sub-Total**		**$25,000**	**$75,000**	**$225,000**	**$300,000**
3rd Party Monitoring Contingency	**Sub-Total**		**$130,000**	**$520,000**	**$780,000**	**$1,300,000**

	Item/Activity	One-Time Cost	Annual Cost	Years 1-5	Remaining 15 Years	20-Year Permit Duration
Estimated Project Sub-Totals						
Tier 1		**One time Cost**	**Years 1-5**	**Remaining 15 Years**	**20-Year Permit Duration**	
	Minimization and General Measures	**$85,000**	**$57,500**	**$40,000**	**$182,500**	
	Seabird Mitigation (Maximum)	**$341,760**	**$200,442**	**$774,623**	**$1,316,824**	
	Nene Mitigation	**$158,290**	**$10,000**	**$270,000**	**$438,290**	
	Hawaiian Hoary Bat	**$0**	**$151,260**	**$161,240**	**$312,500**	
	Sub-Total	**$585,050**	**$419,202**	**$1,245,863**	**$2,250,114**	
Tier 2	Minimization	**$0**	**$50,000**	**$100,000**	**$150,000**	
	Seabird Mitigation	**$0**	**$150,000**	**$100,000**	**$250,000**	
	Nene Mitigation	**$0**	**$0**	**$150,000**	**$150,000**	
	Hawaiian Hoary Bat	**$50,000**	**$0**	**$175,000**	**$225,000**	
	Sub-Total	**$50,000**	**$200,000**	**$525,000**	**$775,000**	
Contingency Measures						
	Contingency Measures if Hanaula Nene Population exhibits failure	**$160,000**	**$86,000**		**$246,000**	
	3rd Party Monitoring Contingency	**$0**	**$520,000**	**$780,000**	**$1,300,000**	
	Sub-Total	**$160,000**	**$606,000**	**$780,000**	**$1,546,000**	
Other						
	Downed Wildlife Monitoring	**$0**	**$580,000**	**$840,000**	**$1,420,000**	
	State Compliance Monitoring	**$0**	**$75,000**	**$225,000**	**$300,000**	
	Sub-Total	**$0**	**$655,000**	**$1,065,000**	**$1,720,000**	

Grand Total Including Expected Cost for Tier 1 Mitigation**	**$3,163,090**
Grand Total Including Maximum Cost for Tier 1 Mitigation	**$3,970,114**
Grand Total Tier 1 + Contingency Measures	**$5,516,114**
Grand Total for Tier 1 + Tier 2 Take Level of Mitigation + Contingency Measures	**$6,291,114**

* Note: The total estimated cost of a 115 ac in-situ colony protection and management program for 16 years is on the order of $3.2M. Due to the substantial scope and logistical challenges of this alternative, for budgeting purposes it is assumed that there will be several partners, and that KWP II would contribute approximately 25% of the total cost.

** consists of cost for 20 year Minimization and General Measures, Tier 1 Preferred Mitigation , 20 year Downed Wildlife Monitoring and State Compliance Monitoring

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 anthyllidifolia*) 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.l. *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 Mā'alaea in the southwestern portion of the Island of Maui, Hawai'i. 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 Honoapi'ilani 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 ʻaʻaliʻi (*Dodonaea viscosa*), pili grass (*Heteropogon contortus*), ʻūlei (*Osteomeles anthyllidifolia*), and ʻilima (*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 ʻaʻaliʻi 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 puʻu). 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 Malalowaia'ole 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)

$$'C = \frac{C}{S_c \times S_e \times P_s}$$

'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:

Makamaka'ole 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.

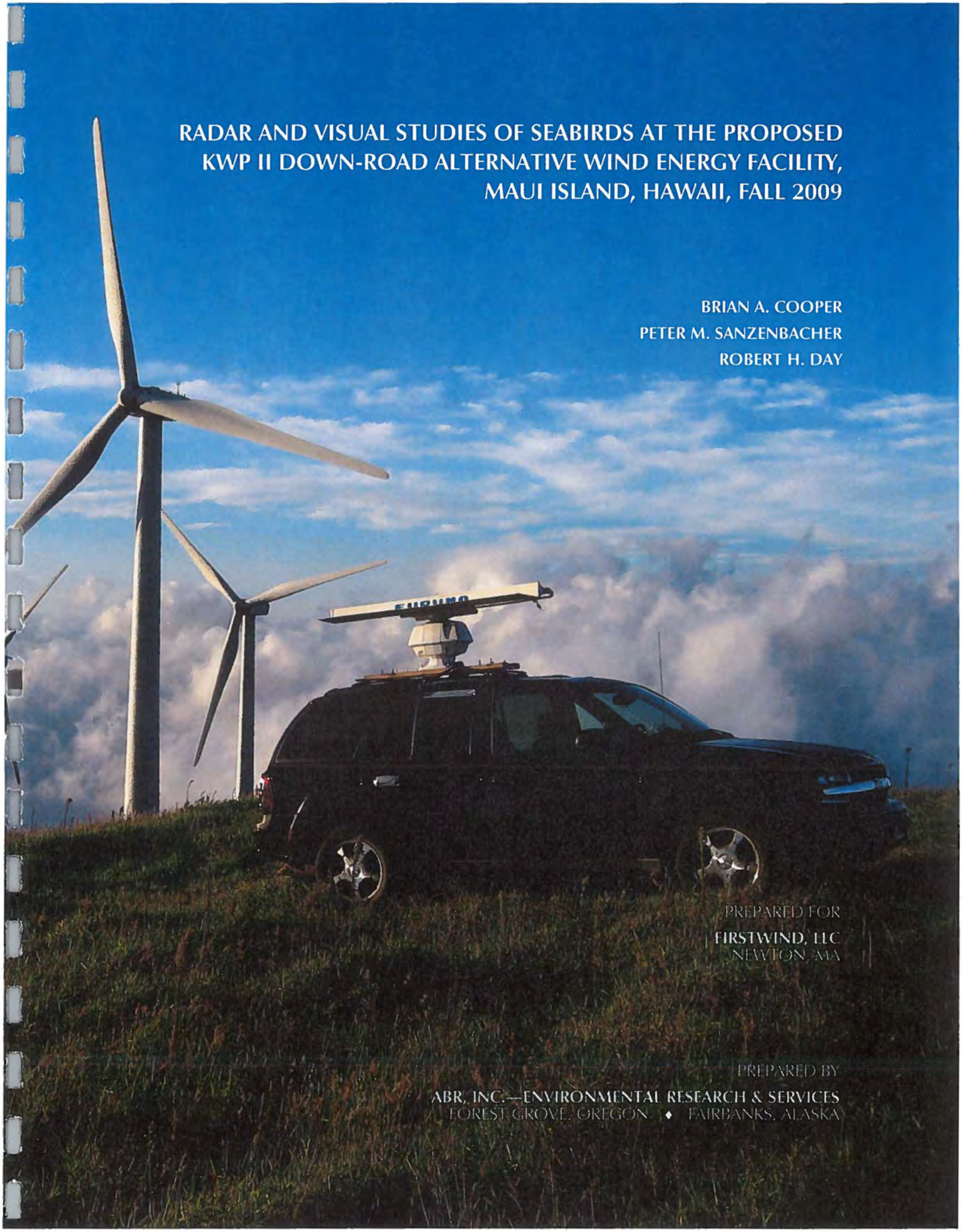
Education

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

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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.

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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

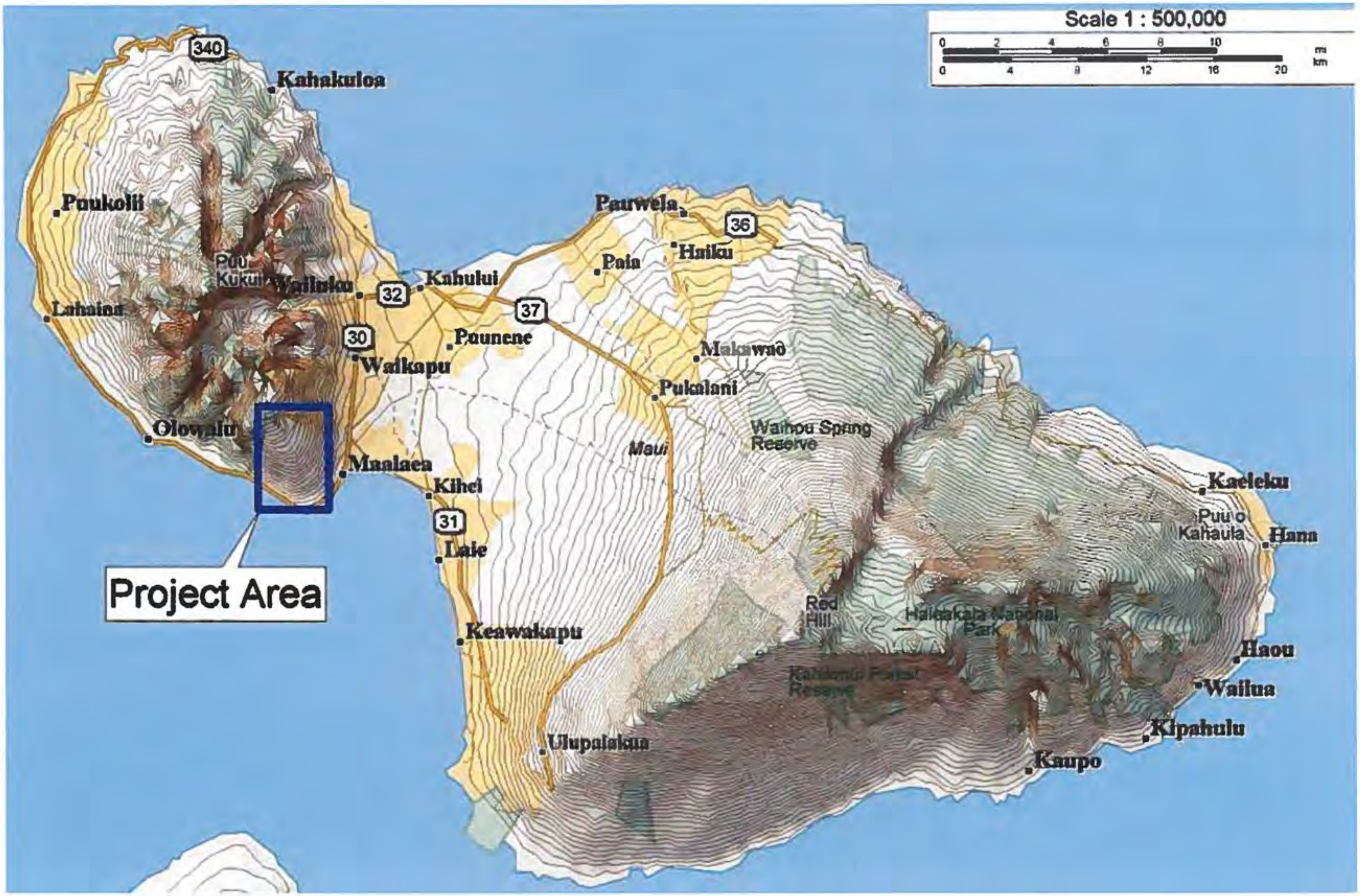

Figure 1. Maui Island, Hawaii, with approximate location of the Kaheawa Pastures Wind Energy Facilities (KWP I and KWP II).

