# Kaheawa Pastures
# Wind Energy Generation Facility

# Habitat Conservation Plan

TMK Nos. 4-8-001: 001 and 3-6-001: 014
Ukumehame, Maui, Hawai`i

Kaheawa Wind Power, LLC
January 2006

**KAHEAWA PASTURES WIND ENERGY GENERATION FACILITY**
**HABITAT CONSERVATION PLAN**

**FIGURES AND APPENDICES**

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# I. INTRODUCTION AND PROJECT OVERVIEW

## Summary

Kaheawa Wind Power, LLC proposes to develop and operate the island of Maui's first commercial wind energy generation facility in the Kaheawa Pastures area of West Maui. The State Board of Land and Natural Resources has approved a Conservation District Use Application (CDUA) for the proposed facility, which will be situated on State conservation lands.

Among the conditions imposed by the approved CDUA is a requirement to "comply with the Incidental Taking Permit requirements of the U.S. Fish and Wildlife Service, including the preparation of the Habitat Conservation Plan." Therefore, pursuant to this condition, as well as in accordance with section 10(a)(1)(B) of the Endangered Species Act (ESA) of 1973, as amended, and Chapter 195-D, Hawai`i Revised Statutes, Kaheawa Wind Power has prepared this Habitat Conservation Plan (HCP) in support of the incidental take permit and license requirements of the U.S. Fish and Wildlife Service (USFWS) and the State Department of Land and Natural Resources (DLNR). The identified applicant, and holder of the permit/license if issued, is Kaheawa Wind Power, LLC, which is seeking a Federal Incidental Take Permit and State Incidental Take License with concurrent durations of twenty (20) years each.

The incidental take of four listed species (Hawaiian Petrel, Newell's Shearwater, Nene, and Hawaiian Hoary Bat) is anticipated to potentially occur as a result of the operation of the wind farm. These species presently, or may, fly in the vicinity of the project site and could be injured or killed if they collide with a wind turbine. No other listed, proposed or candidate species have been found or are known to be present in the project area.

The Hawaiian Petrel is known to nest primarily on Maui and, to a lesser extent, on Kaua`i and Lana`i. On Maui, these petrels are known to nest on Haleakala Crater on East Maui; however, it is not known with certainty whether they also nest in the West Maui mountains in the project vicinity. The anticipated take of the Hawaiian Petrel in conjunction with the operation of the wind energy generation facility is a maximum of one individual per year. When indirect impacts are taken into consideration, the overall take is not expected to exceed 1.5 birds per year on average.

The Newell's Shearwater breeds on several of the main Hawaiian islands, with indications that the species may also nest on Maui, although the status of the species on Maui is unclear at this time. Like the Hawaiian Petrel, the anticipated take of the Newell's Shearwater is a maximum of one individual per year. When indirect impacts are taken into consideration, the overall take is not expected to exceed 1.5 birds per year on average.

As part of the State and Federal plans for Nene recovery, Nene have been re-introduced onto the islands of Kaua`i, Maui, Moloka`i and Hawai`i; this recovery program includes a captive-release pen in the Hanaula area of the West Maui mountains, near the upper end of the project site. As of 2003, 87 Nene have been released from this pen since 1994, but little is known about their exact distribution and movements. The anticipated take of the Nene is two individuals per year. When indirect impacts are taken into consideration, the overall take is not expected to exceed three birds per year on average.

Lastly, little is known about the distribution or habitat use of the Hawaiian Hoary Bat. While it has been recorded on several islands, it is believed to be most abundant on Hawai`i and present in low numbers on Maui. The anticipated take of the Hawaiian Hoary Bat in conjunction with the operation of the wind energy generation facility is no more than one per year.

The purpose of this HCP is to document how Kaheawa Wind Power will minimize, mitigate, and monitor the effects of incidental take of threatened and endangered species anticipated to be adversely affected by the proposed project operation. Efforts have already been made to minimize the potential impact that the facility may have on these listed species, including aspects of the site design and configuration, turbine height and model, rotor speed, and lighting. General and species-specific mitigation is proposed to further survey the occurrence and behavior of these species in the project vicinity, and to compensate for any project-related take. Additionally, a monitoring protocol is outlined to determine the actual take of each species during the operation of the facility. Lastly, an adaptive management strategy will be implemented to allow for necessary and appropriate modifications to the mitigation and monitoring measures.

### Applicant History and Information

The proposed Kaheawa Pastures wind energy generation facility has been pursued by several interested parties for many years. In March 1996, then-applicant Zond Pacific, a subsidiary of Enron Wind, obtained DLNR approval of a CDUA for the installation of six temporary anemometers, or meteorological towers, to collect wind data at the project site. The six 30-meter towers were subject to 15 conditions, including measures to mitigate and monitor impacts to avian wildlife and plant species, as the towers were supported by guy wires. No known or otherwise documented impacts occurred as a result of these towers. As further described below, these towers eventually became inoperable and were abandoned, and were either removed or replaced by Kaheawa Wind Power in late 2004.

In August 1999, Zond Pacific prepared a State final Environmental Impact Statement (EIS) for the project, as required by Chapter 343, Hawai`i Revised Statutes; the final EIS document was ultimately accepted and approved by DLNR.

The assets of Zond Pacific were subsequently acquired by GE Wind Energy, which then submitted the CDUA for the project. This application, file number MA-3103, was approved by DLNR on January 24, 2003.

After the application was approved, Hawi Renewable Development (HRD) assumed the lead project role from GE Wind Energy. In June 2004, Kaheawa Wind Power acquired the project from HRD. Kaheawa Wind Power is the current applicant/proposed developer of the project.

Kaheawa Wind Power is comprised of two entities: UPC Wind Partners, LLC, a Boston-based wind energy generation firm, and Makani Nui Associates, LLC, a Maui-based partnership providing local resources for the project.

The principals of UPC Wind Partners are among the world's leading wind power developers with extensive experience in financing, constructing, operating and managing large wind energy projects in America and worldwide. In North America, UPC Wind Partners has a portfolio of over 1,500 megawatts (MW) in development. Internationally, UPC Wind Partners and its affiliates have over 483 MW of generating capacity in operation, 166 MW under construction, and over 1,000 MW under active development, including the 30 MW facility proposed at Kaheawa Pastures.

The principals of Makani Nui Associates are Hilton Unemori of ECM, Inc., an electrical and civil engineering firm located in Wailuku, and Kent Smith of KRS Development, Inc. (Smith Development), a real estate development company located in Makawao.

ECM is one of Maui's largest and best known electrical engineering firms, with 28 years of experience in Hawai`i and extensive interface with Maui Electric Company, Ltd. (MECO) and its parent company. Smith Development also has ongoing professional relationships with the utilities, as well as 18 years of experience in real estate development, due diligence, entitlements, permitting, financing and construction management.

With UPC Wind Partners' extensive experience in wind energy, and with ECM's and Smith Development's local contacts and combined abilities, the applicant is confident that the Kaheawa Pastures wind energy generation facility can finally become a reality.

## Regulatory Context

<u>Endangered Species Act</u>

Section 9 of the 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).

The USFWS may permit, under certain terms and conditions, any taking otherwise prohibited by section 9(a)(1)(B) if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. To apply for an incidental take permit, an applicant must develop, fund, and implement a USFWS-approved habitat conservation plan (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; and
- Other necessary or appropriate measures required by the Secretary of the Interior, if any, will be met.

To obtain an Incidental Take Permit, 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; and
- Such other measures that the Director of the USFWS may require as necessary or appropriate for purposes of the plan.

Chapter 195D, Hawai`i Revised Statutes (Endangered Species; Habitat Conservation Plans)

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 "take" of such endangered or threatened species is prohibited [Section 195D-4(e)]. The definition of "take" in Section 195D-2, HRS, 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 Board of Land and Natural Resources (BLNR) may permit, under certain terms and conditions, any taking otherwise prohibited by Section 195D-4(e) if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. To apply for a temporary incidental take license, an applicant must develop, guarantee funding of, and implement a BLNR-approved habitat conservation plan (HCP) to minimize and mitigate the effects of the incidental take. Such take may be permitted provided the following criteria of Chapters 195D-4 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 provide adequate funding and/or funding guaranties for the implementation of the HCP;
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild;
- The HCP will adequately address potential cumulative impacts on the species and such impacts will provide net environmental benefits; and
- The applicant will comply with other necessary or appropriate measures required by the BLNR, if any.

To obtain an Incidental Take License, an applicant must prepare a supporting HCP that provides the following information described in Chapter 195D-21:

- The impact that will likely result from such taking;
- Objective, measurable goals that are consistent with relevant approved recovery plans,, and provisions to evaluate the HCP's progress toward these goals;

- Measures to monitor, minimize, and mitigate such impacts, the funding that will be available to implement such measures, and the adaptive management procedures to be used should the HCP not achieve its goals; and

- Such other measures that the BLNR may require as necessary or appropriate for purposes of the license and HCP.

National Environmental Policy Act

Issuance of an Incidental Take Permit 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 in order 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 Incidental Take Permit and approving the implementation of the proposed Kaheawa Pastures Wind Energy Generation Facility HCP. The purpose of the EA is to determine if permit 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 of the proposed action will be prepared and distributed for public review; otherwise, a Finding of No Significant Impact will be issued. The USFWS will not make a decision on permit issuance until after the NEPA process is complete.

Chapter 343, Hawai`i Revised Statutes (Environmental Review)

The approval of a Habitat Conservation Plan and issuance of an Incidental Take License under Chapter 195D, HRS, do not by themselves trigger a requirement for environmental review pursuant to Chapter 343, HRS. However, the project site is situated on lands that are owned by the State of Hawai`i, and that are situated in the Conservation District, both of which are triggers for Chapter 343 review. Therefore, as described in greater detail below, a Final Environmental Impact Statement and a Final Environmental Assessment were prepared and accepted in 1999 and 2004, respectively, thus completing the State environmental review process for the project.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 USC 703-712), 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. All three bird species covered by this HCP are also protected under the MBTA. If the HCP is approved and USFWS issues an ESA Incidental Take Permit to Kaheawa Wind Power, the terms and conditions of that Incidental Take Permit will also constitute a Special Purpose Permit under 50 CFR 21.27 for the take of the Hawaiian Petrel, Newell's Shearwater, and Nene (Hawaiian Goose) under MBTA. Therefore, subject to the terms and conditions to be specified in the ESA Incidental Take Permit, if issued, any such take of the three covered species also will not be in violation of the MBTA. However, because the MBTA provides for no incidental take authorization, other MBTA-listed 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-listed species, Kaheawa Wind Power has adopted applicable measures based on 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.

National Historic Preservation Act

USFWS issuance of an Incidental Take Permit 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 incidental take authorization is obtained by the 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 will 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.

**Project Description**

The proposed wind energy generation facility will consist of 20 wind-generation turbines, situated in a single articulated row at an elevation extending from approximately 2,000 to 3,200 feet in the vicinity of existing MECO transmission lines above Ma`alaea (please reference Figure 1). The height of each turbine tower is 55 meters (180 feet), and the diameter of the rotors is 70.5 meters (231 feet), for a total structural height of approximately 90 meters (296 feet) (please reference Figure 2). In addition to the turbines and their foundations, the project will include an operations and maintenance facility, a substation and wind monitoring equipment, all situated in proximity to the turbines, as well as improvements and some realignment to the existing four-wheel-drive access road. The intra-turbine power collection system and connection to the substation will all be located underground; there will be no additional above-ground power lines.

Because of serious concerns regarding the susceptibility of seabirds to be attracted to lights, resulting in fallout, lighting of the project will be kept to the absolute minimum necessary for safety and operations. Lighting at the project will include that which is required by the Federal Aviation Administration (FAA) for aircraft safety. In March 2005 Kaheawa Wind Power received FAA approval of lighting only six wind turbines (at intervals of 2,500 to 3,000 feet) with medium intensity, simultaneously flashing red lights, utilizing the minimum flash frequency. Similarly reduced lighting plans have been recently approved for new wind energy projects elsewhere in the United States where there are concerns about wildlife and visual impacts. Other lighting will be provided at the operations and maintenance facility and substation for the purpose of illuminating the ground area, solely if and when work would need 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 at nighttime. Inside lights of the maintenance and operations buildings will likewise be turned off at the end of each work day.

As noted above, the six 30-meter meteorological towers that were installed by Zond Pacific eventually fell down or otherwise became inoperable. In August 2004, Kaheawa Wind Power received approval from DLNR to remove all of these towers and replace them with three new 30-meter towers, all of which would still be subject to the 15 conditions of the 1996 CDUA. In October 2004, DLNR also approved the installation of one 60-meter meteorological tower, as such equipment was contemplated under the project's 2003 CDUA approval. The installation and use of the 60-meter tower is subject to 15 similar conditions as the other towers; however, some conditions are more stringent and specific with respect to mitigation and monitoring for impacts to bird and bat species, including the utilization of fluorescent foam wraps and bird diverters on all guy wires and frequent monitoring (two to three times per week from March through May 2005). The 60-meter tower stopped working properly soon after its installation in late 2004.

All of the meteorological towers are supported by guy wires; none are lighted. All of the towers will be removed prior to construction and only the 60-meter tower will be reinstalled as part of the facility's operation so that wind data can be analyzed to verify that the wind turbines are operating properly. The 15 conditions, including marking and monitoring, will remain in effect for this tower.

The proposed 20-turbine layout varies slightly from the original layout that was analyzed in the project's final EIS [pursuant to Chapter 343, Hawai`i Revised Statutes (HRS)] and from the modified layout that was described in the approved CDUA. The final EIS design utilized 27 Zond Z-48 turbines, each consisting of a 50-meter lattice tower and a 48-meter diameter rotor. The CDUA-approved design utilized 30 Vestas V-47 turbines, each consisting of a 40-meter tubular tower and a 47-meter diameter rotor (please reference Figure 3).

Upon consultation with DLNR's Office of Conservation and Coastal Lands, as well as with the Office of Environmental Quality Control, the applicant was directed to prepare an Environmental Assessment (EA) to analyze the potential visual impacts of the current proposed design, as all other potential impacts were analyzed in the HRS 343 final EIS and would remain unaffected by the current proposal. The EA noted that the total combined height (the number of turbines times the total height of the tower and rotor) of the 20-turbine layout was lower than the previous two proposed configurations, thus having less of a visual impact from this cumulative perspective. Additionally, the current proposed rotors are larger and rotate more slowly, which has a less visually intense and intrusive impact. A Finding of No Significant Impact was issued by DLNR and published in the November 23, 2004 issue of the *Environmental Notice*, issued by the State of Hawai`i's Office of Environmental Quality Control.

Like the previously contemplated designs, the proposed 20-turbine layout would fall within an overall project site area that is approximately 8,500 to 9,000 feet long and 1,000 to 1,100 feet wide (approximately 200 acres), as depicted in Figure 1. The current layout utilizes fewer turbines that are larger in height and rotor diameter, which in turn call for greater spacing between turbines. The turbines will be separated by approximately 500 feet, and will each be situated on a concrete foundation that will be no larger than 1600 square feet (40 feet by 40 feet).

The total "developed" area of the site, or the total area that will contain structures or hardened surfaces, is anticipated to be less than one acre, not including access roadways. The developed area would include the 20 turbine foundations that will total 32,000 square feet, an operations and maintenance facility that will be approximately 1,000 square feet, and a substation with a total area of approximately 5,000 square feet.

The site is accessed by an existing four-wheel-drive roadway that leads from Honoapiilani Highway north of Ma`alaea and just east of McGregor Point, as shown in Figure 1. This roadway will be improved as part of the project, in order to facilitate access and to accommodate construction vehicles and equipment. The current roadway alignment runs uphill on the east side of the project site to a point above the site, where it then curves downhill, in a southwesterly direction, to the northern (mauka) end of the site. The project's roadway improvements will follow approximately 1.7 miles of this existing alignment, from the Honoapiilani Highway entrance uphill, and then will include approximately 1.9 miles of a new access roadway (to the west of the existing alignment) which will enter the midpoint of the project site and connect to approximately 1.75 miles of intrasite roadway serving the facility and wind turbines. The current roadway, proposed access route, and intrasite roadway are depicted in Figure 1.

The proposed roadway alignment has several advantages: it will not utilize the higher elevations of the existing route (better native plant habitats are found at the higher elevations), including the portion that is situated in close proximity to the DOFAW's Manawainui Plant Sanctuary; the proposed alignment follows smoother topographical contours and will, therefore, result in fewer cuts and fills than would result from improvements to the existing alignment; and its simpler contours will result in fewer long-term maintenance challenges.

Additionally, a parking, staging and inspection area just inside the roadway entrance will be cleared and graveled (inspection for invasive plant species will be conducted here to ensure that no such species are transported to the project site). The driveway approach from Honoapiilani Highway will be the only element of the roadway improvements that is asphalt paved.

The roadway work will be performed from the bottom to the top (makai to mauka), with any cut material being carefully reused as fill material, thus minimizing the removal of cut material and import of fill material to the site, with a goal of a net zero change in cut and fill material. The roadway will be topped with any available and salvageable screened material from site work cuts, supplemented with a coarse gravel that is locally produced on Maui, with appropriate swales, culverts and crowning to prevent erosion and concentrated runoff. Construction vehicles needed for the roadway are surprisingly basic, given the minimal and linear nature of the construction area, and include caterpillar bulldozers, dump trucks (to redistribute cut and fill material), and a crusher-screener to re-use as much cut material as possible. Once the roadway work has been completed, then work at the turbine site can begin.

A nominal area of approximately 40 feet by 40 feet will need to be cleared and graded for each turbine pad. Construction vehicles needed for site work include the above-referenced bulldozers, trucks and crusher-screener, plus water trucks and cement mixers needed for the concrete foundations. It is expected that concrete will be batched at the site, rather than imported by truck.

The turbine components will be shipped to Maui via containers that will be unloaded at Kahului Harbor. It is expected that they will be transported to the staging area (just above the Honoapiilani Highway entrance) in the evening, to minimize any disruption of vehicular traffic. Other than this component of transportation, no construction work is expected to occur at night.

During daylight hours, the turbine components will be slowly transported on the access roadway to the project site using a combination of vehicles to carry, push and pull each load, including multi-axle lowboy trailers and specialized tractors. Once at the site, the turbines will be erected by a 300-ton crane, which itself must be transported unassembled to the site and assembled prior to its use.

As noted above, each turbine will be set in a concrete foundation that is no more than 40 feet by 40 feet. An additional 20-foot cleared gravel perimeter will be provided around each foundation to facilitate access and maintenance; weed-barrier material will be used beneath the gravel to further aid in maintenance. Beyond this gravel area, the vegetation will remain in its existing natural state, though maintenance (*e.g.*, trimming, watering) may be provided during dry periods as a fire prevention measure. Such maintenance will be discussed with appropriate DLNR forestry and wildlife officials to ensure that it will not present any potential adverse impacts.

Personnel will generally be present at the facility on a daily basis throughout project operation. They will monitor the condition of the roadway and ensure that any needed maintenance is performed promptly, as well as ensuring that the turbines and supporting facilities are operating properly. Site maintenance will include weed and vegetation control (manual and chemical) around the turbine pads and cleared areas to eliminate any foraging attractions of new growth. Additional maintenance and site work may be conducted for fire prevention purposes at the direction of DLNR forestry officials, though any such work will also be verified with USFWS and DLNR wildlife officials to ensure that it would have no adverse impacts on any listed species.

The proposed wind energy generation facility will have the capacity to generate 30 MW of power, which would be purchased by MECO via a Power Purchase Agreement (PPA) that has been fully executed. The PPA is ultimately reviewed and approved by the Public Utilities Commission. Power generated by the facility will enter the existing MECO 69kV (kilovolt) transmission line that passes directly through the southern end of the project site.

The 30 MW of power generated by the facility would eliminate the use of approximately 150,000 to 250,000 barrels of oil annually that would otherwise be used by MECO to produce conventional power. Because of this reduction in oil use, air emissions from MECO's power plant will be reduced by approximately 177.6 million pounds of carbon dioxide (the leading greenhouse gas associated with global warming), 1.24 million pounds of sulfur dioxide (the leading precursor of acid rain), and 0.32 million pounds of nitrogen oxides (another acid rain precursor and a leading component of smog). *(Figures from the American Wind Energy Association and based on NCF, www.awea.org.)*

Initial work on the access roadway is anticipated to begin in early 2005 to alleviate ongoing erosion problems and provide safe and efficient vehicular access to the area where the turbines will be located. This initial phase of construction is not expected to result in any take of listed species, which are considered to be at risk of in-flight collisions with the project's turbines. Construction of the turbine foundations is anticipated to begin after permit issuance, with erection of the turbines to be completed in late 2005 if the Incidental Take Permit/License and HCP are approved, at which time the turbines would become operational.

The turbines are manufactured by GE Wind and each has the capacity to generate 1.5 MW of power. These "GE 1.5 MW" turbines are among the most prevalent in the wind energy industry and are backed by a 20-year manufacturer's warranty. Kaheawa Wind Power anticipates operating the facility for at least this long, providing routine maintenance and upgrading components as technology improves.

After an approximately 20-year period, the operation of the wind energy generation facility may continue: the GE 1.5 MW wind turbines may be re-powered and their operation continued, or they may be upgraded or replaced with newer, more efficient and improved technology. The continuance of the facility's operation would be subject to a renewal of Kaheawa Wind Power's lease with DLNR, as well as a renewal of this HCP, as it may be amended. Should Kaheawa Wind Power discontinue the operation of the facility, during or after this 20-year period, the lease terms require that the turbines and other structures be removed and the site be remediated, to the extent practicable, to its original condition. Such removal and remediation efforts would likely require a supplement or amendment to this HCP.

## II. DESCRIPTION OF HABITAT CONSERVATION PLAN

### Purpose

The location and operation of the Kaheawa Pastures wind energy generation facility could potentially impact four federally-listed species that are known or presumed to fly in the vicinity of the project site. These species have the potential to collide with the stationary towers, or be struck by the rotors, resulting in injury or mortality. These species also may collide with guy wires supporting the one permanent meteorological tower. Of the four, three are birds: the endangered Hawaiian Petrel (*Pterodroma sandwichensis*), the threatened Newell's (Townsend's) Shearwater (*Puffinus auricularis newelli*), and the endangered Nene (*Branta sandvicensis*). The endemic species Hawaiian Petrel (‘Ua‘u) and the endemic subspecies Newell's Shearwater (‘A‘o) are tropical Pacific seabirds that nest only on the Hawaiian islands (American Ornithologists' Union 1998). The fourth species is a mammal, the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) (‘Ope‘ape‘a). Because of their low overall population numbers and restricted breeding distributions, these species are protected under the federal Endangered Species Act. In accordance with the conditions imposed by the CDUA approving the project, and pursuant to ESA section 10(a)(1)(B), as amended, and HRS Chapter 195-D, a Habitat Conservation Plan (HCP) and Incidental Take Permit/License are required if the take of a listed species is anticipated in connection with a proposed action. This HCP has been prepared to fulfill application requirements for a Federal Incidental Take Permit and a State Incidental Take License. Upon issuance of the permit and license, Kaheawa Wind Power will be authorized for the incidental take of these four species in connection with the construction and operation of the proposed wind energy generation facility.

The purpose of this HCP is to make the most supportable determinations as to the potential impact that the wind energy generation facility could have on each of these 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 during this HCP's implementation.

**Scope and Term**

Kaheawa Wind Power is proud and excited to be proposing Maui's first commercial wind energy generation facility. There are exceptional environmental and economic benefits to reducing this island's dependence on, and burning of, imported oil, as demonstrated by the widespread community support that this project has received, including support from Maui's elected State and County leaders, as well as from the well-known community group Maui Tomorrow.

However, the project's positive environmental contributions must not eclipse the potential for the four listed species to experience adverse effects. Through the successful implementation of this HCP, and in keeping with the project's other environmental qualities, Kaheawa Wind Power proposes to offset the risks of impact and, indeed, provide a net conservation benefit to these four species.

One of the challenges in formulating this HCP has been the limited amount of information available concerning the occurrence and behavior of these species in the project vicinity. In response to this challenge, Kaheawa Wind Power has planned and conducted site-specific surveys, in coordination with biologists from DLNR and USFWS, on which this HCP's conclusions and implementation measures are based. Even so, due to the infrequent occurrences of these rare species in the project area, surveys provide only a partial understanding of these species' whereabouts and status in the project vicinity. 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's Division of Forestry and Wildlife (DOFAW), as further detailed in Section VI - Implementation.

This HCP seeks to appropriately balance the potential impact of the proposed wind energy generation facility on three bird and one bat species with measures to protect and perpetuate these species island-wide and statewide. Kaheawa Wind Power anticipates a twenty-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 appropriately adjusted on an annual basis.

**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 "Final Kaheawa Pastures 20 MW Windfarm, Maui, Hawai`i Environmental Impact Statement" prepared for Zond Pacific by WSB-Hawai`i in 1999. Additional general information on the project and site was provided from the "Kaheawa Pastures Wind Energy Generation Facility Final Environmental Assessment" prepared by Kaheawa Wind Power in October 2004 for HRS 343 compliance.

- Eric Nishibayashi Biological Consulting conducted "Downed Wildlife Survey at Six Leeward West Maui Wind Monitoring Towers" from May through July 1996 to inspect any impacts from wind monitoring equipment at the project site. In November 1998, Mr. Nishibayashi prepared "Native Bird Activity at Proposed Access Road" to determine whether the access roadway would impact native birds. These reports were included in the 1999 HRS 343 Final EIS cited above.

- ABR, Inc. prepared "Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Windfarm on Maui Island, Hawai`i, Summer 1999" in late May and early June 1999 for the four subject species. ABR, Inc. also prepared the more recent "Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Wind Energy Facility on Maui Island, Hawai`i, Fall 2004" in mid-October 2004 for the four subject species, focusing on what is understood to be the fall seabird fledging season. Finally, to assist in the determination of incidental take for Hawaiian Petrels and Newell's Shearwaters, ABR, Inc. prepared "Modeling Annual Seabird Use and Fatality at the Proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawai`i" in December 2004. The summer 1999 survey report is attached as Appendix 1, the fall 2004 survey report is attached as Appendix 2, and the December 2004 model is attached as Appendix 3.

- Richard Podolsky used the passage rates derived by Cooper and Day (2004b) to develop another incidental take model, "Avian Risk of Collision (ARC)" to further assist in the determination of incidental take for Hawaiian Petrels and Newell's Shearwaters. This model is attached as Appendix 4.

- A botanical survey was conducted in April 1996 by Arthur C. Medeiros, Biologist, for the site of the wind monitoring equipment. Mr. Medeiros also conducted a survey of the proposed roadway corridor in November 1998. These reports were included in the HRS 343 Final EIS cited above.

- Two botanical surveys were conducted more recently by Robert W. Hobdy, Environmental Consultant. "Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Primary Route" and "Botanical Resources Survey for the Kaheawa Pastures Wind Energy Project Access Road – Alternate Route Section" were prepared in September 2004 to examine the roadway corridor and a potential alternate spur roadway. These surveys are attached as Appendix 5 and Appendix 6, respectively.

- In addition to site-specific surveys, staff from Haleakala National Park, 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 staff also greatly contributed to the preparation of this HCP.

### Wind Energy and Wildlife

While wind energy has been utilized for centuries, it has rapidly expanded relatively recently in the United States and worldwide with advances in technology and increased interest in renewable and alternative energy sources.

With an estimated 50,000 wind turbines now generating power worldwide, land-based and even off-shore, the impacts of wind turbines on wildlife must be carefully evaluated. 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 2003) available through the USFWS website, http://www.fws.gov. The guidelines are currently open to public comment, and their use on projects is considered voluntary. Nonetheless, they acknowledge several important factors: data on wildlife activity and mortality at one facility may not be applicable to others; many potentially impacted species have not been well studied; and local differences in wildlife, habitat, topography, equipment and weather, among other characteristics, necessitate individual evaluation of each proposed facility.

## III. ENVIRONMENTAL SETTING

The physical and biological setting of the project was described in detail by Zond Pacific in the HRS 343 final EIS and in supporting materials prepared for an earlier version of the project (WSB-Hawai`i 1999). Additional information was also provided in the recent HRS 343 Environmental Assessment prepared by Kaheawa Wind Power in October 2004.

### Location and Vicinity

The proposed facility will be located in an area known locally as Kaheawa Pastures, on the southern slope of the mountains of West Maui, approximately 0.4 miles inland from McGregor Point (see Figure 1).

Vegetation at the project site consists of grasslands at lower elevations and a mixture of grasslands and scattered shrubs at moderate to higher elevations. Shrubs and scattered trees line the two nearby gulches. Directly above the site, shrubs dominate, with native `ohia trees (*Metrosideros polymorpha*) and indigenous uluhe ferns becoming more common. These two plant species form the preferred nesting habitat for Newell's Shearwaters (Sincock and Swedberg 1969, Ainley *et al.* 1997). Although the proposed wind energy generation facility itself consists of a dry Mediterranean habitat, vegetation becomes much wetter upland, above the project area and toward the summit of the West Maui mountains. It is presumed that vegetation communities are dominated by native species in higher, wetter areas that appear to be a suitable nesting habitat for Newell's Shearwaters, based upon comparable research of this species on Kaua`i. In addition to the vegetation, the steepness of higher elevations also suggests suitable nesting habitat for Hawaiian Petrels, as it does on Haleakala Volcano on East Maui (Brandt *et al.* 1995), Kaua`i (T. Telfer, pers. comm.), and Lana`i (Hirai 1978).

## Land Use Designations

The entire subject parcel is situated in the State Conservation District and is owned by the State of Hawai`i. As with other Conservation District lands, the parcel is not subject to any County of Maui zoning or community plan designations or restrictions. A portion of the subject property along Honoapiilani Highway is situated in the Special Management Area (*i.e.*, coastal zone), as provided by HRS Chapter 205A. Project-related work in this vicinity will be subject to a Special Management Area use permit, which is administered by the County of Maui Department of Planning.

## Topography and Geology

The dominant topographic and geological features in the study area are the Manawainui Gulch, which borders the project site on the east; the Malalowaiaole Gulch, which is southeast and makai (ocean-side) of the site; the Papalua Gulch, which is west of the site; and several pu`us or hills. The pu`us include Pu`u Lu`au (near the existing MECO transmission lines, at an elevation of approximately 2,300 feet and east of the proposed turbine locations), and Pohakuloa (at an elevation of approximately 1,600 feet at the lower end of Kaheawa Pastures and makai of the site).

The proposed facility would be located on a narrow band of land running mauka (mountainside) to makai (oceanside) between Manawainui Gulch and Papalua Gulch. The slope of the terrain across the site varies, but averages about eight percent. The site has excellent exposure to the trade winds, which accelerate over the Kealaloloa Ridge, east of the project site.

The West Maui mountains are volcanic in origin, being part of the Hawaiian Emperor volcanic chain of islands and seamounts (MECO 1994). Together, the West Maui volcano and Haleakala on East Maui are the two volcanoes that form the island of Maui. The two volcanoes are separated by a flat isthmus composed of lava flows locally covered by dune sand and alluvial deposits. The most common formation in West Maui is basaltic `a`a and pahoehoe lava flows of the Wailuku Volcanic Series (Tw) with selected cinder cones, friable vitric tuff and weathered andesitic lava.

There are no significant topographic features on the site itself, nor are there any known unique or unusual geologic resources or conditions.

### Soils

There are two main soil associations in the Kaheawa Pastures region: Honolua-Olelo and Rock land-Rough mountainous land (USDA, 1972).

The Honolua-Olelo association is defined as deep, gently sloping to moderately steep, and well-drained soils with a fine-textured subsoil that is typically situated on intermediate uplands, such as on West Maui. Naturally-occurring vegetation that generally occurs on this soil association includes guava, ferns, Hilo grass, koa, lantana, `ohia lehua and pukiawe.

The Rock land-Rough mountainous land association is defined as very shallow, steep and very steep, rock land and rough mountain land. The natural vegetation that generally occurs on Rock land is kiawe, klu, piligrass and `ilima in the lower, drier areas, and guava, pukiawe and molasses grass in the higher, wetter areas. Rough mountainous land is generally thickly vegetated with ferns, guava, Hilo grass, kukui and `ohia lehua.

### Hydrology and Water Resources

Average annual rainfall in West Maui varies from a moderately dry 20 inches at the coast to 400 inches in the higher elevations. The annual rainfall on the proposed wind energy generation facility site is estimated to be between 50 inches at 2,000 feet elevation and 80 inches at 3,200 feet elevation. There are no perennial streams in the project area, though two intermittent streams can develop during rainy periods in the Malalowaiaole Gulch and Manawainui Gulch.

There are no 100-year flood zones identified on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps at or near the mouths of either of these gulches. There are no tsunami inundation zones in the project area, nor are there any reservoirs or irrigation ditches.

Hobdy (2004a) reported that the project area does not contain any wetlands. Consistent with this determination, the Department of the Army (DA), Corps of Engineers, concluded that the site is located entirely within an upland area and does not contain or convey waters of the United States subject to authorization by DA permit (letter from George P. Young, P.E., Chief, Regulatory Branch, Honolulu, dated November 8, 2004).

Additionally, according to DLNR's Commission on Water Resource Management, "…The West Maui Manawainui Watercourse does not have sufficient water to support instream uses, therefore it is not considered to be a stream, and a stream channel alteration permit [Hawai`i Revised Statutes Section 174C-71] will not be required for the proposed vehicular crossing" (Letter from Yvonne Y. Izu, Deputy Director, dated October 27, 2004).

## Terrestrial Flora

The vegetation on the proposed site is a mixed grassland/shrubland type dominated by non-native plants. A general botanical survey over the entire project area was conducted from which sites for six meteorological stations were confirmed (Medeiros, 1996). A second study was conducted in November 1998 along the proposed access roadway corridor (Medeiros, 1998). In 2004, further botanical surveys were conducted of the existing access road and along a proposed alternate spur route designed to provide more direct, environmentally friendly and cost-effective access to the site (Hobdy, 2004a and 2004b).

According to Medeiros (1996), the vegetation is predominately composed of non-native species, mostly pasture grasses and cattle-resistant shrubs. No plant species listed as threatened or endangered by USFWS or the State of Hawai`i were encountered at or near any of the six meteorological station sites. The meteorological stations at the four uppermost elevation sites were dominated by non-native pasture species, especially grasses such as rattail grass (*Sporobolus africanus*) and kikuyu grass (*Pennisetum clandestinum*).

The two lower most meteorological station sites contained more native vegetation than the uppermost sites. The native plants included an endemic grass (*Trisetum inadequale*), an indigenous herb (`uhaloa, or *Waltheria indica*) and several endemic or indigenous shrubs: `a`ali`i (*Dodonaea viscosa*), `ulei, u`ulei (*Osteomeles anthyllidifolia*), `iliahialo`e, sandalwood (*Santalum ellipticum*), and `ilima (*Sida fallax*).

In 1998, Medeiros reported that both the eastern (lower) and western (upper) termini of the proposed roadway are pastures. However, the interior of Manawainui Gulch, especially on the steep western slopes above the proposed roadway, has a stretch of fairly intact native leeward shrublands. Nonetheless, no plant species encountered during the survey are listed as threatened or endangered by USFWS or the State of Hawai`i.

Surveys by Hobdy (2004a and 2004b) also found no federally endangered or threatened plant species along the existing or proposed access road routes, nor were any plants proposed as candidates for such status or any other native species of concern identified. All native plant species recorded as rare within the project corridor are, in fact, more common in the context of Maui or the State of Hawai`i in general. Four somewhat less than common native plant species were noted: `iliahi alo`e (*Santalum ellipticum*), orange-flowered naupaka (*Scaevola gaudichaudii*), kolokolo kuahiwi (*Lysimachia hillebrandii*) and the grass *Trisetum inadequale*. A few individuals of each of these may be removed in the course of roadway improvements, but the best populations noted during the survey lie well outside the project corridor.

The existing access road between 3,400 and 3,600 feet passes through the best native plant habitat that contains three of the four species mentioned above, although in general the area is dominated by non-native species. This area is proposed to be avoided by construction of the new alternate spur roadway, which diverges from the existing road at approximately 1,500 feet elevation and connects with the project site at 2,900 feet elevation.

Hobdy (2004a) further reported that the project area in general has experienced a dramatic loss of native plant communities and species over the last century, expressing concern that further losses of species and habitats be avoided with the proposed wind energy generation facility. He concluded that, with a sensitive approach and sound engineering and construction practices, the proposed project is not expected to have a significant negative impact on the botanical resources in this area. The following considerations and recommendations were offered to mitigate potential unintended impacts:

- The pu`u and middle ridge between the two gulches along the proposed alternate spur roadway contain the best native shrubland habitat and the most component native species (although in general the area is dominated by non-native species). Recommended measures to minimize impacts to this 0.2-mile segment include creating the minimum effective road width and keeping equipment within this corridor as much as possible during the construction process.

- The quality of the road created will have a long term effect on surrounding habitat. It is recommended that the road surface be crowned and rolled with stable material, and that swales, drains and culverts be engineered to channel water from the roadway quickly and effectively. These precautions can help prevent erosion and any associated downslope disturbances from moving water and road materials. They have the added benefit of reducing the need for frequent maintenance work that can result in further disturbances.

- 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. The best way to minimize fire is to limit human access along the road corridor to only those with management or other legitimate functions.

Additionally, the approved project CDUA contains several conditions relating to terrestrial flora, including requirements to revegetate cleared areas with native species found in the area and to prevent alien and invasive plant species from being introduced to the site. These conditions, along with Hobdy's recommendations above, will be implemented in the project design, engineering, construction and operations procedures.

**Wildlife (Non-listed Species)**

The mixed grassland/shrubland vegetation on the proposed project site is habitat to several endemic, indigenous and migratory birds and a number of resident mammals, both native and introduced. Then-applicant Zond Pacific contacted avian experts and conducted two surveys to identify avian species present in the project area. A study in support of the HRS 343 final EIS focused on the identification of downed birds near the six meteorological towers (Nishibayashi, 1997). While no downed birds were found, a number of non-native, introduced species were identified opportunistically in the project vicinity (see table below). None of the observed species is listed as endangered, threatened or protected by USFWS or the State of Hawai`i.

Other indigenous bird species could occur in the project area as well, based on recorded sightings elsewhere on Maui and on occurrences in similar habitats on Maui or elsewhere in the Hawaiian islands (see table below). Along with the three ESA-listed species, the Pueo and the Kolea, these other species are protected by the USFWS under the Migratory Bird Treaty Act (MBTA).

| Common Name | Scientific Name | Detections* | Status |
|---|---|---|---|
| Eurasian Skylark | *Alauda arvensis* | 22 | MBTA |
| Ring-Necked Pheasant | *Phasianus colchicus* | 18 | None |
| Black Francolin | *Francolinus francolinus* | 12 | None |
| House Finch | *Carpodacus mexicanus* | 9 | MBTA |
| Common Myna | *Acridotheres tristis* | 7 | None |
| Pueo or Hawaiian Short-eared Owl | *Asio flammeus sandwichensis* | 5 | MBTA, HI Species of Concern (informal) |
| Nutmeg Manikin | *Lonchura punctulata* | 4 | None |
| Gray Francolin | *Francolinus pondicerianus* | 3 | None |
| Northern Cardinal | *Cardinalis cardinalis* | 1 | MBTA |
| Spotted Dove | *Streptopelia chinensis* | 1 | None |
| Kolea or Pacific Golden Plover | *Pluvialis fulva* | 1 (1998) | MBTA |
| Band-rumped Storm-Petrel | *Oceanodroma castro* | 0 | MBTA |
| White-tailed Tropicbird | *Phaethon lepturus* | 0 | MBTA |
| Wandering Tattler | *Heteroscelus incanus* | 0 | MBTA |
| Bristle-thighed Curlew | *Numenius tahitiensis* | 0 | MBTA |

*number of days (of 26 total) species was detected by Nishibayashi (1997)

Among the birds observed by Nishibayashi (1997) was a pair of the native Pueo or Hawaiian Short-eared Owl, which is informally considered a Species of Concern. Pueo were observed on five of the 26 survey days. The pair were observed flying in the vicinity of one of the existing meteorological towers and actively avoiding the guy wires. On a subsequent visit in November of 1998, Nishibayashi (1998) observed up to a dozen Kolea or Pacific Golden Plover either on the ground or flying through the area of the proposed access road. Day and Cooper (1999) also reported observations of Pueo during eight nights of surveys in May and June 1999, noting four to six individuals foraging in the area. Most Pueo activity was concentrated in the nearby gulches, although individuals occasionally were observed foraging over the open, flatter part of the study area. During eight nights of surveys in October 2004, Cooper and Day (2004) noted two to three Pueo behaving similarly to the birds observed in 1999.

Based upon project-related site visits, as well as information provided by Maui DLNR staff, other wildlife occurring in the vicinity of the project site includes mice, rats, mongooses, feral cats and feral dogs.

**Wildlife (Listed Species)**

The status within the project vicinity of the four listed species, and the likelihood of adverse impacts due to collision with the proposed wind turbines, were reviewed by Day and Cooper (1999) and Cooper and Day (2004). Complete copies of these studies are attached as Appendix 1 and Appendix 2. Nishibayashi (1998) also observed Nene about 0.5 miles from the project area, and noted that Hawaiian Petrels have been known to nest at elevations above the project area. The following sections summarize these findings. Selected literature citations have been included here. For complete citations, reference is made to the appended studies.

Hawaiian Petrel

The Hawaiian Petrel is a large petrel, approximately 16 inches long with a wing span of three feet. The species was once abundant on all main Hawaiian islands except Ni`ihau. Today, Hawaiian petrels breed in high-elevation colonies, primarily on East Maui and, to a lesser extent, on Hawai`i, Kaua`i and Lana`i. Recent information on Moloka`i also suggests breeding. The largest breeding colony is found at Haleakala Crater on East Maui.

The Hawaiian Petrel is strictly nocturnal, over land, and active in their nest colony for about nine months each year. The long-lived adults (ca. 30 years) return to the same nesting burrows each year between March and April. Females lay only one egg, which is incubated alternately by both parents for approximately fifty-five days. Eggs hatch in July or August, after which both adults spend their time flying to sea to feed and bring food home for the nestling. The fledged young depart 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.

The most serious threat to the species is depredation of eggs and young in the breeding colonies by introduced mammalian predators such as feral cats and mongoose. According to population modeling, this species could face extinction in a few decades if predation is not controlled (Simons 1984). Recent intensive trapping and habitat protection has helped to improve nesting and fledging success (Harrison 1983, Ainley *et al*. 1997). Other threats include avian malaria, which was found in blood samples of Hawaiian Petrels in the 1960s and may have killed off low-elevation breeders, and occasional mortality from collisions with powerlines and fences near breeding sites. For example, 31 adult birds were killed at Haleakala National Park from 1976 to 1993 as a result of collisions with a fence erected to exclude predators from the nesting colony (Hodges 1994). In addition, fledgling 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 land in brightly lit areas at scattered locations on Maui in most years. The problem is much smaller than the one involving Newell's Shearwaters (see following section), and it is not at present thought to pose a threat to remaining populations (Simons and Hodges 1998).

The United States Fish and Wildlife Service's "Recovery Plan for the Hawaiian Dark-rumped Petrel *(Pterodroma sandwichensis)* and Newell's Townsend's Shearwater *(Puffinus auricularis newelli)*" includes three objectives: (1) reduce annual fallout, (2) provide long-term protection for the known nesting colonies, and (3) develop efficient predator control methods for use in and around isolated nesting sites (USFWS 1983). Predator control in key habitat areas, the establishment of Bird Salvage-Aid Stations, and light attraction studies have been initiated to help save the Hawaiian Petrel. The USFWS, DLNR and the National Park Service work cooperatively to protect their breeding habitats and control predators within Haleakala National Park.

The number of Hawaiian Petrels on Maui has been estimated at 1,800 birds, all of which are believed to be associated with colonies on Haleakala. However, radar counts of petrels on the perimeter of Maui suggest that the number is much higher than 1,800 (Cooper and Day 2003). It is not known with certainty whether they also nest in the western part of the island (*i.e.*, the West Maui mountains) and, if they do, their nesting distribution or habitat use there. On 16 June 1999, however, a Hawaiian Petrel was heard calling from a bed of uluhe ferns (*Dicranopteris linearis*) at 3,300 feet elevation in the Kapunakea Preserve, which lies on the northwestern slope of the West Maui Natural Area Reserve, suggesting breeding in West Maui (A. Lyons, *fide* C. Bailey *in* Cooper and Day 2004). This location is approximately 8 miles from the upper end of the proposed project site. Further, Cooper and Day (2004) observed Hawaiian Petrels flying inland over the northern coast toward the West Maui mountains.

Daily movement rates of Hawaiian Petrels (and Newell's Shearwaters, see following section) near the proposed facility (*i.e.*, on the southern slope of the West Maui mountains) are much lower than those over the eastern and northern sides of Maui. For example, the mean movement rates over the proposed wind farm of 1.0 targets/h in fall 2004, and 1.2 targets/h in summer 1999 are lower than 12 of the 14 sites surveyed on the perimeter of Maui in summer 1999, where movement rates ranged from 4 to 134 targets/h (Cooper and Day 2003). Further, the rates observed at the proposed wind farm represent less than 15 percent of the lowest mean movement rate recorded at any of the 18 sites sampled on Kaua`i during the summers of 1993 to 2001 (Day and Cooper 2001). On both Kaua`i and Maui, the lowest mean movement rates occur on the drier southwestern parts of the islands, *i.e.*, corresponding to the proposed wind farm location (Day and Cooper 1995, Cooper and Day 2003). In summary, the radar data suggest that the general area where the proposed wind farm is located tends to have the lowest passage rates of petrels/shearwaters on the island of Maui (Day and Cooper 1999, Cooper and Day 2003, Cooper and Day 2004).

Newell's Shearwater

The Newell's Shearwater is a bird of the open tropical seas and offshore waters near breeding grounds. A small shearwater, the Newell's is approximately 12-14 inches long, with a wingspan of 30-35 inches. Newell's Shearwater breeds on several of the main Hawaiian islands, with the largest numbers clearly occurring on Kaua`i, where they nest in mountainous terrain between elevations of 500 and 2,300 feet. These birds also nest on Hawai`i, almost certainly nest on Moloka`i, and may still nest on O`ahu. The occurrence on Maui of injured, dead, or grounded adults in summer, of low numbers of radar targets exhibiting Newell's-like timing of movement, and of juveniles in autumn suggest that the species also may nest on Maui; however, the exact status of this species on Maui is unclear at this time. The strictly nocturnal behavior of this species makes determination of its status and distribution more difficult than that of the more crepuscular Hawaiian Petrel.

During their nine-month breeding season from April through November, Newell's Shearwaters live colonially in burrows under ferns on forested mountain slopes. These burrows are used year after year and usually by the same pair of birds. A single egg is laid probably in June. Incubation by both sexes lasts 45 days, and young fledge in October-November. The Newell's Shearwater needs an open downhill flight path through which it can become airborne.

The Newell's Shearwater was once abundant on all main Hawaiian islands. During the last 150 years, 75 percent of the forests on the main islands of the Hawaiian archipelago have been converted to agricultural, military, commercial or residential land uses, leading to a depletion of available nesting habitat for this species. The introductions of the mongoose, black rat, and Norway rat have also played a primary role in the reduction of ground-nesting seabirds. Also a major threat is the species' attraction to light. Increasing urbanization and the accompanying manmade lighting have resulted in substantial problems for fledgling shearwaters during their first flight to the ocean from their nesting grounds. When attracted to manmade lights, fledglings become confused and may suffer temporary night blindness. They often fly into utility wires, poles, trees, and buildings and fall to the ground. Between 1978 and 1981, more than 5,000 Newell's Shearwaters fell on Kaua`i's highways, athletic fields, and hotel grounds (USFWS 2005).

The total population of the Newell's Shearwater is estimated at roughly 84,000 birds (Ainley *et al.* 1997), with approximately 75 percent occurring on the island of Kaua`i. Population models incorporating best estimates of breeding effort and success yielded a population decreasing at a rate of 3.2 percent annually (Ainley *et al.* 2001). When variables describing the anthropogenic mortality suffered by Newell's Shearwater (predation, light attraction and collision) were included, these models predicted a population decline of 30 to 60 percent over 10 years (Ainley *et al.* 2001). As noted by DOFAW (2005a), it is evident that an attraction to lights and collision with power lines and other structures exacts a significant mortality on fledglings and breeding adults.

The United States Fish and Wildlife Service's "Hawaiian Dark-rumped Petrel and Newell's Manx Shearwater Recovery Plan" includes three objectives: (1) reduce annual fallout, (2) provide long-term protection for the known nesting colonies, and (3) develop efficient predator control methods for use in and around isolated nesting sites (USFWS 1983). In order to meet these goals, DOFAW (2005a) recommend the following short-term goals be accomplished first:

1. Increase reproductive success at a minimum of two Newell's Shearwater colonies.
2. Increase fledging success by decreasing fallout at a specified location such as the north shore of Kaua`i.
3. Assess the effects of predators on Newell's Shearwater reproduction.
4. Monitor overall population trends on Kaua`i and improve knowledge of Newell's Shearwater breeding distribution throughout Hawai`i, especially on O`ahu, Lana`i, Moloka`i, and Maui.
5. Monitor results of restoration/conservation activities at specific sites.

Predator control in key habitat areas, the establishment of Bird Salvage-Aid Stations, nest translocation, and light attraction studies have been initiated to help save the Newell's Shearwater. Outreach to Kaua`i's local community has resulted in people picking up and bringing them to aid stations for care and release, giving the seabirds a chance to live (USFWS 2005).

Radar and night-visual observations were recently conducted in the fall of 2004, during the fledging period of both the Newell's Shearwater and Hawaiian Petrel (Cooper and Day 2004). Hawaiian Petrels fledge slightly later (15 October–20 November on Maui) than Newell's Shearwater (1 October–10 November). Radar and night-visual observations by Day and Cooper (1999) and Cooper and Day (2004) indicate that both species still nest somewhere on the West Maui mountains, and low numbers of these birds regularly fly over or near the proposed Kaheawa Pastures site at night, to or from nesting colonies either on the West Maui mountains or (occasionally) on Haleakala. The size of the West Maui nesting population is unknown at this time. However, mean movement rates are very low – less than most other locations on Maui and less than 15 percent of the lowest mean movement rates that were recorded at 18 sites on Kaua`i during 1993–2001 (see summary of these data in above section for Hawaiian Petrel).

<u>Nene</u>

The Nene is a medium-sized goose, with an overall length of approximately 25-27 inches. This species is adapted to a terrestrial and largely nonmigratory lifestyle in the Hawaiian islands with limited freshwater habitat. Compared to the related Canada goose, Nene wings are reduced by about 16 percent in size and their flight is weak. Nonetheless, Nene are capable of both inter-island and high altitude flight (Miller 1937; Banko *et al.* 1999).

The Nene 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).

Nesting peaks in December and most goslings hatch from December to January (Banko *et al*. 1999).

Nene 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. While the female incubates the eggs, the male stands 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 be later in the wild. During molt, adults are flightless for a period of 4 to 6 weeks, generally attaining 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 mongooses. From June to September, family groups join others in post-breeding aggregations (flocks), often far from nesting areas.

Nene occupy various habitat types ranging from beach strand, shrubland, and grassland to lava rock, and elevations ranging from coastal lowlands to alpine areas (Banko 1988; Banko *et al*. 1999). Nene are browsing grazers. The composition of their diet depends largely on the vegetative composition of their surrounding habitats and they appear to be opportunistic in their choice of food plant as long as they meet nutritional demands (Banko *et al*. 1999; Woog and Black 2001).

The main limiting factors currently affecting Nene recovery are predation by introduced mammals, insufficient nutritional resources for both breeding females and goslings, limited availability of suitable habitat, and human-caused disturbance and mortality (USFWS 2004). In order for Nene 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 Nene are highly adaptable, successfully utilizing a gradient of habitats, ranging from highly altered to completely natural, which bodes well for the recovery of the species.

