

Kahuku Wind Power Habitat Conservation Plan FY 2019 Annual Report



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Incidental Take License ITL-10/ BO#2010-F-0190

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EXECUTIVE SUMMARY

This report summarizes work performed by TerraForm Power, LLC (TerraForm), operator of the Kahuku Wind Project (Project), during the State of Hawai'i fiscal year (FY) 2019 (July 1, 2018 – June 30, 2019) under the terms of the approved Habitat Conservation Plan (HCP). The HCP is dated May 27, 2010, and describes TerraForm's compliance obligations under Kahuku Wind Power, LLC's state Incidental Take License ITL-10 and federal Incidental Take Statement BO 2010-F-0190. Species covered under the HCP include eight federally-listed threatened and endangered species and one state-listed endangered species. The Project was constructed in 2010 and has been operating since March 23, 2011.

Fatality monitoring at the Project continued throughout FY 2019 within 35-meter radius circular search plots. These plots are centered on the wind turbine generators (WTGs) 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 94 percent for both bat surrogates and medium-sized birds. No Hawaiian hoary bat fatalities were found in FY 2019, and no fatalities of other listed species have been observed at the Project. The Project's total observed direct take of bats through FY 2019 is 4. The fatality estimate for the four observed bats using the Evidence of Absence estimator at the upper 80 percent credibility level is 9, and the total indirect take for this estimate is two adult equivalents. Combining these values, there is an approximately 80 percent chance that actual take of Hawaiian hoary bats at the Project through FY 2019 was less than or equal to 11 adults.

During FY 2019, four ground-based acoustic detectors were deployed at Project WTG's. Between July 1, 2018 and June 30, 2019, Hawaiian hoary bats were detected on 4 nights out of 1,105 detector-nights (0.36 percent of detector-nights). Seasonal patterns of detection rate were comparable with previous years.

Tier 1 mitigation obligations for the Hawaiian hoary bat were met prior to FY 2019, and mitigation planning for Tier 2 take will occur in FY 2020 to ensure mitigation does not lag potential Project take. Mitigation obligations for baseline levels of take of waterbirds, seabirds, and the Hawaiian short-eared owl were met prior to FY 2019.

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, and discussions regarding mitigation funding and mitigation strategies.

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1.0 Introduction

The Habitat Conservation Plan (HCP) for the Kahuku Wind Project (Project) was approved by the Hawai'i Division of Forestry and Wildlife (DOFAW) in 2010. A federal Biological Opinion (BO 2010-F-0190) and associated Incidental Take Statement (ITS) from the U.S. Fish and Wildlife Service (USFWS) and a state Incidental Take License (ITL; ITL-10) from DOFAW were issued to Kahuku Wind Power, LLC in May and June of 2010, respectively. The ITS and ITL cover the incidental take of seven federally listed threatened and endangered species and one state-listed endangered species (collectively referred to as the Covered Species) over a 20-year permit term. The Covered Species include: the Hawaiian stilt or ae'o (*Himantopus mexicanus knudseni*), Hawaiian coot or 'alae ke'oke'o (*Fulica alai*), Hawaiian duck or koloa maoli (*Anas wyvilliana*), Hawaiian moorhen or 'alae 'ula (*Gallinula chloropus sandvicensis*), Hawaiian petrel or ua'u, (*Pterodroma sandwichensis*), Newell's shearwater or 'a'o (*Puffinus newelli*), Hawaiian hoary bat or 'ope'ape'a (*Lasiurus cinereus semotus*), and the state-listed Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*).

The Project was constructed in 2010 and 2011 and commissioned for operating on March 23, 2011. TerraForm Power, LLC (TerraForm) acquired the Project from Kahuku Wind Power, LLC in 2016 and currently operates the Project. Brookfield Renewable Partners, LP acquired a majority stake in Terraform in 2017. USFWS determined in a letter dated November 19, 2014 that the ITS issued for the Project remains in effect despite ownership change. The HCP and ITL remain unchanged and in the original permittee's name, Kahuku Wind Power, LLC.

This report summarizes work performed for the Project during the 2019 fiscal year for the State of Hawai'i (FY; July 1, 2018–June 30, 2019) pursuant to the terms and obligations of the approved HCP, ITL, and ITS. Kahuku Wind Power, LLC has previously submitted annual HCP progress reports for FY 2011 through FY 2018 to USFWS and DOFAW.

