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Draft Habitat Conservation Plan for Lālāmilo Wind Farm

Submitted to:

US Fish and Wildlife Service
Hawai‘i Department of Land and Natural Resources

Applicant:

Lālāmilo Wind Company, LLC

Prepared by

SWCA Environmental Consultants

April 2016

REVISED DRAFT HABITAT CONSERVATION PLAN FOR LĀLĀMILO WIND FARM

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EXECUTIVE SUMMARY

The County of Hawaiʻi Department of Water Supply is seeking to repower Lālāmilo Wind Farm at Lālāmilo, South Kohala, to supply electricity to existing wells. Site Constructors has been selected to design and construct the facility for the Project owner/operator Lālāmilo Wind Company, LLC. The proposed 3.3-Megawatt facility includes installation of five Vestas V47 660-kilowatt wind turbines and associated power lines, fencing, and roadwork. The original wind farm was operated by Hawaiʻi Electric Light (HELCO) from 1987 to 2010. The wind farm was decommissioned in 2010, turbines removed, and the property was returned to the County of Hawaiʻi. The site of the proposed wind farm is zoned "agriculture."

The U.S. Fish and Wildlife Service (USFWS) voiced concerns regarding the impact of the wind farm on several listed bird species, a listed bat, and birds protected under the Migratory Bird Treaty Act in a letter dated November 2010 to Kevin Moore at the Department of Land and Natural Resource (DLNR). USFWS recommended that surveys for listed species be conducted and, if impacts to any listed species are expected, consultation with USFWS is required. More recently, in a letter dated August 14, 2014, USFWS reiterated their recommendation that a habitat conservation plan (HCP) be developed for this project as part of the application for incidental take authorizations under Section 10 of the Endangered Species Act of 1973. DLNR made a similar recommendation in a pre-consultation notice response dated April 14, 2014 to ensure compliance with Hawaiʻi Revised Statutes (HRS) Chapter 195D.

Lālāmilo Wind Company, LLC has determined that incidental take of two federally listed species could occur as a result of the continued operation of the Project:

- Hawaiian hoary bat (*Lasiurus cinereus semotus*; federally and state endangered)
- Hawaiian petrel (*Pterodroma sandwichensis*; federally and state endangered)

These two species comprise the covered species in this HCP (see Section 6).

To comply with the Endangered Species Act (ESA) and to avoid potential violations of the ESA Section 9 take prohibition, Lālāmilo Wind Company, LLC is voluntarily preparing this HCP and applying to the USFWS for an Incidental Take Permit (ITP) in accordance with Sections 10(a)(1)(B) and 10(a)(2) of the ESA, and is applying to the Hawaiʻi DLNR Division of Forestry and Wildlife (DOFAW) for an Incidental Take License (ITL) pursuant to HRS Chapter 195-D. This HCP has been prepared to fulfill regulatory requirements of both the ITP and ITL applications.

This HCP contains operational impact minimization measures, most notably low wind speed curtailment, and mitigation measures to compensate for the potential incidental take. Mitigation for the Hawaiian petrel consists of contribution to the removal and control of cats and mongoose within a cat-proof fenced area at Hawaiʻi Volcanoes National Park (HVNP), and monitoring and fence maintenance. Mitigation for the Hawaiian hoary bat consists of habitat improvement at the Kahuku Unit of HVNP and research on effects of restoration techniques on Hawaiian hoary bat activity levels and food resources. Habitat improvement includes removal of invasive species and planting of desired native species. All mitigation measures were developed with the intention of providing a net ecological benefit to the species in alignment with state and federal recovery goals.

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ABBREVIATIONS

ALISH	Agricultural Lands of Importance to the State of Hawaiʻi
amsl	above mean sea level
APLIC	Avian Power Line Interaction Committee
BLNR	Board of Land and Natural Resources
CARE	carcass retention
CP	carcass persistence
CFR	Code of Federal Regulation
DLNR	Department of Land and Natural Resources
DOE	Department of Energy
DOFAW	Division of Forestry and Wildlife
DWS	Department of Water Supply
ESRC	Endangered Species Recovery Committee
ESA	Endangered Species Act
GPS	global positioning system
HCP	habitat conservation plan
HELCO	Hawaiʻi Electric Light
HRS	Hawaiʻi Revised Statute
HVNP	Hawaii Volcanoes National Park
ITL	Incidental Take License
ITP	Incidental Take Permit
km	kilometer
kW	kilowatts
KWP	Kaheawa Wind Power Phase I
m	meter
MBTA	Migratory Bird Treaty Act
MW	Megawatts
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NREL	National Renewable Energy Laboratory
PPA	Power Purchase Agreement
SEEF	searcher efficiency
SWCA	SWCA Environmental Consultants
USFWS	U.S. Fish and Wildlife Service

1. INTRODUCTION

Lālāmilo Wind Farm, located near the town of Kamuela, South Kohala District, Island of Hawaiʻi, was originally constructed in the mid-1980s with 120 wind turbines for a nameplate generating capacity of 2.7 megawatts (MW). It was decommissioned in 2010 in anticipation of re-powering the site. The County of Hawaiʻi Department of Water Supply (DWS) awarded Lālāmilo Wind Company, LLC (Lālāmilo) a contract to design, build, and operate the wind farm and associated facilities for the Lālāmilo Wind Farm Repowering Project (Project) on the Island of Hawaiʻi. Lālāmilo proposes to construct and operate the Project with a nameplate generation capacity of 3.3 MW, and would potentially reduce carbon dioxide (CO_2) emissions on the island of Hawaii by as much as 11,000 metric tons per year by eliminating the need for HELCO to generate electricity to power the Lālāmilo -Parker Pumps with their fossil-fuel powered generation assets (Lālāmilo Repower Project EA, Tetra Tech 2014). The proposed Project will include: 1) five Vestas 660-kilowatt V47 wind turbines to power eight existing water wells in the Lālāmilo-Parker well system, and 2) an updated monitoring and control system to optimize the operations of the pumping system. Associated infrastructure will include on-site access road repair, an electrical collection system, an existing operations and maintenance building, a new 13-kilovolt (kV) overhead electrical transmission line, and updated switchgear and electrical interconnection equipment. The Project will be located on state land leased from State of Hawaiʻi's Department of Land and Natural Resources (DLNR) in South Kohala. Lālāmilo owns and operates the Project. The U.S. Fish and Wildlife Service (USFWS) voiced concerns regarding the impact of the wind farm on several listed bird species, a listed bat, and birds protected under the Migratory Bird Treaty Act (MBTA) in a letter dated November 2010 to Kevin Moore at the DLNR, in response to request for input regarding issuance of land lease to DWS. USFWS recommended that surveys for listed species be conducted and, if impacts to any listed species are expected, consultation with USFWS is required. More recently, in a letter dated August 14, 2014, USFWS reiterated their recommendation that a habitat conservation plan (HCP) be developed for this project as part of the application for incidental take authorizations under Section 10 of the Endangered Species Act of 1973 (ESA), as amended. DLNR made a similar recommendation in a pre-consultation notice response dated April 14, 2014 to ensure compliance with Hawaiʻi Revised Statutes (HRS) Chapter 195D.

. Lālāmilo has completed a number of wildlife studies at the Project. These efforts include the following:

- Summer seabird radar survey (ABR 2015; Appendix C)
- Biological reconnaissance survey (Tetra Tech 2014)
- Hawaiian hoary bat acoustic monitoring report (Insight Environmental, LLC 2013)
- Fall seabird audio/visual and radar survey (ABR 2013)

Lālāmilo has determined that incidental take of two federal and state listed species potentially may occur as a result of the continued operation of the Project:

- Hawaiian hoary bat (*Lasiurus cinereus* semotus; federally and state endangered)
- Hawaiian petrel (*Pterodroma sandwichensis*; federally and state endangered)

These two species comprise the covered species in this HCP (see Section 6).

To comply with the ESA and to avoid potential violations of the ESA Section 9 take prohibition, Lālāmilo is voluntarily preparing this HCP and applying to the USFWS for an Incidental Take Permit (ITP) in accordance with Sections 10(a)(1)(B) and 10(a)(2) of the ESA, and is applying to the Hawaiʻi

DLNR Division of Forestry and Wildlife (DOFAW) for an Incidental Take License (ITL) pursuant to HRS Chapter 195-D. This HCP has been prepared to fulfill regulatory requirements of both the ITP and ITL applications.

1.1. Applicant

The applicant for incidental take authorization related to the Project is Lālāmilo Wind Company, LLC.

1.2. Permit Area and Plan Area

The *permit area* for this HCP is defined as the geographical area within which incidental take resulting from covered activities is expected to occur (Figure 1.2). The permit area is approximately 51 hectares (ha) (126 acres), and includes the turbine and met tower locations.

The Project Area is surrounded on all sides by agricultural pastoral lands principally used for cattle (*Bos taurus*) grazing. A heavily disturbed, dry grassland vegetative community dominates the Project Area. Fountain grass (*Pennisetum setaceum*) and buffelgrass (*Cenchrus ciliaris*) are the dominant species, both of which are non-native, aggressive, introduced grasses. Topography of the Project Area consists of a relatively flat plateau falling off to the west and north. Elevations range from 427 meters (m) (1,401 feet) to 349 m (1,145 feet) above mean sea level (amsl) with an average slope of 5%. Several small dry gulches score the landscape around the west and north portions of the Project Area.

Additional lands addressed in the HCP are those that will be used for mitigation. Those areas are addressed in Section 9. Power from the wind farm will be transmitted by the underground electrical collection system to the existing switchyard, where power will be transmitted to the wells through the existing and new 13-kV overhead transmission lines (figure 1.1). Together, the permit area and mitigation lands, and the above ground transmission lines define the *plan area*.

1.3. Permit Duration

Lālāmilo seeks incidental take authorization for a period of 20 years from the effective date of the authorization. This covers the contract term of the Power Purchase Agreement (PPA) between Lālāmilo and DWS.

At an appropriate time before the completion of the 20-year term of the PPA between the DWS and Lālāmilo, the DWS will evaluate whether to continue operation of the Project or decommission it. If the operation is continued, Lālāmilo, or the then owner/operator of the project will apply for an ITP/ITL permit extension.

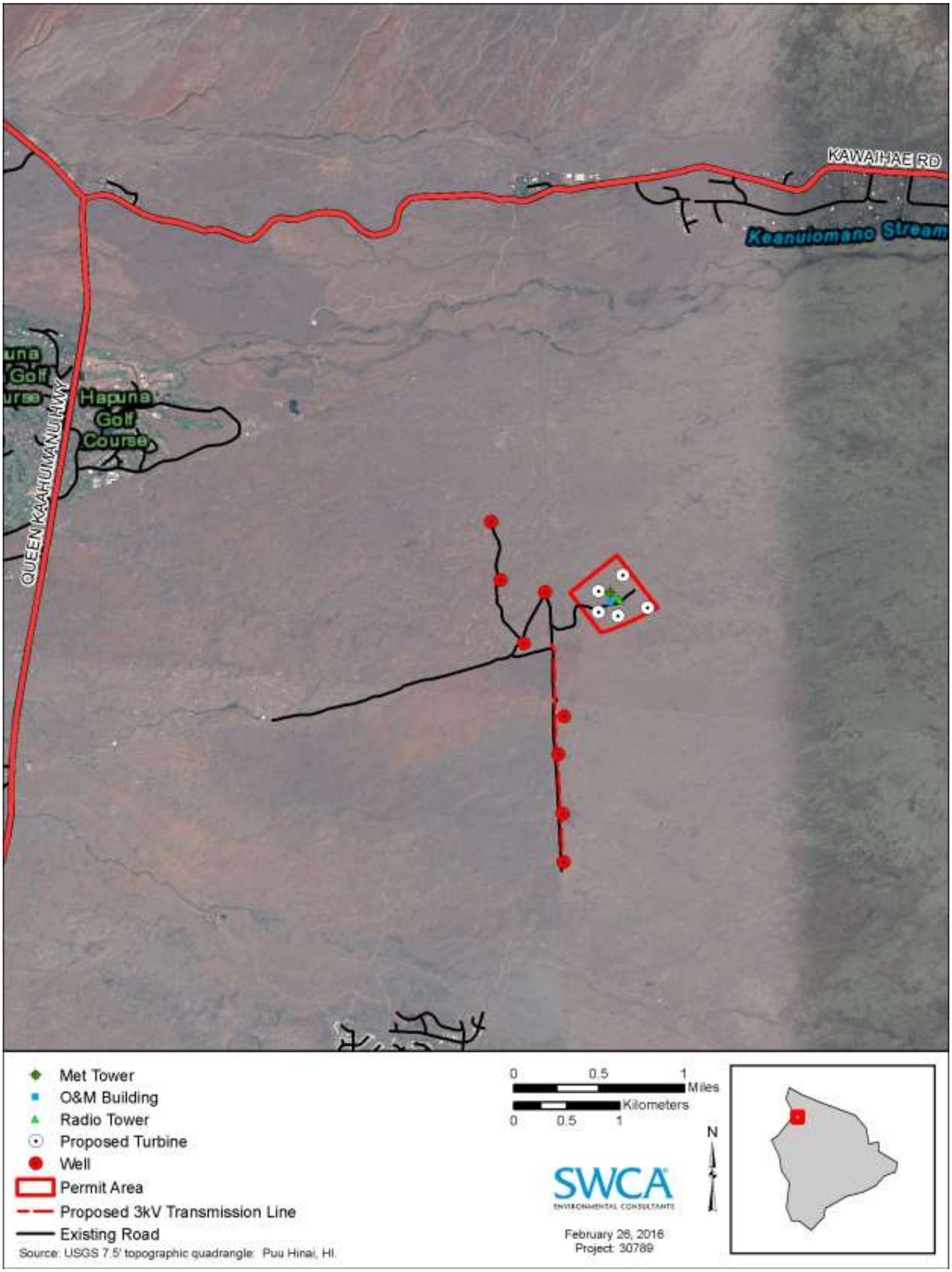

Figure 1.1. Lālāmilo Wind Farm project location.

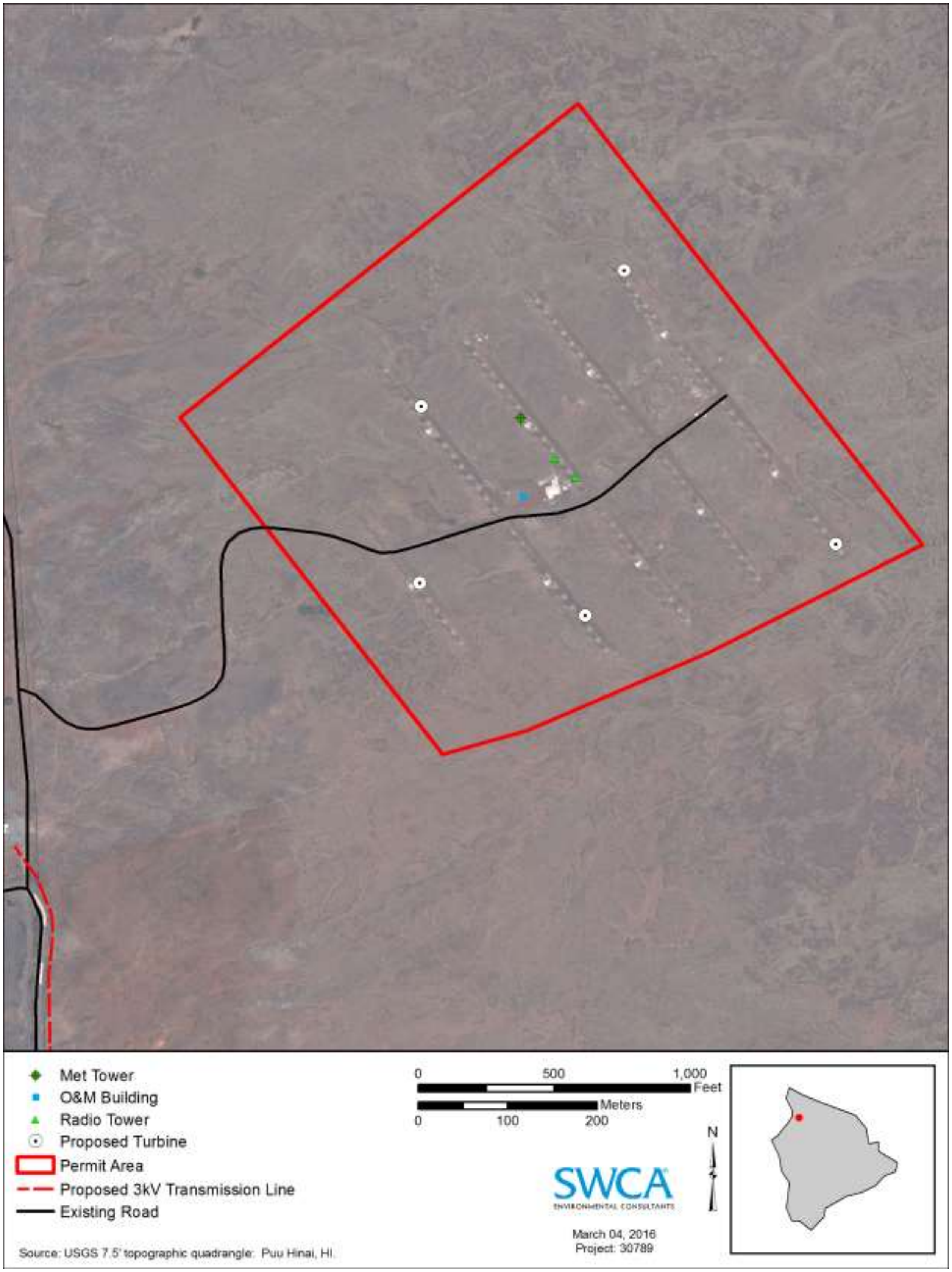

Figure 1.2. Permit Area for Lālāmilo Wind Farm

2. REGULATORY FRAMEWORK

This HCP has been prepared to fulfill regulatory requirements of both the ITP and ITL applications, as described below. Lālāmilo Wind Company, LLC is responsible for complying with other federal, state, and local laws, including, without limitation, the MBTA.

2.1. Endangered Species Act

The ESA protects fish, insects, and other wildlife (wildlife), as well as plants that have been listed as threatened or endangered species. It is designed to conserve the ecosystem on which the species depend. Candidate species, which may be listed in the near future, are not afforded protection under the ESA until they are formally listed as endangered or threatened species.

Section 9, and rules promulgated under Section 4(d), of the ESA prohibits the unauthorized take of any endangered or threatened species of 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. As defined in regulations, the term *harm* means an act that actually kills or injures wildlife; it may include significant habitat modification or degradation, which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 Code of Federal Regulations [CFR] 17.3). The rules define *harass* to mean an intentional or negligent act or omission that 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 take otherwise prohibited by Section 9, or a rule under Section 4(d), of the ESA, if such take is incidental to the carrying out of an otherwise lawful activity ("incidental take"). To apply for an ITP, an applicant must develop and fund a USFWS-approved HCP to minimize and mitigate the effects of the incidental take. Such take may be permitted, provided the following issuance criteria of ESA Section 10(a)(2)(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 taking.
- The applicant will ensure that adequate funding for the HCP and procedures to deal with unforeseen circumstances will be provided.
- The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild.
- Other necessary or appropriate measures required by the Secretary of the Interior, if any, will be met.

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

- The impact that will likely result from such taking.
- The measures that 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 considered by the applicant, and the reasons why such alternatives are not proposed to be used.
- Such other measures that the Secretary may require as necessary or appropriate for purposes of the HCP.

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

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

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

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

Permit Duration: Regulations provide several factors that are used to determine the duration of an ITP, including the duration of the applicant’s proposed activities and the expected positive and negative effects on covered species associated with the proposed duration (50 CFR 17.32 and 222.307). Under the Five-Point Policy, the USFWS will also consider the level of scientific and commercial data underlying the proposed operational program of the HCP, the length of time necessary to implement and achieve the benefits of the program, and the extent to which the program incorporates adaptive management strategies.

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

2.2. Hawaiʻi Revised Statutes, Chapter 195D

The purpose of HRS Chapter 195D is “to insure the continued perpetuation of indigenous aquatic life, wildlife, and land plants, and their habitats for human enjoyment, for scientific purposes, and as members of ecosystems ….” Section 195D-4 states that any endangered or threatened species of fish or wildlife recognized by the ESA shall be so deemed by state statute. Like the ESA, the unauthorized take of such endangered or threatened species is prohibited (HRS 195D-4(e)). Under Section 195D-4(g), the Board of Land and Natural Resources (BLNR), after consultation with the State's Endangered Species Recovery Committee (ESRC), may issue a temporary ITL to allow a take otherwise prohibited if the take is incidental to the carrying out of an otherwise lawful activity.

To qualify for an ITL, the following must occur (language taken from HRS 195D):

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

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

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

- Be consistent with the goals and objectives of any approved recovery plan for any endangered species or threatened species known or reasonably expected to occur in the ecosystems, natural communities, or habitat types in the plan area.
- Provide reasonable certainty that the ecosystems, natural communities, or habitat types will be maintained in the plan area throughout the life of the plan in sufficient quality, distribution, and extent to support in the plan area those species typically associated with the ecosystems, natural communities, or habitat types, including any endangered, threatened, proposed, and candidate species known or reasonably expected to be present in the ecosystems, natural communities, or habitat types within the plan area.
- Contain objective, measurable goals, the achievement of which will contribute significantly to the protection, maintenance, restoration, or enhancement of the ecosystems, natural communities, or habitat types; time frames within which the goals are to be achieved; provisions for monitoring (such as field sampling techniques), including periodic monitoring by representatives of the department or the ESRC, or both; and provisions for evaluating progress achieving the goals quantitatively and qualitatively.
- Provide for an adaptive management strategy that specifies the actions to be taken periodically if the plan is not achieving its goals.

In addition to the above requirements, all HCPs and their actions authorized under the HCP should be designed to result in an overall net benefit to the threatened and endangered species in Hawaiʻi (HRS 195D-30).

Section 195D-25 provides for the creation of the ESRC, which is composed of biological experts, representatives of relevant federal and state agencies (e.g., USFWS, U.S. Geological Survey, and DLNR), and appropriate governmental and non-governmental members. The ESRC serves as a consultant to the DLNR and BLNR on matters relating to endangered, threatened, proposed, and candidate species. ESRC reviews all applications for HCPs and makes recommendations to the BLNR on whether they should be approved, amended, or rejected.

Following preparation of the proposed HCP, it and the application must be made available for public review and comment no fewer than 60 days before approval. If the DLNR approves the HCP, participants in the HCP (e.g., the ITL holder) must submit an annual report to DLNR within 90 days of each fiscal year ending June 30, as further detailed in ESA Section 10 below; this report must include a description of activities and accomplishments, analysis of the problems and issues encountered in meeting or failing to meet the objectives set forth in the HCP, areas needing technical advice, status of funding, and plans and management objectives for the next fiscal year (HRS 195D-21).

2.3. National Environmental Policy Act

Issuing an ITP is a federal action subject to compliance with NEPA. The purpose of NEPA is to promote agency analysis and public disclosure of the environmental issues surrounding a proposed federal action to reach a decision that reflects NEPA's mandate to strive for harmony between human activity and the natural world. The scope of NEPA goes beyond that of the ESA by considering the impact of a federal action on non-wildlife resources, such as water quality, air quality, and cultural resources. The USFWS will prepare and provide for public review an environmental assessment to evaluate the potential environmental impacts of issuing an ITP and approving the implementation of this HCP. The purpose of the environmental assessment is to determine if ITP issuance and HCP implementation will significantly affect the quality of the human environment. If the USFWS determines significant impacts are likely to occur, a comprehensive environmental impact statement for 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 ITP issuance until after the NEPA process is complete.

2.4. Migratory Bird Treaty Act

The Hawaiian petrel is also protected under the MBTA of 1918, as amended (16 United States Code 703-712). The MBTA prohibits the take of migratory birds. A list of birds protected under MBTA implementing regulations is provided at 50 CFR 10.13. Unless permitted by regulations, under the MBTA "it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product … ."

The MBTA provides no process for authorizing incidental take of MBTA-protected birds. However, if the HCP is approved and USFWS issues an ITP to the applicant, the terms and conditions of that ITP will also constitute a Special Purpose Permit under 50 CFR 21.27 for the take of the Hawaiian petrel under the MBTA. Therefore, subject to the terms and conditions to be specified in the ITP, if issued, any such take of listed bird species also will not be in violation of the MBTA. However, because the MBTA provides for no incidental take authorization, other MBTA-protected birds that are not protected by the ESA and that may be adversely affected by the proposed wind facility will not be covered by any take authorization. If take of any MBTA species occurs, these will be documented and reported in a similar fashion to that applied to any endangered or threatened wildlife species listed under the ESA.

On March 23, 2012, the USFWS released Land-Based Wind Energy Guidelines (USFWS 2012a). These voluntary guidelines provide recommended approaches for assessing and avoiding impacts to wildlife and their habitats, including migratory birds, associated with wind energy project development. The guidelines also help towards compliance with federal laws such as the MBTA. The approach described in this document for the proposed development of this Project is consistent with the intent of the guidelines.

3. PROJECT DESCRIPTION

3.1. Project History

The previous Lālāmilo Wind Farm constructed in the mid-1980s was decommissioned in 2010 in anticipation of re-powering the site. The DWS awarded Lālāmilo a contract to design, build, and operate the wind farm and associated facilities for the Project. The proposed Project will consist of five 660-kilowatt Vestas V47 wind turbines, for a nameplate generation capacity of 3.3 MW. The turbines will power eight existing water wells in the Lālāmilo-Parker well system (Parker Wells 1 to 4 and Lālāmilo Wells A to D), as well as an updated monitoring and control system to optimize the operations of the pumping system. Associated infrastructure will include on-site access road repair, an electrical collection system, an existing operations and maintenance building, a new 13-kilovolt overhead electrical transmission line, and updated switchgear and electrical interconnection equipment.

3.2. Project Design and Components

3.2.1. Turbines

Each Vestas V47-660 kW wind turbine has a hub height of 37 m (121 feet) and a rotor diameter of 47 m (154 feet), with a maximum height of 60.5 m (198.5 feet) above ground level at the top of the blade.

Turbines will be a minimum of 235 m (770 feet) apart, 5 rotor diameters. The blades and rotor hub are attached to the nacelle, which houses mechanical and electrical components including the gear box, generator, and controller.

An approximately 800-m^2 (8,611-square-foot) work area will be required at each turbine location to provide space for delivery, laydown and construction of turbine components, crane access, and foundations. The area will be cleared and graded as necessary. Turbines will be erected using a combination of forklifts and cranes; additional construction equipment will include both wheeled and tracked vehicles.

Each turbine foundation will be approximately 6 m (20 feet) in diameter by 1.2 m (4 feet) thick, on-grade concrete pad with rock anchors drilled 7.5 m (25 feet) into the lava for support consisting of approximately 38 m^3 (50 cubic yards) of concrete. Each foundation will require approximately five concrete trucks. During operation, an area with an approximate radius of 45-m (147-feet) will be kept clear of vegetation around each permanent turbine pad.

To meet the energy demands of the project, typically only three of the turbines will be spinning at any given time.

3.2.2. Meteorological Tower and Radio Towers

An existing meteorological 60 m (197 ft) guyed (met) tower and two existing 30 m (88ft) free-standing lattice radio towers are on-site. These will be re-used for the Project. No modifications to these structures are included as part of the Project.

3.2.3. Operations and Maintenance Building

An existing Operations and Maintenance (O&M) building will be reused with minimal retrofitting to house new communication and control equipment. The footprint of the existing building and concrete slab is approximately 12 × 11 m (40 × 37 feet). A minimal gravel area, immediately adjacent to this existing building and used for the original wind farm, will be maintained for parking and outdoor storage.