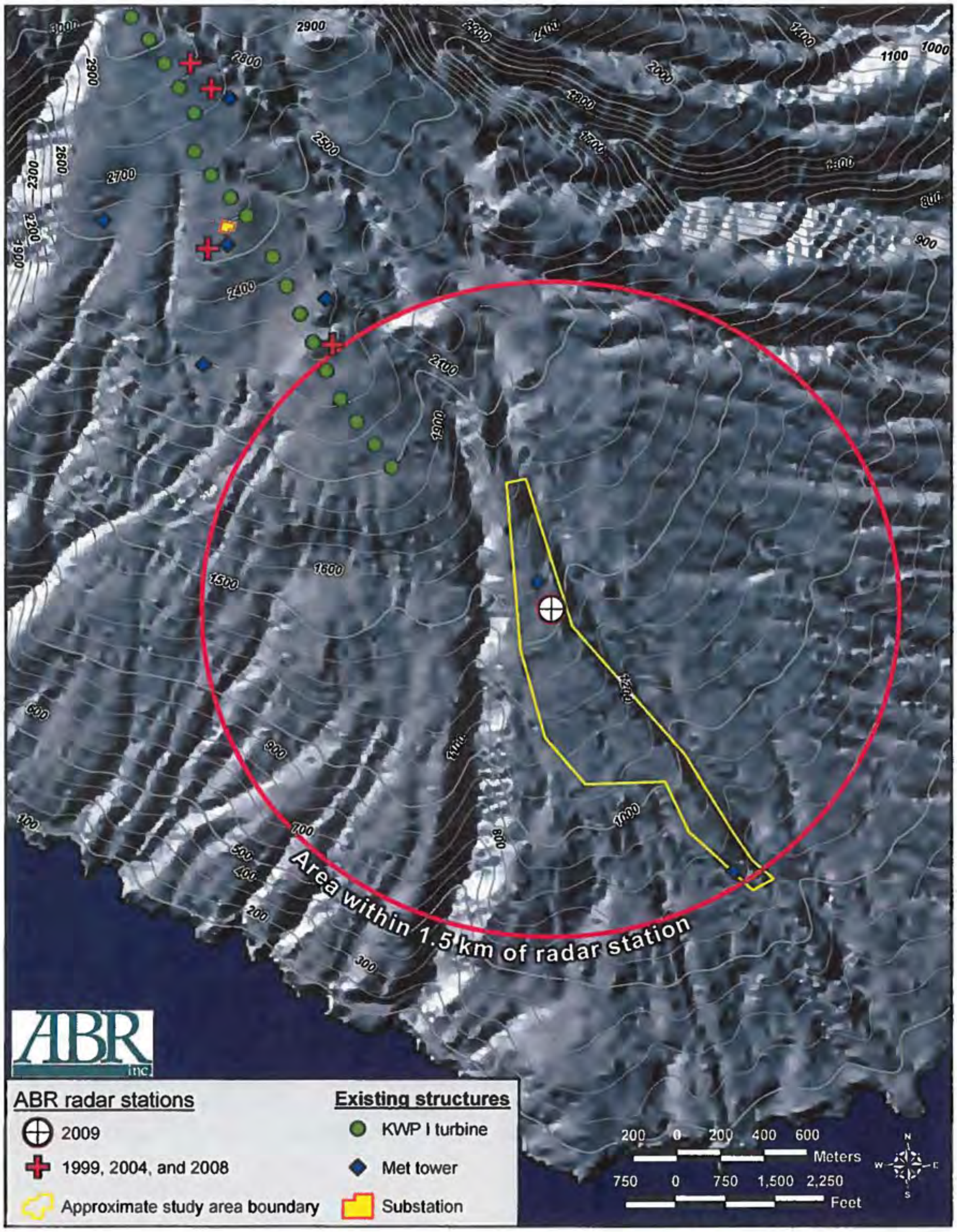

Figure 2. Location of 2009 radar sampling stations relative to sampling stations from previous studies (Day and Cooper 1999, Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009) and areas under consideration for siting of wind turbines at the proposed KWP II Down-road Alternative (KWP II) wind energy 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

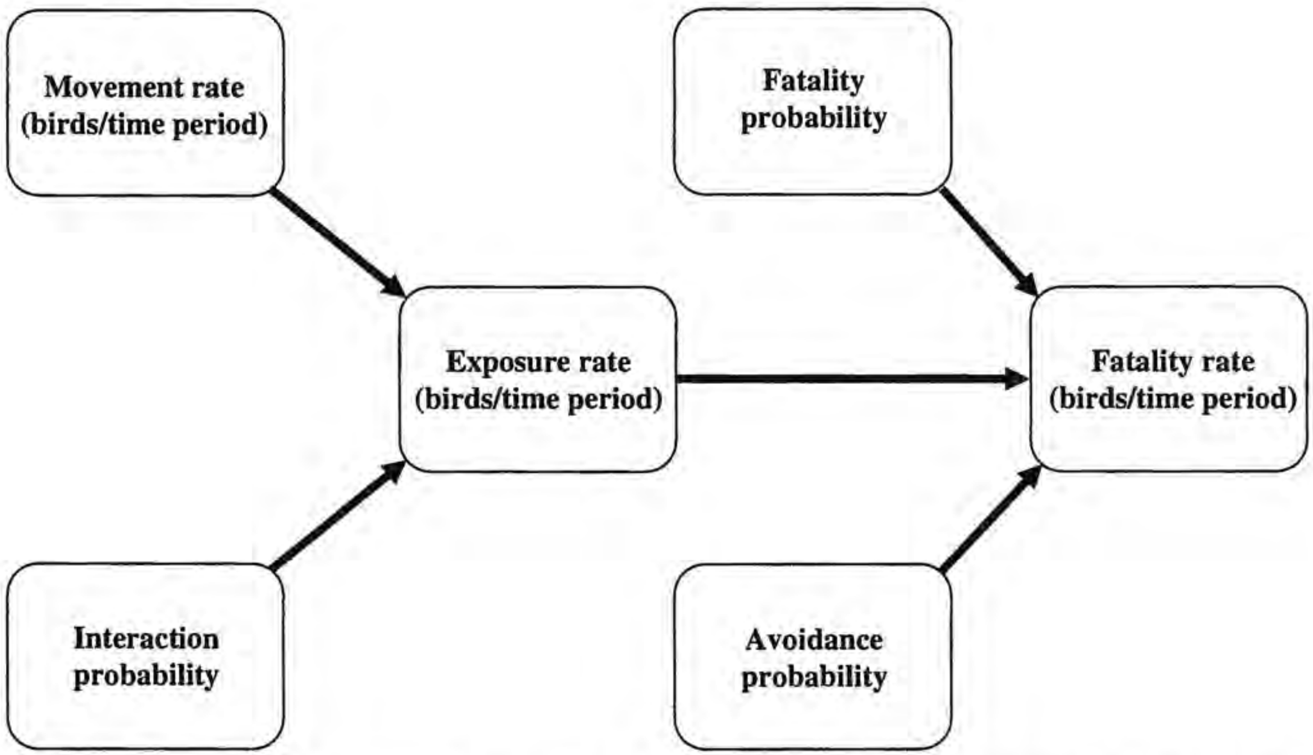

Figure 3. Major variables used in estimating possible fatalities of Hawaiian Petrels and Newell's Shearwaters at wind turbines at the proposed KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii. See Tables 2 and 3 for details on calculations.

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		NESH	
	Minimum	Maximum	Minimum	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

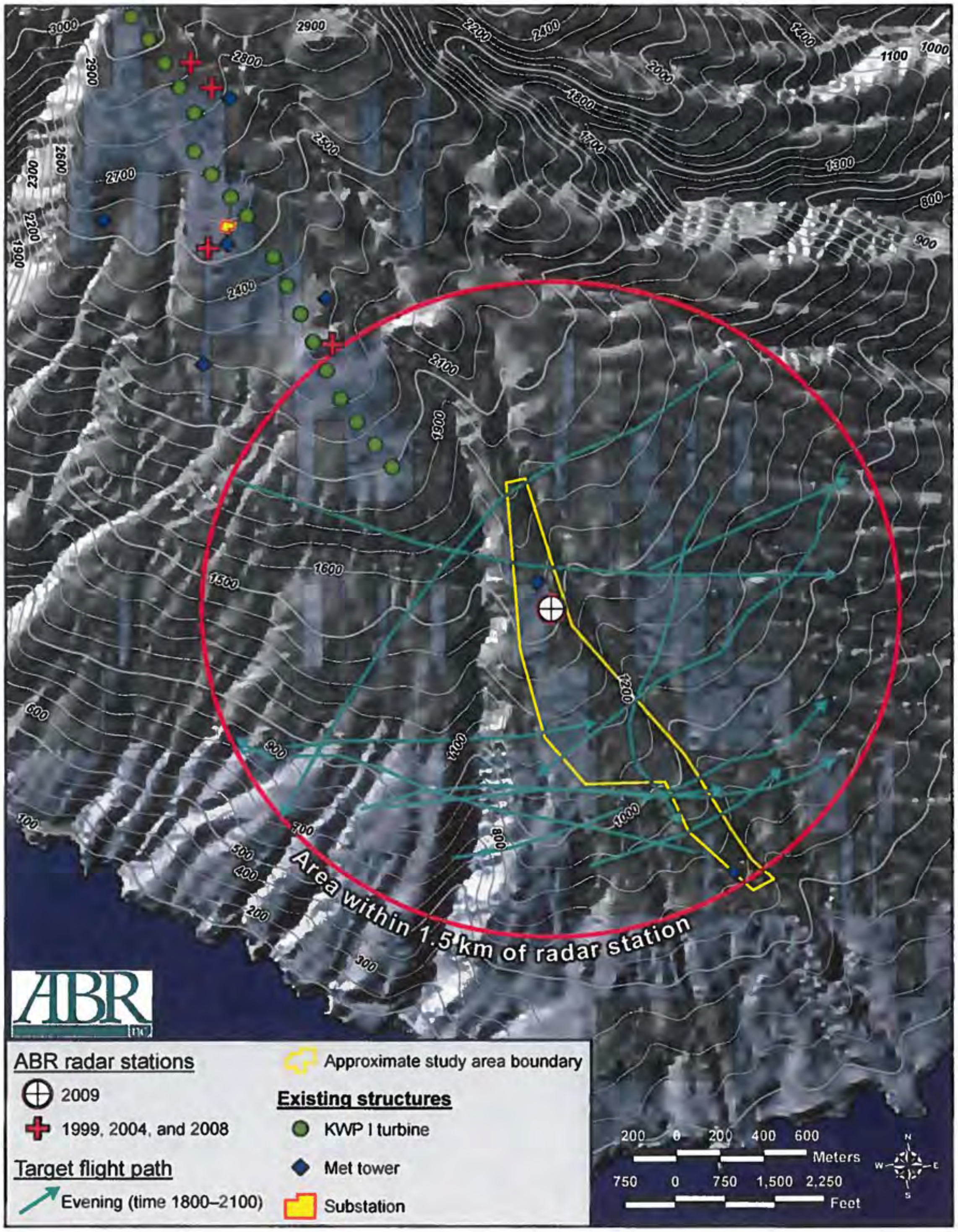

Figure 4. Location of flight paths of petrel-like radar targets observed during the evening sampling period (1800–2100 h) in October 2009 at the KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii.