2.0 Fatality Monitoring

In consultation with USFWS, DOFAW, and the ESRC, fatality search areas and search frequency have evolved over time from the start of operations in 2011 through the initiation of the current approach in April 2015.

- In March 2011, the fatality monitoring effort entailed full, intensive monitoring that involved twice weekly searches within a 64-meter radius circular plot centered on each wind turbine generator (WTG) in addition to searches every other week within a larger 96-meter radius plot.
- In September 2014, the 96-meter radius plot searches were suspended, but searches within the 64-meter radius plots continued on a twice weekly schedule.

- In December 2014, plots were reduced in size to the current 35-meter radius (Figure 1). Monthly searches were carried out from December 2014 through March 2015.
- In April 2015, the search frequency of the 35-meter radius plots was increased to weekly.

Weekly searches of the 35-meter radius plots were completed throughout FY 2019. Fatality monitoring in FY 2019 achieved a mean search interval for WTGs of 7.0 days (Standard Deviation = 0.66 days). The search plots were searched by trained dogs accompanied by their handlers. Should conditions limit the use of dogs (e.g., weather, injury, availability of canine search team, etc.), search plots would be visually surveyed by Project staff. However, no visual searches were required in FY 2019; 100 percent of searches were conducted by canine teams.

No Covered Species were detected during fatality searches. Other fatalities are reported in Section 7.2. An estimate of Project take based on bat fatalities found in previous years is provided in Section 7.1.

3.0 Carcass Persistence Trials

Four, 28-day carcass persistence trials were conducted in FY 2019 using bat surrogates (black rats) and wedge-tailed shearwater carcasses. Wedge-tailed shearwaters are used to represent medium-sized birds and are suitable surrogates for the avian Covered Species (Section 1). For FY 2019, the mean probability that a carcass persisted until the next search was 0.63 (95 percent Confidence Interval [CI] = 0.51, 0.75) for all bat surrogate carcasses (N=20; five per trial), and was 0.94 (95 percent CI = 0.41, 1.0) for medium-sized bird carcasses (N=4; 1 per trial).

4.0 Searcher Efficiency Trials

Forty-four searcher efficiency trials were administered over 10 trial days during FY 2019. As in the carcass persistence trials, black rats were used as surrogates for bats, and wedge-tailed shearwaters were used as surrogates for avian Covered Species. Searcher efficiency trials occurred throughout the year and were exclusive to canine search teams (no un-aided human searches occurred in FY 2019). Vegetation category (short vs. medium) of the search plot was documented at the time the carcasses were placed, as well as when they were found. Of the 37 bat surrogate trial carcasses placed, three were lost to predation. The overall searcher efficiency (i.e., combined vegetation classes) in FY 2019 was 94.1 percent (95 percent CI = [0.82, 0.99]) for bat surrogates (N = 34) and 100 percent (95 percent CI = [0.71, 1.00]) for medium-sized bird (N = 7) carcasses.



Figure 1. HCP Compliance Monitoring

5.0 Vegetation Management

Search plots primarily consist of bare ground and vegetation that is cut when it reaches 4 to 6 inches in height. Plots generally overlap with the maintained WTG pad, providing a relatively smooth search area that is easily maintained; however, a small portion of the WTG 3 plot has a slope that precludes vegetation management. Vegetation within the plots consists mainly of Bermuda grass (*Cynodon dactylon*), sensitive plant (*Mimosa pudica*), and Guinea grass (*Megathyrsus maximus*). All plots around the WTGs were mowed approximately every 3 to 6 weeks within the 35-meter search radius to increase visibility during fatality searches. Plots were not mowed during the last two months of FY 2019 due to logistical issues. Mowing will resume the week of August 5 in FY 2020.

6.0 Scavenger Trapping

Scavenger trapping was last completed at the Project in June 2014 (Kahuku Wind 2014). In order to ensure carcass persistence times that allow for detection of most fatalities, TerraForm plans to renew this effort in FY 2020.

7.0 Documented Fatalities and Take Estimates

All downed wildlife observed during the fatality monitoring were handled and reported in accordance with the Downed Wildlife Protocol provided by USFWS and DOFAW. No Covered Species were detected during FY 2019, and no injured (live) downed wildlife were observed at the Project in FY 2019.