3.2.4. Electrical Collection System

Power generated by each turbine will be collected by a 13-kV underground electrical collection system. Cables will pass from the generator in each nacelle through the foundation to a pad-mounted step-up transformer and will connect the individual wind turbines in a daisy chain configuration to the interconnect. The cables will pass through the existing buried and encased conduits on the wind farm site and will connect with both the existing and new 13-kV overhead transmission lines at the existing switchyard adjacent to the wind farm. A new supervisory control and data acquisition system for the pumping system will transmit data from the turbine controllers to the interconnect and the operations and maintenance building. The system will optimize the pumping demand and maximize the usage of wind-generated electricity. Throughout the Project, small trucks and qualified personnel will routinely monitor, inspect, and maintain the communication and electrical collector cables.

3.2.5. Interconnect

Power from the wind farm will be transmitted by the underground electrical collection system to the existing switchyard, where power will be transmitted to the wells through the existing and new 13-kV overhead transmission lines. Improvements to the existing switchyard, including new interconnection equipment, will be required to accept the power from the wind farm. All work will be conducted within the existing switchyard footprint.

3.2.6. Transmission Line

A new, overhead 13-kV transmission line will be constructed from the existing switchyard to deliver power to Parker Wells No. 1 to 4. The transmission line will be approximately 2.1 kilometers (km) (1.3 miles) long and will be installed adjacent to an existing road and within the existing Department of Water Supply 12-m-wide (40-foot-wide) right-of-way and easement.

Installation of approximately 25 poles spaced approximately every 91 m (300 feet) will be required. Poles are anticipated to be similar to the existing poles supporting HELCO's transmission line (i.e., made of wood and approximately 9 m [30 feet] tall). If any pull-boxes or underground cabling is required, it will be within the existing disturbed right-of-way.

Conductors will be arranged in the same horizontal arrangement and at the same horizontal plane as the existing HELCO medium voltage transmission lines. The transmission line will be fitted with bird flight diverters, in accordance with APLIC guidelines (APLIC 2012), to minimize the potential for collision by birds. Construction of the transmission line will use standard industry equipment and procedures, including surveying, corridor preparation, materials hauling, pull sites, staging areas, structure assembly and erection, ground wire, conductor stringing, cleanup, and revegetation, as necessary. The transmission line will be accessed by the existing DWS Lālāmilo-Parker wells access road. During operations, qualified personnel will routinely monitor, inspect, and maintain the transmission line using light trucks. Heavy construction equipment will only be required if overhead components need to be repaired or replaced. There is an existing 13-kV transmission line running between the switchyard interconnect and Lālāmilo Wells A to D that would be reused. No Project-related activities are proposed for Lālāmilo Wells A to D, other than the provision of power.

3.2.7. Internal Construction Access Route

Existing roads remaining from the original Lālāmilo Wind Farm will be used to access the turbines. Where necessary, the internal access road will be repaired and resurfaced with gravel, as needed, to facilitate construction. The internal access roads are currently approximately 6 m (20 feet) wide and approximately 2.1 km (1.3 miles) long. By reusing the existing access roads, the need to disturb any new ground would be eliminated and the existing water drainage would not be altered. The internal access road will have a gravel surface and stormwater and erosion control features, and will be maintained as such throughout the construction and operation of the Project. The wind farm will be accessed by an existing, paved DWS right-of-way that extends approximately 152 m (500 feet) north from the interconnect to the entrance to the wind farm site. The existing road would be repaired and resurfaced as necessary while remaining in the existing right-of-way, and will be maintained during construction and operation of the Project as the access road. Best Management Practices will be followed to prevent introduction of invasive species to the site.

3.2.8. External Construction Access Route

An approximately 13-km (8-mile) construction access route will be required to transport equipment from Kawaihae Harbor to the wind farm site. The construction access route will primarily follow existing state and county roadways as well as approximately 5 km (3.25 miles) of the DWS Lālāmilo-Parker wells access road between Queen Ka‘ahumanu Highway and the wind farm. The major turbine components that are considered oversized loads will require the use of special transportation equipment (multi-axle transport trailers, stretch trailers, etc.). Where necessary to facilitate crossing steeper portions of the access road, prefabricated ramps may be temporarily placed in the existing road bed to minimize grade break. No modifications (road widening, regrading, or intersection modifications) will be required along the highway.

Personnel will use the existing Lālāmilo-Parker wells access road off Queen Ka‘ahumanu Highway as the access route for the Project during construction and operation of the Project. Most of the existing access road is paved with either concrete or asphalt. Small areas are lined with pressed gravel. No modifications (road widening or regrading) or use of areas outside of the existing road bed will be required along the Lālāmilo-Parker wells access road between the highway and the interconnect. Gravel improvement of the access road between the turn-off at the HELCO interconnect and the entrance to the wind farm (within the existing DWS right-of-way and easement), described above in section 3.2.7, will be maintained for continued access to the wind farm site, as well as repair of any asphalt damaged by construction traffic.

Each turbine will require up to five deliveries (including three permitted oversized loads) of equipment and materials to its pad. Deliveries will be made using transport vehicles that conform to road weight limits. Timing for the transportation of special loads requiring escort vehicles will be coordinated with Hawai‘i Department of Transportation to minimize the impacts to commuter traffic. Other construction traffic will primarily occur between the hours of 7:30 a.m. and 3:30 p.m.

3.2.9. Site Cleanup

All portions of the Project will be maintained in a clean and orderly manner throughout construction and operation, avoiding food and waste storage that could attract fauna. At the completion of the construction phase, a final cleanup of all construction areas will be done, and all construction-related waste will be properly handled in accordance with county, state, and federal policies and permit requirements, and will be removed from the area for disposal or recycling as appropriate. Areas with disturbed soil that will not be used during operations will be stabilized and returned to pre-construction conditions.

3.2.10. Decommissioning

The Project has an estimated 40-year life based on the projected useful life of the turbines. At an appropriate time before the completion of the 20-year term of the PPA between the DWS and Lālāmilo Wind Company, the DWS will evaluate whether to continue operation of the Project or decommission it. If the Project is decommissioned, the power generation equipment will be removed before the expiration of the ITP\ITL and the site will be returned to a condition as close to its pre-construction (post-2010 decommissioned) state as possible, as contractually required in both the lease with DLNR and the PPA with the DWS.

3.3. Purpose and Need for the Lālāmilo Wind Farm

The DWS's mission is to "provide customers with an adequate and continuous supply of drinking water in a financially responsible manner, comply with all relevant standards, and assist and facilitate development of water systems in areas not currently served." In keeping with this mission, the DWS established an energy policy in 2011 to reduce energy use and its associated costs and environmental impacts. The Project is consistent with this policy and its mission of reducing energy costs by replacing a large portion of its pumping energy demands with renewable wind energy and saving up to 50% of its annual pumping cost for the next 20 years. The Project will also contribute to the state's Clean Energy Initiative goal that renewable resources supply 100% of the state's energy by the year 2045. The DWS operates eight existing water wells for a combined available water capacity of 5 million gallons per day

(MGD) in the Lālāmilo-Parker well system. In an average year, the energy required to meet the pumping demands of the Lālāmilo-Parker well system exceeds 10,000,000 kilowatt hour (kWh) at the current HELCO rate of 40 cents per kWh. It is anticipated that with the installed generation capacity of 3.3 MW, the repowering of the Lālāmilo Wind Farm will provide up to 75%–80% of the pumping energy demands, thereby saving the water customers approximately $1 million per year at today's electrical rates.

The Project, on a regional level, is expected to have beneficial effects on climate through the reduction of fossil fuel consumption and greenhouse gas emissions. Renewable energy generated by the Project would replace energy currently generated by combustion of fossil fuels, thereby resulting in a long-term reduction in greenhouse gas emissions that contribute to global warming.

Greenhouse gas emissions from construction and operation of the Project (e.g., exhaust from construction vehicles) would be more than offset by the reduction of emissions resulting from operation of the Project. The emissions reductions associated with the new equipment will depend upon the extent to which different types of other generating resources on the island are reduced as a result of the wind turbines. The wind turbines have a nameplate, or peak, generating capacity of 3.3 MW; however, they would not run at this load 24 hours per day, 365 days per year. If the capacity factor is 40 percent (as has been assumed for other wind projects), and the power generated displaced an equivalent quantity of power generated from Keāhole Power Plant, the associated carbon dioxide (CO_2) emission reductions would be approximately 11,000 metric tons per year. If instead an equivalent quantity of power were displaced from Hāmākua Power Plant, CO_2 emissions reductions would be approximately 6,000 metric tons per year. These amounts far exceed those which would be produced by construction and operation of the Project. Therefore, over the long term, operation of the Project is expected to result in beneficial effects on climate through reduction in levels of greenhouse gas emissions. (Tetra Tech, 2014).

4. ENVIRONMENTAL SETTINGS

4.1. Climate, Location, and Vicinity

The climate of the Hawaiian Islands is characterized by two seasons, summer (May through September) and winter (October through April). Climate, including temperature, humidity, rainfall, and wind patterns, in the islands is influenced by latitude, elevation, proximity to the ocean, and geological features. Summer is typically warmer and drier, whereas winters are cooler and wetter, with most storm events occurring in the winter months (Western Regional Climate Center [WRCC] 2014).

The Project Area, ranging in elevation between approximately 349 m (1,145 feet) and 427 m (1,401 feet) amsl, is on the leeward side of the Island of Hawai‘i and is in the rain shadow of the Mauna Kea and Kohala Mountains. Average temperatures near the Project Area range from approximately 12 degrees Celsius (54 degrees Fahrenheit) to 23 degrees Celsius (74 degrees Fahrenheit) (County of Hawai‘i Data Book 2012).

Average annual precipitation recorded at the Waikoloa Station southwest of the Project Area is approximately 33.5 centimeters (cm) (13.2 inches) and is approximately 39.8 cm (15.7 inches) at the Parker Ranch Range 1 Station northeast of the Project Area (Giambelluca et al. 2013). Most of this rainfall occurs between October and March.

Relatively persistent northeasterly trade winds also influence the climate of the Hawaiian Islands. Trade winds affect cloud formation and precipitation, particularly on the windward slopes (WRCC 2014). Leeward areas of the islands tend to be less cloudy, with cloudier conditions occurring during the winter months. Trade winds are more prevalent, occurring 80%–95% of the time, and typically exhibit the highest wind speeds during the summer months. During the winter months, trade winds are prevalent approximately 50%–80% of the time (WRCC 2014).

In December 2009, the National Renewable Energy Laboratory (NREL), a national laboratory of the U.S. Department of Energy, conducted a preliminary analysis for repowering the old Lālāmilo Wind Farm. They classified the wind resource in the area as a Class 7 wind source, where 1 is minimal and 7 optimal (NREL 2009).

4.2. Topography and Geology

The Project is on the lower (western) flank of the Mauna Kea volcano and is within the U.S. Geological Survey mapped stratigraphic formation "hm," Hāmākua Volcanics (Pleistocene) (Wolfe and Morris 1996; Sherrod et al. 2007). This unit consists of lava flows discontinuously mantled by unmapped windblown, tephra-fall, and colluvial deposits. Elevations across the Project range from 427 m (1,401 feet) to 349 m (1,145 feet) amsl, with an average slope of 5%. Topography consists of a relatively flat plateau, descending to the west and north of the Project Area. Several small dry gulches traverse the landscape in the west and north portions of the Project Area.

4.3. Soils

Soils on the Island of Hawai‘i have been classified and mapped by the U.S. Department of Agriculture Soil Conservation Service and Natural Resource Conservation Service (NRCS) (NRCS 2014), the University of Hawai‘i Land Study Bureau Detailed Land Classification (State of Hawai‘i 2014), and the State Department of Agriculture's Agricultural Lands of Importance to the State of Hawai‘i (ALISH) system (State of Hawai‘i 2014).

The entire Project Area is mapped by the NRCS as Hāpuna-Waikui-Lālāmilo complex, 0%–20% slopes. This soil series consists of approximately 35% Hāpuna and Waikui and similar soils, and 20% Lālāmilo and similar soils, with ‘a‘ā lava flows making up 10% of the soil series. These soils, typically found on mountain flanks, side slopes, and foot slopes, are found on ash fields on ‘a‘ā lava flows. They are well-drained, extremely stony soils that formed from basic volcanic ash over ‘a‘ā lava and alluvium over basic volcanic ash (NRCS 2014). The available water capacity for Hāpuna soils is very low (approximately 6 cm [2.4 inches) per 0.3 m [1 foot] of soil), is moderate (approximately 21 cm [8.3 inches] per 0.3 m [1 foot] of soil) for Waikui soils, and is high (approximately 30 cm [11.9 inches] per 0.3 m [1 foot] of soil) for Lālāmilo soils The NRCS soil report for the Project (NRCS 2014b) identifies limitation ratings for road suitability, potential erosion hazard, and other factors for soils in the Project Area, which will be taken into account during Project construction and operation.

The University of Hawai‘i Land Study Bureau's Detailed Land Classification classifies soils based on productivity rating, with "A" rated soils being the most productive and "E" rated soils being the lowest. The soils in the Project Area are classified as "E," which signifies land that is not suitable for agriculture.

The ALISH system classifies agricultural lands based primarily on soil characteristics. This system classifies land as Prime, Unique, or Other Important Agricultural Lands. The Project Area has not been categorized as agricultural land by ALISH.

4.4. Hydrology

The Project Area is within the boundaries of the Island of Hawai‘i Waimea aquifer (Aquifer Code 8030; State Commission on Water Resource Management 2008). The state-identified sustainable yield for the

Waimea aquifer is 24 MGD. Eight existing, large-capacity deep groundwater wells are in the Lālāmilo-Parker well system operated by the DWS. The wells provide potable water for the system serving Puakō to Kawaihae, including Mauna Lani Resort in the region of South Kohala. The wells are ideally located adjacent, within a distance of approximately 0.24–2.1 km (0.15–1.3 miles), to the Project to efficiently supply a portion of the power needs. The combined capacity of the eight wells is 5 MGD, which range in depth from 337 m (1,106 feet) to 381 m (1,250 feet). During construction, the wells will be used temporarily as a source of water to irrigate exposed soils for fugitive dust control. Pooling and ponding will be minimized to avoid attracting wildlife to the site.

There are no perennial streams, intermittent streams, or wetlands in the Project Area, based on a review of mapping from the National Wetlands Inventory (USFWS 2014) and National Hydrography Dataset (NHD 2014), and based on site observations. Additionally, the U.S. Army Corps of Engineers confirmed that there are no waters of the U.S. in the proposed turbine area. As for the location of the transmission lines, the poles will be placed in locations that will avoid gulches and drainage ways.

4.5. Flora

A biological reconnaissance survey of the wind farm site and access road from the wind farm site to the HELCO interconnect was conducted in December 2013 to document vegetation communities and the presence of rare plants. A follow-up survey along the proposed transmission line corridor was conducted in March 2014. Based on the results of that biological reconnaissance survey, the Project Area consists of heavily disturbed, dry grassland. Fountain grass and buffelgrass were the dominant species, both of which are non-native, aggressive, introduced grasses. Isolated or small groups of introduced kiawe (*Prosopis pallida*), klu (*Acacia farnesiana*), and koa haole (*Leucaena leucocephala*) were broadly distributed along the access road and gulches, and a mixture of introduced and native herbaceous and shrub species was widely scattered among the dominant grasses.

Twenty-three plant species including four indigenous species were observed during the biological reconnaissance survey of the Project Area. The four indigenous species observed are ʻuhaloa (*Waltheria indica*), ʻilima (*Sida fallax*), ʻaʻaliʻi (*Dodonaea viscosa*), and koali ʻawahia (*Ipomoea indica*). All native plants observed in the Project Area are widespread in appropriate habitat on the Island of Hawaiʻi and elsewhere in the Hawaiian Islands. ʻUhaloa was scattered throughout the Project Area, whereas ʻaʻaliʻi, ʻilima, and the single observed koali ʻawahia plant were concentrated near the topographical ridgeline in the northeast portion of the Project Area. Despite the presence of scattered native species, there was no intact native dryland plant community. No federal- or state-listed threatened or endangered plant species or other special status or rare plant species were observed during the biological reconnaissance survey (Tetra Tech 2014).

Although the reconnaissance survey was conducted during a significant and prolonged drought, because of the disturbed nature of the site and its past land use, including a long history of cattle grazing and the former use of the Project Area as a wind farm, it is unlikely that any rare or special status plant species occur in the Project Area. This assessment is further bolstered by the absence of threatened or endangered plant species during a 2006 botanical survey at the Waikoloa Highlands subdivision 4.8 km (3 miles) away from the Project Area (David and Guinther 2006).

4.6. Fauna

4.6.1. Surveys Conducted

Wildlife occurring on or flying over the Project Area has been investigated through a combination of radar surveys (ABR 2013, 2015), the use of bat detection devices (Insight Environmental LLC 2013), and biological reconnaissance surveys (Tetra Tech 2014).

4.6.1.1. RADAR SURVEYS

Two radar surveys were performed at the Project Area to identify seabirds that may potentially transit the Project Area (ABR 2013, 2015). A five-day fall survey was conducted in October 2013, and a 10-day summer survey was conducted in June and July 2015.

The fall 2013 surveys consisted of evening (6:00 p.m. to 9:00 p.m.) and morning (4:20 a.m. to 6:20 a.m.) radar surveys were conducted from October 16 to 20, 2013. These surveys were conducted from a single radar station approximately 200 m (656 feet) west of the met tower and building on the site. This fall survey coincided with the fledgling period for both Hawaiian petrel and Newell's shearwater (*Puffinus auricularis newelli*). Criteria used to identify possible shearwaters and petrels consisted of radar targets moving at airspeeds greater than 48 km (30 miles) per hour, of the appropriate size, flying inland or seaward only (not parallel to shore), and exhibiting directional flight (ABR 2013). The summer 2015 surveys were conducted from June 27-July 6. They consisted of concurrent surveillance and vertical radar sampling and audiovisual (AV) sampling during 3 evening hours (7:00 pm–10:00 pm) and 2.5 morning hours (3:45 am–6:15 pm) (ABR 2015).

4.6.1.2. BAT SURVEYS

An acoustic monitoring survey was conducted from July 2012 through June 2013 at the Project Area. Wildlife Acoustics SM2BAT+ acoustic detectors were installed at locations across the Project Area for full coverage. Four recorder microphones were installed at a height of 0.76 m (2.5 feet), and two were installed 9.1 m (30 feet) above the ground surface. The microphone placement was intended to provide vertical coverage of the Project Area as well as horizontal, within the typical vertical range of the Hawaiian hoary bat. Four additional Wildlife Acoustics SM2BAT+ acoustic detectors were placed at the Project Area from March 22, 2015 to the present at sites corresponding with the placement of the detectors in 2012-2013 for further monitoring of bat activity. Data collected from the acoustic detectors currently recording at the project area has not been summarized and is not reported in this document.

4.6.2. Non-Listed Wildlife Species

Based on results from the biological reconnaissance survey, conducted December 16 – 17, 2013, fauna in the Project Area are scarce and dominated by non-native species (Tetra Tech 2014). Species detected during the biological reconnaissance survey included five introduced birds, an introduced mammal, and two insects, one introduced and one indigenous.

Five introduced bird species were detected during the biological reconnaissance survey, and one additional species, the Pacific golden-plover (*Pluvialis fulva*), an indigenous migrant, was detected during the avian radar surveys (ABR 2013). Of these, three introduced species—sky lark (*Alauda arvensis*), African silverbill (*Lonchura cantans*), and chestnut-bellied sandgrouse (*Pterocles exustus*)—could nest in the Project Area. Other non-listed species could occur in the Project Area. However, because there are few live plants in the Project Area, use of the area by other bird species is expected to be very infrequent and is expected to consist of occasional overflights of the area by other introduced species.

Domestic cattle was the only mammal observed in the Project Area. However, other introduced species such as feral goat (*Capra hirca*), small Indian mongoose (*Herpestes auropunctatus*), cat (*Felis catus*), house mouse (*Mus musculus*), and rat (*Rattus* spp.) could also occur in the Project Area. Populations of these species are likely to be low because of the low availability of live plants in the Project Area, which act as food, or food for supporting prey. No reptiles or amphibians were observed during the surveys. None of the terrestrial reptiles or amphibians that occur in Hawai‘i are native to the Hawaiian Islands, and therefore none of them are species of concern. Populations of each of these species are likely to be low because of the low availability of live plants in the Project Area, which act as food or food for supporting prey.

Two insect species were recorded in the Project Area: the globe skimmer (*Pantala flavescens*), an indigenous dragonfly, and the introduced house fly (*Musca domestica*). These are both common and widespread species in the Hawaiian Islands and across the planet. Given the presence of domesticated cattle in the vicinity, other common, non-native insect species are also likely to occur in the Project Area.

4.6.3. Migratory Bird Treaty Act–Protected Species

The MBTA-protected species with the potential to occur in the Project Area include indigenous species and resident bird species introduced from the mainland U.S. On the mainland, these resident species are considered migratory and are therefore protected under the MBTA; this protection carries over to populations in Hawai‘i, even though they are considered introduced species there. Three MBTA-protected species are known to use the Project Area: Pacific golden-plover (see section 4.6.3), skylark, and house finch (*Carpodacus mexicanus*). The skylark (an introduced species) frequents open ranchland habitats throughout the main Hawaiian Islands (Pyle and Pyle 2009) and is expected to be a permanent resident in and near the Project Area. The house finch (a resident and introduced species) is a widespread species in the main Hawaiian Islands that frequents a variety of habitats, including ranchlands and grassland habitats. It may occasionally use the Project Area, but is unlikely to nest there because of the absence of trees (Pyle and Pyle 2009).

4.6.4. Endangered Species Act–Listed Species

4.6.4.1. HAWAIIAN HOARY BAT

Data collected from the acoustic detectors currently recording at the project area has not been summarized and is not reported in this document. Based on a 1-year acoustic monitoring study conducted by Insight Environmental (2013), the Hawaiian hoary bat is known to occasionally use the area. Results suggest seasonal variability in bat presence, with one or more bats detected during 45% of the nights from May through November, whereas one or more bats were detected during only 5% of the surveys from December through April. On average, 0.13 bat passes per recorder night were identified. Recent research on Hawaiian hoary bats suggests that bats can use a variety of introduced and native trees for roosting, but roost trees are typically at least 5 m (16 feet) tall and have dense foliage cover (USFWS and DOFAW, 2013). Large trees are sparsely distributed in the Project Area, and none have the dense foliage cover preferred by Hawaiian hoary bats. Therefore, the Project Area is likely only used by bats for foraging or in transit between foraging and roosting locations.

4.6.4.2. HAWAIIAN PETREL

Radar images consistent with petrels were detected during the radar surveys (petrel/shearwater target), but no target was identified to species. During 5 days of surveys in the fall of 2013 (October 16-20), this effort identified a daily passage of 1–5 landward-bound petrel/shearwater targets and 0–3 seaward-bound petrel/shearwater targets. During a 10-day radar survey in the summer of 2015 (June 27 – July 6), only three petrel/shearwater targets were documented flying seaward. Flight altitudes ranged from 184–366 m (604–1201 feet) above ground level (agl). No observations occurred at or below the height of the proposed turbines (60.5 m (198 feet) agl) (ABR, Inc. 2015). The timing of the detections, flight direction, and flight characteristics were consistent with Hawaiian petrels, but it is also possible that some or all of these detections were non-listed species exhibiting behavior consistent with listed seabirds. Because radar data do not identify passage rates by species and because there are no recent records of nesting Newell's shearwaters on Hawai‘i, radar detections are understood to be primarily Hawaiian petrels, and the Newell's shearwater is not considered to be at risk of collision with project components. The Hawaiian petrel forages in the open ocean. On the Island of Hawai‘i, the Hawaiian petrel nests above 2,500 m (8,200 feet) in elevation in xeric habitats with sparse vegetation in burrows, crevices, or cracks in lava tubes (Mitchell et al. 2005). The Hawaiian petrel would only occur in the Project Area in transit between the ocean and nesting grounds.

4.6.4.3. HAWAIIAN GOOSE

The Hawaiian goose was not detected during the biological reconnaissance survey and is rare in this area of the island, but is known to breed within approximately 16 km (10 miles) of the Project Area (Pyle and Pyle 2009). The Hawaiian goose sometimes uses non-native grassland communities such as those found in the Project Area (DLNR 2015; Pyle and Pyle 2009). However, because of the lack of food availability in the Project Area, this would not be considered high-quality habitat. A review of aerial imagery near the Project Area indicates that there is an abundance of similar habitat in the surrounding area, and the abundance of similar habitat throughout the region suggests that there is a discountable probability of the species using the specific Project Area. The Project Area lies at least 10 miles north of known distribution of the Hawaiian goose (USFWS, 2004; DLNR 2015; Pyle and Pyle 2009); therefore, it is unlikely to be within a flight path between areas used by Hawaiian geese.

5. COVERED ACTIVITIES

Covered activities are those activities with the possibility of resulting in an incidental take of one or more covered species and for which Lālāmilo seeks incidental take authorization. Of the Project components and activities described above in Section 3, the operation of wind turbines and ongoing existence of the met tower and two radio towers present a possibility for an incidental take of a covered species. Therefore, these are the only Project components and activities for which Lālāmilo seeks incidental take authorization.

Presence and use of the operations and maintenance building and substation do not present potential effects to covered species. As described above, approximately 2.1 km (1.3 miles) of an aboveground transmission line will be installed for the Project, with approximately 25 poles spaced approximately every 91 m (300 feet) apart from the switchyard to the Parker 1 - 4 well sites. The aboveground conductors will be marked in accordance with Avian Power Line Interaction Committee (APLIC) guidelines. The risk of collision between a covered species and the Project transmission line is negligible based on available site-specific flight height data. Mean flight altitudes of targets resembling Hawaiian petrels were 284 ± 54 meters above ground level, well above the height of the proposed tie-line, which is

9 meters (ABR 2015 [Appendix C]). For this reason, the construction and maintenance of the above-ground transmission line is not a covered activity.

6. BIOLOGICAL GOALS AND OBJECTIVES

The 2000 HCP handbook addendum defines biological goals as the broad, guiding principles that clarify the purpose and direction of the conservation components of an HCP (*Federal Register* 2000). The following biological goals and objectives are designed to address the anticipated impacts of the incidental take resulting from the covered activities, and consider the overall conservation needs of the covered species and their habitat. Minimization and mitigation measures identified in this HCP apply the best available science and provide the means for achieving these biological goals and objectives, which are described below.

- Goal 1. Result in net conservation benefit for Hawaiian hoary bats.
    - Objective 1a. Provide new habitat for Hawaiian hoary bats.
    - Objective 1b. Restore existing but degraded habitat for increased use by Hawaiian hoary bats.
- Goal 2. Result in net conservation benefit for Hawaiian petrel.
    - Objective 2a. Protect existing habitat for Hawaiian petrels.
    - Objective 2b. Protect existing populations of Hawaiian petrel.
- Goal 3. Increase knowledge.
    - Objective 3a. Increase the knowledge and understanding of the effectiveness of forest restoration practices on Hawaiian hoary bat activity through research and sharing data with regulatory agencies during the ITP/ITL term.

7. ECOLOGY OF THE COVERED SPECIES

7.1. Hawaiian Hoary Bat

7.1.1. Population, Biology, and Distribution

The Hawaiian hoary bat is the only native land mammal present in the Hawaiian archipelago. It is a sub-species of the hoary bat (*Lasiurus cinereus*), which occurs across much of North and South America. Both males and females have a wingspan of approximately 0.3 m (1 foot). The Hawaiian hoary bats' weight ranges from 12 to 22 grams, and females are typically larger than males. The Hawaiian hoary bat has two varieties of fur color: the normal "hoary" whitish frosting and an alternative reddish hue (Todd 2012.

The Hawaiian hoary bat has been recorded on Kauaʻi, Oʻahu, Molokaʻi, Lānaʻi, Maui, and Hawaiʻi, but no current or historical population estimates exist for this subspecies. Population estimates for all islands in the state have ranged from hundreds to a few thousand bats (Menard 2001). Hawaiian hoary bat activity varies seasonally, and most observations have occurred between sea level and 2,286 m (7,500 feet), although bats have been seen as high as 4,023 m (13,200 feet) (USFWS 1998). On the Island of Hawaiʻi, research indicates that bats concentrate in coastal lowlands from April through October (Todd 2012) and in interior highlands from November through March (Gorresen et al. 2013).

