

Kahuku Wind Power Habitat Conservation Plan FY 2021 Annual Report



Prepared for:
Kahuku Wind Power, LLC
56-1050 Kamehameha Hwy.
Kahuku, HI 96731

Prepared by:



Tetra Tech, Inc.
737 Bishop St., Suite 2340
Honolulu, Hawai'i 96813

November 2021

Final

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

This page intentionally left blank

Executive Summary

This report summarizes work performed by Kahuku Wind Power, LLC (KAH) at the Kahuku Wind Power Project (Project) during the State of Hawai'i fiscal year (FY) 2021 (July 1, 2020 – June 30, 2021) under the terms of the approved Habitat Conservation Plan (HCP). The HCP is dated May 27, 2010, and describes KAH's compliance obligations under Kahuku Wind Power, LLC's state Incidental Take License ITL-10 and federal Incidental Take Statement BO 2010-F-0190. This HCP covers eight species: seven are federally and state-listed as threatened and endangered and one is exclusively a state-listed endangered species. The Project was constructed in 2010 and has been operating since March 23, 2011.

Wildlife fatality (fatality) monitoring at the Project in FY 2021 continued within 35-meter radius circular search plots. These plots are centered on the wind turbine generators (WTGs) and were searched by canine-handler teams once per week year-round. Bias correction trials were conducted quarterly at the Project in FY 2021 to measure the probability that a carcass persists until the next search (carcass persistence) and the probability that an available carcass would be found by a canine search team (searcher efficiency). The results of these trials showed mean probabilities of persistence until the next search of 0.94 (bat surrogates) and 0.99 (medium-sized bird surrogates). Searcher efficiency was 0.88 for bat surrogates and 1.00 for medium bird surrogates.

One Hawaiian hoary bat fatality was found in FY 2021. A total of five bat fatalities have been observed as direct take at the Project since beginning operations March 23, 2011. The cumulative fatality estimate using the Evidence of Absence estimator at the upper 80 percent credibility level is 11 bats, and the total indirect take for this estimate is two adult equivalents. Combining these values, there is an approximately 80 percent chance that cumulative take of Hawaiian hoary bats from the start of operations through FY 2021 was less than or equal to 13 adults. No fatalities of other listed species were observed at the Project in FY 2021.

During FY 2021, KAH monitored bat activity at the Project through four ground-based acoustic detectors located at Project WTGs. Between July 1, 2020 and June 30, 2021, Hawaiian hoary bats were detected on six nights out of 1,409 detector-nights (0.43 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 2021, and mitigation planning for Tier 2 take will continue into FY 2021 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 2021.

KAH communicated actively with USFWS and DOFAW throughout FY 2021 with video and conference calls, submittal of quarterly reports, and e-mail communications related to the Project's HCP and associated mitigation. Communications included discussions of Hawaiian hoary bat Tier 2 mitigation funding and strategy.

This page intentionally left blank

Table of Contents

1.0	Introduction.....	1
2.0	Fatality Monitoring	1
3.0	Carcass Persistence Trials.....	2
4.0	Searcher Efficiency Trials.....	2
5.0	Vegetation Management.....	4
6.0	Scavenger Trapping.....	4
7.0	Documented Fatalities and Take Estimates.....	5
7.1	Hawaiian Hoary Bat	5
7.1.1	Estimated Take	5
7.1.2	Projected Take	7
7.2	Fatalities of Non-Covered Species.....	8
8.0	Wildlife Education and Observation Program.....	8
9.0	Mitigation.....	8
9.1	Hawaiian Hoary Bats	9
9.1.1	On-Site Acoustic Surveys.....	9
9.1.2	Kahikinui Forest Reserve Mitigation.....	12
9.1.3	Tier 2 Mitigation Planning.....	12
9.2	Other Covered Species	13
10.0	Adaptive Management.....	13
11.0	Agency Meetings, Consultations, and Visits.....	13
12.0	Expenditures.....	14
13.0	Literature Cited	14

