Kaheawa Wind Power II Habitat Conservation Plan
FY 2019 Annual Report

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Incidental Take License ITL-15 / Incidental Take Permit TE27260A-0

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EXECUTIVE SUMMARY

This report summarizes work performed by TerraForm Power, LLC (TerraForm), operator of the Kaheawa Wind Project II (Project), during the State of Hawai'i fiscal year 2019 (FY 2019; July 1, 2018 – June 30, 2019) under the terms of the approved Habitat Conservation Plan (HCP). The HCP is dated December 2011 and describes TerraForm's compliance obligations under the Project's state Incidental Take License ITL-15 and federal Incidental Take Permit ITP-TE27260A-0. Species covered under the HCP include four federally-listed threatened and endangered species. The 14-turbine Project was constructed in 2011 – 2012 and has been operating since July 2, 2012.

Fatality monitoring at the Project continued throughout FY 2019. The search plots used for monitoring are on graded pads found within a 70-meter radius circle centered on each wind turbine generator (WTG) and were searched by canine teams once per week year-round. Bias correction trials were conducted at the Project in FY 2019 to measure the probability that a carcass would persist until the next search and the probability that an available carcass would be found by a searcher. The results of these trials were consistent with previous years, with searcher efficiency exceeding 97 percent for bat, seabird, and goose surrogates.

Fatalities of two Covered Species were observed in FY 2019. In January 2019, a Hawaiian goose was observed outside of the designated search area during a routine fatality search by the canine team. The Project's total observed Hawaiian goose take from the date the Project was originally permitted (January 2012) through FY 2019 is five. The fatality estimates for five non-incidental observed geese using the Evidence of Absence estimator (Dalthorp et al. 2017) at the upper 80 percent credibility level is 13. Total indirect take for this estimate is one adult equivalent. In addition, one Hawaiian goose gosling fatality was attributed to Project operations in a previous year, although not as a result of a collision with a WTG. Combining these values, there is an approximately 80 percent chance that actual take of Hawaiian goose at the Project was less than or equal to 15 adults. One Hawaiian hoary bat fatality was found incidentally and outside of the fatality search plots in October 2018; therefore, it was not included in the inputs for the statistical estimate of direct take. The Project's total observed bat take from the date the Project was originally permitted through FY 2019 is four. The fatality estimates for the three observed bats detected during standardized searches using the Evidence of Absence estimator (Dalthorp et al. 2017) at the upper 80 percent credibility level is 12. Total indirect take for this estimate is one adult equivalent. Combining these values, there is an approximately 80 percent chance that actual take of Hawaiian hoary bats at the Project was less than or equal to 13 adults.

During FY 2019, eight ground-based acoustic detectors were deployed at the Project WTGs. Between July 2018-June 2019, Hawaiian hoary bats were detected on 211 of 2,550 detector-nights (8.3 percent of detector-nights). Temporal patterns of ground-based detection rates in FY 2019 were relatively similar to previous years,

Mitigation commitments are ongoing. Two years of funding have been provided to DOFAW for Hawaiian goose mitigation for Tier 1 estimated take. The work began in March 2017 and included

predator control of nesting areas and vegetation management at the Pi‘iholo Ranch release pen on Maui. Mitigation for Tier 1 and Tier 2 estimated bat take has been completely funded and continues as habitat management at Kahikinui State Forest Reserve. Mitigation for higher estimated take in the form of bat ecological research on Hawai‘i Island has been contracted. This work is intended to better inform future bat habitat restoration and conservation, and began in FY 2018 by the U.S. Geological Survey Hawaiian hoary bat research group. Tier 1 mitigation for estimated seabird take at the Project continues at the Makamaka‘ole seabird enclosures. These efforts include trapping and monitoring for potential predators, maintenance of enclosure fences, erosion control, and monitoring seabird activity within the Makamaka‘ole Stream drainage area and near artificial burrows within the enclosures. Site surveys of an alternative seabird mitigation site, as required by the HCP, were completed in East Maui in FY 2016.

TerraForm communicated actively with USFWS and DOFAW throughout FY 2019. The communication was conducted through in-person meetings, conference calls, submittal of quarterly reports, and e-mail communications related to the Project’s HCP. The purpose of these communications varied, and included required semi-annual meetings, discussions regarding the HCP Amendment, mitigation funding, and potential adjustments to mitigation strategies.

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1.0 Introduction

The Hawai‘i Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) approved the Kaheawa Wind Project II (Project) Habitat Conservation Plan (HCP) in 2012. In January 2012, the Project received a federal incidental take permit (ITP; ITP-TE27260A-0) from the U.S. Fish and Wildlife Service (USFWS) and a state incidental take license (ITL; ITL-15) from DOFAW. The ITP and ITL cover the incidental take of four federally listed, threatened and endangered species (the Covered Species) over a 20-year permit term.

The covered species include the:

- Hawaiian petrel or ‘ua‘u (*Pterodroma sandwichensis*);
- Newell’s shearwater or ‘a‘o (*Puffinus newelli*);
- Hawaiian goose or nēnē (*Branta sandvicensis*); and
- Hawaiian hoary bat or ‘ōpe‘ape‘a (*Lasiurus cinereus semotus*).

The Project was constructed in 2011 and 2012, and was commission on July 2nd, 2012. TerraForm Power, LLC (TerraForm) now operates the Project. Brookfield Renewable Partners, LP acquired a majority stake in Terraform in 2017.

This report summarizes work performed for the Project during the State of Hawai‘i 2019 fiscal year (FY 2019; July 1, 2018–June 30, 2019) pursuant to the terms and obligations of the approved HCP, ITL, and ITP. The Project has previously submitted annual HCP progress reports to USFWS and DOFAW for FY 2013 through FY 2018. TerraForm is currently developing an HCP Amendment in collaboration with USFWS and DOFAW to support a request to increase the amount of take for the Hawaiian hoary bat and Hawaiian goose beyond the take authorized under the current ITP/ITL.

2.0 Fatality Monitoring

The Project has implemented a year-round intensive monitoring program to document downed (i.e., injured or dead) wildlife incidents involving Covered Species and other species at the Project since operations began in July 2012. Beginning in July 2015, with agreement from the agencies, the search area was reduced to graded access roads and graded pads that fall within a 70-meter radius circle centered on each of the Project’s 14 wind turbine generators (WTG; Figure 1). Prior to July 2015, monitoring occurred within 75-meter circular plots centered on each WTG.

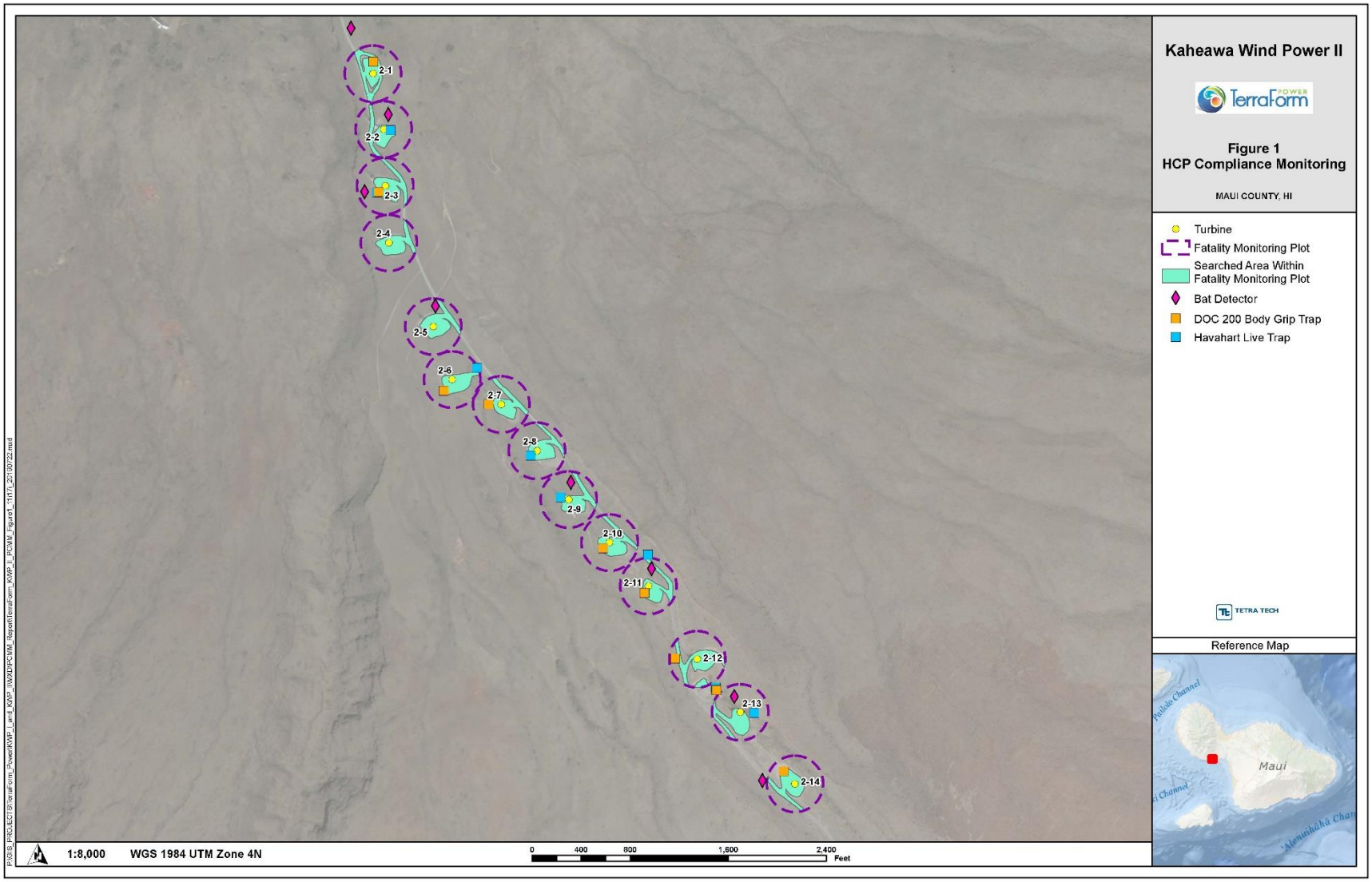

Figure 1. HCP Compliance Monitoring

In FY 2019, all 14 WTGs were searched for fatalities once per week. The FY 2019 mean search interval for WTGs was 6.8 days (Standard Deviation = 0.89 days). The search plots were searched by trained dogs accompanied by their handlers. If search conditions limited the use of dogs (e.g., weather, injury, availability of canine search team, etc.), search plots were visually surveyed by Project staff. However, no visual searches were required in FY 2019; 100 percent of searches were conducted by canine teams. Additionally, special precautions have been taken to eliminate any potential canine interactions with wildlife. The handler was directed to immediately retrieve the dog and postpone or temporarily skip dog searches in favor of visual searches if nearby Hawaiian geese were present. A Hawaiian goose was observed on August 28, 2018, and on January 29, March 13, and March 30, 2019. In each case, the handler moved the canine to a different turbine and returned to finish the disrupted turbine later in the day. No canine wildlife interactions were observed.

3.0 Carcass Persistence Trials

Four 28-day carcass persistence trials were conducted in FY 2019 using seabird carcasses as surrogates for the Hawaiian petrel and Newell's shearwater (e.g., medium birds; wedge-tailed shearwater was used as the surrogate), large chickens for Hawaiian goose surrogates (e.g., large birds), and black rats for Hawaiian hoary bat surrogates. For FY 2019, the mean probability that a carcass persisted until the next search was 0.69 for all bat surrogates (N=20; 95 percent Confidence Interval [CI] = 0.55, 0.79), 0.97 for medium-sized birds (N=4; 95 percent CI = 0.49, 1.0), and 1.0 for large birds (N=4; 95 percent CI = 0.93, 1.0).

4.0 Searcher Efficiency Trials

A total of 67 searcher efficiency trials on 22 trial days were administered during FY 2019. Similar to the carcass persistence trials, wedge-tailed shearwaters and large chickens were used as surrogates for listed bird species, and black rats were used as surrogates for bats. Searcher efficiency trials occurred throughout the year; 100 percent were conducted with canine search teams in FY 2019. Of the 67 trials placed, eight bat surrogates were lost to predation. All other carcasses were available for detection. Searcher efficiency in FY 2019 was 97.1 percent for bat surrogates (N=35; 95 percent CI = 0.87, 1.0), 100 percent for medium-sized birds (N=12; 95 percent CI = 0.815, 1.0), and 100 percent for large birds (N=12; 95 percent CI = 0.815, 1.0).

5.0 Vegetation Management

In order to maximize monitoring efficiency and minimize impacts to native plants without compromising soil stability, TerraForm performed vegetation management at the Project. Vegetation management activities have evolved over time, and account for Hawaiian goose nesting season restrictions:

- The vegetation management activities within the search plots are limited to between April 1 and October 31.
- In November 2016, Stephanie Franklin of DOFAW-Maui verbally approved using hand management tools (spray packs and weed whackers) during the Hawaiian goose nesting season if the activity was within the current search area and did not disturb wildlife.
- Primary vegetation management involves herbicide application and weed whacking.

Vegetation management at the Project was last conducted in September 2018, with a total of approximately 10 acres being treated with glyphosate-based herbicide in FY 2019. TerraForm will continue vegetation management in FY 2020.

6.0 Scavenger Trapping

The scavenger trapping program at the Project occurred throughout FY 2019. Active trap locations covered the same general areas throughout the Project as existed in FY 2018 (Figure 1). Traps deployed at the Project in FY 2019 include nine DOC250 body grip traps and eight Havahart live traps. The scavenger control program documented the removal of 15 mongoose, two rats, and four cats in FY 2019.

7.0 Documented Fatalities and Take Estimates

All observed downed wildlife were handled and reported in accordance with the Downed Wildlife Protocol provided by USFWS and DOFAW. One Hawaiian goose fatality and one Hawaiian hoary bat fatality were found in FY 2019, as described below. No injured (live) downed wildlife were observed at the Project in FY 2019. No other Covered Species were observed at the Project in FY 2019.

To calculate take estimates, the number of observed fatalities is scaled to account for fatalities that are not detected, or unobserved. Unobserved fatalities are the result of three primary factors:

- Carcasses may be scavenged before searchers can find them;
- Carcasses may be present, but not detected by searchers; and
- Carcasses may fall outside of the searched area.

Carcass persistence and searcher efficiency (bias correction; see Sections 3.0 and 4.0) measure the effect of the first two factors. The third factor, the number of carcasses that fall outside of the searched area, is dependent upon the proportion of the carcass distribution that is actually searched. The search area for fatalities at the Project has evolved over time, and therefore the proportion of the carcass distribution searched has varied; however, no change to the search area was made from FY 2018 to FY 2019. Thus, the estimate of the proportion of the carcass distribution searched has remained the same as that described in the FY 2018 annual report (KWP II 2018).

Cumulative take at an upper credible limit (UCL) of 80 percent was calculated for each species for which documented fatalities have occurred, per request of USFWS and DOFAW. The UCL is estimated from three components:

1. Observed direct take (ODT) during protocol (standardized) fatality monitoring;
2. Unobserved direct take (UDT); and
3. Indirect take.