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

A preliminary study (November 2004 to August 2008) of a small sample of Hawaiian hoary bats (n = 18) on the Island of Hawaiʻi has estimated short-term (3-13 calendar days) core use area of 25.5 ha (63.0 acres) (Bonaccorso et al. 2015). The size of home ranges and core areas varies widely among individuals. Core areas include feeding ranges that are actively defended, especially by males, against conspecifics. Female core ranges overlapped with male ranges. Hawaiian hoary bats typically feed along a line of trees, forest edges, or roads, and a typical feeding range stretches approximately 275 m (902 feet). Hawaiian hoary bats will spend 20–30 minutes hunting in a feeding range before moving on to another (Bonaccorso 2011).

It is suspected that breeding primarily occurs between April and August (Menard 2001). Females give birth to as many as two young (USFWS 1998). Lactating females have been documented from June to August, indicating that this is the period when non-volant young are most likely to be present. Breeding has been documented on the Islands of Hawaiʻi, Kauaʻi (Baldwin 1950; Kepler and Scott 1990; Menard 2001), and Oʻahu (Kawailoa Wind Power 2013). Mating was recently observed on Maui (Todd 2012). It is not known whether bats observed on other islands breed locally or only visit these islands during non-breeding periods.

Seasonal changes in the abundance of Hawaiian hoary bats at different elevations indicate that altitudinal movements occur on the Island of Hawaiʻi. During the breeding period (April through August), Hawaiian hoary bat occurrences increase in the lowlands and decrease in the interior highlands between 2,200 m (7,218 feet) and 3,600 m (11,811 feet) (Todd 2015; Gorresen et al. 2013). During the nonbreeding period, bat occurrences increase in interior highlands (Gorresen et al. 2013).

Hawaiian hoary bats feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites (Whitaker and Tomich 1983). They appear to prefer moths ranging from 16 to 20 millimeters (mm) (0.60 to 0.89 inch) (Bellwood and Fullard 1984; Fullard 2001). Koa moths (*Scotorythra paludicola*), which are endemic to the Hawaiian Islands and use koa (*Acacia koa*) as a host plant (Haines et al. 2009), are frequently targeted as a food source (personal communication, Gorresen, 2013). Prey is located using echolocation. Watercourses and edges (e.g., coastlines and forest-pasture boundaries) appear to be important foraging areas (Brooks and Ford 2005; Francl et al. 2004; Grindal et al. 1999; Menzel et al. 2002; Morris 2008). In addition, the species is attracted to insects that congregate near lights (Bellwood and Fullard 1984; DLNR 2015; USFWS 1998). They begin foraging either just before or after sunset depending on the time of year (DLNR 2015; USFWS 1998).

7.1.2. Threats

Little is known regarding threats to the Hawaiian hoary bat. The presumed decline of the species may primarily be due to the decrease in canopy cover during historic times (Tomich 186, Nowak 1994), in particular the severe deforestation in the early nineteenth century (Tomich 1986). The main observed mortality has resulted from bats snagging on barbed wire (Zimpfer and Bonaccorso 2010), and colliding with wind turbines. The extent of the impact of barbed wire fences is unknown, because most are not checked regularly. The extent of mortality at wind farms is well documented (Table 6.1), because intensive monitoring is carried out to document such fatalities. Other threats may include pesticide use, which in the past has impacted federally listed bat species (Clark et al. 1978), the introduction of non-native species such as introduced invertebrates which alter the possible prey composition, and coqui frogs, which have the capacity to attain very high densities (Beard et al. 2009) resulting in reductions of total insect biomass (Bernard 2011).

7.1.3. Known Fatalities at Other Hawaiian Wind Farms

Fatalities of Hawaiian hoary bats have been documented at five operational wind farms in possession of an ITP/ITL in Hawaiʻi (Table 6.1). In their North American range, hoary bats are known to be more susceptible to collision with wind turbines than most other bat species (Erickson 2003; Johnson 2005; Johnson et al. 2000). Most mortality has been detected during the fall migration period. Hoary bats in Hawaiʻi do not migrate in the traditional sense; although, as indicated, some seasonal altitudinal movements occur.

Table 7.1. Documented Fatalities of Hawaiian Hoary Bats at Wind Farms in Hawaiʻi

Location	Observed Take	Calculated Take (80% Dalthorp)*
Auwahi Wind Farm (Maui)	5	17
Kaheawa Wind Farm (Maui)	8	29
Kaheawa II Wind Farm (Maui)	3	19
Kahuku Wind Farm (Oʻahu)	4	14
Kawailoa Wind Farm (Oʻahu)	24	42

Sources: Sempra Energy (2015); Kaheawa Wind Power, LLC (2015a, 2015b); Kahuku Wind Power, LLC (2015); Kawailoa Wind Power, LLC (2015), Diane Sether, USFWS, pers comm 08/17/2015).

* The take estimate is based on the *Evidence of Absence Software* (Dalthorp et al. 2014), existing literature (i.e., Huso et al. 2015), and site-specific data. It includes indirect take estimates.

7.1.4. Known Occurrences in the Project Area

Hawaii's Wildlife Action Plan documents historic (1900-present) incidental records of this species near the towns of Waimea and Kawaihae, Hawaii, but not near the Project (DLNR 2015). Based on a 1-year acoustic monitoring study conducted from July 2012 to June 2013 (Insight Environmental 2013), the Hawaiian hoary bat is known to occasionally use the area. Results of this study suggest seasonal variability in bat presence, with one or more bats detected during 45% of the nights from May through November (high use season), whereas one or more bats were detected during only 5% of the surveys from December through April (low use season). On average, 0.13 bat passes per recorder night were identified. Results from the ongoing survey that began in March 2015 are not reported here, as the results have not yet been summarized. Recent research on Hawaiian hoary bats suggests that bats can use a variety of introduced and native vegetation for roosting, ranging from 1 to 9 m (3 to 29 feet) tall with dense foliage cover (DLNR 2015). Large trees are sparsely distributed in the Project Area, and none has the dense foliage cover preferred by Hawaiian hoary bats. Therefore, the Project Area is likely only used by bats for foraging or in transit between foraging and roosting locations.

Bats have been documented in forests as well as pastureland, and they may use less-forested areas during the non-breeding season (Gorresen et al. 2013). Gorresen et al. (2013) found that contrary to expectations, bat occupancy was not greater at less-windy sites. Hawaiian hoary bats were as likely to occur at windy sites as at low-wind sites, although the authors did not directly correlate activity levels and wind speeds. Based on these findings, bats would be expected to occur at the Project.

7.2. Hawaiian Petrel

7.2.1. Population, Biology, and Distribution

The Hawaiian petrel was once abundant on all main Hawaiian Islands except Ni‘ihau (DLNR 2015). The population was most recently estimated to consist of approximately 20,000 individuals, with 4,000–5,000 breeding pairs (DLNR 2015). The once-significant breeding populations of Hawaiian petrels on the Island of Hawai‘i were reduced to very small numbers by the end of the twentieth century (Banko 1980b; Conant 1980; Richardson and Woodside 1954). Today, Hawaiian petrels continue to breed in high-elevation colonies on Maui, Hawai‘i, Kaua‘i, and Lāna‘i (Richardson and Woodside 1954; Simons and Hodges 1998; Telfer et al. 1987). Radar studies conducted in 2002 suggest that breeding may also occur on Moloka‘i (Day and Cooper 2002). It is believed that breeding no longer occurs on O‘ahu (Harrison 1990). The largest known breeding colony is at Haleakalā National Park, Maui, where as many as 1,000 pairs have been thought to nest annually (DLNR 2015). An accurate population estimate for Hawai‘i Island is lacking; however, a rudimentary estimate suggests approximately 2,000 individuals (Cooper and Day 2004). Hawai‘i Volcanoes National Park (HVNP) currently has the largest active Hawaiian petrel colony on Hawai‘i Island with an estimated 100 - 200 breeding pairs (Pyle and Pyle 2009).

Hawaiian petrels subsist primarily on squid, fish, and crustaceans caught near the sea surface. Foraging may take place thousands of kilometers from their nesting sites during both breeding and non-breeding seasons (Spear et al. 1995). In fact, recent studies using satellites and transmitters attached to Hawaiian petrels show that they can range across more than 10,000 km (6,200 miles) during 2-week foraging expeditions (Adams 2008).

Hawaiian petrels are active in their nesting colonies for approximately 8 months each year. The birds are long-lived (approximately 30 years) and return to the same nesting burrows each year between March and April. Breeding and prospecting birds fly to the nesting site in the evening and leave for foraging trips before dawn. The nesting season occurs between late February and November, with Hawaiian petrels accessing their underground burrows nocturnally (Simons 1985). Mean altitude during transitory inland flight is approximately 190 m (623 feet) above ground for Maui birds (Cooper and Day et al. 2003). Flight altitude is not believed to vary with seasons (Cooper and Day 2004), although flight altitudes tend to be higher inland than at coastal locations (Cooper and Day 1998), and higher in the evening than the dawn (Day and Cooper, 1995). Present-day Hawaiian petrel colonies are typically located at high elevations above 2,500 m (8,200 feet); however, seabird surveys at HVNP have focused on Hawaiian petrels in subalpine areas between 1,825 m (6,000 feet) and 3,050 m (10,000 feet) in elevation (Swift and Burt-Toland, 2009). The types of habitats used for nesting are diverse and range from xeric habitats with little or no vegetation, such as at Haleakalā National Park on Maui, to wet forests dominated by ‘ōhi‘a with uluhe (*Dicranopteris linearis*) understory, such as those found on Kaua‘i (DLNR 2015). Utilized lava flows range in age from 2,000 to 8,999 years old. Despite the extensive age range, the surfaces of all nesting flows were oxidized and broken (Hu et al. 2001). Hu et al. (2001) reveals that approximately half of the nests examined are located in pāhoehoe pits that exhibited evidence of human modification. The other half are located in various naturally occurring features such as lava tubes, cracks in tumuli (fractured hills on the surface of pāhoehoe flows), spaces created by uplift of pāhoehoe slabs, and other miscellaneous nature features (Hu et al. 2001). Females lay only one egg per year, which is incubated alternately by both parents for approximately 55 days. Eggs hatch in June or July, after which both adults fly to sea to feed and return to feed the nestling. The young fledge and depart for sea in October and

November. Adult birds do not breed until age 6, and may not breed every year, but pre-breeding and non-breeding birds nevertheless return to the colony each year to socialize.

7.2.2. Threats

The main factors contributing to population declines of ground-nesting seabirds are habitat degradation; loss of nesting habitat; predation of eggs, hatchlings, and adults at nesting sites by introduced mammals (e.g., dogs [*Canis familiaris*], mongooses, cats, rats, and pigs [*Sus scrofa*]); collision with man-made structures; collapse of nest burrows by goats and pigs; and urban lighting associated with disorientation and fall-out of juvenile birds are main factors contributing to population declines of ground-nesting seabirds (Ainley et al. 1997; DLNR 2015; Hays and Conant 2007). The most common cause of mortality and breeding failure of Hawaiian petrels is predation by introduced mammals (Simons 1985, Simons and Hodges 1998 and Hodges 1994).

Introduced mammals have the potential to severely impact ground-nesting seabirds. Mongoose are abundant in low elevations, with an upper elevation limit of approximately 2,100 m (6,900 feet). As a result, they can prey on ground nesting seabird species who nest along the coast or at low elevations (Swift and Burt-Toland 2009) and may have displaced Hawaiian petrels at lower elevation breeding sites. Feral cats are more widely distributed ranging from sea level to subalpine areas, and may be a major threat to ground-nesting birds at high elevations (Hodges 1994; Winter 2003). Disorientation and fall-out from light attraction are less of an issue on Hawai‘i Island because of Hawai‘i County’s Outdoor Lighting Ordinance (Hawai‘i County Code, Chapter 14, Article 9). The ordinance requires shielded low-pressure sodium lamps for all ground illumination, thereby minimizing upward light pollution. This greatly reduces the risk of fall-out from seabirds. Towers, powerlines and obstructions (e.g. wind turbines) also pose collision hazards to seabirds (USFWS 2005).

7.2.3. Known Fatalities at Other Hawaiian Wind Farms

Hawaiian petrel fatalities have been documented at wind farms on Maui (Table 6.2). These birds are presumed to have collided with turbines while flying to or from their nesting colony (SWCA 2012). Mortality of Hawaiian petrels as a result of collisions with power lines, fences, and other structures near breeding sites or from attraction to bright lights has been documented (Ainley et al. 1997). Juvenile birds are sometimes grounded when they become disoriented by lights on their nocturnal first flight from inland breeding sites to the ocean (Ainley et al. 1997).

Table 7.2. Documented Fatalities of Hawaiian Petrels at Wind Farms in Hawai‘i

Location	Observed Take	Calculated Take (80% Dalthorp)*
Auwahi Wind Farm (Maui)	1	3
Kaheawa Wind Farm (Maui)	7	20**
Kaheawa II Wind Farm (Maui)	0	0
Kahuku Wind Farm (O‘ahu)	0	0
Kawailoa Wind Farm (O‘ahu)	0	0

Sources: Sempra Energy (2015); Kaheawa Wind Power, LLC (2015a, 2015b); Kahuku Wind Power, LLC (2015); Kawailoa Wind Power, LLC (2015), Diane Sether, USFWS, pers comm 08/17/2015.

* The take estimate is based on the *Evidence of Absence Software* (Dalthorp et al. 2014), existing literature (i.e., Huso at al. 2015), and site-specific data. It includes the indirect take estimate.

**Does not include lost productivity, which is in addition to what is reported at the 80% assurance level.

7.2.4. Known Occurrences in the Project Area

HVNP encompasses the only known active Hawaiian petrel colonies on the Island of Hawaiʻi (Judge et al. 2014). The three nearest colonies are located approximately 63 km (39.15 miles) from the Project on the southeast flank of Mauna Loa, with one other known colony located approximately 89 km (55.3 miles) from the Project on the southwest flank of Mauna Loa in the Kahuku section of the national park (Swift and Burt-Toland 2009). Although there is no know breeding colony on Kohala Mountain, petrels have been observed flying up Pololu and Waipio valleys, indicating the species probably nests there (ABR 2015, Appendix C). These valleys are approximately 20.2 km (12.6 miles) and 19.1 km (11.9 miles) from the Project, respectively.

Day et al. (2003) studied the movements and distribution of Hawaiian petrels and Newell's shearwaters on the Island of Hawaiʻi using radar in 2001 and 2002. Because radar data do not identify passage rates by species and there are no recent records of nesting Newell's shearwaters on the Island of Hawaiʻi, Newell's shearwaters will not be included as a covered species and radar detections from Day et al. (2003) are understood to be primarily Hawaiian petrels. Movement rates of petrels and shearwaters on the island were generally low (0.0–3.2 targets per hour), with the exception of Waipiʻo Valley. The timing of evening movements suggested to the authors that Hawaiian petrels fly over the north and south parts of the island. Birds flying over the Project Area would have a low target rate of around two targets per hour, similar to what was observed at Kawaihae by Day et al. (2003).

Fall radar survey results (ABR 2013) included the detection of radar images consistent with petrels or shearwaters (petrel/shearwater target), but no target was identified to species. During 5 days of surveys, this effort identified a daily passage of 1–5 landward-bound petrel/shearwater targets and 0–3 seaward-bound petrel/shearwater targets. The timing of the detections, flight direction, and flight characteristics were consistent with Hawaiian petrel as well as the Newell's shearwater, but it is also possible that some or all of these detections were non-listed species exhibiting behavior consistent with listed seabirds. During the 10-day summer surveys in June-July of 2015, a period during which the flight passage rates for nocturnal inland nesting seabirds including the Hawaiian petrel is the highest, ≤ 3 radar targets that met criteria for petrel/shearwater-like targets were documented. All were headed in a seaward direction. Flight altitudes of these targets ranged from 184–366 meters (m) above ground level (agl) and the mean ($\pm$ SE) flight altitude was 284 ± 54 m agl (median = 302 m agl) (ABR 2015, Appendix C).

The Hawaiian petrel forages in the open ocean. On the Island of Hawaiʻi, the Hawaiian petrel nests above 2,500 m (8,200 feet) in elevation in xeric habitats with sparse vegetation in burrows, crevices, or cracks in lava tubes (DLNR 2015). The Hawaiian petrel would only occur in the Project Area in transit between the ocean and nesting grounds. SWCA was unable to find information to support any hypothesis related to the effect of wind direction and landscape features on flight patterns of the Hawaiian petrel.

8. TAKE ANALYSES

The potential for wind energy turbines to adversely affect birds and bats is well documented in the continental United States (e.g., Erickson 2003; Horn et al. 2008; Johnson et al. 2003a, 2003b; Kerlinger and Guarnaccia 2005; Kingsley and Whittam 2007; Kunz et al. 2007). In Hawaiʻi, all of the wind facilities that have had seabird fatalities have conducted between three and ten years of intensive monitoring to document rates of fatalities.

The only mode of take to covered species with potential to occur at the Project is death or injury by collision with turbines or with the met tower. Other components of the Project operations do not present potential effects that may rise to the level of take for any covered species as compared to baseline conditions. Minimization measures are put in place to limit the extent to which impacts from operational activities result in impacts rising to the level of take. (see Section 9).

Although there is potential for any avian species to collide with power lines, the possibility of Hawaiian petrels colliding with overhead lines at the Project is considered remote. On Kaua‘i, take of Newell’s shearwater (a seabird with similar flight behavior) associated with 1,843 km (1,145 miles) of transmission, distribution, and secondary lines in 2008 was estimated to be 15.5 breeding adults and 63 non-breeding or immature individuals (Planning Solutions et al. 2010). Kaua‘i is estimated to host 75% of the total population of Newell’s shearwater population, which was estimated to be 21,250 breeding and non-breeding birds in 2008 (Planning Solutions et al. 2010). This amounts to 0.067 fatality per year per 1 mile of power line. The populations of inland nesting seabirds on south Hawai‘i are much smaller than those on Kaua‘i.

More recent monitoring of bird strikes at power lines on Kaua‘i indicate that the occurrence of seabird collisions with some power lines is significantly higher than previously reported (Travers et al. 2014). Much of the underreporting of collisions is because very few seabirds fall directly to the ground after colliding with power lines. This indicates that ground searches are not an effective method to document fatalities resulting from power line collisions. However, only 7% of the observed power line strikes resulted in a documented downed bird; therefore, the exact impacts of power line collisions are not well understood. This monitoring effort also showed significant variations of strike rates between different sections of power line. The highest strike rates were associated with particular areas on the island, with power lines at higher altitudes, and with lines that stood the highest above the local topography and vegetation (Travers et al. 2014).

With a Hawaiian petrel population of approximately 100–200 breeding pairs on the Island of Hawai‘i (Pyle and Pyle 2009), collision rates with overhead power lines are expected to be much lower on the Island of Hawai‘i than estimated for Kaua‘i, and for the Project, the collision incidence is expected to be discountable. Furthermore, flight altitudes of petrel-like targets, documented by vertical radar ranged from 184–366 meters (m) above ground level (agl) and the mean (± SE) flight altitude was 284 ± 54 m agl (median = 302 m agl) (ABR 2015, Appendix C). This well above the 9 m height of the power lines associated with the Project.

Described in detail below are the quantitative take analyses completed for each of the covered species, and the results of these analyses.

8.1. Hawaiian Hoary Bat

Most animal fatalities on wind farms across the United States involve hoary bats during their fall migration period when individuals can travel many hundreds of miles (Arnett et al. 2008). In the Hawaiian Islands, it is unclear if the Hawaiian hoary bat (an endemic subspecies found only in the islands) has the same probability to collide with turbines, because their seasonal migration behaviors cover much smaller distances, resulting in different adaptive behaviors from the mainland bats. Despite these differences, there is continued potential for Hawaiian hoary bats to collide with turbines across Hawaiʻi. Take of the Hawaiian hoary bat has been recorded for all five operational wind farms with incidental take authorizations across the state. Table 8.1 details the number of adjusted direct bat fatalities (using Dalthrop et al. 2014) per year for these operational wind farms with turbines. The average adjusted rate of direct take (i.e., the number of bat fatalities directly caused by collision with turbines) varies by site from approximately fourteen bat fatalities per year to two.

Table 8.1. Adjusted Direct Hawaiian Hoary Bat Fatalities at Wind Farms with Operational Turbines for Which Annual Reports are Currently Available (February 2016)

Wind Farm	Location	Habitat	Adjusted Take	Years of Operation	Rate of Direct Take (bats/year)
Auwahi	Maui	Dry scrubland	17	3	5.67
Kaheawa I	Maui	Dry scrubland	28	9	3.11
Kaheawa II	Maui	Dry scrubland	18	3	6.00
Kawailoa	O'ahu	Mesic forest	40	3	13.33
Kahuku	O'ahu	Dry scrubland	10	5	2.00

Sources: Sempra Energy (2015); Kaheawa Wind Power, LLC (2015a, 2015b); Kahuku Wind Power, LLC (2015); Kawailoa Wind Power, LLC (2015), Diane Sether, USFWS, pers comm 08/17/2015.

The Hawaiian hoary bat typically forages for insects in open areas such as the sparsely vegetated grassland on recent lava flows near the proposed Lālāmilo Wind Farm. Roosting habitat is not believed to exist at or near the proposed Project Area because there are no trees that provide suitable roosting habitat on or near the Project Area. However, bats may transit through the site because the distance during foraging from nightly roost locations can be many miles (Cryan et al. 2014). Bat activity is anticipated to be low in the Project Area because of the absence of suitable roosting habitat and the low levels of activities that were recorded by acoustic monitoring.

The results of an acoustic monitoring survey conducted from July 2012 through June 2013 at the proposed Project Area indicate that bats are present year-round (Insight Environmental 2013), despite the fact that suitable roosting habitat does not exist nearby. Results of the acoustic monitoring over a 1-year period detected bats in all months of the year except for April. Bats were recorded at the site at slightly higher rates from May to November averaging around 0.16 passes detected per detector night. In the lower activity months from December to April, average detected bat passes per detector night was 0.02, roughly eight times lower than during the higher activity period. These rates are lower than pre-construction bat activity rates detected at Auwahi Wind Farm, where average bat passage rates of 0.12 per detector night were reported (Auwahi Wind Farm 2012). After three years of operation, Auwahi Wind Farm reported five fatalities (table 7.1, Auwahi Wind Farm 2015). Similarly, Kaheawa Wind Power I (KWP I) indicated low levels of bat activity and after nine years of operation, eight bat fatalities were caused by WTG collisions (Kaheawa Wind Power, LLC 2015a). Because KWP I contains substantially more forest habitat suitable for bat roosting in the vicinity of the wind farm, bat use would be expected to be greater at KWP I than at Lālāmilo Wind Farm.

8.1.1. Collision Fatality Estimate

Four potential sources of direct bat mortality are associated with the proposed Project: 1) vehicle collisions, 2) fatalities occurring during construction and maintenance, 3) collisions with stationary objects (cranes, booms, buildings, etc.), and 4) collisions or other negative interactions with an operational turbine. The first three potential sources of direct take of bat mortality are considered negligible. Vehicle collisions are considered very unlikely because low speed limit signs will be posted and strictly enforced. Furthermore, nighttime traffic will be considerably limited, which further lessens the potential of vehicular fatalities. During construction and maintenance (in relation to the clearing of woody vegetation that is greater than 4.5 m [15 feet] high) of the Lālāmilo Wind Farm, direct take is expected to be negligible because there is very little if any potential roosting habitat in the form of woody vegetation present in the sparsely vegetated area near the Project Area. In addition, if trees greater than 4.5 meters must be cleared, tree removal will not occur between June 1 and September 15, when non-volant bats could be roosting in the trees. Because there is little to no potential roosting habitat in the Project Area and trees will not be cleared when non-volant bats could be present, the potential for take is negligible. Direct take associated with stationary objects is considered very unlikely because bats are generally able to aptly avoid these objects with normal abilities. The final and most likely potential source of direct take of the Hawaiian hoary bat at Lālāmilo Wind Farm would be the direct collision, or some other negative interaction of a bat with an operational turbine. For the reasons listed above, this is the only source of potential fatalities that is used to quantify direct take.

Given that 9 years of fatality data have been collected during operation of KWP I, we use the fatality rates at KWP I to estimate potential direct take resulting from turbine interactions at Lālāmilo Wind Farm. Acoustic monitoring of KWP I has indicated that bat activity is low in general, but higher than was detected at Lālāmilo Wind Farm. This may be because, there is suitable roosting habitat in the nearby forests at KWP I and very little roosting habitat near Lālāmilo. Therefore, it is expected that bat use of the Lālāmilo Wind Farm Project Area and nearby area would actually be less than at KWP I.

Table 8.2. Parameters Used in the Calculation of Adjusted Direct Take Estimation at Lālāmilo Wind Farm

Direct Take Component	Parameter	Estimate
KWP I bat fatality/turbine/year	Fatality $Rate_{KWP\ I}$	0.16
Typical number of Lālāmilo turbines in operation concurrently	$Turbines_{Lālāmilo}$	3
Rotor swept zone for a Lālāmilo Wind Farm turbine	$RSZ_{Lālāmilo}$	18,617 ft^2
Rotor swept zone for a KWP I turbine	$RSZ_{KWP\ I}$	41,888 ft^2
Estimated direct take (bats/year)	Direct $Take_{Lālāmilo}$	0.21

Eight bat fatalities have been observed at KWP I in 9 years of monitoring (Kaheawa Wind Power, LLC 2015), which is expanded to 28 bats after correcting for imperfect searcher efficiency and scavenger activity. This translates to approximately the observed take of one bat per year, or 0.16 bats per turbine per year. When calculating direct take at Lālāmilo Wind Farm, some adjustments were made so that a more accurate estimation could be prepared. First, instead of the twenty-turbine set up at KWP I, there are only five proposed turbines at Lālāmilo Wind Farm. However, typically only three of these turbines will be spinning concurrently at any time to meet the power demand. Moreover, the rotor swept zone (the 3-

dimentional volumes in which the rotor blades move in space) is one-fifth (0.20) at Lālāmilo Wind Farm of the rotor-swept zone of the turbines at KWP I. These adjustments are applied to calculate the annual take at Lālāmilo:

$\text{Direct Take}_{\text{Lālāmilo}} = \text{Fatality Rate}_{\text{KWP I}} * \text{Turbines}_{\text{Lālāmilo}} * (\text{RSZ}_{\text{Lālāmilo}} / \text{RSZ}_{\text{KWP I}})$

Or

0.21 bats/year = 0.06 fatalities/turbine/year* 3 turbines * (18,617 ft^2/41,888 ft^2)

When adjusting for the rotor swept zone size and number of proposed operating turbines at Lālāmilo Wind Farm, the estimated direct bat mortality at Lālāmilo Wind Farm is 0.21 bats per year. It is expected that SEEF will be higher at Lālāmilo Wind Farm because the ground cover is uniform buffelgrass, which is grazed to stubble and interspersed with bare ground. This is more optimal for SEEF than the wetter and more diverse conditions at KWP I. The unobserved take per observed take is therefore expected to be lower at Lālāmilo Wind Farm. However, to ensure a relatively conservative estimate, this is not taken into account in the take analysis, because this difference is difficult to quantify.

8.1.2. Indirect Effects Rising to the Level of Take

Indirect take is likely to occur in the form of mortality of an uncared for, dependent offspring as the result of a direct take of a parental bat. There are several variables that come into play when calculating indirect take: the proportion of take assumed to be adults, the proportion of take that is assumed to be female (only female bats care for dependent young), the proportion of the year that is the breeding season, the likelihood that the loss of a reproductively active female results in the loss of its offspring, and the average reproductive success. Table 7.3 outlines these criteria, gives a rationale for each of the variables used in the calculation of indirect take, and lists the estimated probabilities for indirect take as it relates to Lālāmilo Wind Farm.