List of Tables

Table 1. Observed Hawaiian Hoary Bat Fatalities at the Project through FY 20215
Table 2. Number of Detector-Nights Sampled and Proportion of Detector-Nights with
Bat Detections Between FY 2014 and FY 2021 10
Table 3. Summary of Agency Coordination and Communication in FY 2021..... 13
Table 4. HCP-Related Expenditures at the Project in FY 2021 14

List of Figures

Figure 1. HCP Implementation Components.....3
Figure 2. Monthly Bat Acoustic Activity at Kahuku for FY 2021 with Corresponding
Reproductive Periods..... 11
Figure 3. Monthly Bat Acoustic Activity at Kahuku for FY 2014 through FY 2021 with
Corresponding Reproductive Periods..... 12

List of Appendices

Appendix 1. Dalthorp et al. (2017) Fatality Estimation for Hawaiian hoary bats at the Project
through FY 2021
Appendix 2. Hawaiian Hoary Bat 20-Year Projected Take at the Project in FY 2021
Appendix 3. Documented Fatalities at the Project during FY 2021

1.0 Introduction

The Habitat Conservation Plan (HCP) for the Kahuku Wind Project (Project) was approved by the Hawaii 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 (KAH) in May and June of 2010, respectively. The ITS and ITL cover the incidental take of eight species: seven federally and state-listed threatened and endangered species and one exclusively 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 gallinule or 'alae 'ula (*Gallinula galeata sandwicensis*), 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. Brookfield Renewable Partners, LP (Brookfield) acquired the Project's LLC through acquisition of a controlling interest in TerraForm, LLC in 2017; the Project continues to be operated by KAH.

On behalf of KAH, Tetra Tech, Inc. (Tetra Tech) has prepared this progress report which describes work performed for the Project during the 2021 fiscal year for the State of Hawaii (FY; July 1, 2020 – June 30, 2021) pursuant to the terms and obligations of the approved HCP, ITL, and ITS. Kahuku Wind submitted previous annual HCP progress reports for FY 2011 through FY 2019 to USFWS and DOFAW (Kahuku Wind 2011, Kahuku Wind 2012, Kahuku Wind 2013, Kahuku Wind 2014, Kahuku Wind 2015, Kahuku Wind 2016, Kahuku Wind 2017, Kahuku Wind 2018, Tetra Tech 2019, Tetra Tech 2020).

2.0 Fatality Monitoring

In consultation with USFWS, DOFAW, and the Endangered Species Recovery Committee (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 wildlife fatality monitoring (fatality monitoring) effort involved twice weekly searches within a 64-meter radius circular monitoring plot (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 twice weekly.

- In December 2014, plots were reduced in size to the current 35-meter radius (Figure 1). Search frequency was monthly from December 2014 through March 2015.
- In April 2015, the search frequency of the 35-meter radius plots was increased to weekly where it currently remains.

Weekly searches of the 35-meter radius plots were completed throughout FY 2021. The plots were searched by trained detector dogs and their handlers (canine search teams). To accommodate the detector dogs, starting in January 2021 weekly searches occurred over two consecutive days with searches conducted at six of the 12 WTGs on each day. Fatality monitoring in FY 2021 achieved a mean search interval for WTGs of 6.9 days (Standard Deviation = 1.1 days). Should conditions prevent the use of dogs (e.g., weather, injury, availability of canine search team, etc.), plots would be visually surveyed by Project staff. In FY 2021, all searches were conducted by canine teams.

One Covered Species, Hawaiian hoary bat, was detected during fatality searches in FY 2021 (see Section 7.1). Other species fatalities are reported in Section 7.2, and no fatalities of other listed species have been observed at the Project.