The Evidence of Absence software program (EoA; Dalthorp et al. 2017), the agency-approved analysis tool for analyzing direct take, uses results from bias correction trials and ODT to generate a UCL of direct take (i.e., ODT + UDT). Direct take values from this analysis can be interpreted as: there is an 80 percent probability that actual direct take at the Project over the analysis period was less than or equal to the 80 percent UCL. Associated indirect take is estimated based on factors such as the sex and age characteristics of Covered Species fatalities found at the Project, their associated life history characteristics as described in the Project's approved HCP, and current agency guidance (when available; e.g., USFWS 2016 for Hawaiian hoary bats).

7.1 Hawaiian Goose

7.1.1 Estimated Take

A total of nine adult Hawaiian goose fatalities and one gosling fatality have been observed at the Project since operations began in July 2012. These include fatalities in FY 2013 (1), FY 2015 (2), FY 2016 (1), FY 2018 (5), and FY 2019 (1; described below). In FY 2018, three adults were detected outside of the search area during routine fatality searches, as was the case with the single fatality detected in FY 2019. Thus, four of the 9 observed fatalities were classified as incidental observations.

On January 16, 2019, surveyors observed a single adult Hawaiian goose carcass during a routine canine search. The carcass was approximately 44 meters from the base of WTG 3, in tall grass outside of the routine search area. DOFAW was notified and a technician collected the carcass on January 17, 2019.

The estimated direct take (ODT + UDT) based on the Hawaiian goose fatalities found between the start of operation (July 2012) and end of FY 2019 (June 30, 2019) is less than or equal to 13 geese (80 percent UCL; Appendix 1). In addition, in FY 2018 a Hawaiian goose gosling was found dead at the Project (KWP II 2018). As the gosling was not capable of flight, it was not included in inputs to EoA, but added as a single additional juvenile fatality, adjusted to an adult based on estimated survival rates, and added to the estimate of 13 geese at the 80 percent UCL that resulted from the EoA analysis.

Indirect take is estimated to account for the potential loss of individuals that may occur as the result of the loss their parents. Both parents for the Hawaiian goose exhibit responsibility for care of young until fledging. The point during the breeding season when an adult is taken determines to

what extent offspring may be affected (SWCA 2011). Indirect take was 1.09 juveniles (0.56 adults, assuming a 0.8 annual survival rate and 3 years from fledging to adult; Appendix 2).

The Project may cause a net loss in productivity in the event that take outpaces the number of individuals produced from mitigation efforts. The lag between production of geese through mitigation efforts and the take of geese at the Project drive the estimates of lost productivity. Accrued lost productivity at a given point in time is calculated as the cumulative take less the number of individuals generated from mitigation efforts to date, and then adjusted by a factor of 0.1 to account for the probability that those unmitigated birds would have produced young (SWCA 2011).

Hawaiian goose fledgling data for Project-funded release efforts at the Piʻiholo Ranch and Haleakalā Ranch pens are not yet available for FY 2019. Fledglings produced through FY 2018 had offset the accrued lost productivity at the Project through FY 2018 (Appendix 2). Accrued lost productivity as of FY 2019 will be recalculated when the information becomes available.

The UCL for cumulative Project take of the Hawaiian goose at the 80 percent credibility level is 15 geese (rounded up from 13 [estimated direct take from EoA] + 1 observed gosling fatality*0.512 adults/gosling + 0.56 [estimated indirect take]). That is, there is an approximately 80 percent probability that actual take at the Project at the end of FY 2019 is less than or equal to 15 adult geese.

7.1.2 Projected Take

EoA includes a module that allows users to project future estimates of mortality based on results of past fatality monitoring. Due to the inherent uncertainty of these projections (including the potential future contribution of indirect take) and the amplification of this uncertainty resulting from the use of the 80 percent UCL as the estimate of take for regulatory compliance, long term projections have limited utility. Nevertheless, they do help gauge the likelihood of permitted take exceedance, and may help operators in their mitigation planning, assuming future management and monitoring conditions can be reasonably estimated.

TerraForm projected Hawaiian goose take through the end of the permit term using the fatality monitoring data collected through FY 2019 to evaluate the potential for the Project to exceed the requested (under the draft HCP amendment) take limit at the 80 percent UCL prior to the end of the permit term (Appendix 3). The requested take limit for the Hawaiian goose is 44. As future indirect take is unknown and will potentially vary based on the timing of ODT, we assumed total indirect take for the Project over the permit term would be a maximum of two adult equivalents (four juveniles based on an assumed Hawaiian goose survival rate from juvenile to adult of 0.512 [SWCA 2011]), or 4.5 percent of the requested take limit in the draft HCP amendment. Currently, the proportion of total take that is attributable to indirect take is 4.0 percent. Assuming two adult Hawaiian goose equivalents are attributed to the Project as indirect take, the requested direct take under the draft HCP amendment would be 42 Hawaiian geese.

Based on the analysis described above and presented in Appendix 3, there is more than a 50 percent chance that the 80 percent UCL of cumulative take will not be exceeded during the permit term. Specifically, the median of the 80 percent UCL estimates falls below the requested direct take limit of 42 (Appendix 3). Therefore, the Project is unlikely to exceed the requested take limit under the HCP Amendment within the permit term. The draft HCP Amendment addresses the likely exceedance of the currently authorized take limit in the approved HCP through the identification of additional avoidance and minimization measures, as well as compensatory mitigation for the Hawaiian goose.

7.2 Hawaiian Hoary Bat

7.2.1 Estimated Take

A total of four Hawaiian hoary bat fatalities have been observed at the Project since operations began in July 2012. Fatalities were detected in FY 2013 (1), FY 2014 (2) and FY 2019 (1; Appendix 1). Surveyors documented one Hawaiian hoary bat fatality in FY 2019, on October 3, 2018. This fatality was outside of a routine search and was found outside the 70-meter fatality search plot at WTG 14; therefore, it was categorized as incidental. This bat carcass was transferred to the U.S. Geological Survey for genetic testing on November 28, 2018.

The estimated direct take (ODT + UDT) for the four Hawaiian hoary bat fatalities found between the start of operation (November 2, 2012) and end of FY 2019 (June 30, 2018) is less than or equal to 12 bats (80 percent UCL). Because one of the four observed bat fatalities was found outside of the search areas (i.e., was an incidental observation), three fatalities were used in the analysis, and the one incidental observation detected in FY 2019 is accounted for in the estimated value of UDT.

Indirect take is estimated to account for the potential loss of individuals that may occur indirectly as the result of the loss of an adult female through direct take during the period that females may be pregnant or supporting dependent young. Indirect take for the Project is calculated using the October 2016 USFWS guidance as follows:

- The average number of pups attributed to a female that survive to weaning is assumed to be 1.8.
- The sex ratio of bats taken through UDT is assumed to be 50 percent female, unless there is substantial evidence (10 or more bats) to indicate a different sex ratio.
- The assessment of indirect take to a modeled UDT accounts for the fact that it is not known when the unobserved fatality may have occurred. The period of time from pregnancy to end of pup dependency for any individual bat is estimated to be 3 months. Thus, the probability of taking a female bat that is pregnant or has dependent young is 25 percent.
- The conversion of juveniles to adults is one juvenile to 0.3 adults.

Based on the USFWS methodology (2016), the estimate of cumulative indirect take in FY 2019 is calculated as:

- **Total juvenile take calculated from observed female take (April 1 – September 15)**
    - 0 (observed females) * 1.8 (pups per female) = 0 juveniles
- **Total juvenile take calculated from observed unknown sex take (April 1 – September 15)**
    - 0 (observed unknown sex) * 0.5 (assumed sex ratio) * 1.8 (pups per female) = 0 juveniles
- **Total juvenile take calculated from unobserved take**
    - 8 (unobserved direct take) * 0.5 (assumed sex ratio) * 0.25 (proportion of calendar year females could be pregnant or have dependent pups) * 1.8 (pups per female) = 1.8 juveniles
- **Total Calculated Juvenile Indirect Take** = 1.8 (0 + 0+ 1.8)
- **Total Adult Equivalent Indirect Take =** 0.3 (juvenile to adult conversion factor) * 1.8 = 0.54

Therefore, the estimated indirect take based on the UCL of Hawaiian hoary bat direct take at the Project is 1 adult (rounded up from 0.54).

The UCL for Project take of the Hawaiian hoary bat at the 80 percent credibility level is 13 adult bats (12 estimated direct take + 1 estimated indirect take). That is, there is an approximately 80 percent probability that actual take at the Project at the end of FY 2019 is less than or equal to 13. The draft HCP Amendment addresses the exceedance of the currently authorized bat take limit in the approved HCP through the identification of additional avoidance and minimization measures, as well as additional compensatory mitigation for the Hawaiian hoary bat.

7.2.2 Projected Take

TerraForm projected take through the end of the permit term using the fatality monitoring data collected through FY 2019 to evaluate the potential for the Project to exceed the requested (under the draft HCP amendment) take limit at the 80 percent UCL prior to the end of the permit term (Appendix 3). Low wind speed curtailment (LWSC) has been implemented and adaptively managed at the Project over time. Increases in the period of implementation and cut-in speed has not yielded specific additional benefits that can be attributed to these measures. Therefore, the proportion of risk in the model was not adjusted for any additional benefit; it is assumed (for the purposes of this projection) that a similar LWSC approach, at least as effective at reducing risk as what has already been implemented, will remain in place for the remainder of the Project's permit term. As future indirect take is unknown and will potentially vary based on the timing of ODT, we assumed total indirect take for the Project over the permit term would be a maximum of five adult equivalents (16 juveniles based on assumed Hawaiian hoary bat survival rates [USFWS 2016]), or 13.2 percent of the requested take). Currently, the proportion of total take that is attributable to indirect take is 4.3 percent, making the assumption of the indirect take of five bats upwardly conservative. Assuming

five adult bat equivalents are attributed to the Project as indirect take, the requested direct take under the draft HCP amendment would be 33 bats.

Based on the analysis described above and presented in Appendix 3, there is greater than a 50 percent chance that the 80 percent UCL of cumulative take will not be exceeded during the permit term under the proposed HCP amendment. Specifically, the median of projected mortality estimates falls below the requested direct take limit of 33 bats (Appendix 3). Furthermore, the probability of permit exceedance at the Project may be overestimated given that estimates of the benefit of LWSC are conservatively low, based on unaccounted for changes to the LWSC implementation over time and estimates of the reduction in fatalities on bats from large studies at industrial scale wind projects in North America (Arnett et al. 2011, Good et al. 2011, Hein et al. 2014). Also, results from on-going research on bat deterrents and LWSC are likely to provide improvements to avoidance and minimization measures in the next few years. Therefore, between the conservative assumptions used in this analysis, the inherent uncertainty in projecting future outcomes, and the likely improvement in the ability to reduce risk to bats, the Project is likely to remain below the take limit requested in the HCP amendment for the permit term.

7.3 Non-listed Species

Six bird fatalities representing 5 species were documented at WTGs at the Project site in FY 2019. Three of the species observed in FY 2019 are protected by the Migratory Bird Treaty Act: white-tailed tropicbird (one bird; *Phaethon lepturus*), great frigatebird (one bird; *Fregata minor*), and house finch (one bird; *Haemorhous mexicanus*). In addition, three fatalities of non-native introduced birds without Migratory Bird Treaty Act protection were documented: Gray Francolin (one bird; *Francolinus pondicerianus*), and black francolin (two birds; *Francolinus francolinus*). For a complete list of fatalities for FY 2019 see Appendix 4.

8.0 Wildlife Education and Observation Program

The wildlife education and observation program (WEOP) helps to ensure the safety and well-being of native wildlife in work areas and along site access roadways. The training provides useful information to assist staff, contractors, and visitors to be able to conduct their business in a manner consistent with the requirements of the HCP, the Conditional Use Permit, land use agreements and applicable laws. Personnel are trained to identify Covered Species and other species of wildlife that may be found on-site and what protocol to follow, as determined in the HCP, when downed wildlife is found. The trainees are also made aware of driving conditions and receive instruction on how to drive and act around wildlife. Records of wildlife observations by WEOP-trained staff are also used by the HCP program to identify the patterns of wildlife use of the site.

No WEOP trainings were provided in 2019, but WEOP trainings will continue to be conducted on an as-needed basis to provide on-site personnel with the information they need to be able to respond appropriately in the event they observe a covered species or encounter a fatality while on-site.

9.0 Mitigation

The Project's mitigation requirements are described in Section 6.0 of the approved HCP.

9.1 Hawaiian Goose – Maui Predator Control

Two years of funding was provided by the Project to DOFAW in FY 2017 to begin predator control at locations with high Hawaiian goose activity and/or nesting on Maui. Increases in fledgling survival rates resulting from implementing predator control, vegetation management and fence maintenance will determine the net benefit provided by the Project-funded mitigation actions. DOFAW began mitigation activities in March 2017. No goslings successfully fledged in FY 2017. In FY 2018, DOFAW decided to focus only on the existing Pi'iholo Ranch Hawaiian goose release pen. During FY 2018 five Hawaiian goose fledglings were successfully produced. During FY 2019, DOFAW documented Hawaiian goose reproduction at both the Pi'iholo Ranch and Haleakalā Ranch pens, but Hawaiian goose fledgling production attributable to the Project in FY 2019 has not yet been determined. Overall production at the Pi'iholo Ranch and Haleakalā Ranch pens are reported in the state Hawaiian goose release pens Safe Harbor Agreements FY 2019 report (Appendix 5). Credit attributable to Project-funded Hawaiian goose mitigation actions in FY 2019 will be provided in the FY 2020 HCP annual report.

In FY 2019, TerraForm met with USFWS and DOFAW to better understand the past management of the Hawaiian goose release pen, improve accountability, and identify an approach to allow TerraForm to meet its mitigation obligations for the Hawaiian goose. These discussions will continue in FY 2020, and TerraForm intends to have resolution on a path forward during FY 2020.

9.2 Hawaiian Hoary Bats

Mitigation for Tier 1 and Tier 2 estimated bat take has been completely funded and is ongoing as habitat management at Kahikinui State Forest Reserve. Mitigation for Tier 3 estimated take (34 bats) has been contracted to the U.S. Geological Survey Hawaiian hoary bat research group. Bat ecological research on Hawai'i Island began in FY 2018 Q1 and is intended to better inform future bat habitat restoration and conservation. The Project's Tier 3 funding obligation will be completed by the end of 2021. Assuming the current take rate and search conditions are similar to future results, Tier 4 take mitigation will not be necessary. An annual report on the U.S. Geological Survey's Hawaiian hoary bat ecological research study is provided (Appendix 6).