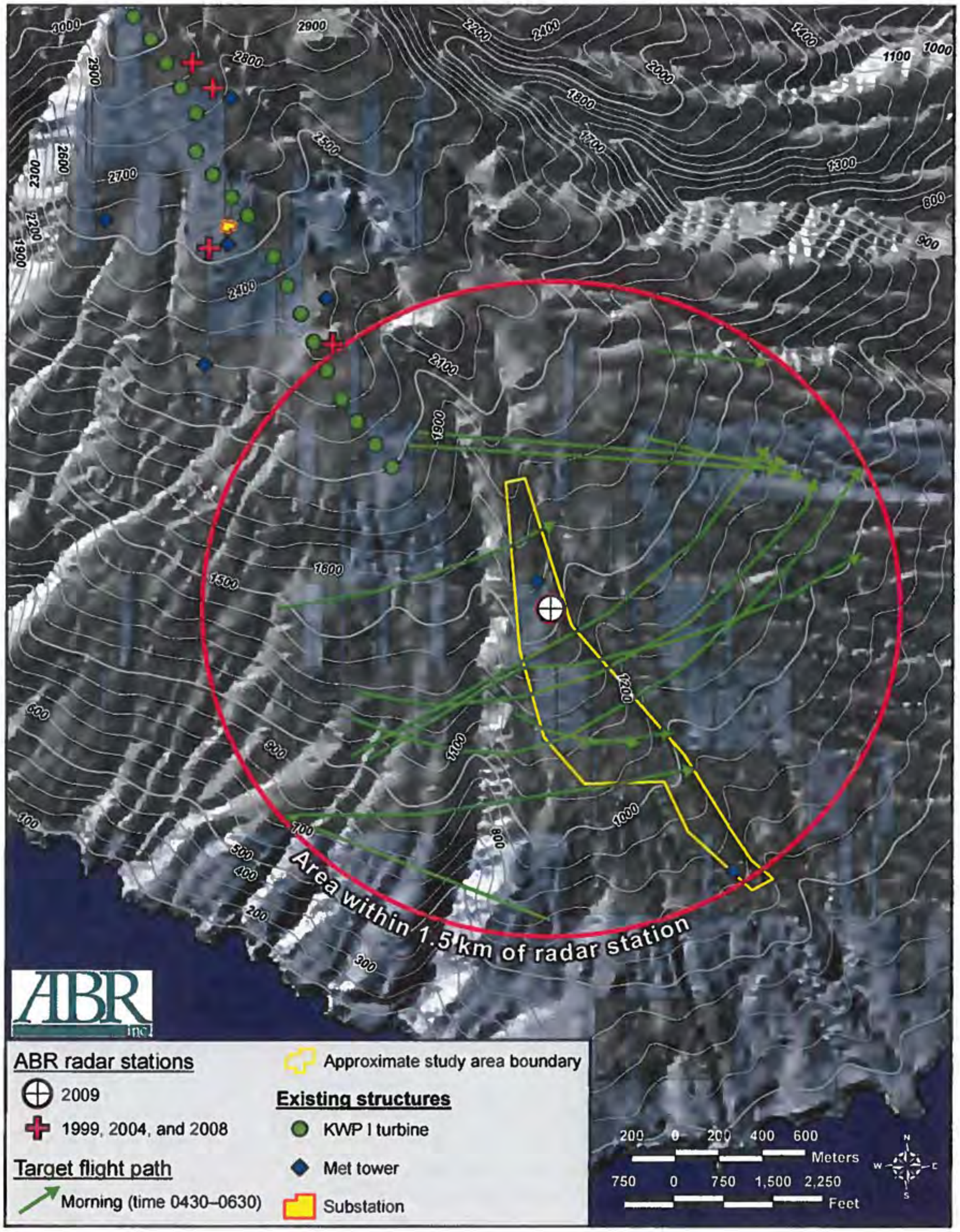

Figure 5. Location of flight paths of petrel-like radar targets observed during the morning sampling period (0430–0630 h) in October 2009 at the KWP II Down-road Alternative (KWP II) wind energy facility, Maui, Hawaii.

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	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 (^oF):	

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*), 'ōhi'a (*Metrosideros polymorpha* vars. *Glaberrima* and *incana*), 'iliahi alo'e (*Santalum ellipticum*), kilau (*Pteridium aquilinum* var. *decompositum*), koali awahia (*Ipomoea indica*), pūkiawe (*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	*pūkiawe*	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'uöwi	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. (2^{nd}. 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

Hawaiian Hoary Bat

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
Kaheawa 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 Hana'ula, 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
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AQUATIC RESOURCES
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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:	CONCUR:
Glenn H. [signature]	Paul J. Conry [signature]
for Branch Manager, DOFAW Maui	Administrator, DOFAW

Appendix 19

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

983 University Ave, Bldg D • Los Gatos, CA 95032 • Ph: 408.458.3200 • F: 408.458.3210

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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		Source
	Full predation	Low predation	
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.

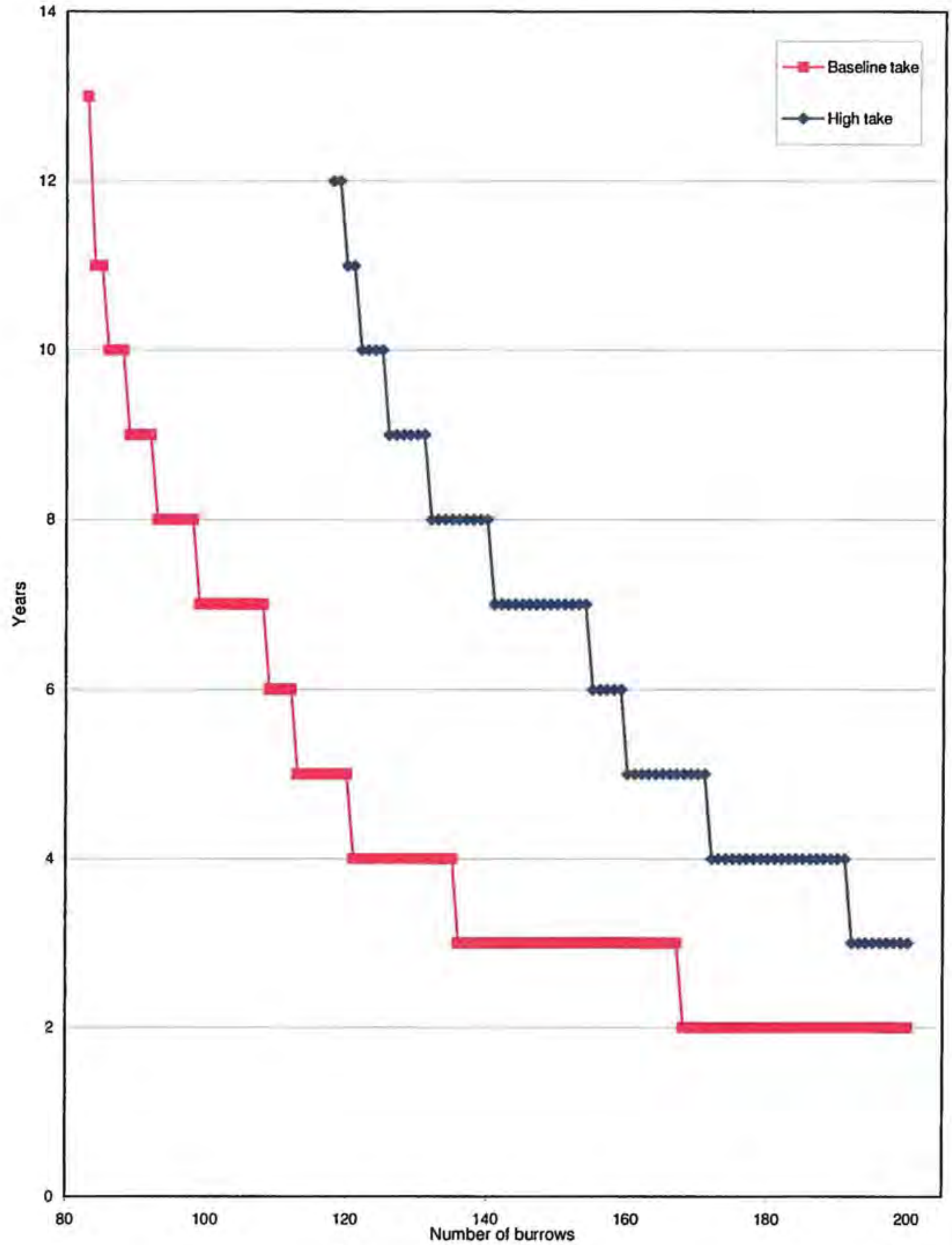

Figure 15. The number of years required to meet mitigation targets in relation to the initial number of active burrows of Hawaiian petrel for potential mitigation site, South Rim of Haleakala; baseline and high levels of take are as specified in the text.
REFERENCES

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
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106	7	NA
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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
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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