3.0 Carcass Persistence Trials

A 28-day carcass persistence trial was conducted in each quarter of FY 2021 for a total of four trials. These trials used carcasses of black rats (*Rattus rattus*) as surrogates for Hawaiian hoary bats and wedge-tailed shearwaters (*Ardenna pacifica*) to represent medium-sized birds (surrogates for the avian Covered Species [Section 1.0]). In FY 2021, the mean probability that a bat surrogate carcass persisted until the next search was 0.94 (95 percent Confidence Interval [CI] = 0.66, 1.00; N=21) and for medium-sized bird carcasses was 0.99 (95 percent CI = 0.88, 1.00; N=10).

4.0 Searcher Efficiency Trials

Searcher efficiency trials occurred throughout the year to test wildlife carcass detection of canine search teams (no un-aided human only searches occurred in FY 2021). Fifty-seven searcher efficiency trials were administered to canine search teams over 17 trial days during FY 2021. Carcasses of black rats were used as surrogates for Hawaiian hoary bats. Carcasses of wedge-tailed shearwaters and cattle egrets (*Bubulcus ibis*) were used as surrogates for avian Covered Species. Of the 61 trial carcasses placed, four were lost to scavenging. The overall searcher efficiency in FY 2021 for bat surrogates was 0.88 (95 percent CI = [0.76, 0.95]; N = 43) and for medium-sized bird carcasses was 1.00 (95 percent CI = [0.84, 1.00]; N = 14).

