DRAFT HABITAT CONSERVATION PLAN FOR PAKINI NUI WIND FARM

JULY 2018

PREPARED FOR

Tawhiri Power LLC

PREPARED BY

SWCA Environmental Consultants

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EXECUTIVE SUMMARY

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

As of June 15, 2018, three Hawaiian hoary bat (*Lasiurus cinereus semotus*) fatalities have been observed at the Project Area. This species is listed as endangered under the Endangered Species Act of 1973 (ESA), 16 United States Code 1531-1544, and also Hawaiʻi Revised Statutes (HRS) §195D. The first recorded fatality (August 31, 2013) marked the first site-specific data available to Tawhiri, indicating that incidental take of an ESA- and state-listed species had occurred at the Project. The first Hawaiian hoary bat fatality was found during a scheduled search the first week of initiating a more intensive, weekly monitoring effort. Prior to the weekly searches, Tawhiri performed less intensive, monthly searches of all turbines starting at the beginning of commercial operations on April 4, 2007. During this less intensive search period, no fatalities were found. The second Hawaiian hoary bat fatality was found on March 1, 2016, after approximately 2½ years of intensive searching. The third Hawaiian hoary bat fatality was found on April 12, 2018.

Based on initial desktop-based risk assessments and avian field surveys (SWCA 2015a, 2015b, 2015c), Tawhiri has determined that the incidental take of three species could occur from the continued operation of the Project. All three species are state listed and ESA federally listed. These three species, which make up the Covered Species discussed in this Habitat Conservation Plan (HCP) (see Section 3) and the requested take amounts are listed below:

- Hawaiian hoary bat (ʻōpeʻapeʻa; federally and state endangered); 26 bats
- Hawaiian petrel (ʻuaʻu; *Pterodroma sandwichensis*; federally and state endangered); three petrels
- Hawaiian goose (nēnē; *Branta sandvicensis*; federally and state endangered); three nēnē

No other listed, proposed, or candidate species have been found or are known or expected to be present in the Project Area, with the exception of the federally and state-listed band-rumped storm-petrel (*Oceanodroma castro*). The band-rumped storm-petrel was state listed as endangered prior to 1998 and federally listed as endangered on September 30, 2016. This species is exceptionally rare on Hawaiʻi Island, and because the risk of death or injury is discountable, it is not included as a Covered Species.

ESA Section 9 prohibits take, unless authorized as incidental take under Section 10. Incidental take as a result of collision with operational turbines may occur as a result of the Project. Therefore, to comply with the ESA and HRS, and to avoid future potential violations of ESA Section 9 and the HRS §195D take prohibition, Tawhiri is voluntarily preparing this HCP and applying to the U.S. Fish and Wildlife Service for an incidental take permit (ITP), in accordance with Sections 10(a)(1)(B) and 10(a)(2) of the ESA, and to the Hawaiʻi Division of Forestry and Wildlife for an incidental take license (ITL), pursuant to HRS §195D. This HCP has been prepared to fulfill regulatory requirements of both the ITP and ITL applications.

This HCP contains operational minimization measures—most notably, low wind speed curtailment—and mitigation measures to offset the impacts of potential incidental take. Mitigation for the Hawaiian hoary bat consists of habitat improvement at the Kahuku Unit of Hawaiʻi Volcanoes National Park (HVNP). Habitat improvement includes removing invasive plant species and planting desired native species. Mitigation for the Hawaiian petrel consists of predator trapping, predator surveillance, and fence maintenance around a Hawaiian petrel nesting colony in HVNP. Mitigation for nēnē is for predator control and nest protection at a breeding pen located at Piʻihonua. 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

BLNR	Board of Land and Natural Resources
CARE	carcass retention
CP	carcass persistence
CFR	Code of Federal Regulations
cm	centimeter
COD	Commercial Operation Date
DLNR	Department of Land and Natural Resources
DOFAW	Division of Forestry and Wildlife
ESRC	Endangered Species Recovery Committee
ESA	Endangered Species Act
GE	General Electric
ha	hectare
HVNP	Hawai‘i Volcanoes National Park
HCP	Habitat Conservation Plan
HRS	Hawai‘i Revised Statutes
ITL	incidental take license
ITP	incidental take permit
km	kilometer
m	meter
MBTA	Migratory Bird Treaty Act
met	meteorological
MW	megawatt
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPS	National Park Service
O&M	operations and maintenance
SD	Standard Deviation
SEEF	searcher efficiency
SHA	Safe Harbor Agreement
SWCA	SWCA Environmental Consultants
U.S.	United States
USFWS	U.S. Fish and Wildlife Service

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1 INTRODUCTION AND PROJECT OVERVIEW

Pakini Nui Wind Farm is a 21-megawatt (MW) operational wind energy facility (the Project; Figure 1.1) near South Point on the Island of Hawai‘i. Construction of the Project began in August 2006 and was completed in April 2007. The Project, consisting of 14 General Electric (GE) 1.5-MW SE turbines, began operations on April 3, 2007. Tawhiri Power LLC (Tawhiri) owns and operates the Project.

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

- Avian report (Day 2005)
- Fatality monitoring reports (Tawhiri Power 2007–2013)
- Avian field survey and survey report (SWCA Environmental Consultants [SWCA] 2015a)
- Acoustic bat activity monitoring (SWCA 2015b)
- Fatality monitoring (SWCA 2015c)

As of June 15, 2018, three Hawaiian hoary bat (*Lasiurus cinereus semotus*) fatalities have been observed in the Project Area. This species is listed as endangered under the Endangered Species Act of 1973 (ESA), 16 United States Code 1531-1544, and as endangered by the State of Hawai‘i under Hawai‘i Revised Statues (HRS) §195D. The first recorded fatality of a Hawaiian hoary bat fatality (August 31, 2013) marked the first site-specific data available to Tawhiri, indicating that incidental take of an ESA- and state-listed species had occurred at the Project. This Hawaiian hoary bat fatality was found at the start of the intensive, weekly monitoring effort, during a scheduled search. Prior to the weekly searches, Tawhiri performed less intensive, monthly searches of all turbines since the Commercial Operation Date (COD), during which no fatalities were found. The second Hawaiian hoary bat was found on March 1, 2016, after approximately 2½ years of intensive searching. The third Hawaiian hoary bat was found on April 12, 2018, after 4½ years of intensive searching.

Based on initial desktop-based risk assessments and avian field surveys (SWCA 2015a, 2015b, 2015c), Tawhiri has determined that the incidental take of three species could occur from the continued operation of the Project. All three species are both state listed and ESA federally listed as endangered. These three species, which make up the Covered Species discussed in this Habitat Conservation Plan (HCP) (see Section 3), are listed below:

- Hawaiian hoary bat (‘ōpe‘ape‘a; state and federally endangered)
- Hawaiian petrel (‘ua‘u; *Pterodroma sandwichensis*; state and federally endangered)
- Hawaiian goose (nēnē; *Branta sandvicensis*; state and federally endangered)

One additional species, the band-rumped storm-petrel (*Oceanodroma castro*), was state listed as endangered prior to 1998 and federally listed as endangered on September 30, 2016. This species was considered but not included as a Covered Species because, as discussed in Section 4.3.1., the risk of death or injury from the Project is discountable. However, as certain minimization and mitigation measures in the HCP may benefit this species, it is included in this HCP.

To comply with the ESA and to avoid future potential violations of the ESA Section 9 take prohibition, Tawhiri is voluntarily preparing this HCP and applying to the U.S. Fish and Wildlife Service (USFWS) for an incidental take permit (ITP), in accordance with Sections 10(a)(1)(B) and 10(a)(2) of the ESA, and to the Department of Land and Natural Resources (DLNR) for an incidental take license (ITL), pursuant to Hawai‘i Revised Statutes (HRS) §195D. This HCP has been prepared to fulfill regulatory requirements of both the ITP and ITL applications.

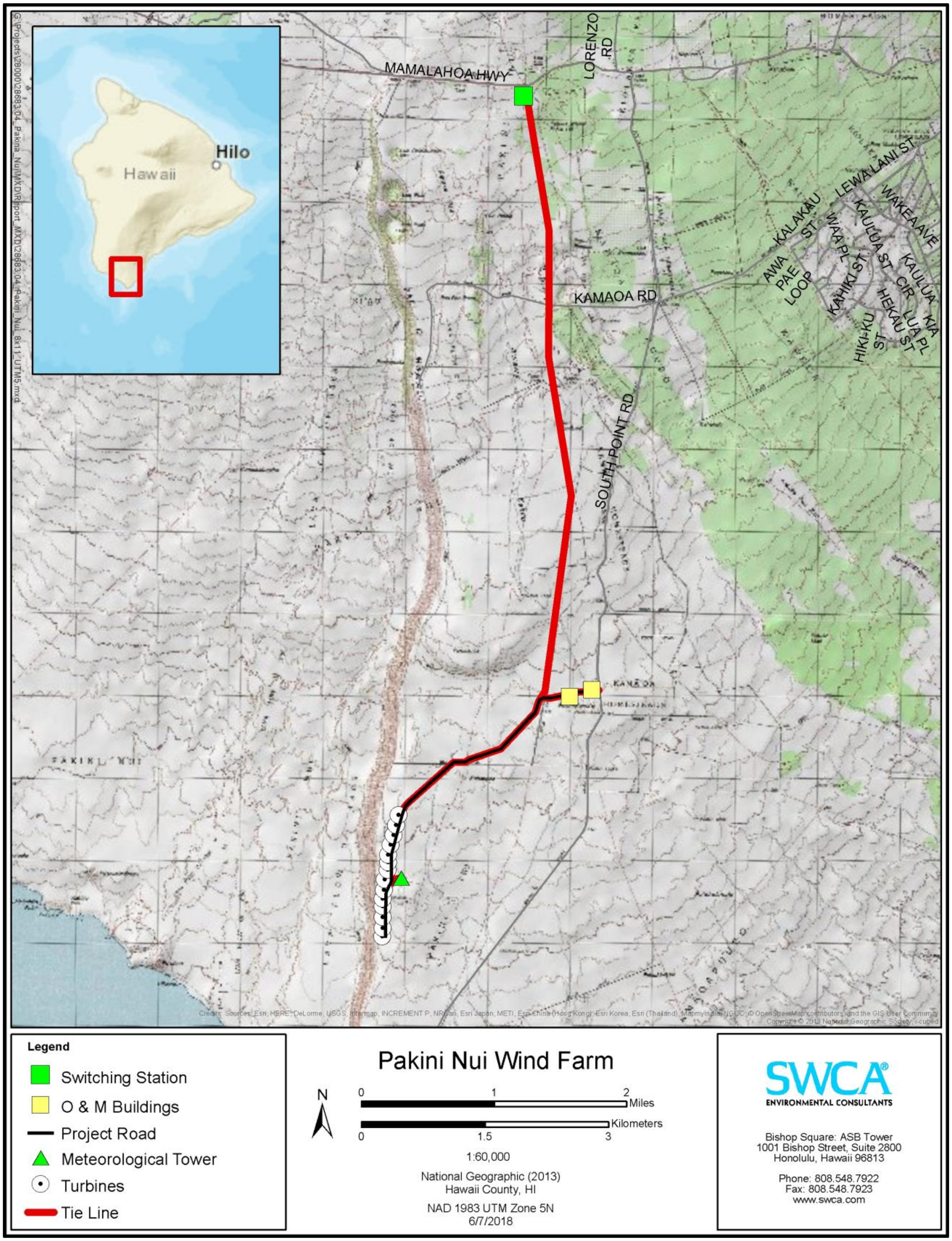

Figure 1.1. Pakini Nui Wind Farm Project location (O&M = operations and maintenance).

1.1 Applicant

The applicant for incidental take authorization related to the Project is Tawhiri. Tawhiri is a partnership made up of wholly owned subsidiaries of Apollo Energy Corporation and GE Capital Corporation.

1.2 Project Description

The Project, located near South Point on the Island of Hawai‘i, is a 21-MW operating wind energy facility (see Figure 1.1). Construction of the Project began in August 2006 and was completed in April 2007. The Project, consisting of 14 GE 1.5-MW SE turbines, began operations on April 3, 2007. Tawhiri owns and operates the Project.

A number of Project components are on leased lands (Figure 1.2). The Project wind turbine easement is 9.8 hectare (ha) (24.3 acres), the tie-line easement is 22.2 ha (54.9 acres), and the meteorological (met) tower easement is 0.09 ha (0.22 acre). Together these lands comprise the Project Area, which totals 32.09 ha (79.42 acres).

Turbines are constructed of tubular towers with a hub height of approximately 65 meters (m) (213 feet); the rotor blades are approximately 70 m (230 feet) in diameter and reach a maximum height of 100 m (328 feet). Project turbines can be programmed to begin spinning at specific wind speeds and stop spinning (shut down) at specific wind speeds. The turbines are operated independently, based on individual turbine anemometry. One lattice structure met tower 62 m (205 feet) high is approximately 183 m (600 feet) east of the middle of the turbine string.

The Project uses a 9.6-kilometer (km)-long (6-mile-long) aboveground transmission line to deliver power generated at the wind farm to the local power grid. This line is a single-conductor three-circuit line operating at 69 kilovolts (grid voltage). There are 82 poles in total: 53 are 17.3 m (57 feet) tall, 21 are 18.5 m (61 feet) tall, two are 15.8 m (52 feet) tall, two are 21.3 m (70 feet) tall, two are 22.9 (75 feet) tall, one is 20 m (66 feet) tall, and one is 24.0 m (79 feet) tall. Spacing between poles is approximately 122 m (400 feet), with three poles having two guy wires, six poles having four guy wires, one pole having six guy wires, and three poles having eight guy wires. The remaining posts are freestanding. Most of the guyed poles (eight) occur along the lower 2.4 km (1.5 miles) of the transmission line. A static line runs along the top of the poles and a fiber optic communications line is located approximately 20 feet from the ground.

The Project also comprises approximately 3.2 km (2 miles) of roads, 1.6 km (1 mile) of underground connector lines, a 0.6-ha (1.5-acre) operations and maintenance (O&M) building area, and a 0.48-ha (1.2-acre) substation (see Figure 1.1). Monthly on-site equipment checks using both 2-wheel- and 4-wheel-drive vehicles are conducted.

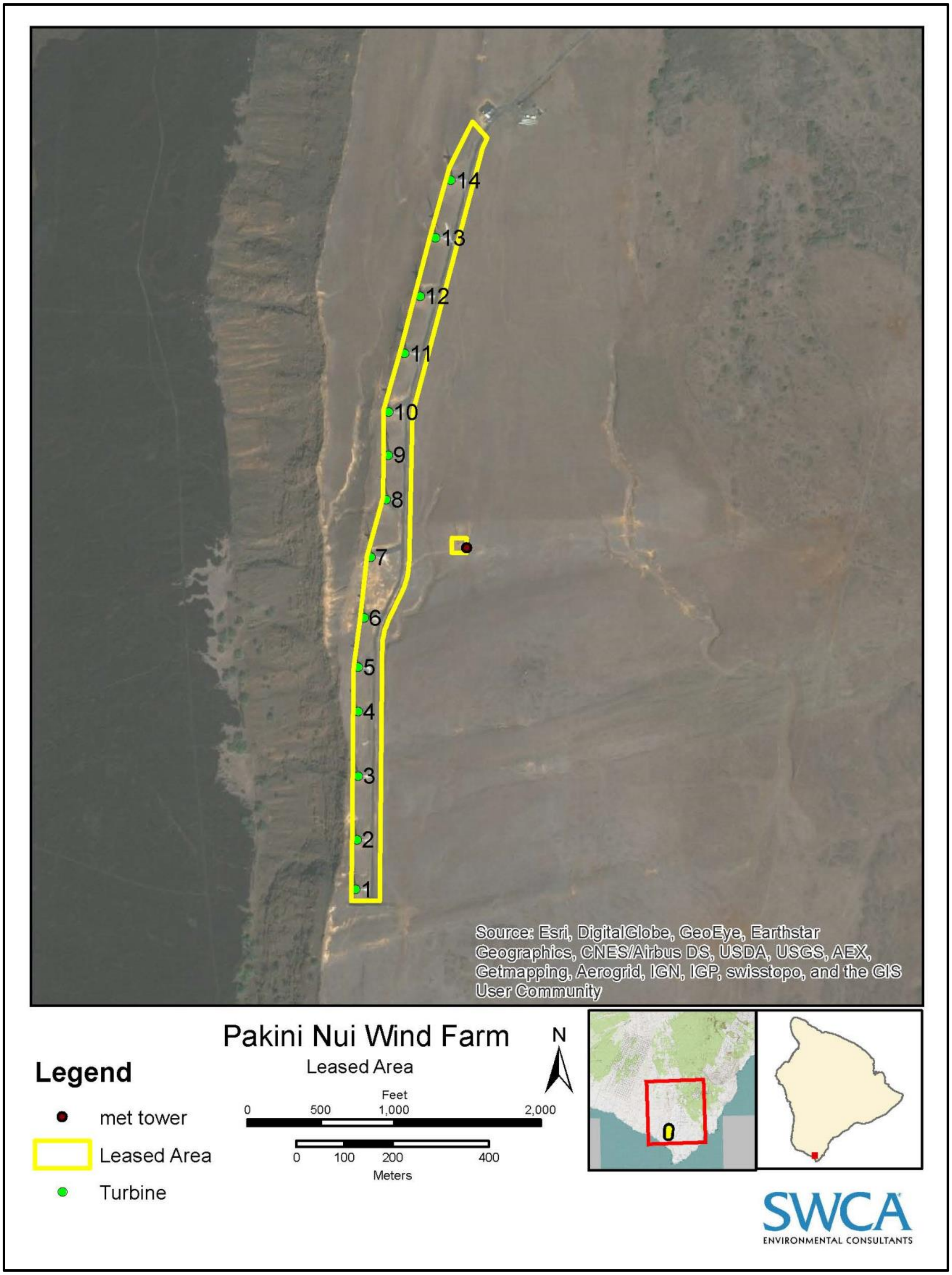

Figure 1.2. Closeup of total Pakini Nui Wind Farm Leased Area.

Minimization measures implemented at the Project Area and intended to decrease the risk of take to Covered Species are as follows (also described in Section 6.1):

- Minimize nighttime activities to avoid the use of lighting that could attract Hawaiian petrels and possibly Hawaiian hoary bats. This measure will also further reduce the attraction risk of band-rumped storm-petrels, which, due to discountable risk of death or injury, are not included as Covered Species in this HCP.
- Observe a speed limit of 40 km (25 miles) per hour while driving in the Project Area. This will help minimize collisions with Covered Species, in the event they are using habitat on-site or are injured. If nēnē are observed at or near the site, a speed limit of 24.1 km (15 miles) per hour will be observed.
- Do not use barbed wire on perimeter fencing within the Leased Area (see Figure 1.2) because it poses an entangling risk to Hawaiian hoary bats.
- If gaps in grazing activity occur, Tawhiri will do its best to maintain vegetation height of less than 9 inches within the Leased Area so as not to attract nēnē breeding behavior.
- Refrain from purposely approaching and maintain a distance (by foot or vehicle) of 30 m (100 feet) from nēnē when present on-site in order to avoid erratic flight behavior that may increase strike risk.
- Implement low wind speed curtailment, as described in Section 6.2.1.

1.3 Purpose and Need

Tawhiri and its managing member, Apollo Energy Corporation, have been providing clean, renewable energy from wind facilities located near South Point on the Island of Hawai‘i since the mid-1980s. The current Project was installed in 2007 to replace the old Kamao‘a Wind Farm, an obsolete and decommissioned farm located several miles northwest of the Project Area (where the current O&M building is located). The new wind farm uses turbines with greater efficiency, power performance, and output, resulting in significantly reduced hub rotational speeds. Fourteen turbines are able to triple the generation that 37 smaller turbines had provided. These new turbines are also able to “ride through” all but the most significant grid events, staying online and providing critical power to rate payers when other conventional fossil-fueled generators have tripped offline. Finally, the Project is able to provide up to 20% of the Island of Hawai‘i’s total electrical generation needs, providing a significant contribution to the county and state renewable portfolio while providing cost-effective, clean, renewable energy for nearly 18,000 homes annually.

The first recorded fatality of a Hawaiian hoary bat carcass on August 31, 2013, marked the first site-specific data available to Tawhiri indicating that an incidental take of an ESA- and state-listed species had occurred at the Project. Therefore, to comply with the ESA and HRS, and to avoid future potential violations of ESA Section 9 and HRS §195D take prohibitions as a result of fulfilling contractual obligations to continue operation of the Project, Tawhiri is voluntarily preparing this HCP and applying to the U.S. Fish and Wildlife Service for an ITP in accordance with Sections 10(a)(1)(B) and 10(a)(2) of the ESA, and to the Hawai‘i Division of Forestry and Wildlife (DOFAW) for an ITL, pursuant to HRS §195D. This purpose of this HCP is to fulfill regulatory requirements of both the ITP and ITL applications.

1.4 Covered Activities

Covered Activities discussed in this HCP are those operational activities within the Permit Area (see Section 1.5) that could result in an incidental take of one or more Covered Species and for which Tawhiri seeks incidental take authorization (see Section 1.2). Of the Project components and activities described in Section 1.2, only the ongoing existence of the met tower and operation of turbines present a likelihood for an incidental take of a Covered Species. Approximately 9.6 km (6 miles) of aboveground tie-lines connect the Project to the island's power grid. Although the risk of collision between a Covered Species and a portion of the Project tie-line is discountable (see Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2), it is also included as a Covered Activity. Therefore, these are the only Project components and activities for which Tawhiri seeks incidental take authorization. Presence and use of the O&M building and substation do not present potential effects to Covered Species.

1.5 Permit Area and Plan Area

The Permit Area for this HCP is the geographical area within which incidental take resulting from Covered Activities is expected to occur. The Permit Area consists of the Project Area, which comprises the lands leased by Tawhiri, and the search plots around the turbines, which extend outside of these leased lands and the Project tie-line (Table 1.1). The Permit Area is shown in Figure 1.3 and is approximately 45 ha (111.2 acres).

Table 1.1. TMKs, Legal Description, and Landowners of the Permit Area

TMK	Legal Description	Landowner(s)
Turbine search plots		
393001006	Hawai‘i County, Zone 9, Section 3, Plat 1	Kamehameha Schools
Tie-line		
393002023	Hawai‘i County, Zone 9, Section 3, Plat 2	Govt. State
393001006	Hawai‘i County, Zone 9, Section 3, Plat 1	Kamehameha Schools
393002006	Hawai‘i County, Zone 9, Section 3, Plat 2	Kamehameha Schools
393004001	Hawai‘i County, Zone 9, Section 3, Plat 1	Kamehameha Schools
393001999	Hawai‘i County, Zone 9, Section 3, Plat 1	Kamehameha Schools

Cattle and feral goats routinely graze the areas below and surrounding the turbines. Vegetation in these areas consists mostly of buffelgrass (*Cenchrus ciliaris*), which is grazed to stubble and interspersed with occasional lantana bush (*Lantana camara*) and kiawe tree (*Prosopis pallida*). The cliff west of the turbine string has similar vegetation but offers shelter from both wind and ungulates; therefore, this area hosts more and larger kiawe trees. The areas south and east of the Project Area consist mostly of grazed buffelgrass grasslands interspersed with non-native trees, such as kiawe tree. North of the Project Area, the vegetation becomes gradually more shrubby and woody, with mostly non-native tree and shrub species. At the northernmost portion of the tie-line, the vegetation consists of mostly native forest, with ‘ōhi‘a (*Metrosideros polymorpha*) and pūkiawe (*Leptecophylla tameiameiae*) as dominant species.