Acoustic monitoring of bat activity has been performed at the Project since 2012, but changes in technology used for monitoring over that time period limit the comparability of earlier data to current data. Therefore, FY 2019 data can be directly comparable to historical data from October 2013 onward. Eight Wildlife Acoustics SM2BAT+ ultrasonic bat detectors with one SMX-U1 microphone (mic) each have been used since October 2013 to acoustically monitor bat activity. The objective of the monitoring is to better understand variations in bat activity specifically near the ground close to the WTGs. The detector microphones are mounted at 6.5 meters' height. Six detectors are placed close to the WTGs while two are placed further away from WTGs near a gulch

edge (near WTG 3 and 14; Figure 1). Each microphone is positioned horizontally, pointing SW (away from the prevailing NE trade winds). Prior to October 2013, Titley Anabat detectors had been deployed around the site near WTGs since 2012 (KWP II 2012). Information gained from this monitoring program provides data in support of the broader research goals for the Hawaiian hoary bat.

In FY 2019, Hawaiian hoary bats were detected on 211 of 2,550 detector-nights (8.3 percent of detector-nights) at the eight WTGs (Table 1). This represents a slight increase from FY 2018, which documented detections on 7.7 percent of detector-nights.

Temporal patterns of ground-based detection rates in FY 2019 (Figure 2) were relatively similar to previous years, with elevated activity levels in the post-lactation period (roughly September through November) compared to the remainder of the year (Figure 3). Spatially, the bat activity was fairly uniformly distributed across WTGs with six of the eight detectors recording annual detection rates between 0.08 and 0.12 (Table 1).

Table 1. Hawaiian Hoary Bats at each Turbine Location Sampled Between July 2018 and June 2019 (FY 2019)

WTG	No. of Nights Sampled	No. Nights with Detections	Proportion of Nights with Detection(s)
1	298	26	0.09
2	356	37	0.10
3	356	42	0.12
5	363	32	0.09
9	284	18	0.06
11	191	23	0.12
13	346	26	0.08
14	356	7	0.02
Total	**2,550**	**211**	**0.083**

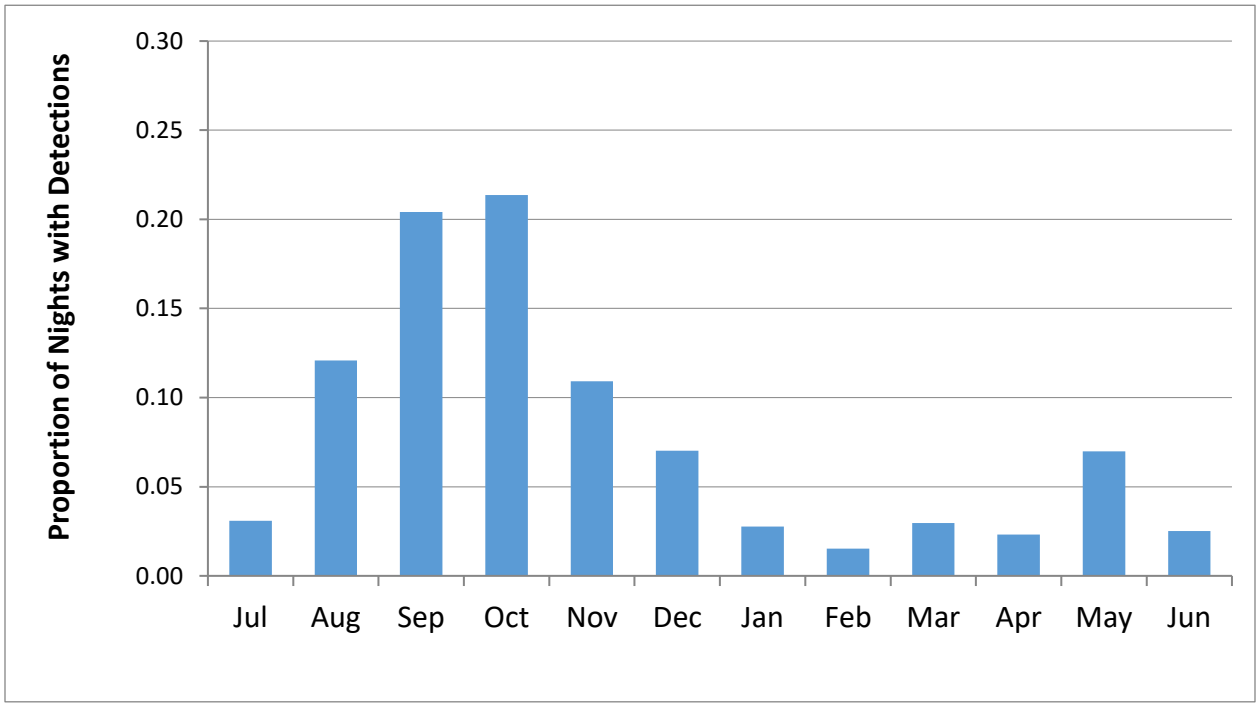

Figure 2. Bat Acoustic Activity at Eight Detectors Sampled during FY 2019

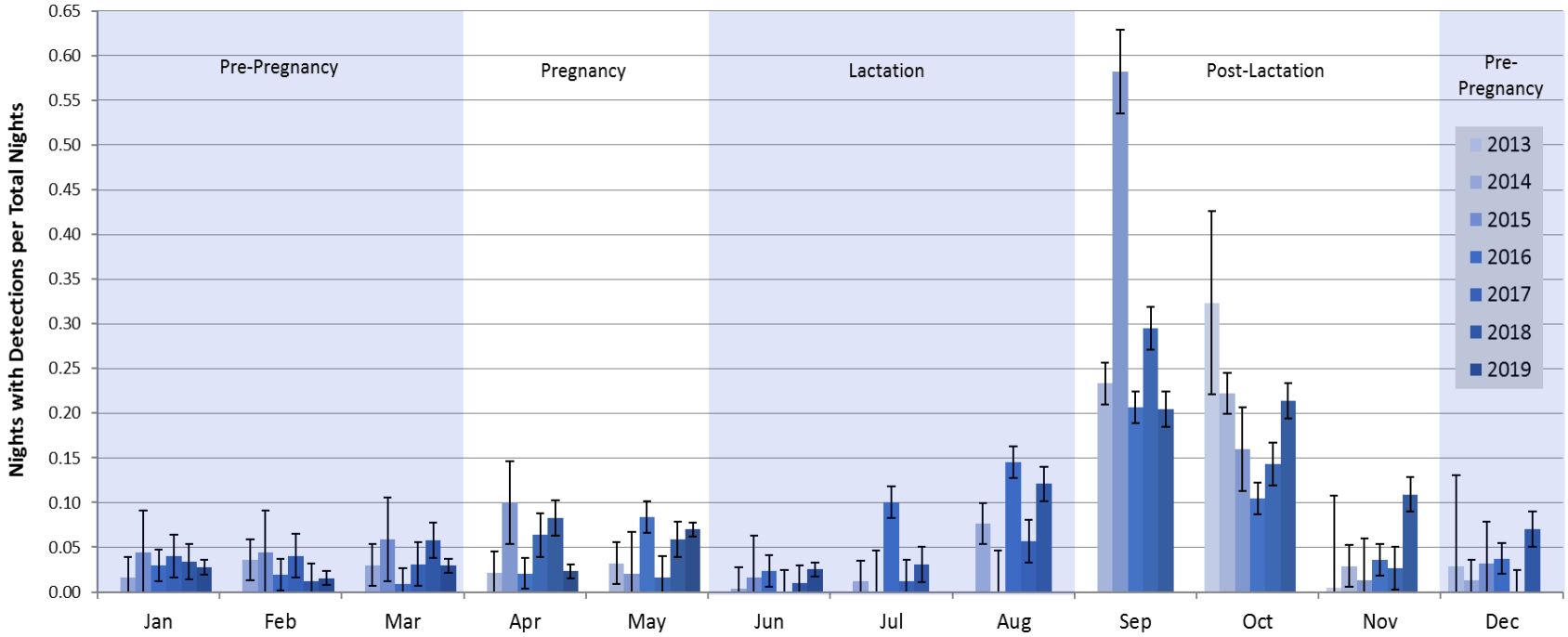

Figure 3. Bat Acoustic Activity with Standard Error Across Reproductive Periods at Eight Detectors for FY 2013 through FY 2019

9.3 Seabirds

TerraForm is committed to seabird protection and recovery on Maui Nui. Although results at Makamaka'ole have suggested the potential for the site to support some reproduction of Newell's shearwaters, the Project is not fulfilling the Project's mitigation needs. Therefore, it is the intent of TerraForm to work with DOFAW, USFWS, and seabird experts, to identify suitable alternatives to the Project's ongoing mitigation efforts at Makamaka'ole.

9.3.1 Hawaiian Petrel and Newell's Shearwater - Makamaka'ole

Mitigation efforts at the Makamaka'ole Seabird Mitigation Site (Makamaka'ole; Figure 4) have been ongoing since construction of the two enclosures was completed on September 5, 2013. Mitigation efforts at Makamaka'ole involve predator monitoring and trapping, artificial burrow checks and monitoring using game cameras, seabird social attraction using decoys and sound systems, and ongoing maintenance of both enclosures. Breeding has not been confirmed for Hawaiian petrels. Breeding is suspected for Newell's shearwaters (eggs and fragments of eggs present at burrows visited by Newell's Shearwaters during the 2017 and 2018 breeding seasons), but no fledglings have been confirmed to date. An annual report will be available and provided in mid-August (Appendix 7).

Currently, mitigation efforts at Makamaka'ole are under contract with H.T. Harvey and Associates. Monitoring checklists recorded via IForm have been created to ensure consistent oversight. These checklists include sound system battery checks, game camera operation and data download, burrow checks for erosion damage, signs of bird activity (visual, scent, and game camera) and ongoing perimeter checks of fences and culverts.

9.3.1.1 Predator Monitoring and Trapping

A total of 82 traps were deployed at Makamaka'ole in FY 2019 (Figure 4). A total of 57 mongooses, 50 rats and 5 mice were captured in FY 2019 (Table 2). All of the mongooses were captured outside the enclosures.

Table 2. Makamaka'ole trapping results for FY 2019

Trap Location	Trap Type	Quantity Deployed	Number Caught
Outside A	Cage	1	0
	Victor Rat Snap	13	26 rats, 1 mongoose
	DOC 200 Body Grip	13	2 rats, 31 mongooses
Inside A	Cage	1	0
	Victor Rat Snap	10	4 rats, 5 mice
	DOC 200 Body Grip	4	0
Outside B	Cage	1	0
	Victor Rat Snap	10	12 rats
	DOC 200 Body Grip	13	2 rats, 25 mongooses

Trap Location	Trap Type	Quantity Deployed	Number Caught
Inside B	Cage	1	0
	Victor Rat Snap	10	3 rats
	DOC 200 Body Grip	5	1 rat

To assess the presence or absence of small mammal activity inside each enclosure, ten tracking tunnels inside each enclosure were inked and baited in August, October, March, and June. Since January 24, 2014 no mongoose have been detected or trapped inside either enclosure. On January 7, 2015, the protocol was approved to continue using Diphacinone bait blocks (KWP II 2015). Twenty-five and 22 bait stations using Diphacinone bait blocks are currently deployed inside enclosure A and enclosure B, respectively. Bait stations within both enclosures continue to be checked biweekly, and re-baited as needed.

Barn owls also pose a predation threat to seabirds. TerraForm continues to renew its USFWS depredation permit (MB 19697C-0) and has obtained a DOFAW wildlife control permit to continue barn owl control. Control work for the 2019 calendar year has been contracted to H.T. Harvey and Associates. To understand the magnitude of the threat presented by barn owls in the area Barn owl (*Tyto alba*), 25 surveys were conducted in FY 2019. Two owls were confirmed hit with shotgun loads, however removal was unconfirmed.

9.3.1.2 Burrow Monitoring

Three species of seabirds, Hawaiian petrel, Newell's Shearwater, and Bulwer's petrel or 'ou (*Bulweria bulwerii*), have frequented burrows within both enclosures between the months of March and October since June 22, 2015. Cameras have been in place at 11 nest boxes known to be visited. Only Newell's Shearwater and Bulwer's petrel nesting activity has been observed during the 2019 breeding season to date; no Hawaiian petrels have been observed in either enclosure. Out of the 100 total nest boxes (50 in each enclosure), there are currently 11 active nest boxes; eight in enclosure A, and three in enclosure B. June 2019 has shown a significant increase in overall activity of birds, mostly Newell's shearwaters, within the enclosures. Two birds have been seen at B22, A25, A26, and A48. Behaviors being exhibited indicate that birds are engaged in a combination of territoriality, pair establishment, and breeding (Appendix 7).

Searches have been conducted regularly for active nests and signs of burrowing and prospecting by both Newell's shearwaters and Hawaiian petrels inside and outside of both enclosures. No burrows or signs of active prospecting outside of the enclosures, and no indications of nesting activity has been observed during infrared night surveillance of both sides of the fenced terrain. Additionally, searches within 10 meters of the fence line have not yielded any active nesting burrows of any seabird species.

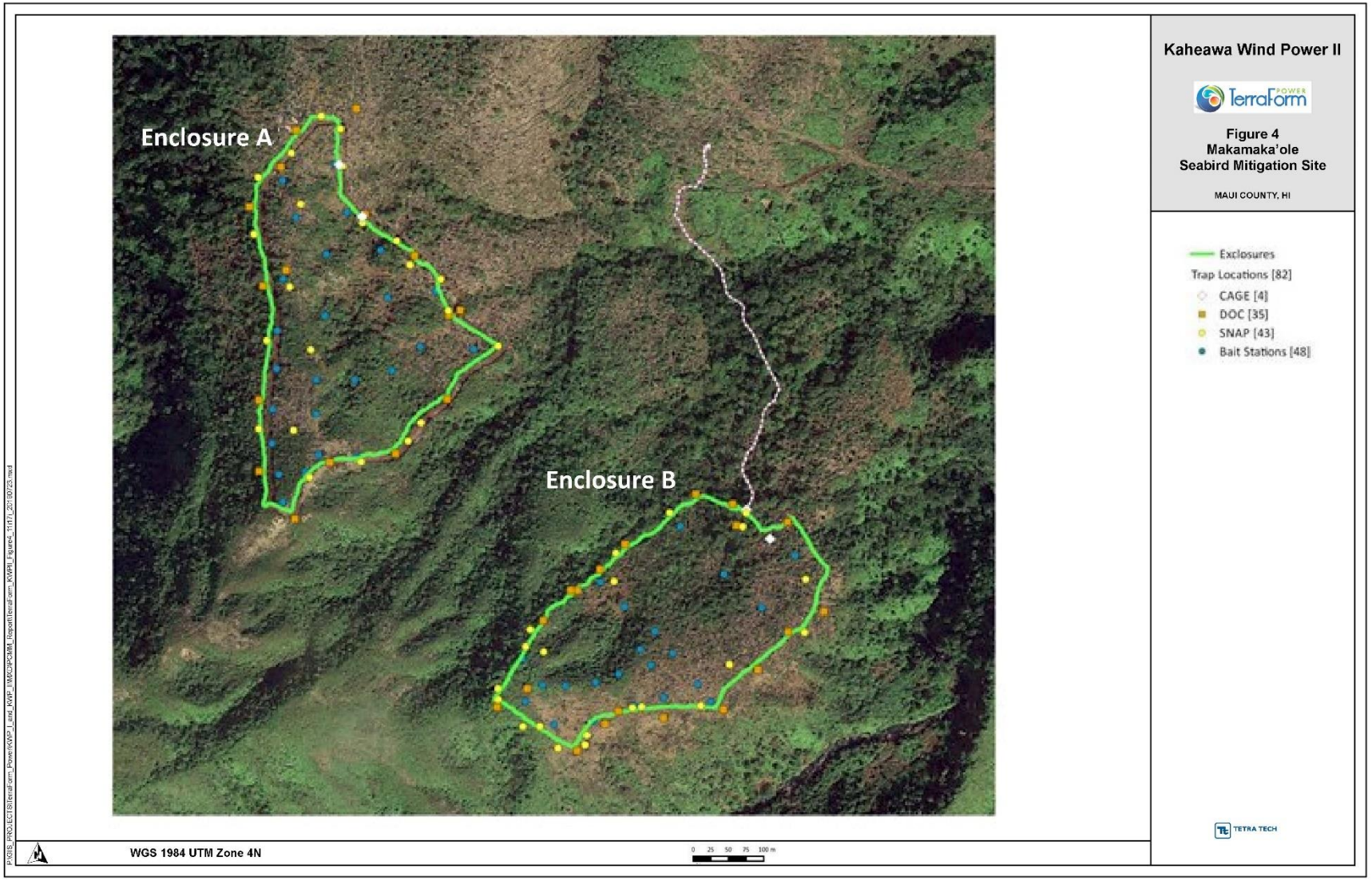

Figure 4. Makamaka'ole Seabird Mitigation Site

9.3.1.3 Seabird Acoustic Attraction

Three sound playback systems are currently in use at Makamaka'ole. Two are deployed in enclosure A and one in enclosure B. Acoustic attraction systems broadcast social calls year-round at night. Newell's shearwater calls are broadcast only in enclosure A, and Hawaiian petrel calls are broadcast only in enclosure B. Periodic night surveys to monitor bird activity in the area and ensure the sound systems are working correctly are ongoing. Observations suggest that the Newell's shearwaters attracted to the sites are selecting nest boxes that are closest to the source of the broadcast (distance, proximity, and direction to the speakers).