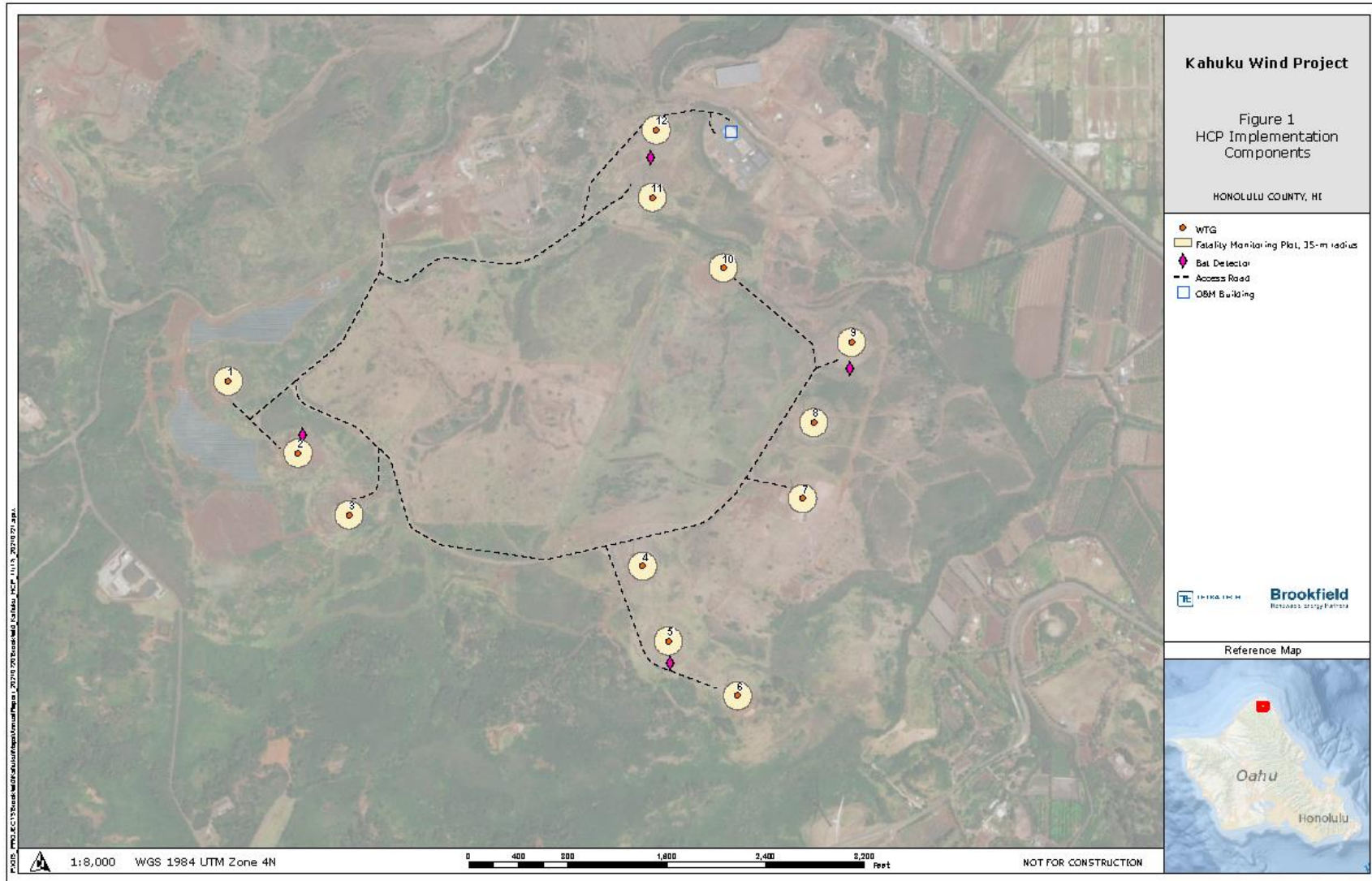


Figure 1. HCP Implementation Components

5.0 Vegetation Management

Search plots cover searchable area out to 35 meters from the base of the WTG. Search plots are comprised of bare ground and vegetation that is mowed when it reaches 4 to 6 inches in height. The search plots accommodate a relatively flat search area that is easily maintained; however, a small portion of the WTG 3 search plot has a slope that precludes vegetation management and is consequently not searched. Vegetation within the plots consists mainly of Bermuda grass (*Cynodon dactylon*), sensitive plant (*Mimosa pudica*), and Guinea grass (*Megathyrsus maximus*).

In FY 2021, vegetation management began in July of 2020 with all plots mowed approximately monthly to maintain high visibility during fatality searches. Plots were generally mowed the first week of each month immediately following weekly fatality searches so as not to mow over any potential fatalities. To accommodate an updated search schedule divided over two days, in late January of 2021, WTGs 1-6 were mowed approximately every four weeks on Wednesdays while WTGs 7-12 were mowed approximately every four weeks on Thursdays. Mowing followed the weekly fatality searches at the specified WTGs.

In June of FY 2020, the weed *Cenchrus echinatus* was identified within the search areas of WTG 12 and WTG 4. This invasive weed produces sharp, bur-like seed heads that are harmful to canine searchers. It was removed by hand from these areas after positive identification. Seed heads were collected and destroyed. These areas were monitored for reemergence in FY 2021. In September of 2020, the *C. echinatus* was identified to have re-emerged within the search plots at WTG 12 and WTG 4. These areas are monitored to assess whether the weed is spreading within the search plots. Currently, the size of the spread is no greater at either location than when it was initially observed in June of FY2020. Management efforts are planned for FY 2022.

6.0 Scavenger Trapping

In FY 2021, up to 75 Doc-250s, 15 Timms, and two Steve Allan traps were in use during trapping efforts. Trap set and check frequency was conducted twice a month thru December 2020, and once monthly after January 2021. During FY 2021, a total of 448 target animals were captured and removed including 324 mongoose (*Herpestes javanicus*), 109 rats (*Rattus* spp.), two mice (*Mus musculus*) and 13 feral cats (*Felis catus*). Nine “other” miscellaneous non-native non-target captures occurred during this timeframe including an invasive African snail (*Lissachatina fulica*) and frogs and toads (*Lithobates catesbeianus* and *Rhinella marina*). The probability of carcass persistence for a bat surrogate until the next search increased from 0.79 (95 percent CI=0.63, 0.90; N=22) in FY 2020 to 0.94 (95 percent CI] = 0.66, 0.99; N=21) in FY 2021.

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 (DOFAW and USFWS 2020). One Covered Species, a Hawaiian hoary bat, was detected during FY 2021. No injured (live) downed wildlife were observed at the Project in FY 2021.