The Permit Area experiences relatively high average wind speeds. Wind direction is predominantly between 70˚ north and 90˚ north.

Additional lands addressed in the HCP are those that will be used for mitigation. Those areas are addressed in Section 6.

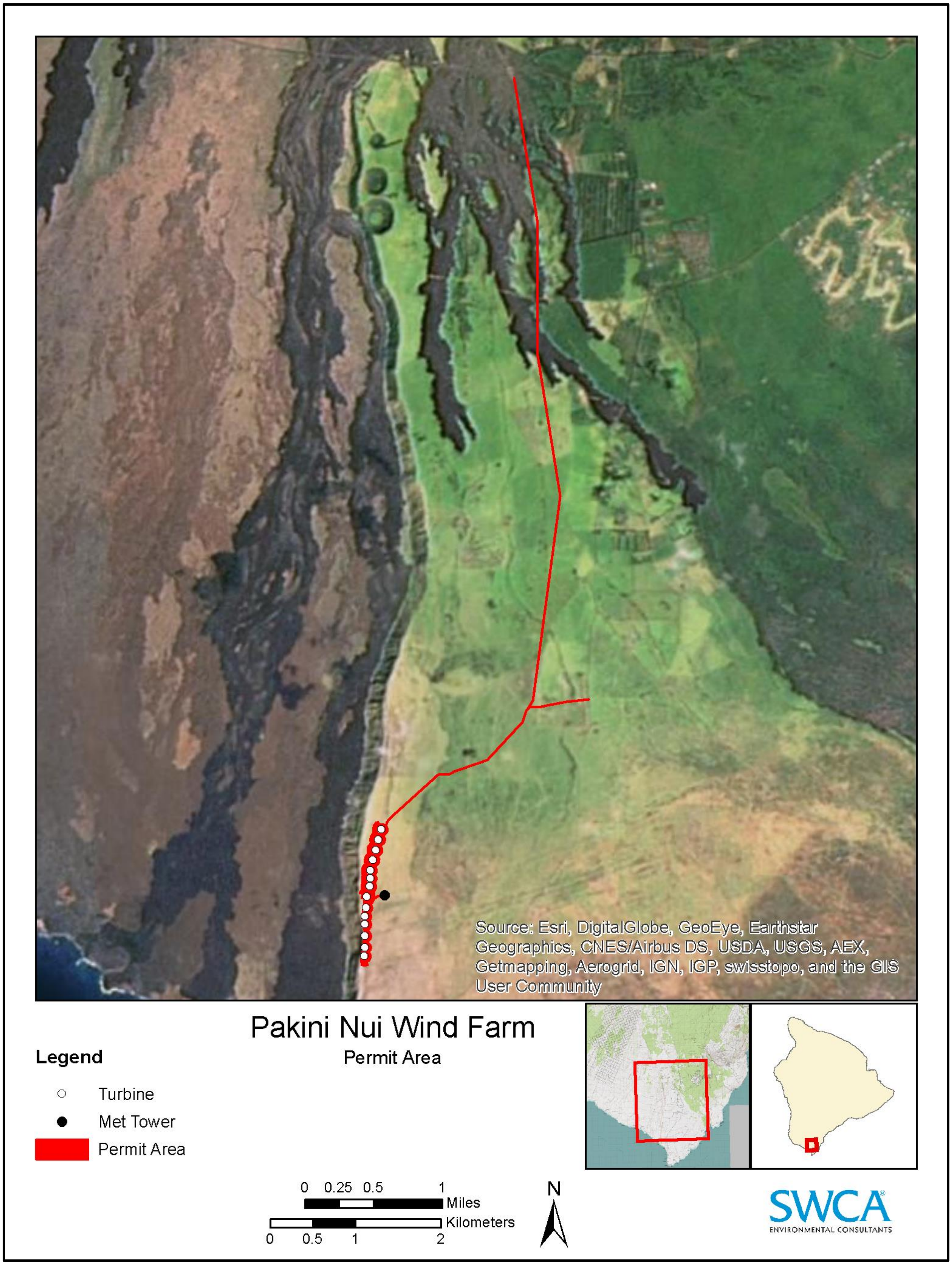

Figure 1.3. Pakini Nui Wind Farm Permit Area.

Together, the Permit Area and mitigation lands define the Plan Area.

A number of project components are on leased lands (see Figure 1.3). The Project wind turbine easement is 9.8 ha (24.3 acres), the tie-line easement is 22.2 ha (54.9 acres), and the met tower easement is 0.09 ha (0.22 acre).

1.6 Incidental Take Permit/Incidental Take License Duration

Tawhiri seeks incidental take authorization for a period of 10 years from the date of USFWS and DLNR authorization. This covers the anticipated remaining operating life of the Project (8 years) and the decommissioning/deconstructing stage (2 years).

2 REGULATORY FRAMEWORK

This HCP has been prepared to fulfill regulatory requirements of both the ITP and ITL applications, as described below. Tawhiri is responsible for complying with all federal, state, and local laws.

2.1 Endangered Species Act

The ESA protects wildlife and plant species that have been listed as threatened or endangered. 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.

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 regulations 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).

By issuance of an ITP under Section 10, 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 ITP issuance criteria of ESA Section 10(a)(2)(B), 50 CFR 17.22(b)(2), and 50 CFR 17.32(b)(2) are met:

- The taking of a Covered Species 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 Covered Species in the wild.
- Other necessary or appropriate measures required by the Secretary of the Interior, if any, will be met and the secretary has received such other assurances as he or she may require that the HCP will be implemented.

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* (*HCP Handbook*), published by the USFWS and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (together, Services) in November 1996, provides additional policy guidance concerning the preparation and content of HCPs. The USFWS and NOAA published an addendum to the *HCP Handbook* on June 1, 2000 (*Federal Register* 65:35242–3525). This addendum, also known as the Five-Point Policy, provides clarifying guidance for applicants applying for ITPs and the Services 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 also will consider the level of scientific and commercial data underlying the proposed operating conservation 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 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 Hawai‘i Revised Statutes Chapter 195D

The purpose of HRS §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." Chapter 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 §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 adapted from HRS §195D-4(g)):

- 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.

Chapter 195D-4(i) directs the DLNR to work cooperatively with federal agencies in concurrently processing HCPs, ITLs, and ITPs. Chapter 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 will be designed to result in an overall net benefit to the threatened and endangered species in Hawai‘i (HRS §195D-30).

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

Following the 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, the participant in the HCP (e.g., the ITL holder) must submit an annual report to the DLNR within 90 days of each fiscal year ending June 30, as further detailed in Section 7; 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 that evaluates the potential environmental impacts of approving the HCP and issuing an ITP. 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 that 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

All three bird species addressed in this HCP—Hawaiian petrel, band-rumped storm-petrel, and nēnē—are also protected under the Migratory Bird Treaty Act of 1918 (MBTA), as amended (16 USC 703-712). The MBTA prohibits the take of migratory birds. A list of birds protected under MBTA implementing regulations is provided at 50 CFR 10.13. Unless permitted by regulations, under the MBTA, "it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product."

The MBTA provides no process for authorizing incidental take of MBTA-protected birds. However, if the HCP is approved and the 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 and nēnē under the MBTA. Therefore, subject to the terms and conditions to be specified in the ITP, if issued, any such take of the two 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 operation of the Project 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 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 ensure compliance with federal laws such as the MBTA. The approach described in this document for the operation of this Project is consistent with these guidelines.

3 ECOLOGY OF THE COVERED SPECIES AND BAND-RUMPED STORM-PETREL

3.1 Hawaiian Hoary Bat

3.1.1 Population, Biology, and Distribution

The Hawaiian hoary bat is the only native land mammal present in the Hawaiian archipelago. It is a subspecies of the hoary bat (*Lasiurus cinereus*), which occurs across much of North and South America. Males and females have a wingspan of approximately 0.3 m (1 foot), although females are typically larger and heavier than males, weighing on average 17.9 grams (0.6 ounce). Males average 14.2 grams (0.5 ounce). Both sexes have a coat of brown and gray fur. Individual hairs are tipped or frosted with white (Jacobs 1993; Mitchell et al. 2005).

Hawaiian hoary bats roost in native and non-native vegetation at least 1 m (3 feet) above ground level. They have been observed roosting in ‘ōhi‘a, hala (*Pandanus tectorius*), coconut palm (*Cocos nucifera*), ironwood (*Casuarina equisetifolia*), kukui (*Aleurites moluccana*), kiawe tree, avocado (*Persea americana*), mango (*Mangifera indica*), shower tree (*Cassia javanica*), pūkiawe, and fern clumps; they are also suspected to roost in eucalyptus (*Eucalyptus* spp.) 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 (Kawailoa Wind Power 2014; USFWS 1998). One lychee tree in Hilo has been used as a nursery tree by multiple bats (personal communication, D. Sether, USFWS, September 14, 2015).

A preliminary study (November 2004 to August 2008) of a small sample of Hawaiian hoary bats (n = 28) on the Island of Hawai‘i had a mean, 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 varied widely among individuals. Core areas included feeding ranges that were 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 May and October (Gorresen et al. 2013). Lactating females have been documented from June to September (personal communication, D. Sether, USFWS, September 14, 2015), indicating that this is the period when non-volant young are most likely to be present. Breeding has been documented on the Islands of Hawai‘i and Kaua‘i, as well as a singular observation on O‘ahu (Baldwin 1950; Kawailoa Power, LLC 2014; Kepler and Scott 1990; Menard 2001). Seasonal changes in the abundance of Hawaiian hoary bats at different elevations indicate that altitudinal movements occur on the Island of Hawai‘i. During the pupping period (May through October), Hawaiian hoary bat occurrences increase in the lowlands and decrease at high-elevation habitats. In the winter, bat occurrences increase in high-elevation areas (above 1,525 m [5,000 feet]) from January through March (Bonaccorso 2011; Gorresen et al. 2013; Menard 2001).

Hawaiian hoary bats feed on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites (Whitaker and Tomich 1983). They appear to prefer moths ranging from 16 to 20 millimeters (0.60 to 0.89 inch) in size (Bellwood and Fullard 1984; Fullard 2001). Koa moths (*Scotorythra paludicola*), which are endemic to the Hawaiian Islands and use koa (*Acacia koa*) as a host plant (Haines et al. 2009), are frequently targeted as a food source (personal communication, M.P. Gorresen, 2013). Microchiroptera bats locate their prey using echolocation. Typical peak frequency for echolocation hunting behavior occurs at 27.8 kilohertz, whereas social calls are recorded at a peak frequency of 9.6 kilohertz (Bellwood and Fullard 1984). Water courses 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, Hawaiian hoary bats are attracted to insects that congregate near lights (Bellwood and Fullard 1984; Mitchell et al. 2005; USFWS 1998). They begin foraging either just before or after sunset, depending on the time of year (Jacobs 1993; Mitchell et al. 2005; USFWS 1998).

Hawaiian hoary bats have been confirmed on all of the main islands except Niʻihau and Kahoolawe (Day and Cooper 2002, 2008; HBMP 2007; SWCA 2011). The species is most common on the islands of Hawaiʻi, Maui, and Kauaʻi (Kepler and Scott 1990). The largest known breeding populations are thought to occur on Kauaʻi and Hawaiʻi, although breeding was recently documented on Oahu (Kawailoa Wind Power 2013). Relatively little research has been conducted on the Hawaiian hoary bat, and data regarding its population status is very limited. Population estimates for this species range from hundreds to a few thousand; however, these estimates are based on limited and incomplete data due to the difficulty in estimating populations of patchily distributed bats (USFWS 2007). Acoustic monitoring of bat activity throughout the main Hawaiian Islands almost always picks up bat detections; however, there is no way to convert acoustic detections into a viable population estimate.

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

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

3.1.2 Threats

Little is known regarding threats to the Hawaiian hoary bat. The presumed decline of the species may be due to the decrease in canopy cover during historic times (Nowak 1994; Tomich 186)—in particular, the severe deforestation on Oʻahu in the early nineteenth century (Tomich 1986). The main observed mortalities of the Hawaiian hoary bat in the State of Hawaiʻi have been from bats snagging on barbed wire, striking vehicles, and colliding with wind turbines. It also may be preyed upon by predatory birds such as owls (Amlin and Siddiqi 2015). 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 3.1) 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), and 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).

3.1.3 Known Fatalities at Other Hawaiian Wind Farms

Fatalities of Hawaiian hoary bats have been documented at six operational wind farms in Hawaiʻi, including the Project (see Table 3.1).

Table 3.1. Documented Fatalities of Hawaiian Hoary Bats at Wind Farms in Hawaiʻi as of December 2017

Location	Observed Take*	Calculated Take (80% Dalthorp†)
Auwahi Wind Farm (Maui)	16	42
Kaheawa Wind Farm (Maui)	8	28
Kaheawa II Wind Farm (Maui)	3	13
Kahuku Wind Farm (Oʻahu)	4	11
Kawailoa Wind Farm (Oʻahu)	32	69
Pakini Nui Wind Farm (Hawaiʻi)	3	Not applicable (N/A)

* *Source*: Personal communication, D. Sether, USFWS, April 11, 2018.

† The take estimate is based on Evidence of Absence software (Dalthorp et al. 2014; Dalthorp et al. 2017), existing literature, and site-specific data. It includes the indirect take estimate.

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.

Baerwald et al. (2009) conducted a study during the peak period of migration (August 1–September 7, 2007) for hoary and silver-haired bats (*Lasionycteris noctivagans*) at a wind energy installation in southwestern Alberta, Canada, where the dominant fatalities were from the two bat species. Three treatment groups were tested (control turbines, treatment turbines with increased cut-in speed, and experimental idling turbines with the blades manipulated to be motionless during low wind speeds), combining the two experimental treatment results and comparing them to control turbines, Baerwald et al. (2009) conclude that the experimental turbines had lower fatality rates for each species (Arnett et al. 2013).

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

Studies from 10 different operational mitigation wind farms in North America found reductions in fatality rates by altering turbine operations. Most studies found at least a 50% reduction in bat fatalities when turbine cut-in speed was increased by 1.5 m (5 feet) per second above the manufacturer's cut-in speed. Similar reductions in bat fatalities were reported by one study that implemented a raised cut-in speed given temperatures were above 9.5 degrees Celsius. One study demonstrated equally beneficial reductions with a low-speed idling approach, whereas another discovered that feathering turbine blades (pitched 90 degrees and parallel to the wind) at or below the manufacturer's cut-in speed resulted in up to 72% fewer bats killed when turbines produced no electricity into the power grid (Arnett et al. 2013).

3.1.4 Known Occurrences in the South Point Area

Hawaiian hoary bats appear to be widespread on the Island of Hawaiʻi (Jacobs 1994). According to Day (2005), Hawaiian hoary bats have been recorded at South Point. Bats also have been detected in the southern portion of the Kahuku Unit of Hawaiʻi Volcanoes National Park (HVNP) and are widespread and present year-round (Fraser and HaySmith 2009). The Kahuku Unit is across the road from the transmission line of the Project and is approximately 12.5 km (7.8 miles) from the Project's turbine string.

Bats have been documented in forests as well as pastureland and may use less forested areas during the nonbreeding 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 are expected to occur at the Project Area, although the sites included in Gorresen et al.'s (2013) study had lower average wind speeds than those recorded at the Project Area. The presence of Hawaiian hoary bats at the Project Area was confirmed when a Hawaiian hoary bat carcass was found below Turbine 12 on August 31, 2013.

Bat detectors have been in place at the Project Area since December 2013, with one detector placed at the met tower, one between Turbine 1 and Turbine 2, one slightly downwind of Turbine 14, and two detectors on turbine nacelles (Turbine 1 and Turbine 14). On-site bat activity was 0.36 passes/detector/night. The data show that bats were present throughout all months of the year. Using data from the five detectors, the months of June through September were found to be significantly higher ($X^2 = 5.46$, $P = 0.0195$, one-tailed test; SWCA 2015b) in bat activity, whereas October through May were lower activity months. Bat activity occurred throughout all hours during which detectors were recording (6:00 p.m. to 6:00 a.m.). Bat activity was not found to be significantly different among the ground-based detectors.

A recent study by Corcoran and Weller (2018) indicates that the mainland hoary bat may occasionally use "micro" calls (acoustic calls with very low sound energy that are very difficult or impossible to detect with current acoustic detection technology) or periodically not echolocate at all. Although this behavior has not been documented in the Hawaiian subspecies, it raises the question whether acoustic surveys accurately depict hoary bat use of an area.

3.2 Hawaiian Petrel

3.2.1 Population, Biology, and Distribution

The Hawaiian petrel was once abundant on all main Hawaiian Islands except Niʻihau (Mitchell et al. 2005). The population was most recently estimated to consist of approximately 17,000–34,000 individuals, with 4,000–5,000 breeding pairs (Spear et al. 1995). The once significant breeding populations of Hawaiian petrels on the Island of Hawaiʻi were reduced to very small numbers by the end of the twentieth century (Banko 1980; Conant 1980; Richardson and Woodside 1954). Today there are an estimated 100 to 200 breeding pairs on the Island of Hawaiʻi (Pyle and Pyle 2009). Hawaiian petrels continue to breed in high-elevation colonies on Maui, Hawaiʻi, Kauaʻi, and Lānaʻi (Richardson and Woodside 1954; Simons and Hodges 1998; Telfer et al. 1987). Radar studies conducted in 2002 also suggest that breeding may occur on Molokaʻi (Day and Cooper 2002). It is believed that breeding no longer occurs on Oʻahu (Harrison 1990). The largest known breeding colony is at Haleakalā National Park on Maui, where as many as 1,000 pairs have been thought to nest annually (Mitchell et al. 2005). HVNP currently encompasses the largest active Hawaiian petrel colony on the Island of Hawaiʻi. An accurate population estimate for Hawaiʻi Island is lacking; however, a rudimentary estimate suggests approximately 2,000 individuals (Cooper and Day 2004).

Hawaiian petrels subsist primarily on squid, fish, and crustaceans caught near the sea surface. Foraging may take place thousands of km from their nesting sites during both breeding and nonbreeding 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. The nesting season occurs between late February and November, with Hawaiian petrels accessing their underground burrows nocturnally (Simons 1985). Breeding and prospecting birds fly to the nesting site in the evening and leave for foraging trips before dawn. Mean altitude during transitory inland flight is approximately 190 m (623 feet) aboveground for Maui birds (Day et al. 2003). Flight altitude is not believed to vary with the season (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 at 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 a uluhe (*Dicranopteris linearis*) understory, such as those found on Kaua‘i (Mitchell et al. 2005). 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). A 2001 study 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 the 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 the sea in October and November. Adult birds do not breed until age 6 and may not breed every year, but pre-breeding and nonbreeding birds nevertheless return to the colony each year to socialize

3.2.2 Threats

The main factors contributing to population declines of ground-nesting seabirds such as Hawaiian petrels are habitat degradation; the loss of nesting habitat; predation of eggs, hatchlings, and adults at nesting sites by introduced mammals (e.g., dogs [*Canis familiaris*], mongooses [*Herpestes javanicus*], cats [*Felis catus*], rats [*Rattus* spp.], and pigs [*Sus scrofa*]); and urban lighting and associated structures (e.g., power lines, buildings, and fences) that cause disorientation and fall-out of juvenile birds (Ainley et al. 1997; Hays and Conant 2007; Mitchell et al. 2005). In addition, introduced ungulates such as feral goats (*Capra hircus*) cause mortality and nest failure by trampling burrows (USFWS 2005a). The most serious cause of mortality and breeding failure of Hawaiian petrels is predation by introduced mammals (Hodges 1994; Simons 1985; Simons and Hodges 1998).

Introduced mammals have the potential to severely impact ground-nesting seabirds. Mongooses 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 that nest along the coast or at low elevations (Swift and Burt-Toland 2009); mongooses may have displaced Hawaiian petrels at lower elevation breeding sites, where they were once common at all elevations on all the main islands (Simons 1985; Simons and Hodges 1998). Feral cats are more widely distributed, ranging from sea level to subalpine areas, and provide a major threat to ground-nesting birds at high elevations (Hodges 1994; Winter 2003). Disorientation and fall-out as a result of light attraction are less of an issue on Hawai‘i Island because of

Hawaiʻi County's Outdoor Lighting Ordinance (Hawaiʻi 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, power lines, and obstructions (e.g., wind turbines) are hazards to seabirds (USFWS 2005b).

3.2.3 Known Fatalities at Other Hawaiian Wind Farms

Hawaiian petrel fatalities have been documented at Kaheawa and Auwahi Wind Farms on Maui (Table 3.2). 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 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 3.2. Documented Fatalities of Hawaiian Petrels at Wind Farms in Hawaiʻi as of December 2017

Location	Observed Take	Calculated Take (80% Dalthorp)*
Auwahi Wind Farm (Maui)	1	4 (no more than 3 adults and 1 juvenile)
Kaheawa Wind Farm (Maui)	6	13**
Kaheawa II Wind Farm (Maui)	0	0
Kahuku Wind Farm (Oʻahu)	0	0
Kawailoa Wind Farm (Oʻahu)	1	Not yet determined
Pakini Nui Wind Farm (Hawaiʻi)	0	0

Source: Personal communication, D. Sether, USFWS, April 11, 2018.

* The take estimate is based on Evidence of Absence software (Dalthorp et al. 2014; Dalthorp et al. 2017), 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.

3.2.4 Known Occurrences in the South Point Area

Day et al. (2003) studied the movements and distribution of Hawaiian petrels and Newell's shearwaters (*Puffinus newelli*) on the Island of Hawaiʻi using radar in 2001 and 2002. Because radar data do not identify passage rates by species and because there are no recent records of nesting Newell's shearwaters on Hawaiʻi Island—the most recent evidence from the Puna region being from 1993 (Reynolds and Richotte 1997)—radar detections from Day et al. (2003) are understood to be primarily Hawaiian petrels. Movement rates of Hawaiian petrels on the island are 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 northern and southern parts of the island. Birds flying over the Project will have a low target rate of approximately 1–2 targets per hour, similar to what was observed at nearby coastal locations (Hoʻopuloa and Punaluʻu) (Day et al. 2003).

The closest known Hawaiian petrel colony is on the southwest flank of Mauna Loa, within the Kahuku Unit of HVNP, approximately 15.3 km (9.5 miles) upslope from the Project (Figure 3.1) (Swift and Burt-Toland 2009). Based on the Day et al. (2003) radar data, most of the birds nesting in this colony fly inland in the southwestern and southeastern parts of the island. A few Hawaiian petrels can be expected to fly over the southern part of the Island of Hawaiʻi during their flights inland toward or seaward from these nesting colonies (Day et al. 2003). A small-scale satellite telemetry study conducted in HVNP indicated that Hawaiian petrels from the largest colony on the island (the eastern slope of Mauna Loa, 54.7 km [34 miles] from the Project Area) may pass by or cross the Project Area on flights to and from the nesting colony.

Three other known colonies are on the southeast flank of Mauna Loa, also within HVNP, approximately 56.3 km (35 miles) from the Project. The park currently encompasses the largest active Hawaiian petrel colony on the Island of Hawai‘i.

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.