The goal of the recently revised United States Fish and Wildlife Service's "Draft Revised Recovery Plan for the Nene or Hawaiian Goose *(Branta Sandvicensis)*" is to enable the conservation of Nene by utilizing a mix of natural and human-altered habitats in such a way that the life history needs of the species are met and the populations become self-sustaining at or above recovery target levels (USFWS 2004). On Maui, captive releases are considered an important strategy for Nene recovery, to establish new populations and to supplement existing unstable populations, but releases must occur in conjunction with predator control and habitat manipulation (USFWS 2004).

Currently, there are wild populations of Nene on Hawai`i, Maui and Kaua`i composed of an estimated 349, 251, and 620 individuals, respectively (USFWS 2004). After nearly becoming extinct in the 1940's and 1950's, this species' population slowly has been rebuilt through captive-breeding programs. As a result of such programs, the Nene has been re-introduced onto four of the main Hawaiian islands (Kaua`i, Maui, Moloka`i, and Hawai`i). The primary release site on Maui is located at Haleakala National Park on East

Maui where, as of 2003, 511 Nene have been released since 1962. Releases on Maui have ranged from a high of 72 birds in 1969, to a low of zero in several years including from1979 through 1991. Annual releases were typically on the order of 20 to 50 birds at Haleakala in the 1960s and 1970s. Since 1995, the majority of Maui releases have been from a new release pen in Hanaula, in the West Maui mountains, in an effort to establish a second population on this part of the island (F. Duvall, Maui DOFAW, pers. comm.). This pen is located near the upper end of the proposed Kaheawa Pastures project site, approximately 1,800 feet from the nearest proposed wind turbine (please reference Figure 4). Since 1994, 87 Nene have been released at Hanaula, compared with 18 at Haleakala (USFWS 2004).

Little is known about the exact distribution and movements of the birds released at Hanaula, although they have been recorded as far west as Lahaina and as far east as Haleakala National Park, indicating that at least some birds from this release site move extensively around the island. (J. Medeiros, Maui DOFAW, pers. comm.). As of this writing, Nene are not believed to be nesting within the area of the proposed access road or turbines, although a thorough search has not yet been conducted (J. Medeiros, Maui DOFAW, pers. comm.).

A number of the Nene from the release site have remained as residents within or near the project area; in 1998, four goslings were successfully fledged from the first nest reported in the area (DOFAW 2000). These individuals are presently at risk from mammalian predators, including rats, mongoose, feral cats and feral dogs. In an effort to reduce this risk, DOFAW maintains an active program to trap mammalian predators in the vicinity of the release site. Nene may also be at risk of colliding with the existing MECO power lines, though no surveys have been done and few observers are present to report any collisions that may occur.

Hawaiian Hoary Bat

The Hawaiian Hoary Bat is the only existing native terrestrial mammal from the Hawaiian archipelago (USFWS 1998). Cooper and Day's (2004) review states that this species is small, nocturnal to crepuscular, and difficult to study and count (see Appendix 2). Little is known about its biology, distribution, or habitat use on the Hawaiian islands, beyond the fact that it is an insectivorous bat that roosts solitarily in tree foliage.

The Hawaiian Hoary Bat has been recorded on Kaua`i, O`ahu, Moloka`i, Maui and Hawai`i, is believed to be most abundant on the latter island, and is thought to be present in low numbers on Maui. The Hawaiian Hoary Bat 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, Maui. The highest altitude record of this species is of one bat at 11,004 feet on Mauna Loa, Hawai`i. This species was recorded between 0 and approximately 9,050 feet in elevation on Maui, with most records occurring at approximately 2,060 feet.

Breeding has been documented on Hawai`i and Kaua`i, but is not known on the other islands (Baldwin 1950, Kepler and Scott 1990). Breeding probably occurs most frequently between September and December, with birth of two young occurring in May or June. Hawaiian Hoary Bat activity apparently varies seasonally, but the nature and timing of this variation is unclear. Although seasonal inter-island and elevational migration has been suggested, migration on the scale of the mainland North American Hoary Bat is unknown in the Hawaiian Hoary Bat (Kepler and Scott 1990, Kramer 1971), Tomich 1986).

Hawaiian Hoary Bats have been observed foraging in a variety of both open and more vegetatively cluttered habitats, including open fields near native or non-native vegetation, over the open ocean (in bays near shore), over lava flows, and at streams and ponds, and have been documented foraging from three feet to over 483 feet above the ground or water (Baldwin 1950, Fujioka and Gon 1988, Kepler and Scott 1990, Jacobs 1993 and 1994, and Reynolds *et al.* 1997). It is not known whether they prefer to roost in native or non-native vegetation cover. Population estimates for all islands have ranged from hundreds to a few thousand, although these estimates are based on limited and incomplete data, and the magnitude of any population decline is unknown (USFWS 2005). Observation and specimen records do suggest, however, that these bats are now absent from historically occupied ranges.

According to the United States Fish and Wildlife Service, "Recovery Plan for the Hawaiian Hoary Bat *(Lasiurus cinereus semotus)*", bat populations can be threatened by habitat loss, pesticides, predation, and roost disturbance (Bat Conservation International 1991). The decline of the Hawaiian Hoary Bat may be primarily due to the reduction of tree cover in historic times, and they may be indirectly impacted by the use of pesticides (USFWS 1998). Research is considered the key to reaching the ultimate goal of delisting the Hawaiian Hoary Bat. The initial focus is on developing standardized survey and monitoring techniques and collecting basic life history information of Hawaiian Hoary Bats on the island of Hawai`i, which apparently has the largest population of this subspecies. Once developed, these techniques can be applied to other islands to determine bat abundance and distribution (USFWS 1998).

On Maui, this bat is believed to primarily occur in moist, forested areas, although little is known about its exact distribution and habitat use on the island, especially in the West Maui mountains. In spite of the species' probable preference for moist forested areas, it has been seen on West Maui in Lahaina and near Mopua, both of which are dry, and on the dry, treeless crest of Haleakala in East Maui. It also is recorded regularly on the drier side of Kaua`i and Hawai`i, especially near the coast, indicating that such habitat does not exclude this species. These bats were found to be more common on the drier side of Hawai`i, probably because the number of flying insects is higher and feeding is less disrupted by rain. During the day, these solitary bats roost in a variety of tree species and occasionally in rock crevices and buildings; they have rarely been recorded hanging from wire fences on Kaua`i and have once been seen leaving and entering caves and lava tubes on Hawai`i. Hawaiian Hoary Bats are generally considered to be tree-roosting bats of primarily forested areas, similar to the North American hoary bat (*Lasiurus cinereus cinereus*).

No Hawaiian Hoary Bats were recorded in the area of the proposed wind turbines during studies conducted in summer 1999 (Day and Cooper 1999) or fall 2004 (Cooper and Day 2004a). However, it is probable that this species may occur in the proposed project area at any time of year, either foraging or in transit, although it probably occurs infrequently and in very low numbers (Cooper and Day 2004a).

## IV. BIOLOGICAL GOALS AND OBJECTIVES

### General

This Habitat Conservation Plan has species-based, rather than habitat-based, goals and objectives. The proposed wind energy generation facility will have only minor, negligible or indirect impacts on the amount or quality of habitat of listed species; that is, the facility itself will not result in the major alteration, degradation or loss of terrestrial habitat. Because the proposed facility is anticipated to have potential direct impacts on four listed species by impacting their flight space, this Plan's goals and objectives are based on individuals or populations of these species and not habitat.

Kaheawa Wind Power has worked cooperatively with USFWS and DLNR to assess the potential for adverse impacts to the four listed species through site-specific studies, and to take all appropriate and practicable steps to minimize the potential for adverse impacts. Where the potential for impacts is unavoidable, it is the intent of this HCP to provide a means to minimize and mitigate any adverse impacts to listed species that may occur.

Specific biological goals of this HCP are to:

- minimize and mitigate, to the maximum extent practicable, the effects of take caused by interaction of ESA-listed wildlife with the wind energy generation facility;

- increase the knowledge and understanding of the four listed species' occurrence and behavior in the project vicinity;

- adhere to the goals of USFWS Nene draft revised recovery plan and DOFAW's Nene Restoration Project;

- adhere to goals of the existing recovery plans for the other three species, considering the most recent updated information and goals; and

- provide a net conservation benefit to each of the four species.

### Project Alternatives

Before evaluating the proposed project's potential impacts, and before discussing measures to minimize and avoid potential impacts, it is helpful to understand how the project site and design were ultimately chosen over other possible alternatives.

<u>No-Action Alternative: "No Build" and Site Selection</u>

The "no-action" alternative that would not result in take of listed species is a "no build" alternative that would mean a commercial wind energy generation facility would not be constructed and operated by Kaheawa Wind Power on Maui. This is not considered to be a desirable alternative from several perspectives. Kaheawa Wind Power proposes to develop such a facility – it 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 percent by the end of 2005, 10 percent by the end of 2010, 15 percent by the end of 2015, and 20 percent by the end of 2020. The "no build" alternative, then, would contradict the State's desire to develop viable renewable energy sources, as well as MECO's obligation to meet these milestones, and Kaheawa Wind Power's business plan to contribute to these goals.

The no-build scenario would result in no take and thus no change to the four listed species' status. There would be no changes to the site or to existing habitats, nor any potential for collision with wind turbines or project infrastructure. Additionally, without the proposed mitigation measures in the CDUA and HCP, there would be no contributions to recovery efforts, no further study or habitat protection funded by the project, and no improvements to the existing jeep trail that wildlife officials presently use to gain access to the site and the existing Hanaula facility.

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

In the early project stages, various sites around the state were considered. Other areas of Maui have suitable wind regimes, but these areas are either considerably less accessible or do not have enough land area to develop a commercially-viable operation. Few other sites on Maui have as robust and reliable a wind regime as Kaheawa Pastures (please reference Figure 5, MECO's "Wind Speed of Maui County at 50 Meters" which depicts wind speeds throughout Maui County at typical wind turbine hub height. Additionally, the Kaheawa Pastures site, though challenging to access, has an existing four-wheel-drive roadway, has ample acreage, and has a landowner (*i.e.*, the State of Hawai`i) who is willing to provide sufficient area for a viable operation.

In general, there are few if any locations in Maui County where federally-listed species are not known or believed to occur at some time of the year. For example, more windward or interior sites having a greater amount of forest cover may have a greater likelihood of harboring roost sites for the Hawaiian Hoary Bat. An alternate site may exist where use by the two seabird species is lower than at the site of the proposed project, however the project site had among the lowest documented movement rates of any location on Maui (Cooper and Day 2003). Nene would probably be at lower risk of collision at an alternate site on West Maui, given the proximity of the existing release site. However, the range of this species has been expanding on the island, and it is possible that they occur, or that they will occur in the future, wherever suitable habitat exists.

Turbine Layout, Design and Size

As previously mentioned, the project has undergone several modifications since the HRS 343 final EIS was prepared for the project in 1999.

The design that was contemplated in the final EIS utilized 27 Zond Z-48 turbines, each producing 750kW, for a total output of approximately 20 MW. The Z-48 consists of a 50-meter lattice tower and a 48-meter diameter rotor. This would create a total individual turbine height of approximately 74 meters (243 feet), which is the total height of the tower plus the tip of the rotor at its highest point. The combined height of all of the turbines would total 1998 meters. (Combined turbine height was utilized in the project's HRS 343 EA to assess overall visual impacts.) The rotor speed of the Zond Z-48 is 34 revolutions per minute (rpm).

The CDUA approved a project design utilizing 30 Vestas V-47 turbines, each producing 660kW, for a total output of approximately 20 MW. The V-47 consists of a 40-meter tubular tower and a 47-meter diameter rotor. This would create a total individual turbine height of approximately 64 meters (208 feet). The combined height of all of the turbines would total 1920 meters. The rotor speed is 28.5 rpm.

Kaheawa Wind Power now proposes a project design utilizing 20 GE 1.5 MW turbines, each producing 1.5 MW, for a total output of approximately 30 MW. The GE 1.5 MW turbine consists of a 55-meter tubular tower and a 70-meter diameter rotor. This would create a total individual turbine height of approximately 90 meters (296 feet). The combined height of all of the turbines would total 1800 meters. The rotor speed is variable at 11-20 rpm.

Factors affecting the risk of bird collisions are not fully understood, however speed of rotation, visibility of the blades, tubular versus lattice towers, and the amount of rotor swept area are all likely to have an affect. The total rotor swept area of the 20 GE 1.5 turbines (76,930 $m^2$) is approximately 50 percent greater than either the Zond Z-48 (52,022 $m^2$) or the Vestas V-47 (48,833 $m^2$). However, the rotor speeds of the previously proposed models are fixed at 34 rpm and 28.5 rpm, respectively. By comparison, the GE 1.5 turbines proposed under the current design rotate at 11 to 20 rpm, depending upon wind conditions. This represents a minimum reduction of 30 to 42 percent at the high end of the variable range, and as much as a 62 to 68 percent reduction at the low end of the range. As noted by Podolsky (2004, 2005), the probability of a bird passing unharmed through a spinning rotor increases at lower rotor speeds. Also, at least to the human eye the larger, slower blades and solid tubular tower of the GE turbine are clearly more visible.

All three alternatives would follow the same design concept of a single row, situated parallel to the slope of the mountainside, approximately 0.25 miles from Manawainui

Gulch and approximately one mile from Kealaloloa Ridge. The current design is believed to be an improvement over the previous two concepts because it utilizes fewer turbines, thus resulting in fewer opportunities for bird and bat collisions; a tubular tower, thus eliminating the bird perching and nesting attractions of lattice; and larger turbines and larger, slower rotors, which are arguably more visible to birds and bats and, therefore, increase the opportunities for intentional avoidance. This concept was discussed at a September 2004 workshop co-sponsored by the American Wind Energy Association and the American Bird Conservancy, where it was suggested that larger, slower rotors cause fewer bird fatalities than smaller, faster rotors with equal swept areas (*www.awea.org* and RESOLVE, p. 38).

The potential for impacts to listed birds and bats is thus believed to be lower for the current design than for the previous designs, for the reasons explained above. However at this point there is no empirical evidence that clearly demonstrates a greater or lesser potential impact for the species under consideration.

Other benefits not relating directly to this HCP include the reliability and strong reputation of the GE wind turbine, as well as the ability to produce 30 MW of power rather than 20 MW or less, thus making the project more economically viable, readily financed and environmentally beneficial.

**Minimization and Avoidance of Impacts**

The analysis of project design alternatives supports the conclusion that the proposed alternative is preferred when all impacts on the human environment are considered. Because complete avoidance of risk to the four listed species is impossible under the preferred alternative, Kaheawa Wind Power has sought to minimize the risk of collisions as much as possible by making the turbines less attractive, more visible, or more likely to be avoided by birds and bats. These measures include:

- employing relatively few turbines situated in a single row, rather than a large number of turbines in multiple rows;

- using “monopole” steel tubular towers, 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;

- using a smaller tower (55 meters) than is typically used with the GE 1.5 turbine (65 meters or greater), to potentially reduce the risk of collision for birds and bats, even though such risk is not demonstrably related to the tower height;

- utilizing a rotor with a significantly slower rotational speed (11-20 rpm), which makes the rotor much more visible during operation (previous designs had 28.5 and 34 rpm rotors), as cited above;

- choosing a site in proximity to existing electrical transmission lines to eliminate the need for an overhead transmission line from the project to the interconnect location;

- placement of all new power collection lines underground to eliminate the risk of collision with new wires;

- designing and installing the site substation and interconnect to MECO's transmission lines using industry-standard measures to reduce the possibility of wildlife electrocutions;

- marking guy wires (presently utilized on temporary meteorological towers, one of which is expected to eventually be a permanent component of the site) with high-visibility bird diverters, such as reflectors, foam tubing, or other suitable marking devices designed to reduce bird strikes;

- restricting construction activity to daylight hours to avoid the use of nighttime lighting that could be an attraction;

- requesting endorsement of a minimal lighting plan by the Federal Aviation Administration (FAA) to reduce the likelihood of attracting or disorienting seabirds (a plan to provide lighting on only six of the twenty turbines was approved by the FAA in March of 2005);

- 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 (these three lighting measures will be taken not only as avoidance and minimization of wildlife impacts, but also to greatly reduce the visual impact for the resident and visitor population of Maui that is accustomed to or expects to see darkness in the West Maui mountains at night);

- limiting on-site vegetation to that which is already established and existing in order to eliminate new growth that would be a foraging attraction to Nene (by leaving existing surrounding vegetation "as-is" except for measures that may be needed for fire prevention, and by controlling new growth through manual or chemical means);

- conducting pre-construction surveys for Nene and Nene 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; a survey protocol has been prepared in conjunction with this HCP and is attached as Appendix 7; and

- following the survey protocol should construction begin and Nene and/or a nest(s) is subsequently discovered.

As stipulated in the DLNR ITL, Special Condition #8 states that DLNR will be notified within 30 days in advance of any planned land management activity (e.g., construction or maintenance), which Kaheawa Wind Power reasonably anticipates will result in the incidental take of covered species on the enrolled property. Kaheawa Wind Power will also provide DLNR, possibly with the assistance of the Service, the opportunity to capture and/or relocate any potentially affected individuals of the covered species before the activity takes place.

Kaheawa Wind Power is also discussing with MECO the possibility of adding "aviation balls" or "bird diverter" reflectors to the MECO transmission lines that traverse the site as an additional effort to increase the visibility of objects in this area that birds and bats could potentially strike.

Periodic or seasonal shut-down of turbines was considered but was ruled out because it is unlikely to significantly reduce the risk of collisions at the Kaheawa site. A periodic or seasonal shut-down might include, for example, such measures as shut-down during Nene or seabird fledging periods (*i.e.*, several weeks during May-June and October-November, respectively). Although seasonal shut-downs have been proposed as one way to reduce bird fatalities at Altamont Pass in California, only a small number of selected turbines are involved (thus having only a minor impact on the project), and shutdowns are considered only a temporary measure until more permanent improvements are implemented. At Altamont it is recognized that the greatest reductions in bird fatalities can only be realized by replacement of the existing, older generation turbines with newer generation, slow-rotation turbines of the type that are proposed at Kaheawa Pastures. According to Podolsky (2004), a complete re-powering of the Altamont area with newer generation turbines similar to the type that are proposed for Kaheawa Wind Power could reduce bird fatalities by as much as 90 percent. In other words, the best available technology for minimizing the risk of bird fatalities is already being incorporated into the Kaheawa Pastures project.

Shutting down turbines has not been shown to reduce collisions at existing projects, and it appears that most collisions would occur regardless of whether or not a turbine is in operation (Evans 2003). Collision events have been reported and occurred when turbines were not operating (*e.g.*, James 2003, and Gill *et al.* 1996), and large collision events have occurred at towers and structures that lack moving rotors (Bird Studies Canada 2003). Modeling by Podolsky (2004) suggests that the probability of a bird colliding with a rotating, newer generation (slow rotation) turbine is only slightly higher (on the order of 10 percent for "average" bird size and speed) than with a stationary turbine. Accordingly, this alternative was not adopted because it is unlikely to significantly reduce the risk of collisions at Kaheawa Pastures.

<u>USFWS Guidelines</u>

As noted above, USFWS has developed interim guidelines for avoiding and minimizing wildlife impacts from wind turbines. Listed below are the recommendations relating to site development and turbine design and operation, and how Kaheawa Wind Power responds to 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 so the benefits of following these recommendations extend beyond the implementation of this HCP (though, in some cases, some of these recommendations are not applicable to the proposed project, on Maui). It should also be noted that these guidelines are both interim and voluntary, and are not required by statute. Nonetheless, Kaheawa Wind Power believes that these guidelines provide several substantive recommendations that are relevant and applicable to the proposed wind energy generation facility.

Comparison of the Kaheawa Pastures Wind Energy Generation Facility with the USFWS Interim Voluntary Guidelines for Wind Projects (USFWS 2003).

| **USFWS Interim Voluntary Guidelines** | **Kaheawa Pastures Facility** |
|---|---|
| *Site Development Recommendations* | |
| 1. Avoid placing turbines in documented locations of any species of wildlife, fish, or plant protected under the Federal Endangered Species Act. | There are no other locations on Maui that (a) could support a financially viable wind energy generation facility and (b) are unlikely to be visited by listed species. Site-specific surveys indicate that the risk to listed species that occur or may occur on the site is low to very low, although no comparative surveys were conducted on relative risks of different sites. The selected alternative avoids risk to listed species as much as possible while still meeting the basic project purpose. |
| 2. 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. Though birds and bats occur or may occur in the project vicinity, the site is not a high concentration area for any of the listed species. |

| USFWS Interim Voluntary Guidelines | Kaheawa Pastures Facility |
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| 3. 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. There are no forest areas that may provide potential roosting habitat in the project vicinity, or any documented use of the site by bats during night surveys. |
| 4. 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 approximately 0.25 miles from Manawainui Gulch where most owl activity has been observed. Although owls have also been observed flying over the higher ground proposed for the wind farm, activity here is lower than in the adjacent gulch. |
| 5. 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. |
| 6. 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 has been previously disturbed by pasturing and grazing uses. Existing areas of native cover types are fragmented and interspersed with disturbed, non-native dominated cover. Even so, in its existing form it does provide habitat for Nene, which are adaptable to a variety of native and non-native cover types. |

| USFWS Interim Voluntary Guidelines | Kaheawa Pastures Facility |
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| 7. 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 habitat fragmentation. In known prairie grouse habitat, avoid placing turbines within five miles of known leks (communal pair formation grounds). | This recommendation is not applicable - no such species or their habitats occur in the area. |
| 8. 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. One of the CDUA conditions requires the preparation of a Wild Land Fire Contingency Plan (note that controlled burn and prairie considerations are not applicable). |
| 9. 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. The CDUA contains several conditions relating to revegetation of the site, to be coordinated with DLNR staff. |
| 10. 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 |
| *Turbine Design and Operation Recommendations* | |
| 1. 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 meteorological tower supports. All existing guy wires should be marked with recommended bird deterrent devices (Avian Power Line Interaction Committee 1994). | This recommendation has been, and will continue to be, followed. Tubular towers are being utilized; the towers will not have ladders or platforms; and guy wires will only be utilized on the one permanent meteorological tower but will be appropriately marked. |

| USFWS Interim Voluntary Guidelines | Kaheawa Pastures Facility |
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| 2. 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. | Kaheawa Wind Power is working with the FAA to apply their newest, pending guidance for aircraft warning lighting. This would allow lighting of just five of the 20 turbines, spaced at roughly 2,500-3,000 foot intervals, using medium-intensity red-flashing lights. Lights would be set to flash at the maximum recommended time interval. Marking solely with white strobe lighting would not conform to either the existing or the pending FAA guidance. Though research is still ongoing, it is generally held that steady-burning lights, regardless of color, pose the greatest risk of attracting birds. Differences between red and white lights have not been well-studied. Lastly, as noted above, other on-site lighting will be minimal, shielded and used infrequently, thus not being an attraction to birds. |
| 3. 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, it should be noted that the 55-meter towers are custom-made, as the GE 1.5 turbine typically utilizes tower that is 65 meters or higher. |
| 4. 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 (1994, 1996) for any required aboveground lines, transformers, or conductors. | This recommendation is being followed; all new power lines will be placed underground where feasible. |

| USFWS Interim Voluntary Guidelines | Kaheawa Pastures Facility |
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| 5. 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. |
| 6. 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; this recommendation will be evaluated and addressed as part of the HCP process (whether a new or amended HCP) at the anticipated end of the project life and HCP term (20 years). |

# V. ASSESSMENT OF POTENTIAL IMPACTS AND MITIGATION

### Assessment of Potential Impacts to Listed Species

With a few important exceptions (*e.g.*, Altamont Pass in California), studies that have been completed to date show very low numbers of bird fatalities at wind energy facilities (Bird Studies Canada 2003, Erickson *et al.* 2002, Erickson *et al.* 2001). Erickson *et al.* (2001) provide a review of studies conducted across the United States, evaluating how wind turbines compare to other sources of bird mortality, such as communication towers and transmission wires. They estimate an average of 2.19 bird fatalities per wind turbine per year in the United States *for all species combined*. Fatality rates are estimated to be lower outside of California, at approximately 1.83 fatalities per turbine per year (corrected for searcher efficiency and scavenging). Over 70 percent of documented fatalities have been passerines, notably horned larks (*Eromophila alpestris*) in the western United States, and a variety of night-migrating songbirds in the eastern United States. The highest average fatality rates reported have been on the order of three to seven birds per turbine per year (primarily night-migrating songbirds) at projects along the Appalachian ridgeline of West Virginia and Tennessee (Kerlinger 2005). In general, the numbers of birds killed at wind turbine installations is several orders of magnitude below the numbers of fatalities caused by other commonplace human structures and impacts, such as lighted buildings, communications towers, powerlines, vehicles, and housecats (Erickson *et al.* 2001).

However, although generally low at most existing wind power installations, even small numbers of fatalities can have serious consequences for endangered species such as those that may fly through or over the Kaheawa Pastures facility. The following sections provide an assessment of potential impacts to the four listed species, and estimates of the anticipated take (as defined) for each.

Petrels and Shearwaters

As reviewed by Cooper and Day (2004), although there has been no documented mortality of Hawaiian Petrels or Newell's Shearwaters at wind energy facilities, there are only a few wind turbines in the Hawaiian islands at this time and none have been monitored for wildlife impacts. There has been documented seabird mortality due to collisions with human-made objects such as power lines on Maui (Hodges 1994) and Kaua`i (Telfer *et al.* 1987, Cooper and Day 1998, Podolsky *et al.* 1998), and collisions of various species of birds and bats with wind turbines are well-documented elsewhere (*e.g.*, Erickson *et al.* 2001).

Of the four petrel or shearwaters that were observed at the site during fall 2004 and summer 1999, only one was flying at an altitude below the proposed wind turbine heights, whereas the other three were observed flying 300 to 500 meters above ground level. Further, only two of the four had a flight path that crossed the proposed turbine string. Considered together, these flight-altitude data and the low movement rates that were observed over the proposed project site suggest that the nightly numbers of Hawaiian Petrels or Newell's Shearwaters actually interacting with the proposed turbines would be low (Cooper and Day 2004).

Issuance of an Incidental Take Permit requires that the number of individuals to be taken be quantified. This is made difficult by the fact that the actual number that may be taken depends on many variables that are difficult to quantify. Further, in the case of these species, there is very little empirical data available on which to base predictions. Recognizing these limitations, but in an effort to provide the firmest possible basis for this HCP, Kaheawa Wind Power sought the input of two independent modelers, both having specialized expertise in the subject species, as well as in assessing the risk of wind turbine facilities to birds in general. Cooper and Day (2004b) developed a model that combines the results of on-site observations with their own observations of these species elsewhere in Hawai`i, and applies assumed ranges of collision probability to predict ranges of annual fatality rates for both species. Podolsky (2005) uses the passage rates derived by Cooper and Day (2004b), but uses his own Avian Risk of Collision (ARC) model to independently estimate potential take ranges. Because of their importance in estimating the take of these two species, the two models are included in their entirety for reference as Appendix 3 and Appendix 4.

The results of modeling by Cooper and Day suggest that the direct take of Hawaiian Petrels due to collision with the turbines would be between 0.03 and approximately 11 birds per year, and the direct take for Newell's Shearwater would be between 0.02 and approximately 7 birds per year. Stated another way, the estimated direct take could be as low as just two shearwaters and three petrels every 100 years, or as high as 7 shearwaters and 11 petrels each year. However, it should be noted that the high end of the range assumes that only 50 percent of the birds that approach the turbines actually detect and avoid them, which is a conservative underestimate of the avoidance rate for the purposes of illustrating a "worst-case" scenario. Although a 50 percent avoidance rate may be conceivable under certain, very limited conditions (*e.g.*, very poor visibility due to foggy or rainy weather), it is not reasonable as an overall rate of avoidance, even under a worst-case scenario. Avoidance of wind turbines (and other tall objects) by birds is clearly much higher than this on average, or the documented fatality rates at existing projects would be much higher than have been observed in the numerous surveys conducted to date. For example, Erickson (2003) compared spring migration passage rates, as determined using radar, to fatalities reported at the Stateline (Oregon/Washington), Buffalo Ridge (Minnesota), and Nine Canyon (Washington) projects, and determined that fatalities at all three sites comprised less than 0.01 percent of the total number of birds passing through the rotor swept area. However, no studies have as yet been conducted to allow the rate of avoidance to be reliably quantified, particularly for the species in question.

In comparison, modeling by Podolsky suggests that the direct take of Hawaiian Petrels would be between 4.4 (worst case) and 0.001 (best case) birds per year, with an "average" case of 0.6 birds per year. For Newell's Shearwaters, the take would be between 2.5 (worst case) and 0.0006 (best case) per year, with an "average" case of 0.4 birds per year. It should be noted that the "average" case is used by Podolsky to describe the use of mid-range values for the variables that are entered into the model, rather than any kind of statistical mean of the predicted outcome. For example, the worst case scenario is based on the assumption that the maximum number of birds all fly on a trajectory that takes them through all 20 turbines, one after another, whereas the best case assumes that the minimum number all fly through just one turbine. Podolsky's average case therefore assumes that an intermediate number of birds fly through ten of the turbines. As Podolsky himself points out, a flight path that goes through 10 turbines is itself highly improbable, with by far the most likely scenario being that of birds crossing through just one or two turbines.

Their potential imperfections and obvious differences aside, the two models are in fairly close agreement in that they predict a very low risk of collision for both seabird species, except under the most unlikely scenarios. Mid-range outcomes for both species, for both modeling exercises, are on the order of one bird per year or less.

A bird colliding with a wind turbine may be either an adult with young, an adult without young, or a newly fledged bird on its first flight to the sea. In the case of an adult with young (or possibly a paired adult about to have young), the ESA requires that the potential indirect loss of an egg or a chick be considered in the take estimate. The potential for a chick to be reared to fledging would be expected to decrease upon loss of a parent, and would probably be nil during the period from egg-laying through the first several weeks after hatching. Later in the chick-rearing period parental feeding and care may drop off dramatically, and the loss of an adult may or may not affect survival of the chick. For example, Simon and Hodges (1998) report that nestlings were fed almost 70 percent of their total food during the first half of the nestling period, and about 95 percent of their total by the time they were 90 days old. Further, some individuals are deserted by their parents up to six weeks before they fledge, whereas others are attended up to the day they take their first flight. Eggs and chicks also die from natural causes, including predation, so loss of an adult during the nesting period may not always be associated with the loss of that year's young. Estimates of annual reproductive success at Haleakala (chicks fledged/eggs laid) from 1979–1981 (Simons 1985) and 1993 (Hodges 1994) averaged 63.4 percent ± 16.0 SD (range 38–82, $n = 128$) at Haleakala, *i.e.*, slightly less than two-thirds of eggs laid were successfully raised to fledglings. Adults present may also include a large number of non-breeders, especially early in the nesting season.

There is also the possibility of unavoidable, accidental vehicle strikes of downed birds by maintenance personnel. During construction the possibility also exists for birds to collide with the crane, which is comparable in height to the turbine towers. Based on the above analyses, Kaheawa Wind Power estimates that the incidental take permit should allow for up to one adult or recently fledged bird of each species to be taken per year of project operation. In addition to the direct take, the potential for indirect take due to the loss of eggs or nestlings is estimated at 0.5 individual per year, *i.e.*, approximately half of the direct take will also result in an indirect take. Thus the anticipated take for each of these two species will be, on average, no more than 1.5 birds per year of project operation. This take applies to the entire project, including all 20 turbines combined over an entire year of operation. Accordingly, the Incidental Take License (ITL) proposed by DLNR will allow the take of up to 40 individuals over the 20-year term of the license, subject to all applicable license conditions.

To ensure that all possible scenarios are addressed, this plan also considers Lower (less than 1.5 per year), Higher (3-5 per year) and Notably Higher (5-10 or more per year) take scenarios. As stated in Special Condition #3, the incidental take authorized by the license can be increased provided that mitigation has been implemented such that benefits to the species outweigh the losses as detailed in the HCP. As further stipulated in Special Condition #4 and #5, incidental take of either species exceeding a running average of two per fiscal year, or greater than five in any one fiscal year, requires the development and implementation of adaptive management strategies approved by DLNR and USFWS and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

There is a low risk of adverse population or cumulative impacts for the Lower and Baseline levels of adjusted take for the two seabird species (*i.e.*, ranging from no take up to 1.5 individuals per year for 20 years), in part because the take is very small relative to their estimated populations. For example, total population estimates for the Hawaiian Petrel, based on observations of birds at sea and birds flying inland on Kauaʻi, range from several thousand to 34,000 birds. For the Newell's Shearwater, population estimates range between 57,000 and 115,000, with roughly 80 percent of the world's population nesting on Kaua'i (Ainley et al 1997). As previously noted, West Maui breeding populations are suspected for both species but have not been confirmed; hence there are no published estimates of numbers or population trends for this location. Although Hawaiian Petrels have been documented flying over the project area, Newell's Shearwaters have not (Cooper and Day 2004a).

Higher and Notably Higher levels of adjusted take (*e.g.*, on the order of 5-10 or more individuals per year), may present a greater risk for local West Maui populations (if they exist), although the take would still be small compared to the two species' overall populations. To ensure there are no adverse population or cumulative impacts, adaptive management measures have been included in the mitigation plan to address the effects of the higher take scenarios. In the unlikely event that Higher or Notably Higher adjusted take does occur, the adaptive management provisions include, (i) increased management and protection of colonies on West Maui, (ii) efforts to protect colonies on East Maui and other islands if opportunities to protect West Maui colonies are insufficient to offset take, and (iii) implementation of alternative measures on West Maui and elsewhere (*e.g.*, shielding of urban lighting, expansion of SOS programs, etc.) if warranted.

While the higher levels of take are possible, one modeler noted that such levels only occur under highly improbable scenarios, for example when birds transiting the site follow a flight path that takes them through all 20 turbines in succession (Podolsky 2005). Another modeler noted that higher take would only occur if it is assumed that only 50 percent of all birds passing through the site detect and avoid the turbines (Cooper and Day 2004b). Actual avoidance rates are likely to be much higher, and in fact are much higher at existing wind turbine installations. It is also important that far higher numbers of individuals transit to and from interior West Maui from the north; passage rates at the project site are among the lowest reported for West Maui (Cooper and Day 2001). Thus, the probability of the higher take scenarios, and of significant adverse effects for West Maui populations, is extremely remote.

Predation by alien mammals and downing due to urban lighting are considered the primary threats to both species' recovery. The proposed mitigation measures, which are focused specifically on these threats (see later sections), 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. For these reasons, there are no adverse impacts to the species' overall populations or significant cumulative impacts anticipated.

<u>Nene</u>

Nene clearly occur in the vicinity of the proposed project, and observations in both fall 2004 and summer 1999 indicate that they occasionally fly over the project site (Day and Cooper 1999, Cooper and Day 2004a). In addition, they commonly flew at altitudes within the proposed turbine height, and they also flew during various times of day, including some night flights. Nene also likely forage, and may nest, in the project area, although no nests have been documented, and no surveys have been conducted to verify this. All of these behaviors put Nene at some risk of colliding with the turbines. There is also the possibility of unavoidable, accidental vehicle strikes by maintenance personnel. During construction the possibility also exists for birds to collide with the crane, which is comparable in height to the turbine towers. It is likely that the location of the captive-release pen near the upper end of the proposed project site contributes to the density of Nene in the local area. As of this writing, no Nene nests are believed to occur within the area of the proposed access road or turbines, although a thorough search has not yet been conducted (J. Medeiros, Maui DOFAW, pers. comm.). The few survey data available are inadequate, however, to determine an anticipated level of take. Accurate population estimates for the project area would require recapturing or re-sighting of banded, released birds.

The effects of wind turbines on waterfowl (ducks, geese and swans) have been examined at many wind sites, particularly in Europe (Bird Studies Canada 2003). In general, waterfowl appear to avoid wind turbines, although some fatalities have been reported. With waterfowl, it is clear that the presence of large numbers of birds near wind energy facilities does not necessarily indicate that large numbers of fatalities will occur (Erickson *et al.* 2002). For example, at Buffalo Ridge in Minnesota, it was believed that migrating waterfowl, such as Greater White-fronted Goose (*Anser albifrons*), Snow Goose (*Chen caerulescens*), Canada Goose (*Branta canadensis*) and Mallard (*Anas platyrhynchos*), were at risk from collision due to large numbers and movements through the wind energy facility site (Strickland *et al.* 2000a). However, only three dead waterfowl (two Mallards and one Blue-winged Teal, *Anas discors*) were found in six years of surveys (Johnson *et al.* 2002).

According to Bird Studies Canada (2003), only three geese, all Canada Geese, have been reported killed at wind farms: one at the Stateline site on the Oregon-Washington border (Erickson *et al.* 2002), and two others at Klondike, Oregon (Johnson *et al.* 2003). Although geese and swans are very rarely victims of collision with wind turbines, small numbers of ducks have been killed. Eider fatalities were noted at Blyth Harbour in the United Kingdom (an offshore facility), but numbers of deaths decreased over time (Still *et al.* 1995). Six Common Eider (*Somateria mollissima*) deaths were attributed to collision with turbines during the first three months of the wind farm's operation, but only three were found in the following six months, and three more were found in the 18 months following that period (Still *et al.* 1995). Collision rates declined further during the following two years (Percival 2001). The decline in collision rates was attributed to the eiders learning to avoid the turbines (Percival 2001). Overall, the number of fatalities was very small compared to the use of the area by eiders (Percival 2001).

Avoidance behavior has been well-documented for waterfowl flying in the vicinity of wind energy facilities. For example, in the Yukon, a single tower was placed along the edge of the Yukon River valley where very large numbers of waterfowl migrate, including 10 percent of the world's Trumpeter Swans (*Cygnus buccinator*) (Mossop 1998). No collisions of any species were recorded, but it was observed that birds avoided flying close to the turbine (Mossop 1998). At the Castle River Windfarm in Alberta, ducks were observed to dramatically increase in flight altitude when they approached the wind energy facility so as to avoid flying through the turbines; only one dead Blue-winged Teal was found during the 96 completed surveys (W.K. Brown, pers. comm., 2003 *in* Bird Studies Canada 2003).

A comprehensive study was conducted at Tunø Knob in Denmark, where a small, modern ten-turbine offshore wind site was constructed in an area where large numbers of Common Eider and Black Scoter (*Melanitta nigra*) feed. Studies found that the Eiders generally avoided flying or landing within 100 meters of the turbines and avoided flying between turbines that were spaced less than 200 meters apart, preferring to fly around the outer turbines. This behavior was accentuated in poor weather conditions (Guillemette *et al.* 1998, Guillemette *et al.* 1999, Tulp *et al.* 1999). Apart from this behavior, no other difference in abundance, foraging or movement behavior was detected. Similar findings are presented by Larsson (1994) for a study at Nogersund in Sweden, and Dirksen *et al.* (1998) for studies conducted at Lely in the Netherlands. At Lely, four 500 kW turbines were examined and two diving duck species, Common Pochard (*Aythya ferina*) and Tufted Duck (*A. fuligula*), were tracked at night using radar to determine their flight behavior around wind turbines (Dirksen *et al.* 1998). Results from this study showed that most birds avoided flying near the turbines, passing around the outer turbines rather than flying between them.

There appear to be very species-specific reactions to wind turbines, as even closely related species can have very different reactions. For example, Pink-footed Geese (*Anser brachyrhynchus*) are reluctant to forage within approximately 100 meters of turbines, whereas Barnacle Geese (*Branta leucopsis*) have been found to forage within 25-50 meters of turbines (Larsen and Madsen 2000). At Pickering, Ontario, James (2003) observed Canada Geese walking and foraging on the grass near the base of the site's single large turbine. Such differences among species may be especially pronounced for the Nene, which have a very distinct behavior and ecology compared to most of the waterfowl species studied at existing wind energy facilities. It remains to be seen, however, whether they will avoid the area of the turbines, and to what degree.

Nene were the subject of a draft HCP prepared by then-applicant Zond Pacific, which concluded then that the anticipated take would be one individual per year of project operation (WSB-Hawai`i 2000). This conclusion was supported by USFWS and DLNR at that time; it was based on a qualitative assessment that concluded that the risk of collision was low, but not zero, and on observations that suggested low use of the area by Nene. Conditions for Nene have not changed substantially since 1999 in the project area, although the total number released by DOFAW since 1994 has increased from 62 in 1999 to 87 as of 2003, approximately 85 of which are believed to have survived as of 2004. Based on the apparent low susceptibility of waterfowl, and geese in particular, to collision at existing wind power facilities, and the lack of conflicting information for the Nene, it is reasonable to expect that the risk of collision is low for Nene at the project site.

One aspect of the potential take that does not appear to have been previously evaluated is the potential for indirect effects on eggs or goslings due to the loss of an adult bird. The loss of an adult female during the early nesting and brood-rearing stages would likely result in the loss of her own eggs or young, if she were nesting at the time. According to Banko et al (1999), females first breed at 2-3 years of age, and wild clutches average 3.1

eggs. However, productivity of Nene is generally very low (possibly the lowest of all goose species) because pairs do not attempt to nest each year, many nests fail because of predation, and many goslings die because of poor foraging opportunities and predation (Banko et al 1999). For example, in populations on Hawai`i and Maui each year during 1978–1981, fewer than 10 percent of all females ($n$ = 258; $n$ = 15–61/yr) raised fledglings. Also, because males may also provide care and protection, loss of a male may reduce survivorship of young, but the degree to which this may occur is unknown. In any event, the impact of the loss of a parent on young birds would drop off sharply after fledging and with the approach of the next breeding season.

Finally, it is possible that Nene will be displaced from potential nesting habitat within and adjacent to the proposed project area. Given the proximity of the release pen and the apparent suitability of the habitat, it is possible that Nene currently nest within or near the site. As of this writing, however, Nene are not believed to be nesting within the proposed footprint of the project, although no site-specific searches have been conducted (J. Medeiros, Maui DOFAW, pers. comm.). While the risk of displacement exists, the apparent low use of the site by Nene, their adaptability to a variety of native and non-native habitats, and the possibility that little or no displacement will occur (based on observations of other species at existing projects) suggest that the risk of an actual take (*i.e.*, harm) is probably low.

Finally, there is also the possibility of unavoidable, accidental vehicle strikes by maintenance personnel. During construction the possibility also exists for birds to collide with the crane, which is comparable in height to the turbine towers. In consideration of these factors, as well as supplemental studies conducted by Cooper and Day (2004a) and summarized in the preceding section, Kaheawa Wind Power estimates that the anticipated direct take should be increased to two individuals per year of project operation. In addition, a take of one should be added to account for the potential for indirect impacts, resulting in a total annual estimated take of three. Accordingly, the Incidental Take License (ITL) proposed by DLNR will allow the take of up to 60 individuals over the 20-year term of the license, subject to all applicable license conditions.

To ensure that all possible scenarios are addressed, this plan also considers Lower (less than 3 per year), Higher (4-5 per year) and Notably Higher (5-10 or more per year) take scenarios. As stated in Special Condition #3, the incidental take authorized by the license can be increased provided that mitigation has been implemented such that benefits to the species outweigh the losses as detailed in the HCP. As further stipulated in Special Condition #6, incidental take exceeding a running average of three per fiscal year, or greater than eight in any one fiscal year, requires the development and implementation of adaptive management strategies approved by DLNR and USFWS and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

The Lower, Baseline, Higher, and Notably Higher take scenarios estimated for Nene are not expected to cause a decline in the status of the species; although the highest levels could result in a decline of the local population that has been established in the vicinity of the Hanaula release pen. When considered in light of the proposed mitigation, however, even the higher levels of take can be exceeded by the proposed mitigation when the adaptive management provisions are implemented. For example, full implementation of all adaptive management measures has the potential to result in the construction of three new release facilities and the propagation and release of 30 birds per year if constructed simultaneously, or until all mitigation obligations have been met (see later sections for mitigation details). This is expected to be more than adequate to compensate for the Notably Higher take scenario, and to ensure a net conservation benefit to the species, as required by State law. For these reasons there are no adverse impacts to the species' overall population or adverse cumulative impacts anticipated.

Hawaiian Hoary Bat

The potential for a take of the Hawaiian Hoary Bat is believed to be very low based on the surveys that have been conducted on-site, other 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 at some time during the lifetime of the project appears likely, and much remains to be known about this creature's habits and population status on West Maui. Hawaiian hoary bats frequently forage for insects over open areas such as pastures, grasslands, and shrublands, and their typical flight altitudes vary between about a foot to almost 500 feet above the ground. Further, Hoary Bats (*Lasiurus cinereus*, of which the Hawaiian Hoary Bat is a subspecies) are known to be susceptible to collision with wind turbines in their North American range, and have been among the most numerous fatalities in recent studies in the eastern United States (*e.g.*, Johnson *et al.* 2000, Erickson 2003). The mechanisms contributing to the susceptibility of this and other bat species are not yet understood, but are the subject of a major cooperative research effort sponsored by the wind industry and Bat Conservation International (Arnett and Tuttle 2004). However, information gathered to date indicates that wind energy facilities do not currently impact resident breeding bat populations where they have been studied in the U.S. (Johnson *et al.* 2003). Available evidence indicates that most of the bat mortality at U.S. wind plants involves migrant or dispersing bats in the late summer and fall. Bat collision mortality during the breeding season is virtually non-existent, despite the fact that relatively large numbers of some bat species (including the Hoary Bat) have been documented in close proximity to wind plants. Further, bat echolocation and collision mortality studies indicate that only a small fraction of detected bat passes near turbines result in collisions (Johnson *et al.* 2003).

Thus, while Hoary Bats in North America are known to be susceptible to collision, the circumstances leading to their susceptibility (*i.e.*, seasonal dispersal or migration) may not occur in Hawai`i, at least not to any degree approaching the migrations that occur on the mainland. Further, differences in susceptibility between Hoary Bats and the Hawaiian subspecies, if any, are unknown. On this basis, Kaheawa Wind Power has determined that, despite their apparent scarcity in the area, the anticipated take for this species should be up to one individual per year of project operation. This level of take will provide a basis for implementing a modest mitigation effort, intended to contribute to furthering our understanding of this species' occurrence and current status in the region.

Accordingly, the Incidental Take License (ITL) proposed by DLNR will allow the take of up to 20 individuals over the 20-year term of the license, subject to all applicable license conditions.

To ensure that all possible scenarios are addressed, this plan also considers Lower (less than 1 per year), Higher (2-5 per year) and Notably Higher (5-10 or more per year) take scenarios. As stated in Special Condition #3 of the DLNR ITL, the incidental take authorized by the license can be increased provided that mitigation has been implemented such that benefits to the species outweigh the losses as detailed in the HCP. As further stipulated in Special Condition #7, incidental take exceeding a running average of one per fiscal year, or greater than two in any one fiscal year, requires the development and implementation of adaptive management strategies approved by DLNR and USFWS and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

Take of one bat per year or less is unlikely to have a significant impact on the population of the Hawaiian Hoary Bat. Although overall numbers of Hawaiian Hoary Bats are believed to be low, they are believed to occur in the greatest numbers on other islands, especially the Big Island (Cooper and Day 1998). Higher levels of take under the Notably Higher Take scenario (*i.e.*, 5-10 individuals per year) could adversely impact the West Maui population (if it exists), but would not likely impact the status of the species at other locations. Observations on West Maui have been few, and the species is believed to occur in highest numbers on Kaua'i and Hawai`i (also the only locations where breeding has been documented), and although the species may migrate seasonally between highlands and lowlands (mauka-makai), it is not believed to be migratory on a larger scale. The applicant's proposed mitigation for the anticipated take will contribute to a greater understanding of the species' occurrence and status, which in turn will help guide future management and recovery efforts and should result in an overall net conservation benefit for the species.

Current threats to Hawaiian Hoary Bats are believed to be habitat loss, pesticides, predation, and roost disturbance. Though research is still being conducted, it is thought that reduction and disturbance of tree cover (*e.g.,* roost sites) as well as use of pesticides may be the cause for the decline of bat populations (DOFAW 2005b). Development of the Kaheawa Wind Power project will not increase losses due to these other causes. However, some of these causes (*e.g.*, loss of tree cover and pesticide use) may be on the increase due to continued real estate development on Maui, and may continue increasing in the future. Thus, there is the possibility of cumulative impacts in addition to the anticipated take at Kaheawa. However, the proposed mitigation is 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. For these reasons, there are no adverse impacts to the species' overall population or significant cumulative impacts anticipated.

### Estimating the "Adjusted Take"

Impacts may include several components in addition to the direct take that is observed, including direct take that occurs but is not observed, indirect take, and loss of productivity. These other factors can be estimated to provide a basis for "adjusting" the direct take to serve as the basis for determining the appropriate mitigation to be provided. Thus:

Adjusted Take = Observed Direct Take + Unobserved Direct Take + Indirect Take + Loss of Productivity

Following is a summary of the components that go into estimating the adjusted take:

1. Observed Direct Take. The fundamental approach for observing direct take will be to conduct regular searches of the project area during operation to quantify the number of individual birds and bats that have been killed or injured. A detailed protocol for conducting regular searches is provided in Section VI – Implementation (Monitoring and Reporting).

2. Unobserved Direct Take. Downed wildlife may be overlooked by searchers, or scavenged by local predators such as mongoose, cats, etc. The monitoring protocol presented in Section VI includes methods for estimating searcher efficiency and scavenging rates, which together provide a basis for estimating the number of individuals that are taken but that go undetected.

3. Indirect Take. These are individuals that are indirectly taken as the result of a direct take of another individual. For example, eggs or young may be lost due to the loss of a parent. Indirect take for each species is explained under impacts in the preceding section.

4. Loss of Productivity. Direct take may result in the loss of productivity of the individual that is taken between the time the take occurs and the time that mitigation is provided. Similarly, productivity may be lost if mitigation for the take of a breeding age adult is provided in the form of a juvenile. The potential for loss of productivity depends upon a variety of 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. The following adjustments to take will be applied as appropriate to account for lost productivity:

The allowable incidental take authorized by the DLNR ITL for the two seabird species and Nene includes both direct and indirect take as defined herein (Special Condition #1). The estimation of incidental take will be conducted according to adjustments made to the observed direct take according to estimates of unobserved direct take, indirect take and loss of productivity (Special Condition #2).

Hawaiian Petrel

Adjustments to the take of Hawaiian Petrels to account for lost productivity were developed based on the following demographic factors and assumptions (from Simons and Hodges 1998 and as otherwise noted):

Age Classes: Three age classes can be defined: (1) young-of-year (YoY), which may pertain to a nestling lost via indirect take or a fledgling that suffers a collision with a turbine, (2) pre-breeding immature/adult (if recognizable), or (3) breeding adult. It is assumed that productivity is equal among individuals within each age class. An analysis of life history by Simons (1984) estimated that a stable population would consist of 52.2 % <6 yr old (pre-breeders), with the balance of breeding age (up to age 35). For the purposes of estimating lost productivity, and to provide additional benefit to the species, adult birds that cannot otherwise be identified as pre-breeding are assumed to be breeding age individuals.

Age at First Breeding: Unknown, but population data suggests age 5-6. Age 5 assumed for purposes of estimating lost productivity.

Adults Breeding/Year: Estimated at 89 %. Assume 90 % for purposes of estimating lost productivity.

Reproductive Success: Estimates of annual reproductive success at Haleakala, Maui (chicks fledged/eggs laid) from 1979–1981 (Simons 1985) and 1993 (Hodges 1994) averaged 63.4 % ± 16.0 SD (range 38–82, $n$ = 128). For the purposes of estimating lost productivity, and to provide additional benefit to the species, it is assumed that the average annual reproductive success is 70 %.

Survival: In an analysis of life history by Simons (1984), annual juvenile survival was assumed to be 80 % and adult survival 93 %; survival to breeding age was estimated to be 27 %. For the purposes of estimating lost productivity, and to provide additional benefit to the species, it is assumed that 30 % of fledged young survive to breeding age.