Various factors affect how the number of observed fatalities is scaled to account for unobserved fatalities. Unobserved fatalities are the result of three primary factors:

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

Sections 3.0 and 4.0 describe methods that are used to estimate the effect of the first two factors. 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 from FY 2018 was made in FY 2019. Thus, the estimate of the proportion of the carcass distribution searched in FY 2019 remains the same as that described in the FY 2018 annual report (Kahuku Wind 2018).

7.1 Hawaiian Hoary Bat

7.1.1 *Estimated Take*

A total of four Hawaiian hoary bat fatalities have been observed at the Project since operations began on March 23, 2011. The most recent documented Hawaiian hoary bat fatality was observed on August 29, 2014. All bat carcasses were transferred to the U.S. Geological Survey for genetic testing. Each of the four bats were found inside of fatality search plots; no incidental bat fatality detections have occurred to date.

An upper credible limit (UCL) of cumulative take 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). USFWS and DOFAW have requested that estimates of direct take be reported at the 80 percent UCL. 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 the sex and age characteristics of bat fatalities found at the Project, and the life history characteristics of (or assumed to be representative of) the Hawaiian hoary bat, as described in the Project's approved HCP and current agency guidance (USFWS 2016).

The estimated direct take (ODT + UDT) for the four Hawaiian hoary bat fatalities found between the start of operation (March 23, 2011) and end of FY 2019 (June 30, 2019) is less than or equal to nine bats (80 percent UCL). Details of the estimated direct take parameters are presented in Appendix 1.

Indirect take is estimated to account for the potential loss of individuals that may occur 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 USFWS (2016) 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 from the 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 (2016) guidance, the estimate of cumulative indirect take in FY 2019 is calculated as:

- **Total juvenile take calculated from observed female take (April 1 – September 15)**
 - $2 \text{ (observed females)} * 1.8 \text{ (pups per female)} = 3.6 \text{ juveniles}^1$
- **Total juvenile take calculated from observed unknown sex take (April 1 – September 15)**
 - $1 \text{ (observed unknown sex)} * 0.5 \text{ (assumed sex ratio)} * 1.8 \text{ (pups per female)} = 0.9 \text{ juveniles}$
- **Total juvenile take calculated from unobserved take**
 - $5 \text{ (unobserved direct take)} * 0.5 \text{ (assumed sex ratio)} * 0.25 \text{ (proportion of calendar year females could be pregnant or have dependent pups)} * 1.8 \text{ (pups per female)} = 1.1 \text{ juveniles}$
- **Total Calculated Juvenile Indirect Take = 5.6 (3.6 + 0.9 + 1.1)**
- **Total Adult Equivalent Indirect Take = 0.3 (juvenile to adult conversion factor) * 5.6 = 1.7**

Therefore, the estimated indirect take based on the UCL of Hawaiian hoary bat direct take at the Project is two adults (rounded up from 1.7).

The UCL for cumulative Project take of the Hawaiian hoary bat at the 80 percent credibility level is 11 adult bats (9 [estimated direct take] + 2 [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 11 bats.

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 take through the end of the permit term using the fatality monitoring data collected through FY 2019. The objective of this analysis was to evaluate the potential for the Project to exceed the permitted take limit at the 80 percent UCL prior to the end of the permit term (Appendix 2). For this analysis, the proportion of risk in the model was adjusted to reflect the assumption that the risk to bats was reduced by 50 percent on an annual basis under the current

¹ DNA results have identified the sex of three of the four bat fatalities detected at the Project, confirming that two of the fatalities were female (Pinzari and Bonaccorso 2018).

Low Wind Speed Curtailment (LWSC) regime (Section 10.0), and that this method of reducing risk would 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 21.7 percent of the permitted take. Currently, the proportion of total take that is attributable to indirect take is 18.2 percent, making the assumption of 5 indirect take upwardly conservative. Assuming five adult bat equivalents are attributed to the Project as indirect take, the permitted direct take under the Project's ITP and ITL would be 18 bats.

Based on the analysis described above and presented in Appendix 2, there is approximately a 50 percent chance that the 80 percent UCL of cumulative take will be exceeded during the permit term. Specifically, the median of the projected mortality estimates is equivalent to the assumed Threshold value (T) of 18 (Appendix 2). The probability of permit exceedance at the Project may be overestimated given that estimates of the benefit of LWSC are conservatively low based on 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). 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 further reduce risk to bats, the Project is likely to remain below the permitted take limit for the permit term.