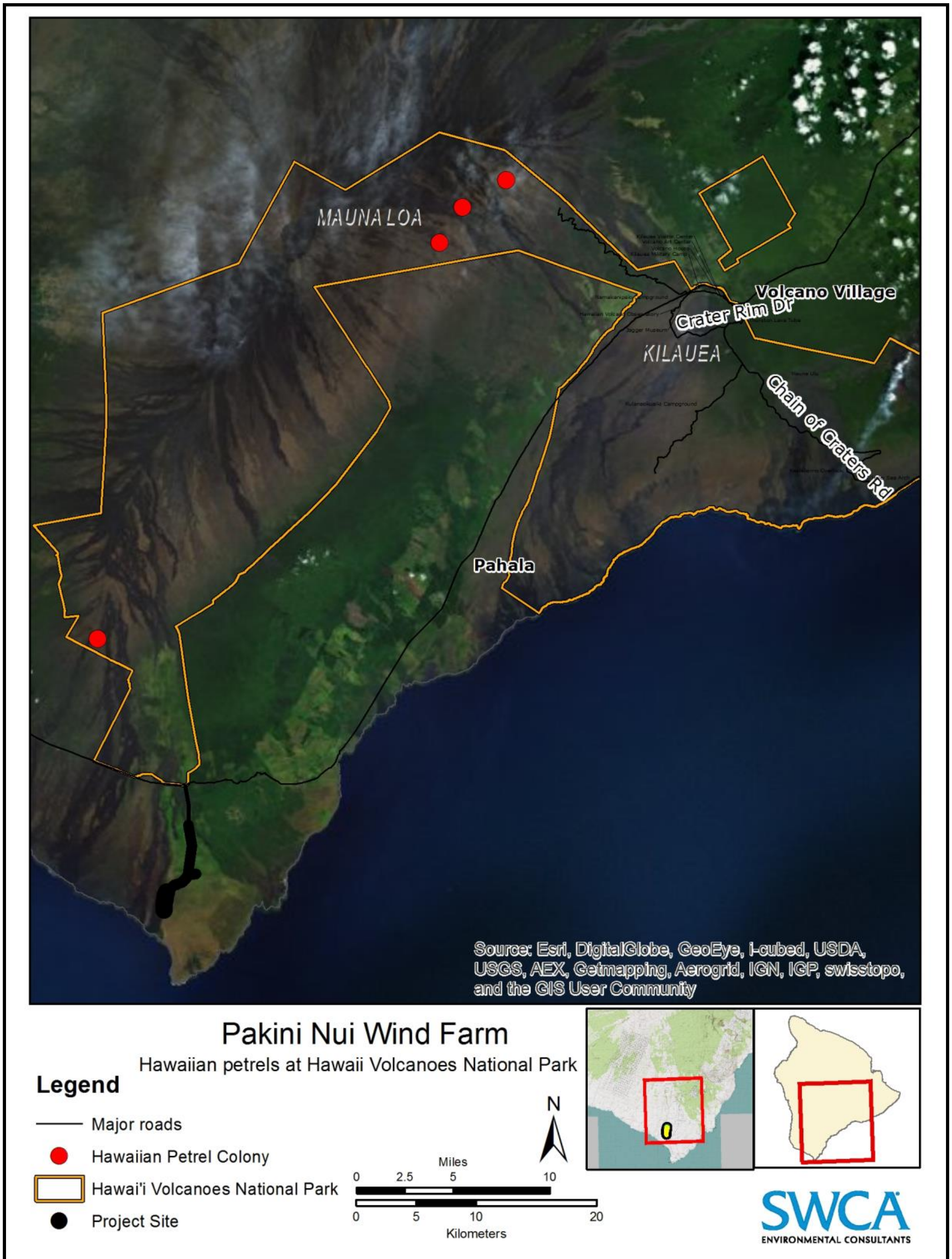

Figure 3.1. Approximate locations of Hawaiian petrel colonies in Hawaiʻi Volcanoes National Park (from Swift and Burt-Toland 2009).

3.3 Nēnē

3.3.1 Population, Biology, and Distribution

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

After nearly becoming extinct in the 1940s and 1950s, the nēnē population has been slowly rebuilt through captive breeding programs. Wild populations of nēnē occur on Hawaiʻi, Kauaʻi, Maui, and Oʻahu. The population of nēnē was estimated in 2014 at 3,047 individuals, with the largest population on Kauaʻi (personal communication, J. Charrier, USFWS, March 7, 2016.). The Hawaiʻi Island population was estimated at 1,140 individuals (personal communication, J. Charrier, USFWS, March 7, 2016). Approximately 400 birds were slated to be moved from Kauaʻi to Maui, Molokaʻi, and Hawaiʻi under an emergency declaration by then governor Neil Abercrombie. A significant portion of these birds has been moved to Hawaiʻi Island.

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

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

3.3.2 Threats

The main factor limiting the recovery of nēnē populations is predation by introduced mammals, most notably cats, rats, and mongooses (Baker and Baker 1995; USFWS 2004). Additional threats may include predation by other mammalian predators, limited access or availability of nutritional resources during breeding, anthropomorphic disturbances (including car strikes, disturbance of nesting and feeding, and fatalities at golf courses), infectious/inflammatory diseases (e.g., *Toxoplasma gondii*), and toxicoses (e.g., lead poisoning) (USFWS 2004; Work et al. 2015). Breeding habitat, particularly at low elevations, may be limited (USFWS 2004).

3.3.3 Known Fatalities at Other Hawaiian Wind Farms

Fatalities of nēnē with wind turbines have been documented at wind farms on Maui. These fatalities have occurred in the Kaheawa area, where a resident population of nēnē is present year-round (SWCA 2012) (Table 3.3).

Table 3.3. Documented Total Nēnē Fatalities at Wind Farms in Hawaiʻi

Location	Observed Take*	Calculated Take (80% Dalthorp†)
Auwahi Wind Farm (Maui)	0	0
Kaheawa Wind Farm (Maui)	23	38
Kaheawa II Wind Farm (Maui)	4	11
Kahuku Wind Farm (Oʻahu)	0	0
Kawailoa Wind Farm (Oʻahu)	0	0
Pakini Nui Wind Farm (Hawaiʻi)	0	0

* *Source*: Personal communication, D. Sether, USFWS, April 11, 2018.

† The take estimate is based on Evidence of Absence software (Dalthorp et al. 2014; Dalthorp et al. 2017), existing literature, and site-specific data. It includes indirect take.

3.3.4 Known Occurrences in the South Point Area

Over 100 nēnē have been identified using the Kahuku Unit of HVNP over the past 10 years (personal communication, K. Misajon, HVNP, July 2016). These birds are wide-ranging, with the closest known population within the Kahuku Unit. The range of the nēnē in the park is shown in Figure 3.2. The Project's turbines are approximately 40 km (25 miles) from this known population.

Day (2005) also mentions that there have been a few anecdotal sightings of nēnē near South Point itself. Potential nēnē feeding habitat in the form of grass seeds is present at the Project Area. If there is a temporary break in grazing in the areas surrounding the Project Area, and if buffelgrass is allowed to set seed, this may attract nēnē to the Project vicinity. Therefore, sporadic presence of nēnē at the Project Area can be expected; however, there is no shrubby vegetation that will attract nēnē to the Project Area for nesting. SWCA biologists surveyed six point count stations from January to December 2014, typically between 6:00 and 11:00 a.m. and 2:00 and 7:00 p.m., during each visit to the Project. During these surveys, no nēnē were observed (SWCA 2015a). Nēnē were incidentally observed by SWCA biologists in November 2015 (two individuals) and January 2016 (one individual).

The nēnē population on the Island of Hawaiʻi is estimated to be 1,140 individuals as of 2014 and is expected to continue to expand in the coming years as a result of the 598 nēnē that were translocated from Kauaʻi to the Island of Hawaiʻi and through other ongoing conservation actions (personal communication, A. Siddiqi, DLNR August 2016). As the population expands, the nēnē will likely start to occupy more of its historical range, which includes South Point (Day 2005), and birds could be observed more frequently at the Project Area.

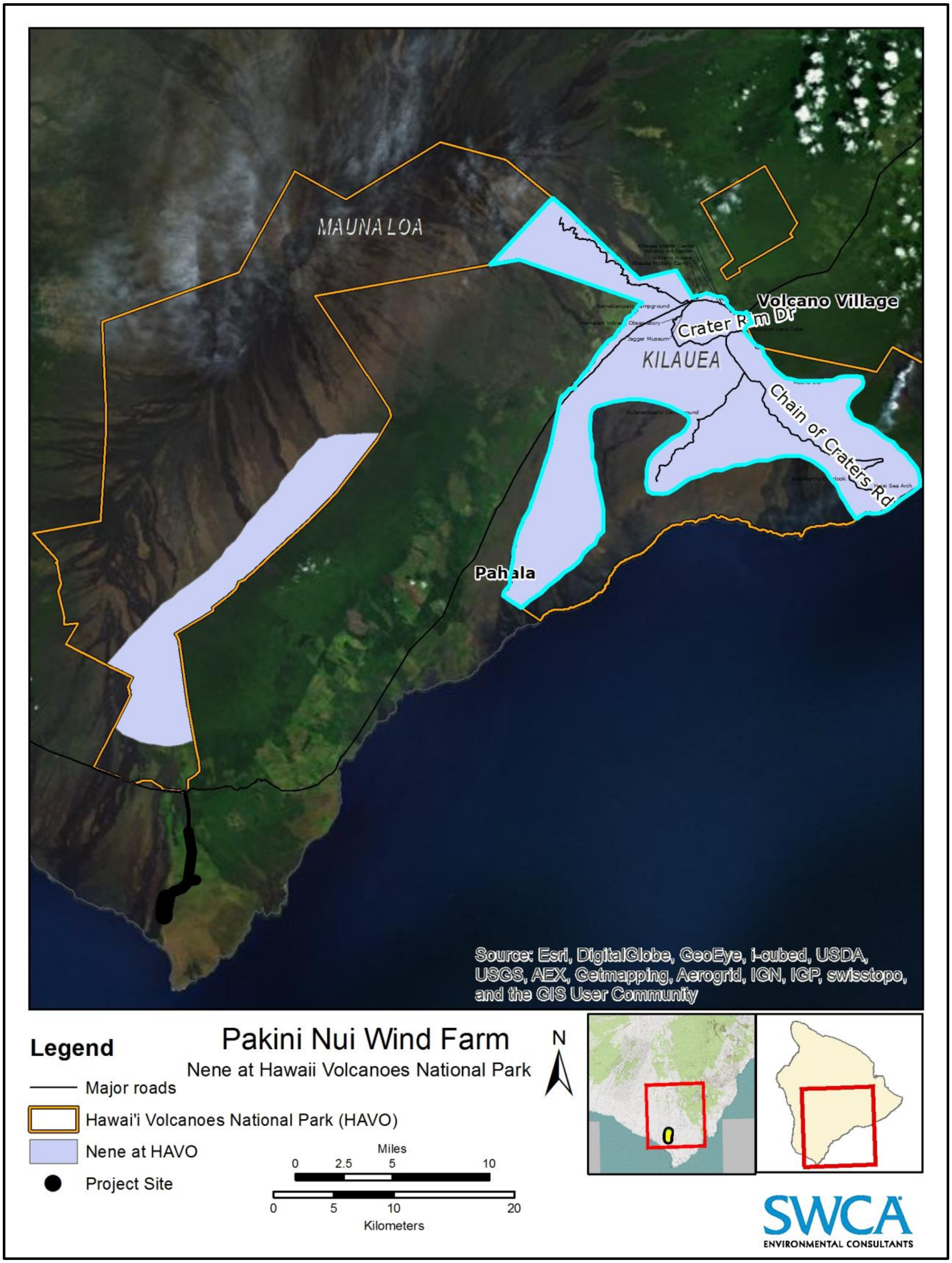

Figure 3.2. Range of nēnē at Hawai‘i Volcanoes National Park (HVNP) (HVNP 2012; Pratt et al. 2011).

3.4 Band-Rumped Storm-Petrel

3.4.1 Population, Biology, and Distribution

Band-rumped storm-petrels are considered the rarest breeding seabird in Hawaiʻi (Banko et al. 1991; Slotterback 2002). The Hawaiian population is listed as an endangered species under the Hawaiʻi State Endangered Species Act (HRS §195D-4(a)) (USFWS 2012c) and was listed as endangered under the ESA on September 30, 2016.

The band-rumped storm-petrel is a small, highly pelagic species dispersed widely around the world's tropical and subtropical ocean regions. Breeding occurs in localized populations in several areas spread along the Atlantic and Pacific Oceans. In the Pacific Ocean, breeding colonies have been documented only in the Galapagos Islands, Japan, the Hawaiian Islands, and possibly Cocos Island near Costa Rica (Pyle and Pyle 2009; USFWS 2012c). The Hawaiian population was once categorized as a distinct subspecies, but it has been included in a single taxon containing all Pacific band-rumped storm-petrel populations (USFWS 2012c).

Based on fossil evidence, band-rumped storm-petrels were once abundant and widespread throughout Hawaiʻi. However, recent surveys only found small breeding locations on remote cliffs on Kauaʻi, a cave on Lehua Islet off Niʻihau, and high-elevation lava fields on the Island of Hawaiʻi, such as the Pohakuloa Training Center (Mitchell et al. 2005; USFWS 2012c). Band-rumped storm-petrels have been documented vocalizing on Maui within the Haleakalā Crater, but evidence of breeding is lacking (Pyle and Pyle 2009). Kauaʻi is estimated to have between 171 and 221 breeding pairs. Worldwide population estimates are unlikely to exceed 25,000 breeding pairs (Mitchell et al. 2005).

Band-rumped storm-petrels typically begin breeding sometime between their third and seventh year, and individuals may live up to 20 years. Pairs produce a single egg per season. In Hawaiʻi, calling birds are heard and eggs are laid between May and July, and nestlings fledge between August and November (Mitchell et al. 2005; Pyle and Pyle 2009). Breeding habits are not well documented, and nests are typically difficult to locate. Nests have been found in crevices and cracks along steep, rugged cliffs and talus slopes (Pyle and Pyle 2009).

Foraging is typically done alone or in small groups, although "rafts" of band-rumped storm-petrels numbering from a few to approximately 100 are observed occasionally off Kauaʻi, perhaps waiting for nightfall before returning to the breeding colony (USFWS 2012c). Band-rumped storm-petrels are reported at various distances offshore in coastal waters around Kauaʻi, Niʻihau, and the Island of Hawaiʻi. Of 39 reported sightings in Hawaiʻi since 1995, 30 have been from Kauaʻi (USFWS 2012c).

3.4.2 Threats

Very little is known about breeding and threats to the band-rumped storm-petrel. Introduced predators such as cats, mongooses, dogs, and barn owls (*Tyto alba*) (Wood et al. 2002) may be the most serious threats on land. Additional threats include habitat destruction by introduced ungulates and disorientation due to artificial lighting—especially in coastal areas—resulting in collisions with structures (e.g., power lines, buildings, and fences) (Banko et al. 1991) or individuals becoming grounded (Harrison et al. 1990).

3.4.3 Known Fatalities at Other Hawaiian Wind Farms

No band-rumped storm-petrel fatalities have been documented at other Hawaiian wind farms. However, birds have reportedly been killed by collisions with human-made objects in the Hawaiian Islands, especially when there are bright lights to attract them (Slotterback 2002).

3.4.4 Known Occurrences in the South Point Area

Vocalizations of band-rumped storm-petrels were heard within the Kahuku Unit of HVNP during surveys (Swift and Burt-Toland 2009). Band-rumped storm-petrels have been detected in known Hawaiian petrel colonies in HVNP via calls and several carcasses. Based on vocalization surveys (Swift and Burt-Toland 2009), the closest known band-rumped storm-petrel occurrence is along a rift in the Southwest Rift Zone on Mauna Loa and one in the southern portion of the Kahuku Unit, an estimated 15.3 km (9.5 miles) away from the Project Area. Since 1994, three band-rumped storm-petrel carcasses have been found in HVNP between 2,400 m and 2,600 m (7,800 and 8,500 feet) on Mauna Loa, and one band-rumped storm-petrel was caught in mist nets at 2,600 m (7,800 feet) in 2003. These data suggest that band-rumped storm-petrels still breed on Mauna Loa.

Day (2005) noted that band-rumped storm-petrels have been seen staging on the ocean (before flying inland to nesting colonies after dark) in the immediate vicinity of South Point (including a flock of 22 birds), and it is therefore possible that some birds fly over the Project on their way to their nesting grounds.

4 TAKE ANALYSES

The potential for wind energy turbines to cause fatalities of 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 Hawai‘i, wind-powered generation facilities are relatively new. Incidental take of listed species has been observed at each of the five wind-powered generation facilities in Hawai‘i that have incidental take authorizations. Tawhiri has conducted postconstruction monitoring to document downed wildlife at the Project Area since operations began in April 2007 (SWCA 2015c).

The modes of take (resulting in death or injury to a Covered Species) with the potential to occur at the Project is by collision with turbines, overhead transmission lines, or the met tower. Measures will be implemented at the Project to avoid the potential for other effects to rise to the level of take (see Sections 1.2 and 6). An example is the observation of speed limits while at the Project to avoid vehicle and Covered Species strikes.

Below are the quantitative take analyses for the Covered Species, and the results of these analyses.

4.1 Hawaiian Hoary Bat

The take request for Hawaiian hoary bats is based on Evidence of Absence software model, Version 2.0 (Dalthorp et al. 2017); existing literature; and site-specific data. The Evidence of Absence software model is more robust than others in estimating fatality rates when the number of observed fatalities is relatively low. The software uses Bayesian-based statistics to measure uncertainty around the actual mortality estimate, expressed as credible limits. The 80% upper credible limit, not the actual mortality, is routinely used for mitigation planning in Hawai‘i and is applied here. The take estimates are based on data from 4 years of searcher efficiency (SEEF) and carcass persistence trials, which were collected between April 15, 2014, and April 15, 2018. Furthermore, the three observed bat fatalities were used as a basis for the take estimation.

4.1.1 Collision Fatality Estimate

The parameters used for the Evidence of Absence software model are described in this section. Five of the 14 turbine search areas are only partially searchable due to turbine proximity to a cliff located 40 m downwind, on average. The fatality estimate is corrected for the searchable area, which is an estimate of the percentage of carcasses that are expected to fall in searchable areas. Based on the ballistics modeling data from Hull and Muir (2010), it is estimated that 80% of bat carcasses will fall within 31.94 m of a small turbine. Considering the shape of the search plots, the distance of the turbines from the cliff, the carcass distributions predicted by Hull and Muir (2010), and prevailing winds, it was estimated that 63% of bat fatalities at Turbines 1–5 will fall in searchable areas. The search plots for the remaining turbines are of sufficient size and distance from the cliff that they can be assumed to be 100% searchable. If 63% of the bat fatalities at Turbines 1–5 fall into searchable areas, and 100% of the bat fatalities at Turbines 6–14 fall into searchable areas, the searchable area for the Project as a whole is 87% (i.e., sampling coverage, a = 0.87). That is, 87% of all bat fatalities will fall within searchable areas, whereas the remaining 13% will fall outside the searchable areas, assuming that the likelihood of incidental take is equal across all turbines.

Monthly fatality monitoring was completed by Tawhiri staff from the COD until August 2013. Intensive, weekly, site-specific monitoring was initiated by Tawhiri in August 2013, as described in Section 7.2.1 of this document. In accordance with USFWS guidance, SWCA began more robust monitoring in March 2014, which included trials to calculate carcass retention (CARE)—the mean amount of time a carcass stays on the ground before being removed by scavengers or otherwise disappears—and SEEF, the probability that a carcass is discovered by a searcher (also described in Section 7.2.1). Canine-led searches replaced human-led searches on July 7, 2017, and this search method continues to be used at this time.

One Hawaiian hoary bat fatality was recorded on August 31, 2013. The second and third Hawaiian hoary bat fatalities were found during routine weekly searches on March 1, 2016, and April 12, 2018, respectively. The fatality projection for the permitted period is based on a lambda (annual fatality rate) calculated from more than 4 years of fatality monitoring data, from March 2014–April 2018. The temporal sampling coverage (v) was 1.0 for that period. The monitoring data were partitioned by year, running April 1 to March 31, to match the initiation of SEEF and CARE trials (e.g., monitoring year 2015 runs April 1, 2015, to March 31, 2016).

SEEF was calculated by dividing the number of surrogate carcasses found by the total amount of surrogate carcasses deployed within the single class module of Evidence of Absence for each monitoring year. SEEF field trials were proctored by SWCA biologists, and searches were done independently by an SWCA biologist who was not knowledgeable of the carcasses' locations. From April 29, 2014, through June 19, 2017, plastic replicas of the hoary bat were deployed for SEEF trials because rat carcasses, which are often used for SEEF trials as proxies for bats, were being scavenged before the searcher had a chance to search for the carcass, significantly hampering the effectiveness of the SEEF trials. Rat carcasses were used for SEEF trials beginning July 19, 2017, when canine-led searches replaced human searchers. Rat carcasses will continue to be used in SEEF trials as a surrogate for bats under this ITP/ITL. SEEF varied among monitoring years and by searcher type (Table 4.1). Monthly searcher efficiency results were visually evaluated for seasonal patterns. No obvious seasonal patterns in SEEF or land use were present, so it was decided that it was not necessary to evaluate SEEF seasonally and that the annual estimates of SEEF would be used in the fatality projection. The factor by which SEEF changes with each successive search (k) could not be determined using plastic bats. Consequently, a k of 0.1 was assumed for the analysis per the recommendation of the USFWS (Widmer 2018).

Table 4.1. Annual Searcher Efficiency Estimates for Monitoring Years 2014–2017 by Searcher Type

Searcher Type	Monitoring Year	Surrogate Carcasses Placed	Surrogate Carcasses Found	SEEF (p-hat)	95% C.I.	
					Lower	Upper
Canine-handler team	2017	15	13	0.867	0.637	0.971
Human	2014	76	55	0.714	0.607	0.806
	2015	38	23	0.605	0.447	0.748
	2016	47	6	0.128	0.055	0.244
	2017	8	1	0.125	0.014	0.454
	All years	169	85	0.503	0.428	0.578

CARE was calculated from field trials using rats separately for each year, using the built-in distribution selection function in Evidence of Absence. CARE trials consisted of 14-day-long trials in which surrogate carcasses were deployed on-site to known locations. Rats were used as surrogates for bats during the CARE trials. The use of similar-sized proxy carcasses is a common practice for listed species, and the proxies are assumed to be subject to the same scavenging rates as the carcasses of the listed species. (Given that three bats have been found to date with various internal or complete body parts missing, this would—if it is established they have been scavenged—bring this assumption into question.) The number of days that a rat carcass was retained was recorded visually or by game camera imaging. The software identified the best-fitting distribution for each year of data: Weibull for monitoring year 2014, exponential for years 2015 and 2017, and lognormal for year 2016. The CARE rates for rats are provided in Table 4.2.

Table 4.2. Annual Carcass Persistence Estimates for Rats for Monitoring Years 2014–2017

Monitoring Year	r[1]	Shape (a)	Scale (β)	95% C.I. for β	
				Lower	Upper
2014	0.584	2.0247	4.7952	3.536	6.503
2015	0.583	0.1712	5.8396	2.971	11.480
2016	0.326	0.7042	0.5416	0.07724	1.006
2017	0.463	0.2581	3.8751	0.9269	16.200
All years	0.500	0.9073	1.075	0.802	1.347

[1] r is the probability the carcass will survive to the next survey, given surveys at 7-day intervals.

The overall probability of detection (g) was calculated for each monitoring year (Table 4.3). For the 2017 monitoring year, the year was split into two periods based on the detection probability difference between canine-assisted and human-only searches, then assigned the appropriate rho value corresponding to the temporal period represented.