Number of Broods: One per year.

Clutch Size: One.

Pair Productivity: Based on the above demographics, the average annual productivity (*i.e.*, annual production of breeding age adults) of an adult pair is estimated as follows:

> Pair Productivity = (% breeding)(clutch size)(% fledging)(% survival to breeding);
>
> = 0.9 x 1.0 x 0.7 x .30 = 0.19
>
> = Say 0.2, or 20 %, for the purpose of estimating lost productivity

Relative Productivity of Males vs. Females: Breeding Hawaiian Petrels are apparently monogamous, form pair bonds and exhibit courtship behavior that may last one or more seasons prior to breeding. Thus loss of a male could cause a breeding hiatus for his mate. Males also take turns with females to incubate eggs and to provide food for nestlings. For the purposes of estimating lost productivity it is assumed that males and females each contribute 15 % to the average annual productivity. This yields an average pair productivity of 30 % per year, which is 50 % higher than the above estimate to ensure additional benefit to the species,

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

Based on these assumptions the following approach is proposed for adjusting each take of a Hawaiian Petrel that occurs to account for lost productivity:

1. No adjustment if in-kind mitigation (*i.e.*, replacement with same-age individual) occurs during same year as take.

2. Increase mitigation by 15 % for each year that replacement lags behind take. Compound adjustments annually to account for lost productivity of offspring.

3. Replacements that occur in advance of take may offset adjustments for lagging replacements on a one-for-one basis. Using this approach, mitigation for a take of two birds in the same year could consist of replacement with one bird in advance and one bird afterward, provided the lag time interval was less than or equal to the advance time interval.

4. Lagging and advanced replacements may result from, (a) replacement with an individual from the same age class at a different time, (b) replacement with an individual from a different age class during the same year as take, or (c) replacement with an individual from a different age class at a different time.

Newell's Shearwater

Adjustments to the take of Newell's Shearwaters were developed based on the following demographic factors and assumptions (from Ainley *et al*. 1997 and as otherwise noted):

Age Classes: Three age classes can be defined: (1) young-of-year (YoY), which may pertain to a nestling lost via indirect take or a fledgling that suffers a collision with a turbine, (2) pre-breeding immature/adult (if recognizable), or (3) breeding adult. It is assumed that productivity is equal among individuals within each age class. For the purposes of estimating lost productivity, and to provide additional benefit to the species, adult birds that cannot otherwise be identified as pre-breeding are assumed to be breeding age individuals.

Age at First Breeding: Age 6 assumed for purposes of estimating lost productivity.

Adults Breeding/Year: For Newell's Shearwater on Kaua‘i, on basis of estimates made by Telfer (1986), incidence of non-breeding is high: 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). For the purposes of estimating lost productivity, and to provide additional benefit to the species, it is assumed that 50 % of adults breed in any given year.

Reproductive Success: Among nests in which eggs are laid, 66.0 % ± 6.4 SD (range 49–75) fledge young. This fledging rate is similar to that of stable Manx Shearwater populations (Brooke 1990). For the purposes of estimating lost productivity, and to provide additional benefit to the species, a 70 % average fledging rate is assumed.

Survival: On basis of allometric equation relating survivorship to body mass in procellariiforms, annual adult survivorship of Newell's Shearwater was estimated to be 0.904 ± 0.017 SE. This figure is close to that estimated for Manx Shearwater by more conventional means (Brooke 1990). For the purposes of estimating lost productivity, and to provide additional benefit to the species, it is assumed that 50 % of fledged young survive to breeding age.

Number of Broods: One per year.

Clutch Size: One.

Pair Productivity: Based on the above demographics, the average annual productivity (*i.e.*, annual production of breeding age adults) of an adult pair is estimated as follows:

> Pair Productivity = (% breeding)(clutch size)(% fledging)(% survival to breeding);
>
> = 0.5 x 1.0 x 0.7 x .50 = 0.18
>
> = Say 0.2, or 20 %, for the purpose of estimating lost productivity

Relative Productivity of Males vs. Females: Relative productivity of males and females is assumed to be similar, as with the Hawaiian Petrel as described above. For the purposes of estimating lost productivity it is assumed that males and females each contribute 15 % to the average annual productivity. This yields an average pair productivity of 30 % per year, which is 50 % higher than the above estimate to ensure additional benefit to the species

Based on these assumptions the following approach is proposed for adjusting each take of a Newell's Shearwater that occurs to account for lost productivity:

1. No adjustment if in-kind mitigation (*i.e.*, replacement with same-age individual) occurs during same year as take.

2. Increase mitigation by 15 % for each year that replacement lags behind take. Compound adjustments annually to account for lost productivity of offspring.

3. Replacements that occur in advance of take may offset adjustments for lagging replacements on a one-for-one basis. Using this approach, mitigation for a take of two birds in the same year could consist of replacement with one bird in advance and one bird afterward, provided the lag time interval was less than or equal to the advance time interval.

4. Lagging and advanced replacements may result from, (a) replacement with an individual from the same age class at a different time, (b) replacement with an individual from a different age class during the same year as take, or (c) replacement with an individual from a different age class at a different time.

Nene

Adjustments to the take of Nene were developed based on the following demographic factors and assumptions (from Banko et al. 1999 and as otherwise noted):

Age Classes: Three age classes are defined: (1) gosling (pre-fledging), (2) juvenile (fledging to breeding), and (3) adult (breeding). It is assumed that productivity is similar among individuals within each age class.

Survival: DOFAW estimates that 85 of the 87 birds released at the Hanaula site between 1994 and 2003 had survived as of 2004, a survival rate of over 97 % over a nine year period. For the purposes of estimating lost productivity, and to provide additional benefit to the species, it is assumed that juvenile birds of both sexes released at West Maui will have a net survival of 90 % from the time they are released to age three.

Number of Broods: Assumed one per year in the wild.

Productivity of Females: Productivity is relatively low in many populations because pairs do not attempt to nest each year, many nests fail because of predation, and many goslings die because of poor foraging opportunities and predation (Hoshide et al. 1990, Banko 1992). During 4 seasons (1978–1981) mostly in highland habitat on Hawai`i and Maui, eggs hatched in at least 36 % (50) of 140 observed breeding attempts, and goslings fledged in 7 % (10; Banko 1992). Eggs hatched in 44.3 % (31) of 70 nests with known outcomes, resulting in ≥59 goslings (1.9 goslings/successful pair ± 0.16 SE, range 1–4) and 1 fledgling (0.03 fledgling/successful pair). Of pairs with broods, 34.5 % (10) of 29 produced 19 fledglings (1.9 fledglings/successful pair ± 0.23 SE, range 1–3). 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). Of 85 eggs produced in the 36 nests, 43 (51 %) failed to hatch. In populations on Hawai`i and Maui each year during 1978–1981, <10 % of all females ($n$ = 258; $n$ = 15–61/yr) raised fledglings (calculated by Banko et al. 1999 from Banko 1992). So far at Hanaula, one brood of four fledglings is known to have been successfully raised in 1998 (USFWS 2004). Based on the above findings, and to provide additional benefit to the species, it is conservatively assumed that an average of 10 % of adult females in the project area produce an average of one fledgling each year.

Productivity of Males: No information was found to quantify the contribution of adult males to breeding productivity, although Nene pair for life and males clearly contribute to the survival of young. For example, males guard the nesting female during incubation and protect goslings during the brood-rearing period. In addition, maintaining a selection of males in the population presumably increases the likelihood of a female forming a successful pair bond. In general, however, the contribution of males to annual productivity is considered to be lower than females. For the purposes of estimating lost productivity, and to provide additional benefit to the species, it is assumed that the average annual productivity of adult males equals that of females (*i.e.*, 10 %).

Based on these assumptions the following adjustments are proposed for each take of a Nene to account for lost productivity:

| Take of Gosling | Take of Immature/Juvenile (Post-fledging, pre-nesting) | Take of Adult |
|---|---|---|
| No adjustment if replacement gosling propagated in same year as take.<br><br>Increase replacement ratio by 10 % for each year release lags behind take.<br><br>Replacements that occur in advance of take may offset adjustments for lagging replacements on a one-for-one basis (*e.g.*, mitigation for a take of two birds in the same year could consist of replacement with one bird in advance and one bird afterward, provided the lag time interval was less than or equal to the advance time interval).<br><br>Compound annually to account for productivity of offspring. | No adjustment if release of juvenile occurs same year as take.<br><br>Increase replacement ratio by 10 % for each year release lags behind take.<br><br>Replacements that occur in advance of take may offset adjustments for lagging replacements on a one-for-one basis.<br><br>Compound annually to account for productivity of offspring. | Assume loss of 3 years productivity (conservative age to first breeding) if release of juvenile occurs concurrent with take.<br><br>Assume loss of 10 % productivity per year, compounded annually to account for productivity of offspring.<br><br>Replacements that occur in advance of take may offset adjustments for lagging replacements on a one-for-one basis.<br><br>Adjust for assumed 90 % survival to adulthood of released juvenile birds. |

<u>Hawaiian Hoary Bat</u>

Detailed demographic information for the Hawaiian Hoary Bat is lacking. As an alternative to accounting for lost productivity, the mitigation proposed for the Hawaiian Hoary Bat has been designed to, (1) support research to better document, among other things, this species' demographics in Hawai`i, and (2) be sufficient to more than offset the anticipated take, with mechanisms for providing additional mitigation if take should be higher than anticipated.

## Mitigation for Potential Impacts

Selection of Mitigation Measures

Kaheawa Wind Power coordinated with biologists from DLNR and USFWS, as well as regional experts, to identify and select appropriate measures to mitigate for potential takings of the four listed species. Several criteria were established on which to base selection of preferred mitigation measures. These include:

- the level of mitigation should be commensurate with the currently anticipated take;
- 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;
- flexibility to adjust to changes in the level of take according to new information during project operation is desirable;
- efforts that are 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 by USFWS over those on federal land;
- measures to decrease the level of take resulting from a private activity unrelated to the project are generally considered the responsibility of the other party and are not preferred as mitigation for the Kaheawa Wind Power 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); and
- alternate or supplemental mitigation measures should be identified for future implementation if the level of take is found to be higher (or lower) as a result of monitoring.

Several mitigation options were identified and screened for each species. Following are the details of the measures selected. In accordance with Section VI, all mitigation measures will be subject to review by DLNR and USFWS over the lifetime of the project and either discontinued, modified, or continued without modification.

General

*Wildlife Education and Observation Program*. Kaheawa Wind Power will implement a long-term Wildlife Education and Observation Program (WEOP) for all staff members who will be on-site on a regular basis, to enable them to identify species that occur in the area, record observations of bird and bat use of the site, and take appropriate steps when downed birds (including MBTA-protected species) or bats are found. A draft plan for the WEOP is attached as Appendix 8.

*Downed Wildlife Protocol*. A protocol for the recovery, handling, and reporting of downed wildlife has been developed for the project, in cooperation with DLNR and USFWS. All on-site personnel will be trained in the protocol. All observed mortality or injury of wildlife, including MBTA-protected birds not otherwise covered by this HCP, will be documented whether project-related or not (*e.g.*, caused by predators). For ESA-listed species, intact or partial remains will be collected and promptly chilled or frozen, and DLNR and USFWS will be notified as soon as possible. Non-ESA-listed species may be collected as well if requested by USFWS or DLNR. As instructed by DLNR and USFWS, collected specimens will be provided to DLNR or USFWS as soon as possible for necropsy by an agency veterinarian. Special Condition #9 of the DLNR ITL stipulates that the DLNR will be notified within three days of any mortalities, injuries, or disease observed on the property. Injured individuals or carcasses will be handled according to guidelines in Appendix 9 of the HCP.

Petrels and Shearwaters

The potential for a take of these two seabird species is considered low, although the ability of their local populations to sustain even a low level of take is unknown at this time. Both species are believed to nest in West Maui, and a very small number have been documented passing over or through the area proposed for wind turbines. Studies have been limited, however, and a better understanding of these species in the area would have future benefits for protection and management, and for understanding the implications of any take that may occur. Accordingly, the proposed mitigation for the potential take of these species will consist of conducting additional studies of bird movement over and through the project area during the first year of operation; research to identify and, where practicable, protect and/or manage as-yet unknown colonies in West Maui; and alternate mitigation measures to be implemented elsewhere in the event that the required mitigation cannot be provided by protection and/or management of West Maui colonies.

Mitigation for the two seabird species will consist of:

- For the first year of project operation, Kaheawa Wind Power will conduct a minimum of eight evening and early-morning radar and thermal imaging/night vision surveys during the spring/summer breeding season when adults are commuting to/from nesting colonies, and again during the peak fledging period for these species (approximately October through December). Both horizontal and vertical radar will be used to obtain information on the number and flight altitudes of seabirds passing through the project area. These two surveys will contribute to a better understanding of these species' habits and population status on West Maui, as well as document the response to the turbines of any birds that fly near or through the project area. Whenever possible, these surveys will include moonless and/or overcast nights when the risk of collisions, or otherwise downed birds, is likely to be greatest. Methods will follow those of Cooper and Day (2004a), with the exception that thermal imaging technology will be used in place of the night-vision equipment as available (Kaheawa Wind Power understands that thermal imaging equipment may be available for loan or rent from an in-state agency or university). The primary objectives of this effort will be to (1) add to the existing information concerning passage rates of seabirds over and through the project area, and (2) document and, if possible, quantify incidences of behavioral avoidance of the turbines. Data for this aspect of turbine/bird interactions is generally lacking in the industry, and is non-existent for these species.

- Additional seabird observations will be documented in conjunction with the monthly thermal imaging/night vision surveys for the Hawaiian Hoary Bat described in the following section.

- Kaheawa Wind Power will conduct surveys in an effort to (a) locate as-yet unknown or unconfirmed nesting colonies of Hawaiian Petrels and Newell's Shearwaters in West Maui, (b) estimate nest numbers and distribution, (c) identify management needs and (d) where possible, implement management measures to offset the anticipated or actual take. While both species are believed to nest somewhere in West Maui, as indicated by radar surveys and other evidence, there is virtually no information concerning the whereabouts and sizes of any colonies that may exist. For at least the first two years of operation, Kaheawa Wind Power will retain a field biologist and assistant for at least four months during the nesting season to conduct colony searches. Methods will include reviewing existing field observations to be provided by DOFAW (F. Duvall, personal communication), consultation with other experts such as Cooper and Day of ABR, reviewing existing topographic maps and aerial photos (as available), and using radar and thermal imaging/night vision techniques to observe and track birds to potential nesting colony locations. As nesting pairs/colonies are located, efforts will shift to identifying management needs, implementing management and protection measures where practicable, and monitoring the effectiveness of the mitigation measures.

  It is assumed that colonies nearest to existing development (*i.e.*, less remote) are most likely to benefit from management and protection and to provide the most practicable opportunities for mitigation. Attempts to access and "manage" colony sites that are remote may actually lead to increased habitat degradation, predation and other unintended adverse effects. Management of such colonies is also less likely to be practicable in terms of the cost and effort required to locate and study them, relative to the likely benefits provided to the species. It is also recognized that attempts to survey colonies on the ground, or implement management measures, may depend upon and be limited by the permission and cooperation of private landowners (though the landowners with whom contact has been made have been amenable to these survey and management efforts).

The design and scope of each year's effort will be determined in coordination with USFWS and DLNR biologists. Management and protection opportunities, where they exist, are likely to include predator/ungulate trapping/removal, fencing to exclude predators/ungulates, and similar measures. Kaheawa Wind Power will implement management and protection measures during the first two years of project operation, as they are identified, to more than offset the anticipated adjusted take for both species. Colony protection and/or management measures will continue beyond year 2 such that the ratio of birds protected to the adjusted take remains greater than 1 throughout the life of the project.

Increases in survival and productivity at seabird colonies through efforts to control predation are well-documented in Hawai`i and elsewhere where mammalian predation is a major limiting factor. For example, fencing and toxicants have been used successfully for a number of years to exclude predators from nesting habitat of Hawaiian Petrels on East Maui (Hodges 1994). However, success rates vary, and can depend on a variety of factors, including:

1. the type(s) of predators/ungulates (*e.g.*, feral cats, rats, pigs, mongoose, barn owls, etc.) being controlled and the types of impacts they are having on the colony (*e.g.*, direct predation, habitat disturbance, etc.);

2. the benefit to the colony of predator/ungulate exclusion/control in terms of fledging success or other indices of reproductive success and survival to adulthood (*e.g.*, as assessed by Hodges 1994 and Telfer 1986); and

3. the population dynamics of the species in question (or closely related species if the subject species dynamics are unknown), as indicated by population modeling (*e.g.*, Ainley *et al.* 2001 and Simons 1984) and other information as available.

It will be necessary to quantify the success of the colony protection and management efforts in order to determine whether the mitigation is sufficient to offset the adjusted take. However, overly intrusive surveys can be disruptive to the colony, and can result in unintended adverse impacts. As an alternative, data on improved survival and productivity rates from previously studied colonies may be used where colony-specific surveys are impracticable. Studies used will be selected for their similarity to the mitigation colony, *i.e.*, colonies having the same or similar species, similar predation pressures, and similar location and habitats. Collection of colony-specific information will be limited to data that can be gathered with minimal risk of disruption and adverse impact. Measures used to evaluate the mitigation value of colony protection and management will be determined by agreement of Kaheawa Wind Power, DLNR and USFWS.

Colony searches and protection/management efforts will continue on West Maui until (a) it is determined that there are unlikely to be any (further) protection/management opportunities on West Maui that are practicable, or (b) enough opportunities have been identified to more than cover the anticipated adjusted take.

If it is determined that there are unlikely to be sufficient protection/management opportunities on West Maui that are practicable to provide mitigation for the adjusted take, then off-site searches for and management/protection of colonies on East Maui, Moloka`i, Lana`i, and the Big Island will be implemented.

If after 10 years of effort no practicable opportunities for colony protection and management have been identified on West Maui or elsewhere, or if opportunities have been exhausted and there is still a need for further mitigation, then Kaheawa Wind Power will work with DLNR and USFWS biologists to identify and implement alternate mitigation measures that may include, but not be limited to:

1. expansion of Save Our Shearwaters (SOS) efforts on Maui;
2. measures to reduce lighting attraction on Maui; and/or
3. measures to reduce the risk of bird strikes with artificial structures on Maui.

Priority will be given to mitigation measures that are practicable, and that will most directly offset the loss of individuals taken by the project, with consideration for population location, feasibility, logistics, and likelihood of success.

With regard to opportunities for colony protection on Maui (East and West), Kaheawa Wind Power has already spoken with representatives of Haleakala Ranch, Maui Land and Pineapple Company, the Department of Hawaiian Home Lands, and the West Maui Mountains Watershed Partnership to discuss the potential for surveys and/or habitat protection of seabird colonies to be conducted on lands under their ownership or jurisdiction in furtherance of these mitigation efforts. The responses from these representatives have been uniformly positive.

- Funding at the Higher and Notably Higher Take levels will be made available if take occurs at a lower annual level, but cumulatively reaches these levels before mitigation has been provided.

- Kaheawa Wind Power recognizes that, especially for the two seabird species, the cost of implementing mitigation measures (for example colony protection) in any one year may exceed that year's budget allocation, even if the overall expenditure for mitigation 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 for unspent funds from previous years to be carried forward for later use.

- If monitoring indicates that take is higher than expected, then Kaheawa Wind Power will: (1) continue the colony search and management/protection efforts, and/or the selected alternate mitigation measures, sufficient to maintain a greater than 1:1 ratio of birds protected to the adjusted take, and (2) conduct on-site investigations to determine the cause(s) of the unexpectedly high level of take, and to identify and implement measures, where practicable, to minimize further take. On-site investigations may include, but will not be 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 or other site-specific conditions account for most of the take. Investigations may also include experimental changes in project operations, structures and lighting, and experimental measures to divert or otherwise repel birds from the area. Lighting will almost certainly be an initial focus of any such studies, given its known potential for attracting local seabirds. Measures to reduce and minimize further take may include, but would not be limited to, implementing permanent changes in project operation, structures or lighting, or measures to divert or repel birds, that are found to be effective and otherwise not harmful.

- If monitoring determines that the level of take is consistently lower than expected, then Kaheawa Wind Power, with the concurrence of USFWS and DLNR, may decrease the level of mitigation, provided that the ratio of birds protected to the adjusted take remains greater than 1 throughout the life of the project. Should no take occur, Kaheawa Wind Power will nonetheless conduct the first two years of surveying and colony protection and/or management efforts in West Maui.

- To further ensure the success of the mitigation effort, Kaheawa Wind Power will establish a $100,000 Seabird Contingency Fund that will be made available prior to construction of the proposed turbines. The value of the fund will be adjusted at 2.5% over the 20-year term of the HCP.. ;. This results in a total maximum of $163,861.64 (if left unused through year 20). If drawn upon at any time, the 2.5% would continue to accrue on the remaining balance. The fund will be available to implement adaptive management strategies to ensure mitigation is commensurate with take. If at the end of the 20-year period, mitigation implemented is not commensurate with take, any remaining funds will be used to continue to implement mitigation measures.

<u>Nene</u>

Nene nest near, and potentially within, the project area, and individuals of this species have been documented flying through the proposed wind farm on several occasions.

Their population numbers and use of the area are somewhat better understood than for the other species covered under this HCP. In addition, a program is already in place to propagate and release Nene, which can serve as a basis for providing mitigation. Mitigation for this species will consist of the following:

- Upon permit issuance, Kaheawa Wind Power will make the following contributions to a Nene propagation and release, or translocation program:

    1. provide for the construction of a new Nene release facility to be constructed within one year of beginning project operation (estimated cost $50,000, not adjusted for inflation). The preferred site for the new facility is on private land, but a state-owned site can be used if the private site is unavailable;

    2. $25,000 toward obtaining 10 Nene goslings;

    3. $9,000 toward the purchase of a truck to support the maintenance and predator control efforts at the new release facility;

    4. $15,000 toward operations and maintenance staffing during the first year; and

    5. $1,000 toward helicopter release during the first year.

    6. Annual contributions for the purchase of 10 chicks/yr ($25,000.00), staffing ($15,000.00/yr) and helicopter release ($1000.00/yr) will continue for the first five years regardless of take.

- In subsequent years Kaheawa Wind Power will provide additional support for obtaining goslings (in minimum lots of either four or ten), operations and maintenance, and helicopter releases as necessary for the mitigation level to remain ahead of the adjusted take level, as determined through fatality monitoring and coordination with USFWS and DLNR. The above measures will make it possible for Kaheawa Wind Power to support the release of up to 10 birds per year.

- Kaheawa Wind Power will fund the construction and operation of a second new release facility (as described above), at a location to be determined by DOFAW, and provide funding for a truck, staffing, helicopter releases, and the purchase of goslings as outlined above, if any of the following occur:

    1. If the running take over a five year period exceeds the capacity of the new release facility to provide mitigation for the adjusted take;

    2. If the Nene population at Hanaula (*i.e.*, the existing release facility near the proposed wind power project), which is currently on the increase and is believed to be self-sustaining, goes into decline as a result of the take that is occurring at the project, when measured over a five-year period; or

3. If the population of birds at the new release site does not increase or is unstable, when measured over a five-year period, indicating that the reintroduction of Nene at the site is failing.

- During the first year of project operation, a wildlife biologist will make systematic visual observations of Nene activity from representative locations within the project area. The objective will be to document the use of the area by Nene (if any) and to record observations of Nene behavior and activity in the vicinity of turbines, including in-flight response (*e.g.*, changing flight direction to avoid the turbines). Observations will be made from at least three locations (upper, middle and lower points within the project site), and will occur on a weekly basis for at least three hours (one hour at each site). The timing of observation periods will vary to represent daylight and crepuscular periods. Night-vision or thermal imaging equipment (as available) will be used during low-light periods.

- Incidental observations of Nene activity and response to the turbines will also be recorded under the Wildlife Education and Observation Protocol (Appendix 8). WEOP observations will continue over the life of the project.

- If monitoring determines that the level of take is consistently lower than expected, then Kaheawa Wind Power, with the concurrence of USFWS and DLNR, may decrease the level of annual contributions to be commensurate with the actual level of take, provided that the ratio of birds released to the adjusted take remains greater than 1 throughout the life of the project. Should no take occur, Kaheawa Wind Power will nonetheless provide the first five years of mitigation (construction of the new release facility, funding for its maintenance and predator control, propagation and release of ten goslings each year, etc.).

- As previously discussed herein, the existing and established vegetation in the project area will be maintained in its current condition, though cleared areas of concrete and gravel (a perimeter of approximately 50–60 feet) will be maintained around each turbine. While tall grass and shrubs at the turbine site may presently attract Nene for nesting (though none have been recently observed), the existence of the wind turbines and site activity may discourage birds from nesting in proximity to the site in the future (J. Medeiros, Maui DOFAW, pers. comm.). Excessive clearing or frequent mowing of vegetation could, however, create a foraging attraction for adults and juveniles, despite the turbines' operation and site activity. Any revegetation of cleared areas will be undertaken with the guidance of both DOFAW and DLNR forestry officials to ensure that such vegetation will not be an attraction for Nene nor have fire hazard potential.

- To further ensure the success of the mitigation effort, Kaheawa Wind Power will establish a $264,000 Nene Contingency Fund prior to construction of the proposed turbines. The value of the fund will be adjusted at 2.5% over the life of the project. This results in a total maximum of $432,594 (estimated 2025 dollars) over the 20-year term of the HCP. If drawn upon at any time, the 2.5% would continue to accrue on the remaining balance. If at the end of the 20-year period, the Hanaula Nene population is smaller than the population existing at the time the permit is issued as a direct result of project operations, the Nene Contingency Fund will be available to construct an additional new release pen, to operate this new pen for up to five years beyond the life of the project, and to supply the new pen with up to 50 Nene.

- Funding at the Higher and Notably Higher Take levels will be made available if take occurs at a lower annual level, but cumulatively reaches these levels before mitigation has been provided.

- Kaheawa Wind Power recognizes that the cost of implementing mitigation measures (for example, construction of a release facility) in any one year may exceed that year's budget allocation, even if the overall expenditure for mitigation 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 for unspent funds from previous years to be carried forward for later use.

<u>Hawaiian Hoary Bat</u>

Because little is known about this species' status in West Maui, Kaheawa Wind Power proposes to conduct surveys to better document patterns of this species' occurrence in the project area throughout the first year of project operation. Because so little is known about this species in general, the recovery plan for the Hawaiian Hoary Bat identifies research, including development of standardized survey and monitoring techniques, as an appropriate interim recovery strategy. Accordingly, the primary mitigation approach by Kaheawa Wind Power will consist of funding the expansion of ongoing research, as follows:

- Immediately following the issuance of the incidental take permit, Kaheawa Wind Power will contribute $20,000 to an appropriate program in support of bat research such as the Hawaiian Bat Research Cooperative (HBRC), the Hawai`i Endangered Species Trust Fund, or a similar program as determined by DLNR and USFWS. This figure is roughly equivalent to the cost of providing equipment and support for radio-tagging and monitoring an additional bat per year for 20 years under the existing HBRC research program (S. Fretz, DOFAW, pers. comm.). Allocation of the $20,000 contribution will be determined by USFWS and DLNR.

- Kaheawa Wind Power will survey for bat activity within the project area monthly for 12 consecutive months, using thermal imaging (as available) or night vision technology and an acoustic bat detector. Each monthly survey will run for two consecutive nights. Surveys will be conducted under suitable weather conditions, with a minimum of six hours of observation each night beginning at dusk. Observations will be made from several established stations throughout the project area. An acoustic bat detector will be used at the same time to scan the project area and listen for bat vocalizations.

- Bats that occur in the area will also be documented during the first year of project operation when the eight nights of radar and thermal imaging/night vision surveys are conducted in May-June and from October through December for seabirds, and during crepuscular observations of Nene activity (as discussed in the previous sections).

- Bat observations will also be incidentally documented during the seabird colony searches and monitoring efforts described above, which will add to the knowledge base of bat distribution and occurrence in West Maui.

- Incidental observations of bats will also be reported under the WEOP (Appendix 8).

- If monitoring indicates a Higher level of take (*i.e.*, a total of 2-5 bats per year), then Kaheawa Wind Power will provide additional funding at the rate of $1000 per bat taken, to be used specifically for the expansion of research efforts as described above.

- If monitoring indicates a Notably Higher level of take (*i.e.*, 5-10 or more bats per year), then Kaheawa Wind Power will: (1) continue to contribute $1,000.00 per bat annually toward research efforts described above, and (2) conduct in-depth on-site investigations to determine the cause(s) of the unexpectedly high level of take, and to identify and implement measures to reduce and minimize further take. On-site investigations may include, but will not be limited to, additional surveys using thermal imaging (as available) or night vision equipment, or newer state-of-the-art technologies, as appropriate, to document bat behavior and movements during periods when collisions are believed to be occurring, and particularly to determine whether certain turbines or site-specific conditions account for most of the take. Investigations may also include experimental changes in project operations, structures and lighting, and experimental measures to divert or otherwise repel bats from the area. Measures to reduce and minimize further take may include, but would not be limited to, implementing permanent changes in project operation, structures or lighting, or measures to divert or repel bats, that are found to be effective and otherwise not harmful.

- Funding at the Higher and Notably Higher Take levels will be made available if take occurs at a lower annual level, but cumulatively reaches these levels before mitigation has been provided.

- Kaheawa Wind Power recognizes that the cost of implementing mitigation measures in any one year may exceed that year's budget allocation, even if the overall expenditure for mitigation 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 for unspent funds from previous years to be carried forward for later use.

- If monitoring determines that the level of take is consistently lower than expected, then Kaheawa Wind Power, with the concurrence of USFWS and DLNR, may decrease the level of mitigation to be commensurate with the actual level of take, provided that the total mitigation effort throughout the project lifetime remains ahead of the actual take level. Should no take occur, Kaheawa Wind Power will nonetheless make the first year's "up front" $20,000 contribution.

- To further ensure the success of the mitigation effort, Kaheawa Wind Power will establish a $20,000 Bat Contingency Fund that will be made available prior to construction of the proposed turbines. The value of the fund will be adjusted at 2.5% over the term of the HCP. This results in a total maximum value of $32,772.40. If drawn upon at any time, the 2.5% would continue to accrue on the remaining balance. The funds will be available in the event that adjusted take exceeds the estimated 20 bats or as required to implement adaptive management strategies to ensure mitigation is commensurate with take. The fund will be used to fund on-the-ground measures such as, but not limited to, implementation of technologies to reduce the likelihood of collisions with the wind turbines and protection of roost sites as agreed to by USFWS and DLNR. If at the end of the 20-year period, mitigation implemented is not commensurate with take, any remaining funds will be used to continue to implement mitigation measures.

**Accounting for Impacts and Mitigation**

The goal of the mitigation effort is to fully compensate for the take that occurs, plus provide an additional benefit to the affected species. This can be viewed as an equation, with the appropriate mitigation equal to the impacts plus an additional benefit:

Appropriate Mitigation = Adjusted Take + Additional Benefit

Adjustments to ensure that Additional Benefits accrue to the target species are built into the estimates of impacts explained in the preceding sections. In general, the various types of impacts have been over-estimated by "rounding up" to ensure that additional benefits will result. In addition, when the mitigation measures are balanced against the adjusted take, a net positive outcome will be maintained.

Following are examples of how the adjusted take and the corresponding mitigation would be calculated for three hypothetical scenarios. For all scenarios it is assumed that assessments of searcher efficiency and scavenging rates have determined that on average 75 % of all fatalities are found by searchers.

Example 1

Assume two recently fledged juvenile Newell's Shearwaters are found killed by collision with a turbine during year three of project operation. Assume that colony protection measures started in the same year were yielding an estimated one additional young fledged per year.

| Component | Take (-) or Mitigation (+) |
|---|---|
| Direct Observed Take = 2 juvenile Newell's Shearwater | -2.0 |
| Direct Unobserved Take = Take of 2 times 25 % (based on 75 % detection rate) | -0.5 |
| Indirect Take = None | 0 |
| **Take Subtotal** | **-2.5** |
| Concurrent Mitigation: Colony protection efforts resulted in one additional fledgling during the same year that the take occurred. | +1.0 |
| Remaining Impact Subject to Loss of Productivity | -1.5 |
| Over the following two years colony protection efforts result in one additional fledgling per year | +2.0 |
| Loss of Productivity = 15 % of 1.5 compounded annually for 2 years = 0. 48 | -0.48 |
| **Net Impact After Mitigation** | **+0.02** |

Example 2

Assume two Hawaiian Petrels are found killed by collisions with turbines during year eight of project operation. Both are breeding age females found during nesting season. Assume further that colony protection efforts started in year three have reduced predation of adult birds by an estimated one per year. Thus, as of the time the take occurs (year five):

| **Component** | **Take (-) or Mitigation (+)** |
|---|---|
| Direct Observed Take = 2 adult Hawaiian Petrels | -2.0 |
| Direct Unobserved Take = Take of 2 times 25 % (based on 75 % detection rate) | -0.5 |
| Indirect Take = (Direct Observed + Direct Unobserved) x (Indirect Take of 0.5) = 2.5 x 0.5 = 1.25 | -1.25 |
| **Take Subtotal** | **-3.75** |
| Advanced and Concurrent Mitigation: By year five, colony protection efforts had prevented the loss of an estimated one adult per year for three years, resulting in a gain to the colony of three adults. | +3.0 |
| Remaining Impact Subject to Loss of Productivity | -0.75 |
| In the following year colony protection efforts prevent the loss of an additional adult | +1.0 |
| Loss of Productivity = 15 % of 0.75 (one year) | -0.11 |
| **Net Impact After Mitigation** | **+0.14** |

Example 3

Assume one breeding age adult Nene is found killed by collision with a turbine during the nesting season of year two of project operation. Assume that the mitigation efforts have been raising and releasing 10 juvenile birds each year as planned.

| **Component** | **Take (-) or Mitigation (+)** |
|---|---|
| Direct Observed Take = 1 adult Nene | -1.0 |
| Direct Unobserved Take = Take of 1 times 25 % (based on 75 % detection rate) | -0.25 |
| Indirect Take = (Direct Observed + Direct Unobserved) x (Indirect Take of 0.5) = 1.0 x 0.5 = 0.5 | -0.5 |
| Loss of Productivity: The surviving juvenile birds released after year one are expected to begin breeding by age three. Thus the take will need to be adjusted for a two-year lag. Loss of Productivity = 10 % of 1.75 compounded annually for two years | -0.37 |
| **Take Subtotal** | **-2.18** |
| Assume 90 % of the 10 juveniles released after year one survive to begin breeding in year three (juveniles released in subsequent years not tallied for this example) | +9.0 |
| **Net Impact After Mitigation** | **+6.82** |

# VI. IMPLEMENTATION

## HCP Administration

Kaheawa Wind Power will administer this HCP under the direction of the USFWS and DLNR. 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.*, Nene Recovery Action Group), consultants, and academia. When appropriate, and as determined by USFWS and DLNR, HCP-related issues may be brought before DLNR's Endangered Species Recovery Committee (ESRC) for formal consideration.

Kaheawa Wind Power 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, Kaheawa Wind Power 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 concerns.

## Monitoring and Reporting

Monitoring and reporting by Kaheawa Wind Power will be designed to address both compliance and effectiveness. Compliance monitoring will verify Kaheawa Wind Power's implementation of the CDUA permit and HCP terms and conditions. Annual reports and other deliverables described above will be provided to DOFAW, DLNR and USFWS, allowing them to independently verify that Kaheawa Wind Power has performed all of the required activities and tasks on schedule. Biological effectiveness monitoring investigates the impacts of the authorized take and the success of the HCP's mitigation program. Biological effectiveness monitoring involves surveys to make sure the authorized level of take is not exceeded, and that the effects of take are minimized and mitigated to the maximum extent practicable (*i.e.*, minimization and mitigation measures are sufficient and successful).

Kaheawa Wind Power proposes to document bird and bat injuries and fatalities, including ESA-listed and non-listed species, following methods that have been used recently and effectively at other wind energy generation facilities in the continental United States. Details of the proposed monitoring protocol are provided in Appendix 9. Key components include:

- local technical staff will be trained by experienced biologists who have specialized expertise in conducting wind turbine/bird interaction studies;

- trained dogs will be considered as a means to improve search effectiveness and reduce labor effort;

- initial studies will be conducted to assess site-specific carcass removal (*i.e.*, scavenging) rates to provide a basis for determining the appropriate search frequency;

- initially, systematic searches under the direction of a qualified biologist will be conducted at least twice per week during the typical May-June fledging period for Nene (which also coincides with the April-July nesting season for seabirds) and during the fledging periods for seabirds (October-November), and at least weekly during the remainder of the initial intensive survey period. Additional searches will be conducted on days after moonless, cloudy or stormy nights, when the wind turbines would be least visible and the potential impact would be greater, especially during peak fledging periods;

- intensive searches will be conducted for the first two years, after which the approach may be modified based on the results obtained up to that point;

- 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 V.

Brief progress reports will be submitted to DLNR and USFWS summarizing the findings of each SEEF trial, scavenging study, and summarizing fatality surveys in July (post-fledging for Nene) and again in January (post-fledging for seabirds). A final report summarizing the results of the first year of intensive monitoring will be prepared and submitted to DLNR and USFWS to determine (1) the actual take for each species, (2) whether there is a need to modify the mitigation for subsequent years, and (3) whether monitoring protocols need to be revised.

In subsequent years, if less intensive monitoring measures are agreed to by USFWS and DLNR, monitoring will consist of a reduced level of effort, consisting of smaller search plots at a subset of turbines, with plots and turbines being 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 in July (post-fledging for Nene) and again in January (post-fledging for seabirds). In addition, in accordance with the Downed Wildlife Protocol, biologists at DLNR and USFWS will be notified whenever a listed species is found dead or injured. Kaheawa Wind Power 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, determine the actual take, and plan appropriate future mitigation and monitoring measures. Any changes to future mitigation and monitoring will be with the concurrence of USFWS and DLNR.

Botanical Resources

Foot traffic has the potential to adversely affect plant life within the areas that will be regularly searched for bird and bat fatalities around each turbine (initially 180 m by 200 m). Large portions of these areas were previously surveyed to assess the potential for construction to adversely affect state- and federally-listed plants or their critical habitats, and no listed or candidate species have been documented within the footprint of the project. However, several listed species and their critical habitats are known to occur within the upper reaches of Papalaua Gulch located to the west and Manawainui Gulch plant sanctuary located to the east of the upper turbine string. According to the USFWS and the Hawaii Natural Heritage Program database, four listed species and their critical habitats fall within the search areas of the four uppermost turbines (T1-T4). To ensure that impacts are avoided and minimized during monitoring, the full 180 m by 200 m search area around all 20 turbines will be surveyed by a qualified botanist in advance of project operations. Any listed or candidate species that are found will be clearly marked, and search activities will be modified as appropriate to avoid direct or indirect impacts.

Location(s) of listed plant species will be documented (including GPS coordinates, photographs, rare plant monitoring data forms) and monitoring of vegetation plots established within and adjacent to the affected critical habitat areas as a baseline for determining whether adverse impacts attributable to the fatality search efforts or project activities occur over time, and if so, whether mitigation needs to be implemented. Vegetation monitoring plots will be established prior to fatality searches and be performed by a qualified botanist. Vegetation monitoring and mitigation (if necessary) will be developed and implemented in consultation with DLNR and USFWS. Potential mitigation measures would depend on the impacts that actually occur, but may include measures such as control of invasive species or propagation and planting of additional specimens.

In addition, because portions of the fatality search area that fall within the sanctuary are designated as critical habitat, methods for conducting searches in these areas will need to proceed adaptively to best meet the objectives of documenting fatalities while avoiding adverse impacts. Potential adaptive measures may include reduced frequency of searches, scanning for fatalities from outside the area, and making adjustments to fatality numbers to account for the reduced search area or reduced level of search effort. Portions of the search areas designated as critical habitat will be documented (as described above) as a baseline for assessing impacts and prescribing any mitigation that may be appropriate.

**Summary of Adaptive Management Program**

An adaptive management strategy is needed for the successful implementation of this HCP to sufficiently and appropriately assess the result of minimization and mitigation efforts. Particularly because little is known or understood about the four species' occurrence and behavior in the project vicinity, and even less is known about the species' potential reaction to the wind turbines, adaptive management must be employed to achieve this HCP's biological goals and objectives.

Adaptive management, therefore, will rely heavily on the monitoring and reporting program. The results of monitoring reports will be evaluated by the USFWS and DLNR to determine the level of take that is occurring. Depending on these results, mitigation efforts may be increased or decreased accordingly. Any changes in mitigation will be done in concurrence with USFWS and DLNR. Regardless, the avoidance and minimization efforts will remain for the project's duration. A table depicting mitigation efforts and adaptive management options is included as Appendix 10.

The adaptive management approach prescribed under this HCP is reflected in several Special Conditions of the DLNR ITL, as follows:

Special Condition 3: The incidental take authorized by this license can be increased provided that mitigation has been implemented such that benefits to the species outweigh the losses as detailed in the HCP.

Special Condition 4: Incidental take of *Pterodroma sandwichensis* authorized under this license exceeding a running average of two per fiscal year, or greater than five in any one fiscal year, requires the development and implementation of adaptive management strategies approved by the Department of Land and Natural Resources (DLNR) and the U.S. Fish and Wildlife Service (USFWS) and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

Special Condition 5: Incidental take of *Puffinus auricularis* authorized under this license exceeding a running average of two per fiscal year, or greater than five in any one fiscal year, requires the development and implementation of adaptive management strategies approved by DLNR and USFWS and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

Special Condition 6: Incidental take of *Branta sandvicensis* authorized under this license exceeding a running average of three per fiscal year, or greater than eight in any one fiscal year, requires the development and implementation of adaptive management strategies approved by DLNR and USFWS and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

Special Condition 7: Incidental take of *Lasiurus cinereus semotus* authorized under this license exceeding a running average of one per fiscal year, or greater than two in any one fiscal year, requires the development and implementation of adaptive management strategies approved by DLNR and USFWS and reviewed by the Endangered Species Recovery Committee in accordance with the HCP.

**Success Criteria**

Kaheawa Wind Power has sought to demonstrate that its measures to minimize and mitigate potential take are appropriate and will be effective in providing a net conservation benefit to the four listed species. In the case of the Nene, mitigation is somewhat quantifiable, given the propagation program, and up-front contributions to be credited against subsequent years' take will allow capital improvements to the Nene propagation efforts to assist in the species' recovery. In the case of the two seabird species, mitigation is less easily quantifiable; therefore, Kaheawa Wind Power will conduct surveys to identify mitigation opportunities, and to implement mitigation measures as they are identified and prioritized in cooperation with USFWS and DLNR. Such efforts will greatly contribute to the recovery efforts of both species by providing the only scientific (as opposed to anecdotal) information on the species' behavior with wind turbines and their colony locations; this information can, in turn, be used to establish additional minimization and mitigation measures as needed. Finally, in the case of the Hawaiian Hoary Bat, whose occurrence and behavior on Maui is understood only peripherally, additional surveys and contributions to DLNR and/or the Hawaiian Bat Research Cooperative will assist in the study of this species on Maui and the State.

Based upon this HCP's biological goals and objectives, and its mitigation and monitoring protocols, Kaheawa Wind Power will consider this HCP to be a success if:

- the actual take of the four listed species is less than or equal to the anticipated take;

- the additional surveying for the Hawaiian Petrel, Newell's Shearwater and Hawaiian Hoary Bat during the first 12 months of operation are successfully completed, including the analysis and interpretation of the results and submittal of the final report;

- the WEOP and the Downed Wildlife Protocol are determined to be effective and reasonably accurate methods for tracking the ongoing impacts of the project; and

- the project is making meaningful contributions toward the management and protection of the four target species that provide a net conservation benefit, i.e., are greater than the actual impacts, if any, experienced by each species as a result of the project.

Through the additional survey work and monitoring protocol, Kaheawa Wind Power will further demonstrate that the above-described minimization and mitigation measures are both effective and appropriate. While take estimates are needed and required for the purposes of the HCP and the ITL/ITP, Kaheawa Wind Power truly believes that the actual take will be less than what is proposed herein. If this is the case, then the minimization measures will be proven to be effective. The proposed mitigation will also be evaluated once actual take is determined, to verify that a net conservation benefit to each species is being achieved. Further appropriate or necessary minimization and mitigation can only be determined once the post-operational surveys and monitoring have been conducted.

**Funding**

An estimate of the costs of funding the proposed mitigation plan is provided in Appendix 11. Assuming project operation begins in spring 2006, the cost of the supplemental studies for seabirds and bats, and intensive monitoring for downed wildlife during the first 12 months of operation, is estimated to be $367,500.00. This figure includes the initial $143,000.00 contribution to the Nene propagation effort. Assuming the take of all species remains at or below the estimate anticipated for the Baseline Take scenario, and contingency funds are not needed, the average annual cost for years 2 through 20 is estimated at $61,605.00 (in 2005 dollars). Total estimated cost over an assumed 20-year project life is $1,538,000.00 (not adjusted for inflation), assuming contingency funds are not needed.

Funding for the initial implementation of the HCP will be provided from the Kaheawa Wind Power loan facility, which closed on March 29, 2005. As part of the Base Case financing pro forma and budget provided to the lenders at financial close, the HCP implementation program will receive $207,000 in funds drawn from the loan facility during the construction period. There is also a $2.25 million contingency fund as part of this financing, a portion of which could be used to fund pre-operational HCP costs. Following commercial operations of the project, the costs of the HCP will be funded 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.

KWP has been financed on a "non-recourse project finance" basis[1] by a syndicate of international commercial banks. What this means in practice is that these banks are solely relying on the future cash flows to be generated by the Project's operation and corresponding payment by Maui Electric Company for electricity delivered at pre-agreed rates as detailed in an agreement between KWP and Maui Electric Company. The banks' reliance on future cash flows indicates their high level of confidence in the financial strength of the project. As is typical with project finance structures, the lending banks have performed an extraordinary amount of due diligence and there is extensive documentation between KWP (the borrower) and the lending banks. An important feature of a project finance structure is that once the borrower's equity has been injected, there is no further support from either the equity investors themselves (UPC Hawai`i Wind Partners II, LLC) or the parent entities of the equity investors (UPC Hawai`i Wind Partners, LLC). However, the lenders' collateral includes the ownership interests in UPC Hawai`i Wind Partners II, LLC.

[1] Standard and Poor's defines project finance as: "A project company is a group of agreements and contracts between lenders, project sponsors, and other interested parties that creates a form of business organization that will issue a finite amount of debt on inception; will operate in a focused line of business; and will ask that lenders look only to a specific asset to generate cash flow as the sole source of principal and interest payments and collateral." *(Source: Standard and Poor's Global Project Finance Yearbook, November 2004)*

The reason for highlighting this is to illustrate the point that the Project is completely self-funding. All of the on-going costs of the HCP have been included in the banks' analysis of the profitability of the Project. The HCP costs have been included as a cash expense line item along with operation and maintenance costs, insurance, payroll, lease payments to the State of Hawai`i, audit costs, and agency fee costs.

The applicant is offering other financial assurances as well. Kaheawa Wind Power will provide a rolling letter of credit (LC) or bond in the amount of $500,000, which will be available to fund mitigation in the unlikely event of a revenue shortfall or, in the worst case scenario, bankruptcy. The LC will name the USFWS and DLNR as beneficiaries. The LC will have a term of four years, and will be automatically renewed prior to expiration, unless it is determined to no longer be necessary by the USFWS and DLNR. In the event of a revenue shortfall or bankruptcy the LC could be drawn upon by the USFWS or DLNR to fund any outstanding mitigation obligations of the project. This LC would be in addition to the $1.5M LC already in place for DLNR to fund turbine removal and site restoration in the event of bankruptcy. During the first 10 years of operation, the value of the LC or bond would increase to $1,000,000 in the event that unmitigated take at the Notably Higher Take level occurs for any species, either annually or as a cumulative total. At the end of year 10, and in subsequent years, if the $1,000,000 bond is in place, the applicant, in cooperation with the DLNR and USFWS, will conduct an assessment to determine whether the value of the bond is sufficient to assure funding over the remaining years of the HCP. The assessment will be based upon an accounting of the amount spent to date, relative to the maximum $3.76M amount. The maximum amount of the bond would be the difference between these two, although the actual amount would be determined by DLNR and USFWS at the time the assessment is made.
The applicant will establish an additional, single bond or letter of credit for the value of the three contingency funds ($384,000). The amount of the bond 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.

In addition, a parent guaranty is being provided by UPC Hawai`i Wind Partners, LLC, the entity that indirectly owns 100 % of the ownership interests of the applicant – KWP (Appendix 12). Since KWP is under construction, all of its assets are not yet in service. KWP has a financing commitment for the full construction costs of the facility. As of June 30, 2005, KWP's assets were $21.8 million and are expected to be $63.3 million at construction completion in April 2006.

The guaranty would be in place in the very unlikely event of a cash shortfall in any one year. The guaranty could be called to fund amounts not available from project cash flows and needed for HCP-related costs. The guaranty amount would be for a maximum of $3.76 million, *i.e.*, equivalent to the estimated costs of all mitigation and monitoring measures, including contingency funds and interest accrued, in the extremely unlikely event of Notably Higher Take occurring for all four species. The maximum guaranty amount would reduce over time by the actual amount expended by the applicant toward these efforts.

Given the strength of the Project's structure and robust financial position, the fact that Kaheawa Wind Power has raised all of the funds to construct the Project, this solution will be much more than adequate to meet the minimum issuance criteria, even in the event of Notably Higher Take of all four species.

### Changed Circumstances

The HCP process allows for acknowledgement of and planning for reasonably anticipated changes in circumstances affecting the subject species. For example, a common illness occurring in one of the subject species (*e.g.*, in Nene released on Maui) could be considered a changed circumstance. Changed circumstances are not unforeseen circumstances, as described below.

Changed circumstances that may affect the implementation of the HCP, in addition to disease, include the outbreak of brush or wild fires through the project site and in the vicinity of the Nene release pen, hurricanes and storms, and changes in the price of raw materials and labor. In the event of such changes, DLNR and USFWS would work with Kaheawa Wind Power as soon as possible to discuss any necessary changes in the implementation of the HCP. Kaheawa Wind Power will implement such changes 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 this HCP.

Kaheawa Wind Power 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)(i and ii) and 50 CFR 17.32(b)(5)(i and ii). If such measures were not provided for in the HCP, and the HCP is otherwise being properly implemented, the USFWS will not require any conservation and mitigation measures in addition to those provided for in the HCP without the consent of Kaheawa Wind Power (50 CFR 17.22(b)(5)(i and ii) and 50 CFR 17.32(b)(5)(i and ii).

### 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 Kaheawa Wind Power, USFWS or DLNR become aware any circumstances that may affect any listed species and/or the ability of Kaheawa Wind Power to implement this HCP, all involved entities should be immediately notified and should 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 Kaheawa Wind Power [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 Kaheawa Wind Power 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 Kaheawa Wind Power be required to provide, any other mitigation beyond that provided for in the adaptive management program covered by the original terms and conditions, and goals and objectives, of this HCP. Any such 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 Kaheawa Wind Power. 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 Kaheawa Wind Power.

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 consider, but not be limited to, the following factors: (1) size of the current range of the affected species; (2) percentage of range adversely affected by the HCP; (3) percentage of range conserved by the HCP; (4) ecological significance of that portion of the range affected by the HCP; (5) level of knowledge about the affected species and the degree of specificity of the species' conservation program under the HCP; and (6) whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the affected species in the wild.

### Permit Duration and Amendments

Kaheawa Wind Power proposes to have a Habitat Conservation Plan in effect for the duration of the wind energy generation facility's operation, which is anticipated to be twenty years.

Minor Amendments

Informal, minor amendments are permissible without a formal amendment process provided that the change(s) necessitating such amendment(s) does not cause a net adverse effect on any of the four subject species that is significantly different from the effects considered in the original HCP.