Table 8.3. Assumptions of Indirect Take of the Hawaiian Hoary Bat at Lālāmilo Wind Farm

Component	Description/Rationale	Estimate
A. Annual direct take (bats/year)	Estimated annual direct take	0.21
B. Proportion of take that is adult	Erring towards a conservative estimate, it was assumed that all take at Lālāmilo Wind Farm would be adult individuals, despite the opportunity for first-year juveniles to pass through the Project Area.	1.00
C. Proportion of take that is female	Hawaiian hoary bats are assumed to have a ratio of 1:1. Furthermore, it is assumed there is no sex-based bias for differential susceptibility for fatal interaction with turbines. Therefore, approximately 50% of bats at Lālāmilo Wind Farm are assumed to be females.	0.50
D. Proportion of "year" that is breeding period (5 of 12 months)	Adults are present in the Project Area throughout the year (Insight Environmental 2013), but the breeding season is recorded as occurring from April to August (Menard 2001). Indirect take of an offspring can only occur from direct take of an adult during these months.	0.42
E. Proportion of breeding adults taken with dependent young	Juvenile bats are completely dependent on females until they are weaned, and therefore their survival depends on the mother bat's ability to provide care. Therefore, all direct take of females with young during the breeding season results in the offspring's indirect take.	1.00
F. Average offspring/breeding pair	Reproductive success based on Bogan (1972) and Koehler and Barclay (2000)	1.83
G. Annual indirect take (young/year)	Indirect take is estimated by multiplying the probabilities of lines A–F	0.08

8.1.3. Take Estimate

The maximum, estimated, annual take resulting from Lālāmilo Wind Farm project construction, operation, and maintenance based on the assumptions above is 0.21 adult bats per year and 0.08 young bats taken per year (see Table 7.3). The combined direct take and indirect take is 0.29 bats taken per year.

To determine the requested, authorized take levels of the Hawaiian hoary bat at Lālāmilo, a two-tiered approach was used. Given that very little potential roosting habitat occurs at or near the Project Area, the expected low levels of bat foraging activity, and the fact that the turbines at Lālāmilo will be curtailed at wind speeds at and below 5.0 m (16 feet) per second (See section 9.1), the calculated level of take is expected to be lower than estimated. Tier 2 was established based on the maximum level of take estimated whereas Tier 1 represents a value that is 50% of the Tier 2 estimation.

Predicted Observed Take:

- Tier 1: One adult and one juvenile over the 20-year permit period

- Tier 2: Two adults and two juveniles over the 20-year permit period

Derivation of take levels for each tier was calculated by extrapolating the annual estimated take over the 20-year project life span, rounding up to the nearest whole number. Tier 2 is based on direct take of 0.21 adults per year and indirect take of 0.08 young per year. Tier 1 is based on direct take of 0.10 adults and indirect take of 0.04 young per year. The expected risk and magnitudes of bat fatalities are expected to be lower than these estimates because the turbines are expected to curtail at wind speeds at and below 5.0 m (16 feet) per second during the night hours when bats are expected to be most active. The effects of low wind speed curtailment during the night are difficult to quantify and were not included into calculation of direct and indirect take estimations.

There is a degree of uncertainty when developing the prediction of take levels compared to the actual level of take. This is for various reasons, for example, scavenger carcass removal and SEEF rates may be different at Lālāmilo Wind Farm than at KWP I. Because of this degree of uncertainty, a request for authorization of take at Lālāmilo Wind Farm is made that is higher than the predicted take. Mitigation will occur accordingly. The requests of take were based on the maximum level of take of 0.29 bats per year for Tier 2, which is the predicted maximum annual rate. For Tier 1, the level of take was based on 0.15 bats per year.

Take Requests:

- Tier 1: Three bats over the 20-year permit period
- Tier 2: Six bats over the 20-year permit period

The number of bats in each tier reflects the total take requested, and therefore the tiers are not additive. Actual take will be recorded and adjusted based on post-construction fatality monitoring at Lālāmilo Wind Farm and will be reflective of SEEF and carcass removal rates. Should the results of the post-construction monitoring and fatality monitoring plan indicate that take levels will exceed Tier 1, then mitigation associated with the initiation of Tier 2 will occur: Tier 2 mitigation will be initiated if more than 66% of Tier 1 take (2 bats) has occurred before year 15.

8.1.4. Impacts of the Taking

The most recent population estimates of the Hawaiian hoary bat indicate that the species may range from several hundred to several thousand individuals (Menard 2001). However, although the overall population size is not known statewide, the largest subpopulations are thought to exist on the Islands of Kaua‘i and Hawai‘i. In addition, the population on Hawai‘i was thought to be either stable or increasing when monitored during the breeding seasons of 2007-2011 (Gorresen 2013). Because the levels of bat activity on-site are expected to be low at Lālāmilo Wind Farm and because a large population exists on Hawai‘i Island where Lālāmilo Wind Farm is to be located, the relatively low level of take expected by Lālāmilo Wind Farm is unlikely to result in a significant impact to the overall population of the Hawaiian hoary bat.

8.2. Hawaiian Petrel

8.2.1. Collision Fatality Estimate

Because the inland movements of Hawaiian petrels are nocturnal, radar surveys are an effective way to determine passage rates. These surveys are particularly useful in areas with relatively high seabird passage rates. However, seabirds, including the Hawaiian petrel, have very limited distribution and abundance on the Island of Hawai‘i (Ainley et al. 1997; Reynolds et al. 1997; Simons and Hodges 1998; Day et al. 2003). During radar surveys on the Island of Hawai‘i in 2001 and 2002, Day et al. (2003) recorded very low numbers of seabirds (0.0–3.2 targets per hour) flying inland at all sites sampled, with the exception of Waipi‘o Valley. Limitations of using radar surveys to determine seabird passage rates include the inability to distinguish between seabird species. Few, and often none, of the targets are visually observed and identified to species. In addition, other birds are similar to petrels in size and flight speed, resulting in target contamination. This results in a positive bias in passage rates. Species that artificially may inflate passage rates include sooty tern (*Onychoprion fuscatus*), mallard-Hawaiian duck hybrids (*Anas wyvilliana* x *platyrhynchos*), and Pacific golden-plover.

Although population viability analyses suggest that the Mauna Loa breeding population may not persist (Hu et al. 2001), breeding colonies of Hawaiian petrels at HVNP where predator control is implemented appear to be fairly stable over the past few years (NPS 2010, 2011, 2012). Birds outside of these somewhat protected areas are likely exposed to higher levels of predation, in particular by cats (Simons 1985; Natividad Hodges 1994; Winter 2003). The nearest location to the proposed Lālāmilo Wind Farm site where Day et al (2003) collected radar data in 2001 and 2002 is Kawaihae, which is at the coast, approximately 5 miles northwest of the proposed Lālāmilo Wind Farm. Passage rates recorded at Kawaihae during this study were 2.4 targets per hour.

ABR performed nocturnal radar surveys consisting of concurrent surveillance and vertical radar sampling at the proposed Lālāmilo Wind Farm for 10 days between June and July, 2015, during evening and morning hours when Hawaiian petrel activity levels peak. During this period, three seabird-like targets were documented. The fall 2013 radar survey results were not used to model annual fatalities because the data collected indicated obvious contamination from Pacific golden-plovers. Plovers are seasonal migrants that overwinter in the region and have radar target characteristics that often are impossible to distinguish from Hawaiian petrels and Newell’s shearwaters. Audiovisual sampling conducted during the 2013 studies indicated that Pacific golden-plovers were present in high numbers in the Project during the fall, and so summer-only passage rates were used for the fatality modeling (ABR 2015, Appendix C).

To determine the risk of collision-caused mortality, the following information was used to generate an estimate of exposure risk: mean passage rates of petrel/shearwater-like targets observed on radar in summer 2015, and dimensions and characteristics of the proposed wind turbines. Although none of the three targets flew below the maximum turbine height, flight altitudes measured from visual studies in the Hawaiian Islands were used to include a vertical probability (ABR 2015, Appendix C). ABR (2015) acknowledged that they could not identify the species by target, and therefore assumed that 50% of the targets were Hawaiian petrels, and 50% were Newell’s shearwaters (ABR 2015, Appendix C). However, considering the very low passage rates, and the fact that there is no recent confirmed breeding of Newell’s shearwaters on Hawaii, we assume all targets may have been Hawaiian petrels. This results in an estimated average passage, or exposure, rate of approximately 0.1 Hawaiian Petrels/yr possibly flying within the space occupied by each wind turbine. This calculation is explained in more detail on page 9 of ABR 2015 (Appendix C). Current evidence suggests the proportion of seabirds that would detect and avoid wind turbines is substantial and potentially ≥ 99% (Cooper and Day 1998; Tetra Tech 2008; KWP 2009, 2010), however, ABR used a conservative range of assumptions for avoidance rates in their fatality models (i.e., 90%, 95%, and 99% avoidance). Based on these calculations the estimated a collision-caused fatality rate is 0.00016–0.00414 Hawaiian Petrels/turbine/yr, and 0.016-0.414 Hawaiian petrel fatalities over the 20-year permit term. These should be considered as maximum estimates, because they are based on summer passage rates, which are expected to be higher than passage rates during the fall.

It is unlikely that a fatality will be detected during 20 years of operation. To cover for the stochastic event of an incidental take of Hawaiian petrels, the total direct take will be assumed to be two Hawaiian petrels

The collection cabling will be placed below ground, and the overhead transmission line conductors will be arranged in the same horizontal arrangement as, and will parallel, the existing transmission line. It will be designed to minimize the potential for collision by birds by constructing it lower than observed local seabird flight heights and fitting it with bird flight diverters, as necessary, consistent with APLIC guidelines. Therefore, the transmission lines do not pose significant additional risk of collision for the Hawaiian petrel. Given that the mean of the flight heights of all petrel-like targets was above turbine height during the 2015 radar survey, it is also unlikely collision with construction cranes or other similar equipment would pose significant additional risk.

8.2.2. Indirect Effects Rising to the Level of Take

Adult and immature Hawaiian petrels have the potential to collide with turbines and met towers while moving between nesting and feeding grounds during the pre-laying period (March–April) and breeding, incubation, and chick-feeding period (May–October). The risk of collision outside the pre-laying period or breeding period (November–February) is considered negligible because Hawaiian petrels do not return to land, and therefore would not be passing through the Project, during this period.

Take of an adult bird during the breeding, incubation, and chick-feeding period (May–October) could result in indirect effects to eggs or chicks if present. Effects could include the total loss of eggs or chicks. Survivability of offspring following take of one parent is dependent upon the time of year during which the parent is lost. Both parents alternate incubating the egg (May–June), allowing the other to leave the colony to feed. Therefore, during the incubation period, it is expected that both parents are essential for the successful hatching of the egg (Simons 1985). Both parents also contribute to feeding the chicks. Chicks are fed 95% of the total food they will receive from their parents within 90 days of hatching (Simons 1985). Because hatching generally occurs in late June, chicks should have received 95% of their food by the end of September. After September, it is likely that chicks could fledge successfully without further parental care because chicks have been documented as abandoned by their parents up to 3 weeks before successful fledging (Simons 1985). Consequently, it is considered probable that after the initial 90 days of parental care, chicks also would be capable of fledging if care was provided by only one parent. Therefore, for purposes of this HCP, both parents are considered essential to the survival of a Hawaiian petrel chick through September, after which a chick has a 50% chance of fledging successfully if adult take occurs (in October).

Not all adult Hawaiian petrels visiting a nesting colony breed every year. Simons (1985) found that 11% of breeding-age females at nesting colonies were not breeding. Eggs are laid and incubated between June and July, and an average of 74% of eggs hatch successfully (Simons 1985). Therefore, there is an 89% chance (100% - 11% = 89%) that an adult petrel taken from May through June was actually breeding or incubating and a 66% ($0.89 \times 0.74 = 0.66$) chance in July and August that the individual had successfully produced a chick. Most non-breeding birds and failed breeders leave the colony for the season by mid-August (Simons 1985). Therefore, there is nearly a 100% chance that birds taken in September or October are tending to young. Based on the above life history parameters and as identified in Table 7.7 below, indirect effects rising to the level of take (loss of eggs or chicks) will be assessed at a rate of 0.89 eggs per adult taken between May and July, 0.66 chicks per adult taken in August, 1.00 chick per adult taken in September, and 0.50 chick per adult taken in October.

Table 8.4. Calculation of Indirect Take for Hawaiian Petrel

Hawaiian Petrel	Season	Average No. of Chicks per Pair (A)	Likelihood of Breeding (B)	Parental Contribution (C)	Indirect Take (A × B × C)
Adult	March–April	–	0.00	–	0.00
Adult	May–July	1	0.89	1.0	0.89 egg
Adult	August	1	0.66	1.0	0.66 chick
Adult	September	1	1.00	1.0	1.00 chick
Adult	October	1	1.00	0.5	0.50 chick
Adult	November–April	–	0.00	–	0.00
Immature	All year	–	0.00	–	0.00

For the requested permitted take (observed and unobserved) of 2 birds, an indirect take of 1 eggs/chicks will be added to the total take request (see Table 7.7).

8.2.3. Take Estimate

Although the estimated incidental take is less than one individual over the life of the project, the take estimate for this species is based on one observed take over a 20-year period, to account for this stochastic event. Accounting for unobserved take, the projected direct take over 20 years is two birds. The addition of indirect take of one eggs/chicks brings the total take estimate to three birds.

8.2.4. Impacts of the Taking

The possible take of three Hawaiian petrels over the 20-year life of the ITP/ITL should not have an adverse, population-level effect on the species. Proposed mitigation measures will both 1) compensate for impacts of the Project take and 2) provide additional mitigation resulting in an overall net conservation benefit for the species (Section 9.3).

9. BEST MANAGEMENT PRACTICES AND MINIMIZATION AND MITIGATION MEASURES

9.1. General Measures

Implementation of the minimization measures listed below reduces the risk of adverse impacts on most natural resources to discountable levels. In the long term, the Project will result in a beneficial impact to the climate through a reduction in greenhouse gases, potentially as much as 11,000 metric tons of CO_2 per year (Tetra Tech, 2014), and reduced costs for the DWS that will be passed to its consumers.

The following minimization measures will be implemented to reduce the likelihood of potential impacts to non-listed birds (including MBTA-protected species), listed seabirds, and Hawaiian hoary bats:

- Minimize nighttime activities to avoid the use of lighting that could attract Hawaiian petrels and possibly Hawaiian hoary bats.

- Minimize use of on-site lighting at buildings and use shielded fixtures. Use on-site lighting on infrequent occasions, for safety reasons, when workers are at the Project at night.

- Observe a maximum speed limit of 40 km (25 miles) per hour while driving on-site, to minimize collision with covered species, in the event they are using habitat on-site or are injured.

- At the on-site operations and maintenance building, use light fixtures that will be shielded and directed downward to avoid attraction and disorientation of night-flying seabirds.

- Place the electrical collection line below ground, thereby reducing the risk of collision for birds and bats.

- The overhead transmission line conductors will be arranged in the same horizontal arrangement as, and will parallel, the existing transmission line, and will be designed to avoid the potential for collision by birds by fitting it with bird flight diverters consistent with APLIC guidelines, as determined necessary (APLIC 2012).

- Lālāmilo will maximize the amount of construction activity that can occur in daylight during the seabird breeding season to minimize the use of nighttime lighting that could be an attraction to night-flying seabirds. Nighttime lighting, which will be shielded, will be used only as needed for safety reasons. Lālāmilo will avoid nighttime construction during the peak fledging period (approximately October 15–November 23).

- Should nighttime construction be required, Lālāmilo will have a biological monitor in the construction area to watch for the presence of night-flying seabirds or bats. Should a seabird or bat be observed, the monitor will stop construction activities and shut down construction lighting until the individual or individuals move out of the area.

- Low-wind speed curtailment (feathering of blades into the wind) will be implemented daily between the hours of 6:00/6:30 p.m. (approximately 1 hour before civil sunset) and 06:30/07:00 a.m. (approximately 1 hour after civil sunrise) year round. This measure may result in less impact to seabirds and bats. The Vestas V47 turbines will be set to have a cut-in speed of 5.5 m (16 feet) per second, which is typically the standard for low-wind speed curtailment to reduce impacts to bats. Curtailment will be based on 10-minute average wind speeds from each turbine's anemometer.

- Typically, only three of five turbines will be in operation at any given time.
- Trees taller than 4.5 m (15 feet) will not be removed or trimmed during the pup-rearing season (June 1–September 15) to avoid impacts to Hawaiian hoary bats.
- To avoid potential for a bat to be caught on a barb, no barbed wire will be used at the project site during construction and maintenance.
- The establishment of tree tobacco and other known hosts of Blackburn's sphinx moth will be avoided during all maintenance, construction, and operations to prevent the establishment on the site of the moth in any of its life stages. All tree tobacco will be removed before reaching a height of 3 feet.
- Best Management Practices will be employed during construction, road building, and repair activities to avoid and minimize the risk of introduction of weedy and invasive species, such as ants and tree tobacco, during construction and maintenance.

- Best Management Practices will be employed to minimize introducing changes in the landscape that would attract fauna, such as altering flora and creating ponded water.
- Best Management Practices will be employed during construction, road building, and repair activities to minimize dust emissions.

9.2. Hawaiian Hoary Bat

Measures intended to avoid or minimize the likelihood of take of bat and avian species at wind farms often are related to the development (e.g., siting) and construction (e.g., seasonality) phases of a wind farm.

One measure often implemented during operation of a wind farm, and intended to minimize the risk of bat fatalities, is to increase the cut-in speed. Generally, data indicate that bat fatalities most commonly occur during lower wind speeds. Thus, applying brakes to the turbines or allowing them to feather and/or freewheel at less than 5.0 m (16 feet) per second may reduce the risk of fatality to bats. Gorresen et al. (2013) found that contrary to expectations, bat occupancy was no greater at less windy sites. Hawaiian hoary bats were as likely to occur at windy sites as at low-wind sites; however, the authors did not directly correlate activity levels and wind speeds. Although the study indicates that average wind speed is not an indicator of bat occupancy, it does not provide data to either support or refute the efficacy of this commonly implemented curtailment.

Lālāmilo will implement daily low-wind speed curtailment. Daily curtailment will consist of operating turbines at individually automated cut-out speed of 5.0 m (16 feet) per second, and cut-in speed of 5.5 m (18 feet) per second, between the hours of 6:00/6:30 p.m. (approximately 1 hour before civil sunset) and 6:30/7:00 a.m. (approximately 1 hour after civil sunrise), based on 10-minute average wind speeds from each turbine's anemometer. The low-wind speed curtailment threshold may be increased as part of an adaptive management strategy if it appears that bat fatalities are higher than anticipated. Because of the paucity of information regarding Hawaiian hoary bat population size, habitat use, and limiting factors, USFWS and DOFAW have recommended that mitigation for this species consist of a habitat management component and a research component. This mitigation plan incorporates both habitat management and applied research that are closely tied to the habitat management component.

In 2003, HVNP acquired the 61,053-ha (150,865-acre) Kahuku Unit. The area provides habitat for a number of rare, threatened, and endangered plant and animal species (Benitez et al. 2005; Tweed et al. 2007; Pratt et al. 2011), including the endangered Hawaiian hoary bats, which have been detected in a variety of forest habitats ranging from 609 m (2,000 feet) to 2,255 m (7,400 feet) in elevation in Kahuku (Fraser and Haysmith 2009).

Unfortunately, much of the lowland forest (< 1,372 m [4,500 feet] in elevation) is badly degraded by decades of land clearing and impacts by cattle, mouflon, and pigs. Large forest tracts have been converted to alien grass pastures with portions invaded by christmasberry (*Schinus terebinthifolius*) and incipient populations of strawberry guava (*Psidium cattleianum*) and kahili ginger (*Hedychium gardnerianum*). Park staff are constructing boundary fences and removing animals, but additional measures, such as invasive plant control and planting of native trees, are needed to facilitate forest recovery and restoration of wildlife habitat. Without active restoration, much of the area will remain dominated by nonnative pasture grasses without native forest regeneration.

The official mission of NPS is to "preserve unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations". This framework of preservation provides an ideal opportunity for mitigation partnerships in which mitigation funds are used to fund active conservation and restoration, in areas preserved by the NPS for purposes of preservation of natural scenery and historical objects. The Kahuku Unit of HVNP was acquired in 2003 for the preservation of habitat for threatened, endangered, and other rare plants and animals. To this end, NPS fenced large tracts of land within this unit, and removed ungulates to reduce the immediate threat to the preservation of these rare species and their habitat. Outside funding, such as mitigation funds, will be necessary to implement restoration methods to improve the habitat for these rare species. HVNP is listed by NPS as National Park with the second highest number of ESA-listed species. Restoration actions to address all of these species in the park will require considerable funds in addition to HVNP's operating funds. This provides an opportunity for this mitigation program to contribute to conservation of multiple species, in an area with long-term preservation guarantees.

The proposed restoration work will benefit the Hawaiian hoary bat along with seven additional listed endangered species; three species of concern, including ʻiʻiwi (*Vestiaria coccinea*), which is proposed for listing); and 17 locally rare species. Kahuku is also part of the Kaʻū Forest Complex, which is among the priority 1 watersheds designated by the state of Hawaiʻi because of high conservation value, unique ecosystems, and critically endangered rare plant and wildlife populations.

Objectives of the restoration are as follows:

1. Prevent establishment of target weed species to promote natural native plant recovery in the entire mitigation area.
2. Plant 80 nursery-reared seedlings per 1 acre and broadcast 50,000 seeds of important native species per 1 acre to facilitate forest recovery in former pasture in the Kahuku Unit.
3. Evaluate community vegetation changes within and outside of the active restoration area.

The methods of the restoration are as follows:

1. Prevent establishment of target weed species. Work crews will conduct ground searches to locate and target weed species throughout the mitigation area. Global positioning system (GPS) data will be collected for areas searched and number of plants treated. Target species will include blackberry (*Rubus discolor*), strawberry guava, kahili ginger, and christmasberry. Control methods will follow established park prescribed treatments for each species. Control will be carried out three times every year during the mitigation period.
2. Seeds of native tree and shrub species will be collected in the local area and processed for propagation. All propagation will be conducted at the HVNP native plant facility. Facilities will be kept free of pest species; individuals will be rigorously monitored and sanitized before planting to avoid contamination of target locations. Techniques for propagating and planting common native species have been developed and applied at HVNP. Before planting and seed broadcasting, alien grasses will be temporarily suppressed by applying a 2% solution of imazapyr and glyphosate. Planting and seeding will be strategically placed to link existing forest fragments or existing solitary trees throughout the mitigation area.
3. Monitor project success. Vegetation monitoring plots will be established both within and outside of the Project Area to evaluate impacts of management actions on the vegetation community composition and structure. Plots will be established in the first year of the project and re-surveyed at 5 and 10 years.

The project will be implemented according to the following schedule:

- Year 1: Begin project coordination and site visits with work leaders. Begin collection of plant material and propagation.
- Year 2–5: Begin planting of nursery reared seedlings. Complete planting of roughly half of the planed seedlings by year 5. Broadcast half of the seeds. Re-read monitoring plots at year 5. Conduct invasive plant sweeps and removal at year 2 and 5.

- Year 6–10: Complete planting of the remaining half of the nursery reared seedlings. Broadcast the remaining half of the seeds. Conduct invasive plant sweeps and removal at year 8. Re-survey monitoring plots at year 10.

USFWS and DOFAW have recommended that mitigation be conducted at a rate of 16 ha (40 acres) per bat, based on the approximate median core range sizes reported by Bonaccorso (2011, 2015). Based on this recommendation, the mitigation will be performed at 16 ha (40 acres) per bat, for half of the requested take of three Hawaiian hoary bats for Tier 1, plus for one additional bat to achieve net conservation benefit as required under HRS 195D-21. Lālāmilo will provide for restoration of habitat commensurate with the level of take.

USFWS requires that the habitat restoration project also include a bat monitoring component (D. Sether, USFWS, pers comm 08/17/2015). Acoustic bat detectors will be placed within the mitigation area to document call frequency as an index of Hawaiian hoary bat activity levels. This monitoring will occur prior to, and during the habitat restoration for a one-year period, and again at year 5, 10, and 20. In addition, the monitoring will occur during the 5-year Hawaiian bat research study described below.

Lālāmilo also proposes to fund a 5-year research project that will take place concurrent with restoration actions to inform future restoration efforts, to offset the incidental take of the remaining half of the requested take of three Hawaiian hoary bats under Tier 1. Sampling will occur every other year for 10 years, resulting in five years' data. The objective of the proposed research is to quantify the effectiveness of forest restoration actions for Hawaiian hoary bats based on bat activity and invertebrate availability.

The research objective will be accomplished by measuring three variables:

- Changes in Hawaiian hoary bat activity over time in restoration plots. This objective is included to fulfill the Hawaiian hoary bat monitoring requirement per USFWS.
- Hawaiian hoary bat activity inside restoration plots and non-restored plots
- Changes in insect biomass over time in restoration plots

Hawaiian hoary bat activity will be monitored with acoustic detectors (SM2BAT, SM3BAT, or SM4BAT models, Wildlife Acoustics). USFWS and DOFAW are currently developing standard sampling methodologies for Hawaiian hoary bat mitigation projects (D. Sether, USFWS, pers comm 08/17/2015). If these methodologies are agreed upon by DOFAW, USFWS, and Lālāmilo, sampling under this HCP will be consistent with those methodologies. Sampling sites will be deployed within the restoration and non-restoration units. Detectors in restoration and non-restoration units will be paired by habitat type. For example, for every sampling site deployed in invasive grassland habitat in the restoration unit, one will be deployed in invasive grassland habitat in a non-restoration unit. Bat passes will be quantified at each sampling site.

Invertebrate sampling will be conducted twice annually in the restoration units using light sampling methods. Light sampling will be conducted during the same moon phase and will take place for the same amount of time for every sampling effort. Invertebrates will be funneled into a collection device. They will be sorted into bat forage and non-forage groups. The forage group will be identified to species, if possible, and quantified for species richness.

Mean weekly and monthly bat passes will be compared within the restoration unit over time and among paired restoration and non-restoration units. Samples of invertebrate species richness will be compared over time. Year 1, which is before planting begins, will constitute baseline activity for comparisons over time.

Null Hypotheses:

- Bat activity will not change in restoration units over time.
- Bat activity will not differ between restored and non-restored units.
- Invertebrate richness in the restored units will remain the same over time.

If Tier 2 take levels are triggered, additional habitat restoration, commensurate with the level of additional take in Tier 2, will be implemented. In addition, the proposed research will be extended at a cost commensurate with the Tier 2 level of take.

On September 8, 2015, DOFAW introduced to the ESRC a white paper outlining new guidelines for ITL applicants regarding bat mitigation. The paper acknowledges challenges in designing mitigation plans due to paucity of data pertaining to Hawaiian hoary bat conservation, and directs applicants to include both research and habitat management in mitigation proposals. In addition, to provide a consistent and standard mitigation value for mitigation plans including research, the cost of mitigation per Hawaiian hoary bat was determined to be $50,000 (DOFAW 2015). The USFWS supports this means of standardization of mitigation (D. Sether, USFWS, pers comm 08/17/2015). Therefore, we include this standard in the mitigation plan for this HCP, and base the mitigation plan on an expense of $50,000 per Hawaiian hoary bat.

Hawaiian hoary bat mitigation will be deemed successful if all of the following occurs:

- The 5-year study has been completed, resulting in acceptance or rejection of the null hypotheses listed above.
- Goals, objectives, and timelines associated with reduction in targeted invasive species as identified in the mitigation proposal are met.
- Activities outlined in the forest restoration and management are executed.
- Status and results of the restoration and research efforts applicable (including expenses) to the appropriate tier are provided in annual reports to DOFAW and USFWS.
- Monitoring indicates a reduction in invasive species and increase in native species as targeted in the mitigation proposal.