7.2 Fatalities of Non-Covered Species

Seven bird fatalities, representing four 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 (MBTA): the wedge-tailed shearwater (two birds; *Puffinus pacificus*), the great frigatebird (one bird; *Fregata minor*), and the cattle egret (three birds; *Bubulcus ibis*). In addition, one fatality of a non-native introduced bird without MBTA protection was documented at the Project substation: the common myna (*Acridotheres tristis*). For a complete list of fatalities detected in FY 2019 see Appendix 3.

8.0 Wildlife Education and Observation Program

Wildlife Education and Observation Program (WEOP) trainings 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 if they observe a Covered Species or encounter a fatality while on-site. WEOP trainings were provided to 23 individuals over eight dates in FY 2019.

9.0 Mitigation

The Project's mitigation requirements are described in Section 7.6 of the approved HCP.

9.1 Hawaiian Hoary Bats

9.1.1 *On-Site Acoustic Surveys*

Acoustic monitoring of bat activity has been performed at the Project since FY 2014. Initially, monitoring occurred from twelve acoustic recorders distributed throughout the Project site, but was decreased to seven acoustic recorders in FY 2018 (Kahuku Wind 2018), and then to four located 50 meters from WTGs 2, 5, 9, and 12 beginning in FY 2019 (Figure 1). In FY 2019, each acoustic monitor consisted of a ground-based Song Meter SM2BAT+™ ultrasonic recorder equipped with one SMX-U1™ ultrasonic microphone (Wildlife Acoustics, Maynard, MA, USA) located 6.5 meters above ground level.

In FY 2019, Hawaiian hoary bats were detected on four nights out of 1,105 detector-nights (0.36 percent of nights with detections) at the four monitored WTGs. The detection rate in FY 2019 was slightly less than the previous FY 2018 detection rate (0.79 percent; Kahuku Wind 2018), although this difference was not significant ($z = 1.35$, $P > 0.177$). Annual detection rates varied considerably among years (Table 1), but with no significant trend in detection rate over time ($F_{1,6} = 0.683$, $P > 0.455$).

The temporal pattern of detection rates in FY 2019 were similar to those observed in previous years (Figure 2, Figure 3): increased activity occurred during the lactation (mid-June to August) and post-lactation (September to mid-December) reproductive periods, with no activity occurring during the pre-pregnancy (mid-December to March) or pregnancy (April to mid-June) reproductive periods (e.g., Kahuku Wind 2018). The general temporal pattern in the detection rates observed at the Project has also been previously reported in Hawaiian hoary bats monitored at other low elevation sites on Oahu (Starcevich et al. 2019) and Hawai'i Island (Todd 2012).