Table 4.3. Probability of Detection (g) for Monitoring Years 2014–2017

Monitoring Year	Searcher Type	g (rho[1])	95% C.I. for g		Fitted Beta (β) Distribution Parameters	
			Lower	Upper	βa	βb
2017	Canine-handler team	0.342 (0.73)	0.147	0.572	6.0064	11.5554
2014	Human	0.366 (1.00)	0.269	0.470	31.7163	54.8437
2015		0.307 (1.00)	0.197	0.429	18.0207	40.7155
2016		0.0392 (1.00)	0.014	0.0763	5.6335	138.2321
2017		0.0688 (0.27)	0.00468	0.208	1.4221	19.2491
All years		0.221 (1.00)	0.173	0.274	57.2098	201.2206

[1] rho is the proportion of the year represented by this searcher type.

A take projection was made for 8 years of Project operation, beginning at the time of permit issuance. The remaining 2 years of the requested 10-year permit duration would consist of decommissioning activities, during which no Covered Activities with the potential to impact bats would take place, and therefore no bat take would be expected. This is primarily because between ceasing operations and beginning decommissioning activities, the rotor lock on the high-speed side of the gearbox would be engaged, keeping the rotor from turning. To date, bats have not been documented flying into stationary turbines (Arnett et al. 2008; Barclay et al. 2007). The multiple years module in Evidence of Absence was used to project fatality over the 8 years of permitted operation. The existing 4 years of monitoring data (2014–2017), plus the first 2 months of monitoring from 2018, were used to set the estimated annual baseline fatality rate (lambda) for this period.

Annual estimates of g and counts of carcasses found were input to the multiple years module. The estimate of g for 2017 was split by assigning a rho of 0.27 to the human searches and 0.73 to the canine-assisted searches. The estimate of g from the canine-assisted searches in 2017 was applied to 2018 monitoring data, and the rho was set to 0.17 to represent the 2 months of searches. Two bat carcasses were found during this monitored period, one in monitoring year 2015 and one in 2018 (i.e., two in 5 years). The first recorded fatality (August 31, 2013) was not included in modeling and projections because SEEF and CARE trials were not being conducted at the time, making it difficult to model the unobserved take without making assumptions about search and scavenger conditions. These methods were approved by the USFWS (Widmer 2018).

The multiple years module projected out 8 future years of operation. For the 8 future years, a constant g equal to the human searcher median (All years, Human in Table 4.3) was assumed because it was more conservative than the g for the canine-assisted searches and a canine searcher may not be available for use for the whole permit duration. The credibility level was set to 0.8. The result was with 80% certainty that no more than 23 direct bat fatalities will occur in 8 years of operation, provided there are no changes to site use, operations, or monitoring intensity.

The fatality estimate at the 80% credibility level is based on multiple input parameters, including CARE, SEEF, search interval, size of search area, terrain, species, and the probability of a searcher finding a carcass if missed previously (k). These inputs can be controlled to some extent by using canines and closer search transects, modifying the terrain to improve the visibility of fatalities, and implementing predator control. Scavenger trapping was initiated at the Project Area, and from November 2014 to April 2015, a total of seven feral cats and one mongoose were trapped.

4.1.2 Indirect Effects Rising to the Level of Take

The equation described in Table 4.4 was used to estimate the requested level of indirect take for the take projection for 8 years of operation. At the time of ITP or ITL issuance, the direct take will be calculated with Evidence of Absence (Version 2.0 or most recent) software (Dalthorp et al. 2017) and indirect take will be added as directed by the *Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take* (USFWS 2016), provided on October 1, 2016, and described below. The direct observed and unobserved take at the 80% credibility level, plus the indirect take based on the standardized guidance provided by the USFWS (2016) will be used to estimate with 80% confidence the adjusted total take that has not been exceeded. The searchable area will be calculated using measurement and fall frequency, as based on Hull and Muir (2010) and the best science at the time.

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 (or pupping) season, the likelihood that the loss of a reproductively active female results in the loss of its offspring, and the average reproductive success. Table 4.4 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 the Project.

Table 4.4. Pakini Nui Indirect Bat Take Equation Description

Component	Description/Rationale	Result
A. Total direct take (bats per tier)	Estimated total direct take	23
B. Proportion of take that is adult	Erring toward a conservative estimate, it is assumed that 100% of take (observed and unobserved) will 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 are assumed to be females.	0.50
D. Proportion of year that is the pupping period (24 of 52 weeks)	Adults are present in the Project Area throughout the year, but the pupping season is recorded as occurring from April to September 15, or 24 weeks. Indirect take of an offspring can only occur from direct take of an adult during these months.	0.46
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 pupping season results in the offspring's indirect take.	1.00
F. Average offspring/breeding pair	Reproductive success is based on Bogan (1972) and Koehler and Barclay (2000)	1.8
G. Conversion of juveniles to adults	Juveniles are converted to adults by multiplying by 0.3, which is in accordance with the *Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take* (USFWS 2016).	0.3
H. Total indirect take	Indirect take is estimated by multiplying the probabilities of lines A–G. This estimate is rounded up to the nearest whole number.	3

4.1.3 Take Projection and Estimation

Real-time estimated take for the duration of the Project will be calculated based on the results of the compliance (i.e., fatality) monitoring. The direct take will be calculated with Evidence of Absence (Version 2.0 or most recent) software (Dalthorp et al. 2017) and indirect take will be added, as described above. The direct observed and unobserved take at the 80% credibility level plus the indirect take based on the standardized guidance provided by the USFWS (2016) will be used to estimate with 80% confidence that the permitted total take has not been exceeded.

The projected 10-year take estimate for the Project, consisting of 8 years of operation and 2 years of decommissioning, is 26 Hawaiian hoary bats (23 direct takes, 3 indirect takes; Table 4.5). Should monitoring and modeling indicate that take has reached 75% of this take request by year 6 of the permit, Tawhiri will immediately meet with the USFWS and DLNR to determine if take is expected to exceed the permitted limit during the remaining duration of the ITP or ITL. If the agencies and Tawhiri determine that permitted take will be exceeded before decommissioning, additional minimization measures will be employed through adaptive management to maintain take below the permitted limit or a formal amendment will be proposed.

Table 4.5. Take Estimate for Hawaiian Hoary Bat at Pakini Nui Wind Farm*

10-Year Direct Take (80% credibility level)	10-year Assumed Indirect Take of Juveniles (80% credibility level)**	10-Year Total Take Authorization
23	3	26

* Includes 8 years of operation and 2 years of decommissioning.

** Indirect take is calculated as described in Section 4.1.2.

4.1.4 Adaptive Management Trigger

If the rate of take (lambda value) is significantly higher than expected as determined by a comparison of each annual rate of take with a cumulative rolling analysis of the previous 4 years' rates of take, then Tawhiri will either seek a formal amendment (as described in Section 10.3.2) or take additional avoidance and minimization steps to reduce the current and future rate of take to stay within the permitted level. These steps may include 1) analyzing the compliance monitoring program, as described in Section 7.2.1, to determine ways to ensure that the model inputs are precise, and 2) raising the cut-in speed of the low wind speed curtailment regime,

4.1.5 Impacts of the Taking

As shown in Table 4.5, the projected 10-year take estimate for the Project is 26 Hawaiian hoary bats. Hawaiian hoary bats are thought to occur in the greatest numbers on the Islands of Hawaiʻi, Maui, and Kauaʻi (Menard 2001). Results from a limited study conducted at several sites on Hawaiʻi from 2007 to 2011, suggested that the population trends in those areas varied from negligible change to a slightly positive change from year to year; however, the study was not conclusive (Gorresen et al 2013). No population estimates were provided. Bats on the Island of Hawaiʻi are habitat generalists and occur from sea level to the highest peaks on the island (Gorresen et al. 2013). The Hawaiian hoary bat is reproductively mature at 1 year of age, and a female Hawaiian hoary bat is estimated to produce on average 1.8 pups a year, 30% of which are estimated to survive. If take is equally distributed across the life of the ITP/ITL (i.e., 2.6 individual takes per year), it will take the offspring of approximately five reproductively active females each year to replace the lost individuals. However, this is a replacement of lost individuals and not a net increase. The proposed mitigation is designed to contribute to preventing the degradation and improving the quality of native bat foraging and roosting habitat in the ways described in Section 6.2. Mitigation measures both 1) compensate for impacts of the taking, and 2) provide additional roosting and foraging habitat, resulting in an overall net conservation benefit for the Hawaiian hoary bat (see Section 6.2).

4.2 Hawaiian Petrel

The incidental take estimate for Hawaiian petrels is calculated using existing radar data from studies conducted near South Point, which constitute the best available scientific data. The passage rates from these studies are used to model the expected fatality rates at the Project.

4.2.1 Collision Fatality Estimate

The best available data from radar surveys were used to estimate potential collision fatality rates. Because of the nocturnal nature of inland movements of Hawaiian petrels, an effective way to determine passage rates is by using radar surveys. Radar surveys are 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 Hawaiʻi (Ainley et al. 1997; Day et al. 2003; Reynolds et al. 1997; Simons and Hodges 1998). During radar surveys 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 the Waipiʻo Valley. Limitations of the use of radar surveys to determine seabird passage rates include the inability to distinguish between seabird species. Very few, and often none, of the targets are visually observed and identified to species. In addition, other birds are similar to Hawaiian 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 terns (*Onychoprion fuscatus*), mallard-Hawaiian duck hybrids (*Anas wyvilliana* x *platyrhynchos*), and Pacific golden-plovers (*Pluvialis fulva*). There are no recent records of nesting Newell's shearwaters on the Island of Hawaiʻi, and this species is not considered to be at risk of collision with Project components.

Although population viability analyses suggest that the Mauna Loa breeding population of Hawaiian petrels may not persist (Hu et al. 2001), Hawaiian petrel breeding colonies where predator control is implemented, at HVNP, appear fairly stable (National Park Service [NPS] 2010, 2011, 2012). Birds outside of this protected area are likely exposed to higher levels of predation—in particular, by cats (Natividad Hodges 1994; Simons 1985; Winter 2003). Therefore, it is reasonable to assume that the Island of Hawaiʻi breeding population of Hawaiian petrels is either stable or decreasing, and the Day et al. (2003) and the more recent Hamer (2008a and b) data represent an accurate or conservative proxy for 2014 passage rates for the Hawaiian petrel. The average passage rates of the two nearest radar sites were used for analyses in this HCP.

The two locations closest to the Project Area at which Day et al. (2003) collected radar data in 2001 and 2002 are Hoʻopuloa and Punaluʻu, located approximately 32 km (20 miles) northwest and 25 km (16 miles) northeast of the Project, respectively. At Hoʻopuloa, the average passage rate in May–June of 2001 and 2002 was 1.2 targets per hour, and at Punaluʻu, the passage rate was 1.6 targets per hour (mean = 1.4 targets per hour). Day and Cooper (2003) performed a 5-day survey near the Manuka State Wayside Park in July 2003 and recorded only one seabird target during 5 days of radar sampling. More recently, radar surveys in fall and spring 2008 approximately 2 miles north of Pakini Nui Wind Farm resulted in the detection of three and 20 targets, respectively, during 5 days of sampling (Hamer 2008a, 2008b). The passage rate during this study was much lower than those recorded at Hoʻopuloa and Punaluʻu in 2003 by

Day et al. (2003). During the Hamer (2008a, 2008b) studies, the average flight altitude was 312.55 m above ground level. None of the targets flew below 132.44 m above ground level and therefore none of these targets would have flown within the altitude of the Project's rotor swept zone.

Based on a passage rate of 1.4 targets per hour per 1.5-km-radius sample area, on average, 0.21 Hawaiian petrels fly in the space occupied by each turbine per year (Tables 4.6 and 4.7), and 0.00 Hawaiian petrels fly in the space occupied by the met tower each year (Table 4.8). Hawaiian petrels are adapted to nocturnal flight and able to navigate forests near their nests under low light conditions. Evidence suggests that Hawaiian petrels are highly capable of avoiding vertical structures under low light conditions, resulting in high avoidance rates (Cooper and Day 1998; KWP 2009, 2010; Tetra Tech 2008). Based on avoidance rates of 95% and 99% from collision with Project turbines or the met tower, respectively, annual fatality rates of Hawaiian petrels range from 0.022 to 0.004 fatality per year (Tables 4.6–4.10).

The best available existing data on the Island of Hawaiʻi were used to estimate seabird passage rates and fatality estimates for the ITP/ITL term.

Table 4.6. Estimated Average Exposure Rates and Fatality Rates of Hawaiian Petrel for the 1.5-Megawatt GE Turbines Rotor Swept Zone at Pakini Nui Wind Farm

Variable		
	Movement Rate	
A	Mean movement rate (birds/hour/ha)	0.001980198
B	Daily movement rate (birds/day/ha) A × 5	0.00990099
C	Fatality domain (days)	210
D	Annual movement rate (birds/year) B × C	2.079207921
E	Proportion of birds flying within rotor swept zone	0.25
F	Annual movement rate within rotor swept zone D × E	0.51980198
	Horizontal Interaction Probability	
G	Volume occupied by rotor swept zone (m^3)	356637.0133
H	Volume of a 1-ha area from minimum to maximum rotor height (m^3)	880000
I	Horizontal interaction probability G ÷ H	0.405269333
	Exposure Index	
J	Daily exposure index (birds/rotor swept zone/day) B × E × I	0.001003142
K	Annual exposure index (birds/rotor swept zone/year) F × I	0.210659802
	Fatality Probability	
L	Probability of striking a blade on frontal approach	0.146664833
M	Probability of fatality if striking a blade	1
N	Probability of fatality if an interaction on frontal approach L × M	0.146664833
	Fatality Index	
O	Annual fatality rate with 90% exhibiting collision avoidance (birds/turbine/year) K × N × 0.1	0.003089638
P	Annual fatality rate with 95% exhibiting collision avoidance (birds/turbine/year) K × N × 0.05	0.001544819
Q	Annual fatality rate with 99% exhibiting collision avoidance (birds/turbine/year) K × N × 0.01	0.000308964

Table 4.7. Estimated Average Exposure Rates and Fatality Rates of Hawaiian Petrel for the 1.5-Megawatt GE Turbines Tubular Tower at Pakini Nui Wind Farm

Variable		
	Movement Rate	
A	Mean movement rate (birds/hour/ha)	0.001980198
B	Daily movement rate (birds/day/ha) A × 12	0.00990099
C	Fatality domain (days)	210
D	Annual movement rate (birds/year/ha) B × C	2.079207921
	Probability of a 1-ha plot with a turbine	0.5
E	Proportion of birds flying below rotor swept zone	0.25
F	Annual movement rate below rotor swept zone D × E	0.25990099
	Horizontal Interaction Probability	
G	Volume occupied by tubular tower (m^3)	942
H	Volume of 1-ha area below hub	750000
I	Horizontal interaction probability G ÷ H	0.001256
	Exposure Index	
J	Daily exposure index (birds/tubular tower/day) B × E × I	3.10891E-06
K	Annual exposure index (birds/tubular tower/year) F × I	0.000326436
	Fatality Probability	
L	Probability of striking a tubular tower if in airspace	1
M	Probability of fatality if striking a tubular tower	0.95
N	Probability of fatality upon interaction L × M	1
	Fatality Index	
O	Annual fatality rate with 90% exhibiting collision avoidance (birds/tower/year) K × N × 0.1	3.26436E-05
P	Annual fatality rate with 95% exhibiting collision avoidance (birds/tower/year) K × N × 0.05	1.63218E-05
Q	Annual fatality rate with 99% exhibiting collision avoidance (birds/tower/year) K × N × 0.01	0.0000032644

Table 4.8. Estimated Average Exposure Rates and Fatality Rates of Hawaiian Petrel for the Met Tower at Pakini Nui Wind Farm

Variable		
	Movement Rate	
A	Mean movement rate (birds/hour/ha)	0.001980198
B	Daily movement rate (birds/day/ha) A × 12	0.00990099
C	Fatality domain (days)	210
D	Annual movement rate (birds/year) B × C	2.079207921
E	Proportion of birds flying below met tower (< 60 m)	0.25
F	Annual movement rate below met tower (< 60 m) D × E	0.51980198
	Horizontal Interaction Probability	
G	Volume occupied by met tower (m^3)	420.1840223
H	Volume of 1-ha area met tower (< 80 m) (m^3)	800000
I	Horizontal interaction probability G ÷ H	5.25E-04
	Exposure Index	
J	Daily exposure index (birds/tower/day) B × E × I	1.30E-06
K	Annual exposure index (birds/tower/year) F × I	2.73E-04
	Fatality Probability	
L	Probability of striking a met tower if in airspace	1
M	Probability of fatality if striking a met tower	1
N	Probability of fatality upon interaction L × M	1
	Fatality index	
O	Annual fatality rate with 90% exhibiting collision avoidance (birds/tower/year) M × P × 0.05	2.73016E-05
P	Annual fatality rate with 95% exhibiting collision avoidance (birds/tower/year) M × P × 0.05	1.36508E-05
Q	Annual fatality rate with 99% exhibiting collision avoidance (birds/tower/year) M × P × 0.01	0.0000027302

Table 4.9. Combined Fatality Estimates for Hawaiian Petrel at Pakini Nui Wind Farm

	Turbine (n = 14)	Met Tower	Total Fatality	10-Year Fatality Estimate
Annual fatality rate with 90% exhibiting collision avoidance (birds/year)	0.04371	0.00003	0.04374	0.4374
Annual fatality rate with 95% exhibiting collision avoidance (birds/year)	0.02186	0.00001	0.02187	0.2187
Annual fatality rate with 99% exhibiting collision avoidance (birds/year)	0.00437	0.00000	0.00437	0.0437

There is a growing body of evidence that collision avoidance of Hawaiian petrels is close to 99% (Sanzenbacher and Cooper 2013); therefore, a range of 95%–99% avoidance rate is used here for the fatality estimate. The 10-year combined fatality estimate of Hawaiian petrels for the Project is between 0.0437 and 0.2187, for 99% and 95% avoidance rates, respectively (Table 4.9). Therefore, it is unlikely that a fatality will be detected during the 10-year permit duration. To cover for the stochastic event of an incidental take of Hawaiian petrels, the direct requested take is two Hawaiian petrels.

Recent monitoring of bird strikes at power lines on Kauaʻi indicate that the occurrence of seabird collisions with some power lines is significantly higher than previously reported (Travers et al. 2014). On Kauaʻi, take of Newell's shearwater (a seabird with similar flight behavior to the Hawaiian petrel) 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 nonbreeding or immature individuals (Planning Solutions et al. 2010). Kauaʻi is estimated to host 75% of the total population of Newell's shearwater, which was estimated to be 21,250 breeding and nonbreeding 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 Hawaiʻi are much smaller than those on Kauaʻi. With a Hawaiian petrel population of approximately 100–200 breeding pairs on the Island of Hawaiʻi (Pyle and Pyle 2009), collision rates with overhead power lines are expected to be much lower on the Island of Hawaiʻi than estimated for Kauaʻi; and for the Project, the collision incidence is expected to be discountable. Flight height data from nearby (approximately 5.5 miles) radar surveys in 2008 (Hamer 2008a, 2008b) show that the average flight altitude of seabird targets was 312.55 m (1,025 feet) above ground level. None of the targets flew below 132.44 m (435 feet) above ground level; therefore, none of these targets would have flown within the altitude of the Project's tie-line or rotor swept zone.

Much of the underreporting of seabird collisions with power lines on Kauaʻi is due to the fact that 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 Kauaʻi, with power lines at higher altitudes and lines that stood the highest above the local topography and vegetation (Travers et al. 2014).

4.2.2 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 periods (May–October). The risk of collision outside the pre-laying period or breeding season (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, which would rise to the level of take. Survivability of offspring following take of 1 parent is dependent on the time of year during which the parent is lost. Both Hawaiian petrel parents alternate incubating the egg (May–July), 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 are 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 May 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 successfully had produced a chick. Most nonbreeding birds and failed breeders leave the colony for the season by mid-August (Simons 1985). Therefore, there is nearly a 100% chance that birds taken in September or October are likely to be young fledglings. Based on the life history parameters above, and as identified in Table 4.10, indirect effects rising to the level of take (loss of eggs or chicks) will be assessed at a rate of 0.89 egg per adult taken between May and July; 0.66 chick per adult taken in August; 1.00 chick per adult taken in September; and 0.50 chick per adult taken in October.

Table 4.10. 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
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
Immature	All year	–	0.00	–	0

For the actual take (observed and unobserved) of two birds, an indirect take of one egg/chick will be added to the total take request, for a take request of three Hawaiian petrels (see Section 4.2.3).

4.2.3 Take Estimate

The 10-year fatality estimate of Hawaiian petrels for the Project is between 0.0437 and 0.2187, for 99% and 95% avoidance rates, respectively (see Table 4.9). Therefore, it is unlikely that a fatality will be detected during 8 years of operation and 2 years of decommissioning. However, to cover for the stochastic event of an incidental take of Hawaiian petrels, and allowing for unobserved direct take, the requested take is based on the direct take of two Hawaiian petrels. The indirect take is one egg/chick; therefore, the total requested take is three Hawaiian petrels.

4.2.4 Impacts of the Taking

The possible take of three Hawaiian petrels over the 10-year life of the ITP/ITL will not have a population-level effect on the species. Mitigation measures both 1) compensate for impacts of the taking, and 2) provide additional mitigation, resulting in an overall net conservation benefit for the species (Section 6.3).

4.3 Nēnē

4.3.1 Collision Fatality Estimate

Most nēnē on Hawai‘i Island are known to occur in HVNP (USFWS 2004). These birds are wide-ranging and may be found in the Kahuku Unit of the park, the southern boundary of which is approximately 40 km (25 miles) from the turbine string at the Project.

During 12 months of avian surveys, no nēnē were observed at or near the Project. Nēnē were incidentally observed by SWCA biologists in November 2015 (two individuals) and January 2016 (one individual). Potential nēnē feeding habitat in the form of grass seeds is present at the Project Area. Furthermore, abundant foraging habitat is not limited at the Project Area and occurs adjacent to the Project Area throughout the South Point area. If there is a temporary break in grazing near the Project Area, and if buffelgrass is allowed to set seed, this may attract nēnē to the Project Area vicinity. Therefore, sporadic presence of nēnē can be expected in the Project Area. Additionally, the population on the Island of Hawai‘i is expected to expand in the coming years as nēnē from Kaua‘i are translocated to the Island of Hawai‘i. As the population expands, nēnē likely will start to occupy more of their historical range, which includes South Point (Day and Cooper 2005), and birds could be observed more frequently in the Project Area. The USFWS therefore recommends that, although only three nēnē have been seen in the Project Area (SWCA 2015a), nēnē will be included as a Covered Species (personal communication, J. Charrier, USFWS, February 20, 2014).

It is assumed that adult nēnē are most likely to collide with turbines and the met tower during the nonbreeding period (May–July) or at the end of the breeding period (breeding season is August–April) when adults and young may travel in family groups. Nēnē are highly territorial during the breeding season (Banko et al. 1999), and males are likely to defend nesting territories while females are incubating. Upon hatching, both parents attend to heavily dependent young. Adult nēnē also molt while in the latter part of their breeding period and are therefore flightless for 4–6 weeks (USFWS 2004). These adults attain their flight feathers at about the same time as their goslings (USFWS 2004). Consequently, such birds are more likely to be in flight within the Project Area only when goslings already have fledged.

Considering the low risk of incidental take of nēnē at the Project, the take estimate attributed to direct take is two nēnē.