9.3. Hawaiian Petrel

A rudimentary population estimate for the Hawaiian petrel on Hawaii suggests approximately 2,000 individuals (Cooper and Day 2004). HVNP currently has the largest, and possibly only active Hawaiian petrel colony on Hawaiʻi Island with an estimated 100 - 200 breeding pairs, with no other known significant colonies on this island (Pyle and Pyle 2009). This colony currently provides the only opportunity to implement conservation measures to benefit this species. Therefore, mitigation for Hawaiian petrels will take place at HVNP. Lālāmilo will provide an annual report to the agencies regarding mitigation activities for Hawaiian petrels.

The National Park Service (NPS) has developed a specific and complete proposal to protect a nesting population of the Hawaiian petrel on Mauna Loa in HVNP.

NPS is completing a cat-proof fence to exclude cats, and plan to remove any predators initially found inside the fenced area; conduct follow-up monitoring to assess colony response; and share information with the conservation community, including adjacent landowners.

Within the colony, currently unprotected from cats, 72% of observed fatalities are attributed to cats (personal communication, Rhonda Loh, NPS, June 30, 2014). Recently, mongooses have been detected at higher elevations than previously noted in the park, including in Hawaiian petrel habitat at over 8,000 feet. While a threat to the species on other islands, mongooses had not been detected in the HAVO colonies previously and represent a new threat. Between 2013 and 2016, NPS has constructed a fence that is based on a successful design used in Australia. Small-scaled tests have shown the fence design to be successful in keeping out mongoose as well as cats. The fence will protect 259 ha (640 acres) of nesting habitat containing approximately 45 active nests (personal communication, Rhonda Loh, NPS, June 30, 2014) and numerous additional burrow sites for future expansion of the sub colony.

Lālāmilo will provide funding to the NPS and ensure protection of the largest sub colony of Hawaiian petrels on the Island of Hawaiʻi from predatory cats and mongoose. Activities to achieve this will include removal of predators (cats and mongooses) from within the recently constructed exclosure (over 600 acres) surrounding a remote Hawaiian Petrel nesting colony, annual fence inspections to ensure fence integrity; surveillance to detect and respond to any incidents of ingress, andensuring that bird deterrent markings on fence are adequate and replaced as needed. Monitor the bird response to predator removal at intervals by assessing changes in nest density over time.

Based on this number, Lālāmilo will fund a portion of the total NPS protection project (Appendix A) that is commensurate with the level of take. Based on effectiveness monitoring by NPS, the mitigation project will be sufficient to 1) offset the impacts of requested take of Hawaiian petrels and 2) provide additional mitigation resulting in an overall net conservation benefit for the species. Funding details are included in Appendix A.

Success of mitigation measures may be measured by a reduction in observed mortality at the colony or increased productivity (average number of fledglings per pair) at the release site over baseline levels. In this case, a taken adult may be replaced through increased survival rates of adults in the area or adults may be replaced by fledglings. The number of fledglings produced will be the result of the difference in productivity before (baseline) and after the implementation of mitigation measures multiplied by the number of nesting pairs estimated to be within the mitigation area. The number of adults saved from predation will consist of the difference in adult survival rates before (baseline) and after the implementation of predator trapping, multiplied by the estimated number of adults within the mitigation area. Baseline levels will be obtained from a mitigation site with existing baseline data, or based on best available scientific data. The mitigation credit for this HCP will be determined by the proportion of the total project funded through this HCP. If mitigation credit falls short of what is required to fulfill statutory requirements, additional mitigation will be implemented at the site as part of adaptive management.

10. HABITAT CONSERVATION PLAN IMPLEMENTATION

10.1. Habitat Conservation Plan Administration

Lālāmilo will administer this HCP. The DLNR and USFWS, as well as experts and biologists from other agencies (e.g., U. S. Geological Survey), conservation organizations, consultants, and academia, may be consulted as needed. HCP-related issues may also be brought before the ESRC for formal consideration when deemed appropriate by Lālāmilo.

10.2. Monitoring and Reporting

Implementation of this HCP includes both compliance (i.e., fatality) monitoring and effectiveness monitoring. Compliance monitoring will be implemented to ensure accordance with the terms and conditions of the ITP (and ITL). Compliance monitoring will be funded by Lālāmilo as a separate expense. Effectiveness monitoring will be undertaken to assess the effectiveness of the HCP's minimization and mitigation measures toward meeting the biological goals and objectives described in Section 8. Effectiveness monitoring is funded and implemented as part of the proposed mitigation plans. The natural resources manager, with the aid of trained staff as appropriate, will coordinate all monitoring activities on-site and off-site. Monitoring efforts for which Lālāmilo is responsible are described in the following sections.

Pursuant to HRS Chapter 195D, DOFAW may conduct independent monitoring tasks during the life of the ITL to ensure compliance with the terms and conditions of the ITP/ITL. USFWS may also conduct inspections and monitoring in accordance with the ESA and its implementing regulations (currently codified at 50 CFR 13.47).

10.2.1. Compliance Monitoring

Fatality monitoring provides a scientifically defensible means of determining compliance with ITP/ITL take limits and authorizations. Lālāmilo, or an assigned third party, will conduct, systematic fatality monitoring to ensure adequate fatality search data are collected for the Project. Compliance monitoring as set forth below will be conducted in ITP/ITL year 1, 2, 5, 10, 15, and 20 and will be referred to as intensive monitoring. During the interim years, fatality monitoring as described below will be performed on a time schedule developed through adaptive monitoring and upon approval by USFWS and DOFAW. If high uncertainty of fatality estimate occur because of low searcher efficiency or high carcass removal, the wildlife agencies have the authority to require continued intensive monitoring.

Fatality monitoring of the site will be conducted weekly for every turbine during the intensive monitoring years. However, this may be increased as an adaptive management measure if carcass retention rates are lower than anticipated. Hull and Muir (2010) found that for small turbines (65 m [213 feet] hub height and 33 m [108 feet] blade length), 99% of bat fatalities landed within 45 m (147 feet) of the turbine base, and for medium-sized carcasses, 99% landed within 108 m (354 feet). Monitoring (search) plots at wind farms in Hawai‘i are typically 75% of turbine height. The radius of the monitoring plots will be 45 m (146.6 feet) (Figure 10.1).

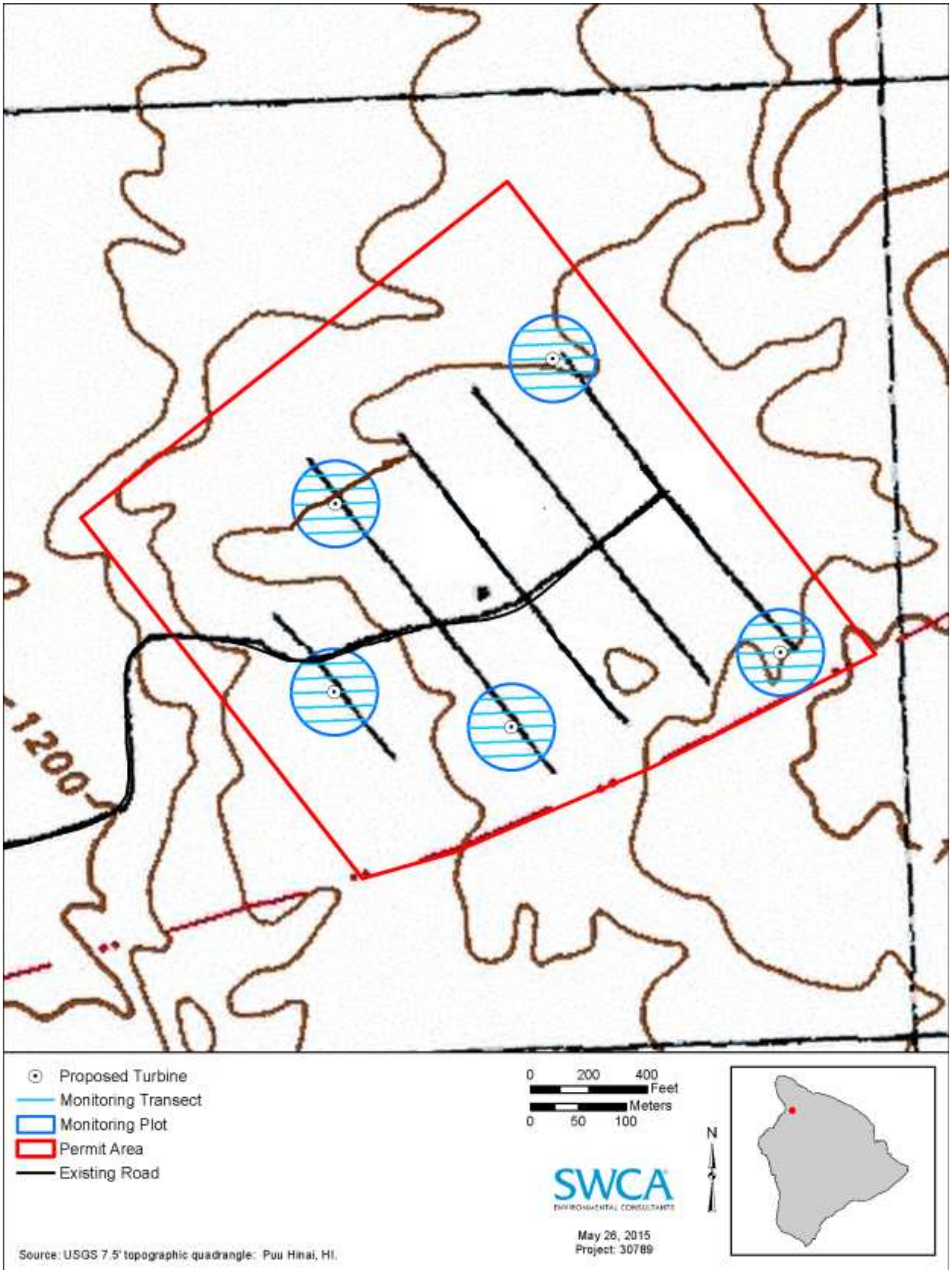

Figure 10.1. Monitoring (search) plots and transects.

To maximize a searcher's ability to spot carcasses, particularly those of small bats, the vegetation in the monitoring plots will be maintained short. Currently, the vegetation is very short and grazed to a stubble at the Project, making carcasses relatively easy to find. Continued grazing by cattle and goats will assure that additional, anthropogenic vegetation maintenance will not be necessary. The ground cover at the site is dominated by short grass interspersed with bare ground. Parallel transects across the monitoring plots will be staked approximately 5 m (16.4 feet) apart (see Figures 10.1). Searchers will follow the marked transects, searching 2.5 m (8.2 feet) on either side. One or more searchers on foot will conduct searching. All data collected—including information about any carcasses discovered, turbines searched, weather conditions, search dates, carcass retention (CARE) status, and SEEF status—will be digitized into a spreadsheet. Photographs will be taken and stored when relevant.

CARE and SEEF trials will be carried out each year when intensive fatality monitoring is conducted. These trials will determine how likely it is that a carcass landing in the monitoring plots is detected. Measuring SEEF and CARE at the Project on a regular basis is an essential part of the fatality monitoring program. Carcass removal rates will help fine-tune search intervals. The SEEF trials will be proctored by a third party and, to avoid searcher bias, staff responsible for the fatality searches will not be aware of when SEEF trials are being conducted.

For CARE and SEEF trials, two size classes (small and medium) of surrogate carcasses will be used in place of endangered species that are at risk of fatality by turbine activity. Dead rats will be used as surrogates for the Hawaiian hoary bat. The approximate body size of the rats is 11.5 cm (4.5 inches) long. For the medium size class, dead chickens will be used as surrogate carcasses for medium-sized birds such as Hawaiian petrels. Because the vegetation is homogenous across the site, a minimum of 20 small surrogates and 10 medium surrogates will be deployed for both SEEF and CARE trials annually. Additional surrogates will be deployed, if necessary, to ensure a minimum data necessary to run the fatality estimator.

A surrogate carcass will considered taken if fewer than 10 of its body feathers and/or fewer than two wing feathers remained (Young et al. 2012).

The study proctor will use Esri's Arc-GIS software to randomly determine the locations of surrogate CARE carcasses from a set of randomly generated GPS locations. The carcasses will be placed by navigating to a random point, then tossing the carcass over the shoulder to further avoid bias in the carcass placement. However, for rat carcasses with white stomachs, proctors will ensure that rats are placed stomach-down to more closely match the appearance of a dead Hawaiian hoary bat. The number of days that surrogate carcasses remain will be recorded either visually by the searcher or by deployed game cameras, which will record scavengers near (and potentially removing) the surrogate carcasses by motion-detecting sensors and digital images.

Surrogate SEEF carcass locations will also be chosen based on randomly generated GPS point locations within the monitoring plots. Rats will be used as surrogates for the Hawaiian hoary bat, which is consistent with other permitted wind farms. For the Hawaiian petrel, similar sized bird carcasses, most likely chickens, will be used in the SEEF trials. Proctors will place carcasses in the same manner as for CARE trials (see above) in the early morning on-site without searcher knowledge. The searcher must be unaware of either timing of SEEF trials or of the number of surrogate carcasses placed during SEEF trials. When the searcher finds a carcass, the approximate location, carcass type, and closest turbine will be communicated by email or text to the project coordinator. Efficiency will be determined as follows:

Searcher efficiency = number of surrogate carcasses found/total surrogate carcasses

After searches are completed for the day, the searcher will notify the project coordinator of any carcasses discovered during the search. Proctors will verify if any undiscovered carcasses are remaining. If so, the carcasses may be left in place to determine the likelihood that the searcher will find them the following week. If a carcass has gone missing or is not recovered after the second search attempt, then that specific trial will not be counted, because it cannot be verified that the carcass was actually in place during the search period. The data will be recorded with left- and right-censoring information so it can be subjected to the fatality estimator to develop r-hat values for the Evidence of Absence software. Results from SEEF and CARE trials, including the raw data, will be submitted to DLNR and USFWS annually.

Should take of any species occur, DLNR and USFWS will be notified as soon as possible within less than 24 hours by telephone (see Appendix B), and an incident report will be filed within 3 business days. Carcass handling is also described in Appendix B.

As noted above, intensive fatality monitoring will be conducted in years 1, 2, 5, 10, 15, and 20 following issuance of the ITP/ITL. In accordance with the Downed Wildlife Protocol promulgated by DLNR (see Appendix B), biologists at DLNR and USFWS will be notified whenever any species (MBTA, non-covered, or covered) is found dead or injured, as described in the previous paragraph and Appendix B. Any changes to monitoring will only be made with the concurrence of USFWS and DLNR.

In addition to fatality searches, Lālāmilo personnel will be trained to look for and identify covered species. This will ensure ongoing monitoring of the property.

During the interim years, fatality monitoring, SEEF, and CARE trials, as described above will be performed on a time schedule developed through adaptive monitoring and upon approval by USFWS and DOFAW.

10.2.2. Effectiveness Monitoring

NPS carries out effectiveness monitoring for habitat restoration for the Hawaiian hoary bat and mitigation for Hawaiian petrels. Petrel burrows will be monitored every year to evaluate the number of active burrows and reproductive success in the fenced area. This will be compared to the baseline data collected by NPS to date to determine the success of the mitigation measures. For the Hawaiian hoary bat habitat restoration, NPS will monitor success of invasive species control and native plant establishment.

Unless otherwise specified, measures included in this HCP will be considered successful if they have been implemented as described in this document and as agreed upon with DLNR and USFWS. Mitigation measures go directly toward effectively achieving the biological goals and objectives described in Section 8. Implementation of mitigation measures will be reported annually to the DLNR and USFWS as described in detail below.

10.2.3. Reporting

Annual reports summarizing all activities implemented under this HCP and per the conditions of the ITP/ITL will be submitted by Lālāmilo to the DLNR and USFWS. These reports will describe the results of compliance (i.e., fatality) and effectiveness monitoring, including 1) actual frequency of monitoring of individual search plots; 2) results of SEEF and CARE trials with recommended statistical analyses, if any; 3) directly observed and adjusted levels of incidental take for each species; 4) whether there is a need to modify the mitigation for subsequent years; 5) efficacy of monitoring protocols and whether monitoring protocols need to be revised; 6) results of mitigation efforts conducted; 7) recommended changes to mitigation efforts, if any; 8) budget and implementation schedule for the upcoming year; and, 9) continued evidence of Lālāmilo's ability to fulfill funding obligations. The annual report will be submitted electronically by August 1 each year along with electronic copies of relevant data. The report will cover the period from June of the current year to July of the previous year. USFWS will have 30 calendar days to respond to the report. DOFAW will respond to the report as soon as possible. After agency responses are received, a final report incorporating responses to the agencies will be submitted.

11. ADAPTIVE MANAGEMENT

Per USFWS policy (see 65 Fed. Reg. 35242 [June 1, 2000]), *adaptive management* is defined as a formal, structured approach to dealing with uncertainty in natural resources management, using the experience of management and the results of research as an on-going feedback loop for continuous improvement. Adaptive approaches to management recognize that the answers to all management questions are not known and that the information necessary to formulate answers is often unavailable. Adaptive management also includes, by definition, a commitment to change management practices when determined appropriate to maintain compliance with the terms and conditions of an ITP and ITL.

Data resulting from compliance (i.e., fatality) and effectiveness monitoring, or significant and relevant new information published, may indicate the need for adaptive management. Any such changes will require the approval of the USFWS and DLNR.

After review of the annual monitoring report and in cooperation with DLNR and USFWS, or if the need for adaptive management becomes otherwise evident, Lālāmilo may implement adaptive management changes approved by the DLNR and USFWS to measures described in this HCP, if warranted, to meet the biological objectives described in this HCP.

11.1. Funding

Consistent with ESA Section 10 and HRS Chapter 195D, a funding plan has been designed to ensure that all identified conservation actions described in this HCP will be funded in whole. Costs included in this HCP constitute a best estimate based on information available at this time.

Prior sections of this HCP describe measures that Lālāmilo will undertake to minimize, mitigate, and monitor the incidental take of covered species. Further, this HCP describes minimization and mitigation measures intended to provide a net conservation benefit, as measured in biological terms pursuant to HRS Chapter 195D. This section summarizes planning-level cost estimates to implement the HCP, and describes timing of funding and funding assurances. As described in the funding assurances section below, Lālāmilo is responsible for covering all costs to meet mitigation obligations detailed out in Appendix A. All cost estimates are stated in constant 2015 dollar terms.

11.1.1. Habitat Mitigation Investments

HCP implementation will require investment in mitigation listed below and as described in Section 9 in detail:

- Hawaiian hoary bat habitat restoration and research (Section 9.2)
- Hawaiian petrel (Section 9.3)

11.1.2. Funding Strategies

The funding approach is based on the following:

As detailed in Appendix A, direct operator funding of all one-time mitigation costs needed for the Hawaiian petrel and Hawaiian hoary bat. Tier 1 proposals will be provided on an up-front lump-sum basis upon issuance of the ITP/ITL. All other demonstrable expenses for mitigation costs for the covered species spanning the life of the ITP/ITL will be paid out on an annual, quarterly, or monthly basis, as applicable. Tier 2 mitigation will be implemented if more than 66% of the Tier 1 take limit has been reached within the first 15 years of the permit lifetime. Any annually protracted mitigation requiring protection from inflationary pressures will be adjusted to reflect changes in the gross domestic product implicit price deflator.

11.1.3. Funding Assurances

Funding assurances are required to remain in compliance with the ITP/ITL. All one-time mitigation costs will be funded upon issuance of the ITP/ITL. A letter of credit or other similar instrument naming the DLNR as beneficiary will secure annual mitigation and monitoring expenses for Tier 1. The letter of credit will be renewed on an annual basis based on the outstanding mitigation cost at the start of the following year. Additional expenses for Tier 2 bat mitigation will be included in the letter of credit in the event that Tier 2 mitigation is triggered. Tier 2 mitigation will be initiated and the funding assurance put into place if more than 66% of Tier 1 bat take (2 bats) has occurred before year 15. The purpose of the letter of credit will be to secure the necessary funds to cover any remaining mitigation and monitoring measures in the unlikely event that there are unmet mitigation obligations due to partnership dissolution.

11.2. No Surprises Assurances

This HCP incorporates by reference the ITP assurances set forth in the Habitat Conservation Plan Assurances (“No Surprises”) Rule adopted by the USFWS, published in the *Federal Register* on February 23, 1998 (*Federal Register* 1998), and codified at 50 CFR 17.22 (b)(5). This rule provides that once an incidental take permit has been issued, and so long as the HCP is being properly implemented, the USFWS will not require the commitment of additional conservation or mitigation measures by the permittee (including additional land, water, or financial contribution, or additional restrictions on the use of land, water, or other natural resources) beyond the level provided in the HCP, without the permittee’s consent.

To implement these assurances, an HCP must identify and analyze reasonably foreseeable, changed circumstances that could affect a species or geographic area during its term (50 CFR 17.3). Should such a changed circumstance occur, the permittee is required to implement the measures specified in the HCP to respond to this change.

The “No Surprises” policy assurances only apply to species adequately covered in the HCP, and does not apply if permitted take is exceeded. Adequately covered species are those species covered by the HCP that satisfy the ITL issuance criteria under HRS Section 195D-21. The species considered adequately covered in this HCP, and therefore covered by the “No Surprises” policy assurances, are the Hawaiian hoary bat and Hawaiian petrel.

11.3. Changed Circumstances

Changed circumstances are *changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that can reasonably be anticipated by plan or agreement developers and the Service and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)* (50 CFR 17.3).

The following lists changed circumstances and methods for adapting the HCP in response to each:

1) The USFWS delists a covered species.

   Should a covered species be delisted during the term of the ITP/ITL, it is expected that the program provided for in this HCP will have contributed in some part to the delisting of the species. Therefore, measures addressing that species will continue in accordance with the HCP, unless and until USFWS and DLNR agree such actions may be discontinued.

2) The USFWS lists a species occurring in the Project Area or a listed species not covered in the HCP begins using the Project Area.

   Lālāmilo will evaluate the likelihood of take as a result of the Project should one or more species that occur in, or transit through, the Project Area be listed pursuant to the ESA or if a listed species not covered in the HCP begins using the habitat of the Project Area. If take of the species is likely, Lālāmilo will seek coverage for the species under an amendment to this HCP or through a separate HCP or Section 7 consultation.

3) Empirical data indicate covered activities do not result in incidental take of a covered species, or result in a different level of incidental take than that anticipated in the HCP.

   Should monitoring results or data from third-party studies indicate a covered species is not being incidentally taken, or is being taken at levels different than that anticipated by this HCP, Lālāmilo will consult with DLNR and USFWS to determine if changes to the Project operation conditions in the HCP are warranted and if necessary, to seek an amendment to the ITP and ITL.

4) New deterrent technology or other take avoidance or minimization methods become available to address take of covered species.

   Lālāmilo may evaluate the value and practicality of using new deterrent technology should it become available. Should Lālāmilo seek to employ new technology, and should the use of such be demonstrated to minimize or avoid take of a covered species, Lālāmilo may consult with the USFWS and DLNR to amend the ITP and ITL if desired. The evaluation and use of new deterrent technology will be at the discretion of Lālāmilo.

5) Disease outbreaks in covered species

   Should prevalence of disease increase substantially and become identified by DLNR and USFWS as a major threat to the survival of a covered species, Lālāmilo will consult with the agencies to determine if changes in monitoring, reporting, or mitigation are warranted. Any such changes will be approved by DLNR and USFWS and will be performed to achieve mitigation objectives described in the HCP. Changes to the mitigation budget will be made with the approval of Lālāmilo, USFWS, and DLNR.

6) Deleterious changes occur in relative abundance of non-native plant species, ungulates, parasites, or predators occurring at mitigation sites.

   Should the proportion or coverage of non-native plant species, parasites, or predators increase at a mitigation site and result in substantial habitat loss or degradation, or in a decline of species population at the site, Lālāmilo will consult with DLNR and USFWS to determine if measures to prevent the further spread of non-native plants, parasites, or predators are available, practical, and necessary. If no new options are available or practical, mitigation for the covered species may be implemented at another site with approval of DLNR and USFWS.

7) Natural/anthropogenic disasters (e.g., hurricanes, severe storms, fires) substantially alter the status of a covered species.

   Natural and anthropogenic disasters, including hurricanes, severe storms, and fires, have potential to alter the status of one or more of the covered species on Hawaiʻi and, consequently, alter the relative importance of the incidental take of individuals. Such disasters could result in loss of habitat, decreased suitability of available habitat, and could hinder or disrupt mitigation efforts. If such changes occur as a result of natural or anthropogenic disasters, Lālāmilo will coordinate with USFWS to determine if any changes to operation of the HCP and mitigation areas are warranted.

8) Global climate change substantially alters status of the covered species.

   Global climate change within the life of the ITP /ITL (20 years) conceptually has the potential to affect covered species through region-wide changes in weather patterns, sea level, average temperature, and levels of precipitation affecting the species or their habitats (Intergovernmental Panel on Climate 2007). Covered species may be affected through changes in temperature, precipitation, the distribution of their food resources, and possible changes in the vegetation at their preferred habitats.

   As an expected result of global climate change, hurricanes or storms may occur with greater intensity (Webster et al. 2005; US Climate Change Science Program 2009), which may increase the risk of damage to established mitigation sites. Sea level is predicted to rise approximately 1 m in Hawaiʻi by the end of the twenty-first century (Fletcher 2009). Given this prediction, any rise in sea level experienced during the life of the Project likely will be less than 1 m (3 feet).

   Precipitation may decline by 5%–10 % in the wet season and increase 5% in the dry season, due to climate change (Giambelluca et al. 2009). This may result in altered hydrology at mitigation sites. Vegetation may change with decreased precipitation or increased temperatures and threat of fire. Other mitigation sites may be considered for continued mitigation if selected sites are considered no longer suitable. The alternate mitigation site(s) will be chosen in consultation with USFWS and DLNR.

   Overall, if changes substantially affecting one or more covered species occur as a result of global climate change, Lālāmilo will coordinate with DLNR and USFWS to determine if changes to operation of the HCP are warranted. Any changes will be performed to meet objectives of the HCP.

9) More than three (3) turbines need to be routinely operational at one time.

   The power demand for this Project do not require more than three turbines to be spinning at one time. Should the power demand change within the life of the ITL/ITP, resulting in the need for routine operation of more than three turbines, Lālāmilo will assess if current mitigation will be sufficient to offset total anticipated incidental take. If the projected take under the new operating conditions are expected to exceed that covered by proposed mitigation, Lālāmilo will consult with DLNR and USFWS to determine if an amendment to the ITP and ITL should be sought.

If changed circumstances occur that are not provided for in this section, and the HCP is otherwise being properly implemented, the USFWS and DLNR will not require any conservation and mitigation measures in addition to those provided for in the HCP without the consent of Lālāmilo.

11.4. Unforeseen Circumstances and "No Surprises" Policy

Unforeseen circumstances are changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that could not reasonably have been anticipated by the plan or agreement developers and the Service at the time of the conservation plan's or agreement's negotiation and development, and that result in a substantial and adverse change in the status of the covered species (50 CFR 17.2).[1] Under the No Surprises policy, with a properly implemented HCP, Lālāmilo will not be required to commit additional land, water, money, or financial compensation, or be subject to additional restrictions on land, water, or other natural resources to respond to such unforeseen circumstances beyond what has been agreed upon in this HCP unless it is with the consent of Lālāmilo. For the purposes of this HCP, changes in circumstances not provided for in section 11.3 that substantially alter the status of the covered species are considered unforeseen circumstances.

In negotiating unforeseen circumstances, the USFWS will not require the commitment of additional land, water or financial compensation or additional restrictions on the use of land, water or other natural resources beyond the level otherwise agreed upon for the species covered by the HCP without the consent of the Applicant [50 CFR 17.22(b)(5)(iii) and 50 CFR 17.32(b)(5)(iii)].

11.5. Notice of Unforeseen Circumstances

The USFWS and DLNR will have the burden of demonstrating based on best available scientific and commercial data that unforeseen circumstances have occurred. The USFWS and DLNR will notify Lālāmilo in writing should the USFWS or DLNR believe that an unforeseen circumstance has arisen.