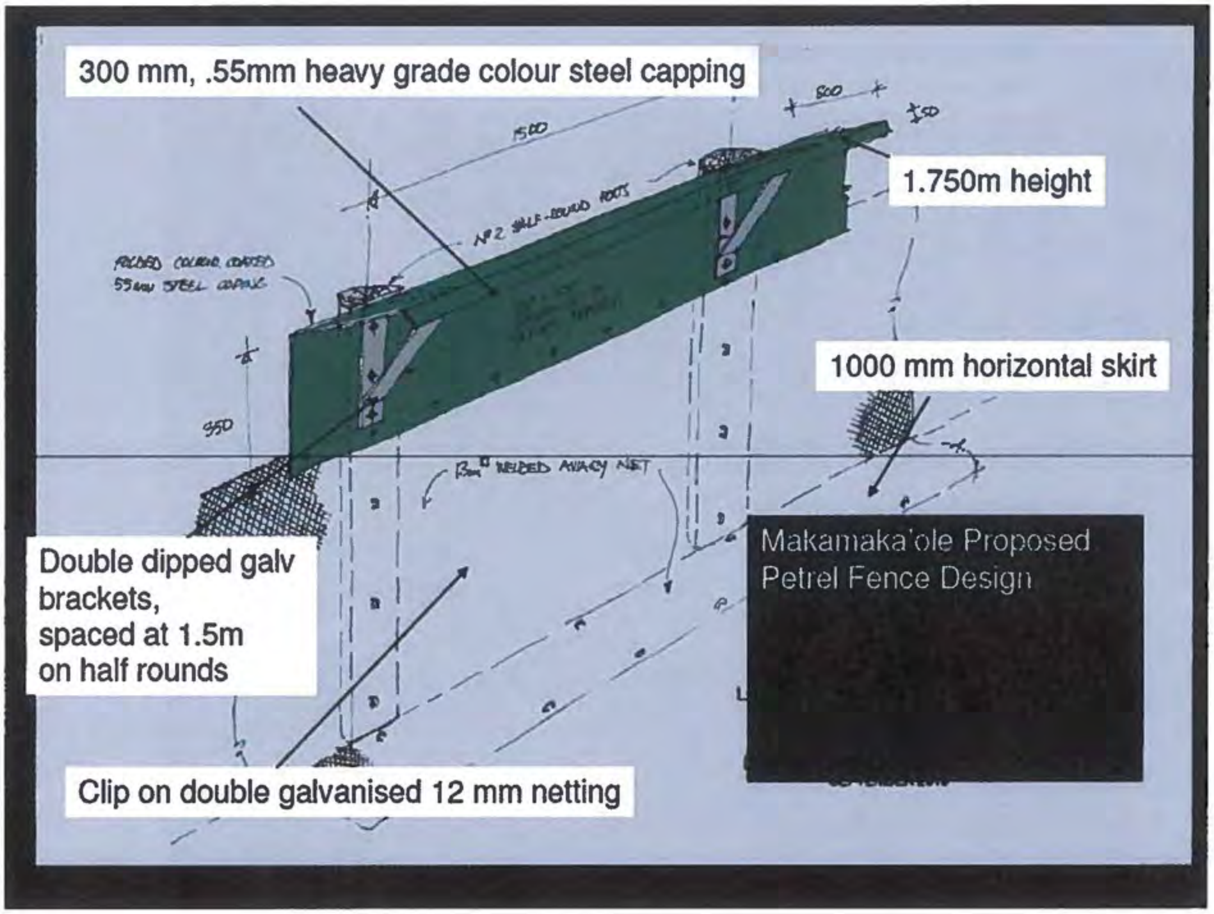
Appendix 22

Makamakaole draft mitigation design and timeline.

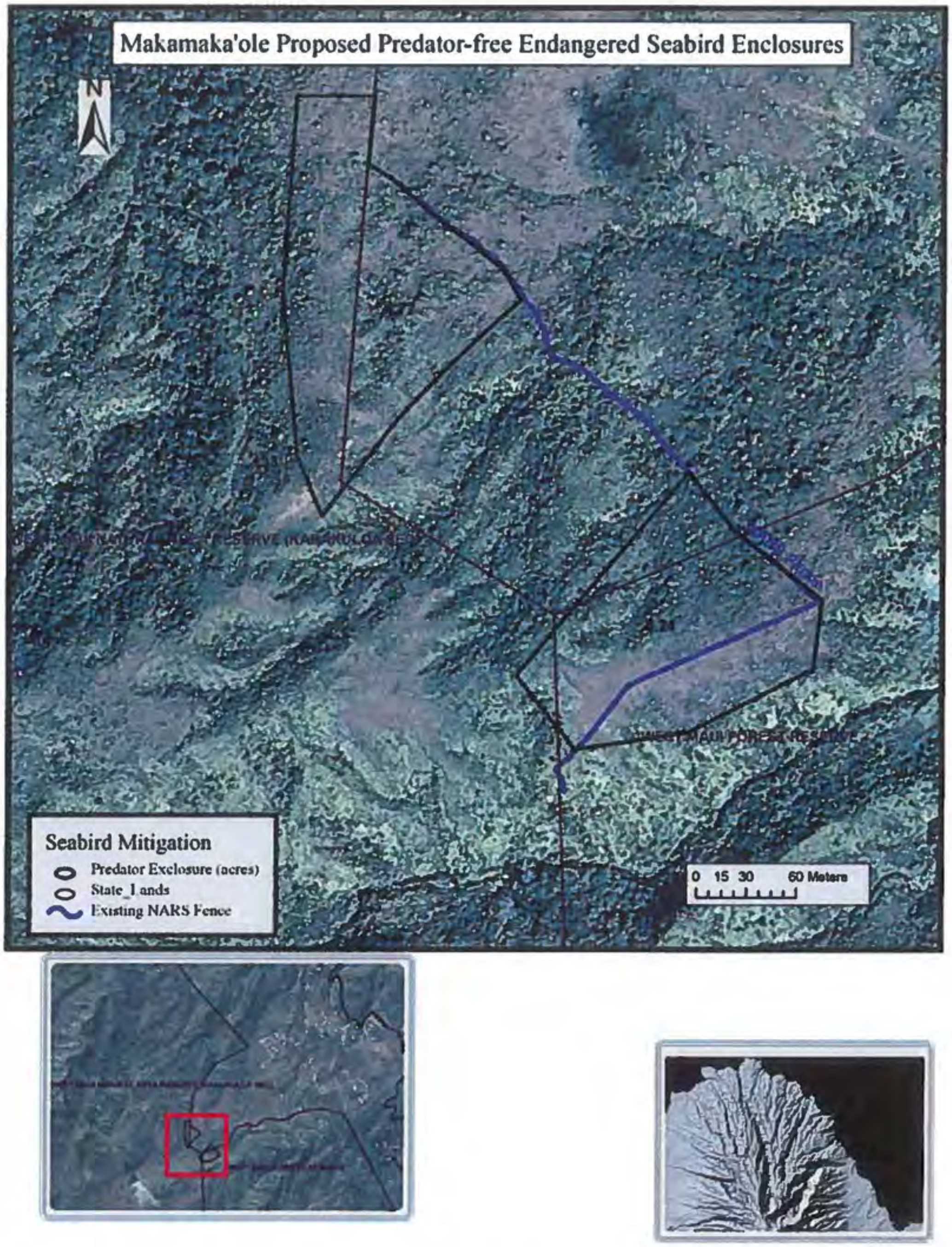
Draft Timeline

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.

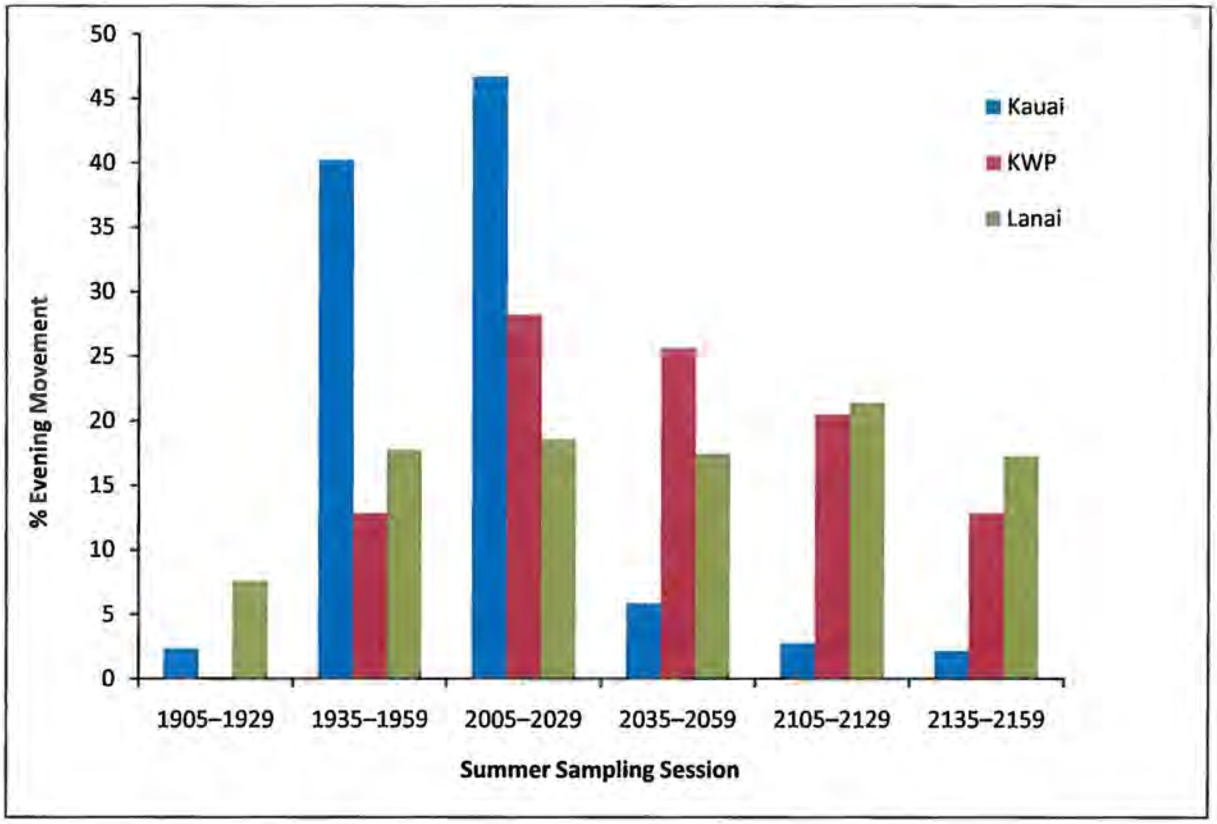


Figure 2. Percent of evening radar targets observed during each sampling session in Kauai during the summers of 1993, 1999, 2000, and 2011 combined (Day et al. 2003), at the KWP wind energy site, Maui, during the summers of 1999, 2008, and 2009 (Day and Cooper 1999; Sanzenbacher and Cooper 2008, 2009; 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

H. T. HARVEY & ASSOCIATES

ECOLOGICAL CONSULTANTS

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

983 University Ave, Bldg D • Los Gatos, CA 95032 • Ph: 408.458.3200 • F: 408.458.3210

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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