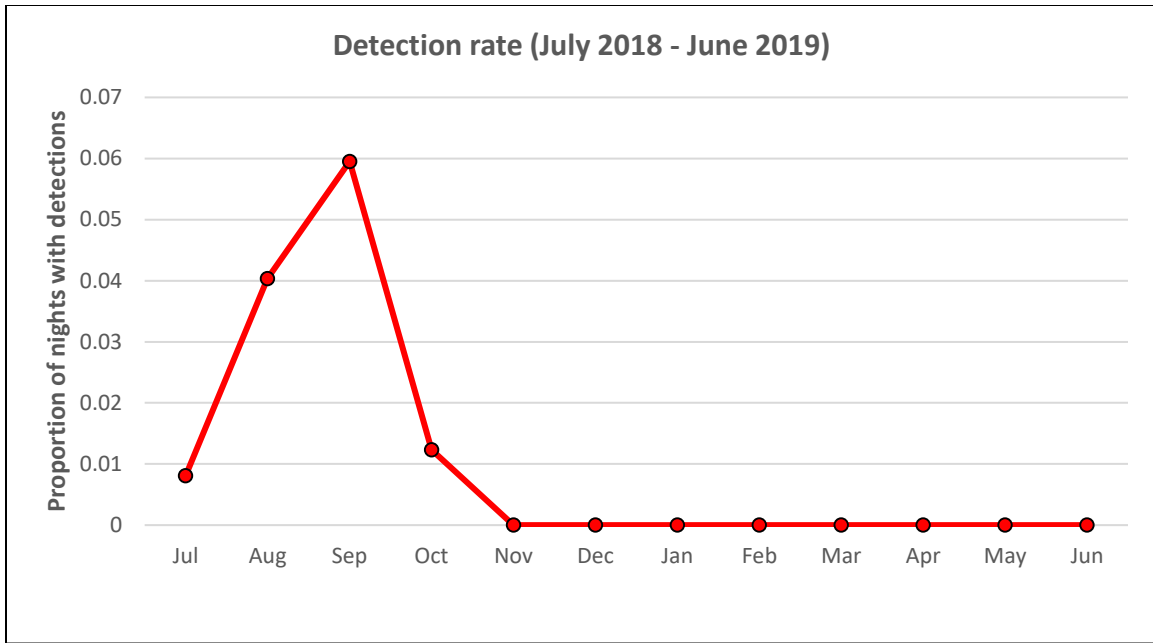


Figure 2. Bat Acoustic Activity at Four Detectors during FY 2019

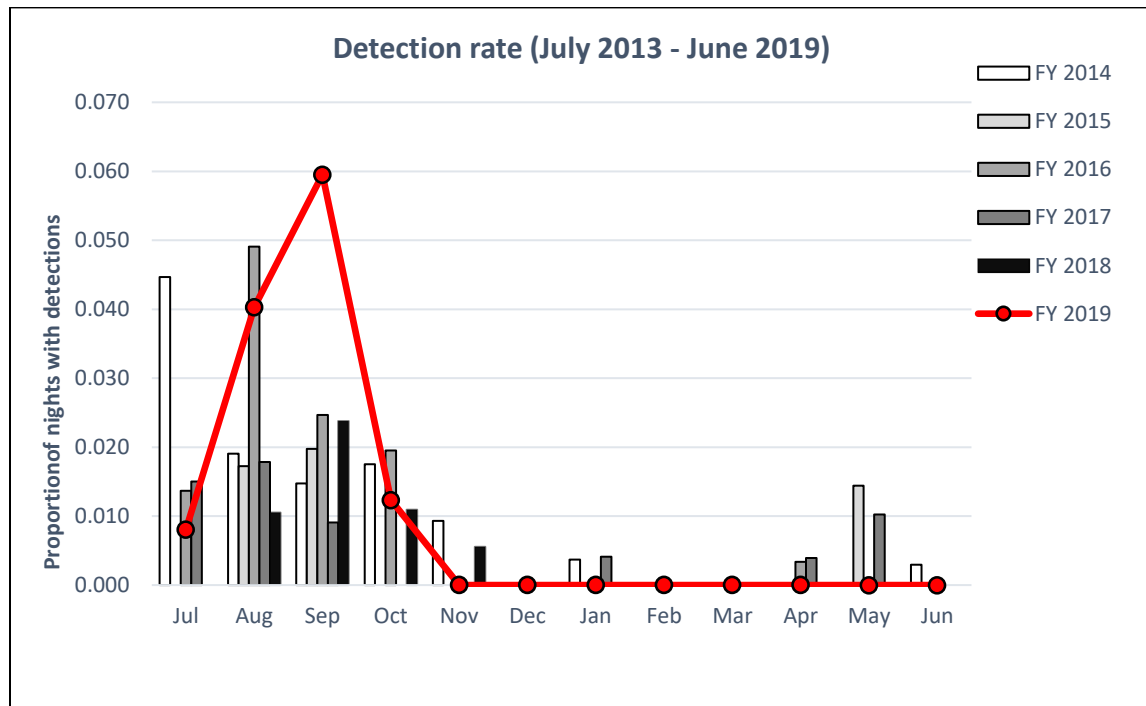


Figure 3. Bat Acoustic Activity at Four Detectors for FY 2014 through FY 2019

Table 1. Percentage of Nights with Bat Detections Between FY 2014 and FY 2019

| Dates | No. of Nights Sampled | Percentage of Nights with Detection(s) |
|--|-----------------------|--|
| FY 2014 (July 2013-June 2014) ¹ | 3487 | 0.92 |
| FY 2015 (July 2014-June 2015) ¹ | 3072 | 0.36 |
| FY 2016 (July 2015-June 2016) ¹ | 2922 | 0.96 |
| FY 2017 (July 2016-June 2017) ¹ | 3146 | 0.48 |
| FY 2018 (July 2017-June 2018) ² | 1273 | 0.79 |
| FY 2019 (July 2018- June 2019) ³ | 1105 | 0.36 |
| 1. Number of detectors = 12. 2. Number of detectors = 7. 3. Number of detectors = 4. | | |

9.1.2 Kahikinui Forest Reserve Mitigation

The Tier 1 Mitigation obligation for the Hawaiian hoary bat is complete. Kahuku Wind Power, LLC paid the full obligation of \$150,000 for ongoing Tier 1 bat mitigation being conducted by DOFAW at the Kahikinui Forest Reserve on Maui in September 2011 (Kahuku Wind 2012). These funds were used for 2,500 meters of ungulate fencing around a 280-acre enclosed restoration area. Mitigation planning for Tier 2 take will occur in FY 2020 to ensure mitigation does not lag potential Project take.