9.3.1.4 Vegetation and Erosion Management

Erosion inside and outside of enclosures continues to be monitored closely. Specially fabricated hydrologic flumes are attached to the outflow sections of two culverts at enclosure A. The flumes direct water away from the enclosure, preventing erosion directly outside of the culvert tube and at the fence line. 'Uki (*Machaerina augustifolia*), propagated by Maui Native Nursery were planted around the approved irrigation ditches dug in December 2017 to stabilize soil in the disturbed areas. As specified by the NARS permit, regular herbiciding and weeding without motorized tools occurred each quarter. Target species for removal were *Clidemia hirta*, *Tibouchina* spp., *Melinus minutiflora* and *Psidium spp.*

9.3.2 Newell's Shearwater Survey – East Maui

Surveys of East Maui for potential additional mitigation sites was funded and completed in September 2015 (KWP II 2016). These surveys evaluated potential colony locations, estimated the numbers of birds present, assessed predator activity, and provided for management feasibility assessment.

10.0 Adaptive Management

In accordance with the Project HCP, LWSC up to wind speeds of 5 meters per second was initially implemented at all WTGs when operations began and was scheduled for the months of April through November. LWSC is expected to reduce bat take as explained in the Project HCP. This curtailment period was extended to begin mid-February and continue through December 15, 2014 in response to bat fatalities documented at the Project on March 13, 2013 and February 26, 2014, and at the Kaheawa Wind Pastures I Project on December 14, 2013. On June 6, 2014 the Project offered an adaptive management proposal to the USFWS and DOFAW to increase take minimization for bats and on July 29, 2014 the LWSC was raised to 5.5 m/s between February 15 and December 15 from sunset to sunrise. The Project continues site-wide bat activity assessment after the required initial three-year period.

11.0 Agency Meetings, Consultations, and Visits

TerraForm communicated actively with USFWS and DOFAW throughout FY 2019 through in-person meetings, conference calls, submittal of quarterly reports, and e-mail communications related to the Project's HCP. The purpose of these communications varied, and included required semi-annual meetings, discussions regarding the HCP Amendment, mitigation funding, and potential adjustments to the Hawaiian goose and seabird mitigation strategies. A summary of agency coordination follows:

- Monthly calls and several in-person meetings for the Programmatic Environmental Impact Statement associated with the HCP Amendment
- October 2018—Submittal of FY 2019 Q1 report
- October 5, 2018—Semi-annual, in-person meeting with DOFAW, USFWS, and TerraForm regarding Project mitigation for the Hawaiian goose and seabirds
- December 2018—e-mail communication among DOFAW, USFWS, and TerraForm regarding status of funding and success for on-going mitigation efforts for the Hawaiian goose, Hawaiian hoary bat, and seabirds
- January 2019—Submittal of FY 2019 Q2 report
- February 2019—e-mail communication between USFWS and TerraForm regarding mitigation funding and bat research as mitigation
- March 7, 2019—TerraForm presented findings from FY 2018 HCP annual report to the ESRC
- April 2019—Submittal of FY 2019 Q3 report

12.0 Expenditures

Total HCP-related expenditures for the Project in FY 2019 were $537,600 (Table 3).

Table 3. HCP-related Expenditures at the Project in FY 2019

Category	Amount
Permit Compliance	$25,000
Fatality Monitoring	$35,000
Equipment and Supplies	$5,000
Staff Labor	$40,000
Makamakaʻole Mitigation Project	$76,000
Tier 2/3 Bat Research Projects	$356,600
Total Cost for FY 2019	**$537,600**

13.0 Literature Cited

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APPENDIX 1. DALTHORP ET AL. (2017) FATALITY ESTIMATION FOR HAWAIIAN GOOSE AND HAWAIIAN HOARY BAT AT PROJECT THROUGH FY 2019

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Appendix 1a. Dalthorp et al. (2017) Fatality Estimation for Hawaiian goose at Project through FY 2019

Modelling parameter		Modelling Period						
		1	2	3	4	5	6	7
FY		2013	2014	2015	2016	2017	2018	2019
Date Range	Begin	7/1/2012	7/1/2013	7/1/2014	7/1/2015	7/1/2016	7/1/2017	7/1/2018
	End	6/30/2013	6/30/2014	6/30/2015	6/30/2016	6/30/2017	6/30/2018	6/30/2019
Period length (days)		364	364	364	365	364	364	364
% of Year		1	1	1	1	1	1	1
Search Interval (days)		7	7	7	7	7	7	7
Number of Searches in Modelling period		52	52	52	52	52	52	52
Observed fatality (X)		1	0	2	1	0	1	0
K		1	1	1	1	1	1	11
DWA		0.7	0.7	0.7	0.3721	0.3721	0.3721	0.3721
g	g	0.654	0.653	0.681	0.358	0.361	0.36	0.361
	min	0.503	0.474	0.583	0.288	0.294	0.285	0.29
	max	0.791	0.812	0.771	0.431	0.43	0.437	0.43
B	Ba	26.321	18.936	62.805	61.664	68.055	54.621	70.09
	Bb	13.906	10.05	29.462	110.49	120.659	97.27	124.2
M*[2]		3	3	6	9	10	13	13

1. Search area reduced to cleared portions of 70 m radius from turbine

2. Cumulative value representing estimate of total direct take from the start of operations through the identified monitoring period at the 80 percent UCL.

Appendix 1b. Dalthorp et al. (2017) Fatality Estimation for Hawaiian hoary bat at Project through FY 2019

Modelling Parameter		Modelling Period						
		1	**2**	**3**	**4**	**5**	**6**	**7**
FY		2013	2014	2015	2016	2017	2018	2019
LWSC		5.0 m/s	5.0 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s
Date Range	**Begin**	7/1/2012	7/1/2013	7/1/2014	7/1/2015	7/1/2016	7/1/2017	7/1/2018
	End	6/30/2013	6/30/2014	6/30/2015	6/30/2016	6/30/2017	6/30/2018	7/1/2019
Period length		364	364	364	365	364	364	364
% of Year		1	1	1	1	1	1	1
Search Interval (days)		7	7	7	7	7	7	7
Number of Searches in Modelling period		52	52	52	52	52	52	52
Observed fatality (X)		1	2	0	0	0	0	0
K		0.7	0.7	0.7	1[1]	1[1]	1[1]	1[1]
DWA		1	1	1	0.559*	0.559*	0.559*	0.559
g	**g**	0.4	0.4	0.3	0.362	0.442	0.375	0.3675
	min	0.241	0.235	0.187	0.27	0.374	0.287	0.289
	max	0.656	0.493	0.504	0.46	0.511	0.467	0.45
B	**Ba**	9.08	18.503	10.953	35.087	87.96	41.223	50.35
	Bb	11.412	33.022	21.675	61.842	111.122	68.772	89.64
M*[3]		5	12	12	12	11	12	12

1. Searches performed by canine teams.

2. Search area reduced to cleared portions of 70 m radius from turbine

3. Cumulative value representing estimate of total direct take from the start of operations through the identified monitoring period at the 80 percent UCL.

APPENDIX 2. LOST PRODUCTIVITY AND INDIRECT TAKE FOR HAWAIIAN GOOSE AT THE PROJECT IN FY 2019

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Parameter	Description	Fiscal Year							
		2013	2014	2015	2016	2017	2018	2019[1]	Total
A	Observed Take	1	0	2	1	0	5	1	10
B	Estimated Take Multiplier (14/10=1.40)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
C	Estimated Direct Take (A x B)	1.40	0.00	2.80	1.40	0.00	7.00	1.40	14.00
D	Observed Indirect Take Multiplier (Season Defined)	0.04	0.00	0.09	0.09	0.00	0.09	0.09	--
E	Observed Indirect Take (A x D)	0.04	0.00	0.18	0.09	0.00	0.45	0.09	0.85
F	Unobserved Direct Take (C - A)	0.40	0.00	0.80	0.40	0.00	2.00	0.40	4.00
G	Unobserved Indirect Take (F x 0.06)	0.02	0.00	0.05	0.02	0.00	0.12	0.02	0.24
H	Accrued Adult Take (Previous Year's Accrued C + H + K)	0.00	1.40	1.40	4.23	5.70	5.89	13.17	--
I	Lost Productivity from Accrued Adult Take (current year's H x 0.1) Fledglings	0.00	0.14	0.14	0.42	0.57	0.59	1.32	3.18
J	Indirect Take + Lost Productivity (E + G + I) Fledglings	0.06	0.14	0.37	0.54	0.57	1.16	1.43	
K	Indirect Take + Lost Productivity as Adult (3 year's previous J x 0.512 (annual survival rate is 0.8))				0.03	0.07	0.19	0.28	
L	Mitigation Fledglings Produced	0	0	0	0	0	5	0	5
M	Net Fledglings Remain (Current Year L - J))	-0.06	-0.14	-0.37	-0.54	-0.57	3.84	-1.43	--
N	Net Adults 3 Years Later (three year's previous M x 0.512)	0.00	0.00	0.00	-0.03	-0.07	-0.19	-0.28	--

1. Productivity information for FY 2019 is not yet available; values will be updated when data becomes available.

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APPENDIX 3. HAWAIIAN GOOSE AND HAWAIIAN HOARY BAT 20-YEAR PROJECTED TAKE AT THE PROJECT IN FY 2019

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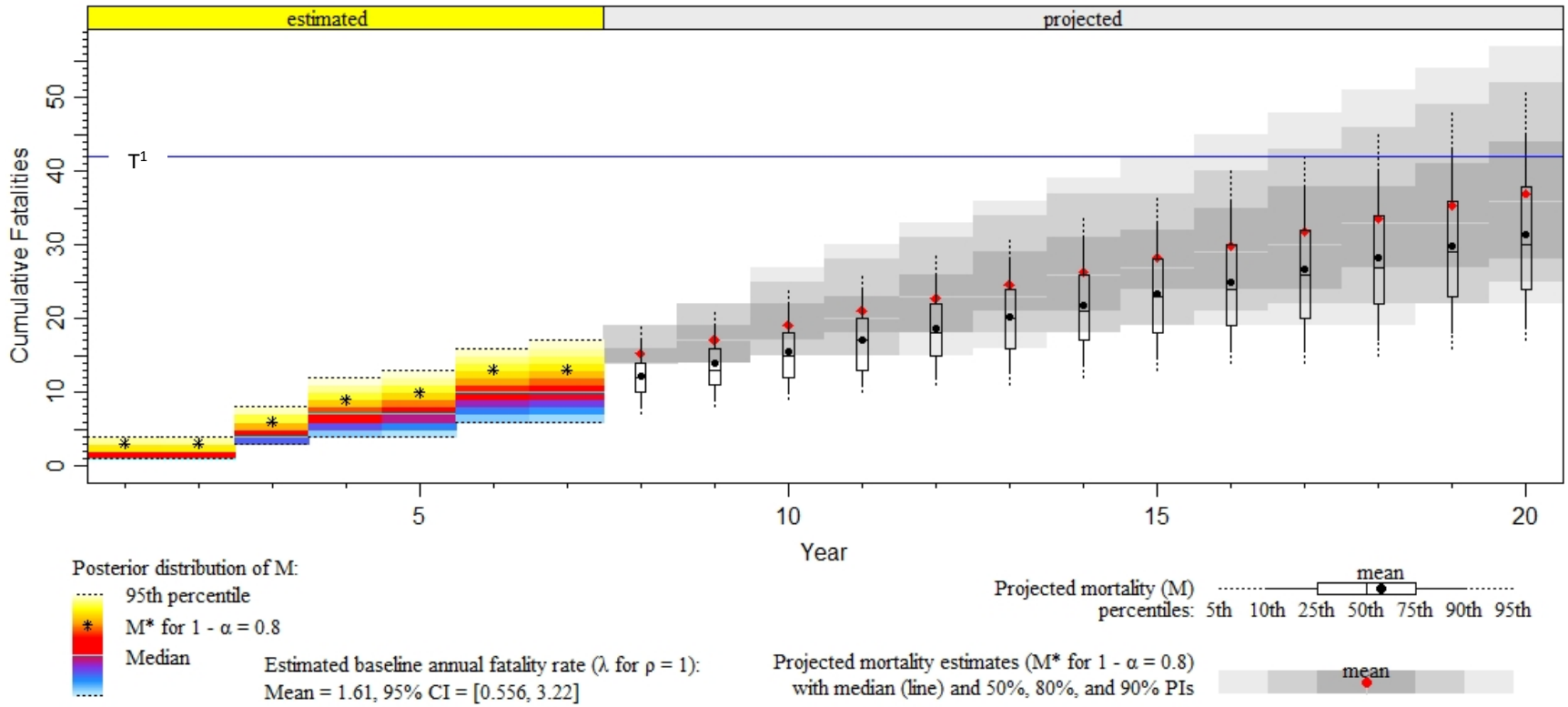
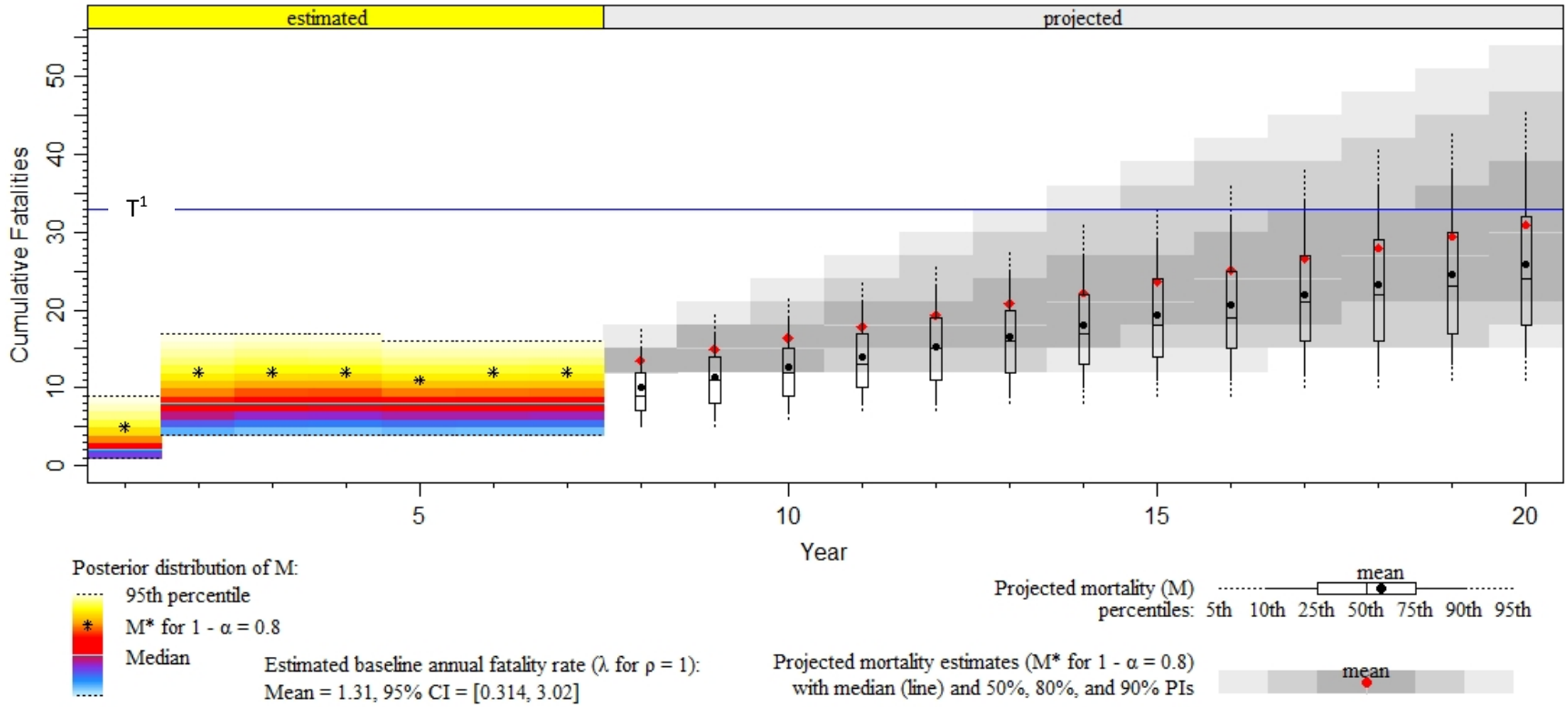
Appendix 3a. Cumulative mortality for the Hawaiian goose