4.3.2 Indirect Effects Rising to the Level of Take

Indirect effects rising to the level of take include loss of dependent young as a result of adult fatalities. This take will be assessed for adult nēnē only when the mortality occurs during the breeding season (August–April). Adults found during October–March will be assumed to have had a 60% chance of having been actively breeding because 60% of the population has been recorded to breed in any given year (Banko et al. 1999). Adult nēnē mortality that occurs outside the peak breeding season (April, August, and September) will be assumed to have had a 25% chance of breeding. Male and female nēnē care for their young fairly equally; therefore, take of dependent young will be assessed equally to the take of any adult male or female nēnē take observed during the breeding season. Because breeding nēnē are not expected to collide with wind turbines before the fledging of their young, the number of young possibly affected by loss of an adult is based on the average number of fledglings produced per pair (studies indicate that average number of fledglings produced annually per pair of nēnē is 0.3 [Hu 1998]).

Based on these assumptions, the additional take by loss of dependent young that will be assessed for each take (fatality) of an adult nēnē during October–March is 0.09 (Table 4.11). The amount of additional take by loss of a dependent young that will be assessed for each actual take (fatality) of an adult nēnē during the remainder of the breeding season is 0.04.

Table 4.11. Calculation of Indirect Take of Nēnē

Nēnē	Season	No. of Fledglings per Pair (A)	Likelihood of Breeding (B)	Parental Contribution (C)	Indirect Take (A × B × C)
Adult, any gender	October–March	0.3	0.60	0.5	0.09
Adult, any gender	April, August, and September	0.3	0.25	0.5	0.04
Adult, any gender	May–July	–	0.00	–	0.00
Immature	All year	–	0.00	–	0.00

For purposes of this HCP, it is assumed that all birds taken, including unobserved take, will be adults. Because nēnē could be flying through the Project Area at any time of year, the likelihood of a nēnē being taken in breeding condition is 37.5% based on a breeding period of 4.5 months (a 1-month incubation period followed by parental care for 3.5 months; 4.5 ÷ 12 = 0.375).

Following Table 4.11, take will be calculated in addition to nēnē lost through observed and unobserved take at the rate of 0.06 fledgling/nēnē (0.3000 × 0.3750 × 0.5000 = 0.0563). The total indirect take for two nēnē is 0.12 fledgling, which is rounded up to 1.

4.3.3 Take Estimate

The total estimated take for nēnē is three.

4.3.4 Impacts of the Taking

The possible take of three nēnē over the 10-year life of the ITP/ITL will not have a population-level effect on the species. Mitigation measures both 1) compensate for impacts of the taking, and 2) provide additional mitigation, resulting in an overall net conservation benefit for the species (Section 6.5).

4.4 Band-Rumped Storm-Petrel

4.4.1 Collision Risk

Band-rumped storm-petrels are the rarest breeding seabird in Hawai‘i (Banko et al. 1991; Slotterback 2002), and most of the Hawaiian population is thought to breed on Kaua‘i (USFWS 2012c). There is a degree of uncertainty regarding the very low passage rates on or near the Project because very little is known regarding the distribution and abundance of band-rumped storm-petrels on the Island of Hawai‘i (Reynolds and Cooper 1997; Slotterback 2002). None of the radar studies cited identified any of their targets as band-rumped storm-petrels. Considering the extremely rare nature of the band-rumped storm-petrel, it is assumed the passage rates on or near the Project are considerably lower than those of the Hawaiian petrel and consequently collision risk with Project components is expected to be considerably lower than that of the Hawaiian petrel, for which the 10-year fatality estimate is less than one bird. Therefore, the risk of take of band-rumped storm-petrels at the Project is considered discountable and therefore no take authorization is requested for the species and the species is not included in the Covered Species.

4.5 Cumulative Impacts

The only other wind projects on Hawaiʻi Island are the 3.3-MW Lalamilo Wind Farm at South Kohala and the 10.56-MW Hawi Wind Farm at Upolu Point. There is the potential for cumulative impacts to the covered species on Hawaiʻi Island due to the presence of these other wind farms. Lalamilo Wind Farm is in the process of preparing an HCP. Two federally and state-listed wildlife species have been identified as having the potential to be adversely impacted by operation of the Lalamilo project: Hawaiian hoary bat and Hawaiian petrel. Mitigation measures to compensate for the take of these Covered Species at Lalamilo has been developed in coordination with the USFWS, DOFAW, and the ESRC.

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

It is important to note that rapid ohia death (ROD), a fungal disease that has killed hundreds of thousands of ohia trees, occurs on Hawaii Island. Ohia is the most abundant native tree in the state and constitutes important habitat for wildlife, including the Hawaiian hoary bat and nēnē. Loss of these trees constitutes an important island-wide loss and degradation of wildlife habitat.

Take for the covered species has been authorized on Oʻahu, Maui, Kauaʻi, and Hawaiʻi through several HCPs and Safe Harbor Agreements (SHAs). Tables 4.12 and 4.13 list take permitted for all HCPs and SHAs that effect the Covered Species. Tables 3.1, 3.2, and 3.3 of this HCP list known and modeled takes of these species from other wind farms in the state, which may differ from permitted take.

Table 4.12. Habitat Conservation Plans Affecting Covered Species

Name	Permit Duration	Location	Species and Total Take Authorization for Permit Term[Z]	Species and Total Take Pending Approval (total includes previous authorized take)[Y]
Tower Kauai Lagoons Land, LLC	12/09/2016–11/09/2042	Lihue, Kauaʻi	Hawaiian petrel (1) Hawaiian goose (15)	N/A
Kahuku Wind Farm[X]	06/07/2010–06/06/2030	Kahuku, Oʻahu	Hawaiian hoary bat (32) Hawaiian petrel (12)	N/A
Kawailoa Wind Power	12/08/2011–12/07/2031	Haleiwa, Oʻahu	Hawaiian hoary bat (60)	Hawaiian hoary bat (266) Hawaiian petrel (7)
Na Pua Makani Wind Project – Phase I	Not yet issued	Kahuku, Oʻahu		Hawaiian hoary bat (51)

Name	Permit Duration	Location	Species and Total Take Authorization for Permit Term[Z]	Species and Total Take Pending Approval (total includes previous authorized take)[Y]
U.S. Army Kahuku Training Area Single Wind Turbine	Federal biological opinion covering 05/05/2010–05/09/2030	Kahuku, O‘ahu	Hawaiian hoary bat (2 adults, 2 pups)	N/A
Auwahi Wind Farm	02/24/2012–02/23/2037	Ulupalakua, Maui	Hawaiian hoary bat (21) Hawaiian petrel (87) Hawaiian goose (5)	Hawaiian hoary bat (140)
Kaheawa Wind Power I (KWP I)	04/30/2012[W]–01/29/2026	Kaheawa, Maui	Hawaiian hoary bat (50) Hawaiian petrel (38) Hawaiian goose (60)	N/A
Kaheawa Wind Power II (KWP II)	1/03/2012–1/02/2032	Kaheawa, Maui	Hawaiian hoary bat (11) Hawaiian petrel (43) Hawaiian goose (30)	Hawaiian hoary bat (38) Hawaiian goose (44)
Big Island Beef Community Wind Project[V]	N/A	Paauilo, Hawai‘i	N/A	N/A
Hawi Wind Farm	Not yet issued	Upolu Point, Hawai‘i		Application not yet submitted
Lalamilo Wind Farm Repowering Project	Not yet issued	Lalamilo, Hawai‘i		Hawaiian hoary bat (6) Hawaiian petrel (3)
North Kohala Microgrid Project[V]	N/A	North Kohala, Hawai‘i	N/A	N/A
Pelekane Bay Watershed Restoration Project	2010 federal biological opinion covering 02/05/2010–02/04/2030	Pelekane Bay, Hawai‘i	Hawaiian hoary bat (16)	N/A
Waikoloa Water Community Wind Project[V]	N/A	Waikoloa, Hawai‘i	N/A	N/A

[Z] Other species may also have incidental take authorizations not reported here.

[Y] Projected take based on using an 80% credibility level in Evidence of Absence software (Dalthorp et al. 2014, 2017) and includes indirect take.

[X] Federal biological opinion. Take numbers listed are from the State of Hawai‘i ITL.

[W] Original permit was issued in 2006 and amended in 2012.

[V] Informal consultation completed with a “not likely to adversely affect” determination—no incidental take (turbines inactive at night).

One SHA is proposed on Hawai‘i Island: Kamehameha Schools, Kiahou and Kilauea Forest (Table 4.13). Under an SHA, a property owner voluntarily undertakes management activities on their property to enhance, restore, or maintain habitat benefiting species listed under the ESA. These agreements assure property owners they will not be subjected to increased property-use restrictions if their efforts attract listed species to their property or increase the numbers or distribution of listed species already on their property. The USFWS issues the applicant an enhancement of survival permit, which authorizes any necessary future incidental take through Section 10(a)(1)(A) of the ESA. Accordingly, all impacts associated with these Section 10 permits have been mitigated.

Table 4.13. Safe Harbor Agreements Affecting Covered Species

Permittee	Permit Duration	Location	Species Covered
Puʻu o Hoku Ranch	Unknown. Approved in 2001.	Molokaʻi	Nēnē
Unknown	Unknown. Approved in 2003.	Molokaʻi	Nēnē
Umikoa Ranch	Unknown. Approved in 2001.	Hawaiʻi	Nēnē
			Hawaiian duck
Piiholo Ranch	50 years (September 2004–September 2054)	Makawao, Maui	Nēnē
Kamehameha Schools, Kiahou and Kilauea Forest	50 years	Kau, Hawaiʻi	Hawaiian hawk
			Nēnē
			Hawaiian hoary bat

4.5.1 Nēnē

No authorized take of nēnē is currently approved on Hawaiʻi Island (see Table 4.12). One Hawaiʻi Island take authorization for this species is being requested for Pakini Nui Wind Farm due to the potential for colliding with wind turbines and other Project components. Statewide, take of 121 nēnē is permitted or pending approval, not including take requested for Pakini Nui. Other developments on Hawaiʻi Island with the potential to have cumulative impacts to nēnē include developments that decrease nesting and foraging habitat and golf courses that may attract nēnē to the area, increasing their vulnerability to vehicular collisions or golf ball strikes (Mitchell et al. 2005).

Proposed mitigation measures for nēnē at Pakini Nui are expected to more than offset the anticipated take and will contribute to the species' recovery by providing a net conservation benefit, as required by state law. Similar offsets can be expected for other projects with permitted take based on the requirement under state law to provide an overall net environmental benefit for the species. Similar measures are expected for other developments on Hawaiʻi Island and statewide with the potential to impact nēnē. Given the low expected rate of take at Pakini Nui and the expectation that impacts of any future projects will include mitigation to provide a measurable net benefit for nēnē, the cumulative impact of take for Pakini Nui combined with previous and future authorized take is not expected to result in a significant cumulative impact to the species.

4.5.2 Hawaiian Petrel

The only authorized take of Hawaiian petrel on Hawaiʻi Island is at the Lalamilo Wind Farm, although Lalamilo has not documented any takes of this species (see Table 3.2). In order to mitigate impacts to Hawaiian petrel, Lalamilo proposes to conduct predator control actions at an unfenced subcolony of petrels located in HVNP. This mitigation effort is expected to offset the requested take and provide a net benefit to the species. Statewide, take of 191 Hawaiian petrels is authorized or pending approval, not including the take requested for Pakini Nui. Other developments on Hawaiʻi Island with the potential to have cumulative impacts to the Hawaiian petrel include tall structures (communication towers, turbines, etc.), developments with excessive lighting, and developments that decrease nesting habitat.

The proposed mitigation measures described for the Hawaiian petrel are expected to more than offset the anticipated take and contribute to the recovery of the species by providing a net conservation benefit, as required by state law. Similar offsets are expected for the Lalamilo Wind Farm. With the low expected rate of take at Pakini Nui, the proposed mitigation measures are expected to produce a measurable net benefit in the form of a marginal increase in the population of the Hawaiian petrel, as estimated prior to Project take. For this reason, the cumulative impact of take authorized for Pakini Nui combined with previous and future authorized take is not expected to result in a significant cumulative impact to the species.

4.5.3 Hawaiian Hoary Bat

There are several factors that, when combined, have contributed to the current status of the Hawaiian hoary bat. Historically, conversion of native forests to large-scale agriculture or the expansion of cities has resulted in a significant reduction in Hawaiian hoary bat roosting habitat.

Original incidental take estimates for permitted wind facilities in Hawaiʻi were underestimated due to a lack of baseline data on the Hawaiian hoary bat and other factors beyond scientific knowledge at the time of permitting. Each permitted wind facility operating in Hawaiʻi has required an amendment to its HCP to increase the amount of authorized take of the Hawaiian hoary bat. Assessing risk to the Hawaiian hoary bat with respect to wind facilities, in combination with substantial gaps in baseline population and life history information for the Hawaiian hoary bat, has increased concern regarding the potential cumulative impacts on the species. Sources of these potential impacts include existing and future wind energy development and other sources of anthropogenic take, such as biomass energy development, habitat destruction, increased human or predator activities, and other environmental and biological effects. However, post-construction fatality monitoring results and preliminary research efforts suggest that the population of Hawaiian hoary bats throughout the Hawaiian Islands is larger and more widespread than previously was known (Kawailoa Wind Power 2015; personal communication, F. Bonaccorso, United States Geological Survey-Biological Resources Division, 2014).

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

Tree trimming and harvesting activities are not necessarily incompatible with bat habitat needs (Johnson and Strickland 2003; Patriquin and Barclay 2003), although they have the potential to impact juvenile bats that may be unable to fly away from an occupied tree when it is cut or disturbed. The USFWS recommends that harvesting or trimming woody plants more than 15 feet tall should not occur between June 1 and September 15. It is not known exactly how much bat take occurs statewide as a result of tree trimming and harvesting. However, the amount is likely so small that it does not contribute significantly to the cumulative impacts to the species.

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

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

There is no currently authorized take of Hawaiian hoary bat on Hawaiʻi Island. Hawaiian hoary bat take of six individuals has been requested at Lalamilo Wind Farm due to the potential for colliding with turbines and other project components, but the project is still undergoing the permitting process. Statewide, take of 654 Hawaiian hoary bats has been authorized or is pending approval, not including the take requested for Pakini Nui. Section 3.1.3 of this document describes fatalities that have occurred at other wind farms. Other developments on Hawaiʻi Island with the potential to have cumulative impacts to the Hawaiian hoary bat include resort or recreational developments, farming, road construction, pesticide use, and other developments that decrease roosting and foraging habitat. Although predatory relationships are largely unknown, it is possible the bat is preyed upon by barn owls, which may further impact populations.

The proposed mitigation measures described in this document for the Hawaiian hoary bat are expected to more than offset the anticipated take and contribute to the recovery of the species by providing a net conservation benefit, as required by state law. Similar offsets are expected for the Lalamilo Wind Farm. With the low expected rate of take at Pakini Nui, the proposed mitigation measures are expected to produce a measurable net benefit in the form of an increase in the population (as estimated prior to Project take) of the species by increasing the quality of available foraging and roosting/pupping habitat, as described in Section 6.2. For this reason, the cumulative impact of take authorized for Pakini Nui combined with previous and future authorized take is not expected to result in a cumulative impact to the species.

5 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* 65:35241). 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 the Hawaiian hoary bat.

Objective 1. Restore existing but degraded habitat for increased use by Hawaiian hoary bats through implementation of a habitat restoration project at the Kahuku Unit of HVNP at a scale commensurate with the authorized take.

Goal 2. Result in net conservation benefit for the Hawaiian petrel.

Objective 2a. Protect existing habitat for Hawaiian petrels by contributing to maintenance and monitoring of an existing predator fence, which will keep out introduced ungulates that cause harm to nesting habitat for seabird species on Mauna Loa.

Objective 2b. Protect existing populations of Hawaiian petrel through contributing to efforts to fence out and trap cats, which have substantial negative impacts on the survival and reproductive success of this seabird species. The population to be protected is located on Mauna Loa in HVNP.

Goal 3. Result in net conservation benefit for the nēnē.

Objective 3. Protect the existing population of nēnē through predator control measures by contributing to predator control measures at the Pi‘ihonua breeding pen on the Island of Hawai‘i.

Goal 4. Increase knowledge.

Objective 4. Increase the knowledge and understanding of Covered Species by monitoring and sharing data with the USFWS and DLNR during the ITP/ITL term at the Project Area, the bat mitigation site at the Kahuku Unit, the petrel mitigation site on Mauna Loa, and the nēnē mitigation site.

6 MINIMIZATION AND MITIGATION

6.1 General Measures

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. Minimization measures implemented at the Project Area and intended to decrease the risk of take to Covered Species are as follows:

- Only emergency work will be scheduled during nighttime hours to avoid the use of lighting that could attract Hawaiian petrels, band-rumped storm-petrels, and possibly Hawaiian hoary bats.
- Use shielded fixtures for all lighting during the infrequent occasions when workers are in the Project Area at night. Outdoor lighting will be fully shielded. Outdoor lights will be restricted to what are needed for safety reasons and will only be used in emergency situations. Otherwise, no nighttime activities will occur on-site.
- Observe a speed limit of 40 km (25 miles) per hour while driving within the Project Area. This will help minimize collision with Covered Species, in the event they are using habitat in the Project Area or are injured. If nēnē are observed at or near the Project Area, a speed limit of 25 km (15 miles) per hour will be observed.
- Avoid use of the top strand of barbed wire within the Leased Area to reduce or eliminate the possibility of entangling Hawaiian hoary bats.
- Refrain from purposely approaching and maintain a distance (by foot or vehicle) of 30 m (100 feet) from nēnē when present in the Project Area in order to avoid erratic flight behavior that may increase strike risk.
- Observe year-round low wind speed curtailment, as described in Section 6.2.1.
- Do not create open water that may attract nēnē.
- Should the Project be decommissioned during the life of the ITL/ITP, these minimization measures will also apply to the decommissioning period. In addition, once decommissioned, the high-speed rotor lock will be engaged, stopping the turbine’s ability to spin, and effectively eliminating collision risk to the Covered Species.

6.2 Hawaiian Hoary Bat

This section describes minimization measures specific to the Hawaiian hoary bat (i.e., curtailment) and a proposed mitigation project (i.e., a forest restoration mitigation project in the Kahuku Unit of HVNP). The combination of minimization and mitigation described in this HCP leaves no remaining impacts of the taking of Hawaiian hoary bats that could be further mitigated or minimized. In other words, the biological value that will be lost from Covered Activities will be fully replaced through implementation of conservation measures (minimization and mitigation) with equivalent or greater biological value and the mitigation is equal with the impacts of taking for the following reasons:

- A resource equivalency analysis (REA) was conducted to quantify, using reasonable assumptions based on the best available science, the conservation benefit of the proposed forest restoration mitigation project in relation to the impacts of the proposed taking. The baseline assumptions and results are provided in detail in Section 6.2.2 and Appendix A. According to the REA, for Tawhiri to get credit for the mitigation project for 10 years, approximately 1,074 acres of habitat restoration fully offsets the impacts of the requested take of 26 bats. This is because multiple generations of bats will be expected to use the restored area given its long-term designation as a National Park. In total, 1,200 acres of forest restoration will be completed to provide a net conservation benefit to the species (46.2 acres per bat). The Hawaiian hoary bat population will benefit from this forest restoration mitigation project by gaining additional roosting habitat along with greater forage diversity.
- In addition to more than fully offsetting the impacts of the taking, the proposed amount and form of mitigation is the maximum extent practicable because there are no other reasonably available, practicable mitigation options available to Tawhiri. Habitat enhancement—particularly forest restoration—is currently one of very few mitigation options available for implementation (in addition to wetland improvements and research). The forest restoration mitigation project proposed in this HCP is based on the assumption that converting vegetation from invasive species to native forest will 1) provide more potential roosting locations, and 2) improve foraging (i.e., arthropod diversity) over current conditions. As currently understood, none of the other options for mitigation have been proven to be better than the forest restoration mitigation project proposed in this HCP.
- The Project currently conducts a nightly curtailment regime with a cut-in speed of 5.5 m (18.0 feet) per second. This curtailment regime is described in greater detail in Section 6.2.1 and will continue for the life of the permit. Low wind speed curtailment is a wind industry best management practice thought to be highly effective at minimizing bat take.
- Based on the best available information, the Hawaiian hoary bat population of Hawaiʻi Island is not trending toward extinction. The best available information is that it is "stable to slightly increasing," as reported in a recent study (Gorresen et al. 2013, p. 20); however, this trend is not conclusive because of the design of the study. The proposed mitigation, which is designed to fully offset the impact of the taking, will increase the likelihood of recovery through the mitigation measures proposed herein (Section 6.2.2) and provide a net environmental benefit to the population. Therefore, the overall impact of the taking will remain low.

The mitigation proposed in this HCP also meets the recommendations put forth in the *Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance Document* (Amlin and Siddiqi 2015).

If the number of bats that will be taken has been underestimated, this HCP includes a mechanism for additional mitigation through a formal amendment, as described below. Additionally, the adaptive management triggers, as defined in this HCP, will keep actual take within the permitted limits.

6.2.1 Low Wind Speed Curtailment

One operational minimization measure being used at wind farms where native populations of bats reside, and that may help minimize Hawaiian hoary bat fatalities, is to increase the turbine cut-in speed to 5.0 m (16.4 feet) per second. Available data indicate that bat fatalities most commonly occur during lower wind speeds (Arnett et al. 2011; Arnett et al. 2013). Therefore, applying brakes to the turbines or allowing them to freewheel at less than 5.0 m (16.4 feet) per second may reduce the risk of fatality to bats. This measure has been implemented at wind farms in Hawai‘i to reduce fatalities of Hawaiian hoary bats.

The Project implemented an interim curtailment program in March 2014 as a precaution to minimize risk of take of the Hawaiian hoary bat. The Project currently curtails turbines 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). Turbines shut down and the blades are feathered if the 10-minute average wind speed is 5.0 m (16 feet) per second or less (cut-out wind speed) and will start back up if the 10-minute average wind speed is greater than or equal to 5.5 m (18.0 feet) per second (cut-in wind speed). Blade feathering refers to when the turbines are offline and blades are pitched to 83 degrees parallel to the wind, which allows rotors to freewheel so that bearing damage is not incurred. This curtailment regime will continue for the life of the ITP/ITL, as described below.

Data collected during a full year of acoustic monitoring in 2014 show a strong seasonal pattern of Hawaiian hoary bat activity levels in the Project Area (SWCA 2015b). Hawaiian hoary bat activity levels in the Project Area were low during the months of October through May, with a pronounced increase in activity levels between June and September, indicating that Hawaiian hoary bats are most likely to be struck by a turbine blade in the months of June through September. However, despite the strong seasonal nature of bat activity at the Project, Tawhiri will continue to implement year-round low wind speed curtailment after ITP/ITL issuance. Low wind speed curtailment will consist of operating turbines at an individually automated 10-minute average cut-out speed of 5.0 m (16.4 feet) per second and a 10-minute average cut-in speed of 5.5 m (18.0 feet) per second between the hours of 6:00/6:30 p.m. and 6:30/7:00 a.m. The turbines are curtailed on an individual basis as determined by on-board turbine anemometry. When offline, blades are feathered, as described above. Rotational speeds at these wind speeds are less than can be measured with the installed equipment (< 0.1 revolutions per minute). Note that this is not the same as “pitching” blades to slow down rotor speeds. The turbines at the Project Area are unable to pitch blades sufficiently to significantly slow rotor rotation to speeds below those experienced prior to normal shutdown because of insufficient wind speeds.

The DOFAW recommends a minimum cut-in speed of 5.0 meters per second (Amlin and Siddiqi 2015). Also, current science does not establish that raising the cut-in speed will significantly reduce fatalities, as stated in the recent BLNR approval of the Na Pua Makani HCP (BLNR 2018). For these reasons, Tawhiri will continue with the current curtailment regime, as described above. The rate of bat take will be analyzed both per annum and cumulatively, and Tawhiri will consider increasing the cut-in speed through adaptive management if it becomes clear that the rate of take is too high to stay within permitted take limits.