11.6. Amendment Procedures

Different procedures allow for the amendment to the HCP and ITP/ITL. However, the cumulative effect of any amendments must not jeopardize any listed species. USFWS and DLNR must be consulted on all proposed amendments. Amendment procedures are described below.

11.6.1. Minor Amendments

Informal, minor amendments are permissible without a formal amendment process provided that the change or changes necessitating such amendment or amendments do not cause a net adverse effect on any of the covered species that is significantly different from the effects considered in the original HCP. Such informal amendments could include routine administrative revisions or changes to surveying or monitoring protocols that do not decrease the level of mitigation or increase take. A request for a minor amendment to the HCP and ITP/ITL may be made with written notice to USFWS and DLNR. A public review process may be required for the minor amendment. The amendment will be implemented upon receiving concurrence from the agencies.

[1] This HCP incorporates by reference the ITP assurances set forth in the Habitat Conservation Plan Assurances ("No Surprises") Rule adopted by the USFWS, published in the *Federal Register* on February 23, 1998 and codified at 50 CFR 17.22 (b)(5).

11.6.2. Formal Amendments

Formal amendments are required when Lālāmilo wishes to significantly modify the Project already in place. Formal amendments are required if the change or changes necessitating such amendment or amendments could produce a net adverse effect on any of the covered species that is substantially different from those considered in the original HCP and ITP/ITL. For example, a formal amendment will be required if the documented level of take exceeds that covered by the ITP/ITL. A formal amendment also will be required if take of another ESA-listed species not adequately covered by the ITP/ITL becomes likely.

The HCP and ITP/ITL may be formally amended upon written notification to USFWS and BLNR with the supporting information similar to that provided with the original ITP/ITL application. The need for a formal amendment should be determined at least 1 year before ITP/ITL expiration to allow for development of the amendment application and subsequent processing before expiration of the original ITP/ITL. A formal amendment may require additional or modified minimization and/or mitigation measures, and/or additional or modified monitoring protocols. It may also require a supplemental NEPA evaluation and additional public review.

11.7. Renewal and Extension

This HCP proposed by Lālāmilo may be renewed or extended, and amended if necessary, beyond its initial 20-year term with the approval of USFWS and BLNR. A written request will be submitted to both agencies that will certify that the original information provided is still current and conditions unchanged or that will provide a description of relevant changes to the implementation of the HCP that will take place. Such a request shall be made at least 180 days before the conclusion of the term of the ITP/ITL. Under federal law, the HCP shall remain valid and in effect while the renewal or extension is being processed, but under State of Hawai‘i law, the HCP will remain valid and in effect during processing only if the renewal or extension is processed during the original ITP/ITL term. If a decision is made to not renew or extend the permit term, decommissioning will be completed during the term of the permit.

11.8. Other Measures

An implementing agreement stipulating the HCP’s terms and conditions in contractual form will be signed by all parties (Lālāmilo, USFWS, and DLNR).

12. ALTERNATIVES

ESA Section 10(a)(2)(A)(iii) requires that an applicant consider and include in the HCP a description of alternative actions to the proposed take authorization that were considered but not adopted. Additionally, an applicant must describe why those alternatives are not being used.

12.1. No Action Alternative

Under the No Action alternative, the Project will not be constructed, and wind-generated electricity will not be supplied to the Lālāmilo-Parker well system. The No Action alternative will have no effect to resources of the biological or human environment, including the beneficial effects of stabilizing water rates for consumers and providing a clean, renewable source of energy to the pumps. Therefore, it will not meet the purpose of and need for the Project, which is to provide a cost savings to DWS consumers over the long term and contribute to the state's Clean Energy Initiative goal.

12.2. Alternatives Eliminated From Further Study

This section describes alternatives that were considered but eliminated from detailed study in this HCP.

12.2.1. Alternative Type of Renewable Energy

The DWS's intent in proposing this Project is to reduce energy costs for water customers by replacing a large portion of its pumping energy demands with renewable wind energy at a discounted rate, as compared with current HELCO rates. Other types of renewable energy technology could be considered for powering the DWS's wells including geothermal, pumped storage hydroelectric, or solar. However, these sources were considered infeasible due to the lack of resource (i.e., insufficient geothermal in the South Kohala region); inadequate available or controlled land area (i.e., not enough water storage capacity for pumped-storage hydroelectric) or space required for the quantity of solar panels necessary to meet generation needs of the Project; or excessive capital costs to develop, construct, and operate (i.e., pumped-storage hydroelectric and solar).

In December 2009, the NREL under the U.S. Department of Energy (DOE) conducted a preliminary analysis for repowering the original Lālāmilo Wind Farm by replacing the original 120 Jacobs wind turbines with modern technology. DOE categorize the wind farm site as a Class 7 "Optimal" wind resource, which is the highest classification for a wind energy project. Additionally, some of the facilities and infrastructure from the original wind farm, which could be used for a repowered wind farm, were left in place after decommissioning the site in 2010. These included an office building/workshop, power poles, power transmission lines, conduits, radio towers, and internal access roads. Thus, in light of the DOE's classification of the wind resource in the Project Area as optimal for a wind farm, and the historical use of the site as a wind farm, alternative forms of renewable energy were eliminated from further consideration.

12.2.2. Larger or Smaller Wind Projects

The Project is intended to produce an amount of energy roughly equivalent to the original Lālāmilo Wind Farm. The preliminary analysis conducted by NREL (NREL 2009) was performed to assess the technical economic viability of a project. The analysis used the Micropower Optimization Model HOMER to optimize the capacity of wind power that will yield the lowest Levelized Cost of Energy for the DWS. The analysis concluded that the 120 original Jacobs turbines could be replaced by 1–10 modern turbines, depending on the technology and unit size selected.

The proposed Project will result in 3.3 MW of generation capacity from five turbines. A smaller project would not provide as much of an economic benefit for the DWS and would not meet the purpose of, and need for the Project, or the Project's goals for percent of fossil-fuel generated energy usage with renewable energy. A larger project would exceed the current load demand of the existing Lālāmilo-Parker pumps, and because HELCO cannot currently accept any as-available energy to the grid if the amount of wind energy generated exceeds the amount of energy required by the pumps, there is no benefit to the owner/operator of the wind farm to offset capital costs for more generation capacity. Therefore, smaller or larger projects were eliminated from further consideration at this time.

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Appendix A. Mitigation Costs and Funding

Appendix B. Incidental Report Form and Downed Wildlife Protocol

Appendix C. Summer 2015 Radar Survey Report

Appendix A

Appendix !: Lalamilo HCP Funding Matrix

Category	Tier	Item	One-time cost	Annual expense	Years	20- year Total	Timing of expense
Compliance		Compliance monitoring weekly	$ -	$ 45,000	5	$ 225,000	Annual basis
		Compliance monitoring every other week	$ -	$ 10,000	15	$ 150,000	Annual basis
		Compliance monitoring by DOFAW		$ 20,000	15	$ 300,000	Annual basis when required
Hawaiian Hoary Bat	Tier 1	Onsite acoustic monitoring	$ 10,000	$ -	4	$ 40,000	Annual basis
		Habitat Restoration at HAVO Kahuku Unit		$ 4,000	10	$ 40,000	Annual contribution
		Mitigation research		$ 14,000	5	$ 70,000	Annual basis
	Tier 2	Additional Habitat Restoration at HAVO Kahuku Unit	$ -	$ 3,500	10	$ 35,000	Annual contribution
		Mitigation research	$ -	$ 13,000	5	$ 65,000	Annual basis
Hawaiian Petrel		Colony protection at HAVO	$ 112,000	$ -	-	$ 112,000	Within 30 days of obtaining ITL/ITP
Subtotal		Compliance Monitoring				$ 675,000	
Subtotal		Tier 1 mitigation (all species)				$ 262,000	
Subtotal		Tier 2 mitigation (bats)				$ 100,000	
Subtotal		Tier 1-2 Mitigation				$ 362,000	
Total						$ 1,037,000	

Appendix B

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

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

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 268 – 5087, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Molokai	(808) 553 – 1745, (808) 870 – 7598	(808) 870 – 7598
Lanai	(808) 565 – 7916, (808) 357 – 5090	(808) 357 – 5090
East Hawaiʻi	(808) 974 – 4221, (808) 974 – 4229	(808) 640 – 3829
West Hawaiʻi	(808) 887 – 6063	(808) 339 – 0983
Oʻahu	(808) 973 – 9786, (808) 295 – 5896	(808) 295 – 5896, (808) 226 – 6050
Kauaʻi	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117 [Secondary: (808) 348 – 5835 for Hokuala (Kauai Lagoons) HCP and Kauai Nene HCP; (808) 212 – 5551 for Kauai Seabirds HCP and KIUC Short-term HCP]	(808) 645 – 1576, (808) 635 – 5117

Fill out information on the downed wildlife form.

OVERVIEW

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

DOWNED WILDLIFE PROTOCOL

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

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

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

PREPARING TO RESPOND FOR DOWNED OR INJURED BIRDS AND BATS

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

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

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

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

DOWNED WILDLIFE PROTOCOL

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

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

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

IF YOU FIND A LISTED DECEASED BIRD OR BAT:

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

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

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 268 – 5087, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Molokai	(808) 553 – 1745, (808) 870 – 7598	(808) 870 – 7598
Lanai	(808) 565 – 7916, (808) 357 – 5090	(808) 357 – 5090
East Hawaiʻi	(808) 974 – 4221, (808) 974 – 4229	(808) 640 – 3829
West Hawaiʻi	(808) 887 – 6063	(808) 339 – 0983
Oʻahu	(808) 973 – 9786, (808) 295 – 5896	(808) 295 – 5896, (808) 226 – 6050
Kauaʻi	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117 [Secondary: (808) 348 – 5835 for Hokuala (Kauai Lagoons) HCP and Kauai Nene HCP; (808) 212 – 5551 for Kauai Seabirds HCP and KIUC Short-term HCP]	(808) 645 – 1576, (808) 635 – 5117

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

DOWNED WILDLIFE PROTOCOL

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

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

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

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

1. Fill out a Downed Wildlife Form (attached). Make written notes concerning the location including GPS points, circumstances surrounding the incident, condition of the animal, and what action you and others took. This information should be reported to the appropriate official(s), including DOFAW and USFWS HCP staff, within 3 days. For DOFAW send to the following email address: dofaw.hcp@hawaii.gov.

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

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

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

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 268 – 5087, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Molokai	(808) 553 – 1745, (808) 870 – 7598	(808) 870 – 7598
Lanai	(808) 565 – 7916, (808) 357 – 5090	(808) 357 – 5090
East Hawaiʻi	(808) 974 – 4221, (808) 974 – 4229	(808) 640 – 3829
West Hawaiʻi	(808) 887 – 6063	(808) 339 – 0983
Oʻahu	(808) 973 – 9786, (808) 295 – 5896	(808) 295 – 5896, (808) 226 – 6050
Kauaʻi	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117 [Secondary: (808) 348 – 5835 for Hokuala (Kauai Lagoons) HCP and Kauai Nene HCP; (808) 212 – 5551 for Kauai Seabirds HCP and KIUC Short-term HCP]	(808) 645 – 1576, (808) 635 – 5117

DOWNED WILDLIFE PROTOCOL

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

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

2. 5. Fill out a Downed Wildlife Form (attached). Make written notes concerning the location including GPS points, circumstances surrounding the incident, condition of the animal, photo documentation and what action you and others took. This information should be reported to the appropriate official(s) including DOFAW and USFWS HCP staff within 3 days. For DOFAW send to the following email address: dofaw.hcp@hawaii.gov.

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

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

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

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

Island	Primary Contact	After business hours/weekends
Maui	(808) 984 – 8100 (808) 268 – 5087, (808) 280 – 4114	(808) 264 – 0922 (808) 280 – 4114
Molokai	(808) 553 – 1745, (808) 870 – 7598	(808) 870 – 7598
Lanai	(808) 565 – 7916, (808) 357 – 5090	(808) 357 – 5090
East Hawaiʻi	(808) 974 – 4221, (808) 974 – 4229	(808) 640 – 3829
West Hawaiʻi	(808) 887 – 6063	(808) 339 – 0983
Oʻahu	(808) 973 – 9786, (808) 295 – 5896	(808) 295 – 5896, (808) 226 – 6050
Kauaʻi	(808) 274 – 3433 (808) 632 – 0610, (808) 635 – 5117 [Secondary: (808) 348 – 5835 for Hokuala (Kauai Lagoons) HCP and Kauai Nene HCP; (808) 212 – 5551 for Kauai Seabirds HCP and KIUC Short-term HCP]	(808) 645 – 1576, (808) 635 – 5117

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

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

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

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

7. Fill out a Downed Wildlife Form (attached) and report to the appropriate official(s) including DOFAW and USFWS HCP staff within 3 days. For DOFAW send to the following email address: dofaw.hcp@hawaii.gov.

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

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

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

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

DOWNED WILDLIFE FORM
LISTED SPECIES

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

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

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

Additional Comments:

IF YOU FIND DOWNED NON-LISTED WILDLIFE:

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

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

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

DOWNED WILDLIFE FORM
NON-LISTED SPECIES

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

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

Appendix C

RADAR AND VISUAL STUDIES OF HAWAIIAN PETRELS AND NEWELL'S SHEARWATERS AT THE PROPOSED LALAMILO WIND ENERGY PROJECT, ISLAND OF HAWAII, SUMMER 2015

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PREPARED BY
ABR, INC.–ENVIRONMENTAL RESEARCH & SERVICES
FOREST GROVE, OR

RADAR AND VISUAL STUDIES OF HAWAIIAN PETRELS AND NEWELL'S SHEARWATERS AT THE PROPOSED LALAMILO WIND ENERGY PROJECT, ISLAND OF HAWAII, SUMMER 2015

FINAL REPORT

Prepared for

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October 2015

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EXECUTIVE SUMMARY

- The County of Hawaii Department of Water Supply and Lalamilo Wind Company, LLC are interested in repowering the Lalamilo Wind Energy Project (hereafter Project) on the island of Hawaii. This report summarizes the results of a radar and audiovisual study of Federal and State listed seabirds conducted at the Project in summer 2015, a continuation of research from fall 2013 (Cooper and Sanzenbacher 2013). The specific objectives of this study were to: (1) summarize available information to help assess use of the Project by Hawaiian Petrels (*Pterodrom sandwichensis*) and Newell's Shearwaters (*Puffinus newelli*); (2) conduct radar and audiovisual (AV) surveys of these species in the vicinity of the Project; and (3) estimate fatality rates of these species at the Project's proposed wind turbines.
- Two observers monitored movements of seabirds and bats at one sampling station for a total of ten nights in summer (27 June–6 July) 2015, following standard ornithological radar and audiovisual techniques used during previous studies of seabirds in the Hawaiian Islands.
- We recorded 0 landward-flying and 3 seaward-flying radar targets during summer 2015 that fit the criteria for petrel/shearwater targets.
- We visually recorded no Hawaiian Petrels, Newell's Shearwaters, or unidentified petrel/ shearwaters during our audiovisual sampling in summer 2015.The mean adjusted nightly passage rates of petrel/shearwater targets (i.e., landward and seaward rates combined) was 0.05 ± 0.03 targets/hour during summer 2015. Literature for seabirds on the island of Hawaii suggests that our radar targets were equally likely to have been Hawaiian Petrels or Newell's Shearwaters.
- During our studies we concurrently recorded a total of 3 petrel/shearwater targets on vertical radar. Flight altitudes of these vertical targets ranged from 184–366 meters (m) above ground level (agl) and the mean (± SE) flight altitude was 284 ± 54 m agl (median = 302 m agl). The percentage of observations that occurred at or below the height of the proposed turbines (60.5 m agl) was 0%.
- To determine the risk of collision-caused mortality, we used the following information to generate an estimate of exposure risk: mean passage rates of petrel/shearwater-like targets observed on radar in summer 2015, flight altitudes measured from visual studies in the Hawaiian Islands, and dimensions and characteristics of the proposed wind turbines.
- We estimated that an average of approximately 0.05 Hawaiian Petrels/yr and 0.05 Newell's Shearwaters/yr would fly within the space occupied by each wind turbine.
- Current evidence suggests the proportion of seabirds that would detect and avoid wind turbines is substantial and potentially ≥99%, however, we used a conservative range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance) and estimated a collision-caused fatality rate of 0.00008–0.00207 Hawaiian Petrels/turbine/yr and 0.00008–0.00199 Newell's Shearwaters/ turbine/yr. Note that these should be considered as maximal estimates, because they are based on summer passage rates, which are expected to be higher than passage rates during the fall.

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ACKNOWLEDGMENTS

Funding for this research came from Site Constructors, Inc. We thank Julie Myhre and Andrew Higa of the County of Hawaii Department of Water Supply for logistical assistance and Reginald David of Rana Productions for his technical advice. At ABR, Tom DeLong provided contract support; Rich Blaha provided GIS support; Susan Cooper and Delee Spiesschaert provided field/logistical support; and Pam Odom produced the report.

INTRODUCTION

The County of Hawaii Department of Water Supply and Lalamilo Wind Company, LLC are interested in repowering the Lalamilo Wind Energy Project (hereafter Project) on the island of Hawaii (Figure 1). As part of the siting process, there is a need for information on Federal and State-listed seabirds in the vicinity of the Project. Ornithological radar and night-vision techniques have been shown to be successful in studying these species across the Main Hawaiian Islands, including: Kauai (Cooper and Day 1995, 1998; Day and Cooper 1995, Day et al. 2003a); Maui (Cooper and Day 2003, 2004a); Molokai (Day and Cooper 2002); Hawaii (Reynolds et al. 1997, Day et al. 2003b); Lanai (Cooper et al. 2007); and Oahu (Day and Cooper 2008, Cooper et al. 2011). This report summarizes the results of a radar and audiovisual (AV) study of Hawaiian Petrels and Newell's Shearwaters conducted by ABR, Inc. (ABR) at the Project in summer 2015, a continuation of research from fall 2013 (Cooper and Sanzenbacher 2013). The specific objectives of this study were to: (1) summarize available information to help assess use of the Project by Hawaiian Petrels and Newell's Shearwaters; (2) conduct radar and AV surveys of these species in the vicinity of the Project; and (3) estimate fatality rates of these species at the proposed wind turbines at the Project.

BACKGROUND

SEABIRDS

Two seabird species that are protected under the Endangered Species Act (ESA) could occur in the Project area: the endangered Hawaiian Petrel

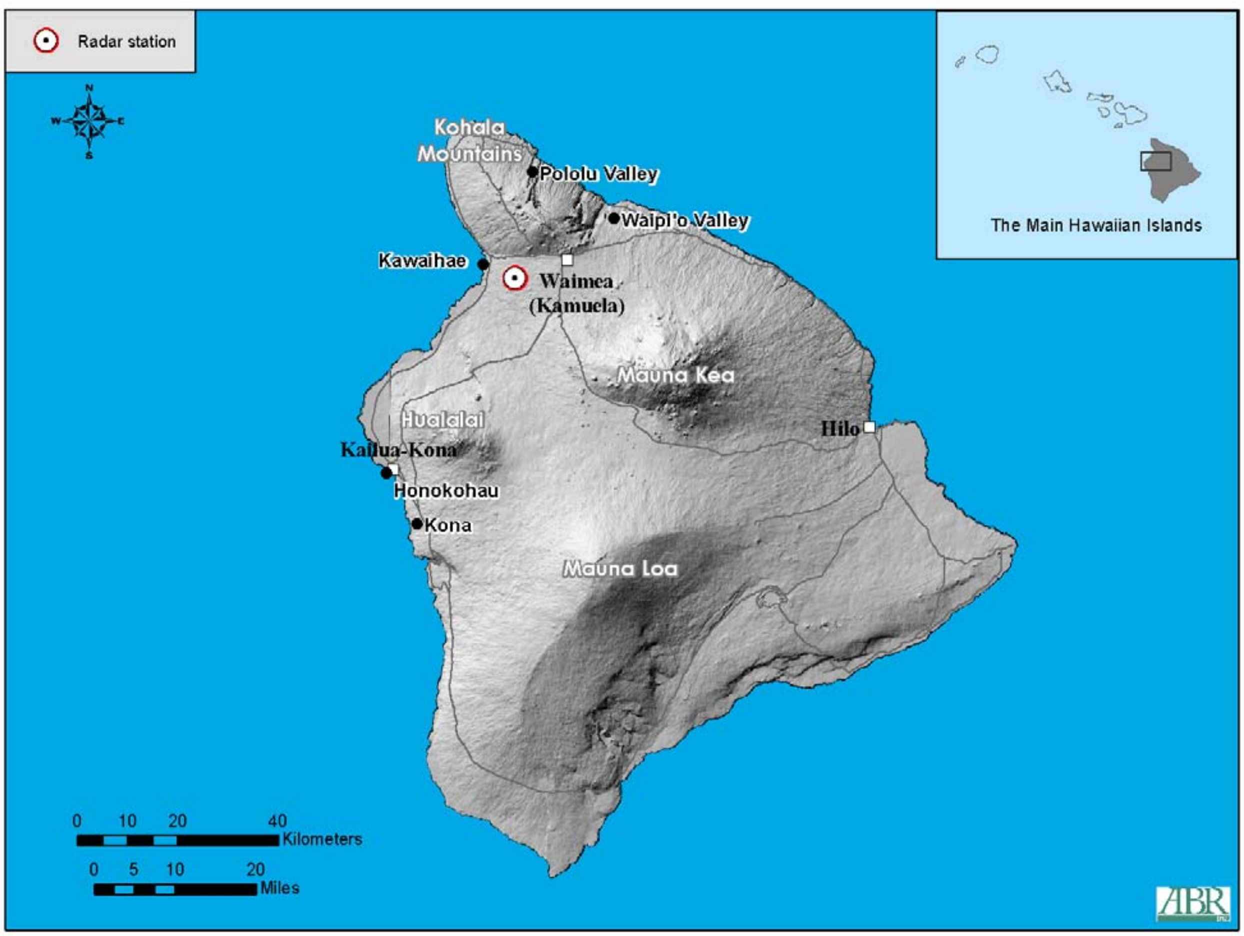

Figure 1. Map of the island of Hawaii with location of the proposed Lalamilo Wind Energy Project and the summer 2015 seabird radar and audiovisual sampling site.

(*Pterodroma sandwichensis*; 'Ua'u) and the threatened Newell's Shearwater (*Puffinus newelli*; 'A'o). The Hawaiian Petrel and the Newell's Shearwater are tropical Pacific species that nest only on the Hawaiian Islands (AOU 1998, Chesser et al. 2015). Both species are Hawaiian endemics whose populations have declined significantly in historical times: they formerly nested widely over all of the Main Hawaiian Islands but now are restricted in most cases to scattered colonies in more inaccessible locations (Ainley et al. 1997a, Simons and Hodges 1998, Pyle and Pyle 2009). The one exception is Kauai, where colonies still are widespread and populations are substantial in size. Of note, Kauai (along with Lanai) also has no (or at most very few) introduced Indian Mongoose (*Herpestes auropunctatus*), which preys on these seabirds (Hawaii Invasive Species Council 2015).

The Hawaiian Petrel nests on most of the Main Hawaiian Islands (Harrison et al. 1984, Harrison 1990, Pyle and Pyle 2009) with documented colonies on Maui (Richardson and Woodside 1954, Banko 1980a; Simons 1984, 1985; Simons and Hodges 1998, Cooper and Day 2003), Lanai (Shallenberger 1974; Hirai 1978a, b; Conant 1980; J. Penniman, State of Hawaii, DOFAW, pers. comm.), Kauai (Telfer et al. 1987, Gon 1988; Ainley et al. 1995, 1997a, b; Day and Cooper 1995, Day et al. 2003b), and Hawaii (Banko 1980a, Conant 1980, Hu et al. 2001, Day et al. 2003b). The information from Molokai (Simons and Hodges 1998, Day and Cooper 2002) also suggests breeding occurs on this island. Munro (1941, 1960) could find no records of the Hawaiian Petrel on Oahu and stated that ancient Hawaiians probably had exterminated this species there.

The exact nesting distribution of the Hawaiian Petrel on the island of Hawaii is not well known. At this time, the primary nesting areas known are on the southeastern slopes of the Southwest Rift Zone on Mauna Loa, and on Mauna Kea and Kilauea (Richardson and Woodside 1954, Simons and Hodges 1998, Hu et al. 2001). On Mauna Loa, these birds are nesting in crevices in nearly-inaccessible lava fields 2,000–3,000 m in elevation (Simons and Hodges 1998, Hu et al. 2001). Based on the timing of movements on ornithological radar, Day et al. (2003b) believed that low numbers of Hawaiian Petrels accessed these colonies by flying inland primarily over the southern and eastern portions of Hawaii, while fewer birds flew over western Hawaii or over Kohala Mountain in northern Hawaii. Deringer et al. (2011) made visual observations of Hawaiian Petrels flying up into Kohala Mountain via both the Waipio and Pololu valleys, indicating that the species probably nests there.

The Newell's Shearwater nests on several of the Main Hawaiian Islands (Harrison et al. 1984, Harrison 1990, Pyle and Pyle 2009), with the largest numbers clearly occurring on Kauai (Telfer et al. 1987, Day and Cooper 1995, Ainley et al. 1995, 1997a, Day et al. 2003a). These birds also nest on Hawaii (Reynolds and Richotte 1997, Reynolds et al. 1997, Day et al. 2003b), Molokai (Pratt 1988, Day and Cooper 2002), and while not proven to do so, may still nest in very small numbers on Oahu (Sincock and Swedberg 1969, Banko 1980b, Conant 1980, Pyle 1983, Pyle and Pyle 2009; but see Ainley et al. 1997a). On Kauai, this species is known to nest at several inland locations, often on steep slopes vegetated by uluhe fern (*Dicranopteris linearis*) undergrowth and scattered ohia lehua trees (*Metrosideros polymorpha*).

The exact nesting distribution of the Newell's Shearwater on the island of Hawaii is not well known, but populations are not thought to be large (Day et al. 2003b). At this time, the species is known to nest in the Puna District in southeastern Hawaii (Reynolds and Ritchotte 1997; Reynolds et al. 1997; Day et al. 2003b). The Newell's Shearwater also must nest in one or more locations on Kohala Mountain in northern Hawaii; in particular, the species must nest in substantial numbers somewhere up the Waipio Valley, as indicated by the number of visual (Hall 1978, Kepler et al. 1979, Reynolds et al. 1997, Deringer et al. 2011) and radar (Reynolds et al. 1997, Day et al. 2003b, Deringer et al. 2011) records from that location. The species also must nest somewhere on the northern slopes of Mauna Kea, given the substantial number of records from the Hamakua, North Hilo, and South Hilo districts in northeast Hawaii (Ralph and Pyle 1977, Kepler et al. 1979, Banko 1980b, Conant 1980; Pyle 1990, 1998). Day et al. (2003b) conducted a large-scale radar study of the island of Hawaii and concluded that Newell's Shearwaters on their way to/from nesting areas fly over essentially the entire island (except for the west-central part), with the highest passage rates around Kohala Mountain.

There is interest in studying Hawaiian Petrels and Newell's Shearwaters because of concerns regarding collisions with human-made structures such as communication towers, met towers, transmission lines, and wind turbines. Habitat Conservation Plan updates through 2014 report observed take of 5 Hawaiian Petrels and 0 Newell's Shearwaters at wind-energy facilities (wind turbines or met towers) within the Hawaiian Islands, all at the Kaheawa Wind Power I Project on Maui (Kaheawa Wind Power I LLC 2014). Based on these observed fatalities the estimated direct take was 7 Hawaiian Petrels over 8 years of operation. While there only are fatality data available for wind energy projects on Maui and Oahu (5 projects total), there has been well-documented petrel and shearwater mortality resulting from collisions with other human-made structures (e.g., transmission lines, communication towers) on Kauai (Telfer et al. 1987, Cooper and Day 1998, Podolsky et al. 1998) and Maui (Hodges 1992).