[1] Permitted take for the Hawaiian goose at the Project is 30, with an increase to 44 under the proposed HCP Amendment currently in process; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 42 is shown, representing requested authorized Hawaiian goose take (44) minus 2 adult equivalents of indirect take (4.5 percent of the requested authorized limit). Currently, the proportion of total take that is attributable to indirect take is 4.0 percent.

Appendix 3b. Cumulative mortality for Hawaiian hoary bat



[1]Permitted take for the Hawaiian hoary bat at the Project is 11, with an increase to 38 under the proposed HCP Amendment currently in process. Take, however, as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 33 is shown, representing authorized bat take (38) minus 5 adult equivalents of indirect take (13.2 percent of the requested authorized limit). Currently, the proportion of total take that is attributable to indirect take is 4.3 percent.

APPENDIX 4. DOCUMENTED FATALITIES AT THE PROJECT DURING FY 2019

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Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
Fregata minor (Great Frigatebird)	9/25/2018	11	55	94
Lasiurus cinereus semotus (Hawaiian Hoary Bat)[1]	10/3/2018	14	77	153
Branta sandvicensis (Hawaiian Goose)[1]	1/16/2019	3	44	180
Francolinus pondicerianus (Gray Francolin)[2]	1/23/2019	8	1	30
Haemorhous mexicanus (House Finch)	2/20/2019	1	1	124
Phaethon lepturus (White-tailed Tropicbird)	5/1/2019	12	82	172
Francolinus francolinus (Black Francolin)[2]	5/8/2019	11	1	228
Francolinus francolinus (Black Francolin)[2]	5/15/2019	5	1	270

1. HCP Covered Species.
2. Species not protected by MBTA.

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APPENDIX 5. HAWAIIAN GOOSE RELEASE PENS SAFE HARBOR AGREEMENTS FY 2019 ANNUAL REPORT

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PU‘U O HOKU RANCH / PI‘IHOLO RANCH / HALEAKALĀ RANCH
SAFE HARBOR AGREEMENT
ANNUAL REPORT

JULY 1, 2018 – JUNE 30, 2019

MOLOKA‘I:

PU‘U O HOKU RANCH:

SIGHTINGS:
Weekly observations and monitoring were accomplished by state personnel throughout the year on Pu‘u O Hoku Ranch. This past year a total of twenty-six (26) banded birds and one (1) unbanded bird were sighted throughout the eastern section of Moloka‘i. Of the twenty-seven (27) birds, twenty-five (25) were recognized as Moloka‘i birds, one (1) was an original released bird, and one (1) was a previous bird that fledged before being banded. An island-wide nēnē survey was conducted on September 5, 2018, during which twenty-one (21) banded birds were recorded. Calculations from banded birds observed and recorded produced an estimated population of twenty-seven (27) birds at Pu‘u O Hoku Ranch.

NESTING:
Two (2) nests were located in the open-top release pen at Pu‘u O Hoku Ranch. Both nests were successful with each producing two (2) goslings resulting in four (4) birds fledging.

BANDING:
Four (4) goslings were successfully banded in the Pu‘u O Hoku Ranch open-top release pen before fledging.

PEN MAINTENANCE:
The fences and watering units were checked and maintained monthly. All wire on the corners of the iron roofing was replaced because of rotting. A new solar panel box was installed, and electrical clamps and wires were replaced. Waterlines and water troughs were checked weekly. Two (2) broken waterlines were replaced, and one (1) trough was changed.

HABITAT MANAGEMENT:
Five (5) acres of alien vegetation (Christmas berry, haole koa, and sour grass) was removed from the pen. Fifty-nine and a half (59.5) acres were mowed this year by DOFAW staff. Ranch personnel mowed an additional nine hundred (900) acres within the ranch. Additionally, six (6) acres along the fenceline was mowed and maintained.

TRAPPING:
Predator trapping using 16 live traps occurred monthly this year except for November when there were cattle in the pasture. A total of thirty-eight (38) mongoose and one (1) cat were removed through predator trapping.

DEATHS:
There were no deaths this season.

MAUI:

PI‘IHOLO RANCH:

SIGHTINGS:
Observations of banded and unbanded birds were recorded at Pi‘iholo Ranch to monitor movements, distribution, and survival of nēnē. This year thirty-seven (37) banded birds were sighted at the ranch. Thirty-four (34) were wild Maui nēnē and three (3) were from the original Olinda released birds. An island-wide annual nēnē survey was conducted on September 19, 2018. During this survey, eighteen (18) birds were seen at Pi‘iholo Ranch.

NESTING:
During nesting season, records were kept on mated pairs and the gravid levels of females found at the ranch. Nests found on the ranch were marked using GPS and checked weekly to determine their status. Nesting activities, nest outcomes, hatching, and fledgling success were recorded for the nesting season.

Seventeen (17) nests or nesting attempts were located within the Pi‘iholo Ranch open-top release pen this year. Seven (7) of these nests were successful. Fifteen (15) nēnē fledged from Pi‘iholo Ranch open-top release pen this season.

BANDING:
Staff attempted to band as many unringed nēnē as possible found at Pi‘iholo Ranch. Banding information is recorded and a database is kept for bird bands sighted at the ranch.

This year fourteen (14) nēnē were banded at the open-top release pen. This included thirteen (13) fledglings and one (1) adult. Two (2) birds fledged before being banded.

PEN MAINTENANCE:
The open-top pen’s fence line was continuously checked and maintained throughout the year. The fenceline was sprayed with herbicide for weed control and trees were trimmed along the exterior boundary. The pond was cleaned and flushed twice a month, and the automatic waters were cleaned and maintained weekly. The water shutoff valve was replaced after it was leaking.

HABITAT MANAGMENT:
Short grass habitat was maintained at the open-top release pen. The one (1) acre open-top pen was mowed once a week and the area around the outside of the pen was maintained as needed. A total of twenty-five and a half (25.5) acres was mowed this year to maintain nēnē short grass habitat. In addition, a quarter (0.25) acre of weeds was removed from the pen. One (1) pilo plant was planted inside the pen.

TRAPPING:
Predator traps are used to control rats, mongoose, feral cats, and dogs that may pose a threat to nēnē and their nesting sites. Year-round traplines were baited and checked at Pi‘iholo Ranch using 30 Tomahawk live traps, 30 Sherman traps, and 10 A24s.

This year at Pi‘iholo Ranch, forty-eight (48) mongoose, three (3) rats, and twelve (12) mice were removed through predator trapping. No avian predators were controlled this season on the ranch.

DEATHS:

The only nēnē deaths that occurred this season at Pi‘iholo Ranch were those of goslings due to failed/unsuccessful nests. A total of five (5) gosling deaths were attributed to abandonment and inclement weather factors.

HALEAKALĀ RANCH:

SIGHTINGS:
Haleakalā Ranch was continuously surveyed and birds observed were recorded. Forty-seven (47) banded birds were recorded this season at the pen. Of these, thirty-six (36) were wild Maui birds, one (1) was an original Olinda released bird, and ten (10) were translocated birds. During the September 2018 survey, twenty-five (25) nēnē where seen, which included twenty-two (22) banded birds and three (3) unbanded birds.

NESTING:
Seven (7) nests were found in the open-top release pens this season. Two (2) nests were successful this season. Two (2) goslings successfully fledged from each nest, producing a total of four (4) fledglings from Haleakalā Ranch open-top release pen.

BANDING:
Four (4) fledglings were banded at Haleakalā Ranch this year.

PEN MAINTENANCE:
The fenceline and electric fence were checked monthly and repaired as needed. A half (0.5) acre of fence line was sprayed with herbicide every three (3) months. The water unit was checked and maintained monthly.

HABITAT MANAGEMENT:
Twenty-six (26) acres were mowed in and around the pen to maintain short grass habitat. An additional seven and a quarter (7.25) acres of alien vegetation, including lantana, guava, Sacramento bur, abutilon, baconia, and glycine, was removed from the pen.

TRAPPING:
Predator trapping occurs year-round at Haleakalā Ranch open-top release pen. Thirty-four (34) Tomahawk live traps and seven (7) A24s traps are checked throughout each week. Two (2) mongoose, three (3) rats, and one (1) mouse were removed from the pen through predator trapping this year.

RELOCATIONS:
Three (3) nēnē were relocated to Haleakalā Ranch open-top release pen. All were injured birds that were captured, treated, and relocated to the pen. None of the birds bred at the pen.

DEATHS:
Four (4) nēnē died this year at the pen. This included three (3) adults and one (1) gosling. One (1) of the adults died from a wing injury. The other two (2) adults were found dead of unknown causes. The gosling was found dead tangled in the vegetation.

TABLES:

NĒNĒ NESTING SUMMARY FOR 2018 - 2019 BREEDING SEASON AT PU‘U O HOKU RANCH - MOLOKA‘I

Total Number of Nests Located in Open-top pen	=	2
Total Number of Nests Successful	=	2
Total Number of Nests Abandoned	=	0
Total Number of Nests Depredated	=	0
Total Number of Renests	=	0
Total Number of Known Eggs	=	5
Total Number of Eggs Salvaged	=	1
Total Number of Eggs Depredated	=	0
Total Number of Eggs Hatched	=	4
Total Number of Goslings	=	4
Total Number of Goslings Died Before Fledged	=	0
Number of Fledglings Fledged from Pen	=	4

NĒNĒ NESTING SUMMARY FOR 2018 – 2019 BREEDING SEASON AT PI‘IHOLO RANCH – MAUI

Total Number of Nests located in Open-top Pen	=	17
Total Number of Nests Successful	=	7
Total Number of Nests Abandoned	=	8
Total Number of Nests Depredated	=	1
Total Number of Nests Failed due to weather	=	1
Total Number of Renests	=	5

Total Number of Known Eggs	=	45
Total Number of Known Eggs Salvaged	=	22
Total Number of Eggs Destroyed Naturally	=	1
Total Number of Known Eggs Depredated	=	2
Total Number of Known Eggs Hatched	=	20

Total Number of Known Goslings	=	20
Total Number of Goslings Died from Weather	=	4
Total Number of Goslings Died from Abandonment	=	1

Number of Nēnē Fledged from Pi‘iholo pen = 15

NĒNĒ NESTING SUMMARY FOR 2018 – 2019 BREEDING SEASON AT HALEAKALĀ RANCH

Total Number of Nests Located in Open-top Pen	= 7
Total Number of Nests Successful	= 2
Total Number of Nests Abandoned	= 0
Total Number of Nests Depredated	= 3
Total Number of Nests Hatched but Unsuccessful	= 2
Total Number of Renests	= 3
Total Number of Known Eggs	= 18
Total Number of Known Eggs Depredated	= 7
Total Number of Eggs Salvaged	= 3
Total Number of Eggs Hatched	= 8
Total Number of Goslings	= 8
Total Number of Goslings Depredated	= 3
Total Number of Goslings Died in Vegetation	= 1
Number of Fledglings Fledged from Pen	= 4

APPENDIX 6. USGS HAWAIʻI ISLAND HAWAIIAN HOARY BAT ECOLOGICAL RESEARCH PROJECT ANNUAL REPORT

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Hawaiian Hoary Bat Conservation Biology: Movements, Roosting Behavior, and Diet

Summary Report of Research 2018-July 2019

Agreement # 17WSTAAZB005541

Prepared by:

Karen N. Courtot[1] and P. Marcos Goressen[2]

29 July 2019

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The Hawaiian Hoary Bat Conservation Biology project is designed to advance understanding of key aspects of endangered Hawaiian hoary bat (*Lasiurus cinereus semotus*) ecology and population biology. Key components of the study will include:

- Movements throughout the annual cycle
- Habitat use
- Roost fidelity and characterization
- Maternal roost ecology and mother-pup behavior
- Diet analysis using molecular techniques
- Insect prey selection and availability
- Insect prey-host plant associations
- Banking of tissue and fur collection for genetic and pesticide studies (outside scope of this study)

Study preparation and design

This USGS-led study is being conducted in collaboration with several researchers with the University of Hawaii at Hilo – Hawaii Cooperative Studies Unit.