Such informal amendments could include changes in surveying protocols or monitoring procedures. This HCP may be so informally amended by written notification to and written concurrence of USFWS and DLNR-DOFAW.

Formal Amendments

Formal amendments, on the other hand, are required if the change(s) necessitating such amendment(s) could produce a net adverse effect on any of the four subject species that is significantly different than 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-DOFAW with the same supporting information that was provided with the original application.

The need for a formal amendment must 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.

Renewal or Extension

This HCP is proposed to be renewed or extended, and amended if necessary, beyond its initial twenty-year term with the approval of USFWS and DLNR. Kaheawa Wind Power 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 within at least 180 days of the conclusion of the permit term, and the HCP shall remain valid and in effect while the renewal or extension is being processed. The permit may not be renewed for levels of take beyond those authorized by the original permit.

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. An Implementing Agreement stipulating the HCP's terms and conditions in contractual form will be signed by all parties (Kaheawa Wind Power, USFWS, and DLNR).

## VII. CONCLUSION

Kaheawa Wind Power looks forward to working with the USFWS and DLNR-DOFAW throughout the approval and long-term implementation of the HCP for the Kaheawa Pastures project. While commercial wind energy generation facilities are acknowledged to be environmentally friendly endeavors, they are not without potential negative environmental impacts. Kaheawa Wind Power is committed to making extensive efforts to avoid, minimize, mitigate and compensate for these impacts as evaluated and determined through the HCP process and its adaptive management strategy.

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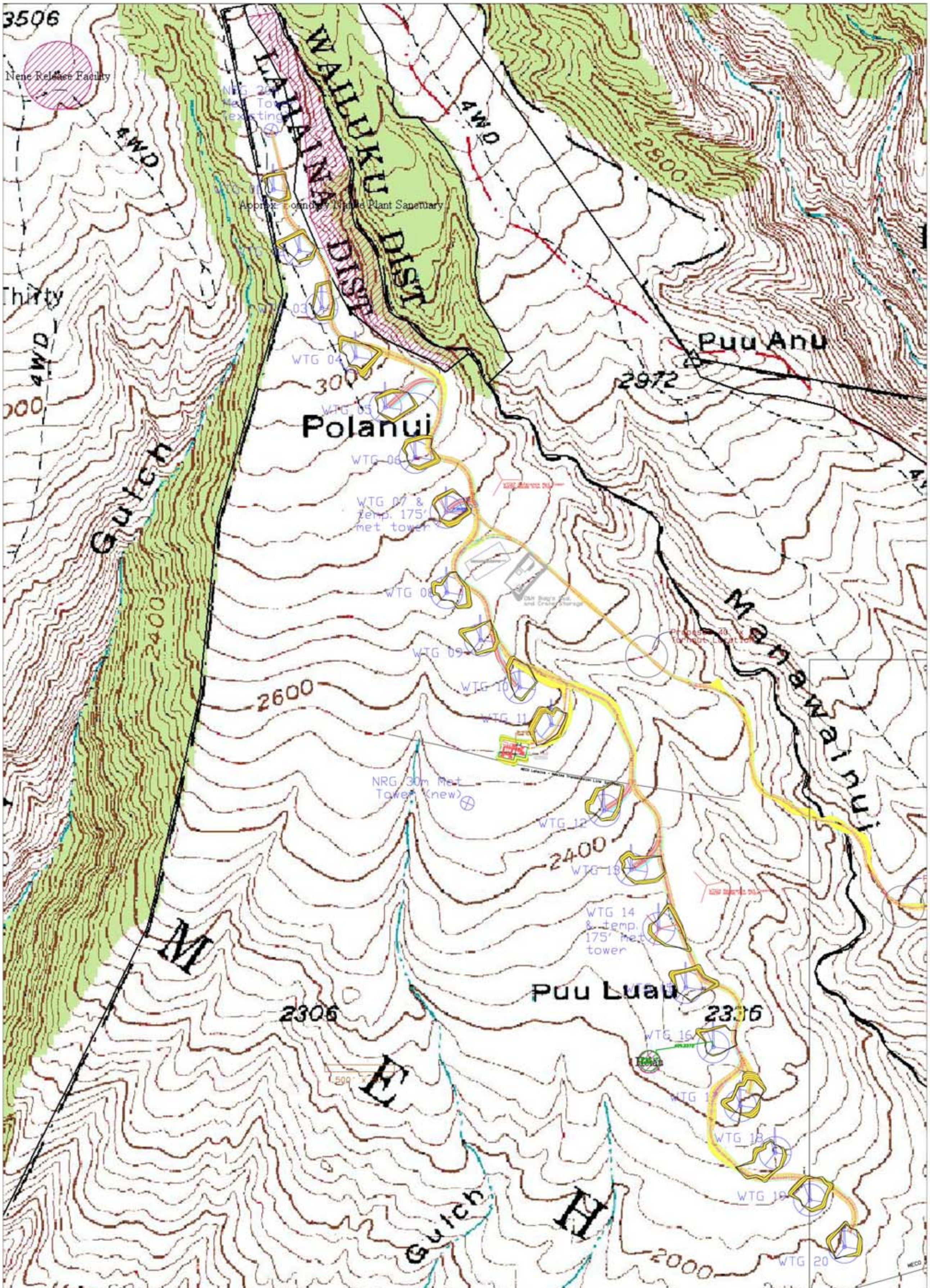
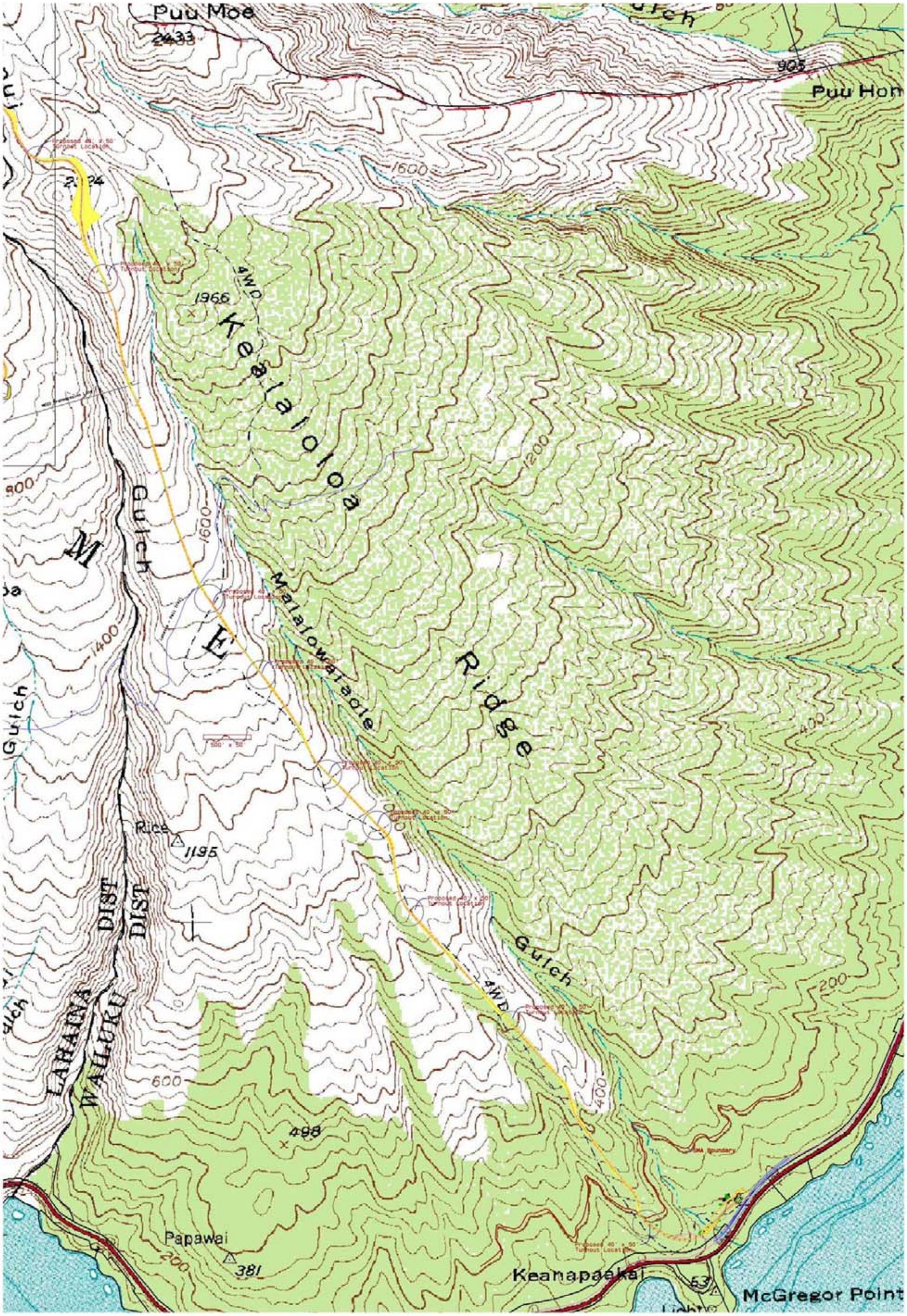



# Figure 1A - Project Site




# Figure 1B - Access Road

**Figure 2**
**GE 1.5 Wind Turbine**

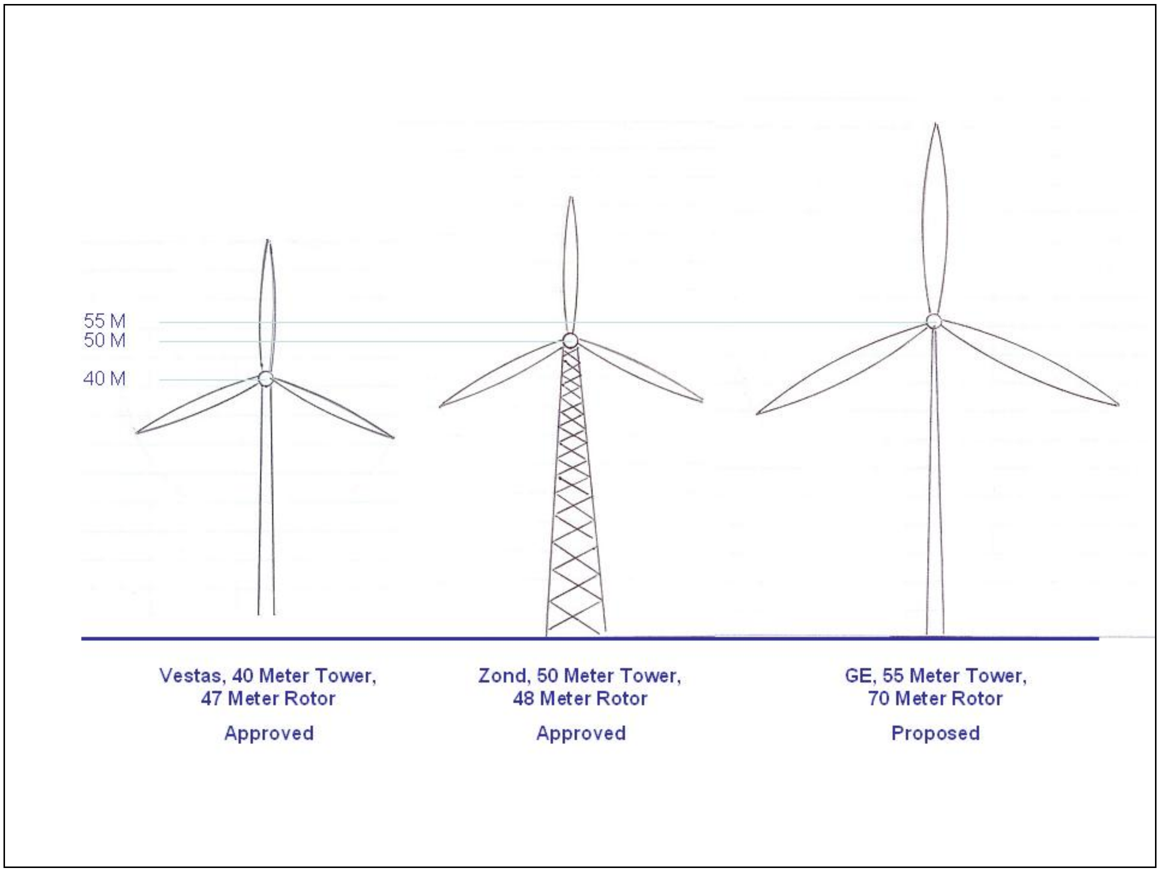



**Figure 3**
**Turbine Comparison**

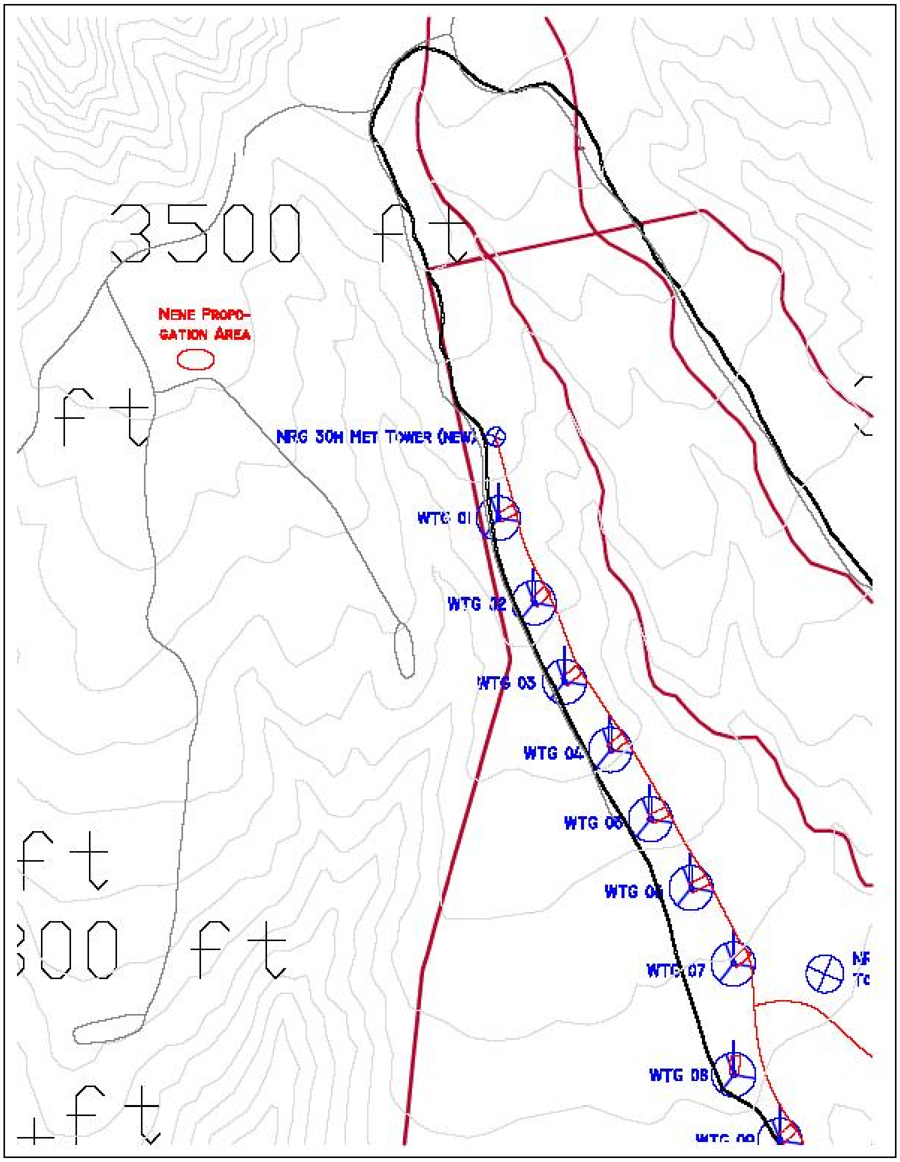



**Figure 4**
**Location of Nene Enclosure at Hanaula**

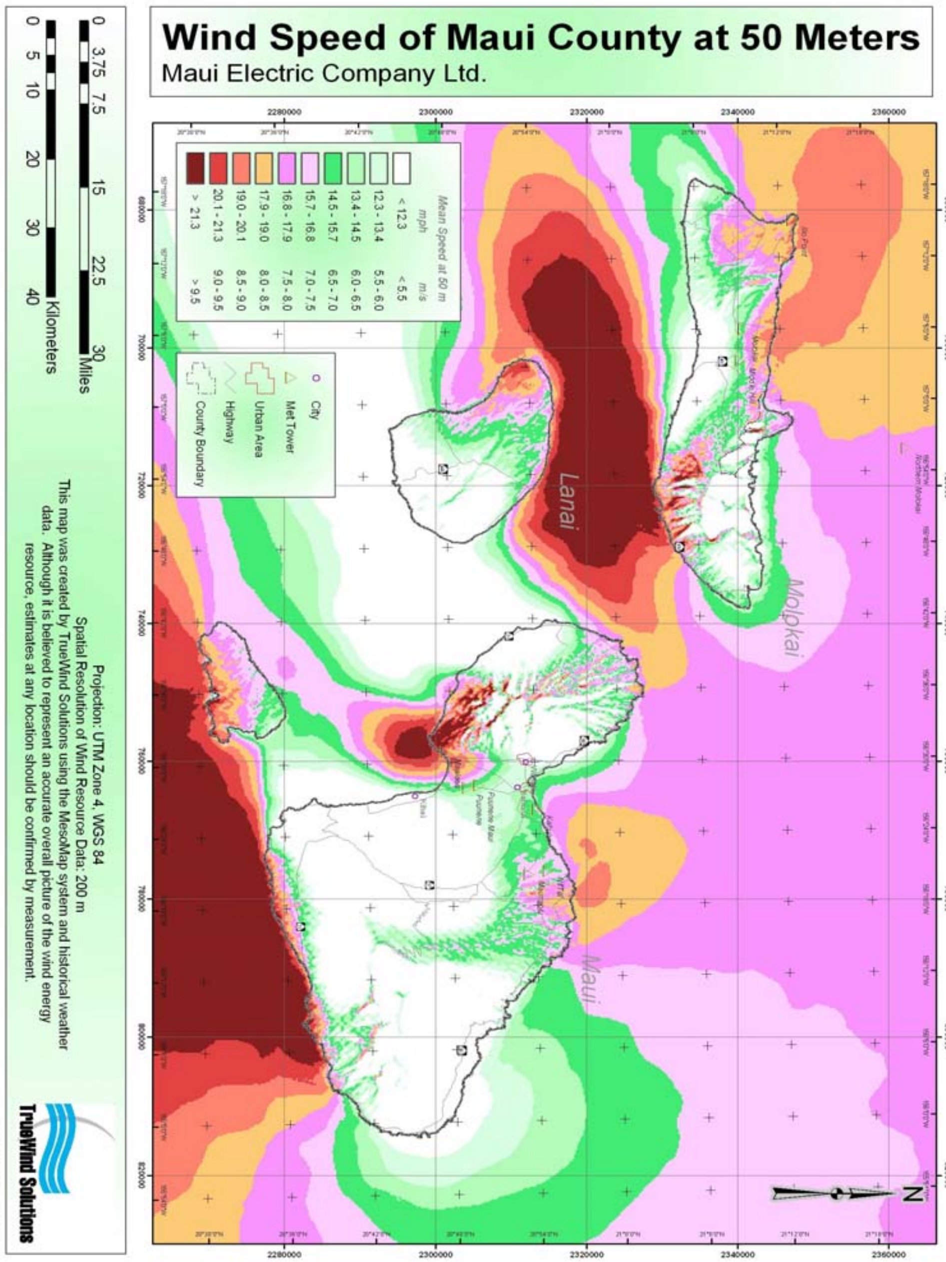



**Figure 5**
**Maui County Wind Regime**

# Appendix 1

## Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Windfarm on Maui Island, Hawaii, Summer 1999

# RESULTS OF ENDANGERED BIRD AND BAT SURVEYS AT THE PROPOSED KAHEAWA PASTURES WINDFARM ON MAUI ISLAND, HAWAII, SUMMER 1999

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## EXECUTIVE SUMMARY

- We conducted surveys for endangered seabirds (Hawaiian Dark-rumped Petrel or 'Ua'u *Pterodroma phaeopygia sandwichensis*; Newell's [Townsend's] Shearwater or 'A'o *Puffinus auricularis newelli*), geese (Nene *Branta sandvicensis*), and bats (Hawaiian Hoary Bat or 'Opa'opa'e *Lasiurus cinereus semotus*) at the proposed Kaheawa Meadows windfarm on Maui between the nights of 28 May and 4 June 1999.
- The primary habitat at the proposed windfarm is grassland. Uluhe ferns and Ohia trees, which are preferred nesting habitat for Newell's Shearwaters and, to some extent, Dark-rumped Petrels, occur from high elevations to the upper end of the proposed windfarm. Thus, habitat does not appear to be suitable for nesting by either species on the windfarm itself, but it does appear to be suitable at higher elevations on West Maui Mountain.
- We used ornithological radar and night-vision equipment to measure movement rates (number of targets/hr on radar) of birds and bats and to identify targets, when possible.
- We sampled two sites for four nights each (28–31 May at Site 1 and 1–4 June at Site 2). Site 1 was located at ~3,200 ft elevation and was near the upper end of the proposed turbine string. Site 2 was located at ~2,300 ft elevation and was in the lower part of the proposed turbine string. Weather and environmental conditions generally were similar between the two sites, although winds were considerably stronger at Site 2 than at Site 1.
- We recorded 40 targets on radar that fit our criteria for counting (i.e., flying over land with a speed of ≥35 mi/hr [56 km/hr]). Of these targets, we saw 28 at Site 1 (i.e., the upper site) and 12 at Site 2 (i.e., the lower site). The temporal breakdown was 18 targets at Site 1 and 8 at Site 2 in the evening, 10 targets at Site 1 and 4 at Site 2 in the morning, and 26 targets in the evening and 14 in the morning at both sites combined.
- Movement rates on radar varied between 0 and 9.6 targets/hr and averaged 1.2 targets/hr overall. Movement rates generally were higher in the evening than in the morning but varied among nights at both sites. The timing of movement of targets was bimodal, peaking at 2035–2059 and 0535–0559 during the evening and morning, respectively. All of the evening movement occurred after sunset, and most of the morning movement occurred before sunrise.
- Mean flight directions were 188 ± 72° in the evening, 176 ± 42° in the morning, and 181 ± 63° overall. The predominant general flight direction of targets on radar was seaward.

Inland flights were much more common in the evening than in the morning, but they were overwhelmed numerically at all times by seaward flights.

- Of the 40 targets seen on radar, 95% were flying in a straight line and 5% were flying erratically; none were circling. One of the erratically flying targets was a flock of four Nene at Site 1; the other erratically flying target was not identified.
- Flight speeds of targets on radar varied between 30 mi/hr (48 km/hr) and 60 mi/hr (97 km/hr), with an overall mean speed of nearly 42 mi/hr (70 km/hr). Flight speeds were slightly higher at Site 2 than at Site 1 and were higher in the morning than in the evening.
- We recorded petrels and shearwaters twice during the night-vision sampling, both at Site 1. One record was of a Dark-rumped Petrel in the evening, and the other was of two unidentified shearwater/petrels in the morning. We recorded Nene five times during the night-vision sampling. Three of 4 records were of birds flying ≤60 m above ground level.
- Most radar targets probably were Dark-rumped Petrels and/or Newell's Shearwaters. The crepuscular timing of movements, the inland–seaward directions of flight, the directional flight behavior, and the rapid flight speeds all are similar to those for the same species on both Kauai and Hawaii. Hence, one or both species still nests somewhere in West Maui Mountain, and some of these birds regularly fly over or near the proposed Kaheawa Pastures windfarm at night. The size of this nesting population is unknown at this time. However, movement rates are very low—less than 10% of the lowest movement rate that we recorded on Kauai. Flight altitudes of the two birds that we saw on the night-vision scope were high over the surrounding landscape.
- Nene occur in the vicinity of the proposed windfarm, and our small sampling effort indicates that they occasionally fly over the proposed windfarm, particularly near its upper end. In addition, they commonly fly at low flight altitudes and at night. All of these behaviors will put them in jeopardy of collision with the towers and turbine blades.
- We recorded no Hawaiian Hoary Bats during this sampling. Although these bats prefer areas with trees, especially moist areas, they have been recorded at Lahaina, which also is dry, and they regularly are seen on the dry southern side of Kauai. Hence, although it is not out of the question for this species to occur in the windfarm, it probably occurs infrequently and in very low numbers.

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## INTRODUCTION

Zond Pacific is proposing to construct a 20-MW wind farm in the Kaheawa Pastures area on the southern slope of West Maui Mountain (Zond Pacific 1999). As part of the permitting process, they are conducting surveys for endangered birds and bats in the vicinity of the proposed windfarm. Zond already had conducted surveys for downed birds and bats at the existing meteorological towers (Nishibayashi 1997) and surveys for native birds in the vicinity of the proposed windfarm (Nishibayashi 1998). Nishibayashi (1997), however, recommended that nocturnal surveys of endangered birds and bats be conducted with ornithological radar, which had been shown to be successful in studying these species on Kauai (Cooper and Day 1994, 1998; Day and Cooper 1995) and Hawaii (Reynolds et al. 1997), to determine use of the area by these nocturnal species.

As a result of these recommendations, we were contracted by Zond Pacific to conduct a survey at the proposed Kaheawa Pastures windfarm on West Maui Mountain in May–June 1999. The objectives of this study were (1) to conduct surveys of endangered birds and bats in the vicinity of the proposed windfarm and (2) to determine the use of the proposed windfarm by any of these species.

## BACKGROUND

Four species that are protected under the Endangered Species Act may occur in the vicinity of the proposed windfarm. Of the four, three are birds: the endangered Hawaiian Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*), the threatened Newell's (Townsend's) Shearwater (*Puffinus auricularis newelli*), and the endangered Nene (*Branta sandvicensis*). The fourth species is a mammal, the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*).

### PETRELS AND SHEARWATERS

Races of the Dark-rumped Petrel ('Ua'u) and the Newell's Shearwater ('A'o) are forms of tropical Pacific species that nest only on the Hawaiian Islands (American Ornithologists' Union 1998). Because of their low overall population numbers and restricted breeding distributions, both of these species are protected under the Endangered Species Act.

Dark-rumped Petrels are known to nest primarily on Maui (Richardson and Woodside 1954, Banko 1980a, Harrison et al. 1984; Simons 1984, 1985; Simons and Hodges 1998). An unknown number (probably several thousand; Telfer et al. 1987, Gon 1988, Day and Cooper 1995; Ainley et al. 1995, 1997a; T. C. Telfer, Hawaii Department of Land and Natural Resources [DLNR]) nests on Kauai, and recent records on Lanai (Shallenberger 1974; Hirai 1978a, 1978b; Conant 1980), Molokai (Simons and Hodges 1998), and Hawaii (Banko 1980a, Conant 1980) suggest breeding. On Maui, these petrels are known to nest only inside the rim of Haleakala Crater (Brandt et al. 1995), but essentially nothing is known about whether they actually nest on West Maui Mountain and, if they do, their nesting distribution or habitat use there (C. N. Hodges, Haleakala National Park, Maui, HI, pers. comm.). On 16 June 1999, however, a Dark-rumped Petrel was heard calling from some Uluhe ferns (*Dicranopteris linearis*) at 3,300 ft elevation in the Kapunakea Preserve, which lies on the northwestern slope of the West Maui Natural Area Reserve (A. Lyons, *fide* C. Hodges); this site was ~8 mi from the upper end of the proposed windfarm. Juvenile Dark-rumped Petrels land in brightly lit areas (i.e., fall out) at scattered locations on Maui in most years (Gassman-Duvall et al. 1988; Hodges, unpubl. data).

Newell's Shearwaters breed on several of the main Hawaiian Islands (Harrison 1990), with their largest population clearly being on Kauai (Telfer et al. 1987; Ainley et al. 1995, 1997b; Cooper and Day 1995, Spear et al. 1995; Telfer, unpubl. data). These shearwaters also nest on Hawaii (Reynolds and Richotte 1997, Reynolds et al. 1997), probably nest on Molokai (Pratt 1988) and Oahu (Sincock and Swedberg 1969; Shallenberger 1976, cited in Conant 1980; Banko 1980b, Conant 1980, Pyle 1990), and, from the occurrence of downed adults in summer (Pyle 1983) and juveniles in fall (Hodges, unpubl. data), almost certainly nest on Maui. Again, however, if they do nest, their nesting distribution and habitat use on Maui, especially on West Maui Mountain, are unknown.

Because of the inaccessibility of nesting colonies of both species, on-the-ground programs for studying and monitoring the populations of these species have been limited. The most extensive work on Dark-rumped Petrels has been done by Simons (1984, 1985), Brandt et al. (1995), and Hodges (1998) on Maui. The most extensive work on Newell's Shearwaters has been done on Kauai by Thomas Telfer of the State of Hawaii Department of Land and Natural Resources [DLNR], who helped to develop a program that aided in the recovery and release of juvenile birds, primarily Newell's Shearwaters, during the fall fledging (Telfer et al. 1987). The

"Save Our Shearwaters" (SOS) Program, which has operated continuously since 1978, has recovered and released over 25,000 young shearwaters since its inception (Telfer, unpubl. data). This program also monitors the downing and mortality of petrels and shearwaters during the spring and summer and aids in rehabilitating downed birds for later release. The most recent on-the-ground research on Newell's Shearwaters on Kauai has been done by Ainley et al. (1995) and Podolsky et al. (1998).

Other than the SOS Program, ornithological radar is the primary method that shows promise for studying and monitoring these birds. This research tool, which has been used successfully on both Kauai (Cooper and Day 1995, 1998; Day and Cooper 1995) and Hawaii (Reynolds et al. 1997), has enabled much to be learned about basic movements, behavior, and distribution of these two species around these islands. The use of radar also shows great promise in population estimation and population monitoring for these species on Kauai (Cooper and Day 1995).

**NENE**

The Nene is a rare bird in the Hawaiian Islands. After nearly becoming extinct in the 1940s and 1950s, this species' population slowly has been built up through captive-breeding programs (Kear and Berger 1980). As a result of such programs, the Nene has been re-introduced onto three of the main Hawaiian Islands (Kauai, Maui, and Hawaii) and is proposed to be released soon on Molokai (information from www.Nene-OMolokai.htm). These re-introductions include Maui, where a release pen has been located on West Maui Mountain, near the upper end of the proposed Kalehawa Pastures windfarm. Other sites on Maui where the Nene occurs include Lahaina, Wailuku, Haleakala National Park, and the outskirts of Haleakala (J. Medeiros, Hawaii DLNR, pers. comm.). More than 60 Nene have been released so far from the Nene release pen on West Maui Mountain, but little is known about their exact distribution and movements on this mountain (Medeiros, pers. comm.). Birds from this release site have been recorded as far west as Lahaina and as far east as Haleakala National Park, indicating that at least some birds from this release site move extensively on the island (Medeiros, pers. comm.).

**HOARY BATS**

The Hawaiian Hoary Bat ('Opa'opa'e) is small, nocturnal, and difficult to study and count. Little is known about its biology, distribution, or habitat use on the Hawaiian Islands. It has been recorded on Kauai, Oahu, Molokai, Maui, and Hawaii, is believed to be most abundant on the latter island, and is thought to be "rare" or "scarce" on Maui (van Riper and van Riper 1982, Tomich 1986, Fujioka and Gon 1988, Kepler and Scott 1990, Duvall and Gassmann-Duvall 1990, Cooper et al. 1996, Reynolds et al. 1997, Day and Cooper, unpubl. data.). In fact, Kepler and Scott (1990) suggested that the species is so rare on Maui (they had only 7 records) that, rather than having a resident population, it is a migrant from nearby Hawaii. This suggestion, however, was refuted by Duvall and Gassmann-Duvall (1991), who discussed records of an additional 60 bats that were not known to Kepler and Scott (1990).

The Hawaiian Hoary Bat occurs primarily below 4,000 ft elevation, although it commonly is seen at 7,000–8,000 ft (~2,100–2,400 m) on Hawaii (van Riper and van Riper 1982, Cooper et al. 1996). The highest-altitude record of this species that we are aware of is of one bat at 3,355 m (11,004 ft) on Mauna Loa (Cooper et al. 1996). Duvall and Gassmann-Duvall (1991) recorded this bat on Maui between 0 and 2,760 m (~9,050 ft) in elevation, with most records occurring around 630 m (2,060 ft).

On Maui, this bat is believed to occur in moist, forested areas (Hodges, pers. comm.; Medeiros, pers. comm.), although little is known about its exact distribution and habitat use on the island, especially on West Maui Mountain. For example, Nishibayashi (1997) recorded none during his surveys of the proposed windfarm but emphasized that his surveys were not conducted at an appropriate time of the day for detecting such species. In spite of the species' probable preference for moist forested areas, it has been seen in Lahaina (Tomich 1986) and near Mopua (Hawaii Natural Heritage Program database), both of which are dry. It also is recorded regularly on the drier side of Kauai (Day and Cooper, unpubl. data; Telfer, unpubl. data), indicating that such habitat does not exclude this species. During the day, this bat roosts in a variety of tree species and occasionally roosts in rock crevices and buildings (Tomich 1986); it even has been recorded hanging from wire fences on Kauai (Telfer, pers. comm.) and has been seen leaving and entering caves and lava tubes on Hawaii (Fujioka and Gon 1988).

## STUDY AREA AND METHODS

### STUDY AREA

The proposed windfarm will be located on the southern slope of West Maui Mountain, in an area called Kaheawa Pastures (Zond Pacific 1999). The proposed site lies on a gently sloping portion of West Maui Mountain between the Manawainui Gulch, to the east, and the Papalaua Gulch, to the west (Figure 1). The site is located ~4 mi inland from McGregor Point. The proposed windfarm would consist of a single articulated row of 27 turbines, each 24 m in radius, on 50-m-high lattice towers. The turbine string would run from ~2,000 ft elevation at the lower end to ~3,200 ft elevation at the upper end. At present, five meteorological stations exist on the proposed windfarm site; they range from Met Station 1, near the lower end of the proposed turbine string, to Met Station 5, at the upper end of the proposed turbine string. A sixth meteorological station (Met Station 6) lies west of Met Station 5, near Papalaua Gulch, but it currently is not operational. In addition, a Maui Electric Company, Ltd., cross-island powerline

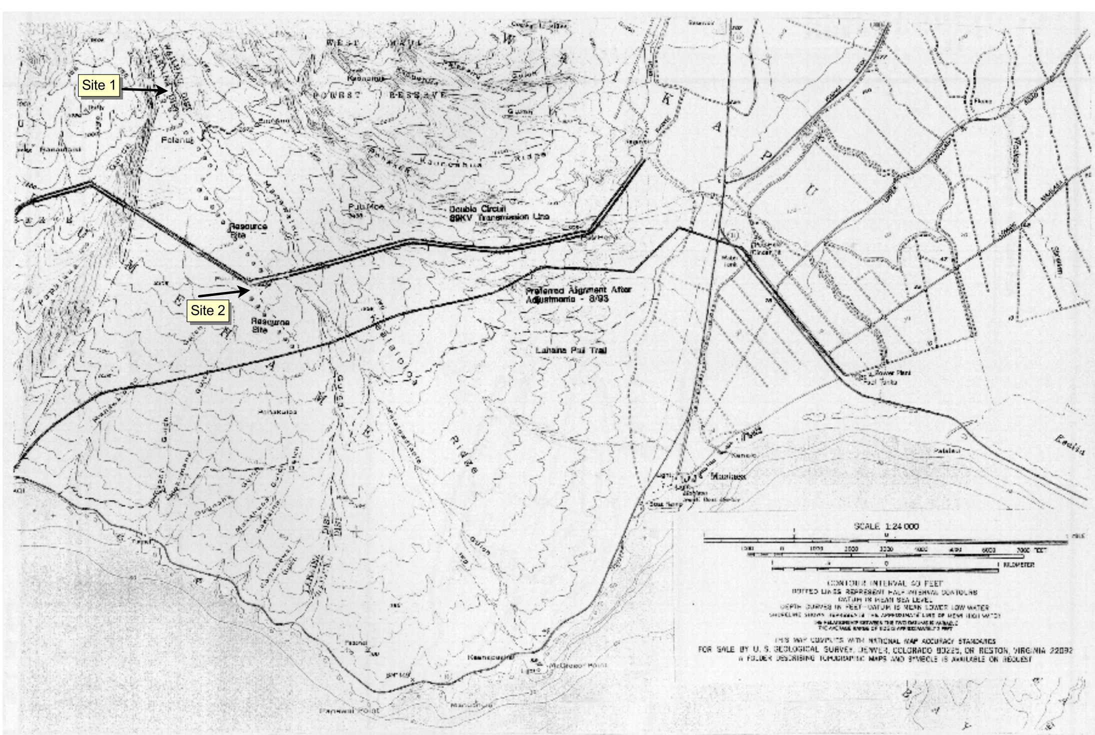


Figure 1. Southern Maui Island, Hawaii, with approximate locations of the proposed Kaheawa Pastures windfarm and study sites for summer 1999 radar studies.

on steel pole crosses the study area at ~2,500 ft elevation (Zond Pacific 1999). Access to the site is by an existing 4-wheel-drive track coming up-slope near McGregor Point.

Vegetation at the proposed windfarm consists of grasslands at lower elevations and a mixture of grasslands and scattered shrubs at moderate to higher elevations. Shrubs and occasional trees line the two nearby gulches. Directly above the site, shrubs dominate, with native Ohia trees (*Metrosideros polymorpha*) and Uluhe ferns becoming more common. These two plant species form the preferred nesting habitat for Newell's Shearwaters (Sincock and Swedberg 1969, Ainley et al. 1997b). Although the proposed windfarm itself is dry, vegetation becomes much wetter toward the summit of West Maui Mountain. Presumably, vegetation communities also are dominated by native species in these higher, wetter areas. They certainly appeared to be appropriate nesting habitat for Newell's Shearwaters, at least, from the habitat that we have seen that species use on Kauai. In addition to the vegetation, the steepness of higher elevations on West Maui Mountain also suggests suitable nesting habitat for Dark-rumped Petrels, as it does on Haleakala (Brandt et al. 1995, Kauai (Telfer, pers. comm.), and Lanai (Hirai 1978b).

Our survey consisted of sampling at each of two sampling sites (Figure 1, Table 1). Site 1 was located at ~3,200 ft elevation and was situated 100 m north of Met Station 5; we parked the mobile radar laboratory in the middle of the roadway. Site 2 was located at ~2,300 ft elevation and was situated 18 m northeast of Met Station 3 and 80 m south of the centerline of the Maui Electric powerline; we parked 3 m west of the roadway.

## DATA COLLECTION

Following Cooper and Day (1994) and Day and Cooper (1995), we monitored movements of birds and bats on West Maui Mountain in May–June 1999 with ornithological radar. This surveillance radar, which is described in Cooper et al. (1991), was an X-band radar transmitting at 9410 MHz through a slotted wave guide with a peak power output of 10 kW. Although the operating range of this radar can be set at a variety of ranges between 0.25 nm (0.5 km) and 72 nm (133 km), it was set in this study at 0.75 nm (~1.4 km), which was the distance to the north and south of the site that we could see on the radar's display screen. Because the left and right sides of the display screen were bowed outward, however, we could see birds flying out to ~1 nm (~1.8 km) at the eastern and western edges of the site at this range setting. At this

Table 1. Sampling effort and activities, summer 1999, Maui, Hawaii.

| Date | Site | Time of day: Radar sampling | Time of day: Night-vision sampling | Comments |
|---|---|---|---|---|
| 27 May | – | – | – | travel |
| 28 May | 1 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | site visit with Smiley Crane; assemble radar lab; little wind during sampling |
| 29 May | 1 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | little wind during sampling; mist in morning |
| 30 May | 1 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | little wind during sampling |
| 31 May | 1 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | Trade Winds return in middle of night, but nearly calm earlier |
| 1 June | 2 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | Trade Winds strong in middle of night; rain at Station 1, but just a few sprinkles at 2 |
| 2 June | 2 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | Trade Winds strong in evening, dropping a little in middle of night |
| 3 June | 2 | 1900–2200<br>0430–0630 | 1900–2200<br>0430–0630 | meet with Warren Bollmeier; Trade Winds strong |
| 4 June | 2 | 1900–2200<br>0430–0530 | 1900–2200<br>0430–0530 | Trade Winds extremely strong |
| 5 June | – | – | – | pack and ship radar |
| 6 June | – | – | – | travel |

range setting, pulse length automatically was set at 0.08 μsec; this short pulse length improves echo definition, giving accurate information on target location. The color plotting feature of the radar display enhanced our ability to detect birds moving across the landscape.

Whenever energy is reflected from the ground, surrounding vegetation, and other objects that surround the radar unit, a ground-clutter echo appears on the radar's display screen. Because ground clutter can obscure targets of interest (i.e., birds and bats), we attempted to minimize it by elevating the forward edge of the scanner face. In addition, because the land decreased in elevation to the south, it provided a large area of open (i.e., uncluttered) air space to search for birds. Ground clutter at both sites was minor and, in our opinion, did not cause us to miss any targets.

During radar-based surveys, we sampled each site four nights each during the evening peak movement that flows inland, toward the nesting colonies, and during the morning peak movement that flows seaward, away from the nesting colonies (Day and Cooper 1995). This sample consisted of six 25-min counts of birds during the period 1900–2159 for the evening period and four counts during the period 0430–0629 for the morning period; on the final morning at Site 2, we sampled for only an hour, between 0430 and 0529 (Table 1). Hence, we had 40 samples at Site 1 (24 in the evening and 16 in the morning) and 38 samples at Site 2 (24 in the evening and 14 in the morning). Each 25-min sampling period was separated by a 5-min break for collecting data on weather between sampling bouts and for switching observers. To eliminate species other than those of interest (e.g., slowly flying birds, insects), we recorded data only for those targets flying ≥35 mi/hr (≥56 km/hr).

We also conducted visual observations for birds and bats concurrently with the radar sampling; hence, the timing and number of samples at each site were identical to those for the radar sampling, with off-sampling data added on species of interest. During the night-vision sampling, we used 10X binoculars during periods of dusk and dawn and used a Noctron-V night-vision scope during periods of darkness. The magnification of this night-vision scope was 5X; its performance was enhanced with the use of a 1,250,000-cp floodlight with an IR filter, to avoid blinding these nocturnal birds.

Before each radar and night-vision sampling period, we recorded standardized weather and environmental data: wind direction (the eight ordinal points—N, NE, E, SE, S, SW, W, NW—plus variable and no wind), wind speed (to the nearest 1 m/sec), percent cloud cover (to the nearest 5%), cloud ceiling height above ground level (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 (phase and whether the moon was present or absent in the night sky). On each radar target, we recorded the time, direction of flight (to the nearest degree), tangential range (the minimal distance to the target when it passed closest to the lab; used in reconstructing actual flight paths, if necessary), transect crossed (the four cardinal points—000°, 090°, 180°, or 270°; also used in reconstructing flight paths), flight behavior (straight, erratic, circling), velocity (to the nearest 5 mi/hr [8 km/hr]) species (if known), and number of organisms (if known). If the wind speed was >10 mi/hr (>16 km/hr) and the bird was flying in such a direction that it was encountering either a headwind or tailwind, we subtracted or added the wind speed to the flight speed. For each bird or bat seen during night-vision sampling, we recorded the time, species (to the lowest possible taxonomic unit; e.g., Newell's Shearwater, unidentified shearwater/petrel), number of organisms, flight direction (the eight ordinal points), and flight altitude (m above ground level).

## DATA ANALYSIS

### RADAR DATA

We used the software Microsoft Excel to generate counts of targets recorded at each sampling site during each sample. These counts then were converted to estimates of movement rates (targets/hr), based on the number of minutes sampled. Rain showers sometimes can obscure significant portions of the screen for several minutes at a time, so these periods when we are unable to sample are subtracted from the standardized 25-min sampling period, with the resulting number of minutes being used to calculate movement rates. Because no rain showers affected sampling in summer 1999, we did not need to correct the 25-min sampling period.

We used the estimated movement rates on radar for each sampling period to calculate the mean ± 1 standard deviation (SD) movement rate at each site. These movement rates were calculated (1) for each evening, morning, and entire night at each site; (2) for all evenings, mornings, and entire nights at each site; and (3) for all evenings, mornings, and entire nights at both sites combined. We used a three-factor ANOVA to test for differences in movement rates by site, night, and time period (evening, morning). The null hypothesis was that movement rates did not differ by site, night, or time period.

We summed total numbers of targets during each sampling period across both sites and all nights and calculated the percentage of all targets in each sampling period. For comparison, we have provided a similar plot for data from Kauai during the summers of 1993 and 1999 combined (Day and Cooper, unpubl. data). As we did for the Maui data, we calculated frequencies of each behavior for all evenings, mornings, and entire nights at all sites combined.

We calculated the mean flight direction (± angular deviation) for all targets seen on radar. (Angular deviation is a statistical equivalent to standard deviation that is used for directional data.) Because sample sizes were so small, we calculated mean flight directions (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. We did not conduct statistical tests of differences in flight directions. We also classified general flight directions of each radar target as inland, seaward, or neither and summarized these directional categories (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. To categorize the general flight direction of each target, we first defined the major axis of the mountain slope (340° inland, 160° seaward), then defined an inland flight as occurring 75° on either side of the inland axis (i.e., 265–055°), a seaward flight as 75° on either side of the seaward axis (i.e., 085–235°), and neither direction as 15° on either side of a line perpendicular to the inland-seaward axis (i.e., 056–084° or 236–264°).

We summarized the flight behavior data as frequencies of each flight behavior (directional, erratic, circling). We calculated frequencies of each behavior (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. Because sample sizes were small, we did not test for differences in flight behaviors.

We calculated mean (± 1 SD) flight speeds (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. For comparison, we have provided similar information for data from Kauai during the summers of 1993 and 1999 combined (Day and Cooper, unpubl. data). As we did for the Maui data, we calculated mean flight speeds for all evenings, mornings, and entire nights at both sites combined. Again, because sample sizes were small, we did not conduct statistical tests.

### NIGHT-VISION DATA

We summarized the night-vision data by taxonomic group seen (i.e., petrels/shearwaters, Nene, and bats). We described the flight behavior, flight altitudes, and other pertinent characteristics of each record.

## RESULTS

Weather during the 8 nights of sampling was good overall. We lost no sampling time to rain, although we saw mist and/or a few scattered showers pushing over the top of West Maui Mountain on the night of 29 May. Cloud cover varied between 5% and 100% at both sites and averaged 32.1 ± 33.5% [SD] ($n$ = 40) at Site 1 and 30.5 ± 27.3% ($n$ = 38) at Site 2. Cloud cover often decreased during the night, generally being lowest in the morning. Moon phase varied between a full moon on the night of 30 May and the third quarter on the night of 6 June.

The one environmental variable that differed between sites was wind speed. During the first 3.5 nights at Site 1, we experienced light winds; however, winds picked up to 6 m/sec at that site on the final morning. The Trade Winds increased when we began our sampling at Site 2, however, and were particularly strong at that site on the night of 4 June, when wind speed was 15 m/sec [~30 mi/hr] during sampling and up to 25 m/sec [~50 mi/hr] in the middle of the night. In fact, it was so windy that night that we shielded the tent with the mobile radar laboratory (a Chevy Blazer) and still were afraid that the tent would blow away. Consequently, mean wind speeds were different between the two sites: only 1.6 ± 1.6 m/sec ($n$ = 40) at Site 1 but 7.3 ± 4.2 m/sec ($n$ = 38) at Site 2.

## RADAR OBSERVATIONS

We recorded 40 targets on radar that fit our criteria for counting (i.e., flying over land with a speed of ≥35 mi/hr [56 km/hr]). Of these targets, we saw 28 at Site 1 and 12 at Site 2. The temporal breakdown was 18 targets at Site 1 and 8 at Site 2 in the evening (26 total) and 10 targets at Site 1 and 4 at Site 2 in the morning (14 total).

We also frequently observed hunting Pueos (*Asio flammeus*) on the radar and with the night-vision scope at night. During these hunting bouts, the Pueos primarily were seen flying up and down the two gulches that bordered the sides of the study area. At times, they also hunted over the open, flatter portions of the grasslands that covered most of the study area. We estimate that 4–6 of these owls foraged over the study area during our sampling. Their echoes were distinctive on the radar display: they often varied between large and small (depending on which direction from the radar they were flying), often varied widely in speed (but usually were slower than the 56-km/hr cutoff speed), and often were moving quite erratically over the landscape.

We did not see any bat-like targets on the radar during our sampling. Their targets also are distinctive and often resemble those of Pueos; however, they almost always are smaller overall, often fly in fairly straight lines back-and-forth over shorter distances, usually fly only 20–25 mi/hr (32–40 km/hr), and often are only seen out to ~1200 m.

We often observed insects on the radar, primarily during the first 1–1.5 hr of the night. In addition, they usually were more abundant during calm nights than during windy nights. Many, if not all, of these insects that were visible on radar were small- to medium-sized moths, at least some of which became active shortly before sunset. The flight speed of insects is <20 mi/hr

(<32 km/hr), unless they are flying with a tail wind. Insect activity was not so heavy that it prevented us from sampling.

## MOVEMENT RATES

Movement rates on radar varied between 0 and 9.6 targets/hr for individual sampling sessions and averaged 1.2 targets/hr overall. At Site 1, rates varied between 0 and 9.6 targets/hr and averaged 1.7 targets/hr overall; we recorded movements on all 4 nights of sampling (Table 2). At Site 2, rates varied between 0 and 7.2 targets/hr and averaged 0.8 targets/hr overall; however, we recorded targets only on the first 2 nights of sampling. Movement rates were higher in the evening than in the morning on 4 of the 8 nights and for all nights combined. In addition, movement rates varied among nights at a given site: 1.0 to 2.4 targets/hr at Site 1 and 0 to 1.4 targets/hr at Site 2.

Table 2. Mean movement rates (targets/hr) on surveillance radar at the proposed Kaheawa Pastures windfarm on Maui, summer 1999, by study site. Data are presented as mean ± SD (*n*).

| | | Movement rate | | |
|---|---|---|---|---|
| Site | Date | Evening | Morning | Total |
| 1 | 28 May | 2.4 ± 2.6 (6) | 1.8 ± 1.2 (4) | 2.2 ± 2.1 (10) |
| | 29 May | 1.6 ± 2.0 (6) | 3.6 ± 4.2 (4) | 2.4 ± 3.0 (10) |
| | 30 May | 2.0 ± 3.2 (6) | 0 ± 0 (4) | 1.2 ± 2.6 (10) |
| | 31 May | 1.2 ± 1.3 (6) | 0.6 ± 1.2 (4) | 1.0 ± 1.2 (10) |
| | Total | 1.8 ± 2.3 (24) | 1.5 ± 2.5 (16) | 1.7 ± 2.3 (40) |
| 2 | 1 June | 2.4 ± 3.7 (6) | 0 ± 0 (4) | 1.4 ± 3.0 (10) |
| | 2 June | 0.8 ± 1.2 (6) | 2.4 ± 2.8 (4) | 1.4 ± 2.0 (10) |
| | 3 June | 0 ± 0 (6) | 0 ± 0 (4) | 0 ± 0 (10) |
| | 4 June | 0 ± 0 (6) | 0 ± 0 (2) | 0 ± 0 (8) |
| | Total | 0.8 ± 2.1 (24) | 0.7 ± 1.7 (14) | 0.8 ± 1.9 (38) |
| Total | Total | 1.3 ± 2.2 (48) | 1.1 ± 2.2 (30) | 1.2 ± 2.2 (78) |

The timing of movement of targets on surveillance radar was bimodal, peaking in the period 2035–2059 during the evening and in the period 0535–0559 during the morning (Figure 2, top). Targets were recorded during all sampling periods except the first one (1905–1930). On Maui, sunset is at ~1915 and it becomes completely dark at ~1945; the first light becomes apparent in the morning sky at ~0505, and sunrise is at ~0550. Hence, all of the evening movement occurred after sunset, and most of the morning movement occurred before sunrise.