STUDY AREA

The County of Hawaii Department of Water Supply and Lalamilo Wind Company, LLC are interested in repowering a former wind energy site on a 31.6 ha (78 acre) parcel of land near the eight Lalamilo- Parker System water supply wells in northwestern Hawaii, ~10 km west-southwest of Kamuela (Figure 1). The site formerly supported 120 small (i.e., ~36-m-tall) wind turbines constructed in 1985, which have since been removed. The purpose of the five new turbines is to generate electrical power to operate the water well pumps. The development plan for the proposed Project is to erect five Vestas V47-660 kW turbines

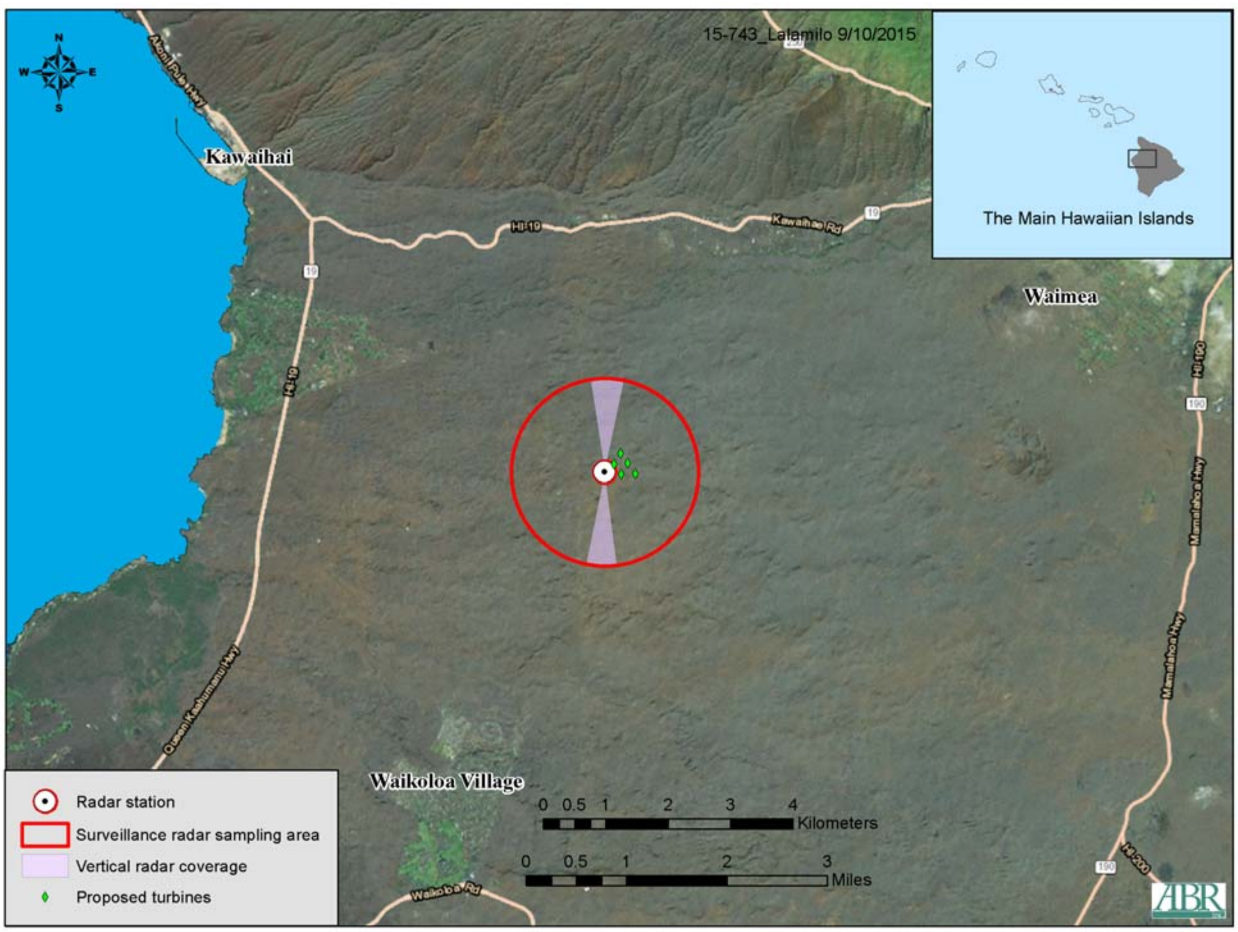

Figure 2. Locations of the summer 2015 seabird radar and audiovisual sampling site and proposed wind turbines at the Lalamilo Wind Energy Project on the island of Hawaii.

(Figure 2). The turbines would have a hub height of 37 m and rotor diameter of 47 m, with a total maximum height of 60.5 m. The area surrounding the project is heavily grazed with extensive disturbance from the footprints of former wind turbines. It consists of dry habitat with a mix of predominantly non-native grasses.

The radar sampling location was located at N 19.98688° W 155.76752° at 417 m above sea level (Figure 3). This sampling location provided excellent surveillance and vertical radar coverage of the area surrounding all proposed structures at the Project.

METHODS

STUDY DESIGN

We used marine radars and binoculars and night-vision optics to collect data on the passage rates, flight paths, and flight altitudes of Hawaiian Petrels and Newell's Shearwaters at the Project for 10 nights in summer 2015 (27 June–6 July). These sampling dates were selected to correspond with the egg-laying and incubation period of both species (Ainley et al. 1995, Simons and Hodges 1998, Deringer 2009). The daily sampling effort consisted of a 3 hour (h) period beginning ~0.5 h past sunset each evening (i.e., 1900–2200 h) and the 2.5 h period beginning ~2 h prior to sunrise each morning (0345–0615 h) with each period divided into 30-minute (min) sampling sessions. Our sampling periods were selected to correspond with the evening and morning peaks of movement of petrels and shearwaters, as described near breeding colonies on Kauai (Day and Cooper 1995, Deringer 2009). For the purpose of recording data, a calendar day began at 0701 h and ended at 0700 h

Figure 3. The surveillance and vertical radars used for studies of Hawaiian Petrels and Newell's Shearwaters at the proposed Lalamilo Wind Energy Project, island of Hawaii, summer 2015.

the following morning; that way, an evening and the following morning were classified as occurring on the same sampling day.

RADAR EQUIPMENT

Our radar setup consisted of two marine radars mounted on vehicles; one radar was operated in surveillance mode and the other in vertical mode (Figure 3). The surveillance radar scanned a 1.5 km radius area around the station and obtained information on flight paths, passage rates (i.e., number of targets per time period), and ground speeds of seabird targets. The vertical radar was used to scan a segment of the surveillance sampling area and collect simultaneous information on the flight altitudes of those radar targets identified on surveillance radar as petrel/shearwater targets.

The surveillance and vertical radars (Furuno Model FCR-1510; Furuno Electric Company, Nishinomiya, Japan) were standard marine radars transmitting at 9,410 MHz (i.e., X-band) through a slotted wave guide (i.e., antenna) 2 m long, with a peak power output of 12 kilowatts (kW). The surveillance radar antenna was tilted upward at ~10° so that the bottom edge of the main beam was just below horizontal to minimize ground clutter and increase the amount of vertical airspace that was sampled. We operated both radars at a range of 1.5 kilometers (km) and set the pulse length at 0.07 microseconds (µsec). Figure 4 shows the approximate sampling airspace for the Furuno FR-1510 marine radar in a) surveillance and b) vertical mode at the 1.5-km range setting, as determined by field trials with Rock Pigeons (*Columba livia*; Cooper et al. 2006); which are smaller (and probably have lower radar detectability) than petrels and shearwaters. Based on these trials and our prior studies, differences in detectability based on distance were not sufficient at the 1.5-km range to necessitate a correction factor. Each radar was powered by two 12-V batteries that were linked in series. To ensure that our radar units perform to specifications, all ABR radars are periodically maintained and tested by licensed Furuno radar dealers. In addition, ABR seasonally tunes all radars and annually performs side-by-side comparisons of all radar units to insure that all units collect comparable information.

DATA COLLECTION

During each survey period one observer operated the surveillance and vertical radars concurrently while another observer conducted AV observations. At the start of each sampling session we collected environmental and weather data, including information on wind speed and direction, cloud cover, ceiling height, visibility, precipitation, and moon phase. We recorded all radar images with frame grabbers (Epiphan Systems Inc., Ottawa, ON) for review and archiving of seabird targets and post-processing of flight altitudes.

We define a petrel/shearwater radar target as a radar echo that represents one or more birds meeting the criteria developed by Day and Cooper (1995) to identify Hawaiian Petrels and Newell's Shearwaters on radar. Specifically, we used the airspeed, signature (i.e., size and appearance), flight characteristics, timing, and flight directions of radar targets to distinguish Hawaiian Petrel and Newell's Shearwater targets from other species. Because Hawaiian Petrel and Newell's Shearwater look similar on radar we were unable to differentiate these two species; thus, hereafter we refer to these radar targets as "petrel/shearwater targets". The airspeed cutoff for inclusion as a petrel/shearwater target was ≥50 km/h (≥ 30 mph). We computed airspeeds (i.e., groundspeeds corrected for wind speed and relative direction) of surveillance radar targets with the formula used by Mabee et al. (2006). We also removed radar targets identified by AV observers as being of other bird species. For each radar target that met the selection criteria for petrel/shearwater targets, we recorded the following key data: species (if identified by AV observer); number of birds (if identified by AV observer); time; flight direction; flight behavior; velocity; distance from the radar. Following surveys we used the timing, direction, and distance of petrel/shearwater targets on surveillance radar to locate these targets on the recorded vertical radar images. We measured flight altitudes relative to the radar location and then used digital elevation models to report flight altitudes of targets relative to ground level where the bird was detected.

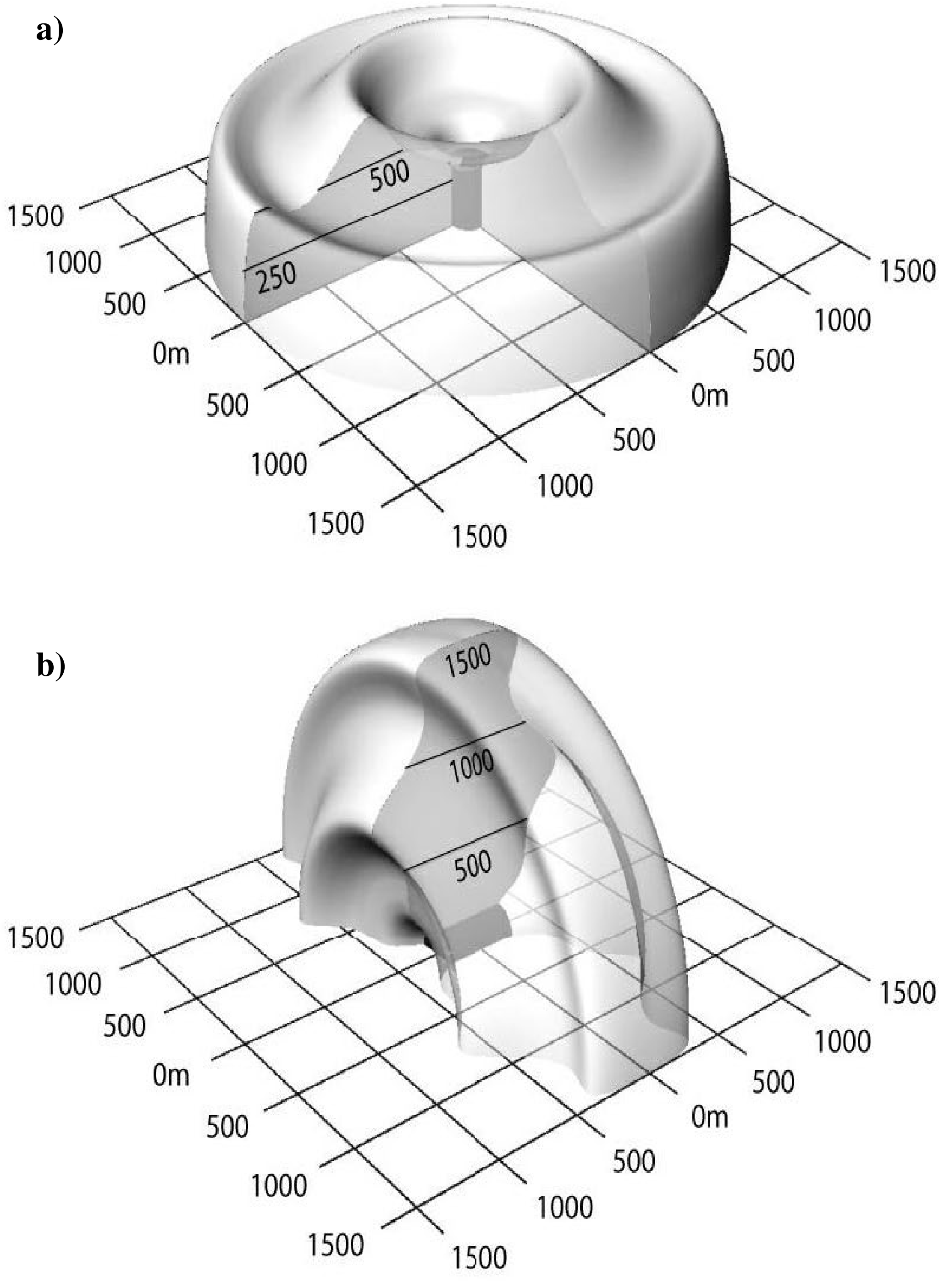

Figure 4. Approximate shearwater-/petrel-sampling airspace for the Furuno FR–1510 marine radar at the 1.5-km range setting, in a) surveillance and b) vertical antenna orientations, as determined by field trials with Rock Pigeons. Note that the shape of the radar beam within 250 m of the origin (i.e., the darkened area) was not determined.

We conducted AV sampling concurrently with the radar sampling to help identify targets observed on radar and to obtain additional flight-altitude information for species of interest (i.e., Hawaiian Petrels and Newell's Shearwaters). The AV sampling is particularly important for identifying the presence of other species that can at times appear similar to petrel/shearwater targets on radar and thus contaminate radar data during these studies. Examples of these non-target species include, but are not limited to, the following: Barn Owl (*Tyto alba*), Black-crowned Night Heron (*Nycticorax nycticorax*), Cattle Egret (*Bubulcus ibis*), Great Frigatebird (*Fregata minor*), and Pacific Golden Plover (*Pluvialis fulva*). During AV sampling, we used 10X binoculars during crepuscular periods and Generation 3 night-vision goggles (Model ATN-PVS7; American Technologies Network Corporation, San Francisco, CA) during nocturnal periods. The magnification of the night-vision goggles was 1×, and their performance was enhanced with the use of a 3-million-candlepower spotlight fitted with an infrared filter to prevent blinding or attracting birds. Observers also used vocalizations of birds passing overhead to assist in identifying radar targets. For each bird observed during AV sampling, we recorded: time; species; number of individuals composing each target; flight direction; and flight altitude. For any species of interest heard but not seen, we recorded species, direction of calls, and approximate distance from the observer.

DATA ANALYSIS

RADAR AND AUDIOVISUAL DATA SUMMARY

We entered all radar and AV data directly into Microsoft Excel spreadsheets and checked data files visually for errors after each night of sampling and then checked files for errors and outliers at the end of the field season, prior to data analyses. We used Microsoft Excel and SPSS statistical software (2009) to conduct data summaries. No sampling nights or individual sessions were canceled due to weather (i.e., rain) during this study.

Data analyses included only radar targets that met the selection criteria for petrel/shearwater targets or were identified as a Hawaiian Petrel or Newell's Shearwater during concurrent AV observations. We categorized general flight directions of each radar target as landward, seaward, or "other". Based on the location of the Project relative to the orientation of the shoreline and potential petrel/shearwater breeding areas, we defined landward flight directions as flights heading between 30°–150° and seaward flight directions as flights between 210°–330°. "Other" flights included all other directions that were not landward or seaward (i.e., 151°–209° or 331°–29°). Because the flight directions of "other" targets were not representative of flights between the ocean and inland petrel or shearwater nesting habitat we assumed these targets were not petrels or shearwaters and excluded them from data summaries and fatality modeling.

PASSAGE RATES AND FLIGHT PATHS

In order to evaluate the among night variation in seabird activity we tabulated counts of petrel/shearwater radar targets recorded during each sampling session, then converted counts to estimates of passage rates of birds (petrel/shearwater targets/h), based on the number of minutes sampled per session. We used all of the estimated passage rates across sampling sessions to calculate the mean ± 1 standard error (SE) nightly passage rate of petrel/shearwater targets at the site. Finally, we plotted all flight paths of petrel/shearwater targets on a map of the Project to look at flight patterns within our sampling areas.

EXPOSURE AND FATALITY RATES

The risk-assessment technique that we have developed uses the radar data on seasonal passage rates to estimate numbers of birds flying over the Project area during the portion of the year (i.e., the breeding season) when birds are flying to and from inland breeding areas. The model then uses information on the physical characteristics of the turbines to estimate horizontal exposure probabilities, uses flight-altitude data and information on the height of the turbines to estimate vertical exposure probabilities, and combines these exposure probabilities with the passage rates to generate annual exposure rates (Figure 5). These exposure rates represent the estimated numbers of petrels and shearwaters that pass within the airspace occupied by a turbine each

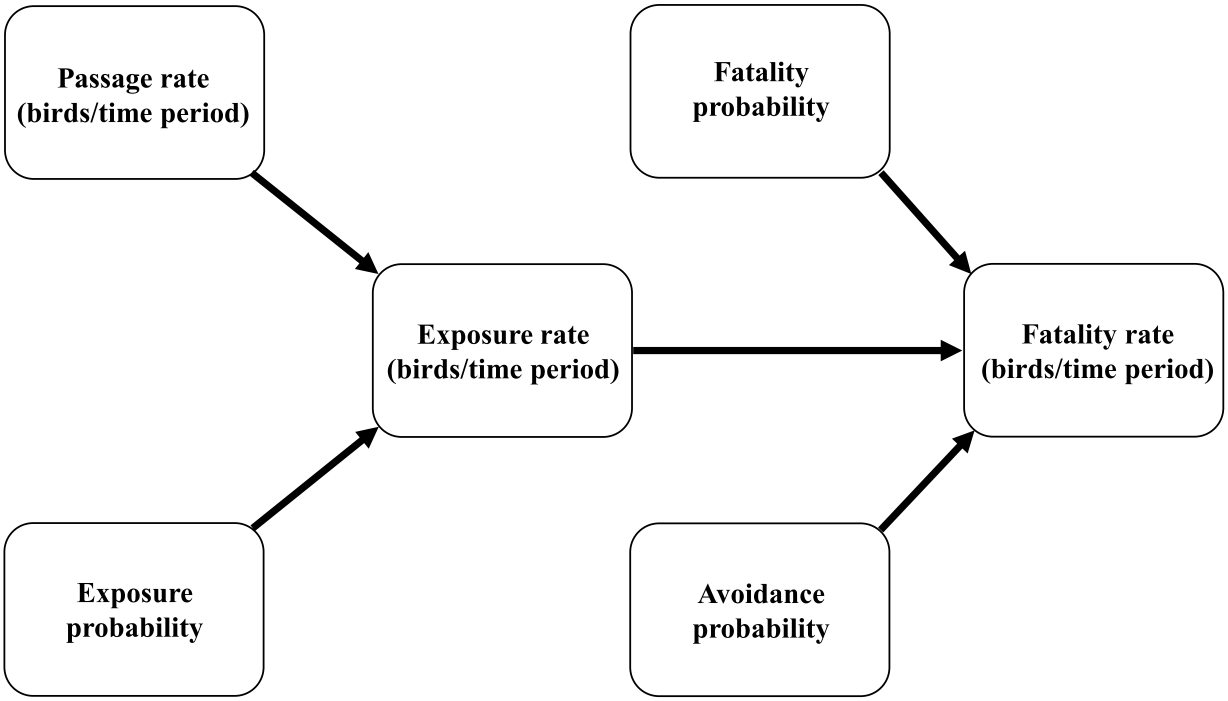

Figure 5. Major variables used in estimating possible fatalities of Hawaiian Petrels and Newell's Shearwaters at wind turbines at the proposed Lalamilo Wind Energy Project on the island of Hawaii.

year. We then combine these exposure rates with (1) the probability that an exposure results in a fatality; and (2) the probability that birds detect structures and avoid interacting with them, to estimate annual fatality rates at each of the proposed turbines.

Normally we would use data from both summer and fall sampling periods to model annual fatalities; however, data collected at the Project in fall 2013 indicated that there was obvious contamination from Pacific Golden-plovers (Cooper and Sanzenbacher 2013). Plovers are seasonal migrants that overwinter in the region and have radar target characteristics that often are impossible to distinguish from Hawaiian Petrels and Newell's Shearwaters. Audiovisual sampling conducted during the 2013 studies indicated that Pacific Golden-plovers were present in high numbers in the Project area during fall (Cooper and Sanzenbacher 2013). Therefore, we followed the precedent of Cooper and Sanzenbacher (2011) and decided that it was most appropriate to use summer-only passage rates for the fatality modeling exercise. This meant assuming that fall passage rates were the same as summer passage rates, a conservative approach because the number of shearwaters visiting breeding colonies generally tends to decline from summer to fall because attendance at colonies by nonbreeders and failed breeders declines as chick-rearing progresses (Serventy et al. 1971, Warham 1990, Ainley et al. 1997, Simons and Hodges 1998). Based on this conservative approach the annual exposure rates and fatality rates presented in this report may overestimate actual rates.

Exposure Rates

The exposure rate is calculated as the product of three variables: annual passage rate, horizontal exposure probability, and vertical exposure probability (Figure 5). As such, it is an estimate of the number of birds flying in the vicinity of a structure (i.e., crossing the radar screen) that could fly in a horizontal location and at a low-enough altitude that they could interact with a structure (i.e., wind turbine).

Passage rates

We generated annual passage rates from the radar data by: (1) multiplying the average passage rates (targets/h) by 5 h to estimate the number of targets moving over the radar station during those peak nightly movements; (2) adjusting the sum of those counts to account for the estimated percentage of movement that occurs during the middle of the night based on studies at Kauai locations (12.6%; Cooper and Day, unpubl. data); (3) multiplying that total number of targets/night by the mean number of Hawaiian Petrels and Newell's Shearwaters per radar target (1.05 ± SE 0.01 birds/flock (*n* = 2,062 flocks; R. Day and B. Cooper, unpubl. data) to generate an estimate of the average number of petrels and shearwaters passing in the vicinity of the proposed wind turbines during a night; and (4) multiplying those numbers by the number of nights that these birds were exposed to risk in each season (i.e., 180 nights in the spring/summer and 75 nights in the fall for Hawaiian Petrel [Simons and Hodges 1998]) and 150 nights in the spring/summer and 60 nights in the fall for Newell's Shearwater [Ainley et al. 1997a; Deringer 2009]). We also corrected the radar data for the proportion of targets that were likely to be Hawaiian Petrels and the proportion that were Newell's Shearwater. Because there are records of both Hawaiian Petrels and Newell's Shearwater from the northern end of the island of Hawaii (Hall 1978, Kepler et al. 1979, Reynolds et al. 1997, Day et al. 2003b, Deringer et al. 2011), it was difficult to determine the exact proportions of targets that were Hawaiian Petrels and those that were Newell's Shearwaters. Thus, we assumed that 50% of our petrel/shearwater targets were Hawaiian Petrels and 50% were Newell's Shearwaters.

Exposure probabilities

Exposure probabilities consist of both horizontal and vertical components. Note that our horizontal and vertical exposure "probabilities" actually are just fractions of sampled airspace occupied by structures, rather than usual statistical probabilities. Hence, we assume that the probability of exposure is equal to the fraction of sampled air space that was occupied by a turbine and that there is a uniform distribution of birds in the sampled airspace.

The horizontal exposure probability is the probability that a bird seen on radar will pass over the two-dimensional space (as viewed from the side or front) occupied by a turbine located somewhere on the radar screen. This probability is calculated from information on the two-dimensional area of the turbine and the two-dimensional area sampled by the radar screen. The proposed Vestas V47 wind turbine systems will each have a maximal height of 60.5 m, a rotor radius of 23.5 m, and minimal (side view) and maximal (frontal view) areas of 151 m^2 and 1,769 m^2 respectively. The ensuing ratio of the cross-sectional area of the turbines to the cross-sectional area sampled by the radar (3-km sampling diameter times the height of the structure) indicates the probability of interacting with (i.e., flying over the airspace occupied by) a turbine.

The vertical exposure probability is the probability that a bird seen on radar will be flying at an altitude low enough that it actually might pass through the airspace occupied by a structure (i.e., wind turbine) located somewhere on the radar screen. This probability is calculated from data on flight altitudes measured by vertical radar (or visual estimates) and from information on the height of the structures. We found that none of petrel/shearwaters (*n* = 3 targets) observed on vertical radar at the Project had flight altitudes ≤60.5 m during summer 2015. Given the small sample size, however, we used visual flight altitude estimates from other study sites throughout the Hawaiian Islands where we observed that 25% of all Hawaiian Petrels [*n* = 646 flocks] and 29% of all Newell's Shearwater [*n* = 699 flocks] flew at or below 60.5 m [Cooper, unpubl. data]).

Fatality Rates

As previously stated, the annual estimated fatality rate is calculated as the product of: (1) the exposure rate; (2) the fatality probability; and (3) the avoidance probability.

Fatality probability

The estimate of the fatality-probability portion of the fatality-rate formula is derived as the product of: (1) the probability of a petrel or shearwater colliding with a wind turbine if the bird enters the airspace occupied by one of these structures (i.e., are there gaps big enough for birds to fly through the structure without hitting any part of it?); and (2) the probability of dying if it collides with the wind turbine (including blades). The former probability is needed because the estimates of horizontal-interaction probability are calculated as if the wind turbines are solid structures, whereas the latter is an estimate of the probability of collision-caused fatality after a bird collided with a structure. Because any collision with a wind turbine falls under the ESA definition of "take," we used an estimate of 100% for this fatality-probability parameter; however, note that the actual probability of fatality resulting from a collision is less than 100% because a bird can hit a wind turbine tower and not die (e.g., a bird could brush a wingtip but avoid injury/death).

A bird approaching from the back or front of a turbine may pass through the rotor-swept area without colliding with a blade. Therefore we calculated the probability of collision for this “frontal” bird approach based upon the length of a Hawaiian Petrel (43 cm; Simons and Hodges 1998) or Newell’s Shearwater (33 cm; Pratt et al. 1987); the average groundspeed of Hawaiian Petrels and Newell's Shearwaters on the Hawaiian Islands (Hawaiian Petrel mean velocity = 37.7 mi/h [60.7 km/h]; n = 91; Newell’s Shearwater mean velocity = 36.6 mi/h [58.9 km/h]; n = 41 identified shearwater targets; Day and Cooper, unpubl. data) and the time that it would take a 43-cm-long petrel or 33-cm-long shearwater to travel completely through an ~1.5-m-wide turbine blade spinning at its maximal rotor speed (28.5 revolutions/min for the Vestas V47-660 kW turbines); also see Tucker (1996). These calculations indicated that up to 22.4% and 22.0% of the disk of the rotor-swept area would be occupied by a blade sometime during the length of time that it would take a petrel or shearwater, respectively, to fly completely past a rotor blade.

Avoidance probability

The avoidance rate is the probability that a bird will see a structure (e.g., turbine or met tower) and change flight direction, flight altitude, or both, so that it completely avoids flying through the space occupied by the structure. Because avoidance rates are largely unknown, we present fatality estimates for a conservative range of probabilities of collision avoidance by these birds by assuming that 90%, 95%, or 99% of all petrels and shearwaters flying near a wind turbine will detect and avoid it. See Discussion for explanation of avoidance rates used.

RESULTS

RADAR OBSERVATIONS

MOVEMENT RATES AND FLIGHT PATHS

During our ten survey nights in summer 2015, we observed a total of 0 landward-flying and 3 seaward-flying radar targets that fit our criteria for petrel/shearwater targets (Table 1). The mean nightly passage rate of petrel/shearwater targets (i.e., landward and seaward rates combined) during summer 2015 was 0.05 ± 0.03 targets/h (Table 2). All petrel/shearwater target flight paths were heading to the southwest (Figure 6) and may represent birds heading seaward from areas thought to support breeding colonies on Kohala Mountain, the Waipio Valley, and Mauna Kea.