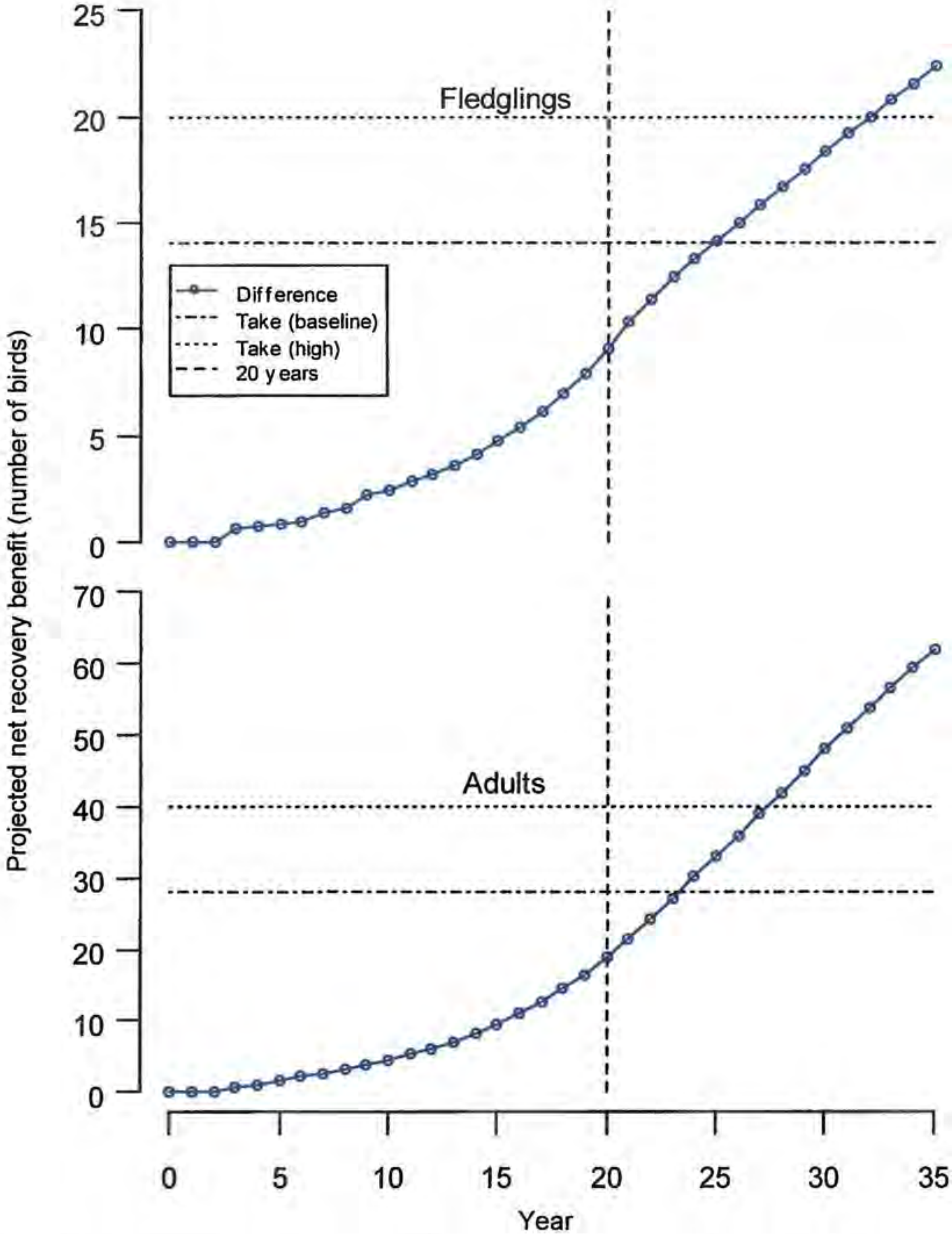

Figure 12. Difference between full predation scenario (existing colony) and mitigation scenario (mitigation and existing colony combined) for Hawaiian Petrel breeding adults and fledglings, Makamaka'ole, assuming that the social attraction mitigation project is implemented. Vertical line indicates the 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.

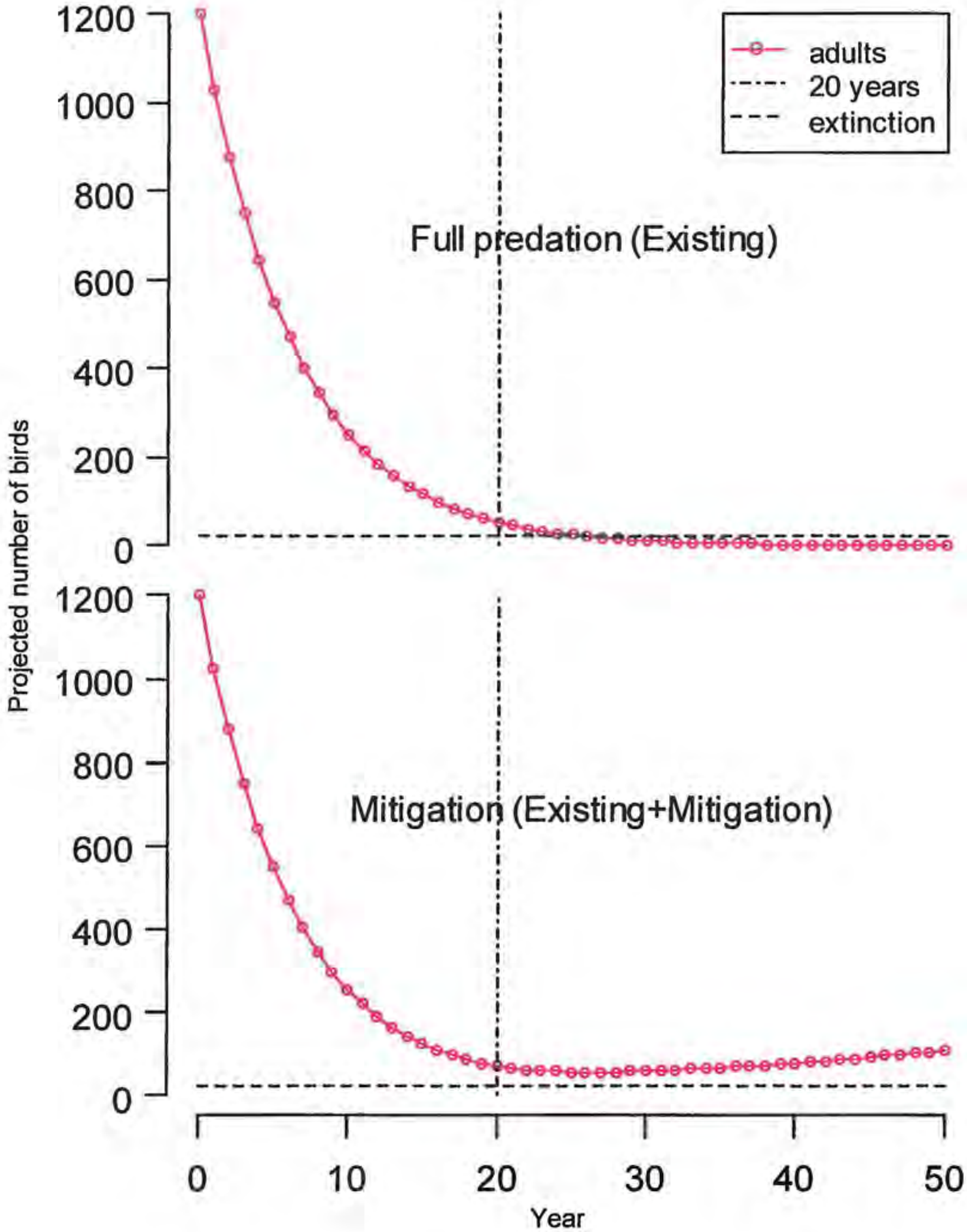

Figure 13. Projected number of Hawaiian Petrels, by life stage, for the overall population under full predation (no mitigation) and mitigation (no predation) scenarios, Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period, and the horizontal line indicates the threshold for extinction (10 breeding pairs), which is only reached in the existing colony (full predation).

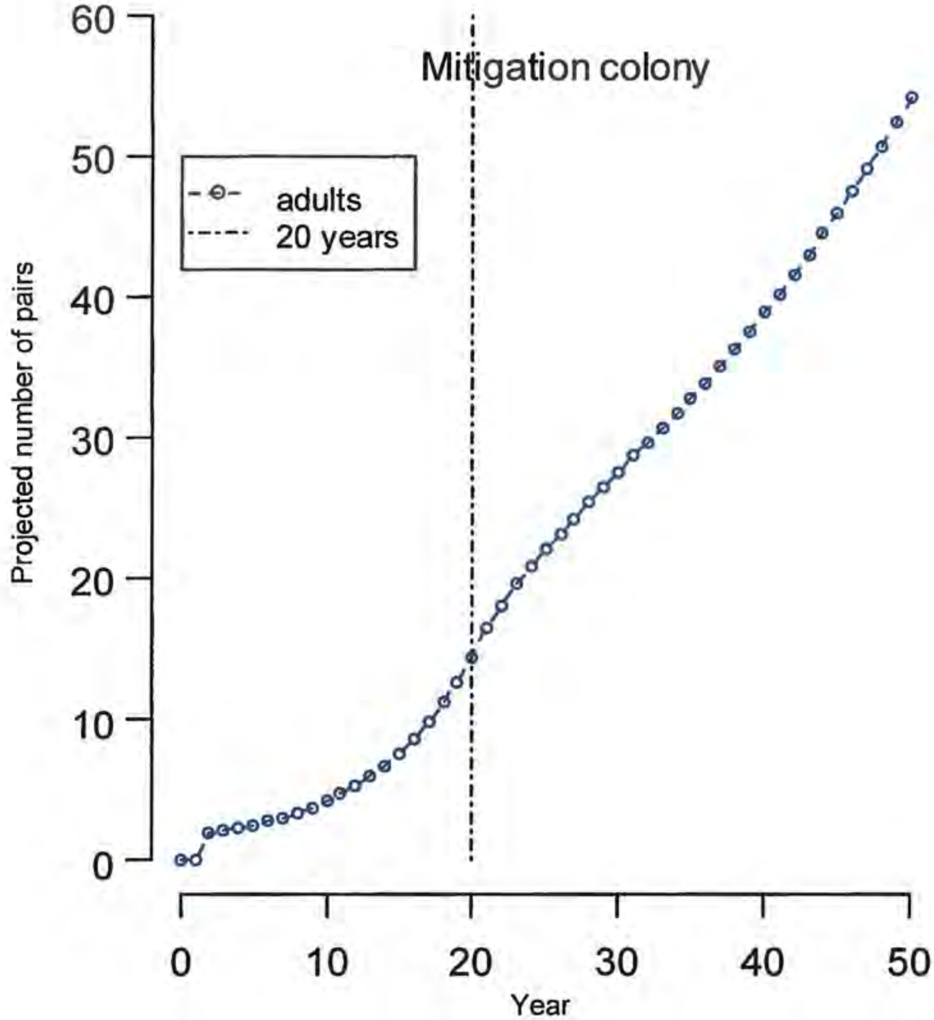

Figure 14. Projected number of Hawaiian petrel adults for mitigation colony (social attraction), Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period.