For comparison, the timing of movements on Kauai differs from that on Maui (Figure 2, bottom). On Kauai, the number of radar targets in the evening peaks between 1930 and 2030 and in the morning peaks between 0500 and 0530, or 30–60 min and 30 min before the peaks on Maui, respectively. No data were collected on Kauai between 0600 and 0630, because the sun was up and so few birds were moving at that time.

FLIGHT DIRECTION

Mean flight directions varied between time periods and sites (Table 3). At Site 1, mean flight directions were 327° in the evening and 164° in the morning (i.e., toward the NNW in the evening and the SSE in the morning). At Site 2, mean flight directions were 149° in the evening and 206° in the morning (i.e., toward the SSE in the evening and the SSW in the morning). Across all samples, mean flight directions were 188 ± 72° (i.e., toward the S) in the evening, 176 ± 42° (i.e., toward the S) in the morning, and 181 ± 63° (i.e., toward the S) overall. Hence, mean flight directions were of a more normal pattern for inland-nesting petrels and shearwaters (i.e., inland in the evening and seaward in the morning) at Site 1 but were southerly at all times at Site 2.

The predominant general flight direction of targets on radar was seaward (Table 4). This pattern was true at both sites in the evening and morning and overall in the evening and morning. Inland flight directions were much more common in the evening than in the morning, but they were overshadowed by seaward flight directions. Only two targets were flying neither general direction (i.e., across the slope), both at Site 1. Of these two targets, the one in the evening was of an unknown species at 2037 on the night of 30 May, and the second was a flock of 4 Nene at 0521 on the night of 28 May.

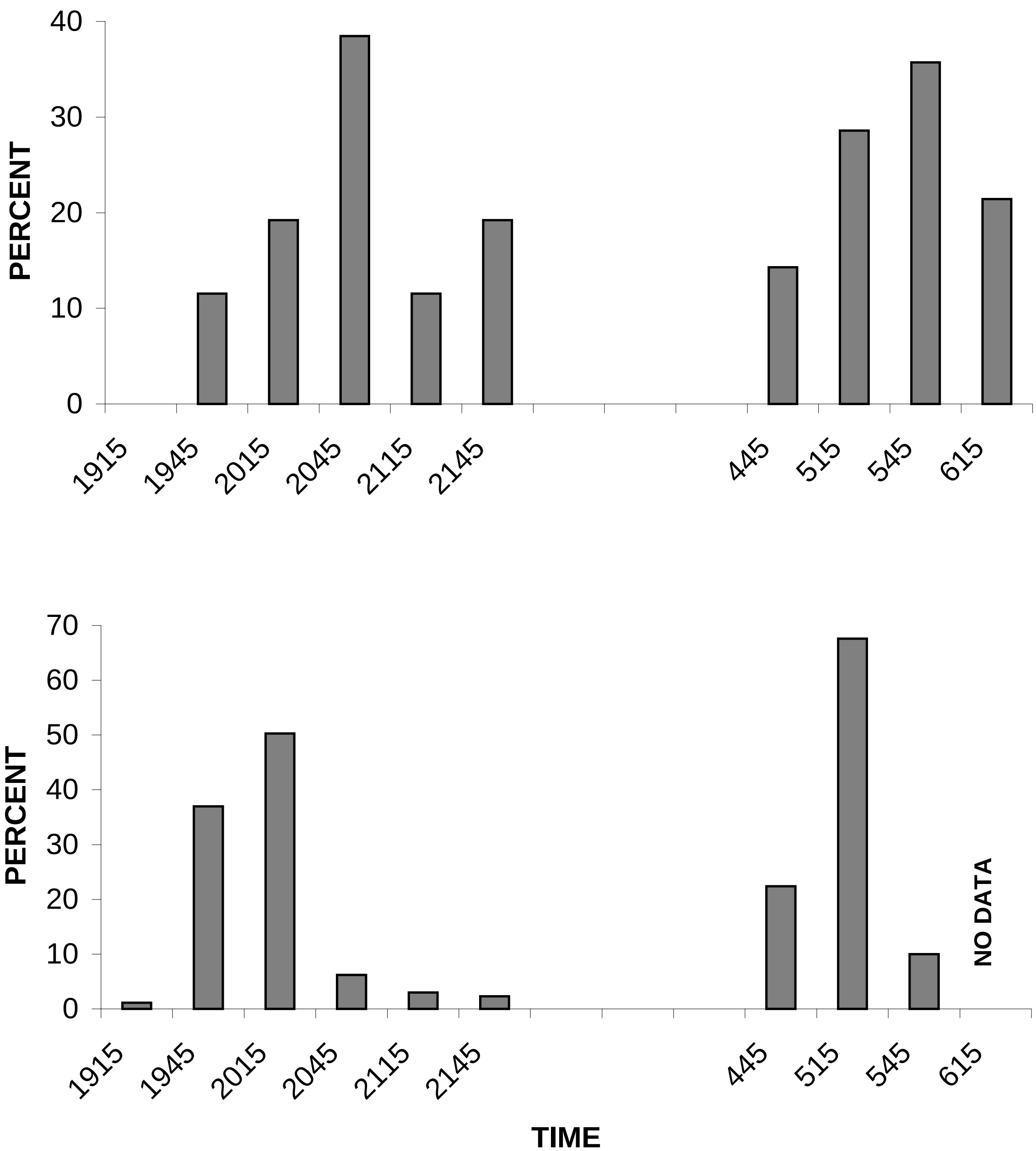


Figure 2. Timing of movement of bird targets on ornithological radar at the proposed Kaheawa Pastures windfarm on Maui in summer 1999 (top) and on Kauai in summer 1993 and 1999 (bottom), by time of night. Within each figure, data are pooled across sites and nights and are expressed as the percentage of the total number of targets in evening or morning seen during each sampling period. Sample sizes for Maui are 28 in the evening and 12 in the morning; sample sizes for Kauai are 16,949 in the evening and 12,305 in the morning.

Table 3. Mean flight directions (°) of individual targets on surveillance radar at the proposed Kaheawa Pastures windfarm on Maui, summer 1999, by study site and time period. Data are presented as mean ± angular deviation (*n*).

| | Flight direction | | |
|---|---|---|---|
| Site | Evening | Morning | Total |
| 1 | 327 ± 72 (18) | 164 ± 39 (10) | 180 ± 64 (28) |
| 2 | 149 ± 67 (8) | 206 ± 40 (4) | 181 ± 62 (12) |
| Total | 188 ± 72 (26) | 176 ± 42 (14) | 181 ± 63 (40) |

Table 4. General flight directions of targets on surveillance radar at the proposed Kaheawa Pastures windfarm on Maui, summer 1999, by study site and time period. Data are presented as number of targets (percentage of total).

| | | Flight direction | | | |
|---|---|---|---|---|---|
| Site | Period | Inland | Seaward | Neither | Total (*n*) |
| 1 | Evening | 7 (38.9) | 10 (55.6) | 1 (5.6) | 18 |
| | Morning | 0 (0) | 9 (90.0) | 1 (10.0) | 10 |
| | Total | 7 (25.0) | 19 (67.9) | 2 (7.1) | 28 |
| 2 | Evening | 3 (37.5) | 5 (62.5) | 0 (0) | 8 |
| | Morning | 1 (25.0) | 3 (75.0) | 0 (0) | 4 |
| | Total | 4 (33.3) | 8 (66.7) | 0 (0) | 12 |
| Total | Evening | 10 (38.5) | 15 (57.7) | 1 (3.8) | 26 |
| | Morning | 1 (7.1) | 12 (85.7) | 1 (7.1) | 14 |
| | Total | 11 (27.5) | 27 (67.5) | 2 (5.0) | 40 |

BEHAVIOR

Of the 40 targets seen on radar, 38 (95%) were flying in a straight line and 2 (5%) were flying erratically; none were circling (Table 5). Both of the erratically flying targets were recorded at Site 1. Of these erratically flying targets, one was a flock of 4 Nene at 0521 on the night of 28 May, and the other was an unidentified target at 2115 on the night of 31 May. Although this latter target may have been a Nene, it was silent (unlike all of the other Nene that we recorded), and we were unable to locate it with the night-vision scope. Hence, we are unsure of the target's identity. Because 2 of the 4 expected values for a contingency-table analysis were <<5, we were unable to test for differences in behavior between sites and time periods.

Table 5. Flight behavior of targets on surveillance radar at the proposed Kaheawa Pastures windfarm on Maui, summer 1999, by island, study site, and time period. Data are presented as numbers of targets (percentage of total). The Kauai data are from June 1993 and 1999 and are for all sites and nights combined (Day and Cooper, unpubl. data).

| | | Flight behavior | | | |
|---|---|---|---|---|---|
| Island/site | Period | Straight-line | Erratic | Circling | Total (*n*) |
| MAUI | | | | | |
| 1 | Evening | 17 (94.4) | 1 (5.6) | 0 (0) | 18 |
| | Morning | 9 (90.0) | 1 (10.0) | 0 (0) | 10 |
| | Total | 26 (92.9) | 2 (7.1) | 0 (0) | 28 |
| 2 | Evening | 8 (100.0) | 0 (0) | 0 (0) | 8 |
| | Morning | 4 (100.0) | 0 (0) | 0 (0) | 4 |
| | Total | 12 (100.0) | 0 (0) | 0 (0) | 12 |
| Total | Evening | 25 (96.2) | 1 (3.8) | 0 (0) | 26 |
| | Morning | 13 (92.9) | 1 (7.1) | 0 (0) | 14 |
| | Total | 38 (95.0) | 2 (5.0) | 0 (0) | 40 |
| KAUAI | | | | | |
| All | Evening | 14,618 (99.7) | 20 (0.1) | 21 (0.1) | 14,659 |
| | Morning | 9,767 (99.9) | 2 (<0.1) | 4 (<0.1) | 9,773 |
| | Total | 24,385 (99.8) | 22 (0.1) | 25 (0.1) | 24,432 |

For comparison, the behavior of birds on ornithological radar on Kauai in June 1993 and 1999 was similar to that seen here (Table 5). For example, the percentage of birds exhibiting straight-line flight was 99.7% in the evening and 99.9% in the morning. Likewise, the percentage of birds exhibiting erratic and circling flight behaviors was low on Kauai during both time periods. The higher percentages of these latter two behaviors on Maui probably resulted from the small sample size.

## FLIGHT SPEED

Flight speeds of targets on radar varied between 30 mi/hr (48 km/hr) and 60 mi/hr (97 km/hr), with an overall mean speed of nearly 42 mi/hr (70 km/hr; Table 6). Flight speeds were slightly higher at Site 2 than at Site 1 and were higher in the morning (when birds were flying downslope) than in the evening (when birds were flying upslope). Speeds were

Table 6. Mean flight speeds (mi/hr [km/hr]) on surveillance radar at the proposed Kaheawa Pastures windfarm on Maui, summer 1999, by island, study site, and time period. The Kauai data are from June 1993 and 1999 and are for all sites and nights combined (Day and Cooper, unpubl. data).

| | | Flight speed | | |
|---|---|---|---|---|
| Island/site | Period | Mean | SD | *n* |
| MAUI | | | | |
| 1 | Evening | 40.0 [64.4] | 5.1 [8.2] | 18 |
| | Morning | 41.5 [66.8] | 5.3 [8.5] | 10 |
| | Total | 40.5 [65.2] | 5.2 [8.4] | 28 |
| 2 | Evening | 42.5 [68.4] | 9.6 [15.4] | 8 |
| | Morning | 47.5 [76.4] | 5.0 [8.0] | 4 |
| | Total | 44.2 [71.1] | 8.5 [13.7] | 12 |
| Total | Evening | 40.8 [65.6] | 6.7 [10.8] | 26 |
| | Morning | 43.2 [69.5] | 5.8 [9.3] | 14 |
| | Total | 41.6 [66.9] | 6.4 [10.3] | 40 |
| KAUAI | | | | |
| Total | Evening | 37.3 [60.0] | 5.8 [9.3] | 1,244 |
| | Morning | 31.4 [50.5] | 3.7 [6.0] | 645 |
| | Total | 35.3 [56.8] | 5.9 [9.5] | 1,889 |

particularly rapid at Site 2 in the morning, when they averaged nearly 48 mi/hr (76 km/hr). For comparison, the one Dark-rumped Petrel that was seen on both radar and night-vision scope was flying 45 mi/hr (72 km/hr), and the two unidentified shearwaters/petrels seen by both sampling methods were flying 40 mi/hr (64 km/hr).

Flight speeds on Kauai were slightly slower overall than those on Maui (Table 6). Although the mean evening flight speed was similar between the two islands, the mean morning flight speed was considerably slower on Kauai than on Maui. Consequently, the mean flight speed for both time periods combined was ~6 mi/hr (~10 km/hr) slower on Kauai than on Maui.

## NIGHT-VISION OBSERVATIONS

We experienced no problems in conducting the night-vision sampling. Observation conditions the first few nights were excellent, primarily because of little cloud cover and a full or nearly full moon. We regularly saw Pueos but did not see any Hoary Bats with the night-vision scope.

We recorded petrels and shearwaters twice during the night-vision sampling (Table 7), both of which also were seen on radar and both of which occurred on the evening of 28 May at Site 1. The first record was of a Dark-rumped Petrel flying to the northeast (measured as 050° on the radar) in the evening. This bird was flying ~350 m east of the sampling site and appeared to be heading across the island. The second observation was of two unidentified shearwater/petrels flying to sea in the morning (measured as 149° on radar). Unfortunately, we were unable to identify these birds to species, because they were traveling so fast and were first

Table 7. Records of Dark-rumped Petrels and Newell's Shearwaters at the proposed Kaheawa Pastures windfarm on Maui, summer 1999.

| Date | Time | Site | Species[a] | Number | Altitude (m agl) | Flight direction | Comments |
|---|---|---|---|---|---|---|---|
| 28 May | 2150 | 1 | DRPE | 1 | 300 | NE | appeared to be flying straight-line across island |
| 28 May | 0608 | 1 | UNSP | 2 | 500 | SE | losing altitude on way to sea |

[a] DRPE = Dark-rumped Petrel; NESH = Newell's Shearwater; UNSP = unidentified shearwater/petrel.

seen ~400 m southeast of the sampling site. Both of these observations indicated that the birds were flying high over the landscape (300–500 m above ground level, which was the valley floor below).

We recorded Nene five times during the night-vision sampling; one of the observations also was seen on radar, and one only was heard (Table 8). These records of Nene occurred on 28 and 31 May, both in the evening (well after dark) and the morning (before sunrise), and only at Site 1. Three of the four records for which we were able to get information on flight altitude indicated that these birds were flying ≤60 m above ground level. In the first record, the birds actually flew over the windfarm and circled near Met Station 5. From what we could determine, these birds vocalized every time that they flew.

Table 8. Records of Nene at the proposed Kaheawa Pastures windfarm on Maui, summer 1999.

| Date | Time | Site | Number | Altitude (m agl) | Flight direction | Comments |
|---|---|---|---|---|---|---|
| 28 May | 2132 | 1 | 2 | 60 | SW | flew directly over wind field, circling just S of Met Station 5 |
| | 0521 | 1 | 4 | 200 | E | flew to E, down slope |
| | 0526 | 1 | 1+ | – | – | heard only, ≤600 m to east |
| 31 May | 1835 | 1 | 1 | 30 | – | flying erratically ~250 m NW of site |
| | 1927 | 1 | 1 | 10 | – | flying erratically ~250 m NW of site |

# DISCUSSION

## PETRELS AND SHEARWATERS

The radar data strongly suggest that the radar targets primarily were Dark-rumped Petrels and/or Newell's Shearwaters. The timing of movements around sunrise and sunset, the inland–seaward directions of flight, the strongly directional flight behavior, and the rapid flight speeds all are highly similar to those for the same species on both Kauai (Cooper and Day 1994, Day and Cooper 1995) and Hawaii (Reynolds et al. 1997). Further, the night-vision data showed that at least Dark-rumped Petrels fly over the southern slopes of West Maui Mountain during the summer. Hence, we conclude that a population of one or both species probably still nests somewhere in West Maui Mountain and that some of these birds regularly fly over or near the proposed Kaheawa Pastures windfarm at night. (Indeed, a record from the northwestern slope of West Maui Mountain on 16 June 1999 indicates that at least Dark-rumped Petrels occur there; A Lyons, *fide* C. Hodges.) The size of the population of these birds nesting on West Maui Mountain is unknown at this time, but only a small number of birds flew over the proposed windfarm area.

The primary difference in movements between the birds that we observed on Maui and those on Kauai is the timing of movement. As seen in Figure 2, the peak of movement at the study site was 2030–2100. In contrast, the evening peak of movement on Kauai is 1930–2030, or 30–60 min earlier than on Maui, and the morning peak of movement is 0500–0530, or 30 min earlier than that on Maui. The evening peak of activity of Dark-rumped Petrels in Haleakala Crater also is late, peaking from ~2100 to ~0000 (Hodges, in litt.), whereas it probably is around 2015–2130 on Kauai (assuming a peak at the coast around 1945 and 30–45 min to fly inland; Cooper and Day 1995, Day and Cooper 1995). Hence, there clearly is a difference in the timing of movements of these species between the two islands. The reasons for such differences are not apparent at this time but may be related at least partially to the longer flight times to the Haleakala nesting colony on Maui. In addition, our sampling sites on Maui were farther inland than were most sampling sites on Kauai, perhaps shifting the timing of movements a little.

A second difference between the birds that we observed on Maui and those on Kauai is flight speed, with the birds on Maui flying considerably more rapidly than they do on Kauai. Although we are unsure why this difference exists, it probably is related to the steep inland sites sampled on Maui and the generally low-moderate coastal slopes encountered at most sites on Kauai.

Although these birds fly over the proposed windfarm, mean movement rates could only be described as very low: a mean movement rate of 1.2 targets/hr across both sites and all nights of sampling represents only 4% of the lowest mean movement rate that we recorded on southwestern Kauai during the summer of 1993 (mean of 31.8 targets/hr at Kekaha; Cooper and Day 1994) and 9% of the lowest rate recorded there in summer 1999 (mean of 13.6 targets/hr at Mana; Day and Cooper 1999). On Kauai, the lowest mean movement rates also occur on the drier southwestern parts of the island (Day and Cooper 1995). Hence, it is possible that the number of these birds flying over the wetter northern slopes of West Maui Mountain is considerably larger than what we have seen here.

The three birds that we saw with the night-vision scope were flying high over the surrounding landscape and well above the proposed turbine heights. Such high flight altitudes are more common inland than they are near the coast (Cooper and Day 1998) and suggest that these birds fly high over the landscape to avoid striking trees, cliffs, and hills. Some birds do fly at lower altitudes at inland locations, however (Day and Cooper, unpubl. data).

**NENE**

Nene clearly occur in the vicinity of the proposed windfarm, and our small sampling effort indicates that they occasionally fly over the proposed windfarm, particularly near its upper end. In addition, they commonly fly at low altitudes, and they also fly at night. All of these behaviors put them at risk of collision with the lattice-type towers or of being struck by the turbine blades. This probability of mortality will increase if, for example, these birds are being harassed by avian predators (Rojek 1994) or by mammalian predators such as cats or mongooses. Under those conditions, these birds may not be paying particular attention to where they are flying, increasing their chances of mortality. Although these turbine blades turn at only 34 revolutions/min under normal usage (Zond 1999), their great rotor diameter (48 m [157 ft]) results in a speed of ~280 ft/sec (~191 mi/hr) at each of the three blade tips.

**HAWAIIAN BATS**

We recorded no Hawaiian Hoary Bats during this study. Although these bats prefer areas with trees, especially moist areas (Hodges, pers. comm.; Medeiros, pers. comm.), they have been recorded at Lahaina (Tomich 1986), which also is dry. They regularly are seen on the drier sides of Kauai and Hawaii, especially near the coast (Cooper et al. 1996; Day and Cooper, unpubl. data). Further, Kepler and Scott (1990) found that these bats are more common on the drier side of Hawaii, probably because the number of flying insects is higher and feeding is less disrupted by rain. Hence, although it is not out of the question for this species to occur in the proposed windfarm during the summer, the species probably occurs infrequently and in very low numbers.

## ACKNOWLEDGMENTS

We thank Keith Avery of Zond Pacific for his interest in this study. On Maui, Smiley Crane helped with logistics and graciously took the time to show us the study site, Warren Bollmeier provided the Environmental Assessment and other background information, and Cathleen Hodges of Haleakala National Park and John Medeiros of Hawaii DLNR generously provided unpublished information, data, and reports. At ABR, Devonee Harshburger helped produce the report, Thomas DeLong provided fiscal oversight, John Rose and John Shook tested, packed, and shipped the radar, and Stephen Murphy and Betty Anderson reviewed the report.

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# Appendix 2

## Results of Endangered Bird and Bat Surveys at the Proposed Kaheawa Pastures Wind Energy Facility on Maui Island, Hawaii, Fall 2004

# RESULTS OF ENDANGERED BIRD AND BAT SURVEYS AT THE PROPOSED KAHEAWA PASTURES WIND ENERGY FACILITY ON MAUI ISLAND, HAWAII, FALL 2004

FINAL REPORT

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## EXECUTIVE SUMMARY


- We conducted surveys for endangered seabirds (Hawaiian [Dark-rumped] Petrel or 'Ua'u *Pterodroma sandwichensis*; Newell's [Townsend's] Shearwater or 'A'o *Puffinus auricularis newelli*), geese (Nene *Branta sandvicensis*), and bats (Hawaiian Hoary Bat or 'Opa'opa'e *Lasiurus cinereus semotus*) at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, between the nights of 12 October and 19 October 2004.
- The primary habitat at the proposed windfarm is grassland. Uluhe ferns (*Dicranopteris linearis*) and Ohia trees (*Metrosideros polymorpha*), which are preferred nesting habitat for Newell's Shearwaters and, to some extent, Hawaiian Petrels, occur from high elevations down to the upper end of the proposed windfarm. Thus, habitat does not appear to be suitable for nesting by either species on the windfarm itself, but it does appear to be suitable at higher elevations on West Maui Mountain.
- We used ornithological radar, night-vision equipment, and acoustic equipment to measure movement rates (number of targets/h on radar) of birds and bats and to identify radar targets, when possible.
- Similar to our study in summer 1999, we sampled two sites for four nights each. The Upper Site was located at ~900 m above sea level and was near the upper end of the proposed turbine string. The Lower Site was located at ~800 m asl elevation and was in the lower part of the proposed turbine string. Weather and environmental conditions were similar between the two sites.
- During fall 2004, we recorded 37 targets on radar that fit our criteria for petrel/shearwater targets. Of these targets, we saw 14 at the Upper Site and 23 at the Lower Site.
- Mean nightly movement rates on radar varied between 0.2 and 1.6 targets/h and averaged 1.0 targets/h overall across all samples. Movement rates varied both within nights and among nights at both sites.
- The timing of movement of targets on surveillance radar was bimodal in the evening, peaking in the period 1805–1835 and 2000–2030. In the morning, timing peaked in the period 0600–0630. Thus, the first evening peak of movement occurred before the point of complete darkness and the second evening peak occurred during the period of darkness; the morning peak occurred after first light.
- Mean flight directions were 186 ± 53° in the evening, 183 ± 42° in the morning, and 184 ± 47° overall. The predominant general flight direction of radar targets was seaward.
- Of the 37 targets seen on radar, 97% were flying in a straight line and 3% were circling.
- We recorded petrels and shearwaters twice during the visual sampling in fall 2004. One record was of a Hawaiian Petrel in the evening, and the other was of an unidentified shearwater/petrel in the morning. We recorded Nene four times during the visual sampling; all were observed during the evening period.
- Most radar targets probably were Hawaiian Petrels and/or Newell's Shearwaters. The predominantly crepuscular/nocturnal timing of movements, the inland–seaward directions of flight, the directional flight behavior, and the rapid flight speeds all are similar to those for the same species on both Kauai and Hawaii. Hence, it is likely that one or both species still nests somewhere on West Maui Mountain, and low numbers of these birds regularly fly over or near the proposed Kaheawa Pastures windfarm at night, to or from nesting colonies either on West Maui Mountain or (occasionally) on Haleakala.
- Our radar data from this study and other studies on Maui suggest that movement rates of petrels and shearwaters are low over the proposed Kaheawa Pastures Wind Energy Facility, and the general area where the proposed windfarm is located has the lowest mean movement rates of petrel/shearwaters measured on ornithological radar on the Island of Maui.
- Of the four visual observations of petrel/shearwaters that were observed at the

site during fall 2004 and summer 1999, only one was flying at altitudes below proposed turbine heights, whereas the other three were observed flying 300–500 m above ground level. Further, only two of four had a flight path that crossed the proposed turbine string. Considered together, these flight-altitude data and the low movement rates that we observed over the proposed windfarm suggest that the nightly numbers of Hawaiian Petrels or Newell's Shearwaters actually interacting with the proposed turbines would be low.

- Nene occur in the vicinity of the proposed windfarm, and our sampling in both fall 2004 and summer 1999 indicates that they commonly fly over the proposed windfarm. In addition, they commonly flew at altitudes within the proposed turbine height, and they flew during low-light crepuscular hours or at night, in addition to their daytime activity. All of these behaviors put them at risk of collision with towers or of being struck by the turbine blades.
- We recorded no Hawaiian Hoary Bats during either our visual or acoustic sampling. Although these bats prefer areas with trees, especially moist areas, they commonly have been recorded at dry sites such as Lahaina and the southern side of Kauai. Hence, although this species probably occurs in the proposed windfarm, it probably occurs infrequently and in very low numbers at most.

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## ACKNOWLEDGMENTS

We thank UPC Wind Management, LLC, and Kaheawa Wind Power, LLC, for funding this study. We thank the U.S. Fish and Wildlife Service for donating the use of their ornithological radar for the study. We thank Dave Cowan (UPC Wind) and Mike Gresham and Michele McLean (Kaheawa Wind Power) for their help with logistical matters. Mike Gresham also graciously took the time to show us the study site, even though it required him to make an extra drive up the challenging access road. Cathleen Bailey of Haleakala National Park and John Medeiros of Hawaii DLNR generously helped with the logistics of radar storage and access and provided unpublished information, data, and reports. Scott Rowland (UPC Wind) provided base maps of the study area. At ABR, Peter Sanzenbacher helped with field work and Rich Blaha helped with figure preparation.

## INTRODUCTION

UPC Wind Management, LLC, and Kaheawa Wind Power, LLC, are proposing to develop a 30-MW wind farm in the Kaheawa Pastures area on the southern slope of West Maui Mountain (Figs. 1 and 2). As part of the permitting process, they are conducting surveys for endangered birds and bats in the vicinity of the proposed windfarm. A previous developer (Zond) conducted surveys for downed birds and bats at the existing meteorological towers (Nishibayashi 1997) and surveys for native birds in the vicinity of the proposed windfarm (Nishibayashi 1998). Nishibayashi (1997), however, recommended that nocturnal surveys of endangered birds and bats in this area be conducted with ornithological radar. Ornithological radar has been shown to be successful in studying these species on Maui (Cooper and Day 2003), Kauai (Cooper and Day 1995, 1998; Day and Cooper 1995, Day et al. 2003b), and Hawaii (Reynolds et al. 1997, Day et al. 2003a).

Day and Cooper (1999) conducted an 8-d radar and visual study of endangered birds and bats in the vicinity of the Kahaewa Pastures wind farm during summer 1999. In fall 2004, we conducted an additional 8-d radar and visual survey at the proposed windfarm to provide survey coverage during the fledging period of endangered seabirds. This report summarizes the results of that fall study. The objectives of the 2004 study were (1) to conduct surveys of endangered birds and bats in the vicinity of the proposed windfarm and (2) to determine the use of the proposed windfarm by any of these species.

## BACKGROUND

Four bird or bat species that are protected under the Endangered Species Act may occur in the vicinity of the proposed windfarm. Of the four,

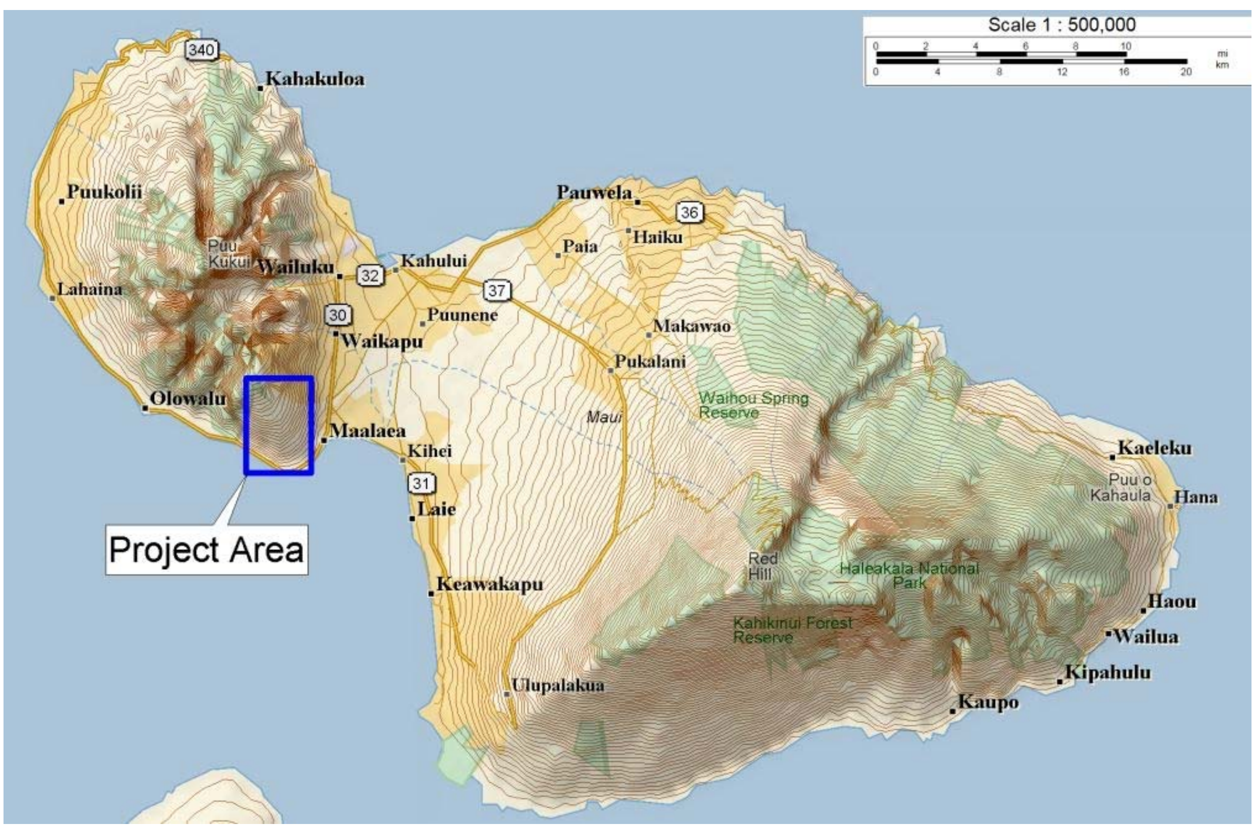


Figure 1. Maui Island, Hawaii, with approximate location of the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, site for summer 1999 and fall 2004 radar studies.

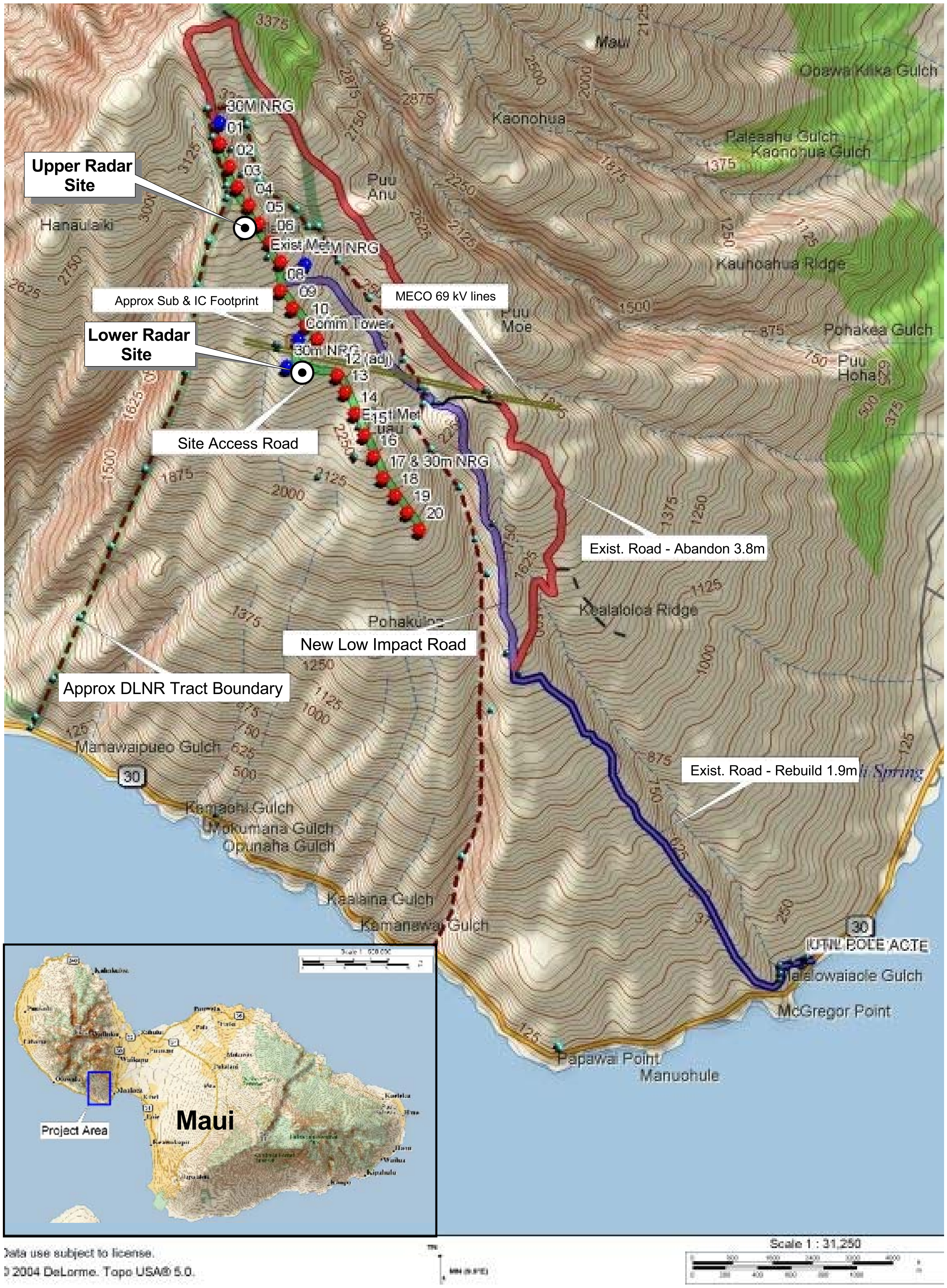


Figure 2. Western Maui Island, Hawaii, with approximate locations of the proposed Kaheawa Pastures wind facilities and sampling sites for the fall 2004 radar studies. The red circles represent proposed turbine placement, and the blue circles represent meteorological tower positions.

three are birds: the endangered Hawaiian Petrel (*Pterodroma sandwichensis*), the threatened Newell's (Townsend's) Shearwater (*Puffinus auricularis newelli*), and the endangered Nene (*Branta sandvicensis*). The fourth species is a mammal, the endangered Hawaiian Hoary Bat (*Lasiurus cinereus semotus*).

**PETRELS AND SHEARWATERS**

Races of the Hawaiian Petrel ('Ua'u) and the Newell's Shearwater ('A'o) are forms of tropical Pacific species that nest only on the Hawaiian Islands (American Ornithologists' Union 1998). Because of their low overall population numbers and restricted breeding distributions, both of these species are protected under the Endangered Species Act.

The Hawaiian Petrel is known to nest primarily on Maui (Richardson and Woodside 1954, Banko 1980a; Simons 1984, 1985; Simons and Hodges 1998, Cooper and Day 2003) and, to a lesser extent, on Kaua'i (Telfer et al. 1987, Gon 1988, Day and Cooper 1995; Ainley et al. 1997a, 1997b; Day et al. 2003a), Hawai'i (Banko 1980a, Conant 1980, Hu et al. 2001, Day et al. 2003a); and Lana'i (Shallenberger 1974; Hirai 1978a, 1978b; Conant 1980). Recent information on Moloka'i (Simons and Hodges 1998; Day et al., in review) also suggests breeding. On Maui, these petrels are known to nest on Haleakala Crater (Brandt et al. 1995, Simons and Hodges 1998); however, it is not known with certainty whether they also nest in the western part of the island (i.e., the West Maui Mountains) and, if they do, their nesting distribution or habitat use there (C. Bailey, Haleakala National Park, Makawao, HI, pers. comm.). On 16 June 1999, however, a Hawaiian Petrel was heard calling from a bed of uluhe ferns (*Dicranopteris linearis*) at 3,300 ft elevation in the Kapunakea Preserve, which lies on the northwestern slope of the West Maui Natural Area Reserve (A. Lyons, *fide* C. Bailey), suggesting breeding in West Maui; this location is ~8 mi from the upper end of the proposed windfarm. Further, Cooper and Day (2003) observed Hawaiian Petrels flying inland over the northern coast toward West Maui Mountain. Daily movement rates of Hawaiian Petrels near the proposed Kaheawa windfarm (i.e., on the southern slope of West Maui Mountain) are much lower than those over the eastern and northern sides of Maui (Cooper and Day 2003).

The number of Hawaiian Petrels on Maui is estimated at 1,800 birds, all of which are believed to be associated with colonies on Haleakala (Simons 1984, 1985; Hodges 1994, Simons and Hodges 1998), however, radar counts of petrels on the perimeter of Maui suggest that the number is much higher than 1,800 (Cooper and Day 2003). Juvenile Hawaiian Petrels land in brightly lit areas (i.e., fall out) at scattered locations on Maui in most years (Gassman-Duvall et al. 1988; C. Bailey, unpubl. data).

Newell's Shearwater breeds 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. 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, et al., in review), and may still nest on O'ahu (Sincock and Swedberg 1969, Banko 1980b, Conant 1980, Pyle 1990; but see Ainley et al. 1997b). The occurrence on Maui of injured, dead, or grounded adults in summer (Pyle 1983), of low numbers of radar targets exhibiting Newell's-like timing of movement (Cooper and Day 2003), and of juveniles in autumn (Ainley et al. 1997b) suggests that the species also may nest on that island; however, the exact status of this species on Maui is unclear at this time. The strictly nocturnal behavior of this species (Day and Cooper 1995) makes determination of its status and distribution more difficult than that of the more crepuscular Hawaiian Petrel.

This study occurred during the fledging period of both species of interest. Dark-rumped Petrels fledge slightly later (15 October–20 November on Maui; Simons 1985, Simons and Hodges 1998) than Newell's Shearwater (1 October–10 November; Telfer et al. 1987, Ainley et al. 1997b).

Although there is no documented mortality of Hawaiian Petrels or Newell's Shearwaters at wind energy facilities, there are only a few wind turbines in the Hawaiian Islands at this time. There has been mortality, however, due to collisions with human-made objects on Maui (Hodges 1992) and

Kauai (Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998).

## NENE

The Nene is listed as endangered by the Federal government and the State of Hawaii. Currently, there are wild populations on Hawaii, Maui, and Kauai composed of an estimated 349, 251, and 620 individuals, respectively (U.S. Fish and Wildlife Service 2004). After nearly becoming extinct in the 1940s and 1950s, this species' population slowly has been rebuilt through captive-breeding programs (Kear and Berger 1980). As a result of such programs, the Nene has been re-introduced onto four of the main Hawaiian Islands (Kauai, Maui, Molokai, and Hawaii). These re-introductions include Maui, where a release pen is located on West Maui Mountain, near the upper end of the proposed Kaheawa Pastures windfarm. Other sites on Maui where the Nene occurs include Lahaina, Wailuku, and Haleakala National Park (J. Medeiros, Hawaii DLNR, pers. comm.; U.S. Fish and Wildlife Service 2004). More than 85 Nene have been released so far from the Nene release pen on West Maui Mountain, but little is known about their exact distribution and movements on this mountain (Medeiros, pers. comm.). Birds from this release site have been recorded as far west as Lahaina and as far east as Haleakala National Park, indicating that at least some birds from this release site move extensively on the island (Medeiros, pers. comm.).

## HOARY BATS

The Hawaiian Hoary Bat ('Opa'opa'e) is small, nocturnal to crepuscular, and difficult to study and count. Little is known about its biology, distribution, or habitat use on the Hawaiian Islands. It has been recorded on Kauai, Oahu, Molokai, Maui, and Hawaii, is believed to be most abundant on the latter island, and is thought to be present in low numbers on Maui (van Riper and van Riper 1982, Tomich 1986, Fujioka and Gon 1988, Duvall and Gassmann-Duvall 1990, Kepler and Scott 1990, Cooper et al. 1996, Reynolds et al. 1997; Day and Cooper, unpubl. data). In fact, Kepler and Scott (1990) suggested that the species is so rare on Maui (they had only 7 records) that, rather than having a resident population, it is a migrant from nearby Hawaii. This suggestion, however, was refuted by Duvall and Gassmann-Duvall (1991), who discussed records of an additional 60 bats that were not known to Kepler and Scott (1990).

The Hawaiian Hoary Bat occurs primarily below 4,000 ft elevation, although it commonly is seen at 7,000–8,000 ft (~2,100–2,400 m) on Hawaii (van Riper and van Riper 1982, Cooper et al. 1996) and at 10,000 ft on Haleakala, Maui (Day, unpubl. data.). The highest-altitude record of this species that we are aware of is of one bat at 3,355 m (11,004 ft) on Mauna Loa (Cooper et al. 1996). Duvall and Gassmann-Duvall (1991) recorded this bat on Maui between 0 and 2,760 m (~9,050 ft) in elevation, with most records occurring around 630 m (2,060 ft).

On Maui, this bat is believed to primarily occur in moist, forested areas (Bailey, pers. comm.; Medeiros, pers. comm.), although little is known about its exact distribution and habitat use on the island, especially on West Maui Mountain. For example, Nishibayashi (1997) recorded none during his surveys of the proposed windfarm but emphasized that his surveys were not conducted at an appropriate time of the day for detecting such species. In spite of the species' probable preference for moist forested areas, it has been seen in Lahaina (Tomich 1986) and near Mopua (Hawaii Natural Heritage Program database), both of which are dry, and on the dry, treeless crest of Haleakala (Day, unpubl. data). It also is recorded regularly on the drier side of Kauai (Day and Cooper, unpubl. data; Telfer, unpubl. data), indicating that such habitat does not exclude this species. During the day, this bat roosts in a variety of tree species and occasionally roosts in rock crevices and buildings (Tomich 1986); it even has been recorded hanging from wire fences on Kauai (T. Telfer, Hawaii DLNR, Lihue, HI, pers. comm.) and has been seen leaving and entering caves and lava tubes on Hawaii (Fujioka and Gon 1988).

# STUDY AREA AND METHODS

## STUDY AREA

The proposed windfarm will be located on the southern slope of West Maui Mountain, in an area called Kaheawa Pastures (Figs. 1 and 2). The proposed site lies on a gently sloping portion of

West Maui Mountain, ~4 mi inland from McGregor Point. The proposed windfarm would consist of a single articulated row of 20 1.5 MW turbines, each with a hub height of 55 m and a rotor diameter of 70.5 m. The turbine string would run from ~3,200 ft elevation at the upper end to ~2,000 ft elevation at the lower end. In addition, a Maui Electric Company, Ltd., cross-island powerline on steel pole crosses the study area at ~2,500 ft elevation (Zond Pacific 1999). Access to the site is by an existing 4-wheel-drive track coming up-slope near McGregor Point.

Vegetation at the proposed windfarm consists of grasslands at lower elevations and a mixture of grasslands and scattered shrubs at moderate to higher elevations. Shrubs and scattered trees line the two nearby gulches. Directly above the site, shrubs dominate, with native ohia trees (Metrosideros polymorpha) and uluhe ferns becoming more common. These two plant species form the preferred nesting habitat for Newell's Shearwaters (Sincock and Swedberg 1969, Ainley et al. 1997b). Although the proposed windfarm itself 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 more upland habitats certainly appeared to us to be suitable nesting habitat for Newell's Shearwaters, from our experience on Kauai. In addition to the vegetation, the steepness of higher elevations on West Maui Mountain also suggests suitable nesting habitat for Hawaiian Petrels, as it does on Haleakala (Brandt et al. 1995), Kauai (Telfer, pers. comm.), and Lanai (Hirai 1978b).

Our survey consisted of sampling at each of the two sampling sites sampled by Day and Cooper (1999) in summer 1999 (Fig. 2, Table 1). The Upper Site (known as Site 1 in 1999) was located

Table 1. Sampling effort and activities at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004.

| Date | Study Site | Time of day: Radar sampling | Time of day: Night-vision and acoustic sampling | Comments |
|---|---|---|---|---|
| 12 Oct | Upper | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Light winds. |
| 13 Oct | Upper | 1800–1930<br>2038–2100<br>0430–0700 | 1800–1930<br>2035–2100<br>0430–0700 | Heavy rain 1935–2038 h; light winds; occasional fog in evening. |
| 14 Oct | Lower | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Light winds; occasional fog in evening. |
| 15 Oct | Lower | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Light winds. |
| 16 Oct | Upper | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Moderate trade winds. |
| 17 Oct | Upper | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Moderate trade winds; occasional fog in morning. |
| 18 Oct | Lower | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Strong trade winds. |
| 19 Oct | Lower | 1800–2100<br>0430–0700 | 1800–2100<br>0430–0700 | Moderate to strong trade winds. |

at 898 m above sea level (asl), adjacent to proposed turbine #6; we parked the mobile radar laboratory in the middle of the roadway. The Lower Site (known as Site 2 in 1999) was located at 793 m asl and was situated 80 m south of the centerline of the Maui Electric powerline; we parked on the roadway west of proposed turbine #13.

## DATA COLLECTION

Following the standard methods (from Cooper and Day 1995 and Day and Cooper 1995) used in the summer 1999 study, we monitored movements of birds and bats at the proposed Kaheawa Pastures Wind Energy Facility in October 2004 with ornithological radar. This surveillance radar, which is described in Cooper et al. (1991), was an X-band radar transmitting at 9.410 GHz through a slotted wave guide with a peak power output of 12 kW. We operated the radar at the 1.5-km range setting and a pulselength of 0.07 µsec.

Whenever energy is reflected from the ground, surrounding vegetation, and other objects that surround the radar unit, a ground-clutter echo appears on the radar's display screen. Because ground clutter can obscure targets of interest (i.e., birds and bats), we attempted to minimize it by picking an optimal sampling location. Ground clutter at both sites was minor and, in our opinion, did not cause us to miss any targets.

During radar-based surveys, we sampled each site four nights each during the evening peak movement that flows inland, toward the nesting colonies, and during the morning peak movement that flows seaward, away from the nesting colonies (Day and Cooper 1995). This sample consisted of six 25-min counts of birds during the period 1800–2100 for the evening period and five counts during the period 0430–0700 for the morning period (Table 1). Each 25-min sampling period was separated by a 5-min break for collecting data on weather between sampling bouts and for switching observers, except that we often sampled straight through our 5-min break between the first and second sessions of the evening and between the penultimate and final sessions of the morning, because those fell near the apex of Hawaiian Petrel movement and we wanted to minimize the chances of missing a bird during those important periods. (i.e., we had 30-min sessions during those periods to get complete coverage of the half-hour period) To eliminate species other than those of interest (e.g., slowly flying birds, insects), we recorded data only for those targets flying >30 mi/h (>50 km/h).

We also conducted visual and acoustic observations for birds and bats concurrently with the radar sampling; hence, the timing and number of samples at each site were identical to those for the radar sampling, with off-sampling data added on species of interest. During the visual sampling, we used 10× binoculars during crepuscular periods and used AN PVS-7 night-vision goggles during nocturnal periods. The magnification of these Generation 3 goggles was 1×, and its performance was enhanced with the use of a 2,000,000-Cp floodlight that was fitted with an IR filter to avoid blinding and/or attracting these nocturnal birds.

In addition to visual sampling, we also used a Pettersson D-100 heterodyne bat detector to conduct acoustic surveys for bats. During acoustic sampling, we set the bat detector to detect bat calls in the peak range for Hawaiian Hoary Bats (~25–30 KHz) and recorded the number of calls heard during each 25-min session. The bat detector was placed ~0.5 m above ground level and was oriented vertically, so that it sampled the airspace directly overhead.

Before each radar and night-vision sampling period, we recorded standardized weather and environmental data: wind direction (the eight ordinal points—N, NE, E, SE, S, SW, W, NW—plus variable and no wind), wind speed (to the nearest 1 m/sec), percent cloud cover (to the nearest 5%), cloud ceiling height above ground level (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). On each radar target, we recorded the time, direction of flight (to the nearest degree), tangential range (the minimal distance to the target when it passed closest to the lab; used in reconstructing actual flight paths, if necessary), transect crossed (the four cardinal points—000°, 090°, 180°, or 270°; also used in reconstructing flight paths), flight behavior (straight, erratic, circling), velocity (to the nearest 5 mi/hr [8 km/h]) species (if known), and number of organisms (if known). If the wind speed was >5 mi/h (>8 km/h) and the bird was flying in such a direction that it was encountering either a headwind or tailwind, we subtracted or added the wind speed to the flight speed, respectively. For each bird or bat seen during night-vision sampling, we recorded the time, species (to the lowest practical taxonomic unit; e.g., Newell's Shearwater, unidentified shearwater/petrel), number of organisms in the target, flight direction (the eight ordinal points), and flight altitude (m above ground level).

For the purpose of all surveys, we defined each day to begin at 0800 and end at 0759. That definition enabled us to treat the evening and following morning's data as occurring on the same date.

## DATA ANALYSIS

### RADAR DATA

We used the software SPSS 7.0 (SPSS 2003) to generate counts of targets recorded at each sampling site during each sample. These counts then were converted to estimates of movement rates (targets/h), based on the number of minutes sampled. Rain showers sometimes can obscure significant portions of the screen for several minutes at a time, so these periods when we were unable to sample (i.e., during one session on 13 October) were subtracted from the standardized 25-min sampling period, with the resulting number of minutes being used to calculate movement rates. We also often sampled straight through our 5-min break between the first and second sessions of the evening and between the penultimate and final sessions of the morning; 30-min was used to calculate rates during those sessions when we worked through our 5-min break.

We used the estimated movement rates on radar for each sampling period to calculate the mean ± 1 standard error (SE) movement rate at each site. These movement rates were calculated (1) for each evening, morning, and entire night at each site; (2) for all evenings, mornings, and entire nights at each site; and (3) for all evenings, mornings, and entire nights at both sites combined. Only known petrel/shearwater targets or unknown targets with appropriate speeds (i.e., >30 mi/h) were included in data analyses of movement rates, flight direction, and flight behavior; all other species were excluded from those analyses.

We calculated the mean flight direction (± angular deviation) for all targets seen on radar. (Angular deviation is a statistical approximation of standard deviation that is used for directional data.) Because sample sizes were so small, we calculated mean flight directions (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. We did not conduct statistical tests of differences in flight directions. We also classified general flight directions of each radar target as inland, seaward, or neither and summarized these directional categories (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. To categorize the general flight direction of each target, we first defined the major axis of the mountain slope (340° inland, 160° seaward), then defined an inland flight as occurring 75° on either side of the inland axis (i.e., 265–055°), a seaward flight as 75° on either side of the seaward axis (i.e., 085–235°), and neither direction as 14° on either side of a line perpendicular to the inland-seaward axis (i.e., 056–084° or 236–264°).