Various factors affect how the number of observed fatalities is scaled to estimate the unobserved fatalities. Unobserved fatalities are due to 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; therefore, the proportion of the carcass distribution searched has varied. However, no changes to the search area have been made since December 2014 (Section 2.0). Thus, the estimate of the proportion of the carcass distribution searched in FY 2021 remains the same as described in the FY 2018 annual report (Kahuku Wind 2018).

7.1 Hawaiian Hoary Bat

7.1.1 Estimated Take

A total of five Hawaiian hoary bat fatalities have been observed at the Project since operations began on March 23, 2011. The most recently documented Hawaiian hoary bat fatality was a male detected on July 22, 2020 during a regular search. The carcass was detected 29 meters from the base of WTG 1, and was collected and transferred to the U.S. Geological Survey (USGS) for genetic sexing. All previous bat fatalities have been transferred to USGS for genetic sexing. The five bats were found inside of search plots; no incidental bat fatality detections have occurred to date. The observed Hawaiian hoary bat fatalities by fiscal year are listed in Table 1.

Table 1. Observed Hawaiian Hoary Bat Fatalities at the Project through FY 2021

Fiscal Year	Hawaiian Hoary Bat Observed Direct Take	Hawaiian Hoary Bat Incidental Fatality Observations	Total
2011	0	0	0
2012	3	0	3
2013	0	0	0
2014	0	0	0
2015	1	0	1

Fiscal Year	Hawaiian Hoary Bat Observed Direct Take	Hawaiian Hoary Bat Incidental Fatality Observations	Total
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	1
2020	0	0	0
2021	1	0	1
Total	5	0	5

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), an agency-approved analysis tool for analyzing direct take, uses results from bias correction trials and ODT to generate an upper credible limit (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 (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 five Hawaiian hoary bat fatalities found between the start of operation (March 23, 2011) and end of FY 2021 (June 30, 2021) is less than or equal to 11 bats (80 percent UCL). Details of the estimated direct take parameters are in Appendix 1.

Indirect take is estimated to account for the potential loss of future individuals (offspring) that may occur as the result of the loss of an adult female through direct take during the breeding period when 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 offspring (pups) per female that survive to weaning is assumed to be 1.8.
- The sex ratio of Hawaiian Hoary bats taken through UDT is assumed to be 50 percent female unless there is 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 from pregnancy to end of pup dependency for any individual Hawaiian hoary bat female 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 indirect take assessment uses a conversion of one juvenile bat as equal to 0.3 adults.

Based on the USFWS (2016) guidance, the estimate of cumulative indirect take in FY 2021 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**
 - $6 \text{ (unobserved direct take)} * 0.5 \text{ (assumed sex ratio)} * 0.25 \text{ (proportion of calendar year females could be pregnant or have dependent pups)} * 1.8 \text{ (pups per female)} = 1.4 \text{ juveniles}$
- **Total Calculated Juvenile Indirect Take = 5.9 (3.6 + 0.9 + 1.4)**
- **Total Adult Equivalent Indirect Take = 0.3 (juvenile to adult conversion factor) * 5.9 = 1.8**

Therefore, the estimated indirect take based on the UCL of Hawaiian hoary bat direct take at the Project is two adults (rounded up from 1.8).

The UCL for cumulative Project take of the Hawaiian hoary bat at the 80 percent credibility level is 13 adult bats (11 [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 2021 is less than or equal to 13 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.

KAH projected take through the end of the permit term using the fatality monitoring data collected through FY 2021. 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

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

2). For this analysis, the detection probability for future years is assumed to be constant at 0.63 (95 percent CI = [0.55, 0.71]). 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. 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 (i.e., 23 permitted take – 5 indirect take = 18 direct take).