9.2 Waterbirds

Mitigation for waterbirds is complete. Kahuku Wind Power, LLC completed its obligation for listed waterbirds in 2013 with funding provided to DOFAW for 4 years of waterbird mitigation at Hamakua Marsh. Waterbird mitigation included 4 years of predator and vegetation control, and productivity assessment. Quarterly and annual reports of progress and results were provided by DOFAW and included in the Project's annual reports (Kahuku Wind 2012, Kahuku Wind 2013, Kahuku Wind 2014, Kahuku Wind 2015). Total Hawaiian coot, Hawaiian moorhen, and Hawaiian stilt fledgling production from FY 2012 through FY 2015 was 13, 141, and 24, respectively. The total funding for this project was \$457,000.

9.3 Newell's Shearwater and Hawaiian Petrel

Mitigation for the Newell's shearwater and Hawaiian petrel is complete. Kahuku Wind Power, LLC provided funds to the Kaua'i Endangered Seabird Recovery Project to meet seabird mitigation obligations. The purpose of the funding was to survey for Newell's shearwater and Hawaiian petrel nesting colonies using Song Meter SM2BAT+TM ultrasonic recorders (Wildlife Acoustics, Maynard, MA, USA) at multiple locations in Kaua'i's remote mountains. Recorders were deployed in August 2013, April 2014, and April 2015 via helicopter, and were retrieved in October 2013, August 2014,

and August 2015, respectively. Acoustic data were analyzed and results summarized by Conservation Metrics, Inc. (Kahuku Wind 2016).

Additional mitigation for the Newell's shearwater and Hawaiian petrel on Kaua'i began in FY 2015 and was completed in FY 2017 (Kahuku Wind 2017). Kahuku Wind Power, LLC funded DOFAW to conduct a barn owl predator control project on Kaua'i and Lehua Island, Niihau at selected seabird colonies. Total funding for these projects was \$349,000.

9.4 Hawaiian Short-Eared Owls

Mitigation for the Hawaiian short-eared owl is complete. Kahuku Wind Power, LLC contributed \$25,000 to the Hawai'i Wildlife Center in December 2010, and \$50,000 to DOFAW for population research. Hawaiian short-eared owl population research began in FY 2017 to investigate their population size, distribution, and habitat use on Oahu (Pueo Hui 2018).

10.0 Adaptive Management

Kahuku Wind Power, LLC has implemented adaptive management steps in accordance with the adaptive management framework in Section 8.3 of the approved HCP to understand and reduce the risk to the Hawaiian hoary bat. Adaptive management measures that have been and continue to be implemented include acoustic monitoring at four turbines and implementing the LWSC regime. LWSC of all turbines up to a wind speed of 5 meters per second (m/s) began April 27, 2012 and continues to be implemented between sunset and sunrise from April through November. Curtailment is achieved by feathering blades to minimize rotation.

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 and discussions regarding Tier 2 bat mitigation. A summary of agency coordination follows:

- October 2018—Submittal of FY 2019 Q1 report
- September/October 2018—Semi-annual meeting with DOFAW, USFWS, and TerraForm regarding status of the Project
- December 2018—e-mail communication among DOFAW, USFWS, and TerraForm regarding status of funding and success for on-going mitigation efforts for the Hawaiian hoary bat
- 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 \$170,000(Table 2).