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

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

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

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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%

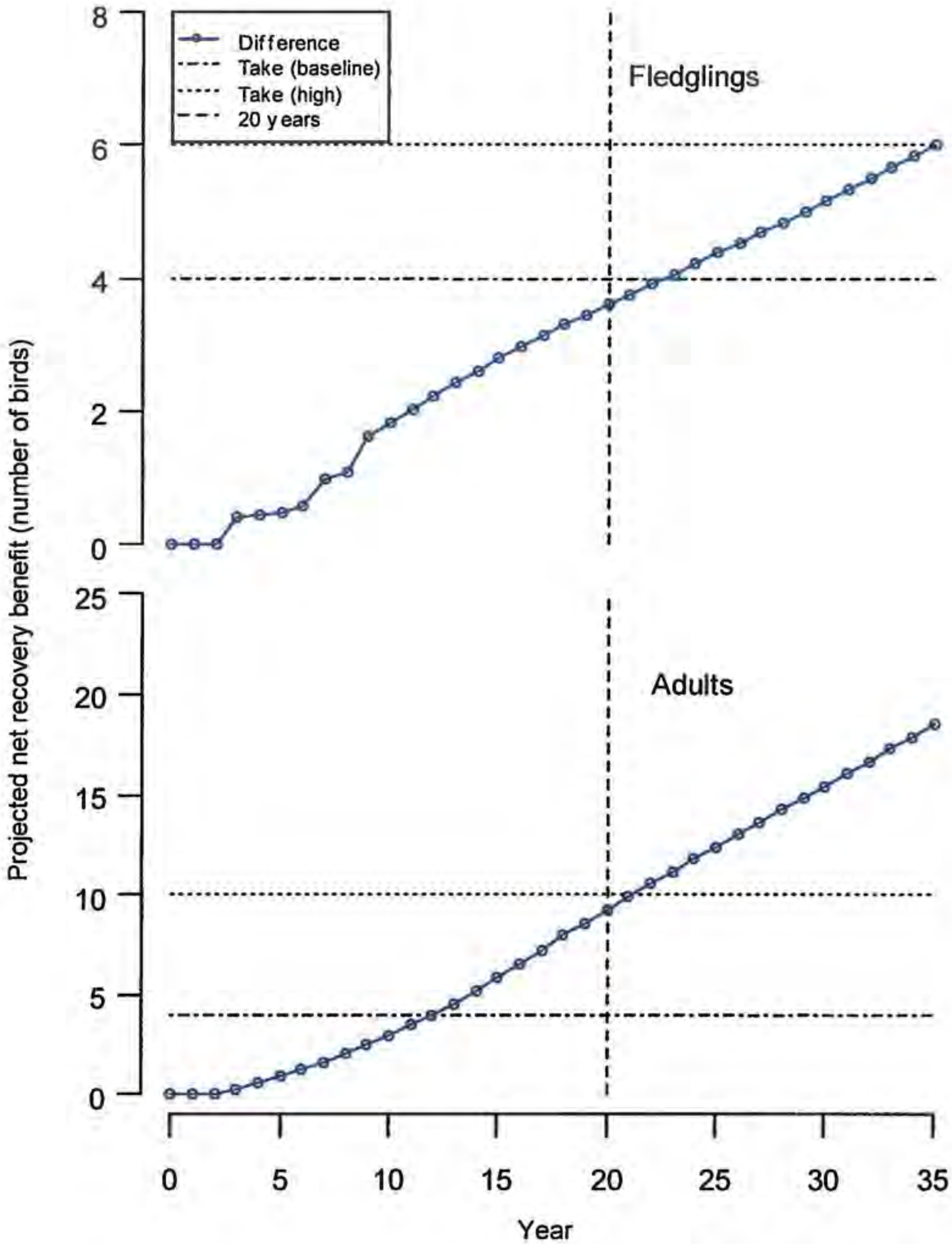

Figure 19. Difference between full predation scenario (existing colony) and mitigation scenario (mitigation and existing colony combined) for Newell's shearwater breeding adults and fledglings, Makamaka'ole, assuming that the social attraction mitigation project is implemented. Vertical line indicates 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).

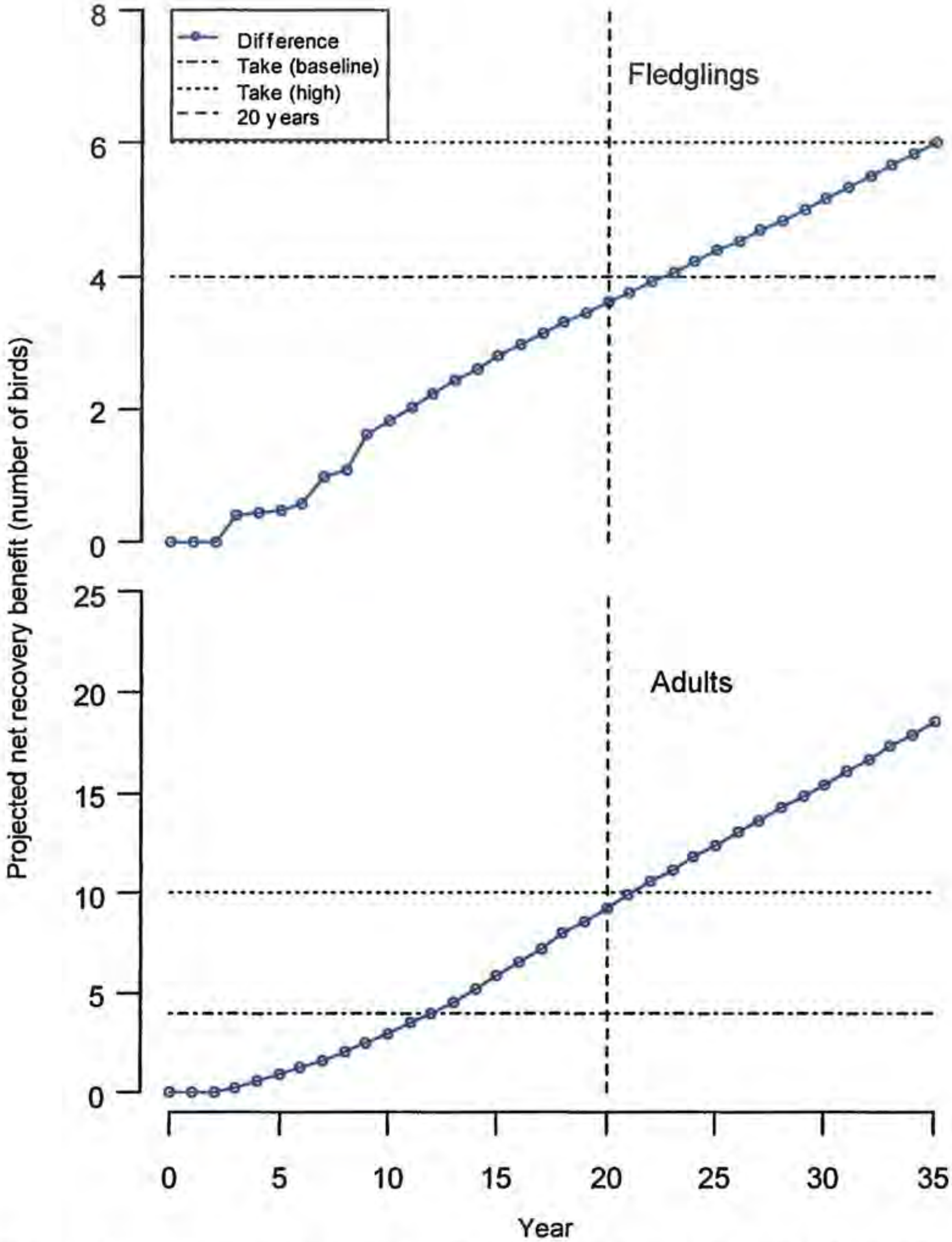

Figure 20. Difference between full predation scenario (existing colony) and mitigation scenario (mitigation and existing colony combined) for Newell's shearwater breeding adults and fledglings, east Maui, assuming that the social attraction mitigation project is implemented. Vertical line indicates the 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.

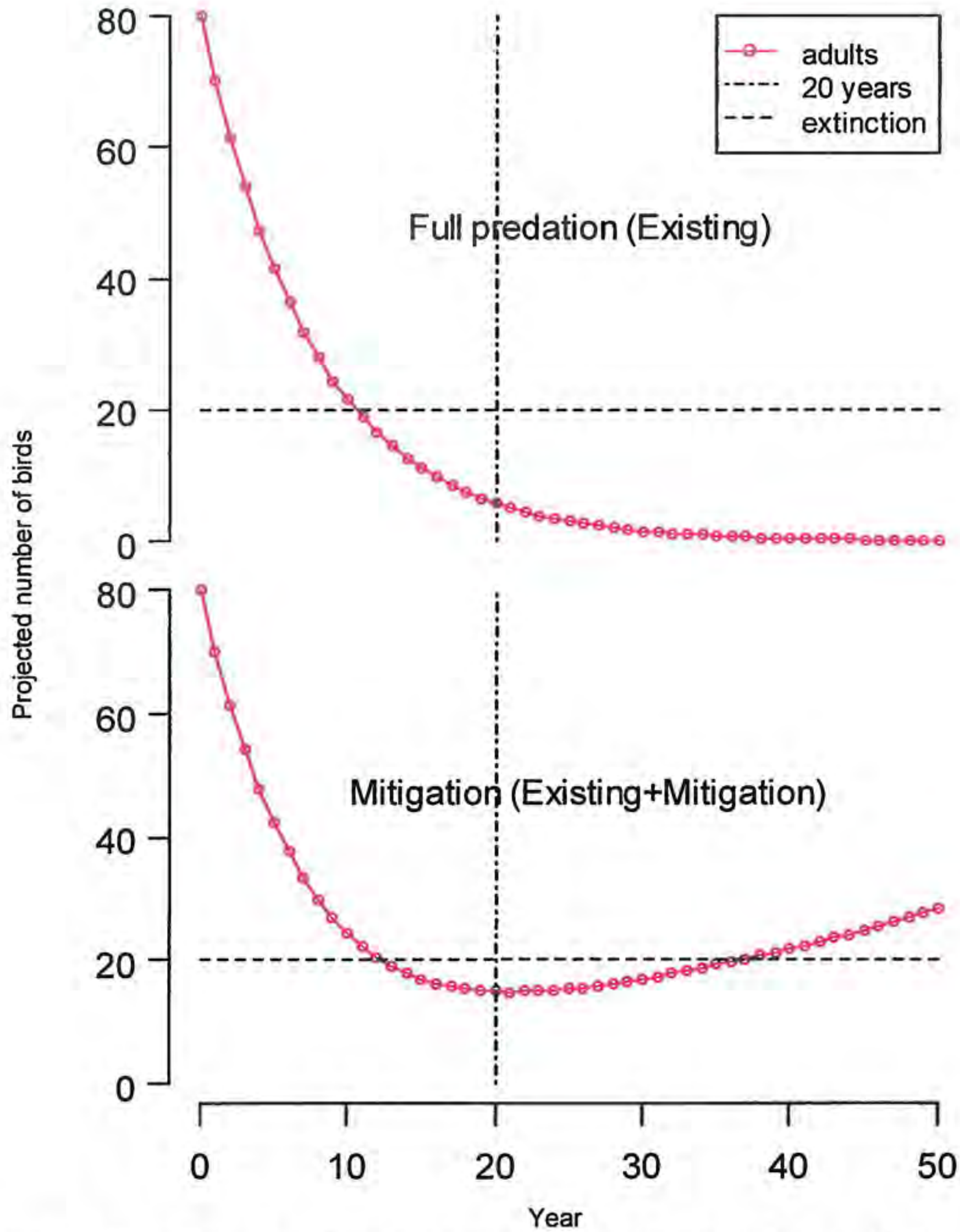

Figure 21. Projected number of Newell's shearwaters, by life stage, for the overall population under full predation (no mitigation) and mitigation (no predation) scenarios, Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period, and the horizontal line indicates the threshold for extinction (10 breeding pairs), which is only reached under full predation.