Significant permitting and land access requirements were addressed during the initial phase of the project. State of Hawaii Department of Land and Natural Resources – Division of Forestry and Wildlife (HI DLNR-DOFAW) has granted permits for access and special use in several Forest Reserves and Natural Area Reserves and the Laupahoehoe Hawaii Experimental Tropical Forest. A native invertebrate collection permit has been granted by HI DLNR-DOFAW. Additionally, State and Federal permits for the capture, handling, and sampling of Hawaiian hoary bats have been renewed. The USDA Forest Service - Institute for Pacific Islands Forestry and the University of Hawaii College of Tropical Agriculture and Human Services have granted permission to station automated telemetry receiver stations on their properties. All permits will be renewed annually.

The study area spans much of the east side of Hawaii Island (Figure 1). Eight fixed sampling sites have been selected for regularly scheduled bat mist netting and insect collections; these sites will be sampled three times per year (approximately 4-month interval between visits). Four fixed sites are located at high elevation (above 1000 m asl) and four at low elevation (below 600 m asl). The fixed sample sites include native and exotic forests, orchards, pastures, and mixed habitats. Sampling cycles are divided by breeding cycle phase: non-reproductive (December-March), pregnancy/pupping (April-July), post-lactation/fledging (August-November). Additional bat mist netting efforts are conducted at a variety of sites that span a range of habitat types in east Hawaii.

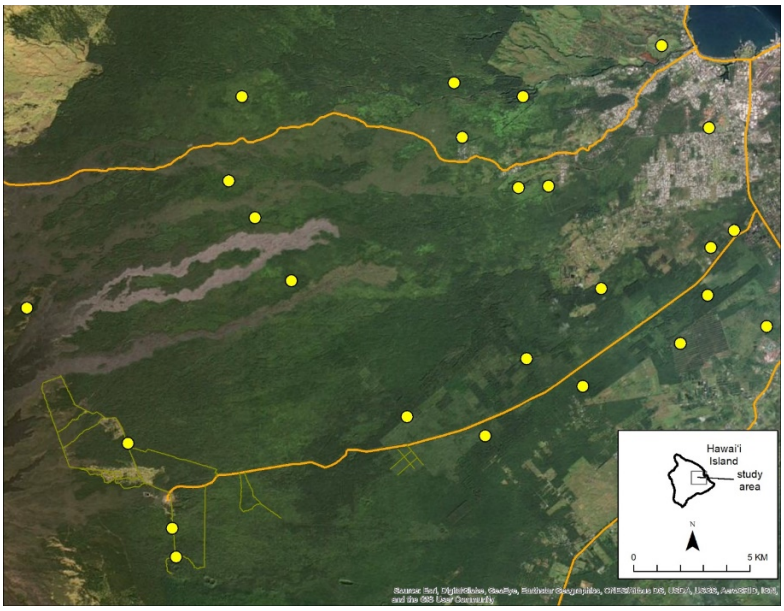

Figure 1. Mist nest sites in the Wailuku watershed of east Hawaii Island. For clarity, map excludes several net sites in the Laupahoehoe Natural Area Reserve (20 km to north).

Capture effort

Ninety-six nights of bat mist netting effort were conducted 14 May 2018 – 24 July 2019; bats were captured on thirty-four of these nights (Figure 2). Forty-five individuals were captured and from all individuals tissue and hair samples were collected and morphometric measurements and reproductive status recorded. All bats were marked with unique color-coded bands. Radio-telemetry tags were affixed to 41 individuals. Additionally, three individuals were captured twice, two of which were radio-tagged twice.

Figure 2. Mist nest set to capture Hawaiian hoary bats (left) and bat with color-coded wing band (right).

Movements

Study of Hawaiian hoary bat movements were limited in year one of the study; increased effort on this objective is planned through years two and three. A network of 20-30 ft masts with antennas and radio receivers (Figure 3) that will function as automated telemetry systems across a broad section of the Hilo watershed is undergoing testing. Technical issues with the effectiveness of radio receivers for this system have occurred. Extensive testing of receivers has occurred and continues. Full field trials will begin in August 2019. Five of the seven to eight stations have been installed (Figure 3). Once operational, the receiver systems should allow for a better understanding of the distances traveled and elevational migrations made by bats within a night and within the approximately two- to three-week period that a radio tag is active. Additional movement information is documented when possible, including site fidelity and seasonality of re-captured bats (*n* = 3) and the distance between capture and roost locations (see below).

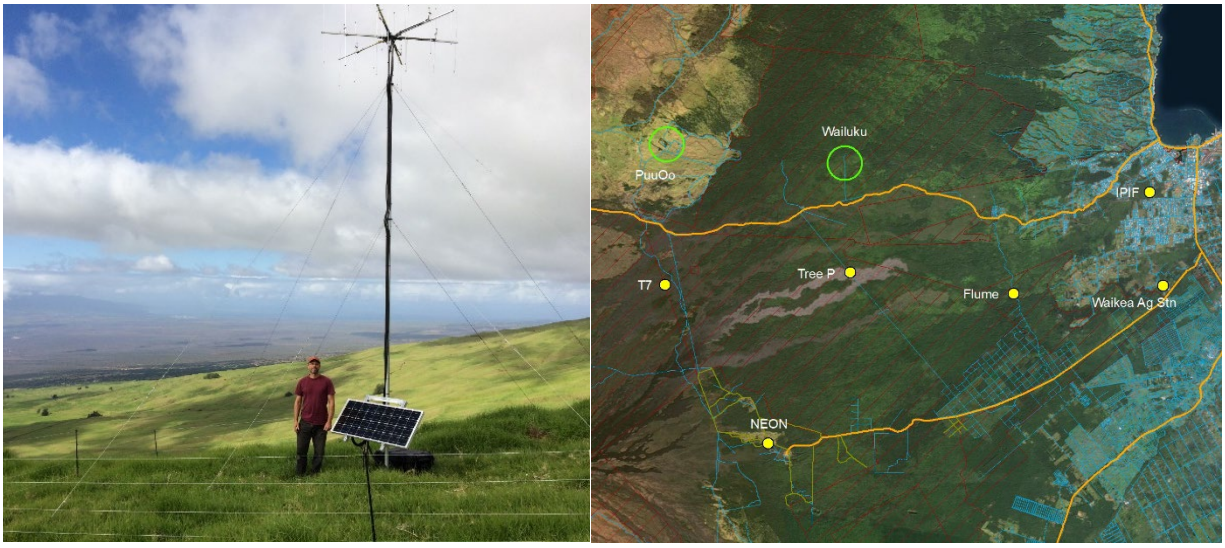

Figure 3. Automated telemetry system station (left). Map of locations of automated telemetry system stations (right), yellow dots are permitted and established stations, green circles are proposed additional locations.

Roost ecology

Roost ecology studies were a primary focus of field efforts during year one of the project. Once individuals are captured and radio-tagged, efforts to track the individual to a day roost tree commence within one day. Dense forest vegetation and a limited road network creates extremely difficult conditions for tracking individuals to their day roost resulting in significant effort devoted to this work. Radio telemetry (Figure 4) has been used to track 13 bats to a day roost tree, an additional 19 bats have been tracked to the forest stand of their day roost.

Roost trees are identified to species and characteristics are measured (e.g., height, dbh, percent canopy cover, etc.). To date, roost tree metrics have been collected at 11 trees. Stand-level characteristics (e.g., stand height, dominant tree, understory, etc.) will be derived from a combination of satellite and airborne imagery and ground measurements.

Where possible, roost fidelity of bats with active radio tags is monitored using an automated receiver station near the roost (Figure 4). Data from these systems have been collected and downloaded at four roosts since May 2019, when the system was first used. We expect data collection using this system to be more frequent in the coming year. The automated system is augmented by manual searches using thermal imaging scanners and binoculars (Figure 4) at known roost sites where bats are not radio-tagged (or no longer tagged).

Video monitoring of a maternal roost to assess behavior was conducted during the summer of 2018. Two known maternal roosts were monitored for returning females during April-July 2019 (ongoing). The first mother with pups was observed in late July; regular monitoring of this site will commence.

Figure 4. Radio telemetry effort to located day roost tree (left). Automated receiver station for measure roost fidelity (middle). Manual search for roosting bat at a historical roost site (right).

Diet studies

Studies of diet are focused on three primary lines of research: prey selection (comparison of availability with what is in fecal samples), seasonal and elevational comparisons, host-plant associations with diet species.

Insect collection commenced in February 2019. Nocturnal flying insects are collected using light traps (Figure 5) run at each fixed collection site concurrently with mist netting. Insect collection is conducted during two nights in each sampling cycle (i.e., 16 nights per cycle). Insects will be categorized by size class and identified to the highest possible taxonomic classification; this lab work is underway. Additionally, samples will be submitted for genetic meta-barcoding to establish a reference library of potential bat prey items.

To identify bat prey, genetic meta-barcoding of guano samples will be conducted, and a bioinformatics approach will be used to match bat prey items in with the reference library (above) and public databases (see Pinzari et al. 2019). To date, 28 guano samples have been collected. Lab work to begin analysis of these samples will commence in early 2020.

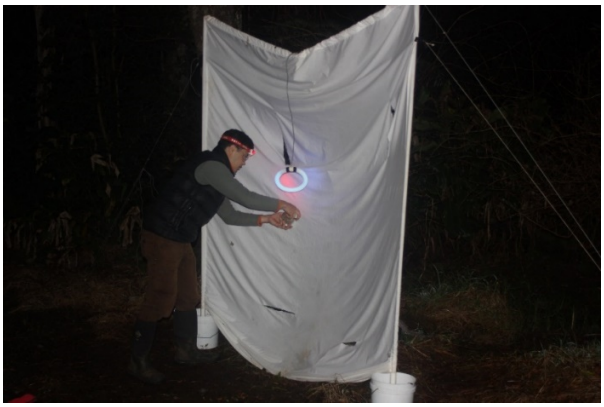

Figure 5. Insect collection using UV light trap.

Future research efforts

We plan to continue field work and data collection across east Hawaii through mid-year 2021 including regular efforts to capture, collect samples, and radio-tag bats. Tracking individuals to roost trees and data collection at roost trees will continue to be a focus of field efforts during 2020. Additionally, during 2020 we expect to increase efforts to track long-distance movements using the automated telemetry system supplemented with ground tracking. Diet studies including aerial nocturnal insect collection and fecal sample collection will also continue into 2020. Work to associate host plants with bat insect prey will commence during 2020. Fecal samples collected to date will be submitted for lab analysis in early 2020. Data analysis and report writing is planned for 2021.

APPENDIX 7. MAKAMAKA‘OLE SEABIRD MITIGATION AREA 2019 ANNUAL REPORT

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H. T. HARVEY & ASSOCIATES
Ecological Consultants

Makamaka'ole Seabird Mitigation Project
2019 Annual Report

Project No. 3978-02

August 15, 2019

To: **Lily Henning, Senior Manager, Environmental Affairs and Permitting, TerraForm Power**

From: **Gregory Spencer and David Ainley, H. T. Harvey & Associates**

Subject: **Makamaka'ole Seabird Mitigation Project, Kaheawa Wind Power I and IIz Habitat Conservation Plans: 2019 Annual Report**

Summary

The following report contains a summary of the work that H. T. Harvey & Associates has performed in continuance of the seabird mitigation initiatives set forth in the Kaheawa Wind Power I and II Habitat Conservation Plans (HCPs) and at the Makamaka'ole Seabird Mitigation Project area during the 2019 breeding season. Actions being implemented at Makamaka'ole are intended to partially satisfy mitigation obligations for the endangered Hawaiian petrel Pterodroma sandwichensis and threatened Newell's shearwater Puffinus newelli. Mitigation measures involve the establishment of viable colonies of these species, including predator exclusion fencing, removal and ongoing control of predators, and broadcasting attractive calls to facilitate recruitment and breeding at artificially constructed nesting burrows. Recorded calls are broadcast through weather-resistant horns (speakers) in an effort to attract birds to nest boxes that have been installed inside two protective fenced enclosures, each 4-5 acres in area. Predators are controlled inside and outside of each using a combination of bait stations containing diphacinone targeting rodents and specially designed traps that target rats and mongoose. Attention is paid to owls and control measures have been ramping up since July.

In its sixth year, Makamaka'ole has demonstrated the capacity to provide favorable conditions for recruitment and nest site establishment by Newell's shearwaters. The project site has also attracted at least one individual, or pair, of dark petrels believed to be Bulwer's petrel *Bulweria bulwerii*. Hawaiian petrels have not been documented landing, prospecting, or attempting to establish nest sites at the mitigation area since 2017. In anticipation of seabird site use during the 2019 breeding season, we conducted pre-season field site assessments, nesting box inspections and preparations, fence inspections, inventory and provisioning of project components such as traps and bait-stations, evaluated performance of the audio playback system, and produced new and enhanced call playback sequences in an effort to achieve more effective representations of both species. Once

birds began arriving and visiting nest sites, we installed high performance game cameras and managed habitat in the vicinity of burrows and active burrow clusters.

Work Performed

Mitigation Site Inspections and Nest Box Preparation

Initial fence line inspections of enclosures A and B started in late February 2019 and continued into early March. We evaluated the condition of both fenced areas to identify any damage or severely worn sections for which immediate repair might be needed. In early March, David Ainley, Brad Yuen, Gregory Spencer, and Spencer Engler performed inspections of all nest boxes in both enclosures. The effort included removing the lid from each box and examining the contents and evaluating the condition of each nest box lid. Contents within the nest boxes were carefully inspected to identify the presence of feathers and nest material, physical conditions inside the nest boxes, and composition of the nesting substrate (Figure 1). Photos gathered during inspections at the end of the 2018 season showed at least one egg found outside of a nest box (Kaheawa Wind Power 2018). We shifted gravel to make nesting "bowls," when one was not evident, to reduce the potential for eggs to be accidentally rolled out of nest chambers during incubation. We also added small amounts of grass to pad the substrate, as photos from previous years also indicated egg breakage. During our initial nest box inspections at enclosure A in early March, we encountered four nest boxes that contained feathers and eight that contained pieces of grass, twigs, and tips of grassy vegetation that suggested past visitation. In enclosure B, we observed feathers in five nest boxes. One small egg was discovered intact inside a well-prepared nest bowl in B50 (Figure 2). Based on its small size, we concluded that it had been laid by the small dark petrel species that has been steadily active at this nest box for most of the entire preceding year. In our reporting, we refer to this species as Bulwer's petrel *Bulweria bulwerii* until a more definitive species determination is made (see discussion below).

Figure 1. Nest box contents during site inspections and preparations in spring, 2019.