FLIGHT ALTITUDES

During summer 2015 we recorded a total of 3 flight altitudes of petrel/shearwater targets on vertical radar that initially were identified on surveillance radar. Flight altitudes ranged from 184–366 m agl. The mean (± SE) flight altitude was 284 ± 54 m agl (median = 302 m agl). The percentage of observations that occurred at or below the height of the proposed turbines (i.e., ≤60.5 m agl) was 0%.

AUDIOVISUAL OBSERVATIONS

We did not have any AV observations of Hawaiian Petrels, Newell's Shearwaters, unidentified petrel/shearwaters during our ten nights of sampling in summer 2015 (Table 1).

EXPOSURE RATES

Based on the average passage rate from summer 2015 (Table 2), we estimate that an average of approximately 0.05 Hawaiian Petrels/yr and 0.05 Newell’s Shearwaters/yr would fly within the space occupied by each proposed wind turbine (Table 3). Note that these calculations are exposure

Table 1. Sampling dates and summary of the number of seabird radar targets at the proposed Lalamilo Wind Energy Project, island of Hawaii, summer 2015.

	Number of petrel/shearwater radar targets		
Date	Landward[1]	Seaward[2]	Other[3]
27 June	0	0	0
28 June	0	0	0
29 June	0	0	0
30 June	0	0	0
1 July	0	0	0
2 July	0	1	0
3 July	0	1	0
4 July	0	0	0
5 July	0	1	1
6 July	0	0	0
Radar Totals:	0	3	1

[1] Landward directions = 30–150°.
[2] Seaward directions = 210–330°.
[3] Other directions = 151–209° and 331–29°. Presumably not petrel/shearwater targets based on flight directions.

Table 2. Mean passage rates (targets/h ± SE) of petrel/shearwater radar targets observed at the proposed Lalamilo Wind Energy Project, island of Hawaii, during summer 2015. *n* = number of sampling days.

Station	Time period (*n*)	Landward	Seaward	Total
Lalamilo	Eve (10)	0 ± 0	0.10 ± 0.05	0.10 ± 0.05
	Morn (10)	0 ± 0	0 ± 0	0 ± 0
	Eve & Morn (10)			0.05 ± 0.03

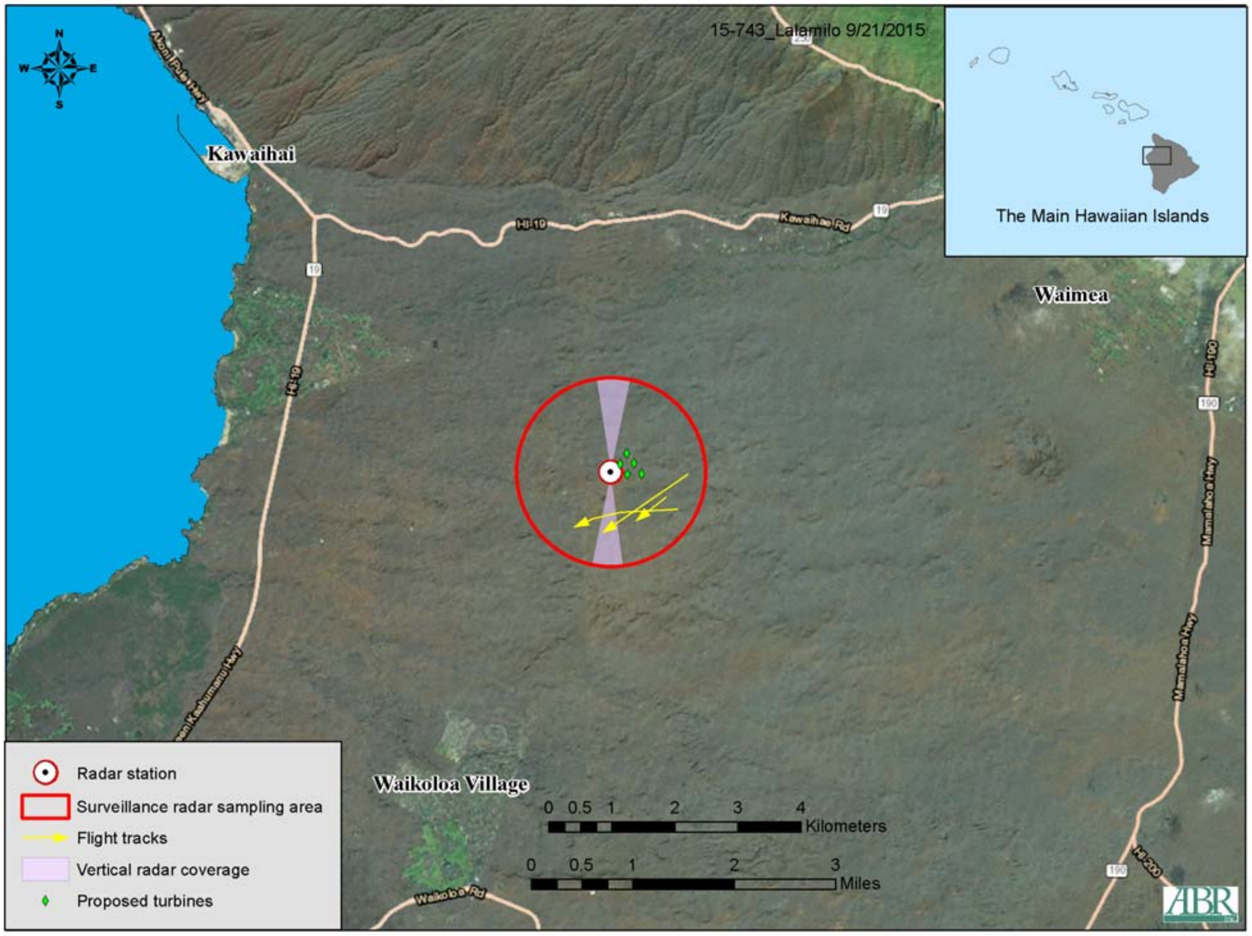

Figure 6. Flight paths of petrel/shearwater radar targets observed during ten nights in summer 2015 at the proposed Lalamilo Wind Energy Project on the island of Hawaii.

rates and, thus, include an unknown proportion of birds that would detect and avoid the turbines. Note that exposure rates estimate how many times/yr a petrel or shearwater would be exposed to each turbine and not the number that actually would collide with those structures.

FATALITY MODELING

The individual steps and estimates involved in calculating fatality rates are shown in Table 3. We speculate that the proportions of birds that detect and avoid turbines is substantial (see Discussion), but limited petrel/shearwater-specific data are available to use for estimates of avoidance rates for these structures. Because it is necessary to estimate the fatality of petrels and shearwaters at the proposed Project, we assumed that 90%, 95%, or 99% of all birds will be able to detect and avoid the turbines. Also assuming that 100% of the birds colliding with a turbine die, we estimated a fatality rate of 0.00008–0.00207 Hawaiian Petrels/turbine/yr and 0.00008–0.00199 Newell's Shearwaters/turbine/yr (Table 3). The cumulative annual fatalities at all five of the Vestas V47 turbines combined would be 0.00040–0.01035 Hawaiian Petrels/yr and 0.00040–0.00995 Newell's Shearwaters/yr (Table 4). Note that these should be considered to be maximal fatality estimates because they are based upon summer passage rates which tend to be higher than fall rates.

Table 3. Estimated average exposure rates and fatality rates of Hawaiian Petrels and Newell's Shearwaters at Vestas V47 wind turbines at the proposed Lalamilo Wind Energy Project, island of Hawaii, based on radar data collected in summer 2015. Values of particular importance are in boxes.

Variable/parameter	Hawaiian Petrels		Newell's Shearwaters	
	Minimum	Maximum	Minimum	Maximum
PASSAGE RATE (PR)				
A) Mean movement rate (targets/h)				
A1) Mean rate during nightly peak movement periods in spring/summer based on spring/summer 2015 data (targets/h)	0.05	0.05	0.05	0.05
A2) Mean rate during nightly peak movement periods in fall based on spring/summer 2015 data (targets/h)	0.05	0.05	0.05	0.05
B) Number of hours of evening and morning peak-period sampling	5	5	5	5
C) Mean number of targets during evening and morning peak-movement periods				
C1) Spring/summer (A1*B)	0.25	0.25	0.25	0.25
C2) Fall (A2*B)	0.25	0.25	0.25	0.25
D) Mean proportion of birds moving during off-peak h of night	0.126	0.126	0.126	0.126
E) Seasonal movement rate (targets/night) = ((C*D) + C)				
E1) Spring/summer	0.3	0.3	0.3	0.3
E2) Fall	0.3	0.3	0.3	0.3
F) Mean number of birds/target	1.05	1.05	1.05	1.05
G) Estimated proportion of each species	0.50	0.50	0.50	0.50
H) Daily movement rate (birds/day =E*F*G)				
H1) Spring/summer	0.15	0.15	0.15	0.15
H2) Fall	0.15	0.15	0.15	0.15
I) Fatality domain (days/year)				
I1) Spring/summer	180	180	150	150
I2) Fall	75	75	60	60
J) Annual movement rate (birds/year; = ((H1*I1) + (H2*I2)), rounded to next whole number)	38	38	32	32
HORIZONTAL INTERACTION PROBABILITY (IPH)				
K) Turbine height (m)	60.5	60.5	60.5	60.5
L) Blade radius (m)	23.5	23.5	23.5	23.5
M) Height below blade (m)	13.5	13.5	13.5	13.5
N) Average turbine front to back width (m)	2.5	2.5	2.5	2.5
O) Minimal side profile area (m^2) = (K*N)	151.25		151.25	
P) Maximal front profile area (m^2) = (M*N) + (π x L^2)		1,769		1,769
Q) Cross-sectional sampling area of radar at or below 60.5 m turbine height (= 3,000 m * 60.5 m = 181,500 m^2)	181,500.0	181,500.0	181,500.0	181,500.0
R) Minimal horizontal interaction probability (= O/Q)	0.00083		0.00083	
S) Maximal horizontal interaction probability (= P/Q)		0.00974		0.00974
VERTICAL INTERACTION PROBABILITY (IPV)				
T) Proportion of petrels flying ≤ turbine height)	0.25	0.25	0.25	0.25

Table 3. Continued.

Variable/parameter	Hawaiian Petrels		Newell's Shearwaters	
	Minimum	Maximum	Minimum	Maximum
EXPOSURE RATE (ER = PR*IPH*IPV)				
U) Daily exposure index (birds/turbine/day = H*(R or S)*T, rounded to 5 decimal places)				
U1) Spring/summer	0.00003	0.00036	0.00004	0.00042
U2) Fall	0.00003	0.00036	0.00004	0.00042
V) Annual exposure index (birds/turbine/year = J*(R or S)*T, rounded to 5 decimal places	0.00792	0.09258	0.00773	0.09043
FATALITY PROBABILITY (FP)				
W) Probability of striking turbine if in airspace on a side approach	1.00	1.00	1.00	1.00
X) Probability of striking turbine if in airspace on frontal approach	0.224	0.224	0.220	0.220
Y) Probability of fatality if striking turbine[1]	1.00	1.00	1.00	1.00
Z1) Probability of fatality if an interaction on side approach (= W*Y)	1.00		1.00	
Z2) Probability of fatality if an interaction on frontal approach (= X*Y)		0.224		0.220
FATALITY RATE (= ER*FP)				
Annual fatality rate with 90% exhibiting collision avoidance (birds/turbine/year = V*(Z1 or Z2)*0.1)	0.00079	0.00207	0.00077	0.00199
Annual fatality rate with 95% exhibiting collision avoidance (birds/turbine/year =V*(Z1 or Z2)*0.05)	0.00040	0.00104	0.00039	0.00099
Annual fatality rate with 99% exhibiting collision avoidance (birds/turbine/year =V*(Z1 or Z2)*0.01)	0.00008	0.00021	0.00008	0.00020

[1] Used 100% fatality probability due to ESA definition of "take"; however, actual probability of fatality with collision <100% (see methods).

DISCUSSION

SPECIES COMPOSITION

The breeding distribution of Hawaiian Petrel and Newell's Shearwater on the island of Hawaii is not fully understood, but it is likely that both species occasionally fly over the Project area on their way to/from nesting areas on Kohala Mountain to the northeast and possibly to/from the slopes of Mauna Kea to the southwest. For example, it is known that Hawaiian Petrels formerly nested (and probably still do) somewhere on Mauna Kea, given the number of both old and recent records from there and the Hamakua and North Hilo Districts (Richardson and Woodside 1954, Banko 1980a; Pyle 1986; Pyle and Pyle 2009). In addition, 3 Hawaiian Petrels have been observed flying up the Pololu Valley and seven birds flying up the Waipio Valley in the direction of Kohala Mountain (Deringer et al. 2011), suggesting that the species also nests in that area. Indeed, the flight directions of the petrel/ shearwater targets we observed over the Project were generally headed away from Kohala Mountain.

The literature also suggests that low numbers of Newell's Shearwater could fly over the Project site on their way to/from Kohala Mountain. The substantial number of visual (Hall 1978, Kepler et al. 1979, Reynolds et al. 1997, Deringer et al. 2011) and radar (Reynolds et al. 1997, Day et al. 2003a) records from Kohala Mountain strongly suggests that they nest there. Newell's Shearwater also may fly over the Project on their way to/from the slopes of Mauna Kea: the species is highly likely to nest there, given the substantial number of records from the Hamakua, North Hilo, and South

Table 4. Summary of exposure rates, fatality rates, and cumulative fatality rates for Hawaiian Petrels (HAPE) and Newell's Shearwaters (NESH) at wind turbines at the proposed Lalamilo Wind Energy Project, island of Hawaii, based on radar data collected in summer 2015.

Structure type	Exposure rate/structure (birds/structure/yr)		Avoidance rate	Fatality rate/structure (birds/structure/yr)		No. structures	Cumulative fatality rate (birds/yr)	
	HAPE	NESH		HAPE	NESH		HAPE	NESH
Vestas V47-660 kW turbine	0.00792 (min)	0.00773 (min)	0.90 (min)	0.00079	0.00077	5	0.00395	0.00385
	0.09258 (max)	0.09043 (max)	0.90 (max)	0.00207	0.00199	5	0.01035	0.00995
			0.95 (min)	0.00040	0.00039	5	0.00200	0.00195
			0.95 (max)	0.00104	0.00099	5	0.00520	0.00495
			0.99 (min)	0.00008	0.00008	5	0.00040	0.00040
			0.99 (max)	0.00021	0.00020	5	0.00105	0.00100

Hilo districts in northeast Hawaii (Ralph and Pyle 1977, Kepler et al. 1979, Banko 1980b, Conant 1980; Pyle 1990, 1998). Day et al. (2003b) conducted a large-scale radar study of the island of Hawaii and concluded that Newell's Shearwaters on their way to/from nesting areas fly over essentially the entire island (except for the west-central part), with the highest passage rates around Kohala Mountain.

Our radar data indicate that both Hawaiian Petrels and Newell's Shearwaters fly over the Project, however, it also is possible that some non-target species were included in our radar data, despite our attempts to filter them out. As mentioned previously there are several species present in Hawaii during the summer that are active during nocturnal and crepuscular hours and are known to have radar target signatures that can be confused with signatures of petrel/shearwaters. However, while some of these species could occur in the Project area, our AV observations suggest that none occurred regularly during the summer study. Thus, while it still is possible that some non-target species were included in our radar data, we believe it is minimal for our summer data.

PASSAGE RATES AND FLIGHT DIRECTIONS

Passage rates from similar radar studies on most other Hawaiian Islands (except Oahu and West Maui) are much higher than the seasonal mean passage rate observed at the proposed Project (mean = 0.05 targets/h, Table 5). For example, the mean summer passage rate from studies on Kauai was 131 targets/h (n = 17 sites). Potentially more relevant are other studies conducted on the island of Hawaii; they report a mean passage rate of 1.8 targets/h in summer across 25 different sites. Perhaps the best comparison available, however, is with the radar data collected in northwestern Hawaii during summer 2001 by Day et al. (2003b): using similar radar methods to the current study, they observed 2.4 seabird targets/hr at their Kawaihae site (located ~8 km northwest of the Project), 0 targets/h at their Honokohau site (~40 km to the southwest), and 0 targets/h at their Kona site (~45 km to the southwest). Thus, the passage rates we observed in summer 2015 were very low, even when compared to low rates observed in the same general area in summer 2001 by Day et al. (2003b).

EXPOSURE RATES AND FATALITY ESTIMATES

We estimated that an average of approximately 0.05 Hawaiian Petrels/yr and 0.05 Newell's Shearwaters/yr would fly within the space occupied by each proposed wind turbine (Table 3). We used these estimated exposure rates as a starting point for developing a complete avian risk assessment.

COLLISION AVOIDANCE RATES

Few data are available on the proportion of petrels and shearwaters that do not collide with wind turbines or met towers because of collision-avoidance behavior (i.e., birds that completely alter their flight paths horizontally and/or vertically to avoid flying through the space occupied by a structure). Some collision-avoidance information near transmission lines is available on petrels and shearwaters from earlier work that we conducted on Kauai (Cooper and Day 1998). In summary, those data suggest that the behavioral-avoidance rate of Hawaiian Petrels and Newell's Shearwaters near transmission lines is very high. For example, of the 207 Hawaiian Petrels observed flying within 150 m of transmission lines on Kauai, 40 exhibited behavioral responses; of those 40 birds that exhibited collision-avoidance responses, none (0%) collided with a transmission line. Thus, the collision-avoidance rate for Hawaiian Petrels was 100% (i.e., 40 of 40 interactions resulted in collision avoidance). Of the 392 Newell's Shearwaters observed flying within 150 m of transmission lines, 29 exhibited behavioral responses; of those 29 birds that exhibited collision-avoidance responses, none (0%) collided with a transmission line. Thus, the observed collision-avoidance rate for Newell's Shearwaters was 100% (i.e., 29 of 29 interactions resulted in successful collision avoidance).

Observations of Hawaiian Petrels at an aerial display location on Hawaii Island indicated that displaying Hawaiian Petrels actively avoided fences in their path (Swift 2004). Only one collision out of 1,539 flight passes (i.e., <0.1% of

Table 5. Summary of passage rates (targets/h) of probable Hawaiian Petrel and/or Newell's Shearwater targets observed during radar studies on Oahu, Molokai, Lanai, Kauai, East Maui, West Maui, and Hawaii islands. Results for the current study on the island of Hawaii are marked in bold.

Island (Season)	Year	Passage rate (targets/h)[1] Mean	Range	No. sites sampled	Species (HAPE, NESH, or BOTH)	Source
Hawaii (Lalamilo, summer)	**2015**	0.05	**0.05**	**1**	**BOTH**	**Current study**
Hawaii (Lalamilo, fall)	2013	0.9	0.9	1	BOTH	Cooper and Sanzenbacher 2013
Hawaii (summer)	2001, 2003	1.8	0–25.8	25	BOTH	Day et al. 2003b;Day and Cooper 2003, 2004, 2005
Hawaii (fall)	2002	0.5	0.1–0.7	6	BOTH	Day et al. 2003c
Oahu (summer)	2008, 2009	0.5	0.2–0.6	3	NESH	Day and Cooper 2008, Cooper et al. 2011
Oahu (fall)	2007, 2009	0.3	0.3[3]	1	NESH	Day and Cooper 2008
Molokai (summer)	2002, 2014	3.4	0.2–9.6	5	BOTH	Day and Cooper 2002, Sanzenbacher and Cooper 2014
Lanai (summer)	2007	2.9	0.5–7.1	9	HAPE	Cooper et al. 2007
Kauai (summer)	2001	131.0	7–569	17	BOTH	Day et al. 2003a; Day and Cooper 2001
Kauai (fall)	1993	160.0	35–320	14	BOTH	Cooper and Day 1995
East Maui (summer)	2001, 2004	38.6	1.9–134	12	HAPE	Cooper and Day 2003, Day et al. 2005
East Maui (fall)	2004	13.6	6.2–26.8	4	HAPE	Day et al. 2005
West Maui (summer)	1999, 2001, 2008, 2009	5.2	0.3–21.0	11	BOTH	Cooper and Day 2003, 2009; Day and Cooper 1999; Sanzenbacher and Cooper 2008, 2009
West Maui (fall)	2004, 2008, 2009	0.7	0.0–1.6	5	BOTH	Cooper and Day 2004a; Sanzenbacher and Cooper 2008, 2009; Cooper et al. 2010

[1] All rates are total movement rates (i.e., landward + seaward) for evening and morning combined, if available, or evening only if morning data not available.
[2] HAPE = Hawaiian Petrel; NESH = Newell's Shearwater; BOTH = both Hawaiian Petrel and Newell's Shearwater potentially present.
[3] Fall passage rates from studies at the Kawailoa Wind Energy Project excluded due to reported high levels of contamination of radar data by non-target species.

passes resulted in a collision) was observed during treatment nights, and of the 17 birds that exhibited close-in avoidance maneuvers at the fences, only one (~6%) collided with them. There is some additional information available on collision-avoidance of Hawaiian Petrels on Lanai, where the behavior of petrels was studied as they approached large communication towers near a petrel breeding colony (Tetra Tech 2008). In that study, all 20 (100%) of the Hawaiian Petrels that were on a collision-course toward communication towers exhibited avoidance behavior and avoided collision.

Additional data that provide some insights on collision-avoidance behavior of petrels and shearwaters at windfarm structures (e.g., wind turbines and met towers) are available from other studies associated with the operational KWP I wind facility on Maui and the six meteorological towers on Lanai. Based on fatality searches and observations during the first five years of operation at the 20-turbines and three met towers at the KWP I facility, the estimated total annual take was 0.93 Hawaiian Petrels and 0 Newell's Shearwater fatalities per year. (Kaheawa Wind Power II, LLC 2011). Cooper and Day (2004b) used similar methods as the current study to model seabird fatality for the KWP I wind turbines, based on passage rates from radar studies at the site (Day and Cooper 1999; Cooper and Day 2004a, 2004b). They estimated that the combined annual fatality of Hawaiian Petrels and Newell's Shearwaters at the KWP I turbines would be ~3–18 birds/yr with a 50% avoidance rate, ~1–2 birds/yr with a 95% avoidance rate, and <1 bird/yr with a 99% avoidance rate. Their fatality model that used a 99% avoidance value was a closer fit with the measured fatality rates than were the fatality estimates based on a 50% or 95% avoidance rates.

Similarly, 0 Hawaiian Petrels were found in five years of fatality searches at 1–6 met towers on Lanai (A. Oller, Tetra Tech, pers. comm.), which fit the preconstruction fatality estimates based upon radar data and a >99% avoidance factor (i.e., <0.07–0.77 petrels/met tower/yr with an assumption of 99% avoidance; Cooper et al. 2007). Thus, the two wind energy projects in Hawaii with preconstruction fatality estimates and post-construction fatality data both suggest that fatality models based on an assumption that 99% of petrels avoided structures (i.e., wind turbines and met towers) produced more realistic estimates of fatality than did models using lower avoidance values.

In summary, currently available data suggest that the avoidance rate of petrels and shearwaters at transmission lines and communications towers is high and approaches 100%. Data from the fatality searches at wind turbines and met towers on Maui and Lanai are more difficult to interpret because they are not a direct measure of avoidance, but they also suggest high avoidance rates. Thus, the overall body of evidence, while incomplete, is consistent with the hypothesis that the average avoidance rate of petrels and shearwaters at wind turbines and met towers is substantial and potentially is ≥99%. The ability of Hawaiian Petrels and Newell's Shearwater to detect and avoid objects under low-light conditions makes sense from a life-history standpoint, since they are known to forage extensively at night and to fly through forests near their nests during low-light conditions.

We agree with others (Chamberlain et al. 2006, Fox et al. 2006) that species-specific, weather-specific, and site-specific avoidance data are needed in models to estimate fatality rates accurately. Until further petrel- and shearwater-specific data on the relationship between exposure and fatality rates are available for structures at windfarms, however, we continue to provide a conservative range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance). With an assumption of a 99% avoidance rate, the estimated average direct annual take at all turbines combined at the proposed Project would be <1 Hawaiian Petrel/yr (0.00040–0.00105 Hawaiian Petrels/yr) and <1 Newell's Shearwaters/yr (0.00040–0.00100 Newell's Shearwaters/yr; Table 4).

POTENTIAL BIASES

There are a number of factors that could bias our exposure model and collision estimates in a positive or a negative direction. A positive bias is that our fatality estimates are based upon summer passage rates, which generally are expected to be higher than passage rates in fall (Serventy et al. 1971, Warham 1990, Ainley et al. 1997a, Simons and Hodges 1998). Another potential positive bias was the inclusion of targets that were not petrels or shearwaters (see above). Our extensive use of directional filters and the elimination of petrel/shearwater radar targets that were confirmed by concurrent AV observations to be non-target species helped to minimize the inclusion of non-target species. An additional positive bias in our fatality model is our simplistic assumption that passage rates of seabirds do not decrease as individual fatalities occur (i.e., we assumed sampling with replacement for fatalities). Given the low passage rates observed in this study, it is likely that the fatality of just a single bird would substantially reduce the average nightly passage rates.

There are other factors that could create a negative bias in our fatality estimates. One example would be if targets were missed because they flew within radar shadows. However, the radar sampling site was exceptionally good and so it is unlikely that we missed many petrel/shearwater targets due to radar shadows.

Interannual variation in the number of birds visiting nesting colonies could increase or decrease our fatality estimates. There are examples of sites with high interannual variation in petrel and shearwater radar counts, such as the three sites on Kauai where counts were ~100–300 birds/hr lower (approximately four times lower) in fall 1992 than in fall 1993; the lower counts in 1992 were attributed to the effects of Hurricane Iniki (Day and Cooper 1995).

Oceanographic factors (e.g., El Niño–Southern Oscillation [ENSO] events) also vary among seasons and years and are known to affect the distribution, abundance, and reproduction of seabirds (e.g., Ainley et al. 1994, Oedekoven et al. 2001). During summer 2015 there were ENSO-positive conditions (NOAA 2015). Thus, El Niño-related oceanographic effects could have had a significant, although unknown effect on seabird passage rates during our summer 2015 sampling. Another factor that could cause interannual variation in counts in either direction, especially over a longer time period such as the lifespan of a wind energy facility, is overall population increases or declines. For example, there was a ~60% decline in radar counts on Kauai between 1993 and 1999–2001 that was attributed to population declines of Newell's Shearwaters (Day et al. 2003a).

SUMMARY

This study focused on the movement patterns and flight behavior of Hawaiian Petrels and Newell's Shearwaters near the proposed Lalamilo Wind Energy Project on the island of Hawaii during summer 2015. The key results of the study were: (1) passage rates of petrel/shearwater targets at the Project were even lower than the low rates observed at other locations in the vicinity; (2) the existence of recent records of both Hawaiian Petrels and Newell's Shearwaters from Kohala Mountain and Mauna Kea suggest that the petrel/shearwater radar targets that we observed probably included both species; (3) no Hawaiian hoary bats were detected during AV observations; (4) we estimated an average of 0.05 Hawaiian Petrels/yr and <0.05 Newell's Shearwaters/yr would fly within the space occupied by each proposed wind turbine; (5) current evidence suggests the proportion of seabirds that would detect and avoid wind turbines is substantial and potentially ≥99%, however, using a conservative range of assumptions for avoidance rates in our fatality models (i.e., 90%, 95%, and 99% avoidance), we estimated a fatality rate of 0.00008–0.00207 Hawaiian Petrels/turbine/yr and 0.00008–0.00199 Newell's Shearwaters/turbine/yr. The cumulative annual fatalities at all five of the Vestas V47 turbines combined would be 0.00040–0.01035 Hawaiian Petrels/yr and 0.00040–0.00995 Newell's Shearwaters/yr. Note that these should be considered as maximal fatality estimates, both because they are based on summer passage rates which are expected to be higher than passage rates during the fall.

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