6.2.2 Forest Restoration Mitigation Project

This forest restoration mitigation project will be completed in partnership with HVNP. HVNP has developed a forest restoration mitigation project to restore 1,200 acres of degraded lowland mesic-wet ‘ōhi’a forest within the Kahuku Unit of HVNP. This forest restoration mitigation project is expected to benefit the Hawaiian hoary bat and numerous other wildlife species (Appendix B, Table B-1). The full description of this forest restoration mitigation project is detailed below and in Appendix B. This forest restoration mitigation project will take place in an area that had been clear-cut of native forest and then utilized for cattle grazing, resulting in primarily non-native vegetation (Figure 6.1). HVNP acquired the 150,865-acre Kahuku Unit in 2003 for the preservation of habitat for threatened, endangered, and other rare plants and animals. Cattle grazing continued on the site under a special use permit until 2009.

Figure 6.1. Current condition of the forest restoration mitigation project area. Photograph courtesy of Hawai‘i Volcanoes National Park.

The methods of the forest restoration mitigation project consist of controlling invasive plants, planting native trees and shrubs, and scarification around existing koa trees to regenerate the existing koa seed bank. This work will take place in an area where seed supplies for native tree species are limited and competition from invasive or aggressive grasses and woody species inhibits forest recovery. With the threat of the spread of rapid ‘ōhi’a death into the HVNP Kahuku Unit, forest restoration projects of this type gain high importance in maintaining roosting habitat for the Hawaiian hoary bat because of the potential for the existing ‘ōhi’a stands to die off. The current Kilauea eruption is dropping ash on the forest restoration mitigation project area, making it inhospitable to human presence. However, the NPS believes this impact will be short term and will not impede the forest restoration mitigation project or its chances for success (personal communication, Sierra McDaniel, HVNP, June 13, 2018). Tawhiri will assure restoration of an area commensurate with the level of take requested in this HCP.

As stated above, HVNP acquired the 150,865-acre Kahuku Unit in 2003 for the preservation of habitat for threatened, endangered, and other rare plants and animals. To this end, HVNP fenced large tracts of land within this unit and removed ungulates to reduce the immediate threat to the preservation of these rare species and their habitat. The forest restoration mitigation project area, which is adjacent to the Ka‘ū Forest Reserve, provides habitat for a number of rare, threatened, and endangered species, including the Hawaiian hoary bat and nēnē. Hawaiian hoary bats were detected in the forest restoration mitigation project area year-round, although a density of individuals was not estimated (Fraser and HaySmith 2009).

Much of the Kahuku lowland forest (< 1,372 m [4,500 feet] elevation) is badly degraded by decades of land clearing and destruction by cattle, mouflon sheep, and pigs. Large forest tracts have been converted to alien grass pastures and are invaded by Christmas berry (*Schinus terebinthifolius*), strawberry guava (*Psidium cattleianum*), and kāhili ginger (*Hedychium gardnerianum*). HVNP staff have constructed boundary fences and removed animals (feral pigs and cattle), but additional measures, such as invasive plant control and the planting of native trees, are needed to facilitate forest recovery and restoration of wildlife habitat. Without active restoration, much of the area would remain dominated by non-native pasture grasses and would not provide roosting or pupping habitat for the species.

Requested bat take will be mitigated through funding of $1,463,728 for a contiguous 1,200 acres of forest restoration within HVNP that would be permanently protected by the NPS. The forest restoration mitigation project area is within the known range of the Hawaiian hoary bat and is proposed on lands for which there is currently no management plan nor is there funding for habitat restoration. The methods used by the NPS to achieve this restoration (described in detail below) are reliable because the removal of invasive plants, reintroduction of native plants, and overall increased native biodiversity of the vegetation are expected to boost bat forage biodiversity and availability within the first few years after planting. In 2007, HVNP completed a forest restoration project on an experimental plot in the Kahuku Unit in an effort to refine the forest restoration methods used for this mitigation project to increase the chances of success for future projects. Long-term roosting and potential pupping resources are expected to begin establishing after 6 years (when koa seedings are expected to reach over 15 feet or more in height; personal communication, Sierra McDaniel, HVNP, June 13, 2018). As such, roosting habitat within the entire forest restoration mitigation project area is expected to be fully established within 14 years after starting the mitigation effort. Figures 6.2 and 6.3 depict the 2007 experimental plot 8-years post-planting. Due to the design, the improved functionality and resources of the forest restoration mitigation project area is expected to continue to provide those resources for the lifespan of each successful tree, which in some cases could be hundreds of years. Prior to implementation of the forest restoration mitigation project, it is assumed that this 1,200-acre forest restoration mitigation project area supports one bat per 80 acres to account for the provision of low-quality forage and transitory space.

The Pakini Nui Project site does not have any roosting or pupping habitat because of a dearth of trees. Furthermore, it is expected there are few native arthropods available for foraging in the predominant invasive plants. It is most likely that any bats frequenting the area are searching for prey in the lee of the nearby cliff and only infrequently enter the area occupied by turbines. The forest restoration mitigation project area, once restored, will provide forested habitat comprised mostly of native species, providing roosting/pupping and improved foraging habitat for Hawaiian hoary bats. The forest restoration mitigation project will mitigate for impacts to low-quality habitat by improving roosting and pupping habitat in a perpetually protected location that currently constitutes low-quality habitat.

The official mission of the 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" (NPS 2018). This framework of preservation provides an ideal opportunity for mitigation partnerships in which mitigation monies are used to fund active conservation and restoration in areas preserved by HVNP for purposes of preserving natural scenery and historical objects. However, habitat restoration falls outside of this mission, and there is currently no management plan for the Kahuku Unit of HVNP. Outside funding, such as these mitigation funds, is necessary to implement restoration to improve the habitat for rare species. The mitigation work proposed by this HCP would not be completed with government funds if private funds were not to be provided. HVNP provides habitat for several ESA-listed species. Restoration actions to address all of these species in the park would require considerable funds in addition to HVNP's operating funds. This forest restoration mitigation project provides an opportunity for this mitigation program to contribute to the conservation of multiple species in an area with long-term preservation guarantees that would not otherwise be restored.

Figure 6.2. Condition of experimental restoration plot 8 years post-planting. Photograph courtesy of Hawai‘i Volcanoes National Park.

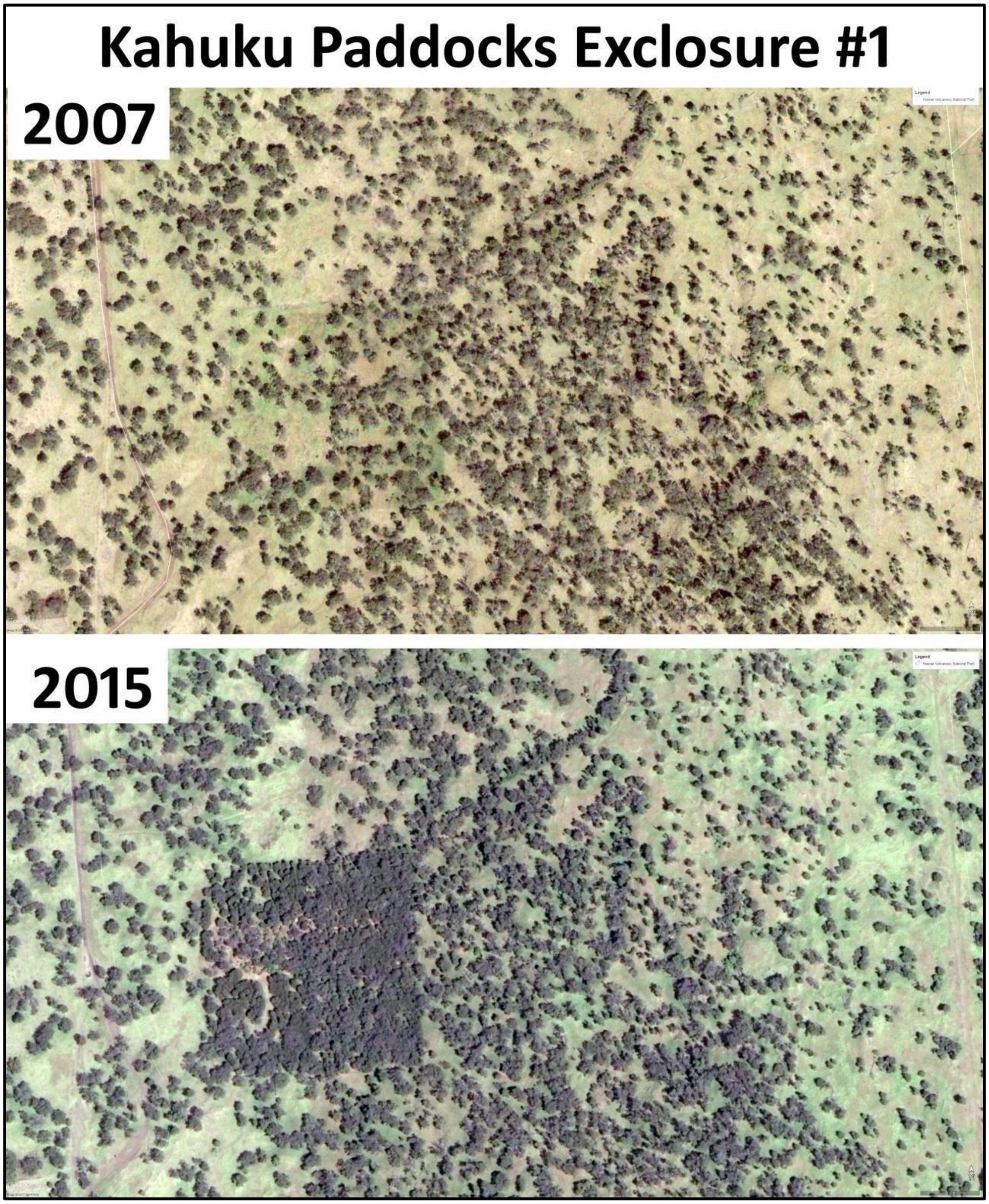

Figure 6.3. Experimental restoration plot 8 years post-planting (dense forest left of center). Photograph courtesy of Hawai'i Volcanoes National Park.

6.2.2.1 DETERMINATION OF PROJECT SIZE

An REA was completed to provide biologically sound logic for the size of the forest restoration mitigation project that would fully offset the impact of the anticipated level of take. REA is an economic model that provides a science-based, peer-reviewed method of quantifying interim and permanent resource losses (i.e., losses of animals) associated with an environmental disturbance and scaling compensatory mitigation to offset those losses (Allen et al. 2005; Dunford et al. 2004; King 1997; NOAA

2006, 2009). An REA quantifies and balances losses (take due to Project operation) and gains (benefits of compensatory mitigation) in animal-years. On the loss side of the REA, animal-years is the sum of the additional years the animals would have lived if they had not been killed by the environmental disturbance. On the gains side of the REA, animal-years is the sum of the increased per-acre carrying capacity of the animal over the lifetime of the mitigation project.

Appendix A provides detail and support for the inputs used to inform this REA, which are summarized in Table 6.1. Although Tawhiri acknowledges that some of the Hawaiian hoary bat life history inputs are not known and must be based on surrogates, the REA is presented as the best available method in the absence of better methods or definitive agency guidance.

Table 6.1. Data Need, Estimates Used, and Sources for Pakini Nui Hawaiian Hoary Bat Mitigation Resource Equivalency Analysis

Data Need	Estimates Used	Source
The timing and duration of the disturbance and an estimated number of animal fatalities.	26 takes in 8 years of operation	Section 4.1 of this HCP
An estimate of the animal's normal lifespan and the age distribution of the population so that the average animal-years lost per animal killed can be estimated without knowing the actual ages of the animals killed; age distribution can be estimated from age-specific survival rates if lifespan is known.	Maximum lifespan is 10 years. Assumed annual survival rates of juveniles (30%) and adults (85%) were used to characterize the age distribution of the population.	Lifespan: as noted in Amlin and Siddiqi (2015) Adult survival: O'Shea et al. 2011; Pryde et al. 2006 Juvenile survival: *Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take* (USFWS 2016)
An estimate of the new resource services produced by the mitigation project per unit of application (e.g., number of animals supported per year per acre of habitat improved).	The forest restoration mitigation project area may currently support limited use by bats. Bats were detected at the project by Fraser and HaySmith 2009), but bat roosting and pupping habitat is limited. The bat use baseline is estimated in the model as one bat per 80 acres (0.5 bat per 40 acres). One bat-year per 80 acres is a conservative assumption that includes the possibility that bats may currently travel through and potentially forage in the forest restoration mitigation project area. For comparison, two bat-years per 40 acres is considered full carrying capacity based on mapping core range habitat sizes (Bonaccorso et al. 2015). The model assumes that the forest restoration mitigation project area will support two bat-years per 40 acres in the sixth year following planting in each section (full value).	Professional opinion, Fraser and HaySmith 2009; Bonaccorso et al. 2015
The timing and duration of the mitigation project, including the time of implementation and the time to full benefit.	Funding for the forest restoration mitigation project will be provided in year 1 of the permit. Noxious and invasive plant removal and the planting of tree seedlings will take place on approximately an eighth (12.5%) of the forest restoration mitigation project area every year for years 2–9 of the mitigation project. Koa, the fastest growing tree species to be planted and/or regenerated, will reach 15 feet in height after about 5 years and will provide roosting habitat 6 years following scarification/planting. Therefore, the creation of pupping habitat will begin on 12.5% of the forest restoration mitigation project	Professional opinion based on design of project, as described in Appendix B

Data Need	Estimates Used	Source
	area 6 years after planting (year 7 of the forest restoration mitigation project) and expand an additional 12.5% of the forest restoration mitigation project area until year 14 of the permit (final planting in year 9 plus 6 years of growth, including the initial year). High-quality pupping habitat would result following 15–20 years of tree growth.	
The economic discount rate being used.	0% annual discount rate	The standard rate typically used in REAs (e.g., USFWS eagle take REA) is 3%; however, 0% is consistent with the discount rate used for the Indiana Bat REA.

The REA assumes that the forest restoration mitigation project will begin the first year of permit implementation, with roosting benefits occurring 6 years following scarification/planting. As stated above, the REA takes into account the mitigation project duration and will credit fewer acres per bat if more than one generation may use the same territory (i.e., if the mitigation project will persist beyond the average bat lifetime). This forest restoration mitigation project is designed such that tree saplings will be planted in dense nodes that will outcompete the invasive grasses for the life of the tree without additional management intervention, which in some cases may be hundreds of years. As described in Section 6.2.3.1 (vegetation monitoring), if less than 60% of the seedlings survive the first year, additional herbicide application and plantings will take place. According to the REA, with Tawhiri maintaining credit for the forest restoration mitigation project for 10 years following funding, a minimum of 1,074 acres would need to be restored to fully offset the impacts of the proposed take, which is less than the 1,200 acres proposed in this HCP.

Another factor considered in determining the forest restoration mitigation project's size is its location in a National Park. Although this means the mitigation project will be protected into perpetuity, it also can be asserted that mitigation would have been more valuable on private lands that could otherwise be subject to development. For this reason, an adjustment factor is sometimes added to mitigation projects on federal lands whereby additional mitigation is completed. In this HCP, the forest restoration mitigation project's ultimate size is approximately 12% greater than the acreage resulting from the REA (i.e., (1,200 acres − 1,074 acres) ÷ 1,074 acres). This size inflation accounts for the project taking place on federal land and ensures a net conservation benefit to the population.

After taking the results of the REA and the location on federal land into consideration, it was determined that a forest restoration mitigation project consisting of 1,200 acres (46.2 acres per bat) would fully offset the impacts of the proposed taking for the following reasons:

- It encompasses the estimate provided by the REA.
- It is commensurate with the 40 acre per bat mitigation recommendation described in Amlin and Siddiqi (2015), which is based on research by Bonoccorso et al. (2015).
- It adds a 12% upwards adjustment factor to the forest restoration mitigation project because the mitigation will take place on federal land.

6.2.2.2 OBJECTIVES

Forest restoration mitigation project objectives are as follows:

- Prevent establishment of target weed species to promote natural recovery and an increase in native biodiversity.
- Plant 90,000 nursery-reared seedlings to facilitate forest recovery in 1,200 acres of degraded former pasture in the Kahuku Unit according the methods and implementation schedule described below.
- Evaluate vegetation community changes within the forest restoration mitigation project area.
- Evaluate bat activity and arthropod diversity within the forest restoration mitigation project area.

6.2.2.3 METHODS

The forest restoration mitigation project methods are as follows. These methods have been tested at an experimental paddock in the Kahuku Unit and have been shown to be successful.

- To prevent establishment of target weed species, work crews will conduct ground searches to locate target weed species. Global positioning system data will be collected for areas searched and the number of plants treated. Target species include blackberry, strawberry guava, kahili ginger, and Christmas berry. Control methods will follow established HVNP-prescribed treatments for each species.
- Plant 90,000 nursery-reared seedlings and remove grasses from select existing koa trees using herbicide or mechanical scarification. Seeds of native tree and shrub species will be collected within the local area and processed for propagation at the HVNP native plant facility. The native plant facility 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. Prior to planting and seed broadcasting, alien grasses will be temporarily suppressed by applying a 2% solution of imazapyr and glyphosate. In addition, grasses around select existing koa trees will be removed either with herbicide or mechanical scarification to regenerate koa from the seed bank.

  Planting and scarification will be strategically placed to link existing forest fragments or build biodiversity around existing solitary trees. Forest nodes built around scattered, tall ‘ōhi‘a and koa trees in the pasture may attract birds to disperse seeds and have higher nutrient inputs because of leaf litter and higher moisture levels because of cloud water interception. Planting seedlings in dense nodes will reduce light levels as the canopy develops and suppress the dominate invasive grasses. This will create forest habitat that would be extant for the life of the trees, needing very little long-term management.
- To monitor forest restoration mitigation project success, vegetation monitoring plots will be established both within and outside of the forest restoration mitigation project area to evaluate impacts of management actions on the vegetation community composition and structure. Pre-planting/scarification plots (baseline) will be established and reevaluated at year 10 of the permit. Results of the monitoring will be compared to the baseline to determine if native biodiversity and the canopy cover have changed significantly.

6.2.2.4 IMPLEMENTATION SCHEDULE

Because of the large size of the forest restoration mitigation project, the planting and scarification schedule will be staggered so that a manageable portion of the overall forest restoration mitigation project area is reforested each year. HVNP has proposed to split the 1,200-acre project into eight sections of approximately 150 acres each and reforest each part according to the example schedule below. Monitoring actions are described below.

Table 6.3. Example Reforestation and Monitoring Schedule, Forest Restoration Mitigation Project

Restoration Section	Forest Restoration Mitigation Project Year									
	1	2	3	4	5	6	7	8	9	10
1	Project coordination, site visits with work leaders, collection of plant material, and propagation. Survey baseline vegetation, bat activity, and invertebrate diversity monitoring for restoration section 1.	Plant seedlings and scarify	Monitor seedling survival							Monitor invertebrate diversity, bat activity, and vegetation
2		Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival						Monitor invertebrate diversity, bat activity, and vegetation
3			Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival					Monitor invertebrate diversity, bat activity, and vegetation
4				Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival				Monitor invertebrate diversity, bat activity, and vegetation
5					Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival			Monitor invertebrate diversity, bat activity, and vegetation
6						Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival		Monitor invertebrate diversity, bat activity, and vegetation
7							Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival	Monitor invertebrate diversity, bat activity, and vegetation
8								Baseline vegetation, bat activity, and invertebrate diversity monitoring	Plant seedlings and scarify	Monitor seedling survival

6.2.3 Monitoring

Monitoring actions for vegetation, bat activity, and invertebrates are described below, with the timing of actions displayed in Table 6.3, along with the forest restoration mitigation project implementation schedule. Costs anticipated for monitoring are detailed in Appendix C (Mitigation Costs and Funding).

Bat activity and invertebrate diversity monitoring will require obtaining a research permit from HVNP, which will be done at the time of permit issuance.

6.2.3.1 VEGETATION

Vegetation monitoring plots will be established both within and adjacent to the forest restoration mitigation project area to evaluate impacts of management actions on the vegetation community composition and structure Vegetation monitoring methods will mimic those described in McDaniel et al. (2011). The area of each plot will be 20 × 30 m. Vegetation baseline conditions will be measured in year 1 and resurveyed in year 10 of the forest restoration mitigation project. Seedling survival will be monitored the year following planting. If fewer than 60% of the seedlings have survived 1 year, additional herbicide applications and planting/scarification may occur.

The vegetation monitoring results will be compared with the baseline to measure changes in forest structure and diversity. The variables measured in each plot will be 1) percent of outplanted seedling survival, 2) native species richness, and 3) stand density and species comprising the forest canopy (native versus non-native).

6.2.3.2 BAT ACTIVITY

The USFWS requires that the forest restoration mitigation project also include a bat monitoring component (personal communication, D. Sether, USFWS, August 17, 2015). Monitoring will be accomplished by measuring two variables:

- Changes in Hawaiian hoary bat activity and behavior (i.e., documented foraging attempts) over time in the forest restoration mitigation project area
- Changes in insect biomass over time in the forest restoration mitigation project area

The following null hypotheses will be challenged:

- Bat activity will not change in restoration sections over time.
- Invertebrate richness in the restoration sections will remain the same over time.

Seven acoustic bat detectors will be deployed at any one time to document call type (i.e., feeding buzzes) and frequency as an index of Hawaiian hoary bat activity levels. The detector and microphone technology currently deemed to be best suited to record the subspecies and for the local conditions will be used (such as Wildlife Acoustics SM3 or SM4 models). Acoustic sampling stations will be deployed in each restoration section prior to restoration actions to document baseline conditions. Acoustic data collected after restoration will be compared with the section’s baseline conditions. All acoustic stations will be deployed for a 1-month period during peak activity. Bat passes will be quantified at each acoustic sampling station. Feeding buzzes and search phase sequences will be distinguished and tallied and compared with the baseline dataset. Mean weekly bat passes will be compared within the forest restoration mitigation project area before and after restoration of the areas. This monitoring will be conducted by a qualified third party to be determined at the time of permit issuance.

6.2.3.3 INVERTEBRATE DIVERSITY

Samples of invertebrate species richness will be compared over time. Data collected during the year prior to beginning reforestation actions will constitute baseline activity for comparisons over time. Invertebrate sampling will be conducted using light sampling methods twice annually (rainy season and dry season) and during the acoustic monitoring. Light sampling will be conducted during the same moon phase within each restoration section and will take place for the same amount of time for each 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.

The results of the vegetation, acoustic, and invertebrate monitoring will be summarized in the annual report corresponding with the year of monitoring.

6.2.4 Success Criteria

Habitat restoration of 1,200 acres of degraded forest/pasture will take place within the Kahuku Unit of HVNP (forest restoration mitigation project), according to the methods provided above and in Appendix B and amounts and schedules provided in Appendix C (Mitigation Costs and Funding). Success will be achieved when the following tasks are completed:

- 1,200 acres are swept for control of target weed species according to established HVNP-prescribed treatments to promote natural native plant establishment
- 90,000 native tree and shrub seedlings are planted, areas around existing koa trees are scarified, and at least 60% of produced seedlings survive for 1 year.
- Vegetation monitoring plots measuring 20 × 30 m are established within each of the restoration sections to evaluate impacts of management actions on the vegetation community composition and structure, seedling survival is monitored 1 year post-planting, and native species richness and canopy cover/species are resurveyed on the schedule presented in Table 6.3
- Monitoring results indicate the following when compared with the baseline:
  - 60% seedling survival 1 year following planting/scarification
  - Native species richness significantly increases over time
  - The canopy comprises entirely native tree species
  - An increase of bat activity and invertebrate diversity
- Status and results of the restoration and monitoring efforts (including expenses) are provided in annual reports to DOFAW and the USFWS.