Based on the analysis described above and presented in Appendix 2, there is a 41.1 percent chance that the 80 percent UCL of cumulative take will not be exceeded during the permit term. Specifically, the median of the projected mortality estimate 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 the estimate of indirect take is high, and the proportion of risk in the model was not adjusted to reflect that the Low Wind Speed Curtailment (LWSC) regime (Section 10.0) initiated in April 2012. LWSC will remain in place for the remainder of the Project's permit term. Reductions in fatalities of other bat species were estimated from large studies at industrial scale wind projects in North America with LWSC (Arnett et al. 2011, Good et al. 2011, Hein et al. 2014) and on-going research on bat deterrents and LWSC may provide improvements to avoidance and minimization measures. Two bat fatalities have been observed over approximately eight years since the LWSC implementation at KAH.

7.2 Fatalities of Non-Covered Species

Seven bird fatalities, representing six species, were documented at WTGs at the Project site in FY 2021. Four of the species observed in FY 2021 are protected by the Migratory Bird Treaty Act: wedge-tailed shearwater (one fatality), Pacific golden-plover (*Pluvialis fluva*; one fatality), great frigatebird (*Fregata minor*; one fatality), and cattle egret (two fatalities). For a complete list of fatalities detected in FY 2021 see Appendix 3.

8.0 Wildlife Education and Observation Program

Wildlife Education and Observation Program trainings continue to be conducted on an as-needed basis to provide on-site personnel with the information to respond appropriately if they observe a Covered Species or encounter downed wildlife while on-site. Wildlife Education and Observation Program trainings were provided to 16 individuals over 10 dates in FY 2021.

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

The HCP commits to performing acoustic monitoring for bat activity during years when systematic fatality monitoring is conducted. Bat acoustic monitoring has been conducted continuously at the Project since the start of operations; Anabat detectors were replaced with Wildlife Acoustics detectors beginning in FY 2014 (July 2013). Between FY 2014 and FY 2017, monitoring was conducted at 12 locations distributed across the Project. However, due to the low frequency in the number of nights with recorded bat activity, monitoring efforts were reduced to seven locations beginning in FY 2018 (Kahuku Wind 2018), and then reduced to four locations (WTGs 2, 5, 9, and 12; Figure 1) beginning in FY 2019. Acoustic monitoring units were located within 50 meters of the WTGs and consisted of a ground-based Song Meter SM2BAT+ ultrasonic recorder equipped with one SMX-U1 ultrasonic microphone (Wildlife Acoustics, Maynard, MA, USA) positioned 6.5 meters above ground level.

The objective of monitoring is to better understand the annual and seasonal variations in bat activity at the project. Analysis of variance (ANOVA) was used to test for differences in detection rates between FY 2014 and FY 2021. To test for a change in detection rates across all monitoring years we used a linear mixed-effect model (LMM) which include an interaction between year and sampling effort (i.e., the number of monitoring locations) and the site location as a random effect. All data were normalized using an Ordered Quantile normalization transformation. The distribution of residuals from the LMM were examined to check for violations of model assumptions. All tests were 2-tailed, employed an alpha value of 0.05, and were conducted in the R version 4.05 (R Core Team, 2017). The reporting period for FY 2021 spans the months June 2020 to May 2021. All previous sampling years have been adjusted to reflect this same sampling period. This change was made to allow adequate time for data review and analysis.

Bat activity at the Project is generally low. Across the four WTGs monitored during FY 2021, Hawaiian hoary bats were only detected on 9 nights out of the 1,283 (0.70 percent) detector-nights sampled. The annual detection rate in FY 2021 was higher than the annual detection rate in FY 2020 (0.42 percent). Among all monitoring years, annual detection rates were consistently low with no significant difference in the annual detection rate between years (ANOVA: $F_{7,67} = 1.08$, $P = 0.386$; Table 2). Annual detection rates across all monitoring years appear to be stable, with no significant increasing or decrease trend, regardless of the variation in the sampling effort (LMM; Year: $t_{15,67} = -1.04$, $P < 0.302$; Year*sampling effort: $t_{15,67} = 0.56$, $P < 0.576$).