We summarized the flight behavior data as frequencies of each flight behavior (directional, erratic, circling). We calculated frequencies of each behavior (1) for all evenings, mornings, and entire nights at each site; and (2) for all evenings, mornings, and entire nights at both sites combined. Because sample sizes were small, we did not test for differences in flight behaviors.

### VISUAL DATA

We summarized the visual data by taxonomic group seen (e.g., petrels/shearwaters, Nene, bats). We described the flight behavior, flight altitudes, and other pertinent characteristics of each record.

# RESULTS

Weather during the 8 nights of sampling was good overall, and we lost only two sampling sessions (both on 13 October) to rain. Average wind speeds varied from calm to 30 mi/h and cloud cover varied between 0% and 100%. Cloud cover often decreased during the night, generally being lowest in the morning. Ceiling height also was quite variable, and, on 7 of 86 sessions, the clouds dropped to ground level. Moon phase varied between a New Moon on the night of 13 October and the First Quarter on the night of 20 October.

## RADAR OBSERVATIONS

We recorded 37 targets on radar that fit our criteria for petrel/shearwater targets. Of these targets, we saw 14 at the Upper Site and 23 at the Lower Site. The temporal breakdown was 7 targets at the Upper Site and 8 at the Lower Site in the evening (15 total) and 7 targets at the Upper Site and 15 at the Lower Site in the morning (22 total).

We also frequently observed hunting Pueos (*Asio flammeus*) on the radar and with the night-vision scope at night. During these hunting bouts, the Pueos primarily were seen flying up and down the two gulches that bordered the sides of the study area and over the open, flatter portions of the grasslands that covered most of the study area. We estimate that 2–3 of these owls foraged over the study area during our sampling. Their echoes were distinctive on the radar display: they often varied between large and small (depending on which direction from the radar they were flying), often varied widely in speed (but usually were slower than the 50-km/hr cutoff speed), often were moving extremely erratically over the landscape, and sometimes disappeared when they landed.

We often observed moderate levels of insects on the radar, primarily during the first 1–1.5 h of the night. In addition, they usually were more abundant during calm nights than during windy nights. Many, if not all, of these insects that were visible on radar were small- to medium-sized moths, at least some of which became active shortly before sunset. The flight speed of insects is <20 mi/h (<32 km/h), unless they are flying with a tailwind (Cooper and Day, unpubl. data). Insect activity was not so heavy that it prevented us from sampling.

### MOVEMENT RATES

Movement rates of shearwater and petrel targets on radar varied between 0 and 6.0 targets/h for individual sampling sessions and averaged 1.0 targets/h overall. At the Upper Site, session rates varied between 0 and 4.8 targets/h and averaged 0.7 targets/h overall; we recorded at least some targets on 3 of 4 evenings and on all 4 mornings of sampling (Table 2). At the Lower Site, session rates varied between 0 and 6.0 targets/h and

Table 2. Mean movement rates (targets/h) on surveillance radar at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004, by study site. Data are presented as mean ± SE (*n* number of sessions).

| | | Period | | |
|---|---|---|---|---|
| Site | Date | Evening | Morning | Total |
| Upper | 12 Oct | 1.2 ± 0.5 (6) | 1.0 ± 1.0 (5) | 1.1 ± 0.5 (11) |
| | 13 Oct | 0.0 ± 0.0 (4) | 0.4 ± 0.4 (5) | 0.2 ± 0.2 (9) |
| | 16 Oct | 0.8 ± 0.5 (6) | 1.3 ± 0.8 (5) | 1.0 ± 0.4 (11) |
| | 17 Oct | 0.7 ± 0.7 (6) | 0.4 ± 0.4 (5) | 0.5 ± 0.4 (11) |
| | Total | 0.7 ± 0.3 (22) | 0.8 ± 0.3 (20) | 0.7 ± 0.2 (42) |
| Lower | 14 Oct | 0.8 ± 0.5 (6) | 2.5 ± 1.2 (5) | 1.6 ± 0.6 (11) |
| | 15 Oct | 0.4 ± 0.4 (6) | 1.0 ± 0.6 (5) | 0.7 ± 0.3 (11) |
| | 18 Oct | 1.6 ± 0.8 (6) | 1.3 ± 0.8 (5) | 1.5 ± 0.5 (11) |
| | 19 Oct | 0.4 ± 0.4 (6) | 1.8 ± 1.1 (5) | 1.0 ± 0.6 (11) |
| | Total | 0.8 ± 0.3 (24) | 1.6 ± 0.5 (20) | 1.1 ± 0.3 (44) |
| Total | Total | 0.8 ± 0.2 (46) | 1.2 ± 0.3 (40) | 1.0 ± 0.2 (86) |

averaged 1.1 targets/h overall; we recorded targets on all four evenings and mornings of sampling. Movement rates were higher in the morning than in the evening on 5 of the 8 nights and for all nights combined. In addition, mean nightly movement rates varied substantially at both sites: 0.2 to 1.1 targets/h at the Upper Site and 0.7 to 1.6 targets/h at the Lower Site.

The timing of movement of targets on surveillance radar was bimodal in the evening, peaking in the periods 1805–1835 and 2000–2030 (Fig. 3). In the morning, timing peaked in the period 0600–0630. Targets were recorded during all sampling periods. On Maui in October, sunset is at ~1800, and it becomes completely dark at ~1830; the first light becomes apparent in the morning sky at ~0545, and sunrise is at ~0620. Hence, the first evening peak of movement occurred before the point of complete darkness and the second evening peak occurred during dark hours; the morning peak occurred after first light.

FLIGHT DIRECTION

Mean flight directions were similar between time periods and sites (Table 3). At the Upper Site, mean flight directions were 193° in the evening and 184° in the morning (i.e., toward the south in both periods). At the Lower Site, mean flight directions were 181° in the evening and 185° in the morning (i.e., toward the south in both periods). Across all samples, mean flight directions were 186 ± 53° (i.e., toward the south) in the evening, 183 ± 42° (i.e., toward the S) in the morning, and 184 ± 47° (i.e., toward the south) overall. Hence, mean flight directions at both sites were southerly at all times.

The predominant general flight direction of targets on radar was seaward (Table 4). This pattern was true at both sites in the evening and morning and overall in the evening and morning. The single inland flight we observed occurred in the evening. Only two targets were flying neither general direction (i.e., they flew across the slope), both at the Upper Site.

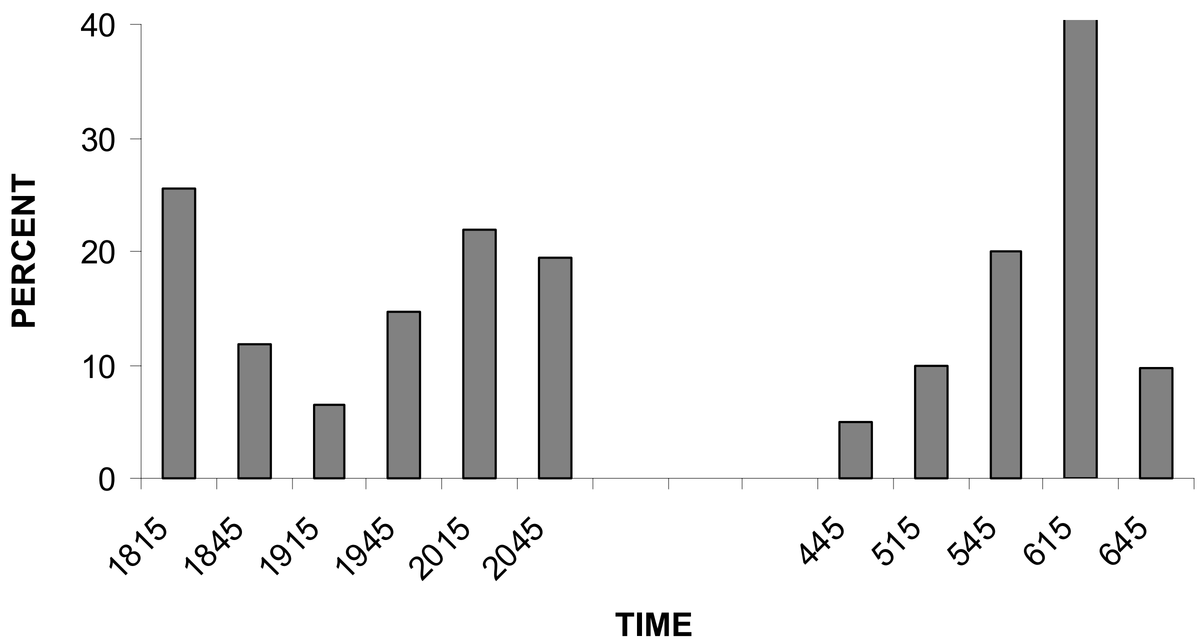


Figure 3. Timing of movement of bird targets on ornithological radar at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, in fall 2004, by time of night. Within each figure, data are pooled across sites and nights and are expressed as the percentage of the total number of targets in the evening or morning period. Sample sizes are 15 targets in the evening and 22 targets in the morning.

Table 3. Mean flight directions (True) of individual targets on surveillance radar at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004, by study site and time period. Data are presented as mean ± angular deviation (*n* number of targets).

| | Period | | |
|---|---|---|---|
| Site | Evening | Morning | Total |
| Upper | 193 ± 55 (7) | 184 ± 52 (7) | 184 ± 54 (14) |
| Lower | 181 ± 51 (8) | 185 ± 38 (15) | 184 ± 42 (23) |
| Total | 186 ± 53 (15) | 183 ± 42 (22) | 184 ± 47 (37) |

Table 4. General flight directions of targets on surveillance radar at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004, by study site and time period. Data are presented as number of targets (percentage of total).

| | | Flight direction | | | |
|---|---|---|---|---|---|
| Site | Period | Inland | Seaward | Neither | Total (*n*) |
| Upper | Evening | 0 (0) | 5 (71.4) | 2 (28.6) | 7 |
| | Morning | 0 (0) | 7 (100) | 0 (0) | 7 |
| | Total | 0 (0) | 12 (85.7) | 2 (14.3) | 14 |
| Lower | Evening | 0 (0) | 8 (100) | 0 (0) | 8 |
| | Morning | 1 (6.7) | 14 (93.3) | 0 (0) | 15 |
| | Total | 1 (4.3) | 22 (95.7) | 0 (0) | 23 |
| Total | Evening | 0 (0) | 13 (86.7) | 2 (13.3) | 15 |
| | Morning | 1 (4.5) | 21 (95.5) | 0 (0) | 22 |
| | Total | 1 (2.7) | 34 (91.9) | 2 (5.4) | 37 |

BEHAVIOR

Of the 37 targets seen on radar, 36 (97%) were flying in a straight line and 1 (3%) was circling; none were flying erratically (Table 5). In addition to this observation of one circling shearwater/petrel-type target, 2 of the 4 flocks of Nene that we observed on radar were circling.

## VISUAL AND ACOUSTIC OBSERVATIONS

We recorded petrels and shearwaters twice during the visual sampling (Table 6). The first record was of a Hawaiian Petrel flying to the southeast in the evening. This bird was flying ~750 m east of the sampling site (i.e., it did not cross over the proposed turbine string location) and appeared to be heading downslope toward the sea at an altitude of ~500 m above ground level (agl). The second observation was of an unidentified

Table 5. Flight behavior of targets on surveillance radar at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004, by study site and time period. Data are presented as numbers of targets (percentage of total).

| | | Flight behavior | | | |
|---|---|---|---|---|---|
| Site | Period | Straight-line | Erratic | Circling | Total (*n*) |
| Upper | Evening | 6 (85.7) | 0 (0) | 1 (14.3) | 7 |
| | Morning | 7 (100.0) | 0 (0) | 0 (0) | 7 |
| | Total | 13 (92.9) | 0 (0) | 1 (7.1) | 14 |
| Lower | Evening | 8 (100.0) | 0 (0) | 0 (0) | 8 |
| | Morning | 15 (100.0) | 0 (0) | 0 (0) | 15 |
| | Total | 23 (100.0) | 0 (0) | 0 (0) | 23 |
| Total | Evening | 14 (93.3) | 0 (0) | 1 (6.7) | 15 |
| | Morning | 22 (92.9) | 0 (0) | 0 (0) | 22 |
| | Total | 36 (97.3) | 0 (0) | 1 (2.7) | 37 |

Table 6. Records of Hawaiian Petrels and Newell's Shearwaters at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004.

| Date | Time | Site | Species[a] | Number | Altitude (m agl) | Flight direction | Comments |
|---|---|---|---|---|---|---|---|
| 12 Oct | 0608 | Upper | HAPE | 1 | 500 | SE | Did not cross proposed turbine string. |
| 15 Oct | 0454 | Lower | UNSP | 1 | 65 | SW | Crossed proposed turbine string. |

[a] HAPE = Hawaiian Petrel; NESH = Newell's Shearwater; UNSP = unidentified shearwater/petrel.

shearwater/petrel flying toward sea in the morning (measured as 229° on radar). Unfortunately, we were unable to observe this bird long enough to identify it to species, even though it flew almost directly overhead. This bird crossed over the proposed turbine string location at ~65 m agl.

We recorded Nene four times during the visual sampling; all of those flocks also were observed on radar (Table 7). All of these records of Nene occurred at the Lower Site, and all occurred during evening sampling. Further, all of these birds were flying ≤70 m agl, and two of the four flocks had flight paths that crossed the proposed turbine string. Two of the four flocks exhibited circling behavior. Two of the flocks were observed landing in the area: one landed ~600 m west of the proposed turbine string, and one landed ~100 m east of the proposed string. In addition to the Nene observed during visual sampling, we frequently observed 1–2 pairs of Nene above the upper end of the turbine string on our way to and from the study site in the evening and morning, respectively.

We did not see any Hawaiian Hoary Bats during visual sampling or have any acoustic detections of bats (Table 8). We regularly saw Pueos and Pacific Golden-Plovers (*Pluvialis fulva*)

Table 7. Records of Nene at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004.

| Date | Time | Site | Number | Altitude (m agl) | Flight direction | Comments |
|---|---|---|---|---|---|---|
| 15 Oct | 1816 | Lower | 2 | 75 | SE | Crossed proposed turbine string. |
| 19 Oct | 1803 | Lower | 3 | 70 | Circling | Crossed proposed turbine string. |
| | 1813 | Lower | 1 | 20 | E | Did not cross turbine string; landed west of string. |
| | 1816 | Lower | 2 | 50 | Circling | Did not cross turbine string. |

Table 8. Number of Hawaiian Hoary Bats observed during visual and acoustic surveys at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, fall 2004, by study site (*n* number of sampling sessions).

| | | Visual | | Acoustic | |
|---|---|---|---|---|---|
| Site | Date | Evening | Morning | Evening | Morning |
| Upper | 12 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | 13 Oct | 0 (4) | 0 (5) | 0 (4) | 0 (5) |
| | 16 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | 17 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | Total | 0 (22) | 0 (20) | 0 (22) | 0 (20) |
| Lower | 14 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | 15 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | 18 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | 19 Oct | 0 (6) | 0 (5) | 0 (6) | 0 (5) |
| | Total | 0 (24) | 0 (20) | 0 (24) | 0 (20) |
| Total | Total | 0 (46) | 0 (40) | 0 (46) | 0 (40) |

during night-vision sampling and during our trips to and from the study site.

# DISCUSSION

## PETRELS AND SHEARWATERS

The radar data suggest that the radar targets primarily were Hawaiian Petrels and/or Newell's Shearwaters. The timing of movements around sunrise and sunset, the inland–seaward directions of flight, the strongly directional flight behavior, and the rapid flight speeds all are similar to those for the same species on Maui (Cooper and Day 2003), Kauai (Day and Cooper 1995), and Hawaii (Reynolds et al. 1997, Day et al. 2003a). Further, the visual data from this study and the earlier summer study (Day and Cooper 1999) showed that at least Hawaiian Petrels fly over the southern slopes of West Maui Mountain during the summer, and Hawaiian Petrels also have been seen flying inland toward West Maui Mountain from the north (Cooper and Day 2003). Also, the timing of movement observed on radar by Cooper and Day (2003) suggested that both Hawaiian Petrels and Newell's Shearwater were flying inland toward West Maui Mountain during summer evenings, with Newell's Shearwaters probably being proportionately more important in West Maui than in East Maui. Hence, we conclude that a population of one or both species probably still nests somewhere in West Maui Mountain and that low numbers of these birds regularly fly over or near the proposed Kaheawa Pastures windfarm at night. (Indeed, a record from the northwestern slope of West Maui Mountain on 16 June 1999 indicates that at least Hawaiian Petrels occur there; A Lyons, *fide* C. Hodges.) The size of the nesting population of these species on West Maui Mountain is unknown at this time, but only a small number of birds flew over the proposed windfarm area.

Our fall sampling dates fell within the fledging periods of both Hawaiian Petrel and Newell's Shearwater (Simons 1985; Telfer et al. 1987; Ainley et al. 1997b; Simons and Hodges 1998). During this fall period, adult breeders stop visiting the nest and, the young leave the colony and fly to the ocean for the first time after several days without being fed. The combination of our observations of a second peak of movement in the evening and seaward flight directions in the evening suggested that at least some of the birds that we observed on radar this fall were fledgling young that were headed to the sea from the colony for the first time (in contrast to summer, when we typically observe a unimodal peak in evening activity and only landward-bound flights in evening [Day and Cooper 1995, Cooper and Day 2003]).

Although these birds fly over the proposed windfarm, mean movement rates could only be described as very low: the mean movement rate of 1.0 targets/h in fall 2004 and 1.2 targets/h in summer 1999 (Day and Cooper 1999) across both sites and all nights of sampling is lower than 12 of the 14 sites surveyed on the perimeter of Maui in summer 1999, which ranged from 4 to 134 targets/h (Cooper and Day 2003). Further, the rates we observed at the proposed wind farm represents <15% of the lowest mean movement rate that we recorded at any of the 18 sites sampled on Kauai during the summers of 1993–2001 (Day and Cooper 2001). On both Kauai and Maui, the lowest mean movement rates occur on the drier southwestern parts of the islands (Day and Cooper 1995, Cooper and Day 2003). In summary, our radar data from this study and others suggest that passage rates of petrels and shearwaters are low over the proposed Kaheawa Pastures Wind Energy Facility and that the general area where the proposed windfarm is located tends to have the lowest passage rates of petrel/shearwaters on the Island of Maui (Day and Cooper 1999, Cooper and Day 2003).

Of the four visual observations of petrel/shearwaters that were observed at the site during fall 2004 and summer 1999 (Day and Cooper 1999), only one was flying at altitudes at or below proposed turbine heights, whereas the other three were flying at 300–500 m agl. Further, only two of these four birds had a flight path that crossed the proposed turbine string location. Considered together, these behavioral data and the low movement rates over the proposed windfarm that we recorded suggest that the nightly numbers of Hawaiian Petrels or Newell's Shearwaters actually interacting with the proposed turbines would be low.

**NENE**

Nene clearly occur in the vicinity of the proposed windfarm, and our sampling efforts in both fall 2004 and summer 1999 (Day and Cooper 1999) indicate that they occasionally fly over the proposed windfarm. In addition, they commonly (i.e., 7 of 8 flocks) flew at altitudes within the proposed turbine height, and they also flew during any time of the day, as well as had some night flights. All of these behaviors put them at risk of collision with towers or of being struck by the turbine blades. It is likely that the captive release pen near the upper end of the proposed wind farm contributes to their density in the local area.

**HAWAIIAN BATS**

We recorded no Hawaiian Hoary Bats during this study or during the summer 1999 study (Day and Cooper 1999). Although these bats prefer areas with trees, especially moist areas (Bailey, pers. comm.; Medeiros, pers. comm.), they have been recorded at Lahaina (Tomich 1986) and near the summit of Haleakala (Day, unpubl. data), both of which also are dry. They regularly are seen on the drier sides of Kauai and Hawaii, especially near the coast (Cooper et al. 1996; Day and Cooper, unpubl. data). Further, Kepler and Scott (1990) found that these bats are more common on the drier side of Hawaii, probably because the number of flying insects is higher and feeding is less disrupted by rain. Hence, although it is probable that this species occurs in the proposed windfarm in the summer or fall, it probably occurs infrequently and in very low numbers.

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# Appendix 3

## Modeling Annual Seabird Use and Fatality at the Proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii
## 10 December 2004

# MODELING ANNUAL SEABIRD USE AND FATALITY AT THE PROPOSED KAHEAWA PASTURES WIND ENERGY FACILITY, MAUI ISLAND, HAWAII

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## INTRODUCTION

We conducted surveys for endangered seabirds (Hawaiian [Dark-rumped] Petrel or 'Ua'u *Pterodroma sandwichensis*; Newell's [Townsend's] Shearwater or 'A'o *Puffinus auricularis newelli*) at the proposed Kaheawa Pastures Wind Energy Facility, Maui Island, Hawaii, for eight nights in June 1999 (Day and Cooper 1999) and eight nights in October 2004 (Cooper and Day 2004). The proposed windfarm would consist of a single articulated row of 20 1.5-MW turbines, each with a hub height of 55 m and a rotor diameter of 70.5 m. In both seasons, we sampled during both the evening and the morning activity peaks of movement of these birds (Day and Cooper 1995). In summer 1999, we recorded 40 targets on radar that fit our criteria for petrel/shearwater targets and estimated a mean nightly movement rate of 1.2 targets/h. In fall 2004, we recorded 37 petrel/shearwater targets and estimated a mean nightly movement rate of 1.0 targets/h.

In this report, we use the results of the 1999 and 2004 studies to estimate the annual number of Hawaiian Petrels and Newell's Shearwaters that would fly through the area occupied by the 20 proposed turbines at the Kaheawa Wind Energy Facility. We then present a range of estimates for annual bird fatalities, based on a series of assumptions.

## METHODS AND RESULTS

To estimate the minimal and maximal number of birds that fly through the area occupied by the proposed turbines over the course of an average year (based on 180 nights/year that these species are present on the islands), we used the radar-based movement data from the Kaheawa Pastures wind site (Day and Cooper 1999, Cooper and Day 2004), visual flight-altitude data on petrels and shearwaters from Kauai (Day and Cooper, unpubl. data), data on the timing of movements at the nearby Ukumehame site from Cooper and Day (2003) to determine the proportion of Hawaiian Petrels vs. Newell's Shearwaters, data on the timing of movements from Day and Cooper (1995) to determine the proportion of birds flying during the off-peak hours in the middle of the night that we did not sample at Kaheawa, and information on mean flock size from Kauai (Day and Cooper, unpubl. data), plus information on the dimensions and number of the turbines (Table 1). Each of the main variables involved in generating these estimates is discussed below.

The movement rate is an estimate of the average number of birds/km passing over the proposed turbine string during the peak evening and morning activity periods. Because rates typically are higher during the summer breeding season than during the fall fledging season, when fewer non-breeding birds are present (Day and Cooper 1995), the movement rate that we used was a mean of summer and fall rates. Further, our rate was based on the subset of radar targets that actually crossed the turbine string. Because data from only the first 3 h of the evening and the last 2–2.5 h of the morning were available for estimation of nightly movement rates, we used data from all-night sampling sessions on Kauai in 1993 (Day and Cooper 1995) to estimate the proportion of a night's movement that occurs during the off-peak hours in the middle of the night, when we did not sample. The mean percentage of a night's movement that occurred during those off-peak hours on Kauai in summer/fall of 1993 was 12.6% (Table 1). Hence, the number of targets/km/day that occurred during the off-sampling (i.e., off-peak) hours was calculated by multiplying the number of targets/km/day we observed during peak hours by 1.126. This rate (targets/km/day) then was multiplied by the mean number of birds/target, to derive an estimate of the mean number of petrels and shearwaters/km/day flying over the turbine string. Mean flock sizes on Kaua'i are 1.02 ± SE 0.01 Hawaiian Petrels/flock (*n* = 585 flocks) and 1.03 ± SE 0.01 Newell's Shearwaters/flock (*n* = 722 flocks; Day and Cooper, unpubl. data), so we used an estimate of 1.025 birds/flock in this modeling exercise because the timing of movements suggested that both species probably were present. The estimate of the mean number of birds/km/day was then multiplied by 180 days (the number of days a year these birds are visiting the islands for breeding), to estimate the total number of birds/km flying across the turbine string during an average year. Through these methods, we estimate that 267 petrels or shearwaters will pass over each km of the proposed turbine string during an average year (Table 1).

We used all of the visual data from Kauai (where we have reasonable sample sizes of both species combined; *n* = 1,825 birds, including unidentified petrels/shearwaters; Day and Cooper, unpubl. data) to estimate the percentage of shearwaters flying at or below the proposed turbine height of 91 m; sample sizes from Kaheawa studies (*n* = 4), the island of Maui (Cooper and Day 2003, *n* = 24), and other nearby island (*n* = 14; Day and Cooper, unpubl. data) are too small for us to be able to use those data. Because we do not have sufficient data to determine whether flight altitudes differ between summer and fall, we assume here that flight altitudes do not vary seasonally. Across all species, seasons, and years on Kauai, the proportion of petrels and shearwaters that flew at or below proposed turbine height was 38%. To generate a movement rate of birds within the turbine zone (birds/year/$m^2$), we multiplied the overall movement rate by the proportion occurring within turbine height (0.38) and standardized to the rate to $m^2$ (Table 1). We then multiplied this movement rate within the turbine zone by the minimal and maximal areas (i.e., the side profile and frontal profile of the turbines, respectively) of all turbines combined, to determine the range in the annual number of seabirds that flew through the space that the proposed turbines occupy. The final calculation for the model was the proportion of targets that were Hawaiian Petrels vs. Newell's Shearwaters. The timing of inland flights of seabirds at the nearby Ukumehame site (Cooper and Day 2003) suggests that 60% of the seabirds in the area are Hawaiian Petrels and 40% are Newell's Shearwaters (however, note that the only two seabirds identified to species during the Kaheawa studies [Day and Cooper 1999, Cooper and Day 2004] were Hawaiian Petrels). Applying those proportions to our data (and rounding up to the nearest whole number), we estimate that 8–54 Hawaiian Petrels and 5–36 Newell's Shearwater will fly through the space occupied by the proposed Kaheawa turbines in an average year (Table 1).

## ESTIMATION OF FATALITY

Our estimate of the number of birds flying through the turbine space each year provides a starting point for developing a complete avian risk assessment; however, to estimate the annual seabird fatality, those numbers must be combined with an estimate of the proportion of seabirds that (1) pass through the turbine blades without being hit and (2) do not collide with turbines because they detect and avoid them by flying around or over the turbine string. Once this information is known, one may be able to assess the likelihood of avian fatalities at the proposed wind power project. We speculate that the proportions are substantial for both of these missing pieces of information, but there is no seabird-specific data available to use for an estimate of these factors. For instance, the proportion of seabirds that would detect and avoid turbines is currently unknown. Further, Tucker (1996) estimated that a bird with a 1-m wingspan flying through the rotor-swept area of a turbine with three 10-m blades had a mean probability of a collision of 0.217 (i.e., collision would occur on 21.7% of all passes) if it was flying downwind and 0.397 if it was flying upwind. Because, however, the collision probability varies with bird species, turbine type, and turbine dimensions, the collision probability for a seabird flying through the larger, slower-moving blades planned for the Kaheawa project is unknown.

Because it is necessary to calculate the take of petrels and shearwaters for the Kaheawa Pastures HCP, however, we made some calculations to explore what level of magnitude take might be. We assumed that 60% of these birds will pass through the turbine blades without getting hit by blades(based on the low end of the range estimated by Tucker (1996) and that 50%, 95%, or 99% of all birds will be able to detect and avoid the turbines (Table 2). Under those scenarios, and assuming that all of the birds colliding with a turbine die, we estimate that the minimal take will range from <1 to 2 Hawaiian Petrels/yr and the maximal take will range from <1 to 11/yr (Table 2). For Newell's Shearwater, we estimate that the minimal take will range from <1 to 1 bird/yr and the maximal take will range from <1 to 8 birds/yr. We caution again, however, the assumptions are not based on empirical data.

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Table 1. Steps used in estimation of annual number of Hawaiian Petrels and Newell's Shearwaters that fly through the area occupied by turbines at the proposed Kaheawa Pastures Wind Energy Facility, Maui. Calculations are based on movement rate data collected at the wind facility during summer 1999 and fall 2004, plus other sources, as noted.

| Variable/parameter | Estimate |
|---|---|
| TURBINE CHARACTERISTICS | |
| (A) Turbine height (m) | 91 |
| (B) Blade radius (m) | 35.25 |
| (C) Height below blade (m) | 19.75 |
| (D) Front to back width (m) | 6 |
| (E) Minimal side profile area ($m^2$) = (A x D) | 546 |
| (F) Maximal front profile area ($m^2$) = (C x D) + ($\pi$ x $B^2$) | 4022 |
| (G) # turbines | 20 |
| TOTAL CROSS-SECTIONAL AREA OF ALL WIND TURBINES | |
| (H) Minimal area of all turbines combined ($m^2$) = (E x G) | 10920 |
| (I) Maximal area of all turbines combined ($m^2$) = (F x G) | 80443 |
| MOVEMENT RATE | |
| (J) Mean rate during daily peak movement period (targets/d/km) | 1.286 |
| (K) Mean proportion of birds moving during off-peak hours of the night | 0.126 |
| (L) Daily rate of movement (targets/d/km) = (J x K)+ J | 1.448 |
| (M) Number birds/target | 1.025 |
| (N) Movement rate (birds/d/km) = L x M | 1.484 |
| (O) Length of breeding season (days) | 180 |
| (P) Birds/yr/km = N x O | 267.163 |
| RATE CORRECTED FOR FLIGHT ALTITUDE | |
| (Q) Proportion of birds on Kauai flying at or below turbine height (91 m agl) | 0.38 |
| (R) Movement rate within turbine zone (birds/yr/91,000 $m^2$) = P x Q | 101.522 |
| (S) Movement rate within turbine zone (birds/yr/$m^2$) = R/91,000 | 0.0011 |
| TOTAL NUMBER IN TURBINE ZONE EACH BREEDING SEASON | |
| (T) Minimal number of birds in zone of risk each year = H x S | 12.183 |
| (U) Maximal number of birds in zone of risk each year = I x S | 89.744 |
| (V) Proportion of Hawaiian Petrels in area | 0.6 |
| (W) Proportion of Newell's Shearwaters in area based | 0.4 |
| Minimal number of Hawaiian Petrels in zone of risk/yr = T x V | 7.3 |
| Maximal number of Hawaiian Petrels in zone of risk/yr = U x V | 53.9 |
| Minimal number of Newell's Shearwaters in zone of risk/yr = T x W | 4.9 |
| Maximal number of Newell's Shearwaters in zone of risk/yr = U x W | 35.9 |

Table 2. Estimation of annual fatality of Hawaiian Petrels and Newell's Shearwaters at the proposed Kaheawa Wind Energy Facility, Maui, based on a range of assumptions regarding the proportion of birds that pass through the rotor-swept area without being hit and the proportion of birds that detect and avoid the turbines. We caution that the assumptions are not based on empirical data.

| | Assumption | | Annual fatality (birds/yr) | |
|---|---|---|---|---|
| Species | Proportion that passes through rotor-swept area without being hit | Proportion that detects and avoids turbines | Minimal | Maximal |
| Hawaiian Petrel | 60 | 50 | 1.46 | 10.77 |
| | 60 | 95 | 0.15 | 1.08 |
| | 60 | 99 | 0.03 | 0.22 |
| Newell's Shearwater | 60 | 50 | 0.97 | 7.18 |
| | 60 | 95 | 0.10 | 0.72 |
| | 60 | 99 | 0.02 | 0.14 |

# Appendix 4

# Peer Review and Avian Risk of Collision Model
# Kaheawa Pastures Wind Farm
# Maui, HI
# February 19, 2005

# Peer Review and Avian Risk of Collision Model
# Kaheawa Pastures Wind Farm
# Maui, HI

Prepared for:

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**Content**

## 1. Overview and Justification

The purpose of this report is to accomplish two tasks. Task One is to produce a peer-review of the report entitled: MODELING ANNUAL SEABIRD USE AND FATALITY AT THE PROPOSED KAHEAWA PASTURES WIND ENERGY FACILITY, MAUI ISLAND, HAWAII prepared for UPC by ABR, Inc., and hereafter referred to as "Cooper and Day 2004(a)." The goal of Task Two is to take the same avian inputs used by Cooper and Day 2004(a) and run them through an alternate model called Avian Risk of Collision (ARC) developed by the author of this report. Because modeling entails an inherent leap-of-faith with regards to the assumptions one needs to make to build a simulation model, there is considerable value in corroborating the predictions made by two separate modeling efforts. Both tasks are focused on two species of endangered Hawaiian avifauna, the Hawaiian Petrel (*Pterodroma sandwichensis)*, and the Newells Shearwater (*Puffinus auricularis newelli*).

## 2. Task One: Peer Review Results

Cooper and Day 2004(a) present results from field data collected during 2 eight-day radar surveys of the proposed site, one in June 1999 and the other from October 2004. To prepare these data for a run through the Tucker (1996) collision model, it was necessary to calibrate and augment these survey data with results derived from similar but more extensive radar surveys of petrels and shearwaters from the Island of Kauai (Cooper and Day 1995).

Regarding their treatment of the radar survey data, overall, given the limitations of these data, I felt that Cooper and Day (2004(a)) were conservative and wholly appropriate in their handling and preparation of these data. Yet, I also felt the following was true:

- Two eight day surveys (of roughly 5.5 hours per night), one in June and other in October, *and* separated by 5 years, is a small amount of survey data upon which to be able to characterize use and birds/km passage rates for these two species at the Kaheawa site.
- Nevertheless, passage rates of 40 "targets" in 1999 and 37 in 2004 is, I believe, sufficient data (though minimally so), for a first approximation of passage rates at Kaheawa.
- It was of great value being able to bring both the data and experience from Kauai to bear on these data from Kaheawa. I support the way they used Kauai data to derive the ratio of petrels to shearwaters as well as the proportion of birds that fly

above and within the Kaheawa wind facility.

Regarding the collision modeling based upon Tucker 1996, I felt the following:

- The Tucker model appears to assess the risk of collision only with the spinning rotors; it was not apparent to me if or how the Tucker model quantifies the risk of collision with the large, steel monopole tubes that support modern WTGs and can represent an additional potential for collision risk.
- Similarly, it was not apparent to me if or how the Tucker model as used by Cooper and Day takes account of the variable, and overall slower, RPMs for modern WTGs. Indeed, the GE 1.5se WTG's being proposed for Kaheawa are variable-speed WTGs and the blade speeds vary between 0 and 22.2 RPMs (mean value of 13.7), depending on ambient wind. This part of the modeling could be important because the Rotor Swept Area of these turbines cover a very large area (70.5 meters in diameter), and not accounting for rotating blades would yield an underestimate of collision risk.
- Finally, while I think it is very important to be conservative when building and running simulation models, I felt that Cooper and Day were unnecessarily cautious when they ran the model assuming that only 50 percent of the birds approaching the site can detect and avoid turbines. While there is next to no empirical data that pertain the ability of birds to avoid obstacles, running the model, any model, where one assumes that only half the birds can detect an obstacle, is not justifiable, in my opinion, on common-sense grounds alone. (Even if the intention were to try and capture proportion of birds at risk under the most horrendous, foggy, low-visibility conditions, using a rate of detectors of only 0.5 would, even in that case, be overly cautious to a fault). Therefore, I am leery of Cooper and Day's "Maximal" estimation of annual mortality of petrels of 10.77 and 7.18 for shearwaters at Kaheawa.

## 3. Task Two – ARC Model Methods and Inputs

Avian Risk of Collision (ARC) is a dynamic model designed to estimate the risk that flying objects will run into or collide with both the fixed and moving parts of a wind turbine generator. As such, in ARC probability of collision (P) is a function of the ratio of collision flight paths (CFP) to total flight paths (TFP), that is;

$$P = \frac{CFP}{TFP}$$

Because WTGs themselves have a lot of open space in them but mainly because WTGs are spatially arranged to be separated by spaces that are not less than 2 times the rotor diameters, TFP is invariably much larger than CFP. CFP is a function of the size of the WTG equipment including the supporting monopole, the nacelle and the 3 rotor blades. In addition, CFP increases as the size and the RPMs of the rotor blades increase. Also, CFP varies as a function of the orientation of the rotor plane – which can be facing frontally towards an oncoming bird or bat, i.e., worst case, or oriented sideways to oncoming flyers, i.e., best-case orientation (Figure 1). Finally, both CFP and TFP are impacted by the size, flying speed and height of birds and bats.

ARC extends the Tucker model used by Cooper and Day in several ways. First, in ARC one can build and model the risk of the monopole portion of the WTG and examine that risk in isolation. ARC allows input of all the specifics regarding the rotor blades, including the RPM (Table 1). Also, ARC takes into account the speed and size of birds or bats as they move though the wind park. In ARC it is possible to have any number of birds cross any number of WTGs thus allowing the modeling of the accumulation of risk to birds crossing wind parks of different sizes. ARC also allows the user to model proportion of birds that can detect and thereby avoid WTG *as well as* model the proportion of birds attracted to WTG lighting. Finally, ARC allows the user to specify the height of flight for birds and measure directly the risk of flying through a wind park at various elevations (Table 2).

Petrel and shearwater body size data came from Harrison 1983. For reasons mentioned above, in the ARC results discussed below, I use **0.9, 0.95, 0.995** for the worst-case, average-case and best-case scenarios for the proportion of birds that are able to see, detect, and subsequently avoid the WTGs. As stated above with regards to ABR's use of 0.5, a proportion of detectors of 0.9 still means that 1 out of every 10 birds is a candidate for collision which this author believes is rarely, if ever, so high even under the most "visually challenged" conditions. Nevertheless, in the absence of direct, empirical data pertaining to rates of avoidance to plug into ARC or any model, it is necessary to choose, albeit somewhat arbitrarily, a starting point for such collision modeling.

Multiple-turbine facilities pose a greater risk to birds or bats simply because they drive up the value of CFP relative to TFP (Figure 2). ARC models this allowing one to pre-set the number of turbines a given flight path will include and how much mass there is at a given flight height. In the case of Kaheawa, the worst case assumes that the highest number of birds are moving through all 20 turbines at the worst height of 55.5M, a situation that is very unlikely to be realized.

As mentioned above, higher RPMs increase CFP relative to TFP so it is important to specify this parameter accurately. The RPM values used in the three scenarios reported here, **0**, **13.7** and **22.2** for the best, average and worst cases respectively, were derived from the 4 years of wind monitoring at the Kaheawa site. These data indicate that RPM will be zero approximately 24.2% of the time, the average RPM will be 13.7 45.8% of the time, and that the turbine would run at a maximum speed of 22.2 RPM 30% of the time.

Bird speeds used in ARC were extracted from field measurements of petrel and shearwater radar "targets" traced at Kaheawa (ABR 2005). The flight speeds used were **10m/s, 15m/s** and **20m/s** for worst, average and best case scenarios respectively.

## 4. ARC Results

Figure 3 presents a risk-profile-curve for the GE 1.5se WTG showing that risk of collision varies considerably depending on the height the bird or bat is above the ground. Tables 3 and 4 present the results of collision risk assessment for petrels and shearwaters respectively. Note that for each of the three species, input variables change and generally get more aggressive moving from the worst to the best case scenarios. In the worst case runs of the ARC, the birds are flying up wind and their speed is 0.54 that of their downwind speed (a proportion that was chosen to be consistent with the up v. downwind speeds used by Cooper and Day ala Tucker). In the worst case the turbines are all spinning at maximum RPMs – 22.2, and the turbines are all facing front-forward presenting the most aggressive profile. In the worst case, the birds are flying through the wind park at the worst possible elevation -- 55.5M corresponding to the location of the rotor hub and nacelle - and they fly down through and cross all 20 turbines! In the worst case the number of birds put at risk is the highest that Cooper and Day estimate will be flying through the wind facility. Finally, the worst case assumes that only 0.9 of the birds can avoid the WTGs during their transit.

In the best case runs of ARC, the birds are flying down wind and their speed is 0.54 higher than their upwind speed. In the best case none of the turbines are spinning, and the turbines are all facing side-to, presenting the least aggressive profile to oncoming birds. In the best case, the birds are flying through the wind park at a relatively benign elevation – 20M, or just below the 6-oclock sweep of the turbine blades. In the best case the number of birds at risk is the lowest estimated by Cooper and Day to be flying through the wind facility. Finally, the best case assumes that 0.995 of the birds can avoid the WTGs during their transit. Also note that the average case uses input values that are essentially halfway between the best and worst case inputs. Thus it is not a true average in the statistical sense, but rather a run of the model based on mid-range input values.

## 5. Discussion

Modeling of bird or bat collision and mortality risk has value in terms of helping to identify many potential problems *before* a project gets built. But it is important to realize that all models are limited by the fact that they invariably make assumptions about how a given system may perform after it is built. This is true of ARC and for that matter, all avian mortality risk models. A particularly significant assumption with all collision risk models pertains to how they integrate bird behavior, specifically the ability of birds to detect and avoid flying objects under different times of day and atmospheric conditions. The problem here is that there is very little quantitative data pertaining to obstacle avoidance. Empirically we know that birds are simultaneously endowed with highly efficient visual and neuro-motor systems but that can, under certain circumstances, breakdown to result in significant collision events. Because avoidance behavior is so important the typical approach is to try and capture this dilemma by modeling both the best and worst cases with regards to avoidance behavior with the hope being that actual performance will fall between the two. And while I present both best and worst cases along with an average case, I believe that the actual performance of the facility will be much closer to the best case results than to the worst or average case results for these reasons:

1. Studies of petrel and shearwater collision with urban structures from Kauai (Ainley et al 1997, 2001; Podolsky et al 1998) showed that virtually all of the collisions were clustered on moon-less nights around obstacles with strong point sources of artificial light rather than the size of structure. For this reason, and

especially if lighting of the WTG is kept to minimum, I believe that detection and avoidance rates of the proposed WTGs will be much higher in the field than 0.90 used in our worst case and be a lot closer to the 0.995 level used in the best case.

2. I think it very unlikely that all the birds traveling through the Kaheawa Pastures would choose flight paths that would take them through all 20 WTGs at the most dangerous elevation of 55.5M, with all the turbines spinning maximally at 22.2 RPMs and oriented to be facing the flight paths. Indeed a spatial analysis of this likelihood (Figure 4) indicates that only 3.3% of random flight lines across the entire Kaheawa Pastures facility would carry the birds through all twenty WTGs. Rather, from a probabilistic standpoint, well over 96.7% of the flight paths would have them pass by only one or two WTGs.

The number of collisions per year estimated from the ARC model are both within and below the range that ABR predicted primarily due to the fact that I did not run ARC at the 0.5 detector level and did run it at, what I believe to be the more realistic 0.995 level. Even the 0.995 level means that at any given time 5 out of 1,000 birds are essentially blind. I believe that this would represent an unrealistically low level of behavioral avoidance of collision risk for any wild bird population to sustain.

## 6. Tables

| | |
|---|---|
| **Turbine Model** | GE 1.5se |
| **Turbine Wattage (MW):** | 1.5 |
| **RPM:** | 11.1 - 22.2 |
| **Radius of Rotor (m):** | 35.25 |
| **Blade Width at Hub (m):** | 0.8 |
| **Blade Width at Widest Point (m):** | 1.5 |
| **Radius at Widest Point on Rotor(m):** | 8 |
| **Blade Width at Tip (m):** | 0.1 |
| **Number of Rotor Blades:** | 3 |
| **Monopole Diameter at Ground Level (m):** | 3.5 |
| **Monopole Diameter at Widest Point (m):** | 3.5 |
| **Elevation at Widest Point on Monopole (m):** | 0 |
| **Monopole Diameter at Hub (m):** | 2 |
| **Elevation at Hub (m):** | 55.5 |
| **Nacelle Height (m):** | 4 |
| **Nacelle Width (m):** | 3.6 |

Table 1. These are the data used as inputs into ARC that pertain to the WTG, specifically the rotor blades and the monopole structures.

| | |
|---|---|
| **L (m):** | Bird Length (beak to tail) |
| **W (m):** | Bird Wingspan |
| **S (m/s):** | Speed of Bird |
| **LD:** | Lag Distance (Distance spent in plane of rotor based on angles of attack) |
| **DT (s):** | Danger Time (Total time in which bird intersects the rotor-swept plane) |
| **AS (degrees/s):** | Angular speed of rotor |
| **BD (m):** | Depth of Blade |
| **BW (m):** | Width of Blade |
| **P(R):** | Probability of Collision at Radius R |
| **VΘ:** | Vertical Angle of Attack (measured as angle from orthogonal vector) |
| **HΘ:** | Horizontal Angle of Attack |
| **BSA (degrees):** | Blade Swept Angle (angle each blade sweeps through during the danger time) |
| **AoD (m):** | Arc of Danger (arc along circle corresponding to BSA) |
| **TAoD (m):** | Arc of Danger |
| **R (m):** | Radius at which bird enters rotor-swept plane |

Table 2. The key terms used by ARC in the calculation of collision risk probability for birds entering the rotor sweep area of a WTG.

| | Worst-Case | Average-Case | Best-Case |
|---|---|---|---|
| **Turbine RPM:** | 22.2 | 13.7 | 0 |
| **Turbine Orientation:** | Front | Mixed | Side |
| **Bird Length (M):** | 0.43 | 0.43 | 0.43 |
| **Bird Wing-span (M):** | 0.91 | 0.91 | 0.91 |
| **Flight Speed (M/S):** | 10 | 15 | 20 |
| **Flight Height (M):** | 55.5 | 38 | 19 |
| **Turbines Crossed:** | 20 | 10 | 1 |
| **Birds Passing/Year:** | 54* | 31* | 8* |
| **Fraction Avoiders:** | 0.90 | 0.95 | 0.995 |
| **Probability of Collision:** | 0.0822 | 0.0195 | 0.0001 |
| **Number of Collisions/Year** | 4.4403 | 0.6069 | 0.0011 |

*From Cooper and Day 2004(a).

Table 3. Estimates for annual collisions for **Hawaiian Petrel** at the Kaheawa Pastures Wind Energy Facility. Results presented are a simulation only and are based on assumptions that may or may not accurately represent the behavior of birds or the performance of wind parks and equipment.

| | Worst-Case | Average-Case | Best-Case |
|---|---|---|---|
| **Turbine RPM:** | 22.2 | 13.7 | 0 |
| **Turbine Orientation:** | Front | Mixed | Side |
| **Bird Length (M):** | 0.32 | 0.32 | 0.32 |
| **Bird Wing-span (M):** | 0.82 | 0.82 | 0.82 |
| **Flight Speed (M/S):** | 10 | 15 | 20 |
| **Flight Height (M):** | 55.5 | 38 | 19 |
| **Turbines Crossed:** | 20 | 10 | 1 |
| **Birds Passing/Year:** | 36* | 21* | 5* |
| **Fraction Avoiders:** | 0.90 | 0.95 | 0.995 |
| **Probability of Collision:** | 0.0692 | 0.0184 | 0.0001 |
| **Number of Collisions/Year** | 2.4915 | 0.3869 | 0.0006 |

*From Cooper and Day 2004(a).

Table 4. Estimates for annual collisions for **Newells Shearwater** at the Kaheawa Pastures Wind Energy Facility. Results presented are a simulation only and are based on assumptions that may or may not accurately represent the behavior of birds or the performance of wind parks and equipment.

## 7. Figures

A. B.

Figure 1. WTG A is oriented frontally or orthogonally to the flight paths of birds or bats whereas B is oriented side-to the flight paths. Frontal orientation yields a higher value for CFP in the ARC model.

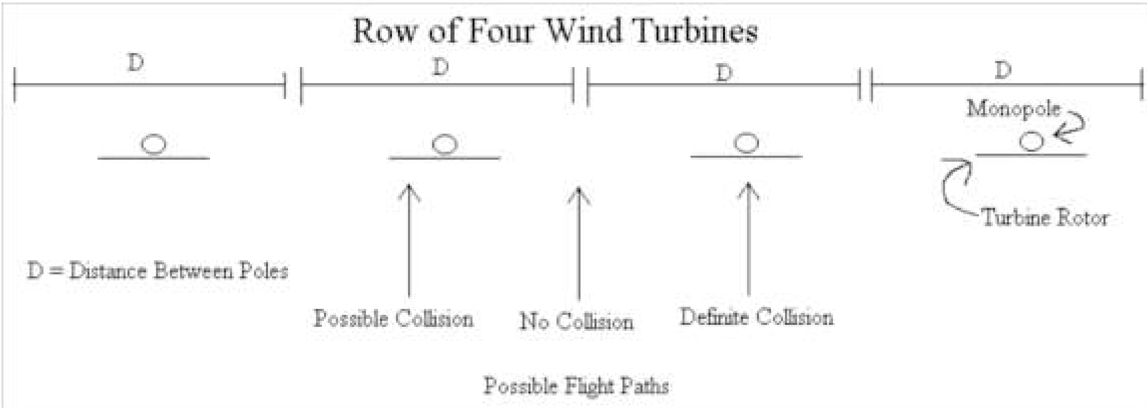


Figure 2. Because adjacent WTG monopoles and rotors have considerable space between them (often 2-5 times the rotor diameter), means that most flight paths through a wind park yield **no collision** whatsoever. Other possible outcomes when flying through a wind park are **definite collision** where a bird flies directly into a monopole or nacelle and **possible collision** where a bird flies into the rotor sweep plane of a WTG. In this graphic the probability of a collision is function of the proportion of these three outcomes for the bird at the elevation it is flying. Should there be another row of turbine in the flight path the risk of collision with all rows transited by a bird is additive. Thus the bigger the wind park the more cumulative risk there is to birds attempting to transit through the facility.

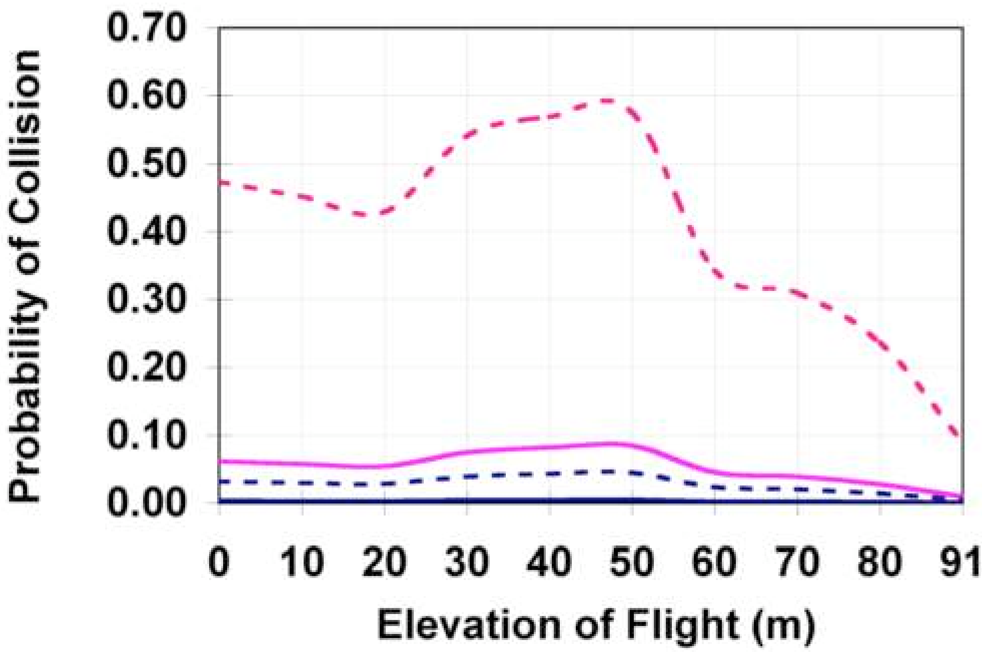


Figure 3. Probability of colliding with sections of a wind turbine generator are not equal at all elevations and depend on the amount of machinery mass and its rate of movement at different elevations. In this graph of a GE 1.5se wind turbine the red dotted line represents risk for birds for whom the WTGs are invisible, i.e., the fuchsia line is for 0.95 discriminators, blue dotted line for 0.99 discriminators and solid blue line for 0.995 discriminators. Note that risk drop between zero and 20 meters because the mono pole decreases from 3M to 2M. Risk increase above 20M as elevation begins to include the spinning rotors and peaks at the hub/nacelle at 55.5M. Thereafter, the risk drops off as one runs out the tip of the rotor blade.