Table 2. HCP-related Expenditures at the Project in FY 2019

| Category | Amount |
|-------------------------------|------------------|
| Permit Compliance | \$25,000 |
| Fatality Monitoring | \$45,000 |
| Equipment and Supplies | \$5,000 |
| Staff Labor | \$95,000 |
| Total Cost for FY 2019 | \$170,000 |

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**APPENDIX 1. DALTHORP ET AL. (2017) FATALITY ESTIMATION
FOR HAWAIIAN HOARY BATS AT PROJECT THROUGH FY 2019**

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| Modelling parameter | | Modelling Period | | | | | | | | | |
|--|---------|------------------|-----------|----------|-----------|------------|-----------|------------------|------------------|------------------|------------------|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 (current) |
| LWSC | | N/A | N/A | Partial | 5 m/s | 5 m/s | 5 m/s | 5 m/s | 5 m/s | 5 m/s | 5 m/s |
| Date Range of Modelling Period | Begin | 1/1/2011 | 10/1/2011 | 4/1/2012 | 9/1/2013 | 8/1/2014 | 11/1/2014 | 4/1/2015 | 7/1/2016 | 7/1/2017 | 7/1/2018 |
| | End | 10/1/2011 | 3/31/2012 | 8/1/2012 | 7/31/2014 | 10/31/2014 | 3/31/2015 | 6/30/2016 | 6/30/2017 | 6/30/2018 | 6/30/2019 |
| Period length (days) | | 273 | 182 | 122 | 333 | 91 | 150 | 456 | 364 | 364 | 364 |
| Percent of Year | | 0.75 | 0.50 | 0.33 | 0.91 | 0.25 | 0.41 | 1.25 | 1.00 | 1.00 | 1.00 |
| Search Interval (days) | | 3.5 | 2.5 | 3.5 | 3.5 | 3.5 | 30.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Number of Searches in Modelling period | | 77 | 72 | 34 | 94 | 25 | 4 | 64 | 51 | 51 | 52 |
| Observed fatalities (X) | | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| K | | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 1 ¹ | 1 ¹ | 1 ¹ | 1 ¹ |
| DWP | | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 0.7 ² | 0.7 ² | 0.7 ² | 0.7 ² |
| g | g | 0.464 | 0.796 | 0.746 | 0.830 | 0.670 | 0.347 | 0.565 | 0.530 | 0.535 | 0.413 |
| | 95% LCI | 0.262 | 0.675 | 0.611 | 0.647 | 0.460 | 0.166 | 0.486 | 0.465 | 0.464 | 0.328 |
| | 95% UCI | 0.672 | 0.894 | 0.861 | 0.955 | 0.850 | 0.554 | 0.642 | 0.595 | 0.605 | 0.501 |
| B | Ba | 9.841 | 39.661 | 33.652 | 17.270 | 13.943 | 7.456 | 87.013 | 119.453 | 101.741 | 50.726 |
| | Bb | 11.385 | 10.180 | 11.429 | 3.528 | 6.853 | 14.05 | 67.090 | 105.814 | 88.595 | 72.185 |
| M* ³ | | 4 | 3 | 7 | 6 | 7 | 8 | 8 | 9 | 9 | 9 |