Figure 2. An egg observed at B-50 believed to belong to Bulwer's Petrel.

Fence Inspections and Repairs

Fence inspections consist of walking the perimeter and inner edges and inspecting the structural components including mesh and skirt, posts and braces, hood, brackets, overlap sections, and all components to identify wear and needed repairs. We also look closely for signs of erosion, particularly where terrain is steep, which may signal further close attention. We have not been seeing any significant erosion but recognize the potential, especially during or following periods of heavy rainfall. Until early August 2019, most interim repairs were limited to patching and plugging small holes, cracks, or crevices that sometimes form around the margins of the culverts. Numerous older brackets contain some rust, and while quite a few have been replaced, especially in the lower sections of the enclosures, they appear to be holding up well. We intend to continue replacing brackets based on the severity of rust and corrosion observed. Severely rusted brackets, which may begin to separate from the adjacent hood, require prompt replacement. The mesh on the windward (east) upper side of enclosure A contains a substantial amount of rusted brackets and includes portions of mesh. We observed failure of the mesh on two joining panels during an episode of high winds in early August 2019 (Figure 3). Our response entailed placing a new 25-foot long section of mesh over the entire worn section to ensure that any further disintegration of the meshing will not result in a breach (Figure 4). Based on what we are observing with respect to failure of rusted mesh sections and bracket replacement needs, we are taking a proactive approach and implementing needed interim repairs before failure occurs, by installing new mesh panels and brackets where the need is greatest.

Figure 3. Fence damage caused by excessive rust detected in August 2019

Figure 4. Fence repairs in August 2019

Erosion Management

There have not been significant erosion issues encountered at the mitigation site since monitoring began in early March 2019. Conditions were saturated in the early weeks but have steadily improved throughout the summer. When rainfall is consistent or surface runoff is evident, we examine areas that contain standing water and trace sources of runoff to ensure new rills aren't forming outside of previously installed erosion control features (water bars, flow deflectors). We systematically look for any evidence of sediment flow and/or slumping of mud or other debris to ensure that there is no accumulation along the fences, especially in the steep and lower sections.

Vegetation and Invasive Weed Control

Vegetation has not presented significant issues and has been managed so far by placing a high priority on maintaining a cleared corridor along the fencelines. Facilitated by mechanized and hand tools (weed-whackers, machete), regular clearing helps provide a condition that allows easy access along the perimeter (inside and outside each fenced enclosure), helps reduce seed dispersal, and enables the partially buried fence skirt to be inspected for wear, signs of digging by unwanted mammals, or breaches of any kind. Much of our vegetation management activities that include weed control, have occurred in the course of maintaining the cleared areas around the fences and culverts and in the maintenance of habitat around the burrow groups. The latter consists of trimming back grasses and small shrubs, by hand, to enhance the visibility of decoys, burrow entrances, and the field of view for each camera. This is not an exhaustive exercise, but enables us to target the removal of some particularly unwanted weeds, such as clidemia *Clidemia hirta* and *Tibouchina* spp., by removing individual plants at the root from the management area and disposing of these off site. There are benefits in this approach, indicated by expansion of uluhe fern *Dicranopteris linearis* and other native plants within the enclosures, and thereby contributing to habitat improvements within the management area. We also conducted spot treatments of clidemia and tibouchina in late July 2019 using Round-Up and will expand these treatments, as needed and at least quarterly, to include other unwanted species such as molasses grass and guava, and continue to control the proliferation of these and other weed species along the fencelines and other access areas.

Culverts

We have used hand tools and weed whacker to completely clear all of the culverts of thick weeds and have successfully closed off several holes that appeared capable of allowing small mammal ingress, mostly around the grouted margins. We frequently inspect the four culverts (three at enclosure A, one at enclosure B) and manage the weeds and vegetation around these features to near ground level so that we are able to monitor the integrity of all margins, status of interim repairs, and ensure unimpeded flow through the culverts during heavy rains. We use care in applying spot treatments of Round-Up to inhibit weed regeneration around the grouted margins of the culverts. We only apply herbicide around the culverts during dry periods when rainfall is absent or forecast to be negligible.

Predator Control

Rodents and Mongoose

The predator control program being implemented at Makamaka'ole specifically targets the removal and ongoing control of rats, mice, and mongoose inside the two enclosures and Barn owls *Tyto alba* in the general vicinity of the management area using lethal dispatch. DOC-200 traps (New Zealand Department of Conservation) and Victor snap traps are used for mongoose and rats, respectively. These traps are secured within a wooden box designed to exclude seabirds and non-target species. There have been no mongoose captured inside either enclosure (Table 1).

Table 1. Trapping Success by Target Species and Location (July 1, 2018 to August 2, 2019).

Location	Trap	Enclosure	Mongoose	Rat	Mouse
Outside	DOC	A	34	3	0
		B	27	2	0
	Snap	A	1	27	0
		B	1	12	0
Inside	DOC	A	0	1	0
		B	0	0	0
	Snap	A	0	4	5
		B	0	3	0
	Total		**63**	**52**	**5**

We provision and check bait stations (24 per enclosure in an approximate grid) loaded with Ramik Mini-Bars (active ingredient 0.005% diphacinone) every two weeks for signs of consumption by rats and to ensure bait freshness. Although the bait is mold- and moisture-resistant, it generally needs replacement after a period of six to ten weeks, depending on the weather conditions and placement within the grid. Thus far, all bait replacement has been done due to molding with no bait bars chewed by rats by more than approximately 25%. Overall, most bait checked and replaced has not shown evidence of consumption by rats, with the same bait boxes generally showing evidence of consumption from check to check. This suggests that density of bait boxes may need to be increased to target areas with more evidence of rat consumption.

Barn Owls

Our initial work on managing the threat presented by Barn owls was limited to observations in the vicinity of the hunting zone, to learn about presence, activity and habits when we could observe them, and to coordinate on control. We also conduct surveillance for owls while we make observations of seabirds at night, mostly from the stable, elevated platform in the uppermost corner of enclosure B, and along the road near the preferred hunting area. We have not observed many barn owls at Makamaka'ole in 2019, which is encouraging.

H. T. Harvey & Associates processed a new Wildlife Control Permit with the Division of Forestry and Wildlife, which was issued at the end of June 2019. Active owl-control efforts began on July 12th. We have hunted

actively on three occasions since the permit was issued and anticipate much more effort to be directed at this activity for the remainder of the breeding season, which is now in the chick-provisioning period. No owls have been shot at or removed from the project area as of this reporting.

One owl was seen flying into our lure and playback calls on April 4th, during efforts to attract them; and another owl was heard calling in the vicinity on May 16th. Table 2 provides a summary of observations in which surveillance was conducted at night, using IR-enhanced visual aids, to evaluate the response of owls to playback and visual cues, detect them flying anywhere at night near the project area, and includes observations of seabird activity.

Table 2. Summary of Avian Surveillance and Barn Owl Control Activities at the Makamaka'ole Seabird Mitigation Project through July 2019.

Date	Day	Time	Location	Objective	Summary
2/21/19	Thursday	Dusk, early evening (18:30-20:45)	Enclosure B deck.	Observe the airspace for barn owls; evaluate for hunting and general reconnaissance.	Broad area can be seen including much of adjacent Maka valley and enclosure B; not preferred for hunting owls due to immediate proximity to encl. No owls observed.
2/22/19	Friday	Dusk, early evening (18:30-20:10)	Along the road near the enclosure B trail spur.	Surveillance scanning for owls moving through the upper gulches, approaching from lower pastures, or other movement patterns and timing of arrival.	No owls observed; mostly overcast, light rain late.
3/20/19	Wednesday	Late afternoon through early evening (17:30-20:00)	Enclosure B deck; casual observations from points along the access road.	Surveillance scans to detect owls – first arrivals and movement and early season seabird arrivals.	No owls observed. Few HAPE. Broken clouds, no precip.
3/21/19	Thursday	Dusk, early evening (18:00-20:00)	Along the road near the enclosure B trail spur; adjacent to established hunting site.	Surveillance scanning for owls moving through the upper gulches, approaching from lower pastures, or other movement patterns and timing of arrival.	On site discussion of hunting procedures; surveillance in 5-10 minute segments from road, overlook, and across adjacent forested pastures. No Barn owls observed.
4/3/19	Wednesday	Dusk, early evening (18:30-20:00)	Along the road near the enclosure B trail spur.	Surveillance scanning for owls moving through the upper gulches, approaching from lower pastures, or other movement	No owls observed. Very dark, mostly overcast, intermittent drizzle late.

Date	Day	Time	Location	Objective	Summary
				patterns and timing of arrival.	
4/4/19	Thursday	Dusk, early evening (18:30-20:00)	Hunting location below enclosure B spur.	Deploy audio and visual attraction cues (small rodent distress calls, battery-operated lure); observe owl response.	One Barn owl detected at about 19:15; approached from lower gulch – flew directly to the lure and sound playback source; departed quickly in response to observers; no further observations. Very dark conditions, overcast, no precip.
4/18/19	Thursday	Dusk, early evening (18:30-20:00)	Enclosure B deck; casual observations from points along the access road.	Mostly observe activity of seabirds; secondary surveillance for presence of Barn owls.	HAPE and few NESH; no owls. Weather mostly fair, light wind, no precip.
4/19/19	Friday	Dusk, early evening (18:30-20:00)	Enclosure B deck; casual observations from points along the access road.	Mostly observe activity of seabirds; secondary surveillance for presence of Barn owls.	HAPE and few NESH; no owls. Light wind, occasional gusts, no precip.
4/23/19	Tuesday	Dusk, early evening (18:30-20:30)	Enclosure B deck.	Mostly observe activity of seabirds and effort to observe any birds landing near nest boxes or adjacent areas; secondary surveillance for presence of Barn owls.	HAPE and several NESH; no owls. Light wind, occasional gusts, and light precip late.
4/26/19	Friday	Dusk, early evening (18:30-20:30)	Enclosure B deck; casual observations from points along the access road.	Mostly observe activity of seabirds; secondary surveillance for presence of Barn owls.	HAPE and several NESH; no owls. Light wind, 50% overcast.
5/16/19	Thursday	Dusk, early evening (18:30-20:30)	Hunting location below enclosure B spur and well below road.	Deployed audio attraction cues (two separate types of small rodent distress calls).	Set up audio playback in two separate locations (snag and road berm) to widen broadcast; one owl call heard; no owls observed.
5/30/19	Thursday	Dusk, early evening (18:30-20:30)	Enclosure B deck	Comprehensive assessment from high point in the management area to evaluate landscape	Seabirds active; no owls observed.

Date	Day	Time	Location	Objective	Summary
				structure relative to hunting position; surveillance for owls and seabirds after sundown.	
7/2/19	Tuesday	Dusk, early evening (18:45-20:30)	Enclosure B deck and road outcropping	Surveillance for owls and seabirds after sundown.	Seabirds active; no owls observed.
7/12/19	Friday	Early evening	Hunting location below enclosure B spur and well below road.	Set up attractive lure, sound playback (distressed vole and mouse).	No owls approached or observed; seabirds present and calling during flyovers.
7/15/19	Monday	Early evening	Hunting location below enclosure B spur and well below road.	Set up attractive lure, sound playback (distressed vole and mouse).	No owls approached or observed; seabirds present and calling during flyovers.
7/19/19	Friday	Early evening	Hunting location below enclosure B spur and well below road.	Set up attractive lure, sound playback (distressed vole and mouse).	No owls approached or observed; seabirds present and calling during flyovers.
7/20/19	Saturday	Early evening (18:45-20:00)	Along the road above Makamaka'ole Stream	General seabird and owl reconnaissance	Several petrels and Newell's — several Newell's heard above the sound playback near A.

Tracking-Tunnel Surveys

Tracking-tunnel surveys are performed quarterly. Surveys are designed to sample rodent and mongoose presence by deploying forty track tunnels and cards in each enclosure over a 96 hour exposure period (n=20 per treatment, 2 treatments; treatment exposure time = 24 hours for rodents, 72 hours for mongoose). We conducted two tracking-tunnel surveys for rodents and mongoose inside both enclosures between 21 and 25 March, then again between 3 and 6 June 2019. During the first survey in March we did not detect the presence of small rodents (rat or mouse, 24-hour exposure time) or mongoose (72-hour exposure) on any of the track cards deployed in enclosure B; nine cards contained evidence of rodent activity inside enclosure A (average 0.25 activity level for rats and mice combined, range: rats 0.5-0.6, mouse 0.1-0.3). The June survey resulted in no tracks of rodents (mice or rats) or mongoose on ten cards placed at tunnel stations in each enclosure. Table 3 summarizes the results of all tracking tunnel surveys performed July 1 to August 2, 2018-19.

Table 3. Percentage of Tracking Tunnel Cards with Activity by Month (July 1, 2018 to August 2, 2019) at the Makamaka'ole Seabird Mitigation Area, Fiscal Year 2019.

Predator	Month	Enclosure A	Enclosure B
Mongoose	August	0	0
	October	0	0
	March	0	0
	June	0	0
Rat/Mouse	August	10	10
	October	60	20
	March	20	0
	June	10	0

These results suggest very low to negligible levels of rodents, and high probability that mongoose remain completely absent inside both enclosures. We remain somewhat skeptical that these results are a true estimation of the level of rodent presence and activity. Therefore, we will be exploring a modified approach that may be used outside of the quarterly sampling regime in a separate independent assessment capacity.

Social Attraction and Nesting Colony Establishment

Sound Playback System

Three sound playback systems are currently in use at Makamaka'ole. Two of these are deployed in enclosure A and one is set up in enclosure B. Prior to initiating the system upgrades described below, each amplifier and playback system broadcasted sound through two weather resistant 50-watt speakers, or horns (TOA Electronics). The systems in enclosure A broadcasts only Newell's shearwater calls while the system in enclosure B only broadcasts Hawaiian petrel calls. Each of the three systems are solar-powered and each is configured to play from sundown to sunrise.

Our observations, substantiated by what we have expected based on similar work with closely related species elsewhere and consistent with nest site visitation patterns in past years, suggest there is a strong positive relationship between the number and distribution of horns and the number and distribution of burrows receiving visitation. The Newell's shearwaters we are attracting to the site are selecting nest boxes that are closest in terms of distance, proximity, and direction to the horns (i.e. the source of the broadcast). In our evaluation of this relationship, we concluded that it made sense to select additional locations where horns can be placed to increase the probability that more active burrows spread over a wider area will be visited and to reduce the amount of competition for prime nest sites.

We added four new 30-watt horns to the playback systems in each enclosure in early July (for a total of eight new horns). Prior to adding the new horns, we made some adjustments in the directional orientation of the existing 50-watt TOAs, to evaluate whether this would affect the recruitment of birds visiting nesting burrows.