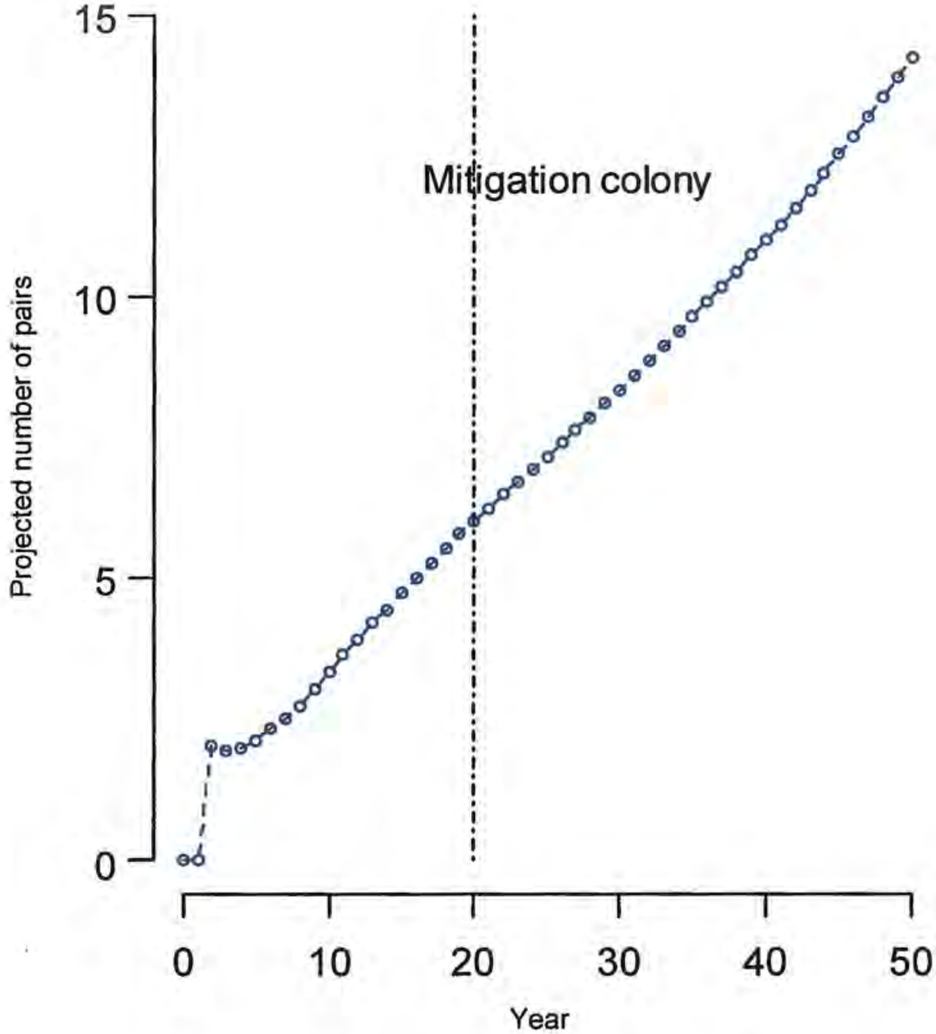

Figure 22. Projected number of Newell's shearwater adults for mitigation colony (social attraction), Makamaka'ole, West Maui. Vertical line indicates the end of the 20-year license period.

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

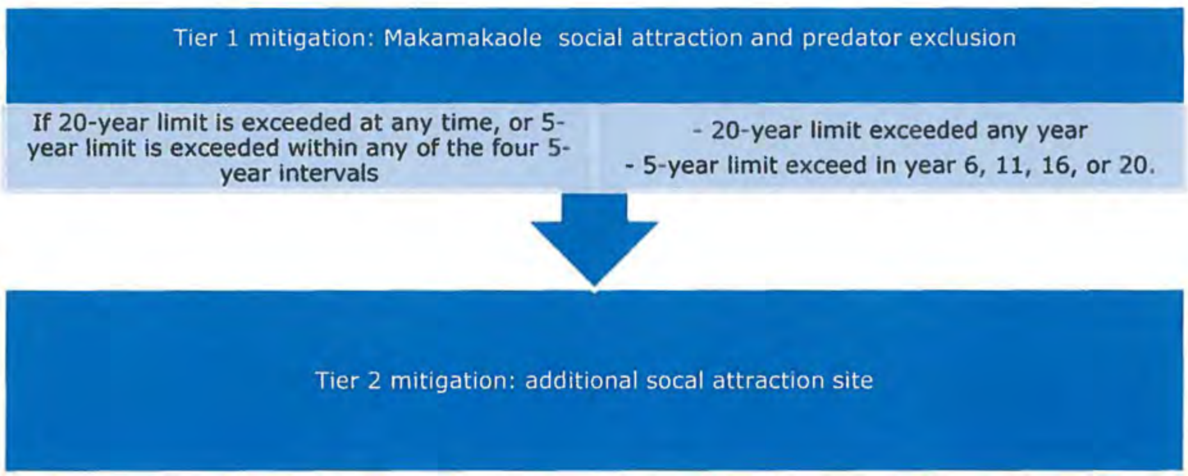

Figure 1: Triggers and timeline for Tier 2 mitigation for Newell's shearwater

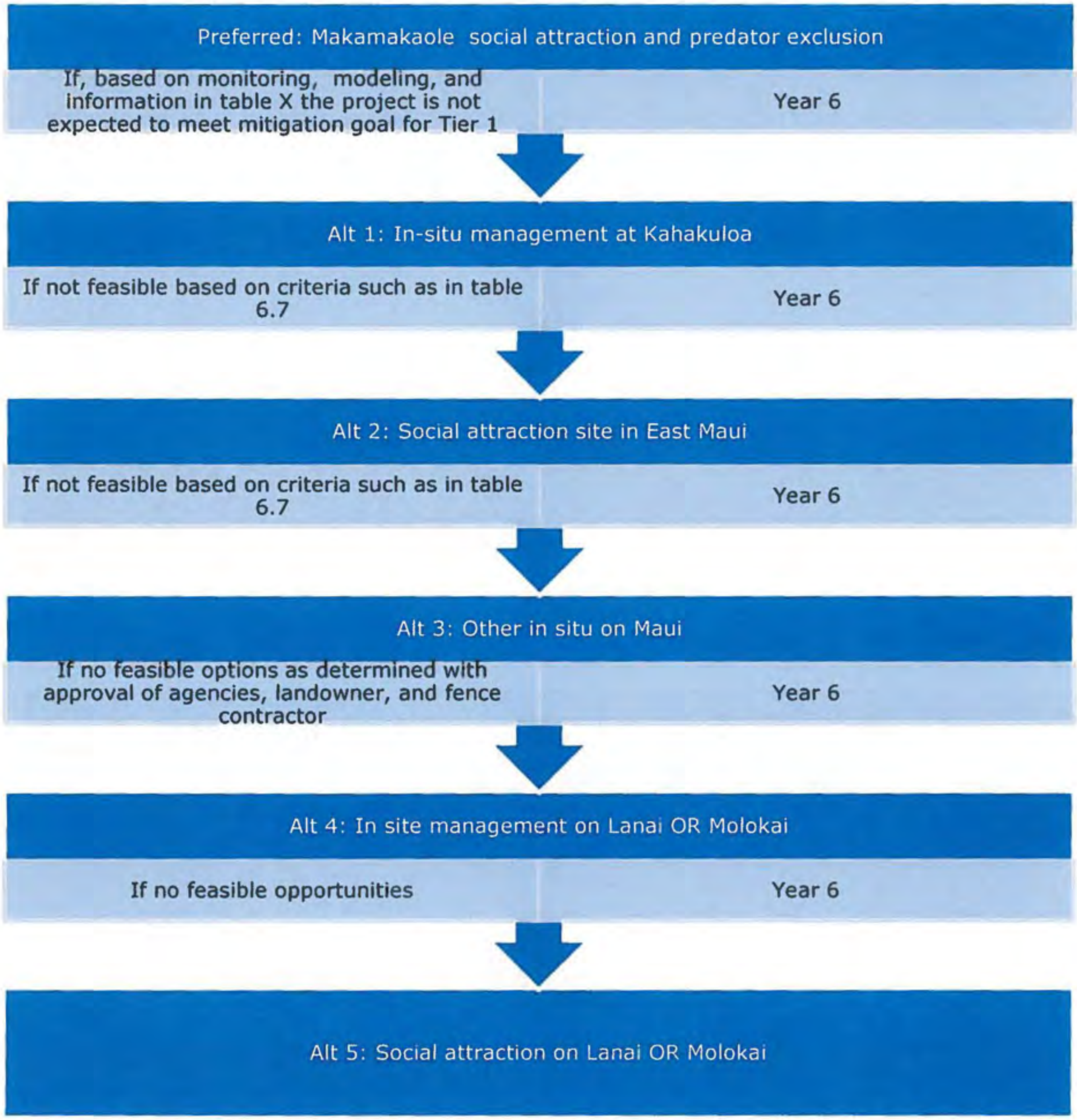

Figure 2: Triggers and timeline for mitigation contingencies for Newell's shearwater