1. Searches performed by canine teams.

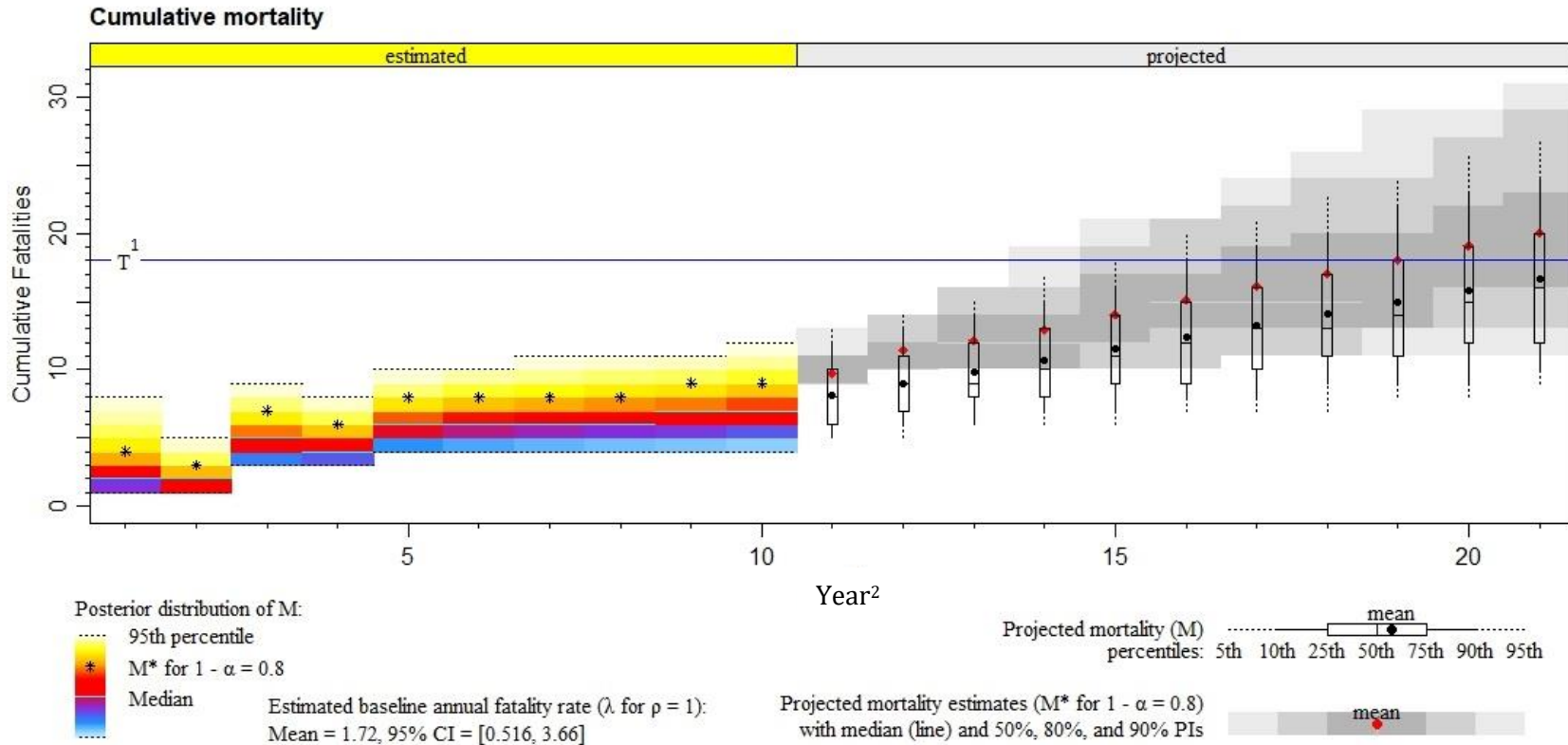
2. Reduced search area (See FY 2018 Annual Report for detailed analysis).

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

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**APPENDIX 2. HAWAIIAN HOARY BAT 20-YEAR PROJECTED
TAKE AT PROJECT IN FY 2019**

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1. Permitted take for the Hawaiian hoary bat at the Project is 23; however, projected take as calculated using EoA only includes direct take. To account for indirect take in this analysis, an approximate take threshold (T) of 18 is shown, representing permitted bat take (23) minus 5 adult equivalents of indirect take (21.7 percent of the permitted limit). Currently, the proportion of total take that is attributable to indirect take is 18.2 percent. T overlaps the median (line) for projected mortality estimates at modelling period 21 (19.5 years of operation).
2. The years 1 – 7 represent unique modelling periods rather than FY (see Appendix 2) and cumulatively represent 5.5 years of operation. In contrast, starting with year 8 the years represent FYs. Therefore, the length of time displayed represents 19.5 years, or the actual time turbines are anticipated to be operational during the 20-year permit term.

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**APPENDIX 3. DOCUMENTED FATALITIES AT THE PROJECT
DURING FY 2019**

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| Species | Date Documented | WTG | Distance to WTG (meters) | Bearing from WTG (degrees) |
|--|------------------------|-------------------|---------------------------------|-----------------------------------|
| <i>Puffinus pacificus</i> (Wedge-tailed Shearwater) | 7/11/2018 | 12 | 43 | 330 |
| <i>Puffinus pacificus</i> (Wedge-tailed Shearwater) | 8/8/2018 | 10 | 30 | 210 |
| <i>Fregata minor</i> (Great Frigatebird) | 9/4/2018 | 8 | 58 | 300 |
| <i>Bubulcus ibis</i> (Cattle Egret) | 12/19/2018 | 4 | 3 | 30 |
| <i>Bubulcus ibis</i> (Cattle Egret) | 1/23/2019 | 11 | 3 | 350 |
| <i>Bubulcus ibis</i> (Cattle Egret) | 2/5/2019 | 12 | 26 | 180 |
| <i>Acridotheres tristis</i> (Common Myna) ¹ | 5/2/2019 | Kahuku Substation | N/A | N/A |
| 1. Species not afforded protection under the MBTA. | | | | |

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