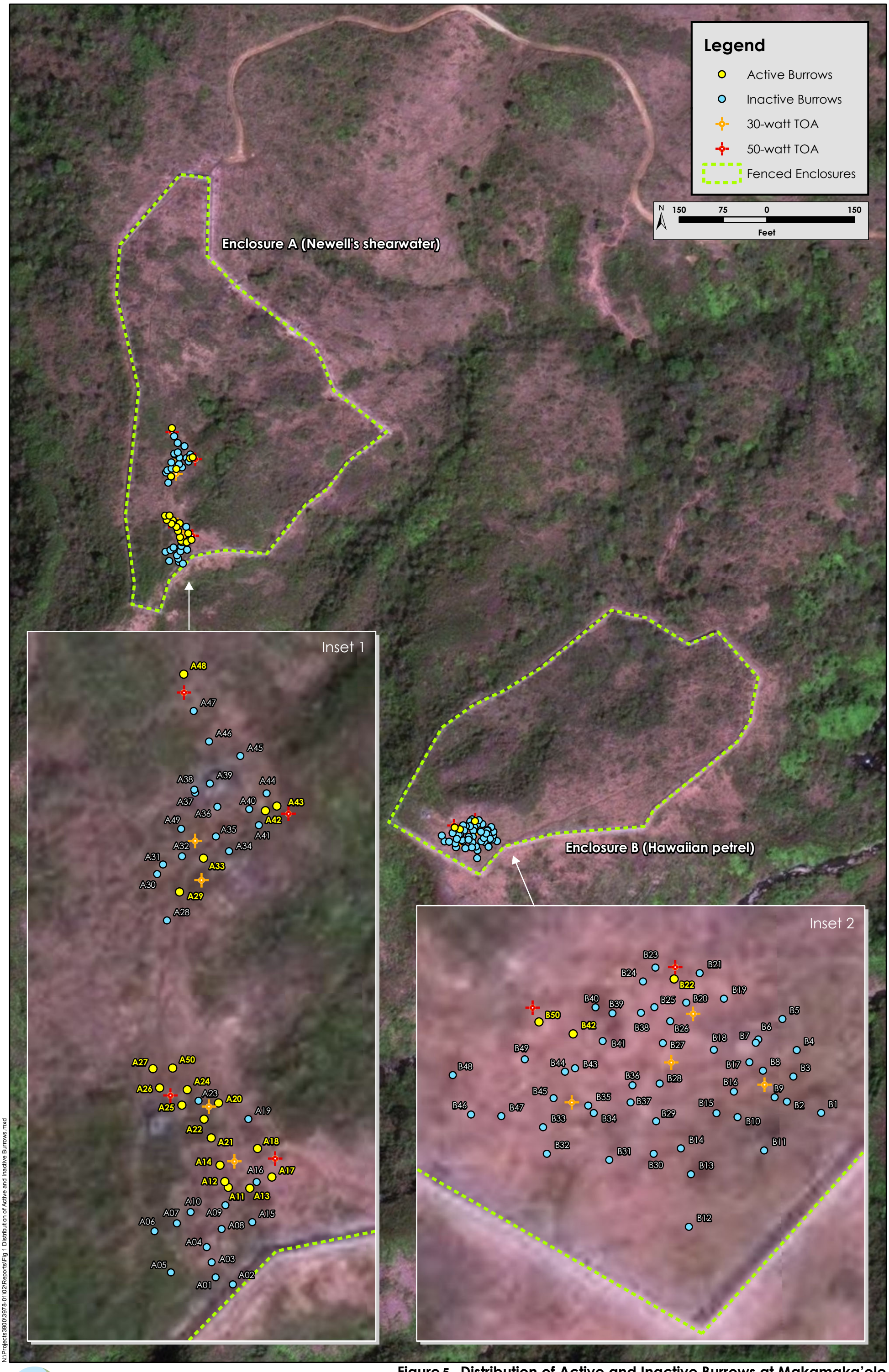
The response by seabirds was characterized by new visitation documented at burrows near the 50-watt horns (within 1-3 meters), within days, essentially confirming that depending on the proximity of horns to burrows, we could begin to manipulate recruitment by selecting the placement of additional horns relative to the locations of burrows. By expanding the sound system, we essentially expanded the distribution and number of active burrows. We believe these adjustments have greatly facilitated the process of attracting new birds to nest at Makamaka'ole and are providing important insights that will continue to inform success and enhance project performance.

At the beginning of the season, we evaluated the call playback sequences being used in each enclosure and were surprised to learn that the sequence being played from the systems in enclosure A was still a mix of Newell's shearwater and Hawaiian petrel. We quickly made a new recording sequence that contains only the calls of Newell's shearwaters and this sequence has been in use from late February through the present. Similarly, we went to work on evaluating the recording sequence being played in enclosure B and, although this track contained only Hawaiian petrels, the sequence needed refinement. The vast majority of the sequence we produced for Hawaiian petrels is derived from recordings made on Lanai'hale and provided by the Cornell Lab of Ornithology (Macaulay Library). These were chosen because of their general resemblance to the types of calls petrels seem to produce at Makamaka'ole in addition to geographic proximity to petrels breeding on Lanai.

Nest Site Monitoring

In March, we placed 4-6 toothpicks upright in the ground across the entrance to each nesting box in both enclosures to document when and where specific burrows would begin to receive visitation by shearwaters and petrels. We also evaluated the distribution and posture of decoys, considering that prospecting shearwaters and petrels may exhibit guarding behavior, and thereby be sensitive to the position of decoys relative to nest sites. We elected to rearrange decoys in both enclosures, increase the distance between decoys and burrow entrances, and adjust the postures and orientations of individual decoys. We also compared our preliminary observations with patterns of visitation documented in past years (Kaheawa Wind Power 2015-2018) to help us anticipate the distribution of nesting activity in 2019.

We began documenting nest site visitation by Newell's shearwaters on about April 8, 2019. Since that time, we have seen a gradual and sometimes marked increase in the number of nest sites being visited by Newell's shearwaters, mostly in enclosure A; the steady rate of visitation suggests increasing site tenacity of this species (Figure 5). At the time of this reporting there are a total of 19 active nest sites receiving regular visitation by Newell's shearwaters within enclosure A; there are 3 active nests in enclosure B, originally designed for Hawaiian petrel, and are occupied at this time by Newell's shearwater and Bulwer's petrel (Table 4).



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Ecological Consultants

Figure 5. Distribution of Active and Inactive Burrows at Makamaka'ole

Makamaka'ole Seabird Mitigation (3978-02)

August 2019

Table 4. Timeline of Visitation and Nesting Burrow Establishment at Makamaka'ole in 2019.

Burrow	Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
A-11	NESH								
A-12	NESH								
A-13	NESH								
A-14	NESH								
A-17	NESH								
A-18	NESH								
A-20	NESH								
A-21	NESH								
A-22	NESH								
A-24	NESH								
A-25	NESH								
A-26	NESH								
A-27	NESH								
A-29	NESH								
A-33	NESH								
A-42	NESH								
A-43	NESH								
A-48	NESH								
A-50	NESH								
B-22	NESH								
B-42 [1]	BUPE								
B-50 [2]	NESH and BUPE						Egg		

[1] Bulwer's Petrel began occupying this burrow as soon as Newell's shearwater arrived.

[2] On approximately April 20, 2019 Newell's shearwater began to cohabitate B-50 with Bulwer's petrel; Bulwer's relocated to neighboring B-42 where it has remained active.

Notes: NESH = Newell's shearwater; BUPE = Bulwer's petrel; Egg = Fractured egg observed at entrance June 21, 2019; visitation continued, possible relay.

Camera Deployments and Review

We have been monitoring visitation and activities of mostly Newell's shearwaters at all of the active nest sites using primarily the professional quality Reconyx covert IR game cameras (*HyperFire* and *HyperFire 2*, Reconyx, Inc., Holmen, Wisconsin) and also some older digital trail cameras with similar IR-illumination capacity manufactured by Moultrie. These cameras are motion triggered, capturing high quality digital monochrome photos using a nighttime infrared illuminator and are custom programmed to function according to a specific set of operational parameters that maximize data acquisition and quality. Although both types of cameras perform these functions, the Reconyx is superior in terms of meeting project performance criteria. Burrows are selected for camera monitoring based on initial indications of toothpick displacement and the appearance of

fresh guano at burrow entrances. Grass outside burrows is trimmed by hand and regularly maintained to enhance the quality of the photos and reduce unwanted triggering.

The cameras are designed for securing to a stationary object and are capable of surveying areas up to several meters from the target of interest. We install one camera at each active nesting burrow at Makamaka'ole using a wooden stake in a position that allows the entrance of the nesting burrow to be under continuous surveillance. In some cases, depending on the amount of activity and number of birds present at a given site, we have positioned cameras to observe more area in the immediate vicinity of the entrance while, at others, the camera looks directly at the entrance itself (Figures 6 and 7). Reducing unwanted triggering by trimming weeds and grass in the foreground is important and also helps to enhance the quality of the images and our interpretation of activities being observed. This is done very carefully, especially when birds are suspected of being present inside the nest box during the day, in order to minimize any disturbance. Camera data cards are switched and reviewed at least weekly and slight changes in the position of cameras are sometimes made, as needed.

Figure 6. Reconyx HyperFire 2 camera Monitoring Active Nesting Burrow at Makamaka'ole, 2019

Figure 7. Newell's Shearwaters Activity Documented at the Entrance to an Artificial

Burrow using the Reconyx HyperFire Camera.

Data obtained with game cameras is being used to develop a data base in order to characterize the activities of seabirds associated with active nesting burrows. Changes we have observed over the course of the season are useful indicators of the relative likelihood that pairs are engaged in breeding, incubation, and/or chick provisioning, or simply pioneering new sites prior to breeding in subsequent seasons.

Searches for Active Nesting Burrows, Inside and Outside of the Protective Enclosures

We continue to search for and investigate the presence of active nests and signs of burrowing and prospecting by both Newell's shearwaters and Hawaiian petrels inside and outside of both enclosures. While we are on site and working inside the enclosures we frequently move into areas containing dense understory habitat that could be suitable for nesting. We examine and search areas, independently and as a team, coordinate and discuss observations, to achieve consistency in our searches.

So far, we have not found any burrows or signs of active prospecting outside of the immediate management areas within the exclosures (i.e. outside the fences). The modest investigations we have done within 10 meters of the fencelines, thus far, have not yielded any active nesting burrows of any seabird species. What we have learned is that Newell's shearwaters have started prospecting at least one site in close proximity to one of the large 50-watt horns, a few meters behind one of the more active burrows in this portion of the new colony. We have directed considerable attention at this site – deploying a camera for several weeks, in addition to surrounding areas, and regularly investigate short trails we know are used by birds because guano is evident.

Any places that birds may be exploring or beginning to tunnel or excavate are areas that we look for in order to maintain our understanding of where naturally established burrows might be set up.

As we broaden our searches and define the area within which Newell's shearwaters and/or Hawaiian petrels are prospecting or attempting to establish nest sites independent of those provisioned by the project, we will include search profiles and description of habitat. These will be represented in subsequent maps showing nest distribution, prospecting or independent nest site establishment, and how these variables may change over time, within the context of our overall assessment this breeding season.

Preliminary Assessment of Seabird Productivity and Trends in Recruitment Dynamics at Makamaka'ole in 2019

The first Newell's shearwaters arrived at Makamaka'ole and began entering burrows on approximately April 8 2019. By the end of June there were eight nest sites being visited by Newell's shearwaters; that number increased to twenty-one by mid-July. We attribute the three-fold increase in the number of nesting burrows receiving visitation by Newell's shearwaters to the modifications we made to the playback system and digital call playback sequences. By installing several new horns in proximity to unused burrows, we facilitated the expansion of prospecting opportunities, as indicated by the cascade of visitation and subsequent activity we are now observing.

There is good reason to suspect that at the time of this writing there are likely to be young chicks and perhaps a few eggs being incubated in some, if not several, of the Newell's shearwater nests we are monitoring. We are planning to evaluate the status of each of the active nest boxes over a period of several days in mid-August using a fiber-optic burrow scope designed to be maneuvered through the burrow passage to the nest box. The contents and/or occupants can be viewed in situ; a video feeds via a phone app. The burrow scope is fitted through a tennis ball so that noise or disturbances can be avoided or minimized and to stabilize the lens.

Hawaiian petrels have not been observed actively visiting any burrows at Makamaka'ole since 2017, when there were one or more birds associated with the "uluhe" burrow and B-22, both in enclosure B. The Hawaiian petrels that were visiting these sites appear to have been displaced by Newell's shearwaters toward the end of 2017, as indicated by the camera data gathered at the time. In 2016 the call playback sequences were modified, and for a period of several months, a mix of Hawaiian petrel and Newell's shearwater calls were broadcast. We have learned that Newell's shearwaters can be extremely responsive to audio playback of the species' recorded calls, and that during nest site establishment they may fiercely, at times, protect a chosen nest site (Figure 8).

In 2016, after it appeared that Hawaiian petrels had stopped landing to prospect and visit potential nesting burrows during the period when the mixed recorded sequences were playing, the call playback sequence was supposed to have been returned to species specific calls being broadcast from the playback systems in the two species respective enclosures. This is not consistent with the mixed recording that was being broadcast from the systems in enclosure A at the beginning of 2019. The quality and character of the recorded call playback sequences are very important. Our preliminary assessment suggests that it may be problematic to expect both species to establish equally successful nesting colonies in close association due to what appears to be the more

aggressive behavior exhibited by Newell's shearwaters. Further refinement in the sound delivery system may alter that assessment. Options may exist to dilute the Newell's shearwater playback, reducing intensity of the sound output, while ramping up the Hawaiian petrel output to surpass the calls being broadcast in enclosure A. Given the present status of Newell's shearwater recruitment, aiming more attention on the attractiveness of enclosure B for Hawaiian petrels may reveal the species capacity to use the site for breeding in a manner resembling what we have seen thus far for Newell's shearwaters, without compromising the performance trajectory of the latter.

Figure 8. Newell's shearwater, possibly a male, exhibiting territoriality.

Discussion

Developing a better understanding of the most important factors affecting Hawaiian petrel prospecting and nest site visitation and establishment capacity at Makamaka'ole will remain an important component of our work this season. We are currently in the chick-rearing period when we should see a marked reduction in the presence of pre-breeders and non-breeding birds that may be using Makamaka'ole this year for prospecting and developing site specific pair bonds. Our current priorities include examining the status of each active nesting burrow to determine reproductive status using the burrow scope, and to ensure needed interim repairs to the fence(s) when needed. We have repositioned some traps and been providing continuous fresh bait to all DOCs and Victor snap traps in their respective boxes inside the enclosures and regularly outside. Barn owl control is a primary focus through November.

The number of active Newell's shearwater burrows is impressive and is likely to accelerate the project toward meeting its mitigation targets consistent with the models that were developed to examine success factors and probabilities for both species at Makamaka'ole (H. T. Harvey & Associates 2011).

Our final report at the conclusion of the 2019 season will provide 1) a comprehensive assessment and analysis of the project performance, success criteria, challenges and future needs, 2) a detailed set of findings and recommendations, for both Hawaiian petrels and Newell's shearwaters. The latter relates to Makamaka'ole and its capacity to continue providing a net conservation benefit, and which might arguably exceed the ordinary threshold for this criterion, by expanding the science and understanding of the ecology, breeding biology, and restorative capacities of both these covered species.

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