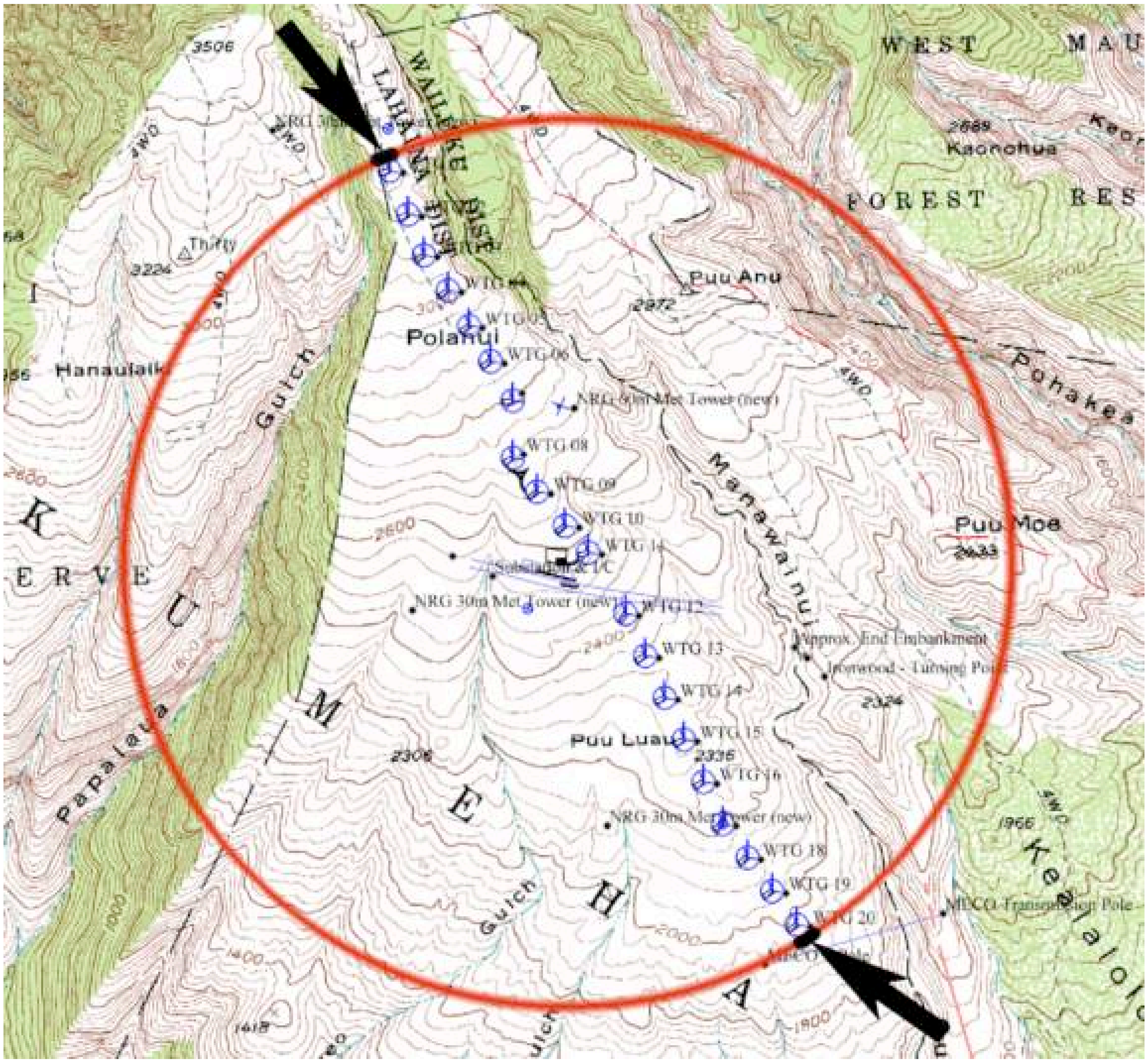


Figure 4. The proportion of all flight paths through the Kaheawa facility (indicated by the red circle), that would yield trajectories through all 20 turbines are shown in black (indicated by the two black arrows) and together these two flight paths represent only 0.033 (280M/8,370M) or 3.3% of all the flight paths available to birds transiting the wind park. Indeed, the vast majority of flight paths across the Kaheawa facility would yield encounters with single turbines only.

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# Appendix 5

**Botanical Resources Survey**
**for the**
**Kaheawa Pastures Wind Energy Project**
**Access Road – Primary Route**
**September 2004**

# BOTANICAL RESOURCES SURVEY

**for the**

## Kaheawa Pastures Wind Energy Project
## Access Road – Primary Route

## UKUMEHAME, MAUI, HAWAII

**by**

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**September 2004**

**Prepared for:**
**Kaheawa Windpower, LLC**

# BOTANICAL RESOURCES SURVEY
# Kaheawa Pastures Wind Energy Project

## INTRODUCTION

The Kaheawa Pastures Wind Energy Project, consisting of an array of 20 wind generators, is to be situated on a remote ridgetop above the southern tip of West Maui between 1900 ft. and 3200 ft. elevation. The existing vehicular access to this project, a rough 7.5 mile 4-wheel drive road that will have to be substantially upgraded for the purposes of this project, is the subject of this botanical survey. Both the project area and the access road lie on State owned Conservation District land within the ahupua'a of Ukumehame.

## SITE DESCRIPTION

The terrain along this route rises rather evenly from the Honoapi'ilani Highway to 3600 feet at a 16% grade. Several rocky gulches run down through this slope creating a rough dissected topography. Annual rainfall varies tremendously from a near desert 12 in. to 15 in. at the bottom, to 20 in. at 2000 ft., to 50 in. at 3000 ft., to 75 in. at 3600 ft. at the top (Armstrong, 1983). The lower area gets its rainfall primarily during a few winter storms while the upper slopes supplement this with frequent misty rains throughout the year. The area is frequently windy as trade winds funneling out of the central valley spill over the ridge.

Soils in the lower half of the mountain derive from secondary trachyte lava flows from the West Maui volcano. The soil forms a thin mantle over great quantities of subangular, gray rock. The upper slopes are mostly reddish brown silty clay loams with an increasing clay fraction towards the highest elevations (Foote et al, 1972). Soil erosion is a problem along the entire length of the roadway.

## BIOLOGICAL HISTORY

In pre-contact times this mountain slope was entirely covered with native vegetation of low stature with dry grass and shrublands below and mesic to wet windblown forests above. 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 Maui Electric Co. installed high voltage powerlines 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. A large fire swept across the mountain in 1999 consuming more than 2500 acres, further depleting native resources. Today some native forest remnants persist in steep gulches or on barren ridgetops, and above the forest fence.

**DESCRIPTION OF THE VEGETATION**

The existing vegetation along the entire 7.5 mile road corridor can be placed into four general categories that correspond with elevation and rainfall. They are as follows:

1. Dry rocky grassland (100 ft. – 1500 ft.) - The vegetation here is dominated by a nearly complete cover of buffelgrass (*Cenchrus ciliaris*) and scattered kiawe (*Prosopis pallida*) trees. Only two other species are of common occurrence, ‘ilima (S*ida fallax*) and ‘uhaloa (*Waltheria indica*). Seven species of native plants were identified. All are common to abundant in Hawai’i.

2. Rough broken land with silty loam soil (1500 ft. – 3000 ft.) - The vegetation here is a diverse array of mostly non-native weeds. The most abundant species is molasses grass (*Melinus minutiflora*) which is taking over following the 1999 fire that swept through here. Also common are ‘ilima, narrow-leaved plantain (*Plantago lanceolata*), ironwood (*Casuarina equisetifolia*), long-leaved ironwood (*Casuarina glauca*), ‘a’ali’i (*Dodonaea viscosa)* and lantana (*Lantana camara*). Eleven species of native plants were identified, ten of which are common to abundant in Hawaii. The eleventh, ‘iliahi alo’e (*Santalum ellipticum*), while not common is by no means rare and is not on the Endangered Species list.

3. Open grassland (3000 ft. – 3400 ft.) – This area is dominated by the grass species molasses grass, pangola grass (*Digitaria pentzii*) and rattail grass (*Sporobolus africanus*), but has a variety of other species that are able to grow up through it or on the margins. Ten species of native plants were identified, eight of which are common to abundant in Hawaii. *Trisetum inaequale* (no common name)

is a small grass known from Maui and Lanai in mesic forests. It is not widespread but is locally common in this part of West Maui. The orange-flowered naupaka (*Scaevola gaudichaudii*) occurs in dry shrublands throughout Hawaii, but is only locally common in these habitats. It is scattered throughout the middle elevations of the project area. Neither of these species is listed as Endangered.

4. Dwarf native forest (3400 ft. – 3600 ft.) – This area above the forest fence is a low statured forest that is still predominantly native in character. The dominant species is ʻohia (*Metrosideros polymorpha*) which along with pukiawe (*Styphelia tameiameiae*) makes up about 80% of the vegetation. Seventeen other native species occur within this matrix along with a number of herbaceous weeds. Of the nineteen total native species recorded here, only the above-mentioned *Trisetum inaequale* and kolokolo kuahiwi (*Lysimachia hillebrandii*) are less than common. Neither however is on the Endangered Species list.

## SURVEY OBJECTIVES

This report summarizes the findings of a botanical survey of the access road corridor leading to the proposed Kaheawa Pastures Wind Energy Project which was conducted in September, 2004.
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 7.5 mile access road corridor was surveyed by vehicle and on foot. The corridor was covered to a width of 30 feet (10 ft. in from each side of the road) on straight and smooth areas and to a width of approximately 100 ft. on sharp turns and rough terrain to allow for route alterations. Areas most likely to harbor native or rare plants were more intensively examined. Notes were made on plant species, distribution and abundance as well as 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).

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 | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| **FERNS** | | | | |
| BLECHNACEAE (Chain Fern Family) | | | | |
| *Sadleria cyatheoides* Kaulf. | 'ama'u | endemic | 4 | rare |
| DENNSTAEDTIACEAE (Bracken Family) | | | | |
| *Pteridium aquilinum* (L.) Kuhn. var. decompositum (gaudich.) R.M. Tryon | kilau | endemic | 2 | rare |
| | | | 3 | uncommon |
| | | | 4 | uncommon |
| GLEICHENIACEAE (False Staghorn Family) | | | | |
| *Dicranopteris linearis* (Burm.f..) Underw. | uluhe | indigenous | 4 | uncommon |
| LINDSAEACEAE (Lindsaea Family) | | | | |
| *Sphenomeris chinensis* (L.)Maxon | pala'a | indigneous | 3 | uncommon |
| | | | 4 | uncommon |
| LYCOPODIACEAE (Club-moss Family) | | | | |
| *Lycopodiella cernua* (L.) Pic. Serm. | wawae'iole | indigenous | 4 | uncommon |
| PTERIDACEAE (Brake Family) | | | | |
| *Pityrogramma austroamericana* Domin | gold fern | non-native | 3 | rare |
| **MONOCOTS** | | | | |
| CYPERACEAE (Sedge Family) | | | | |
| *Carex meyenii* Nees | ------------ | indigenous | 4 | rare |
| *Gahnia gahniiformis* (Gaud.) A. Heller | ----------- | indigenous | 4 | rare |
| *Machaerina angustifolia* (Gaud.) T. Koyama | 'uki | indigenous | 4 | rare |
| POACEAE (Grass Family) | | | | |
| *Andropogon virginicus* L. | broomsedge | non-native | 3 | uncommon |
| | | | 4 | common |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| *Axonopus fissifolius* (Raddi) Kuhlm. | narrow leaved carpetgrass | non-native | 3 | uncommon |
| | | | 4 | rare |
| *Bothriochloa bardbinodis* (Lag.) Herter | fuzzy top | non-native | 2 | rare |
| *Briza minor* (L.) | little quaking grass | non-native | 3 | rare |
| *Cenchrus ciliaris* (L.) | buffelgrass | non-native | 1 | abundant |
| | | | 2 | uncommon |
| *Chloris barbata* (L.) Sw. | swollen fingergrass | non-native | 1 | uncommon |
| *Cynodon dactylon* (L.) Pers. | manienie | non-native | 2 | rare |
| *Danthonia pilosa* R. Br. | hairy oatgrass | non-native | 4 | rare |
| *Digitaria pentzii* Stent | pangola grass | non-native | 3 | uncommon |
| | | | 4 | rare |
| *Digitaria insularis* (L.) Mez ex Ekman | sourgrass | non-native | 2 | rare |
| *Eragrostis brownei* (Kunth)Nees ex. Steud. | sheepgrass | non-native | 4 | uncommon |
| *Eragrostis tenella* (L.) P. Beauv. Ex Roem. & Schult. | ------------- | non-native | 1 | rare |
| *Eragrostis variabilis* (Gaud.) Steud. | kawelu | endemic | 4 | rare |
| *Heteropogon contortus* (L.) P. Beauv. Ex Roem & Schult. | pili | indigenous | 1 | uncommon |
| | | | 2 | uncommon |
| *Holcus lanatus* L.. | velvet grass | non-native | 3 | uncommon |
| | | | 4 | uncommon |
| *Melinus minutiflora* P. Beauv. | molasses grass | non-native | 1 | rare |
| | | | 2 | abundant |
| | | | 3 | abundant |
| | | | 4 | uncommon |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| *Panicum maximum* Jacq. | Guinea grass | non-native | 1 | rare |
| | | | 2 | uncommon |
| *Paspalum conjugatum* Bergius | Hilo grass | non-native | 3 | uncommon |
| | | | 4 | uncommon |
| *Paspalum dilatum* Poir. | Dallis grass | non-native | 4 | rare |
| *Paspalum urvillei* Steud. | Vasey grass | non-native | 3 | rare |
| | | | 4 | uncommon |
| *Pennisetum clandestinum* Chiov. | kikuyu grass | non-native | 3 | uncommon |
| *Rhynchelytrum repens* (Willd.) Hubb. | Natal redtop | non-native | 1 | uncommon |
| | | | 2 | uncommon |
| *Setaria parviflora* (Poir.) Kerguelen | yellow foxtail | non-native | 3 | rare |
| | | | 4 | rare |
| *Sporobolus africanus* (Poir.) Robyns & Tournay | rattail grass | non-native | 2 | uncommon |
| | | | 3 | common |
| | | | 4 | uncommon |
| *Trisetum inaequale* Whitney | ------------ | endemic | 3 | rare |
| | | | 4 | rare |

## DICOTS

ANACARDIACEAE (Mango Family)

| | | | | |
|---|---|---|---|---|
| *Schinus terebinthifolius* Raddi | Christmas berry | non-native | 3 | uncommon |
| | | | 4 | rare |

APIACEAE (Parsley Family)

| | | | | |
|---|---|---|---|---|
| *Centella asiatica* (L.) Urb. | Asiatic pennywort | non-native | 3 | rare |
| | | | 4 | uncommon |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| ASCLEPIADACEAE (Milkweed Family) | | | | |
| *Asclepias physocarpa* (E.Mey.) Schlecter | baloon plant | non-native | 3 | rare |
| ASTERACEAE (Sunflower Family) | | | | |
| *Acanthospermum australe* (Loefl.) Kuntze | spiny bur | non-native | 2 | uncommon |
| | | | 3 | uncommon |
| | | | 4 | uncommon |
| *Ageratina adenophora* (Spreng.) R. King & H. Robinson | Maui pamakani | non-native | 3 | rare |
| *Bidens micrantha* Gaud. | ko'oko'olau | endemic | 2 | uncommon |
| *Conyza bonariensis* (L.) Cronq. | hairy horseweed | non-native | 2 | uncommon |
| | | | 3 | rare |
| | | | 4 | rare |
| *Conyza canadensis* (L.) Cronq. var. pusilla (Nutt.) Cronq. | horseweed | non-native | 2 | rare |
| | | | 3 | rare |
| *Emilia fosbergii* Nicolson | red pualele | non-native | 1 | rare |
| | | | 2 | rare |
| *Erigeron karvinskianus* DC | daisy fleabane | non-native | 3 | uncommon |
| | | | 4 | uncommon |
| *Heterotheca grandiflora* Nutt | telegraph plant | non-native | 2 | uncommon |
| | | | 3 | uncommon |
| *Hypochoeris radicata* L. | gosmore | non-native | 3 | uncommon |
| | | | 4 | uncommon |
| *Pluchea carolinensis* (Jacq.) G. Don | sourbush | non-native | 2 | rare |
| *Senecio madagascariensis* Poir. | fireweed | non-native | 1 | rare |
| | | | 3 | uncommon |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| *Tridax procumbens* L. | coat buttons | non-native | 1 | uncommon |
| *Xanthium strumarium* L. | kikania | non-native | 2 | uncommon |
| *Zinnia peruviana* (L.) L. | puapihi | non-native | 1 | uncommon |
| | | | 2 | rare |
| BRASSICACEAE (Mustard Family) | | | | |
| *Sisymbrium officinale* (L.) Scop. | hedge mustard | non-native | 2 | rare |
| CACTACEAE (Cactus Family) | | | | |
| *Opuntia ficus-indica* (L.) Mill. | panini | non-native | 1 | rare |
| CASUARINACEAE (She-oak Family) | | | | |
| *Casuarina equisetifolia* L. | ironwood | non-native | 2 | common |
| | | | 3 | uncommon |
| *Casuarina glauca* Siebold ex Spreng.. | longleaf ironwood | non-native | 2 | common |
| | | | 3 | uncommon |
| | | | 4 | rare |
| CHENOPODIACEAE (Goosefoot Family) | | | | |
| *Atriplex semibaccata* R. Br.. | Australian saltbush | non-native | 2 | rare |
| CONVOLVULACEAE (Morning Glory Family) | | | | |
| *Merremia aegyptia* (L.) Urb. | hairy merremia | non-native | 1 | rare |
| EPACRIDACEAE (Epacris Family) | | | | |
| *Styphelia tameiameiae* (Cham.& Schletend.) F.V.Muell. | pukiawe | indigenous | 2 | uncommon |
| | | | 3 | uncommon |
| | | | 4 | common |
| ERICACEAE (Heath Family) | | | | |
| *Vaccinium dentatum* sm. | 'ohelo | endemic | 4 | uncommon |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| EUPHORBIACEAE (Spurge Family) | | | | |
| *Chamaecyce hirta* (L.) Millsp. | hairy spurge | non-native | 1 | rare |
| FABACEAE (Pea Family) | | | | |
| *Acacia farnesiana* (L.) Willd. | klu | non-native | 1 | uncommon |
| | | | 2 | uncommon |
| | | | 3 | rare |
| *Acacia mearnsii* De Wild. | black wattle | non-native | 2 | rare |
| *Chamaecrista nictitans* (L.) Moench | partridge pea | non-native | 1 | common |
| | | | 2 | uncommon |
| | | | 3 | uncommon |
| *Crotalaria incana* L. | fuzzy rattlepod | non-native | 1 | rare |
| *Crotalaria retusa* L. | ---------- | non-native | 1 | uncommon |
| | | | 2 | uncommon |
| *Desmanthus pernambucanus* (L.) Thellung | slender mimosa | non-native | 1 | uncommon |
| | | | 2 | uncommon |
| *Desmodium incanum* DC | ka'imi clover | non-native | 3 | rare |
| *Desmodium Sandwicense* E. Mey. | Spanish clover | non-native | 2 | rare |
| *Desmodium tortuosum* (SW.) DC | Florida beggarweed | non-native | 1 | uncommon |
| *Indigofera suffruticosa* Mill. | 'iniko | non-native | 1 | rare |
| | | | 2 | uncommon |
| *Leucaena leucocephala* (Lam.) de Wit | koa haole | non-native | 1 | uncommon |
| | | | 2 | uncommon |
| | | | 3 | rare |
| *Macroptilium lathyroides* (L.) Urb. | wild bean | non-native | 1 | uncommon |
| | | | 2 | uncommon |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| *Prosopis pallida* (Humb. & Bonpl. Ex Willd.) Kunth | kiawe | non-native | 1 | common |
| | | | 2 | rare |
| GENTIANACEAE (Gentian Family) | | | | |
| *Centaurium erythraea* Raf. | bitter herb | non-native | 2 | uncommon |
| GOODENIACEAE (Goodenia Family) | | | | |
| *Scaevola gaudichaudii* Hook. & Arnott | orange naupaka | endemic | 3 | rare |
| LAMIACEAE (Mint Family) | | | | |
| *Salvia coccinea* B. Juss. Ex Murray | scarlet sage | non-native | 3 | rare |
| *Leonotis nepetifolia* (L.) R.Br. | lion's ear | non-native | 1 | rare |
| LYTHRACEAE (Loosestrife Family) | | | | |
| *Lythrum maritimum* Kunth | pukamole | indigenous | 4 | rare |
| MALVACEAE (Mallow Family) | | | | |
| *Malvastrum coromandelianum* (L.) Garke | false mallow | non-native | 2 | rare |
| *Sida fallax* Walp. | 'ilima | indigenous | 1 | common |
| | | | 2 | common |
| | | | 3 | rare |
| MYRSINACEAE (Myrsine Family) | | | | |
| *Myrsine lessertiana* A.DC | kolea lau nui | endemic | 4 | rare |
| MYRTACEAE (Myrtle Family) | | | | |
| *Metrosideros polymorpha* Gaud. | 'ohi'a lehua | endemic | 2 | uncommon |
| | | | 3 | uncommon |
| | | | 4 | abundant |
| *Psidium guajava* L. | guava | non-native | 3 | rare |
| *Syzygium cumini* (L.) Skeels | Java plum | non-native | 2 | rare |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| OLEACEAE (Olive Family) | | | | |
| *Nestegis sandwicensis* (A. Gray) Degener, I.Degener & L.Johnson | olopua | endemic | 3 | rare |
| PAPAVERACEAE (Poppy Family) | | | | |
| *Argemone glauca* (Nutt. Ex Prain) Pope | puakala | endemic | 1 | rare |
| PLANTAGINACEAE (Plantain Family) | | | | |
| *Plantago lanceolata* L. | narrow leaved plantain | non-native | 1 | uncommon |
| | | | 2 | common |
| | | | 3 | uncommon |
| | | | 4 | uncommon |
| PLUMBAGINACEAE (Leadwort Family) | | | | |
| *Plumbago zeylanica* L. | 'ilie'e | indigenous | 1 | rare |
| POLYGALACEAE (Milkwort Family) | | | | |
| *Polygala paniculata* L. | ---------- | non-native | 2 | uncommon |
| | | | 3 | uncommon |
| | | | 4 | uncommon |
| PRIMULACEAE (Primrose Family) | | | | |
| *Anagallis arvensis* L. | scarlet pimpernel | non-native | 2 | rare |
| *Lysimachia hillebrandii* J.D. Hook. ex A. Gray | kolokolo kuahiwi | endemic | 4 | uncommon |
| PROTEACEAE (Protea Family) | | | | |
| *Grevillea robusta* (A. Cunn.) ex R.Br. | silk oak | non-native | 2 | uncommon |
| | | | 3 | rare |
| ROSACEAE (Rose Family) | | | | |
| *Osteomeles anthyllidifolia* (Sm.) Lindl. | 'ulei | indigenous | 2 | uncommon |
| | | | 3 | uncommon |
| | | | 4 | uncommon |

| SCIENTIFIC NAME | COMMON NAME | STATUS | AREA | SITE ABUNDANCE |
|---|---|---|---|---|
| RUBIACEAE (Coffee Family) | | | | |
| *Coprosma foliosa* A. Gray | pilo | endemic | 4 | rare |
| SANTALACEAE (Sandalwood Family) | | | | |
| *Santalum ellipticum* Gaud. | 'iliahi alo'e | endemic | 2 | rare |
| SAPINDACEAE (Soapberry Family) | | | | |
| *Dodonaea viscosa* Jacq. | 'a'ali'i | indigenous | 1 | rare |
| | | | 2 | common |
| | | | 4 | uncommon |
| SOLANACEAE (Nightshade Family) | | | | |
| *Solanum linnaeanum* Hepper & P.Jaeger | apple of Sodom | non-native | 1 | rare |
| *Solanum Lycopersicum* L. | cherry tomato | indigenous | 1 | rare |
| STERCULIACEAE (Cacao Family) | | | | |
| *Waltheria indica* L. | 'uhaloa | indigenous | 1 | common |
| | | | 2 | uncommon |
| THYMELAEACEAE ('Akia Family) | | | | |
| *Wilkstroemea oahuensis* (A.Gray) Rock | 'akia | endemic | 1 | rare |
| | | | 2 | uncommon |
| | | | 3 | uncommon |
| VERBENACEAE (Verbena Family) | | | | |
| *Lantana camara* L. | lantana | non-native | 1 | uncommon |
| | | | 2 | common |
| | | | 3 | uncommon |
| *Stachytarpheta jamaicensis* (L.) Vahl | Jamaica vervain | non-native | 1 | uncommon |
| | | | 2 | uncommon |

## DISCUSSION

There are a few environmental concerns that need to be addressed with respect to the development of improved access to the Kaheawa Pastures Wind Energy Project site. The road corridor passes through a number of different habitats, each with a variety of species and conditions. The area in general has experienced a dramatic loss of native plant communities and species over the last century and there is concern that further losses of species and habitats be avoided. The widening of the access road will impact vegetation on either side of the existing roadway and needs to be done sensitively. Collateral concerns are soil erosion and fire which could have serious impacts on native plant resources.

A total of 102 plant species were recorded within the 7.5 mile road corridor. Of these 28 were native species. It is recognized that other species both native and non-native are known to occur in the general area outside of this corridor (i.e. the nearby Manawainui Plant Sanctuary). None-the-less the species recorded are enough to accurately characterize the vegetation in the corridor and surrounding areas.

No Federally Endangered or Threatened plant species (USFWS, 1999) were identified during the course of this survey, nor were any plants proposed as candidate for such status or any other native species of concern identified. All native plant species recorded as rare within the project corridor are in fact more common in the context of Maui or the State in general. Four somewhat less than common native plant species were noted: ‘iliahi alo’e, orange-flowered naupaka, kolokolo kuahiwi and the grass *Trisetum inaequale*. A few individuals of each of these may be destroyed in the course of road improvement but the best populations noted during the course of the survey lie well outside the project corridor. Area 4 between 3400 ft. and 3600 ft. contains the best native plant habitat and three of the four species mentioned above.

No wetlands occur within or near to the project area. Nothing remotely approaching the three essential criteria that define a Federally recognized wetland, namely 1) hydrophytic vegetation, 2) hydric soils and 3) wetland hydrology occur within this dry project area.

With a sensitive approach and good road engineering practices the proposed project is not expected to have a significant negative impact on the botanical resources in this area. The following considerations and recommendations are offered as a means to mitigating potential unintended impacts.

## RECOMMENDATIONS

Area 4 at the highest point of the road contains the best native forest habitat and the most component species.  More than anywhere else along the 7.5 mile route, this 0.9 mile segment requires the most careful use of equipment.  This means creating the minimum effective road width here and keeping the equipment within this corridor during the construction process as much as possible.

The quality of the road  created will also 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 surface 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.  The best way to minimize fire here is to limit human access along the road corridor to only those with management or other legitimate functions.

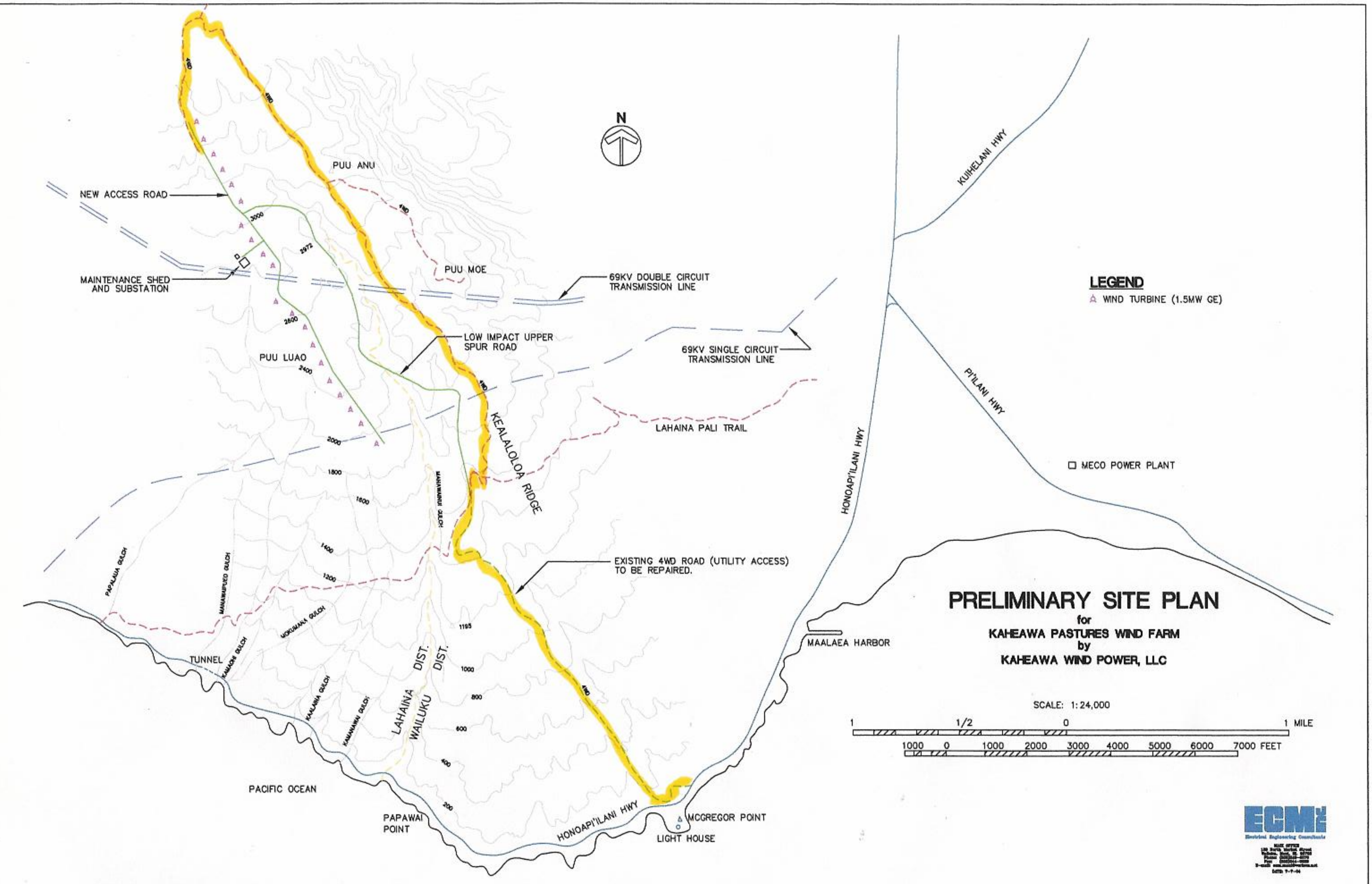


FIGURE 1 EXISTING PRIMARY ACCESS ROAD HIGHLIGHTED IN YELLOW 7.5 MILES

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# Appendix 6

## Botanical Resources Survey
## for the
## Kaheawa Pastures Wind Energy Project
## Access Road – Alternate Route Section
## September 2004

# BOTANICAL RESOURCES SURVEY

**for the**

**Kaheawa Pastures Wind Energy Project**
**Access Road – Alternate Route Section**

**UKUMEHAME, MAUI, HAWAII**

**by**

**ROBERT W. HOBDY**
**ENVIRONMENTAL CONSULTANT**
**Kokomo, Maui**
**September 2004**

**Prepared for:**
**Kaheawa Windpower, LLC**

# BOTANICAL RESOURCES SURVEY
# Kaheawa Pastures Wind Energy Project

## INTRODUCTION

During the course of evaluating the feasibility of utilizing the primary road corridor to access the proposed Kaheawa Pastures Wind Energy Project site, other alternate routes were considered that were thought might provide a more direct, environmentally friendly and cost-effective solution. One such alternate route, approximately 3 miles in length,
(see figure 1 on page 10) is the subject of this botanical survey.

## SITE DESCRIPTION

This route diverges from the existing road at approximately 1500 ft. elevation, traverses two gulches and connects with the Kaheawa Pastures Wind Energy Project site at 2900 ft. elevation. The ridgetops are broad and evenly sloping while the gulches are moderately steep sided. Soils are mostly reddish brown silty clay loams with highly weathered, crumbly rock in the deeper horizons (Foote et al, 1972). Rainfall ranges from 20 in.
to 50 in. per year along the length of this alternate route (Armstrong, 1983) with the higher amounts at the upper end.

## BIOLOGICAL HISTORY

The historical description prepared for the primary access route is sufficient to represent this alternate route as well, as they lie in close proximity to each other. The vegetation along the alternate route has been converted to a largely non-native grassland by over a century of cattle grazing and periodic fires.

## DESCRIPTION OF THE VEGETATION

The existing vegetation type along the entire 3 mile alternate route lies within Area 2 as described for the primary route. The dominant species is molasses grass (*Melinus minutiflora*) which has taken over on both the flat topped ridges and the gulch sites where it forms dense stands 2 to 4 feet deep. Molasses grass is a fire adapted species which becomes increasingly dominant with each fire event as less adapted species are destroyed and then cannot regenerate in competition with it.

Other plant species which are frequently encountered are ironwood (*Casuarina equisetifolia*), ‘ilima (*Sida fallax*), ‘a’ali’i (*Dodonaea viscosa*) and lantana (*Lantana camara*). Ten species of native plants were identified eight of which are common to abundant on Maui. Two of them, ‘iliahi alo’e (*Santalum ellipticum*) and the orange-flowered naupaka (*Scaevola gaudichaudii*), while not common are found in localized populations in dry shrubland habitats such as this. Both occur throught the State and neither is on the Endangered Species list.

## SURVEY OBJECTIVES

This report summarizes the findings of a botanical survey of the alternate access road corridor leading to the proposed Kaheawa Pastures Wind Energy Project which was conducted in September, 2004.
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 3 mile alternate route corridor was surveyed on foot. The corridor was covered to a width of 30 feet along straight and smooth areas, and to a width of approximately 100 feet on sharp turns and rough terrain to allow for route alterations. Areas most likely to harbor native or rare plants were more intensively examined. Notes were made on plant species and abundance as well as 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).

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 | SITE ABUNDANCE |
|---|---|---|---|
| **FERNS** | | | |
| DENNSTAEDTIACEAE (Bracken Family) | | | |
| *Pteridium aquilinum* (L.) Kuhn. var. decompositum (gaudich.) R.M. Tryon | kilau | endemic | uncommon |
| **MONOCOTS** | | | |
| POACEAE (Grass Family) | | | |
| *Melinus minutiflora* P. Beauv. | molasses grass | non-native | abundant |
| *Panicum maximum* Jacq. | Guinea grass | non-native | rare |
| *Pennisetum clandestinum* Chiov. | kikuyu grass | non-native | rare |
| *Rhynchelytrum repens* (Willd.) Hubb. | Natal redtop | non-native | uncommon |
| *Sporobolus africanus* (Poir.) Robyns & Tournay | rattail grass | non-native | uncommon |
| **DICOTS** | | | |
| ANACARDIACEAE (Mango Family) | | | |
| *Schinus terebinthifolius* Raddi | Christmas berry | non-native | rare |
| *Bidens micrantha* Gaud. | ko'oko'olau | endemic | uncommon |
| *Conyza bonariensis* (L.) Cronq. | hairy horseweed | non-native | uncommon |
| *Conyza canadensis* (L.) Cronq. var. pusilla (Nutt.) Cronq. | horseweed | non-native | rare |
| *Hypochoeris radicata* L. | gosmore | non-native | uncommon |
| *Senecio madagascariensis* Poir. | fireweed | non-native | uncommon |
| CASUARINACEAE (She-oak Family) | | | |
| *Casuarina equisetifolia* L. | ironwood | non-native | common |
| *Casuarina glauca* Siebold ex Spreng.. | longleaf ironwood | non-native | rare |
| EPACRIDACEAE (Epacris Family) | | | |
| *Styphelia tameiameiae* (Cham.& Schletend.) F.V.Muell. | pukiawe | indigenous | uncommon |

| **SCIENTIFIC NAME** | **COMMON NAME** | **STATUS** | **SITE ABUNDANCE** |
|---|---|---|---|
| FABACEAE (Pea Family) | | | |
| *Acacia farnesiana* (L.) Willd. | klu | non-native | uncommon |
| *Chamaecrista nictitans* (L.) Moench | partridge pea | non-native | uncommon |
| *Desmodium Sandwicense* E. Mey. | Spanish clover | non-native | rare |
| *Indigofera suffruticosa* Mill. | 'iniko | non-native | rare |
| GENTIANACEAE (Gentian Family) | | | |
| *Centaurium erythraea* Raf. | bitter herb | non-native | uncommon |
| GOODENIACEAE (Goodenia Family) | | | |
| *Scaevola gaudichaudii* Hook. & Arnott | orange naupaka | endemic | uncommon |
| MALVACEAE (Mallow Family) | | | |
| *Sida fallax* Walp. | 'ilima | indigenous | uncommon |
| MYRTACEAE (Myrtle Family) | | | |
| *Metrosideros polymorpha* Gaud. | 'ohi'a lehua | endemic | uncommon |
| *Psidium guajava* L. | guava | non-native | rare |
| PLANTAGINACEAE (Plantain Family) | | | |
| *Plantago lanceolata* L. | narrow leaved plantain | non-native | uncommon |
| POLYGALACEAE (Milkwort Family) | | | |
| *Polygala paniculata* L. | ---------- | non-native | uncommon |
| PROTEACEAE (Protea Family) | | | |
| *Grevillea robusta* (A. Cunn.) ex R.Br. | silk oak | non-native | uncommon |
| ROSACEAE (Rose Family) | | | |
| *Osteomeles anthyllidifolia* (Sm.) Lindl. | 'ulei | indigenous | uncommon |
| SANTALACEAE (Sandalwood Family) | | | |
| *Santalum ellipticum* Gaud. | 'iliahi alo'e | endemic | rare |

| SCIENTIFIC NAME | COMMON NAME | STATUS | SITE ABUNDANCE |
| --- | --- | --- | --- |
| SAPINDACEAE (Soapberry Family) | | | |
| *Dodonaea viscosa* Jacq. | 'a'ali'i | indigenous | common |
| STERCULIACEAE (Cacao Family) | | | |
| *Waltheria indica* L. | 'uhaloa | indigenous | uncommon |
| VERBENACEAE (Verbena Family) | | | |
| *Lantana camara* L. | lantana | non-native | uncommon |

## DISCUSSION

There are a few environmental concerns that need to be addressed with respect to the development of the 3 mile alternate access route to the Kaheawa Pastures Wind Energy Project site. The area in general has experienced a dramatic loss of native plant communities and species over the last century and there is concern that further losses of species and habitats be avoided. The construction of this alternate road will create significant road cuts, especially on steep gulch slopes and streambed crossings, and will need to be well engineered. Collateral concerns are soil erosion and fire, both of which could have serious impacts on native plant resources.

A total of 32 plant species were recorded within this 3 mile alternate route corridor. Of these 10 were native species. No Federally Endangered or Threatened plant species (USFWS, 1999) were identified nor was any plant candidate for such status observed.
All native plant species recorded as rare within the project corridor are in fact more common in the context of Maui or the State in general. Two native species, however, ‘iliahi alo’e and the orange flowered naupaka, although not formally protected, are worthy of special focus to make sure that any significant populations are minimally impacted. Most of the alternate route is densely covered with non-native weed species and thus presents little of botanical concern. The middle ridge between the two gulches including the sparsely vegetated unnamed pu’u at 2,324 ft. elevation, however, does contain a moderate array of native dryland shrubby species including the ‘iliahi alo’e, the orange flowered naupaka and a dwarf form of mamane (*Sophora chrysophylla*). The alternate route passes well below this hill and then crosses the ridge above it in a saddle through a grove of non-native ironwood trees. A few of each of the ‘iliahi alo’e and the orange flowered naupaka would be unavoidably destroyed in the course of road construction, but the best populations noted during the course of the survey lie well outside the project corridor.

No wetlands occur within or near to the project area. Nothing remotely approaching the three essential criteria that define a Federally recognized wetland, namely 1) hydrophytic vegetation, 2) hydric soils and 3) wetland hydrology occur within this dry project area.

With a sensitive approach and good road engineering practices the proposed project is not expected to have a significant negative impact on the botanical resources in this area. The following considerations and recommendations are offered as a means to mitigating potential unintended impacts.

## RECOMMENDATIONS

The pu'u and middle ridge between the two gulches contain the best native shrubland habitat and the most component species. More than anywhere else along the 3 mile route, this 0.2 mile segment requires the most careful use of equipment. This means creating the minimum effective road width here and keeping the equipment within this corridor during the construction process as much as possible.

The quality of the road created will also have a long term effect on surrounding habitat. Poorly engineered roads in this entire alternate route section will 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 surface 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. The best way to minimize fire here is to limit human access along the road corridor to only those with management or other legitimate functions.

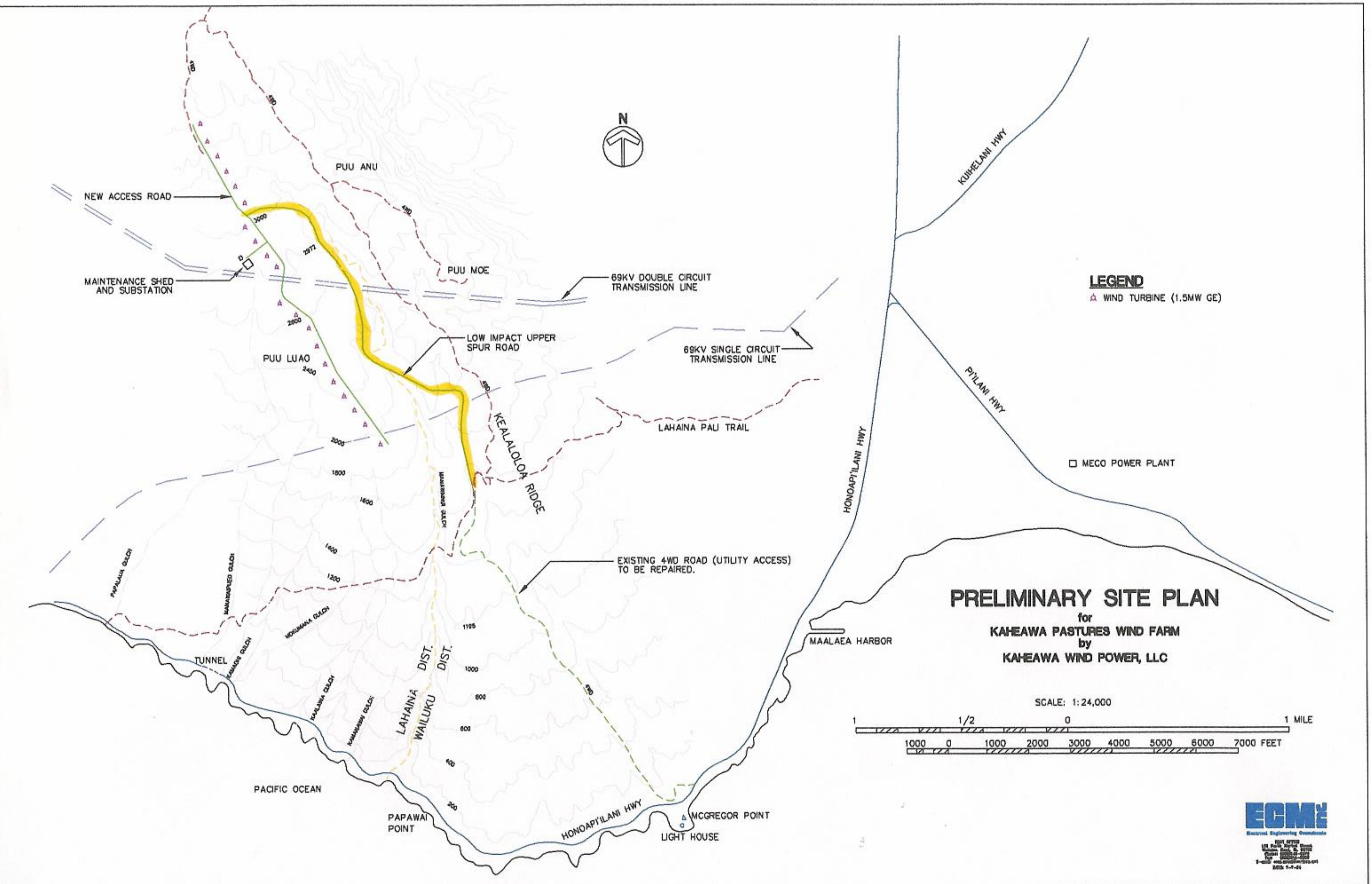


FIGURE 1 PROPOSED ALTERNATE ACCESS ROUTE HIGHLIGHTED IN YELLOW 3 MILES

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# Appendix 7

# Nene and Nest Survey Protocol

# Appendix 7

## Nene and Nest Survey Protocol

### INTRODUCTION

Surveys for Nene and Nene nests will be conducted by a qualified biologist, ornithologist or similarly experienced professional, prior to any clearing, grading or construction of the project roadway, turbines and accessory facilities. These surveys are required by the project's Conservation District Use Permit, and are also a component of avoidance and minimization in the project's Habitat Conservation Plan.

Conservation District Use Permit condition no. 24 reads "The applicant shall inspect, in coordination with the DLNR, Division of Forestry and Wildlife, turbine sites to insure that no bird nests are present in the immediate area of the proposed tower foundation and access road."

Additionally, subsequent letters received by DLNR-DOFAW and USFWS have indicated that these pre-construction surveys are required to assist in avoiding the incidental take of Nene (including nests, eggs, chicks, etc.).

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."

According to Maui DOFAW officials, Nene nesting season typically begins in October and ends in April. Therefore, construction activities from May 1st to September 1st would typically be the least likely to encounter Nene nesting in the project vicinity. However, Nene may still be present in the project area during the non-nesting season.

## FIELD METHODS

Survey Reliability

Surveys should be conducted in a timeframe as close as possible to construction activities in order for the survey to accurately represent the occurrence of birds in the project area. Even in the months of May through September, Nene may nest, so the reliability of a survey depends largely on it being performed immediately before construction activities.

Because these surveys will have a shorter term of validity during nesting season than during non-nesting season, the timing and protocol of each pre-construction survey will be confirmed with USFWS and DOFAW prior to its being conducted to ensure that the subsequent proposed construction activity can be safely undertaken.

Search Area

The survey area should cover any area where construction activity will occur, plus at least 100 meters (328 feet) on either side of these areas. 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. The size of the search grids (i.e., spacing and configuration of transects) will be dependent upon topography and vegetation in the area, subject to the surveyor's qualified opinion as to the survey's reliability.

Construction Monitoring

Kaheawa Wind Power will provide a biologist who will inspect areas of proposed active construction for evidence of nests, adult birds or young immediately prior (same day) to work proceeding. During the nesting period, once an area is searched and determined to be "cleared" (of nene nests and or family groups with unflighted goslings), Kaheawa Wind Power may, where practicable, place a temporary orange construction fence or similar barrier at the edge of the surveyed area to inhibit ingress of nene, and to designate the limits of the area that has been "cleared". This temporary fence may be moved and re-used as surveying, "clearing" and construction progresses from site to site.

If nests or birds are found, the discovery protocol provided in the following section will be followed.

## DISCOVERY PROTOCOL

### Discovery During Survey

Should any Nene or nests be found during a survey, DOFAW and USFWS will be contacted and will advise the on-site biologist and Kaheawa Wind Power 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-basis protocol, as there are many factors that DOFAW and USFWS will consider if birds and/or nests are discovered, including topography and terrain; vegetation and recent weather; proximity to proposed construction activity; potential viability of eggs; and age, health and behavior of chicks and adults.

If a nest is found, 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; fencing or other protection will likely be required to be installed between any other construction areas and the nest; future monitoring of the nest may be required to ensure that the nest, chicks and adults are not disturbed by project activities elsewhere; or the nest may be relocated by agency officials. DOFAW and USFWS will likewise advise Kaheawa Wind Power on appropriate measures to avoid any inadvertent harm or harassment of non-nesting birds, family groups, or other individuals or groups of birds that are discovered off of the nest during the search.

### Discovery During Construction

Even with timely surveys, it is possible that construction activities will encounter birds or nests that were not discovered during a survey. If a nest or evidence of any Nene 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 will be followed: construction may be allowed to resume in other areas beyond a certain perimeter of the nest; fencing will likely be required; monitoring may be required; or the nest may be relocated by agency officials.

### Education

DOFAW has indicated that it would be beneficial to have a pre-construction educational session with all construction workers, inspectors and managers to provide information about Nene, nesting habits, nesting and foraging habitats, and general behavior. The understanding and cooperation of all site personnel will be critical to successfully fulfill the conditions of the project’s permits and to accomplish the goals of the Habitat Conservation Plan, as well as to avoid violations and penalties pursuant to the Endangered Species Act.

**RESULTS**

Survey results will be immediately provided to DOFAW and USFWS, and Kaheawa Wind Power requests expeditious review to ensure that any survey remains as timely and valid as possible.

The pre-construction surveyor and Kaheawa Wind Power's environmental inspector (biologist) will work together to provide DOFAW and USFWS with a report of all discovery-related activity, including the protocol established by DOFAW and USFWS, its implementation; its conclusion; and any other pertinent information.

# Appendix 8

# Wildlife Education
# and
# Observation Program

## Appendix 8

## 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:<br>- attend wildlife education briefings conducted in cooperation with DOFAW and USFWS;<br>- monitor wildlife activity while on the site;<br>- identify key species when possible (Hawaiian Petrel, Newell's Shearwater, Nene and Hawaiian Hoary Bat);<br>- document specific observations with the filing of a Wildlife Observation Form;<br>- identify, report and handle any downed wildlife in accordance with the Downed Wildlife Protocol, including filing a Downed Wildlife Monitoring Form – Incidence Report;<br>- 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

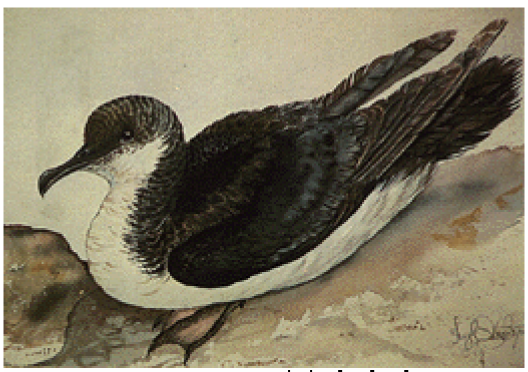
HVNP/W. Banko

*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.<br><br>On Maui, this bat is believed to primarily occur in moist, forested areas. In spite of this preference, though, it has been seen in Lahaina and near Mopua, both of which are dry, and on the dry, treeless crest of Haleakala. During the day, this bat roosts in a variety of tree species and occasionally in rock crevices and buildings; it even has been recorded hanging from wire fences on Kaua`i and has been seen leaving and entering caves and lava tubes on Hawai`i. |


*source: http://pacificislands.fws.gov/wesa/hrybatindex.html*

*source: http://www.honoluluzoo.org/hawaiian_bat.htm*

*SAMPLE*

**Wildlife Education and Observation Program**
Kaheawa Pastures
**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 9

# Wildlife Casualty Monitoring Protocol

## Appendix 9

## Wildlife Casualty Monitoring Protocol

### INTRODUCTION

The primary objective of the monitoring protocol is to document injuries and fatalities of the four state- and federally-listed species during project operation, as a basis for determining the annual take attributable to the project. Monitoring will also document injuries and fatalities to other, non-listed species (including MBTA-listed species) to provide data on overall project impacts. While the primary risk to wildlife is considered to be in-flight collisions with project structures, all observed injuries and fatalities (e.g., vehicle strikes, predation, etc.) will be documented regardless of cause.