6.2.5 Adaptive Management Trigger

A report will be submitted annually to the USFWS and DOFAW that will analyze whether the native vegetation biodiversity, acoustic activity, and invertebrate biodiversity are increasing as expected in the forest restoration mitigation project. Adaptive management actions will be taken if it is apparent that the success criteria will not be achieved following submittal of the forest restoration mitigation project year 4 report. Adaptive management actions may consist of reapplying herbicide, rebroadcasting seed, planting additional seedlings, conducting additional scarification, increasing or altering monitoring activity, or other actions necessary to achieve the success criteria.

Research on Hawaiian hoary bat is currently being planned for mitigation credit for other Hawai‘i wind power projects. Results of this research will be reviewed annually by the USFWS and DOFAW and may suggest a completely new strategy for bat mitigation in the future or other refinements to improve effectiveness of existing hoary bat habitat management strategies. In addition, the *Endangered Species Recovery Committee Hawaiian Hoary Bat Guidance* recommends review of research priorities every 5 years and making modifications to respond to new information. At the future direction of the USFWS and DOFAW, mitigation activities may consist entirely of restoration, research, or a combination of both.

6.3 Hawaiian Petrel

HVNP constructed a 5-mile barrier fence encompassing over 600 acres of nesting habitat to protect the largest subcolony of endangered Hawaiian petrels on Hawaiʻi Island. Construction began in 2013 and was completed in 2016. HVNP conducted predator control and surveillance within the fence during the 2016 and 2017 breeding seasons. No cats have been detected and no predation events were documented; therefore, the area has been deemed free of cats. Tawhiri will augment postconstruction management actions for 3 years, as described in this section and Appendix D.

HVNP conducts one complete fence inspection per year. Funds provided by Tawhiri will support more frequent fence inspections and rapid responses to potentially damaging events, like a significant storm, with a complete inspection and repair as needed, thus minimizing potential impacts to nesting birds, such as predator ingress.

Real-time surveillance for predator ingress will be improved with the addition of eight remote texting game cameras, which will be funded by Tawhiri. Images are sent to park staff via emails, allowing for a rapid response by HVNP staff should ingress be detected. Monitoring for ingress predators within the exclosure is best accomplished by placing cameras at nest sites, as potential routes are excluded by the fence, thus providing additional reproductive data on a subset of nests. This will improve HVNP's estimate of reproductive success, as cameras have proven to provide more accurate information on this cryptic species than human observation of indirect cues (such as guano and the presence of chick down).

Although the fence was completed in 2016, the primary strike deterrent (two strands of white woven tape) was installed in 2013 when the fence posts were installed; this alert birds to the presence of the poles and conditions them to anticipate the coming fence. With funds provided by Tawhiri, the white tape will be replaced as soon as it is deemed necessary.

HVNP conducted 5 consecutive years of a nest density survey to establish baseline density estimates before and during fence construction and to refine the new monitoring protocol techniques. This level of monitoring is not sustainable given current fiscal uncertainty and will, therefore, occur only when funding is available. Funds provided by Tawhiri will provide the support needed to conduct this systematic monitoring at 5 to 6 years following fence construction, an appropriate time to expect change given the maturation rate of the species.

HVNP staff will be responsible to carry out the methods and monitoring, as described in this section. Methods are as follows:

- Set remote texting game cameras to monitor in real time for ingress of predators.
- Conduct additional fence inspections each year to better ensure the integrity of the fence. An inspection will be in response to a potentially damaging event, if one occurs; otherwise, it will be planned opposite HVNP's annual inspection.
- Replace deteriorated anti-strike devices (white marking tape or an alternate) to ensure that the fence remains visible to transiting birds.

Surveillance for ingress of predators and annual fence inspections will take place in years 1–3 of the mitigation project. The deteriorated anti-strike devices will be replaced in years 1, 2, or 3 (when needed).

The proposed mitigation will be sufficient to 1) offset the impacts of authorized take of Hawaiian petrels, and 2) result in an overall net conservation benefit for the species by ensuring that the colony remains protected from predators. Mitigation measures are expected to contribute to increased survival rates of adults in the area and/or in increased fledgling production. Mitigation efforts will not include or overlap with other projects.

6.3.1 Monitoring

The following monitoring activities will take place in the Hawaiian petrel colony during the life of the mitigation project:

- Reproductive success will be monitored at a subset of nests using the game cameras for each of 3 successive years.
- Pedestrian nest surveys will be conducted in 50 × 50–m grids as outlined in the Hawaiian Petrel Monitoring Protocol (Hu et al. 2015). Data collected will be used to calculate nest densities and contribute to the detection of trends over time.

Due to the slow maturation and reproductive rate of the species, monitoring on an annual time frame does not provide the long-term data necessary to determine a trend in petrel numbers or an increase in fledging rates. The results of the nest surveys conducted for this mitigation project will be compared with the HVNP 5-year nest density survey that was conducted before and during fence construction. Results of effectiveness monitoring will be included in the annual reports that are submitted to the DLNR and USFWS.

6.3.2 Success Criteria

The following criteria will be used to determine the success of the mitigation project:

- Replacement of 10 miles (two strands) of white tape is completed to ensure that the fence remains visible to Hawaiian petrels.
- Reproductive success results are reported for a subset of Hawaiian petrel nests for each of 3 successive years.
- Results of consistent, remote surveillance for ingress predators are reported annually.
- Comprehensive annual fence inspections and repairs are conducted.
- Predator removal and nest density estimates are reported, comparable with estimates obtained before and during construction.
- Annual reports detailing mitigation activities and progress toward success criteria are provided to the USFWS and DLNR.

6.3.3 Adaptive Management Trigger

Adaptive management actions will be triggered if after year 2 of the mitigation project it is determined that the methods described above are not effective at reducing predators from the fenced colony.

6.4 Nēnē

As a result of the emergency declaration by Governor Abercrombie in 2011 to move 598 nēnē from Kauaʻi, the conservation needs for this species have shifted since work on this HCP first began (personal comment, A. Siddiqi, DLNR, August 2016). This nēnē mitigation project will provide a net benefit by increasing the nēnē population on Hawaiʻi Island above the level of take requested.

Mitigation for nēnē will consist of construction of a new 7-acre breeding pen on Hawaiʻi Island approximately 1.25 acres from existing DOFAW-managed breeding pens. The new 7-acre pen would contain two reservoirs and part of a hill. Nēnē have been seen in the area, but no nesting attempts or fledging has been observed. The predator-proof fence would be constructed during the first year of the nēnē mitigation project. The remaining funds would be used to maintain the fence and enclosure, completing tasks such as repair of fences, purchase of vegetation maintenance equipment (i.e., lawn mowers and weed trimmers), repair of the reservoir to maintain year-round water, and control of predators. Funding for this nēnē mitigation project is detailed in Appendix C (Mitigation Costs and Funding). This nēnē mitigation project is intended to provide a net benefit to the species in alignment with state and federal species recovery goals to promote the recovery of the species within portions of its historic range and to contribute to an increase in adult or juvenile survival and/or increased productivity (average number of fledglings per pair) at the mitigation site.

Because adult nēnē will be replaced by fledglings, the possible loss of production during the lag years between take of adult birds and the sexual maturity of the fledglings will be accounted for. Female nēnē mature at age 3 and males at age 2 (Banko et al. 1999). For the purpose of this HCP, it is assumed that an adult lost in year 1 will be replaced by fledglings in year 1 (with indirect take separately accounted for, as described in Section 4.3.2), and no gosling production will occur in years 2 and 3 because the fledgling would still be immature. The female fledgling produced in year 1 could begin breeding in year 4. Only 1 year of lost productivity will be attributed for the take of a mature male.

Average loss of productivity through mortality of one adult has been determined to be 0.09 goslings/individual/year (see Section 4.3.2). Because adults will be replaced by goslings, loss of productivity will be assessed at an additional 0.09 fledglings for an adult male (1 year loss of productivity) and 0.18 fledglings for an adult female (2 years loss of productivity) assuming same-year replacement (Table 6.4). The mortality of captive-reared released goslings to year 1 was reported to be 16.8% for females and 3% for males (Banko et al. 1999; Hu 1998). For the purpose of this HCP, an annual survival rate of 83% is assumed to occur for both genders of geese through maturity (age 2 or 3, depending on gender). Males and females are assumed to be equally vulnerable to collision with the turbines and associated structures. Table 6.4 identifies the number of fledglings that will be produced to offset the take anticipated for nēnē during operation of the Project. It is anticipated that all take will be replaced with fledglings within the same year or earlier. If increased adult survival can be demonstrated, the estimate can be adjusted accordingly.

Table 6.4. Fledgling Requirement for Nēnē Take Assuming Same-Year Replacement

	Direct Take		Indirect Take	
	Male	**Female**	**Fledglings**	**Total Required Fledglings**
Total requested baseline take	1	1	1	
Fledglings required	1.5 (= 1.0 ÷ 0.83 ÷ 0.83)	1.8 (= 1.0 ÷ 0.83 ÷ 0.83 ÷ 0.83)	1	4.3 (= 1.5 + 1.8 + 1)
Loss of productivity	0.09 (= 0.09 × 1 x 1 year)	0.18 (=0.09 × 1 × 2 years)		0.27 (= 0.9 + 0.18)
			Total	**4.6, rounded up to 5**

Based on the numbers provided in Table 6.4, if the full amount of projected take of nēnē occurs at the Project over the 10-year life of the mitigation project (three nēnē), a net accrual of six (5 + 1) fledglings would result in a net benefit for the species.

Mitigation for nēnē will be considered successful and complete following the completion of pen construction and 4 years of maintenance and predator control, as described above.

6.4.1 Monitoring

The increase in the number of nēnē fledglings produced after pen construction will be determined through near-daily monitoring by DOFAW employees. Fledglings will be banded at 8–12 weeks in age, and fledging will be considered successful when a chick leaves the breeding pen on its own. Nēnē have been observed in the area, but no nesting attempts or fledging has been observed; therefore, any successful fledging will be attributable to the presence of the new pen (i.e., baseline is 0).

6.4.2 Success Criteria

The following criteria will be used to determined success of the mitigation project:

- A new 7-acre breeding pen is constructed and maintained for 4 years.
- Annual reports detailing mitigation activities and progress toward success criteria are provided to the USFWS and DLNR.

6.4.3 Adaptive Management Trigger

Adaptive management will be triggered if at least four fledglings (80% of mitigation amount) have not been produced from the pen by the third breeding season following pen construction. Adaptive management actions may include incorporating changes to the trapping protocol to increase the chances of nest success and increased monitoring to ensure documentation of fledging success.

6.5 Band-Rumped Storm-Petrel

Although the band-rumped storm-petrel is not a Covered Species, the minimization and mitigation designed for the Hawaiian storm-petrel will also benefit this species.

7 HABITAT CONSERVATION PLAN IMPLEMENTATION

7.1 Habitat Conservation Plan Administration

Tawhiri will administer this HCP. The DLNR and USFWS, as well as experts and biologists from other agencies (e.g., the U.S. Geological Survey) and 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 Tawhiri.

7.2 Monitoring and Reporting

Implementation of this HCP includes compliance (i.e., fatality) monitoring and effectiveness monitoring. Compliance monitoring will be implemented to ensure accordance with the terms and conditions of the ITP/ITL. Compliance monitoring will be funded by Tawhiri 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 5 of this HCP. Effectiveness monitoring is funded and implemented as part of the proposed mitigation plans. All monitoring activities on-site and off-site will be coordinated by Tawhiri’s natural resources manager, with the aid of trained staff, as appropriate. Monitoring efforts for which Tawhiri is responsible are described in the following sections. Any changes to monitoring will only be made with the concurrence of the USFWS and DLNR.

Pursuant to HRS §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. The USFWS also may conduct inspections and monitoring in accordance with the ESA and its implementing regulations (currently codified at 50 CFR 13.47).

7.2.1 Compliance Monitoring

Fatality monitoring provides a scientifically defensible means of determining compliance with ITP/ITL take limits and authorizations. An assigned third party approved by the USFWS and DOFAW will conduct systematic fatality monitoring to ensure adequate fatality search data are collected for the Project. In addition to over 4 years of weekly pre-ITP/ITL fatality monitoring, compliance monitoring, as set forth below, will be conducted throughout the life of the ITL/ITP.

Fatality monitoring of the site will continue to be conducted weekly for every turbine, but search frequency may be changed with concurrence from the USFWS and DLNR if considered prudent based on site-specific data, which will include SEEF and CARE trial results. Searches of the met tower will also be conducted, with the frequency of searches based on the current CARE trial results for medium-sized birds, since seabirds could collide with the tower but bats are not expected to. Search frequency will be approved by the agencies with each annual and semiannual report. A canine searcher will be used when possible.

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% fall within 108 m (354 feet). Search plots at wind farms in Hawai‘i typically range from 75–100% of turbine height. However, because of the strong prevailing winds at the Project Area that blow consistently from the east (between 70 and 90 degrees) for more than 90% of the time, it was agreed, with USFWS and DLNR concurrence (meeting with the USFWS and DLNR, February 20, 2014), that the upwind portion of the search plot could be reduced to 60% of turbine height, whereas the downwind portion could be lengthened to 90% of turbine height. This would increase the chances of locating a fatality if it were blown downwind, although bats could fall into the upwind direction during low wind speed conditions. The wind turbine search plot will extend 60 m (197 feet) upwind and 90 m (295 feet) downwind (Figure 7.1). Because the turbines are placed close to one another and all individual turbine search areas overlap, a single final search area was designed. More carcasses are expected to be found in the downwind portion of the site because of the strong prevailing winds. The downwind portion of the search plots of several turbines is unsearchable due to their proximity to vertical cliffs (see Figure 1.2). This reduction in the searchable area will be accounted for in the Evidence of Absence (Version 2.0 or most recent) model and will result in a lower g value and increased uncertainty, thus, a higher take estimate (Dalthorp et al. 2017). The specific model inputs to be used are described in Section 4.1.1. The radius of the met tower search area will be equal to 50% of its height.

The USFWS and DOFAW will approve a compliance monitoring plan at the time of permit issuance. The offset search areas, based on prevailing wind direction, will be reviewed periodically and modified under adaptive management if new information reveals that a different search pattern is necessary. Any fatalities that occur upwind but outside of the search area are accounted for in the unobserved take.

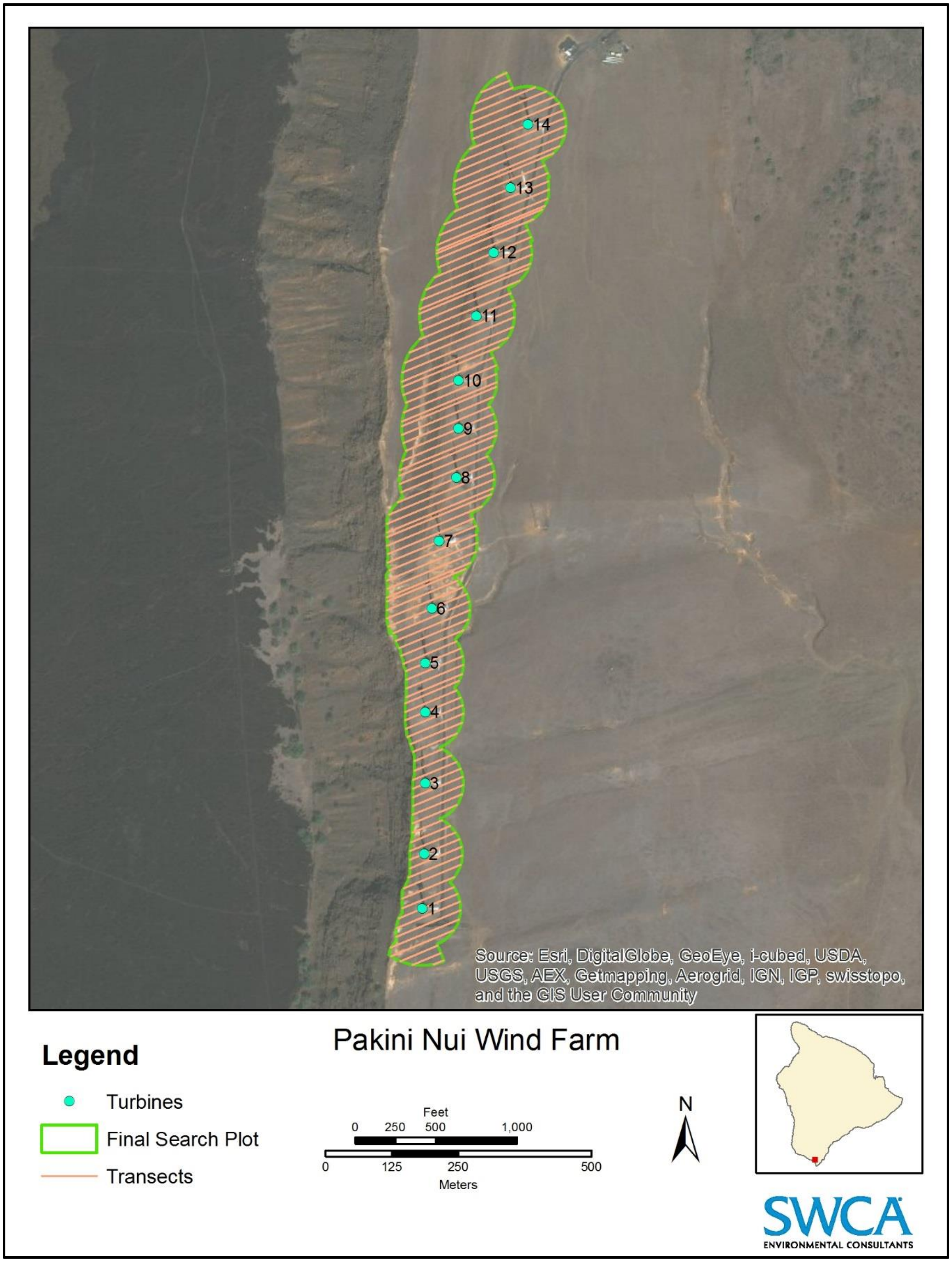

Figure 7.1. Pakini Nui Wind Farm, showing search plot area, search transects, and numbered turbines.

To maximize a searcher's ability to spot carcasses—particularly those of small bats—the vegetation in the easement areas around the turbines will be maintained as short as possible by Tawhiri. Tawhiri will also coordinate with local ranchers to maintain the vegetation as short as practical outside of the Project turbine easement areas. Currently, depending on the intensity of grazing at different locations, grass height ranges from ankle to knee high in the Project Area, making carcasses relatively easy to find. It is anticipated that continued grazing by cattle and goats will assure that additional anthropogenic vegetation maintenance will not be necessary.

The ground cover at the search area is dominated by short grass. Two types of ground cover are present; short grass/bare ground is the dominant ground cover, whereas a small area of taller grass is present in the upwind section of the site (upwind of Turbines 4–6).

In all, 90 parallel transects, spaced 5 m (16.4 feet) apart across the search area will be used for compliance monitoring (see Figure 7.1). Searchers will follow the transects, searching 2.55 m (8.2 feet) on either side. Searching will be conducted either by one or more human searchers on foot or by a human and canine search team. All data collected—including information about any carcasses discovered, turbines searched, weather conditions, search dates, CARE status, and SEEF status—will be entered into a Microsoft Excel spreadsheet format for use in Evidence of Absence (Version 2.0 or most recent) software (Dalthorp et al 2017). Photographs will be taken and stored. The data inputs and outputs will be shared with the DLNR and USFWS.

CARE and SEEF trials will be carried out each year that fatality monitoring is conducted to determine how likely it is that a carcass landing in the search plots is detected. Measuring SEEF and CARE in the Project Area on a regular basis will be 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 approved by the USFWS and DOFAW, and staff responsible for the fatality searches will not be aware of when SEEF trials are being conducted; this will help to avoid searcher bias. DOFAW will be notified by the proctor and provided with a map of the surrogate locations at least 2 days prior to the planned date of the trials.

For CARE, 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 centimeters (cm) (4.5 inches) long. For the medium size class, dead chickens—or wedge-tailed shearwaters, if available—will be used as surrogate carcasses for Hawaiian petrels. At least 10 successful trials of each size class will be performed during each season (wet and dry) to form a robust data set with which to estimate take.

A surrogate avian carcass will be considered taken by a scavenger if fewer than 10 of its body feathers and/or fewer than two wing feathers remain (Young et al. 2012).

Random locations for placement of surrogate CARE carcasses by the proctor will be generated using ESRI's ArcGIS software. 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. The duration of CARE will be confirmed directly by the searcher on a daily basis or by deploying motion-triggered game cameras. The cameras have the added benefit of aiding in documenting the cause of carcass removal.

For SEEF trials, rats will be used as surrogates for the Hawaiian hoary bat. For the medium size class, wedge-tailed shearwaters will be used when available. Otherwise, chickens will be used, which closely match Hawaiian petrels in size. Double extra-large chickens or similar will be used to represent a large size class. At least 10 successful trials of each size class will be performed during each season (wet and dry) to form a robust data set with which to estimate take. Surrogate SEEF carcass locations will also be chosen based on randomly generated global positioning system point locations within the Project search area. Proctors will place carcasses in the same manner as done for the CARE trials (see above), typically in the early morning hours and without the searcher having knowledge of where the carcasses are located. The searcher must be unaware of either the timing of SEEF trials or of the number of surrogate carcasses placed during these trials. When a carcass is found by the searcher, the approximate location, carcass type, and closest turbine will be recorded on the Project avian inspection report and communicated by email and/or cell phone text message to the person tasked with overseeing the trials.

Efficiency will be determined as follows:

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

After searches have been completed for the day, the searcher will notify the third-party proctor if any carcasses were discovered during the search. Proctors will verify if any undiscovered carcasses were remaining. There are two different options in the Evidence of Absence model for the SEEF approach to undiscovered carcasses. For the larger carcasses, a “repeated” search approach can be used, whereby the carcasses may be left in place to determine the likelihood that the searcher will find it the following week. If a carcass has gone missing, then that specific trial will not be counted because it cannot be verified whether or not the carcass was actually in place during the search period. It is likely that the repeated search approach will not be suitable for the small carcass size.

Direct take will be estimated using the Evidence of Absence (Version 2.0 or most recent) software (Dalthorp et al 2017). The numerical values for all parameters input into the Evidence of Absence software will be provided in the reports to the USFWS and DLNR. This will include the data sheets in compatible file format used for the Evidence of Absence software and the software outputs. Indirect take will be added to the direct take using *wildlife agency guidance for calculation of Hawaiian hoary bat indirect take* (USFWS 2016).

Should a carcass of a Covered Species or suspected Covered Species be discovered, the DLNR and USFWS will be notified as soon as possible within 24 hours by phone, and an incident report will be filed within 3 business days (Appendix E). Reporting of carcasses that are not MBTA species or Covered Species may be reduced to annual reporting upon future agreement with the DLNR and USFWS. Carcass and downed wildlife handling, including handling of injured wildlife, is described in Appendix E, as updated by the agencies. Tawhiri will follow the agency guidelines for carcasses found incidentally (not during routine searches), which can be found in Appendix F.