Hawaiian Petrel

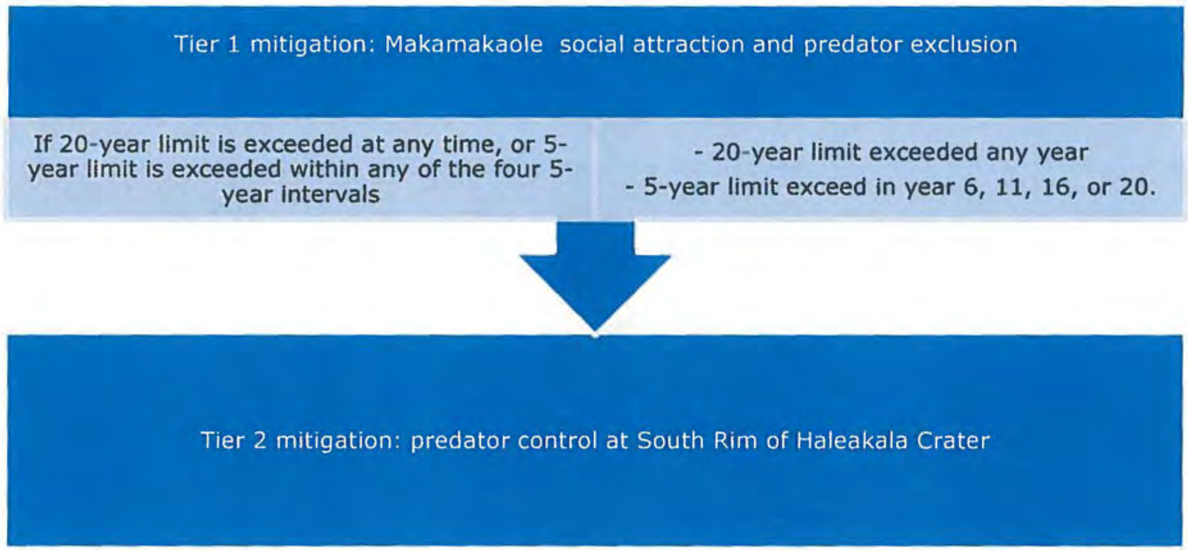

Figure 3: Triggers and timeline for Tier 2 mitigation for Hawiian petrel

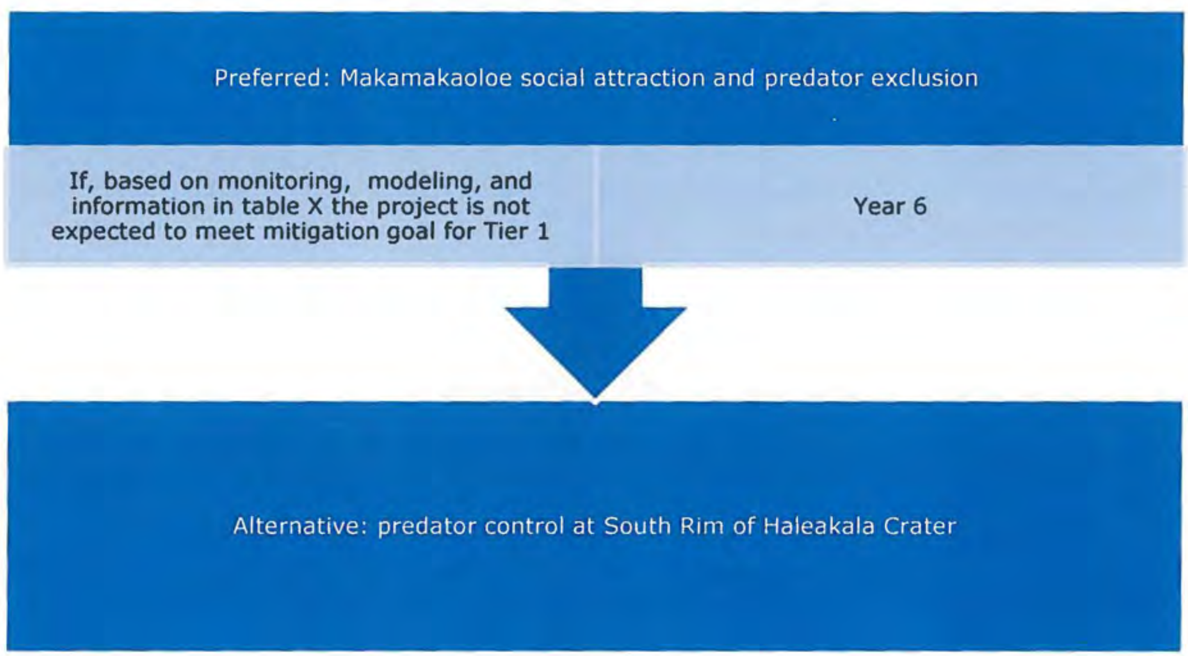

Figure 4: Triggers and timeline for mitigation contingencies for Hawaiian petrel

Nene

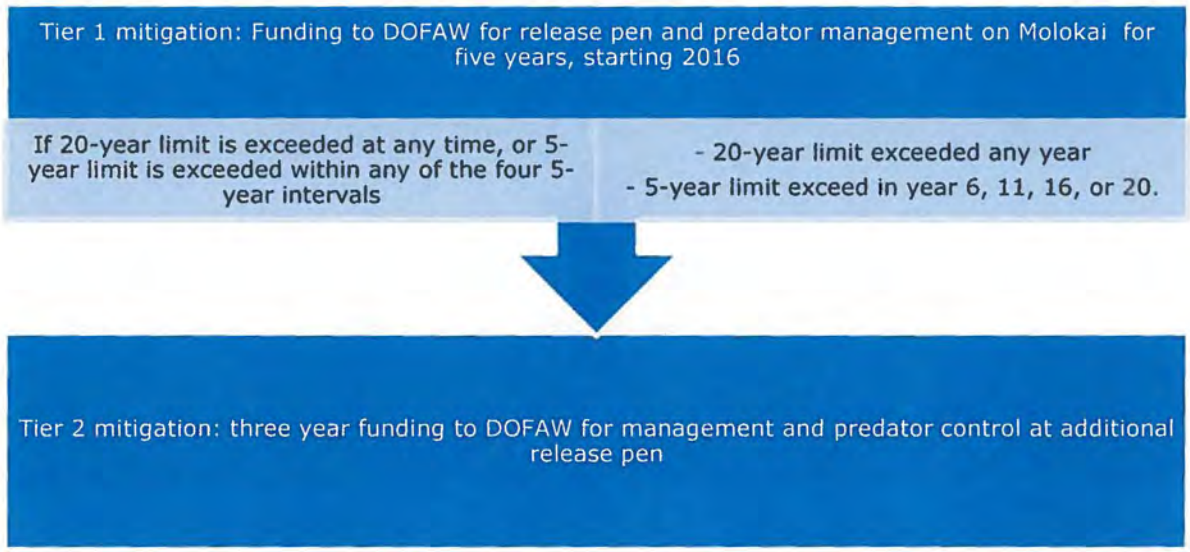

Figure 5: Triggers and timeline for Tier 2 mitigation for nene

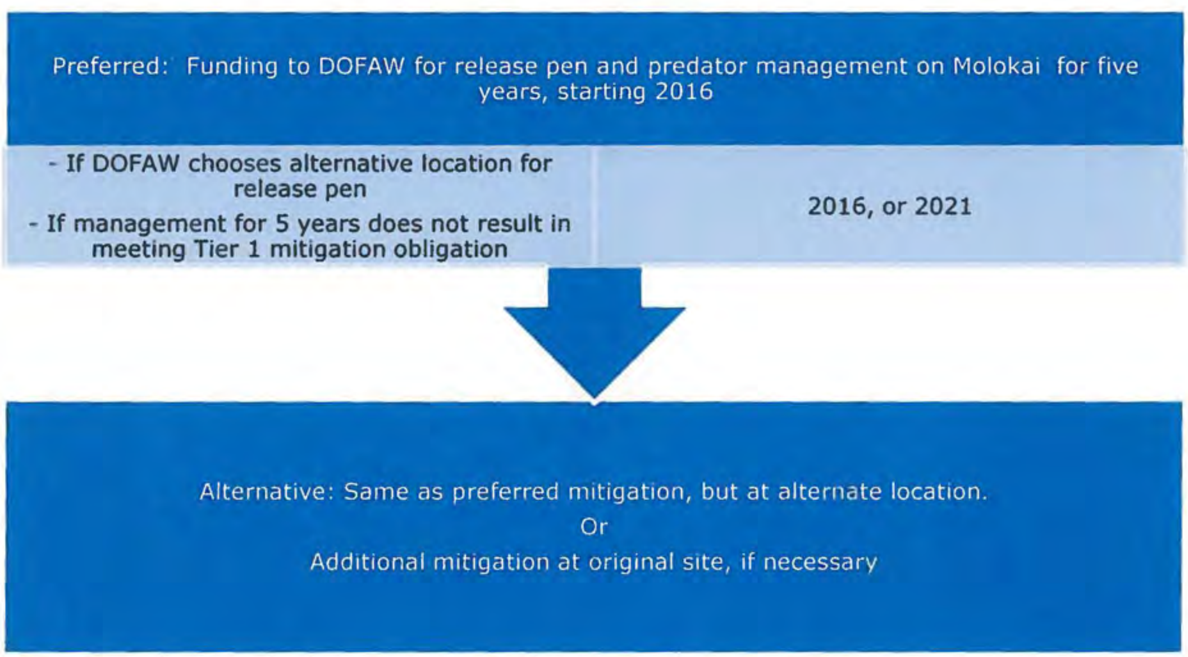

Figure 6: Triggers and timeline for mitigation contingencies for nene

Hawaiian Hoary Bat

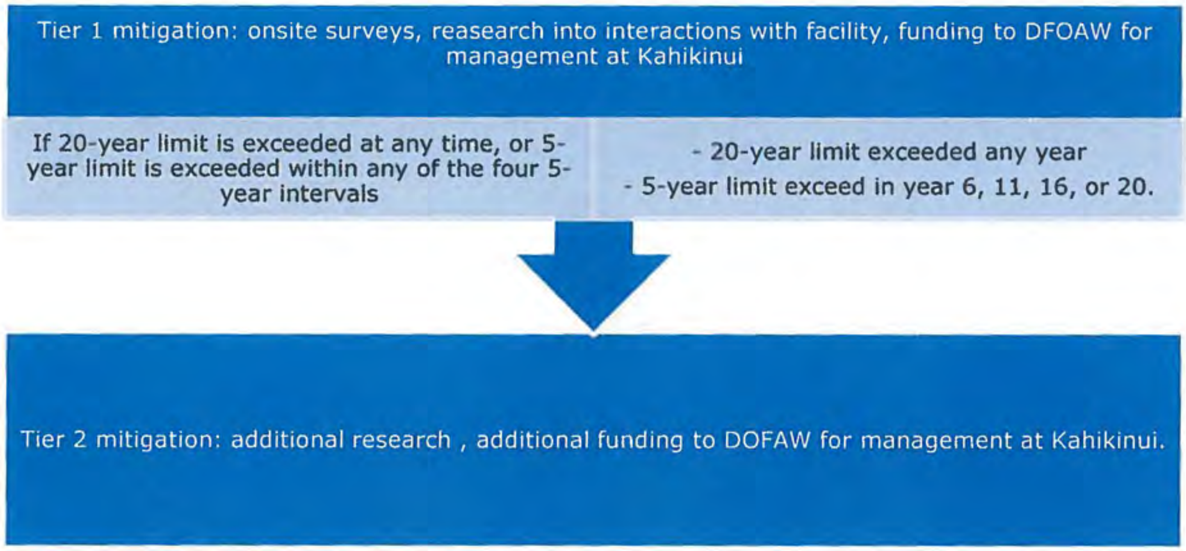

Figure 7: Triggers and timeline for Tier 2 mitigation for Hawaiian hoary bat