Important Considerations

Three of the subject species are relatively large birds with adult wing spans in excess of 30 inches, including Nene, Hawaiian Petrel, and Newell's Shearwater. Downed individuals of these species are expected to be relatively detectable (e.g., compared to smaller bird species and most bats). In contrast, the small size and cryptic coloration of the Hawaiian Hoary Bat will make downed individuals much more difficult to detect using visual searches, especially if the level of take is only on the order of one individual per year. An additional factor to be considered will be the type of vegetation cover and terrain that will exist within the search area following construction. Low, grassy cover and level topography are easiest for searching, and are expected to dominate in many areas as they do now. Vegetation management, for example by periodic mowing, may be useful to maintain the area around each turbine in a searchable condition. However, short-mown grass that may attract Nene to graze will be avoided. Finally, search methods evolve and new approaches are periodically introduced, both of which may improve searcher efficiency or result in time savings. A recent example has been the use of trained dogs to assist in searches (Erickson et al. 2004a).

Considering these factors, the protocol outlined below is designed to allow an adaptive approach to monitoring, such that methods and timing of efforts can be modified over the course of the project to increase effectiveness and efficiency of effort. The protocol includes (1) an initial round of pilot studies to assess site-specific carcass removal rates and test the use of trained dogs prior to operation, (2) a protocol for early, intensive monitoring of fatalities, and (3) provisions for developing a long-term monitoring protocol based on the findings of the initial studies.

### PRE-OPERATION PILOT STUDIES

Pre-operation pilot studies will include the following:

Carcass Removal Trials

The objective of the carcass removal trials is to estimate the percentage of avian/bat fatalities that are removed from study plots by scavengers over standardized time periods. This will provide a basis for determining the search frequency needed to ensure that birds are not scavenged before they can be detected by the monitoring program (see Barrios and Rodriguez 2004).

Use of carcasses will follow all appropriate animal use protocols. Carcasses used in the trial will include representatives of the four listed species, if available (DOFAW biologists may be able to provide). Surrogates may include locally-obtained road kill, downed seabirds, or species not protected by MBTA such as pheasant (*Phasianus colchicus*), domestic fowl, Common Myna (*Acridotheres tristis*), and Java sparrow (*Padda oryzivora*). Use of species protected under ESA or MBTA will require permission from USFWS.

To conduct a trial, several carcasses will be distributed along the length of the project area, parallel to the turbine row, to represent a range of elevations and habitat conditions. All birds will be checked on days 1, 2, 3, 4, 5, 7, 10, and 14, or until all evidence of the bird is absent. On day 14, all birds, feathers or parts will be retrieved and properly discarded. At least three trials will be conducted prior to operation.

Trained Dog Trials

The use of trained dogs has recently been shown to increase the efficiency and effectiveness of searches to locate fatalities (especially bats) that occur at wind power installations by as much as 200 to 400 percent, and even more in difficult cover types (Erickson et al. 2004a). This not only improves the quality of the data but also has the potential to greatly reduce labor costs. Although local trainers with capable dogs are known to exist on Maui, they have never been called upon to conduct the kind of systematic searches that will be required for the project. Kaheawa Wind Power will therefore select several prospective trainers and their dogs to participate in on-site practice trials to evaluate and improve their ability to conduct systematic surveys. Trainers who successfully demonstrate the ability to perform the required work will be considered for use during operational monitoring.

## INITIAL INTENSIVE MONITORING

The initial period of fatality monitoring will entail frequent, systematic searches of the area beneath each turbine, by either trained technicians, or by trainers with trained dogs. Intensive sampling will be conducted during the first two years of operation, and will include the peak fledging periods of the subject species (seabirds in October-November and Nene in May-June). Depending upon the results, and subject to the review and approval of USFWS and DOFAW, intensive monitoring may be extended beyond this initial period, modified and extended, or replaced with a less intensive monitoring protocol that has been developed based on the results of intensive monitoring.

The field methods proposed below are based primarily on the recommendations of biologists at Northwest Wildlife Consultants, Inc. (NWC), based in Pendleton, OR (R. Gritzki and K. Kronner, pers. comm..). NWC has provided, and continues to provide, fatality assessment services at several projects in the northwestern United States (e.g., Erickson *et al.* 2004b, 2003 and 2000, Johnson *et al*. 2000a and 2000b). Other recent studies of bird and bat fatalities at wind power projects in the U.S. and Europe were also reviewed with regard to methods and search techniques (e.g., Osborn et al. 2000, Barrios and Rodriguez 2004, de Lucas et al. 2004, and Krewitt and Nitchs 2003).

Plot Size

Studies by Osborn et al. (2000) showed that smaller birds, as well as birds dropped from higher elevations, generally landed farther from the base of the turbine on windy days. Thus the potential for wind drift, turbine size, and size of the birds being studied are all important considerations in determining the size of the search area. Based on their trials, they arrived at a search area that extended a minimum of 50m outward from the base of the KVS-33 turbines that were the subject of their study, which have a total structural height (support tower plus vertical rotor blade) of approximately 52m.

In their experience with numerous projects, NWC biologists have come to recommend a plot size that extends outward from the base of the turbine a distance equal to the turbine height. Thus for the turbines to be constructed at Kaheawa Pastures, which have a structural height of approximately 90m, they have recommended square plots of 180m on a side, centered on each turbine. This plot size is considerably larger than what has been used in past studies (e.g., Erickson *et al.* 2004b, 2003 and 2000, Johnson *et al*. 2000a and 2000b), and is the result of larger turbine sizes and the accumulated experience of researchers over time.

In addition to the standard plots, the initial searches will include a search area that extends 20m farther on the prevailing downwind side of each plot to assess the effects of wind drift. The results of searches in these areas will be used to determine whether to locate plots off-center of the turbines in the future. Search areas are shown on the accompanying site plan.

Search Frequency

Searches will occur at regular intervals to be determined based on the results of the pilot carcass removal study. At this time it is anticipated that systematic searches will be conducted at least twice per week during the fledging periods for the two seabird species (assume eight weeks during October–December) and Nene (assume eight weeks during May-June), and at least weekly during the remainder of the year. In addition to the regular searches, additional searches to be conducted on the days following conditions that are expected to increase the likelihood of collisions, such as stormy, overcast, foggy and moonless nights.

Standardized Searches

For searches conducted by humans (without dogs), square plots will be searched by walking parallel transects at regular intervals. Initially, transects will be set at 6-8 meters apart in the area to be searched. A searcher will walk at a rate of approximately 40-60 meters a minute along each transect, searching on both sides out to 3 meters for casualties. Searcher speed may be adjusted by habitat (vegetation) and degree of slope after practice and with site familiarity. Depending upon terrain, and whether casualties are found, it should take an average of 60-90 minutes to search each plot and then travel to the next. All casualties will be documented on standardized field forms, located with GPS, photographed and, if a listed species, collected and reported, all in accordance with the Downed Wildlife Protocol. A modified search protocol will be developed for trainers and dogs if they prove effective in the pre-operational trials.

Searcher Efficiency Trials (SEEF)

SEEF trials will be conducted in the same area as the searches to estimate the percentage of avian/bat fatalities that are found by searchers. Searcher efficiency will be estimated by habitat type, (grassland, shrubs, etc., as applicable) and species. Estimates of searcher efficiency will be used to adjust for detection bias.

SEEF trials will be conducted at least quarterly during the initial intensive monitoring period. Additional trials will be conducted to account for changes in personnel, methods, or site conditions (*e.g.*, vegetation cover). Multiple trials will be conducted to increase statistical power and reduce variance, in consultation with and subject to the approval of DLNR and USFWS.

Personnel conducting carcass searches will not be told when or where trials will be conducted. The number of carcasses, their distribution and species will be determined on an ongoing, adaptive basis in consultation with, and subject to the approval of, DLNR and USFWS. All carcasses will be placed at random locations prior to the carcass search on the same day, and each trial carcass will be discreetly marked so it can be identified when found. If carcasses of the three subject species are not available, carcasses of surrogate species will be used as previously described.

Carcass Removal Trials

Two carcass removal trials will be conducted during the survey period, independently of the SEEF trials. The objective is to estimate the percentage of avian/bat fatalities that disappear from the study plots from scavengers or other means (mowing equipment, etc.). Estimates of carcass removal will be used to adjust the number of carcasses found, correcting for removal bias.

For each trial, eight carcasses, including two of each of the four listed species (as available – small birds such as house sparrows may be used in place of bat carcasses) will be used for carcass removal trials. Birds will be placed out near carcass search plots but not in plots to avoid contamination of plots from blowing feathers, etc. All birds will be checked on days 1, 2, 3, 4, 5, 7, 10, and 14, or until all evidence of the bird is absent. On day 14, all birds, feathers or parts will be retrieved and properly discarded.

## LONG-TERM MONITORING

The goal of long-term monitoring is to effectively assess take throughout the life of the project. Methods to achieve this goal will be developed in concurrence with DLNR and USFWS based on the results of and experience gained during the initial intensive monitoring surveys. Depending upon the outcome of the initial intensive surveys, it may be possible to develop a less labor-intensive protocol for the long-term monitoring of bird and bat fatalities at the site. Long-term methods may include sampling a subset of turbines, searching smaller plots or subplots, or simply conducting less frequent searches if it is determined that scavenging rates are low. Methods will continue to be adapted in consultation with, and subject to the approval of, USFWS and DLNR.

## RESULTS

The wildlife casualty data will be considered together with the results of the additional radar, thermal imaging/night-vision and acoustic bat surveys, to determine the number of individuals taken by the project for each of the four listed species. Casualties that can be demonstrated to be unrelated to the wind project operations, through direct observations or necropsy (for example, individuals lost to predation), will be excluded from the take. The resulting take determination will provide a basis for establishing the appropriate level of monitoring and mitigation for future years of operation, as approved by USFWS and DLNR.

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## Downed Wildlife Protocol

| | |
|---|---|
| **Purpose:** | To locate and care for any wildlife that may have been downed on the Kaheawa Pastures site, whether located opportunistically or from regular monitoring. |
| **Applicability:** | This protocol applies to all employees of Kaheawa Wind Power and its affiliates, and extends to all consultants or other personnel who work on the site. |
| **Species of Concern:** | Species of particular interest are the Hawaiian Petrel, Newell's Shearwater, Nene and Hawaiian Hoary Bat. |
| **Overall Approach:** | Downed wildlife may be located during the course of regular monitoring or opportunistically during routine site work.<br><br>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 downed wildlife when working at individual turbine sites, when traveling along the site by vehicle, and when traveling the site on foot. Should any downed wildlife be found, the responsible party shall contact Maui DOFAW (John Medeiros) at 873-3510, and will likely be instructed to transport the downed individual in an appropriate container (e.g., pet carrier) either to a qualified veterinarian or to the DOFAW facility 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 – Incidence Report. |
| **Facility Information:** | John Medeiros, Maui DOFAW<br>DLNR Kahului Baseyard<br>685 Old Haleakala Highway<br>Kahului, Hawai`i 96732<br>phone: 873-3510 |
| **Contact Information:** | Kaheawa Wind Power, LLC<br>1043 Makawao Avenue, Suite 208<br>Makawao, Hawai`i 96768<br>contact: Mike Gresham at 298-1055 |

*SAMPLE*

**Downed Wildlife Monitoring Form**
**Standard Report**

| | | | | |
|---|---|---|---|---|
| Monitor’s Name: | | | Date: | |
| Temperature: | Wind Direction: | Wind Speed: | Precipitation: | Cloud Cover: |

| | | |
|---|---|---|
| Turbine 1 (mauka end) | Time Start: | Time End: |
| Turbine 2 | Time Start: | Time End: |
| Turbine 3 | Time Start: | Time End: |
| Turbine 4 | Time Start: | Time End: |
| Turbine 5 | Time Start: | Time End: |
| Turbine 6 | Time Start: | Time End: |
| Turbine 7 | Time Start: | Time End: |
| Turbine 8 | Time Start: | Time End: |
| Turbine 9 | Time Start: | Time End: |
| Turbine 10 | Time Start: | Time End: |
| Turbine 11 | Time Start: | Time End: |
| Turbine 12 | Time Start: | Time End: |
| Turbine 13 | Time Start: | Time End: |
| Turbine 14 | Time Start: | Time End: |
| Turbine 15 | Time Start: | Time End: |
| Turbine 16 | Time Start: | Time End: |
| Turbine 17 | Time Start: | Time End: |
| Turbine 18 | Time Start: | Time End: |
| Turbine 19 | Time Start: | Time End: |
| Turbine 20 (makai end) | Time Start: | Time End: |

| | |
|---|---|
| Other facilities or areas opportunistically surveyed: | Time Start: |
| | Time End: |
| Other facilities or areas opportunistically surveyed: | Time Start: |
| | Time End: |

| | |
|---|---|
| Species Detected: | Species Detected: |
| Comments: | Comments: |
| Species Detected: | Species Detected: |
| Comments: | Comments: |

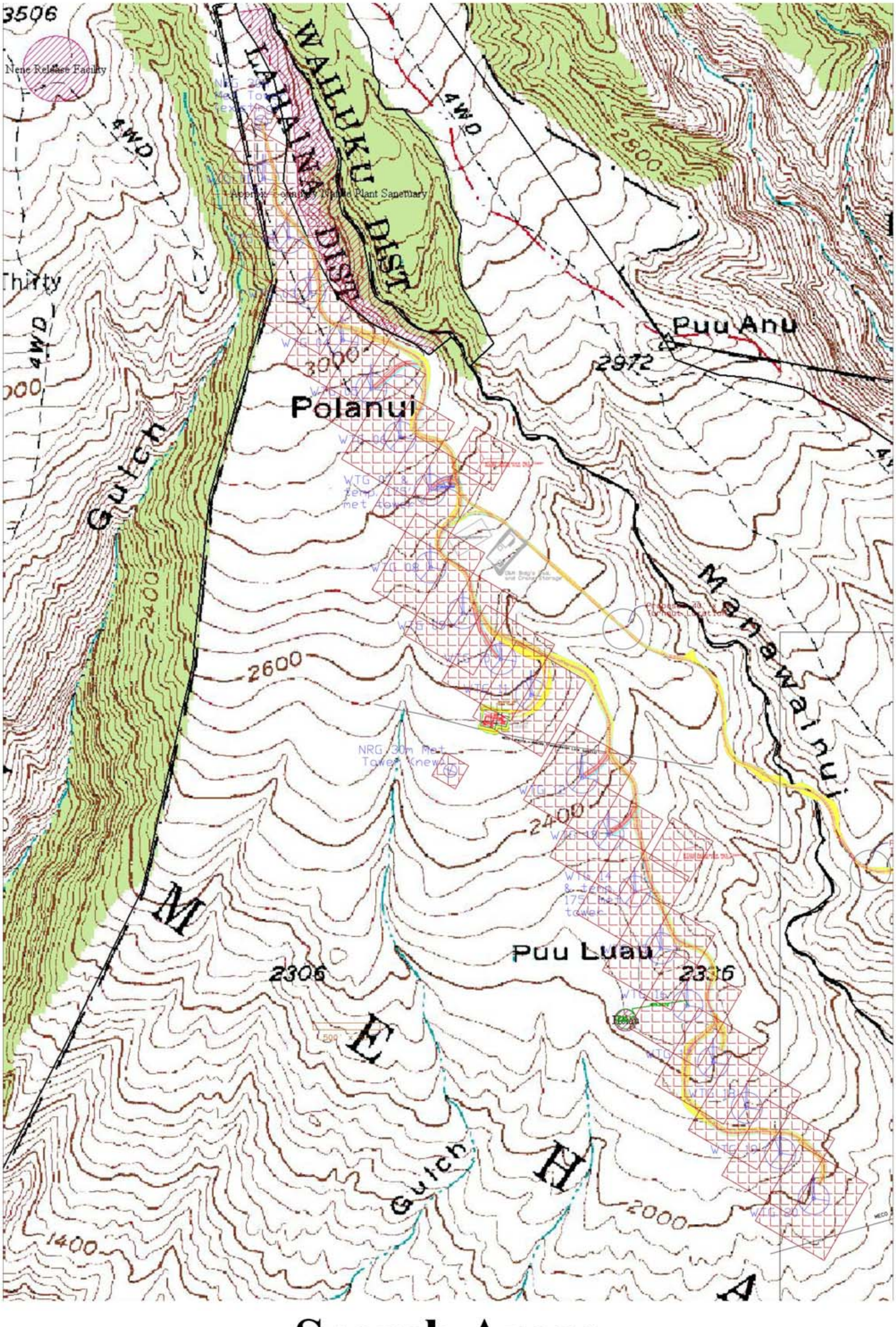
*SAMPLE*

**Downed Wildlife Monitoring Form**
**Incidence Report**

| Turbine No.: | Species: | |
|---|---|---|
| Bearing from turbine: | Distance from turbine: | Location marked on map: |
| Condition of subject and description of injury: | | |
| Probable cause of injury and supportive evidence: | | |
| Evidence of scavenging: | | |
| Action taken: | | |

| Turbine No.: | Species: | |
|---|---|---|
| Bearing from turbine: | Distance from turbine: | Location marked on map: |
| Condition of subject and description of injury: | | |
| Probable cause of injury and supportive evidence: | | |
| Evidence of scavenging: | | |
| Action taken: | | |

| Turbine No.: | Species: | |
|---|---|---|
| Bearing from turbine: | Distance from turbine: | Location marked on map: |
| Condition of subject and description of injury: | | |
| Probable cause of injury and supportive evidence: | | |
| Evidence of scavenging: | | |
| Action taken: | | |




# Search Areas

# Appendix 10

# Mitigation and Adaptive Management Matrix

## Appendix 10

## Mitigation and Adaptive Management Matrix

| SPECIES AND EXPECTED TAKE | MITIGATION AND IMPLEMENTATION | WHAT IF ACTUAL TAKE IS ZERO? | WHAT IF TAKE IS LOWER? | WHAT IF TAKE IS HIGHER? | WHAT IF TAKE IS NOTABLY HIGHER? |
|---|---|---|---|---|---|
| **General** | On-site searches for wildlife casualties at least twice weekly during nesting and fledging seasons, and at least once weekly during the rest of the year; intensity of surveys may be modified based on scavenging rates and effectiveness of trained dogs or other alternative methods. | Site surveys to be conducted regardless of take. | Site surveys to be conducted regardless of take. | Site surveys to be conducted regardless of take. | Site surveys to be conducted regardless of take, intensive surveys may be extended into subsequent years as warranted. |
| | Wildlife Education and Observation Program (WEOP); construction through life of project. | No change proposed. | No change proposed. | No change proposed. | No change proposed. |
| | Downed Wildlife Protocol; construction through life of project. | Not applicable. | No change proposed. | No change proposed. | No change proposed. |

| SPECIES AND EXPECTED TAKE | MITIGATION AND IMPLEMENTATION | WHAT IF ACTUAL TAKE IS ZERO? | WHAT IF TAKE IS LOWER? | WHAT IF TAKE IS HIGHER? | WHAT IF TAKE IS NOTABLY HIGHER? |
|---|---|---|---|---|---|
| **Petrels and Shearwaters:** Direct take of 1 individual and indirect take of 0.5 individual. | Radar and night-vision/ thermal on-site surveys during breeding and fledging seasons; to be conducted during the first year of project operation. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. |
| | Surveys of colonies in mountains of West Maui. | Surveys will be conducted in years one and two regardless of take. | Surveys will be conducted in years one and two regardless of take. | Surveys will be conducted in years one and two regardless of take. | Surveys will be conducted in years one, two and three/ |
| | Protection and/or management of West Maui colonies as they are identified and as need for active management is determined. | Protection and/or management of West Maui colonies, as available, will occur during years one and two regardless of take. | Protection and/or management of West Maui colonies, as available, will occur during years one and two regardless of take. | Protection and/or management of West Maui colonies, as available, will continue beyond year 2 as necessary to maintain mitigation greater than adjusted take. | Protection and/or management of West Maui colonies, as available, will continue beyond year 2 as necessary to maintain mitigation greater than adjusted take. |
| | Surveys of other colonies on East Maui, Moloka`i, Lana`i, and the Big Island; habitat protection of identified colony(ies). | No need; will not be implemented. | No need; will not be implemented. | Will be implemented in following years if West Maui efforts not adequate. | Will be implemented in following years if West Maui efforts not adequate. |
| | Focused on-site studies, (e.g. radar & night vision) to understand causes behind high take levels and develop effective mitigation. | Not applicable. | Not applicable. | Not applicable. | Will be implemented; use contingency fund as needed for further mitigation. |

| SPECIES AND EXPECTED TAKE | MITIGATION AND IMPLEMENTATION | WHAT IF ACTUAL TAKE IS ZERO? | WHAT IF TAKE IS LOWER? | WHAT IF TAKE IS HIGHER? | WHAT IF TAKE IS NOTABLY HIGHER? |
|---|---|---|---|---|---|
| **Nene:** Direct take of 2 individuals and indirect take of 1 individual. | Up-front contribution of $100,000 to Nene propagation program (for new release pen, truck, one-year labor for maintenance and predator control, one-year helicopter release, and 10 chicks) and funding minimum of five years of operations/maintenance. | $100,000 up-front contribution and $41,000 per year for years 2-5 to be given regardless of take. | $100,000 up-front contribution and $41,000 per yearr for years 2-5 to be given regardless of take. | 50 chicks will be “credited” over the first 5 years, with additional contributions for purchase of chicks, operations and maintenance in future years as needed to stay ahead of adjusted take. | First year’s model will be replicated for a new release pen, truck, labor, chicks, etc., in addition to continued support of first year’s pen, labor, chicks, etc. |
| | Site surveys to be conducted before, during and after construction. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. |
| | Focused on-site studies to understand causes behind high take levels and develop effective mitigation measures. | Not applicable. | Not applicable. | Not applicable. | Will be implemented; use contingency fund as needed for further mitigation. |

| SPECIES AND EXPECTED TAKE | MITIGATION AND IMPLEMENTATION | WHAT IF ACTUAL TAKE IS ZERO? | WHAT IF TAKE IS LOWER? | WHAT IF TAKE IS HIGHER? | WHAT IF TAKE IS NOTABLY HIGHER? |
|---|---|---|---|---|---|
| **Hawaiian Hoary Bat:** No more than 1 individual per year. | Thermal imaging/night vision and acoustic bat detector site surveys; to be conducted for two consecutive nights each month during the first year of operation. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. | First-year site surveys to be conducted regardless of take. |
| | Observations in conjunction with first year seabird and Nene surveys/observations. | First-year surveys/ observations to be conducted regardless of take. | First-year surveys/ observations to be conducted regardless of take. | First-year surveys/ observations to be conducted regardless of take. | First-year surveys/ observations to be conducted regardless of take. |
| | $1,000 per take, via annual contribution to Hawai`i Bat Research Cooperative. | $20,000 up-front contribution to HBRC regardless of take. | $20,000 up-front contribution to HBRC regardless of take. | $20,000 up-front contribution plus $1,000 per actual take. | $20,000 up-front contribution plus $1,000 per actual take. |
| | Focused on-site studies to understand causes behind high take levels and develop effective mitigation measures; additional mitigation measures (i.e., habitat protection) based on HBRC research. | Not applicable. | Not applicable. | Not applicable. | Will be implemented; use contingency fund as needed for further mitigation. |

# Appendix 11

# Wildlife Monitoring
# and
# Mitigation Budget

## Appendix 11
## Wildlife Monitoring and Mitigation Budget

**Baseline Scenario**

| **Baseline Scenario** - assumes actual take is as expected | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Subsequent Years (15)** | **Lifetime Total** |
|---|---|---|---|---|---|---|---|
| **General Measures** | | | | | | | |
| Annual vegetation management - mowing around turbines to facilitate searches | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 7,500.00 | $ 10,000.00 |
| Wildlife Education and Observation Program (WEOP) and Downed Wildlife Protocol - initial (year 1) and periodic (years 6, 11 and 16) training, annual reporting efforts | $ 3,000.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 15,000.00 | $ 20,000.00 |
| General Subtotal | $ 3,500.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 22,500.00 | $ 30,000.00 |
| **Nene: Potential take of 3 per year** | | | | | | | |
| Pre-construction surveys - assume 2 surveys by staff biologist, field assistant and/or consultant | $ 8,000.00 | | | | | | $ 8,000.00 |
| On-site full-time/on-call environmental inspector during construction, also covering erosion/sedimentation control (biologist/specialist) - 6 mos at $25K. | $ 25,000.00 | | | | | | $ 25,000.00 |
| Regular on-site observations of nene response to turbines - staff biologist/intern | $ 10,000.00 | | | | | | $ 10,000.00 |
| Construction of new release pen (DOFAW) | $ 50,000.00 | | | | | | $ 50,000.00 |
| New DOFAW truck | $ 9,000.00 | | | | | | $ 9,000.00 |
| Labor for maintenance and predator control plus $1000 helicopter | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 240,000.00 | $ 320,000.00 |
| Cost of propagating 10 chicks/yr yrs 1-5, 4 chicks every 2 years thereafter | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 80,000.00 | $ 205,000.00 |
| Contingency fund (see text) | $ 264,000.00 | $ 6,600.00 | $ 6,765.00 | $ 6,934.13 | $ 7,107.48 | $ 141,187.40 | $ 432,594.00 |
| Nene Subtotal | $ 407,000.00 | $ 47,600.00 | $ 47,765.00 | $ 47,934.13 | $ 48,107.48 | $ 461,187.40 | $ 1,059,594.00 |

| **Baseline Scenario, continued** - assumes actual take is as expected | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Subsequent Years (15)** | **Lifetime Total** |
|---|---|---|---|---|---|---|---|
| **Seabirds: Potential take of 1.5 per year of each species** | | | | | | | |
| Vehicle, radar, night-vision and related equipment for surveys, plus training | $ 50,000.00 | | | | | | $ 50,000.00 |
| Conduct on-site radar and night-vision/thermal surveys to document seabird interaction and response to turbines (2 surveys, June and October fledging seasons, by staff biologist and intern) | $ 16,000.00 | | | | | | $ 16,000.00 |
| Conduct seraches to identify West Maui colonies in need of protection and implement protection measures - assume colonies found in first two years by staff biologist and intern | $ 60,000.00 | $ 60,000.00 | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 390,000.00 |
| Contingency fund (see text) | $ 100,000.00 | $ 2,500.00 | $ 2,562.50 | $ 2,626.56 | $ 2,692.23 | $ 53,480.35 | $ 163,861.64 |
| Seabird Subtotal | $ 226,000.00 | $ 62,500.00 | $ 17,562.50 | $ 17,626.56 | $ 17,692.23 | $ 278,480.35 | $ 619,861.64 |
| **Hoary Bat: Potential take of 1 per year** | | | | | | | |
| Conduct monthly 2-night surveys - staff biologist/intern | $ 10,000.00 | | | | | | $ 10,000.00 |
| Up-front 20-year donation to Bat Research Cooperative | $ 20,000.00 | | | | | | $ 20,000.00 |
| Contingency fund (see text) | $ 20,000.00 | $ 500.00 | $ 512.50 | $ 525.31 | $ 538.45 | $ 10,696.14 | $ 32,772.40 |
| Bat Subtotal | $ 50,000.00 | $ 500.00 | $ 512.50 | $ 525.31 | $ 538.45 | $ 10,696.14 | $ 62,772.40 |
| **Fatality Monitoring** | | | | | | | |
| Initial carcass scavenging assessment - staff biologist and intern | $ 5,000.00 | | | | | | $ 5,000.00 |
| Intensive searches of all turbines at initial high frequency - staff biologist/intern and outside canine trainers/handlers. Assume 2 years only | $ 60,000.00 | $ 60,000.00 | | | | | $ 120,000.00 |
| Lower intensity searches for life of project and annual scavenging calibration | | | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 270,000.00 |
| Fatality Monitoring Subtotal | $ 65,000.00 | $ 60,000.00 | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 395,000.00 |
| **Annual Subtotals** | **$ 751,500.00** | **$ 171,600.00** | **$ 81,840.00** | **$ 82,086.00** | **$ 82,338.15** | **$ 997,863.89** | **$ 2,167,228.04** |

**Lower Take Scenario**

| **Lower Take Scenario** - assumes actual take is lower than expected | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Subsequent Years (15) | Lifetime Total |
|---|---|---|---|---|---|---|---|
| **General Measures** | | | | | | | |
| Annual vegetation management - mowing around turbines to facilitate searches | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 7,500.00 | $ 10,000.00 |
| Wildlife Education and Observation Program (WEOP) and Downed Wildlife Protocol - initial (year 1) and periodic (years 6, 11 and 16) training, annual reporting efforts. | $ 3,000.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 15,000.00 | $ 20,000.00 |
| General Subtotal | $ 3,500.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 22,500.00 | $ 30,000.00 |
| **Nene: Potential take of near zero per year on average** | | | | | | | |
| Pre-construction surveys - assume 2 surveys, staff biologist, field assistant and/or consultant | $ 8,000.00 | | | | | | $ 8,000.00 |
| On-site full-time/on-call environmental inspector during construction, also covering erosion/sedimentation control (biologist/specialist) - 6 mos at $25K | $ 25,000.00 | | | | | | $ 25,000.00 |
| Regular on-site observations of nene response to turbines - staff biologist/intern | $ 10,000.00 | | | | | | $ 10,000.00 |
| Construction of new release pen (DOFAW) | $ 50,000.00 | | | | | | $ 50,000.00 |
| New DOFAW truck | $ 9,000.00 | | | | | | $ 9,000.00 |
| Labor for maintenance and predator control plus $1000 helicopter release | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ - | $ 80,000.00 |
| Cost of propagating 10 chicks/yr in yrs 1-5, none thereafter | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ - | $ 125,000.00 |
| Contingency fund (available but not spent under this scenario) | $ 264,000.00 | $ 6,600.00 | $ 6,765.00 | $ 6,934.13 | $ 7,107.48 | $ 141,187.40 | $ 432,594.00 |
| Nene Subtotal | $ 143,000.00 | $ 41,000.00 | $ 41,000.00 | $ 41,000.00 | $ 41,000.00 | $ - | $ 307,000.00 |

| **Lower Take Scenario, continued** - assumes actual take is lower than expected | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Subsequent Years (15) | Lifetime Total |
|---|---|---|---|---|---|---|---|
| **Seabirds: Potential take of near zero per year of each species** | | | | | | | |
| Vehicle, radar, night-vision and related equipment for surveys, plus training | $ 50,000.00 | | | | | | |
| Conduct on-site radar and night-vision/thermal surveys to document seabird interaction and response to turbines (2 surveys, June and October fledging seasons, by staff biologist and intern) | $ 16,000.00 | | | | | | $ 16,000.00 |
| Conduct seraches to identify West Maui colonies in need of protection and implement protection measures - assume colonies found in first two years by staff biologist and intern | $ 60,000.00 | $ 60,000.00 | $ 15,000.00 | | | $ - | $ 135,000.00 |
| Contingency fund (available but not spent under this scenario) | $ 100,000.00 | $ 2,500.00 | $ 2,562.50 | $ 2,626.56 | $ 2,692.23 | $ 53,480.35 | $ 163,861.64 |
| Seabird Subtotal | $ 126,000.00 | $ 60,000.00 | $ 15,000.00 | $ - | $ - | $ - | $ 151,000.00 |
| **Hoary Bat: Potential take of near zero per year on average** | | | | | | | |
| Conduct monthly 2-night surveys - staff biologist/intern | $ 10,000.00 | | | | | | $ 10,000.00 |
| Up-front 20-year donation to Bat Research Cooperative | $ 20,000.00 | | | | | | $ 20,000.00 |
| Contingency fund (available but not spent under this scenario) | $ 20,000.00 | $ 500.00 | $ 512.50 | $ 525.31 | $ 538.45 | $ 10,696.14 | $ 32,772.40 |
| Bat Subtotal | $ 30,000.00 | $ - | $ - | $ - | $ - | $ - | $ 30,000.00 |
| **Fatality Monitoring** | | | | | | | |
| Initial carcass scavenging assessment - staff biologist and intern | $ 5,000.00 | | | | | | $ 5,000.00 |
| Intensive searches of all turbines at initial high frequency - staff biologist/intern and outside canine trainers/handlers. Assume 2 years only | $ 60,000.00 | $ 60,000.00 | | | | | $ 120,000.00 |
| Lower intensity searches for life of project and annual scavenging calibration | | | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 270,000.00 |
| Fatality Monitoring Subtotal | $ 65,000.00 | $ 60,000.00 | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 395,000.00 |
| **Annual Subtotals** | **$ 367,500.00** | **$ 162,000.00** | **$ 72,000.00** | **$ 57,000.00** | **$ 57,000.00** | **$ 247,500.00** | **$ 913,000.00** |

**Higher Take Scenario**

| **Higher Take Scenario** - assumes actual take is higher than expected | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** | **Subsequent Years (15)** | **Lifetime Total** |
|---|---|---|---|---|---|---|---|
| **General Measures** | | | | | | | |
| Annual vegetation management - mowing around turbines to facilitate searches | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 7,500.00 | $ 10,000.00 |
| Wildlife Education and Observation Program (WEOP) and Downed Wildlife Protocol - initial (year 1) and periodic (years 6, 11 and 16) training, annual reporting efforts. | $ 3,000.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 15,000.00 | $ 20,000.00 |
| General Subtotal | $ 3,500.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 22,500.00 | $ 30,000.00 |
| **Nene: Potential take of 4-5 per year OR Take at a lower annual level that cumulatively reaches this level before mitgation has been provided** | | | | | | | |
| Pre-construction surveys - assume 2 surveys, staff biologist, field assistant and/or consultant | $ 8,000.00 | | | | | | $ 8,000.00 |
| On-site full-time/on-call environmental inspector during construction, also covering erosion/sedimentation control (biologist/specialist) - 6 mos at $25K | $ 25,000.00 | | | | | | $ 25,000.00 |
| Regular on-site observations of nene response to turbines - staff biologist/intern | $ 10,000.00 | | | | | | $ 10,000.00 |
| Construction of new release pen | $ 50,000.00 | | | | | | $ 50,000.00 |
| New DOFAW truck | $ 9,000.00 | | | | | | $ 9,000.00 |
| Labor for maintenance and predator control plus $1000 helicopter release | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 240,000.00 | $ 320,000.00 |
| Cost of propagating 10 chicks/yr in yrs 1-5, 4/yr thereafter | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 150,000.00 | $ 275,000.00 |
| Contingency fund (see text) | $ 264,000.00 | $ 6,600.00 | $ 6,765.00 | $ 6,934.13 | $ 7,107.48 | $ 141,187.40 | $ 432,594.00 |
| Nene Subtotal | $ 407,000.00 | $ 47,600.00 | $ 47,765.00 | $ 47,934.13 | $ 48,107.48 | $ 531,187.40 | $ 1,129,594.00 |

| **Higher Take Scenario, continued** - assumes actual take is higher than expected | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Subsequent Years (15) | Lifetime Total |
|---|---|---|---|---|---|---|---|
| **Seabirds: Potential take of 2-5 per year of each species OR Take at a lower annual level that cumulatively reaches this level before mitigation has been provided** | | | | | | | |
| Vehicle, radar, night-vision and related equipment for surveys, plus training | $ 50,000.00 | | | | | | $ 50,000.00 |
| Conduct on-site radar and night-vision/thermal surveys to document seabird interaction and response to turbines (2 surveys, June and October fledging seasons, by staff biologist and intern) | $ 16,000.00 | | | | | | $ 16,000.00 |
| Conduct seraches to identify West Maui colonies in need of protection and implement protection measures - assume colonies found in first two years by staff biologist and intern | $ 60,000.00 | $ 60,000.00 | $ 20,000.00 | $ 20,000.00 | $ 20,000.00 | $ 300,000.00 | $ 480,000.00 |
| Contingency fund (see text) | $ 100,000.00 | $ 2,500.00 | $ 2,562.50 | $ 2,626.56 | $ 2,692.23 | $ 53,480.35 | $ 163,861.64 |
| Seabird Subtotal | $ 226,000.00 | $ 62,500.00 | $ 22,562.50 | $ 22,626.56 | $ 22,692.23 | $ 353,480.35 | $ 709,861.64 |
| **Hoary Bat: Potential take of 2-5 per year** | | | | | | | |
| Conduct monthly 2-night surveys - staff biologist/intern | $ 10,000.00 | | | | | | $ 10,000.00 |
| Up-front 20-year donation to Bat Research Cooperative | $ 20,000.00 | | | | | | $ 20,000.00 |
| Annual contributions to offset additional take at $1000 per bat (assume 3 per year on average) | $ 3,000.00 | $ 3,000.00 | $ 3,000.00 | $ 3,000.00 | $ 3,000.00 | $ 45,000.00 | $ 60,000.00 |
| Contingency fund (see text) | $ 20,000.00 | $ 500.00 | $ 512.50 | $ 525.31 | $ 538.45 | $ 10,696.14 | $ 32,772.40 |
| Bat Subtotal | $ 53,000.00 | $ 3,500.00 | $ 3,512.50 | $ 3,525.31 | $ 3,538.45 | $ 55,696.14 | $ 122,772.40 |
| **Fatality Monitoring** | | | | | | | |
| Initial carcass scavenging assessment - staff biologist and intern | $ 5,000.00 | | | | | | $ 5,000.00 |
| Intensive searches of all turbines at initial high frequency - staff biologist/intern and outside canine trainers/handlers. Assume 2 years only | $ 60,000.00 | $ 60,000.00 | | | | | $ 120,000.00 |
| Lower intensity searches for life of project and annual scavenging calibration | | | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 270,000.00 |
| Fatality Monitoring Subtotal | $ 65,000.00 | $ 60,000.00 | $ 15,000.00 | $ 15,000.00 | $ 15,000.00 | $ 225,000.00 | $ 395,000.00 |
| **Annual Subtotals** | **$ 754,500.00** | **$ 174,600.00** | **$ 89,840.00** | **$ 90,086.00** | **$ 90,338.15** | **$ 1,187,863.89** | **$ 2,387,228.04** |

**Notably Higher Take Scenario**

| **Notably Higher Take Scenario** - assumes actual take is notably higher than expected | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Subsequent Years (14) | Lifetime Total |
|---|---|---|---|---|---|---|---|---|
| **General Measures** | | | | | | | | |
| Annual vegetation management - mowing around turbines to facilitate searches | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 7,000.00 | $ 10,000.00 |
| Wildlife Education and Observation Program (WEOP) and Downed Wildlife Protocol - initial (year 1) and periodic (years 6, 11 and 16) training, annual reporting efforts. | $ 3,000.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 500.00 | $ 3,000.00 | $ 12,000.00 | $ 20,000.00 |
| General Subtotal | $ 3,500.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 1,000.00 | $ 3,500.00 | $ 19,000.00 | $ 30,000.00 |
| **Nene: Potential take of 5-10 or more per year OR Take at a lower annual level that cumulatively reaches this level before mitigation has been provided** | | | | | | | | |
| Pre-construction surveys - assume 2 surveys by staff biologist, field assistant and/or consultant | $ 8,000.00 | | | | | | | $ 8,000.00 |
| On-site full-time/on-call environmental inspector during construction, also covering erosion/sedimentation control (biologist/specialist) - 6 mos at $25K | $ 25,000.00 | | | | | | | $ 25,000.00 |
| Regular on-site observations of nene response to turbines - staff biologist/intern | $ 10,000.00 | | | | | | | $ 10,000.00 |
| Construction of new release pen (DOFAW) (second pen year 6) | $ 50,000.00 | | | | | $ 50,000.00 | | $ 100,000.00 |
| New DOFAW truck | $ 9,000.00 | | | | | $ 9,000.00 | | $ 18,000.00 |
| Labor for maintenance and predator control plus $1000 helicopter release | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 16,000.00 | $ 32,000.00 | $ 448,000.00 | $ 560,000.00 |
| Purchase of 10 chicks/yr (doubles beginning year 6) | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 50,000.00 | $ 700,000.00 | $ 875,000.00 |
| Contingency fund (see text) | $ 264,000.00 | $ 6,600.00 | $ 6,765.00 | $ 6,934.13 | $ 7,107.48 | $ 7,285.17 | $ 133,902.97 | $ 432,594.74 |
| Nene Subtotal | $ 407,000.00 | $ 47,600.00 | $ 47,765.00 | $ 47,934.13 | $ 48,107.48 | $ 148,285.17 | $ 1,281,902.97 | $ 2,028,594.74 |

| **Notably Higher Take Scenario, continued** - assumes actual take is notably higher than expected | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Subsequent Years (14) | Lifetime Total |
|---|---|---|---|---|---|---|---|---|
| **Seabirds: Potential take of 5-10 or more per year of each species OR Take at a lower annual level that cumulatively reaches this level before mitigation has been provided** | | | | | | | | |
| Vehicle, radar, night-vision and related equipment for surveys, plus training | $ 50,000.00 | | | | | | | $ 50,000.00 |
| Conduct on-site radar and night-vision/thermal surveys to document seabird interaction and response to turbines (2 surveys, June and October fledging seasons, by staff biologist and intern) | $ 16,000.00 | | | | | | | $ 16,000.00 |
| Conduct seraches to identify West Maui colonies in need of protection and implement protection measures - assume additional colonies need to be found over three-year period, followed by extra management and possibility of further searches or off-site efforts. Work by staff biologist and intern | $ 60,000.00 | $ 60,000.00 | $ 60,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 375,000.00 | $ 630,000.00 |
| Contingency fund (see text) | $ 100,000.00 | $ 2,500.00 | $ 2,562.50 | $ 2,626.56 | $ 2,692.23 | $ 2,759.53 | $ 50,720.82 | $ 163,861.64 |
| Seabird Subtotal | $ 226,000.00 | $ 62,500.00 | $ 62,562.50 | $ 27,626.56 | $ 27,692.23 | $ 27,759.53 | $ 425,720.82 | $ 859,861.64 |
| **Hoary Bat: Potential take of 5-10 or more per year OR Take at a lower annual level that cumulatively reaches this level before mitigation has been provided** | | | | | | | | |
| Conduct monthly 2-night surveys | $ 10,000.00 | | | | | | | $ 10,000.00 |
| Up-front 20-year donation to Bat Conservation Program | $ 20,000.00 | | | | | | | $ 20,000.00 |
| Annual contributions to offset additional take at $1000 per bat (assume 10 per year on average) | $ 10,000.00 | $ 10,000.00 | $ 10,000.00 | $ 10,000.00 | $ 10,000.00 | $ 10,000.00 | $ 140,000.00 | $ 200,000.00 |
| Contingency fund (see text) | $ 20,000.00 | $ 500.00 | $ 512.50 | $ 525.31 | $ 538.45 | $ 551.91 | $ 10,144.17 | $ 32,772.34 |
| Bat Subtotal | $ 60,000.00 | $ 10,500.00 | $ 10,512.50 | $ 10,525.31 | $ 10,538.45 | $ 10,551.91 | $ 150,144.17 | $ 262,772.34 |
| **Fatality Monitoring** | | | | | | | | |
| Initial carcass scavenging assessment | $ 5,000.00 | | | | | | | $ 5,000.00 |
| Intensive searches of all turbines - high frequency | $ 60,000.00 | $ 60,000.00 | | | | | | $ 120,000.00 |
| Lower intensity searches for life of project | | | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 350,000.00 | $ 450,000.00 |
| Fatality Monitoring Subtotal | $ 65,000.00 | $ 60,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 25,000.00 | $ 350,000.00 | $ 575,000.00 |
| **Annual Subtotals** | **$ 761,500.00** | **$ 181,600.00** | **$ 146,840.00** | **$ 112,086.00** | **$ 112,338.15** | **$ 215,096.61** | **$ 2,226,767.96** | **$ 3,756,228.72** |

# Appendix 12

## Funding Guaranty
## for the
## Kaheawa Pastures Wind Energy Generation Facility
## Habitat Conservation Plan

# GUARANTEE AGREEMENT

This GUARANTEE AGREEMENT dated as of [_____________], 2006 (this "***Guarantee***") is made by UPC HAWAII WIND PARTNERS, LLC, a limited liability company duly formed and validly existing under the laws of Delaware (the "***Guarantor***"), in favor of the U.S. FISH AND WILDLIFE SERVICE ("***USFWS***") and the HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES ("DLNR")) (collectively with USFWS, the "***Beneficiaries***" and each a "***Beneficiary***"). Capitalized terms used herein without definition shall have the meanings ascribed thereto (whether by reference to another document or otherwise) in the Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan as approved at the June 24, 2005 meeting of the Board of Land and Natural Resources, or subsequently revised (the "***HCP***").

## Recitals

**WHEREAS**, Kaheawa Wind Power, LLC (the "***Project Company***") is developing a commercial wind energy generation facility in the Kaheawa Pastures area of Ukumehame in West Maui;

**WHEREAS**, the State Board of Land and Natural Resources approved a Conservation District Use Application ("***CDUA***") for the proposed facility;

**WHEREAS**, the Project Company is an indirect wholly-owned subsidiary of the Guarantor;

**WHEREAS**, in order to satisfy the requirements of the HCP, and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Guarantor has agreed to execute and deliver this Guarantee.

**NOW THEREFORE**, the Guarantor hereby agrees as follows:

Section 1. **Guarantee.**

(a) The Guarantor hereby unconditionally and irrevocably guarantees to each of the Beneficiaries the payment of the Guaranteed Obligations (as such term is defined below).

(b) The Guarantor hereby agrees that, except as specifically provided herein, and to the fullest extent permitted by applicable law, its obligations hereunder shall not be conditioned on, and the Guarantor waives any defense arising under or based upon: (1) the validity or enforceability of any Guaranteed Obligation or of the agreement under which such Guaranteed Obligation arises; (2) the taking of any action by any Beneficiary to enforce any Guaranteed Obligation or the HCP; (3) the insolvency, bankruptcy, liquidation or dissolution of the Guarantor or the Project Company; (4) any default, failure, omission or delay, willful or otherwise, on the part of the Project Company or the Guarantor to perform or comply with the any of the Guaranteed Obligations; or (5) any suit or other action brought by, or any judgment in favor of, any beneficiaries or creditors of the Project Company for any reason whatsoever, including, without limitations, any suit or action in any way attaching or involving any issue, matter or thing in respect of the HCP or the Guaranteed Obligations (other than a suit or action to which a Beneficiary is a party or by which a Beneficiary is bound concerning the scope of the Guaranteed Obligations or concerning the provisions of this Guarantee).

The term "***Guaranteed Obligations***" shall mean all amounts due and payable by the Project Company to fulfill its obligations pursuant to the HCP; provided, however, that the total Guaranteed Obligations shall not exceed the "Notably Higher Take Scenario" of Three Million Seven Hundred and Sixty Thousand Dollars ($3.76 million), which total Guaranteed Obligations shall be irrevocably and unconditionally reduced on an annual basis by the annual take payment actually paid.

Section 2. **Certain Limitations.**

Notwithstanding anything in Section 1 to the contrary:

(a) The Guarantor shall not be required by this Guarantee to perform any Guaranteed Obligation or undertaking if the performance thereof is illegal or impossible in the place where performance is required;

(b) The Guarantor shall not be required to perform any Guaranteed Obligation while the performance of such Guaranteed Obligation is being disputed in good faith by the person required to perform such Guaranteed Obligation; and

(c) Guarantor's liability hereunder with respect to any failure by any person to perform a Guaranteed Obligation shall not exceed the liability of such person subject to such obligation.

Section 3. **Representations and Warranties of the Guarantor.**

Guarantor represents and warrants as of the date hereof as follows:

(a) Organization and Authority; Binding Obligations. The Guarantor is a limited liability company duly formed, validly existing and in good standing under the laws of Delaware. The Guarantor has all necessary power and authority to execute and deliver this Guarantee, to perform its obligations hereunder and to consummate the transactions contemplated hereby. This Guarantee has been duly authorized, executed and delivered by the Guarantor and constitutes the valid and binding obligation of the Guarantor, enforceable against the Guarantor in accordance with its terms, subject, as to enforceability of remedies, to limitations imposed by bankruptcy, insolvency, reorganization, moratorium or other similar laws relating to or affecting the enforcement of creditors' rights generally and to general principles of equity.

(b) Non-Contravention; Consents. The execution and delivery by the Guarantor of this Guarantee and the consummation of the transactions contemplated hereby do not conflict with or result in a breach of, or require any consent under, the organizational documents of the Guarantor, or any applicable law or regulation, or any order, writ, injunction or decree of any court or governmental authority or agency, or any agreement or instrument to which the Guarantor is a party or by which the Guarantor is bound or to which the Guarantor is subject, or constitute a default under any such agreement or instrument, or result in the creation or imposition of any lien, charge, claim or encumbrance upon any of the revenues or assets of the Guarantor pursuant to the terms of any such agreement or instrument. No consent, action, approval or authorization of, or registration, declaration or filing with, any governmental authority or other third party is required to be obtained by the Guarantor to authorize the execution, delivery or performance by the Guarantor of this Guarantee or for the validity or enforceability hereof.

(c) No Actions, Suits or Proceedings. There are no pending or, to the Guarantor's knowledge, threatened actions, suits or proceedings against the Guarantor or affecting it or its properties before or by any court or administrative agency which, if adversely determined, would adversely affect its ability to perform its obligations under this Guarantee.

Section 4. **Expiration.**

This Guarantee shall expire upon the earlier to occur of the following: (i) the prior written consent of each of the Beneficiaries or (ii) the termination or satisfaction of the HCP obligations.

Section 5. **Miscellaneous.**

(a) Notices. All notices under this Guarantee shall, until any party furnishes written notice to the contrary, be mailed or delivered as set forth below. All notices shall be effective when received by the addressee thereof.

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

General Counsel
UPC Wind Management, LLC
100 Wells Avenue, Suite 101
Newton, MA 02459
Telephone:
Telefax: 617-964-3342

(b) Interpretation. The headings of the sections and other subdivisions of this Guarantee are inserted for convenience only and shall not be deemed to constitute a part hereof.

(c) Successors and Assigns; Substitute Guarantor. This Guarantee shall be binding upon and inure to the benefit of the respective successors and permitted assigns of the Guarantor and each Beneficiary, provided, however, that the Guarantor shall not assign or transfer its rights or obligations hereunder without the prior written consent of the Beneficiaries, which consent shall be reasonably granted.

(d) No Waiver; Amendments. No failure on the part of a Beneficiary to exercise, and no course of dealing with respect to, and no delay in exercising, any right, power or remedy hereunder shall operate as a waiver thereof, nor shall any single or partial exercise by a Beneficiary of any right, power or remedy hereunder preclude any other or further exercise thereof or the exercise of any other right, power or remedy. The terms of this Guarantee may be waived, altered or amended only by an instrument in writing duly executed by the Guarantor and the Beneficiaries.

(e) Counterparts. This Guarantee may be executed by the parties hereto in separate counterparts, each of which when so executed and delivered shall be an original, but all such counterparts shall together constitute but one and the same instrument.

(f) Severability. If any provision hereof is invalid and unenforceable in any jurisdiction, then, to the fullest extent permitted by law, (1) the other provisions hereof shall remain in full force and effect in such jurisdiction and (2) the invalidity or unenforceability of any provision hereof in any jurisdiction shall not affect the validity or enforceability of such provision in any other jurisdiction.

*[Remainder of Page Intentionally Left Blank]*

IN WITNESS WHEREOF, the Guarantor has caused this Guarantee to be duly executed as of the day and year first above written.

**UPC HAWAII WIND PARTNERS, LLC**, as Guarantor

By:____________________________________
Name:__________________________________
Title:___________________________________