As part of the annual and semiannual reports, a table summarizing the results of incidental observations will be submitted to the DLNR and USFWS twice each year. The first will be submitted in January (post-fledging for Hawaiian petrels in the previous year) and the second in July (post-fledging for nēnē). In addition, in accordance with the Downed Wildlife Protocol, which was promulgated by DLNR (see Appendix E), biologists at the DLNR and USFWS will be notified whenever an MBTA species or Covered Species is found dead or injured.

In addition to fatality searches, Tawhiri personnel will be trained by DOFAW or another qualified biologist to look for and identify MBTA species and Covered Species while at the Project Area for O&M activities to increase the potential for incidental fatalities to be documented. This will ensure ongoing monitoring of the Project.

The likelihood of a Covered Species colliding with the tie-line is discountable, as described in Sections 3.1.2, 3.2.2, 3.3.2, and 3.4.2. Ground searches have proven to be highly ineffective (Travers et al. 2014), and acoustic monitoring of the tie-line will only cover a relatively small part of the tie-line because the sound of a strike does not jump across poles. Considering the discountable likelihood of a strike, sampling is not expected to result in any detections; therefore, fatality searches associated with the tie-line are not included in the compliance monitoring for this HCP. Similarly, the likelihood of a Covered Species colliding with the met tower is discountable (see Table 4.8).

7.2.2 Effectiveness Monitoring

Effectiveness of the mitigation projects will be monitored as outlined in Sections 6.2.3, 6.3.1, and 6.4.1 of this document.

Unless otherwise specified, measures included in this HCP will be considered successful if they have been implemented as described and achieved the criteria listed in this document (Sections 6.2.4, 6.3.2, and 6.4.2). Mitigation measures go directly toward effectively achieving the biological goals and objectives described in Section 5 of this HCP. Implementation of mitigation measures will be reported annually to the DLNR and USFWS, as described in detail below.

7.2.3 Reporting

Within 30 days of a fatality of a Covered Species or receiving a necropsy report for a Hawaiian hoary bat fatality that confirms it was killed as a result of turbine operations, Tawhiri will submit to DOFAW a new modeled take estimate (observed and unobserved take), including indirect take. Annual and semiannual reports summarizing all activities implemented under this HCP, and per the conditions of the ITP/ITL, will be submitted by Tawhiri to the DLNR and USFWS. These reports will include 1) results of compliance (i.e., fatality dates and species) and effectiveness monitoring; 2) actual frequency of the monitoring of individual search plots; 3) results of SEEF and CARE trials with recommended statistical analyses, if any; 4) numbers used for input into the models and copies of model outputs; 5) observed and unobserved direct take and estimated indirect take for each species for the annual period as well as the cumulative period since permit issuance; 6) a detailed description of the current status of the mitigation projects and whether there is a need to modify the mitigation for subsequent years; 7) efficacy of monitoring protocols and whether monitoring protocols need to be revised; 8) implementation and results of mitigation efforts conducted; 9) description of any changed circumstances, evaluation of exceedance of adaptive management triggers, and adaptive management decisions, if any; 10) budget and implementation schedule for the upcoming year; and 11) continued evidence of Tawhiri's ability to fulfill funding obligations. The annual report will be submitted by August 1 each year, along with electronic copies of relevant data. The report will cover the period from July of the previous year to June of the current year. The USFWS and DLNR will have 30 calendar days to respond to the report, after which a final report incorporating responses to the USFWS and DLNR will be submitted by September 30. The report may also be presented to the ESRC, as required. The semiannual reports will be submitted to the USFWS and DLNR within 30 days of January 31 and will cover the period from July through December.

8 ADAPTIVE MANAGEMENT

Per USFWS policy (see *Federal Register* 65:5242), *adaptive management* is defined as a formal, structured approach to dealing with uncertainty in natural resources management, using the experience of management and the results of research as an ongoing feedback loop for continuous improvement. Adaptive approaches to management recognize that the answers to all management questions are not known and that the information necessary to formulate answers is often unavailable. Adaptive management also includes, by definition, a commitment to change management practices when determined appropriate 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. Specific adaptive management triggers are defined in Sections 4.1.4, 6.2.5, 6.3.3, and 6.4.3. Funding assurance for adaptive management is included in the contingency fund, as outlined in the funding matrix (see Appendix C).

Regardless of recorded take levels, the avoidance and minimization measures described in Section 6.0 will be employed for the duration of the Pakini Nui Wind Farm project. The only exception would be if evidence clearly demonstrates that removing the avoidance or minimization measure will not appreciably increase take. Removing any avoidance and minimization measure would only take place with agency approval. For example, if bat take is low or fatality is determined to be caused by factors other than the wind turbines and it is proven at other wind facilities that removing low wind speed curtailment does not appreciably increase bat take, then curtailment could be removed. This could occur due to factors not associated with wind farm operation, bats not foraging at the height of the rotor-swept zone, or bats being less vulnerable to collisions due to the lack of a long-distance migration, which is when hoary bats on the mainland seem to be most susceptible.

Monitoring of seabird and nēnē mitigation efforts is intended to inform Tawhiri, the USFWS, and the DLNR whether these efforts are adequately compensating for take. If monitoring reveals that a particular mitigation effort is not achieving the necessary level of success, Tawhiri will consult with the USFWS and DLNR whether SEEF and CARE are not being conducted appropriately and/or require the agencies' approval to develop and implement a revised mitigation strategy to meet any changes in mitigation requirements.

If the take of any of the Covered Species exceeds 75% of the requested limit, Tawhiri will consult with the USFWS and DLNR to determine if additional take for that species may be anticipated and thus a major amendment initiated. Tawhiri may also consider whether changes in operational practices are needed to reduce levels of take. Any changes to the mitigation efforts will be made only with the approval of the USFWS and DLNR and Tawhiri's commitment to fully mitigate for its authorized take levels.

After review of the annual monitoring report and in cooperation with the DLNR and USFWS, or if the need for adaptive management becomes otherwise evident, Tawhiri will 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.

Tawhiri will meet at least semiannually with the USFWS and DLNR. Additional meetings/conferences may be called by any of the parties at any time to address immediate concerns. The purpose of the regular meetings will be to evaluate the efficacy of monitoring methods, compare the results of monitoring to the estimated take, evaluate the success of mitigation, and develop recommendations for future monitoring and mitigation. Regular meetings will also provide opportunities to consider the need for adaptive management measures. In addition, Tawhiri will meet annually with the ESRC to provide updates of monitoring, mitigation, and adaptive management and to solicit input and recommendations for future efforts. Additional meetings may be requested by Tawhiri or the wildlife agencies at any time to address immediate questions or concerns.

9 FUNDING

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

Prior sections of this HCP describe measures that Tawhiri 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 §195D. This section summarizes planning-level cost estimates to implement the HCP and describes funding and funding assurances. As described in the funding assurances section below, Tawhiri is responsible for covering all costs to meet mitigation obligations. All cost estimates are stated in constant 2019 dollar terms, assuming the permit is issued in 2019.

9.1 Habitat Mitigation Costs and Investments

HCP implementation will require investment in the mitigation listed below and described in Section 6.0 in detail.

- Hawaiian hoary bat habitat restoration (Section 6.2)
- Hawaiian petrel population protection (Section 6.3)
- Nēnē mitigation (Section 6.4)

9.2 Funding Strategies

As detailed in Appendix C, direct Project operator funding of all mitigation costs needed for the Hawaiian hoary bat, Hawaiian petrel, and nēnē proposals will be provided on an annual 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 as detailed in Appendix C. A USFWS-requested contingency fund, consisting of 10% of the mitigation and compliance costs (less up-front contributions) will cover adaptive management, changed circumstances, and inflation. An additional DOFAW-requested contingency fund consisting of 5% of the total mitigation project costs will be available to cover mitigation project management, if needed.

Costs are included in the funding matrix (see Appendix C) for DLNR HCP program compliance monitoring audit, which is authorized under HRS §195D-23 (c)(4)(d). This program was formed to establish a habitat conservation technical assistance program to assist landowners in developing, reviewing, or monitoring HCPs by providing technical assistance. Under this program, the department may collect fees and payment for costs incurred for use of the technical assistance program in the development, review, or monitoring of a specific HCP. Fees are charged at an hourly rate of $50. The fees and payment for costs collected are deposited into the endangered species trust fund established under §195D-31. Billing by the DLNR for this program is paid by the license holder upon receipt of billing up to the amount budgeted per annum, or higher in connection with development of an amendment for the HCP, when substantial adaptive management is required or if there are major compliance or legal issues.

9.3 Funding Assurances

All mitigation and compliance monitoring costs a total of $2,218,828 over the 10-year permit term. Total costs for mitigation, compliance monitoring, and the contingency funds described in Section 9.2 are $2,425,656. Following permit issuance, a total of $881,964 will immediately be paid toward Hawaiian hoary bat, Hawaiian petrel, and nēnē mitigation and mitigation project monitoring, and the first year of the compliance program will be funded. Any remaining mitigation, compliance monitoring, DLNR compliance audit, and contingency fund costs (initially projected to be $1,543,692) will be assured with a letter of credit (LOC) and will be in place prior to the effective date of the permit. The LOC will be issued by a financial institution organized or authorized to do business in the United States and identify the

DLNR as the sole payee with the full authority to demand immediate payment in the case of default in the performance of the terms of the permit and HCP. The LOC presented for approval will contain the following provisions:

- it will be payable to the State of Hawai‘i DLNR;
- the expiration date will not be less than 1 year from the effective date of the LOC and will contain a provision for automatic renewal for periods of not less than 1 year unless the bank provides written notice of its election not to renew to the DLNR at least 90 days prior to the originally stated or extended expiration date of the LOC;
- it will contain provisions allowing collection of the remainder of the costs by the DLNR for failure of the permittee to replace the LOC when a 90-day notice is given by the bank that the LOC will not be renewed and the LOC is not replaced by another LOC approved by the USFWS and DLNR at least 30 days before its expiration date; and
- the LOC will be payable to the DLNR upon demand, in part or in full, upon notice stating the basis thereof (e.g., default in compliance with the permit or HCP or the failure to have a replacement for an expiring LOC).

LOCs will include 1) guarantee of funds for adaptive management, and 2) sufficient contingency funds to cover inflation and changed circumstances to ensure that success criteria are met, as reflected in the funding matrix (see Appendix C). The LOC will be renewed annually based on the outstanding mitigation cost at the start of the following year. The purpose of the LOC 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.

Annual payments, as presented in Appendix C, will meet HVNP funding requirements and ensure that the mitigation projects are continually funded. Tawhiri and HVNP will provide a copy of a signed contract or Memorandum of Understanding between Tawhiri and HVNP that outlines the payment and performance schedule and responsibilities of each party. The signed contract or Memorandum of Understanding will be in place prior to issuance of the ITP and ITL.

10 UNFORESEEN AND CHANGED CIRCUMSTANCES

10.1 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 [USFWS] and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events) (50 CFR 17.3).

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

10.1.1 Designation of Critical Habitat

If the USFWS designates Critical Habitat, and such Critical Habitat may be adversely affected by the activities covered in the HCP, the USFWS may consider this to be a changed circumstance. If the USFWS makes such a determination, Tawhiri, in consultation with the USFWS, may implement adjustments in Covered Activities in the area of designated Critical Habitat to ensure that Project activities are not likely to result in adverse modification of the Critical Habitat. Tawhiri will consider practicable adjustments in activities until Tawhiri has applied for an amendment to the HCP/ITP and the USFWS has approved the amendment, if agreed to be appropriate, in accordance with then applicable statutory and regulatory requirements or until the USFWS notifies Tawhiri that these adjustments are no longer necessary.

10.1.2 Hurricane, Severe Storm, Volcanic Eruption, or Fire

Hurricanes and severe storms periodically strike or affect the Hawaiian Islands, and the likelihood of a hurricane, severe storm, volcanic eruption, or fire causing severe damage on Hawai‘i during the term of the HCP is high enough to merit treatment as a changed circumstance. Such a hurricane, severe storm, volcanic eruption, or fire could affect the activities covered by the HCP in several ways. For instance, it could cause significant damage to or destruction of Project facilities or pose a threat to the Covered Species by causing injury or death either directly or indirectly through the destruction of habitat in ways that increase or decrease the potential effects of Project facilities on the Covered Species.

Construction and operation of the facilities at Pakini Nui is consistent with applicable codes and industry standards, which are intended to avoid significant damage in severe weather conditions. Should a hurricane, severe storm, volcanic eruption, or fire cause significant damage to Hawai‘i during the term of the HCP, any resulting effects on the Covered Species will be considered based on the best available information at the time. The HCP mitigation efforts will be modified to respond to impacts from a hurricane, storm, volcanic eruption, or fire should the USFWS and DOFAW reasonably determine, in consultation with Tawhiri, that such a response is necessary.

10.1.3 Invasive Species

Introduced animal and plant species have had, and will continue to have, a detrimental effect on the Covered Species. The likelihood that the threat from this source will increase during the term of this HCP is sufficient to warrant treating this threat as a changed circumstance. The habitat enhancement and management measures to be implemented through this HCP could be compromised by new and/or increased populations of invasive species. Should these measures be compromised by invasive species during the term of this HCP, the HCP mitigation efforts that have not yet been paid for and implemented will be modified should the USFWS and DOFAW reasonably determine, in consultation with Tawhiri and HVNP, that such a response is necessary.

10.1.4 Changes in Status

If a new species that occurs on the Island of Hawai‘i is added to the federal or state endangered species lists, Tawhiri will evaluate the likelihood of incidental take of the species due to Project operation. If incidental take appears possible, Tawhiri may seek coverage for the newly listed species under an amendment to the existing HCP/ITP. Tawhiri may also reinitiate consultation with the USFWS and DOFAW to discuss whether mitigation measures in place provide a net benefit to the newly listed species or if additional measures may be recommended by the USFWS or DOFAW. Should any of the Covered Species become delisted over the permit term, Tawhiri will consult with the USFWS and DOFAW to determine if mitigation measures should be discontinued.

10.1.5 Disease Outbreaks in a Covered Species or Covered Species Habitat

Should the prevalence of disease increase substantially and become identified by the DLNR and USFWS as a major threat to the survival of a Covered Species or Covered Species habitat, Tawhiri will consult with the agencies to determine if changes in mitigating, monitoring, or reporting are warranted. This changed circumstance would apply if rapid ‘ōhi‘a death disease impacts the success of the forest restoration mitigation project, which is assumed to constitute roosting and pupping habitat for the Hawaiian hoary bat. Any such changes will be approved by the DLNR and USFWS and will be performed to achieve the monitoring and reporting objectives described in the HCP.

10.1.6 Changes in Distribution of Currently Listed Species

New research could alter the understanding of the potential impacts to species listed at the time this HCP was prepared. The likelihood that our understanding of risks to species and/or the distribution of their populations would change in a manner that would alter the assessment made in preparing this HCP is sufficient to warrant treating this possibility as a changed circumstance. If, as a result of new information, incidental take of a non-covered federally or state-listed species appears possible, or if an increase in take of a Covered Species is reasonably anticipated, Tawhiri would seek coverage under an amendment to the HCP. Tawhiri would also reinitiate consultation with the USFWS and DOFAW to discuss whether mitigation measures in place meet permit issuance criteria for the non-covered listed species or if additional measures are warranted.

10.1.7 Development of an Effective, Economical, and Commercially Viable Bat Deterrent

Preliminary research indicates that technologies may be developed during the Project permit term that could deter the Hawaiian hoary bat from flying into the airspace near the wind turbine rotors (Arnett et al 2013; Szewczak and Arnett 2007). Such a development could be used independently of, or in coordination with, low wind speed curtailment to further reduce the risk of Hawaiian hoary bat fatalities. If an effective, economical, and commercially viable bat deterrent technology becomes available during the Project’s permit term, Tawhiri will consult with the USFWS and DOFAW to determine if implementation of the technology is appropriate and, if implemented, how to measure the effectiveness of the measure.

10.1.8 Global Climate Change Substantially Alters the Status of the Covered Species

Global climate change within the term of the HCP (20 years) conceptually has the potential to affect Covered Species through regionwide changes in weather patterns, sea level, average temperature, and levels of precipitation affecting the species or their habitats (Intergovernmental Panel on Climate Change 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 (U.S. Climate Change Science Program 2009; Webster et al. 2005), which may increase the risk of damage to established mitigation sites. Sea level is predicted to rise approximately 1 m in Hawai‘i by the end of the twenty-first century (Fletcher 2009). Given this prediction, any rise in sea level experienced during the life of the Project likely will be less than 1 m (3 feet).

Precipitation may decline by 5%–10 % in the wet season and increase by 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 investment of unexpended mitigation funds if selected sites are considered no longer suitable. The alternate mitigation site(s) will be chosen by Tawhiri in consultation with the USFWS and DLNR.

10.1.9 Adaptive Management

The U.S. Department of the Interior defines *adaptive management* as a structured approach to decision-making in the face of uncertainty that makes use of the experience of management and the results of research in an embedded feedback loop of monitoring, evaluation, and adjustments in management strategies (Williams and Brown, 2009; Williams et al. 2009). Uncertainties may include a lack of biological information for the Covered Species, a lack of knowledge about the effectiveness of mitigation or management techniques, or doubt about the anticipated effects of the Project. Adaptive management is a required component of HCPs that allows for the incorporation of new information into conservation and mitigation measures during HCP implementation. Effective implementation of this approach requires explicit and measurable objectives and identifies what actions are to be taken and when they are to occur. Adaptive management measures do not trigger the need for an amendment.

If any of the proposed mitigation projects do not meet the success criteria, and it is determined the anticipated cost of the project will be exceeded in order to meet the success criteria, the permittee will consult with the USFWS and DOFAW to determine the best course of action.

10.2 Unforeseen Circumstances and "No Surprises" Policy

Unforeseen circumstances are defined as changes in circumstances affecting a Covered Species or geographic area covered by an HCP that could not reasonably have been anticipated by the plan and that result in a substantial and adverse change in the status of the Covered Species (50 CFR 17.3). Should the USFWS determine, based on considerations outlined in 50 CFR §17.22(b)(5)(iii)(c), that unforeseen circumstances have arisen during the ITP term, the USFWS and DLNR will notify Tawhiri in writing.

This HCP incorporates by reference the ITP assurances set forth in the Habitat Conservation Plan Assurances (No Surprises) Rule adopted by the USFWS (*Federal Register* 63:8859–8871) and codified at 50 CFR 17.22 (b)(5). The No Surprises regulations provide Tawhiri with assurances that, assuming the plan is being properly implemented, the Services will not require additional measures or funding beyond what was agreed to in the HCP without Tawhiri's consent.

10.3 Amendment Procedures

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

10.3.1 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 an 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 the USFWS and DLNR. A public review process may be required for the minor amendment. The amendment will be implemented upon receiving concurrence from the USFWS and DLNR.

10.3.2 Formal Amendments

Formal amendments are required when Tawhiri wishes to significantly modify the Project already in place. Formal amendments are required if the change or changes necessitating such an amendment or amendments could produce a net adverse effect on any of the Covered Species that is substantially different from adverse effects 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 may also be necessary if take of another ESA-listed species not covered by the ITP/ITL becomes likely and such take is not addressed in a separate HCP or Section 7 consultation. The HCP and ITP/ITL may be formally amended upon written notification to the USFWS and DLNR with the supporting information similar to that provided with the original ITP/ITL application. The need for a formal amendment will be assessed annually, with a formal assessment when there are 2 years of planned operations remaining on the permit (approximately 4 years before the ITP/ITL expires) to allow for development of the amendment application and subsequent processing before the original ITP/ITL expires. Tawhiri will review and implement additional avoidance measures, up to and including ceasing any operation that may pose a threat to the species, if, after the timely filing of an amendment application, the permitted take level is reached prior to an amended ITP/ITL being obtained. A formal amendment may require additional or modified minimization, and/or mitigation measures, and/or additional or modified monitoring protocols, and appropriate funding assurances. Formal amendments undergo the same regulatory process as an original HCP and may require a supplemental NEPA evaluation and additional public review.

A formal amendment would be triggered for this HCP if the following occurs:

- Any observed take of Hawaiian petrel or nēnē
- 75% of the requested Hawaiian hoary bat take is reached and there are more than 2 years of planned operations remaining on the permit

If the need for a formal amendment should arise, Tawhiri will work with the agencies to follow the most current agency regulations and handbook.

10.4 Renewal and Extension

This HCP proposed by Tawhiri may be renewed or extended and amended if necessary, beyond its initial 10-year term with the approval of the USFWS and DLNR. A written request will be submitted to the USFWS and DLNR that will certify that the original information provided is still current and conditions are unchanged or, alternatively, 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 Hawaiʻi 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.

11 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. Alternatives focused on development and preconstruction phases of a wind farm (e.g., timing of construction, micrositing of turbines and other infrastructure) are not applicable for consideration as alternatives at an already-operational facility. Therefore, two alternative actions to the proposed take authorization were identified, considered, and rejected by Tawhiri. Section 4 provides a detailed description of the chosen take authorization.

11.1 No Action Alternative

Under the No Action Alternative, all facility turbines would be shut down. This alternative would likely reduce the risk of take of the Covered Species to at or below a negligible level and no ITP/ITL would be needed. Under this alternative, the USFWS would not authorize incidental take of Covered Species and Tawhiri would not have the regulatory assurance requested to avoid a potential violation of the ESA. Any incidental take would not be authorized.

This alternative would result in complete loss of renewable electricity production. This would completely reduce the total renewable-based power production and negate Tawhiri's power purchase agreement, resulting in an economically unviable project. However, inclusion of the No Action Alternative is prescribed by the federal CEQ regulations (40 CFR 1502.14(d)) and is carried forward for analysis in the associated environmental impact statement.

11.2 Alternative 1. Proposed Alternative

The Proposed Alternative is described above in Sections 1–10.

11.3 Alternative 2. Decreased Curtailment

As described in Section 1.2, the Project implemented a curtailment program starting in March 2014 as a precaution to minimize the risk of take of a Hawaiian hoary bat. The Project currently curtails turbines between the hours of 6:00/6:30 p.m. and 6:30/7:00 a.m. Under Alternative 2, the turbines would shut down if the 10-minute average wind speed is 5.0 m (16 feet) per second or less (cut-out wind speed) and would start back up if the 10-minute average wind speed is greater than or equal to 5.5 m (18 feet) per second (cut-in wind speed).

Under Alternative 2, turbines would operate at an individually automated cut-in speed of 4.5 m (14.7 feet) per second, and this curtailment would occur during a shortened period (e.g., between 7:00/7:30 p.m. [near the time of civil sunset] and 5:30/6:00 a.m. [near the time of civil sunrise, or seasonally]). The reduced cut-in speed and shortened curtailment window proposed under Alternative 2 would likely result in an increase in the amount of time during which the turbine blades would be rotational.

A measure commonly implemented at wind facilities with the intent of minimizing the risk of bat fatalities is to increase the turbine cut-in speed to 5.0 m (16 feet) per second. As indicated by the data, it is widely held among experts that bat fatalities most commonly occur during lower wind speeds. Thus, applying brakes to the turbines or allowing them to freewheel at less than 5.0 m (16 feet) per second may reduce the risk of fatality to bats. Therefore, while a reduced cut-in speed and shortened curtailment period would likely result in increased energy production at the Project, these variables may also present a greater risk of bat mortality. For this reason, Tawhiri did not adopt this alternative.

11.4 Alternative 3. Nighttime Shut Down

Under this alternative, turbines would be shut down daily between the hours of 6:00/6:30 p.m. and 06:30/07:00 a.m. This measure may result in less risk of bat fatalities during the nighttime period. However, the Project would experience annual production losses exceeding 50%. This type of production loss would rapidly push the Project into a financially stranded situation. Therefore, Tawhiri did not adopt this alternative.

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