Table 2. Number of Detector-Nights Sampled and Proportion of Detector-Nights with Bat Detections Between FY 2014 and FY 2021

Dates	No. of Nights Sampled	No. of Nights with Detections	Proportion of Nights with Detections
FY 2014 (June 2013 – May 2014) ¹	3,484	31	0.009
FY 2015 (June 2014 – May 2015) ¹	3,113	12	0.004
FY 2016 (June 2015 – May 2016) ¹	3,030	28	0.009
FY 2017 (July 2016 – June 2017) ¹	3,093	15	0.005
FY 2018 (June 2017 – May 2018) ²	1,458	10	0.007
FY 2019 (June 2018 – May 2019) ³	1,046	12	0.011
FY 2020 (June 2019 – May 2020) ³	1,413	6	0.004
FY 2021 (June 2020 – May 2021) ³	1,283	9	0.007
1. Number of detectors = 12. 2. Number of detectors = 7. 3. Number of detectors = 4.			

In FY 2021 no activity was observed prior to August of the lactation reproductive period (mid-June to August)². Detection rates peaked in September (0.028, $n = 107$) of the post-lactation reproductive period (September to mid-December), consisting of three nights with a single detection. Following the peak in September, detection rates steadily declined in the months of October and November. No activity was observed between December of the post-lactation reproductive period through May of the pregnancy reproductive period (Figure 2).

² Corresponding reproductive periods defined by Gorresen et al. 2003.

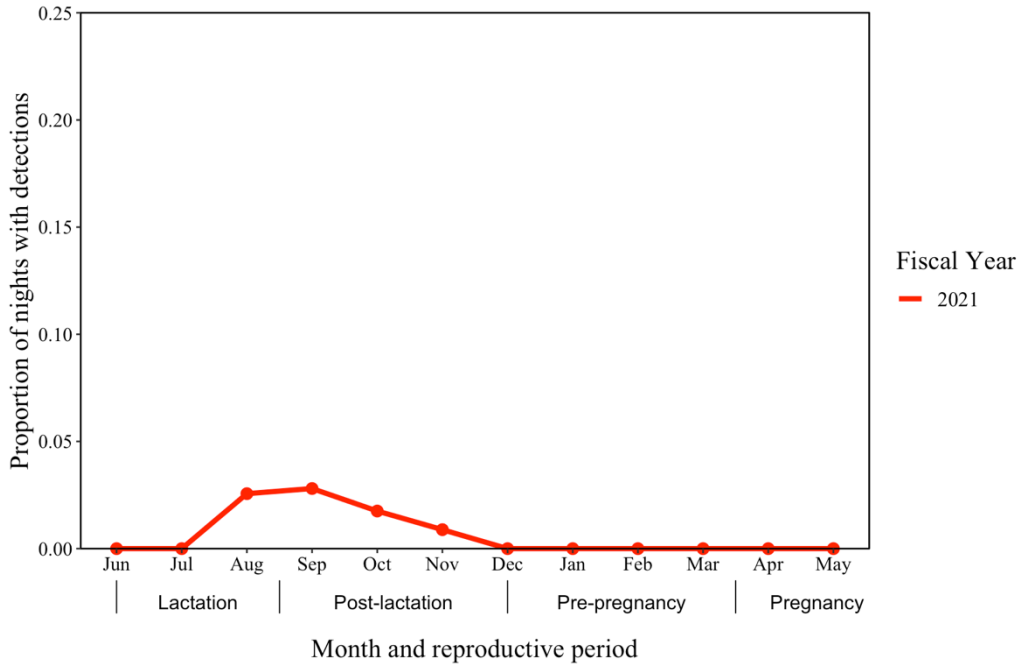


Figure 2. Monthly Bat Acoustic Activity at Kahuku for FY 2021 with Corresponding Reproductive Periods

The temporal pattern of the detection rates in FY 2021 was similar to the pattern of detection rates observed in previous years (Figure 3). 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 O’ahu (Starcevich et al. 2019) and Hawai’i Island (Todd 2012).

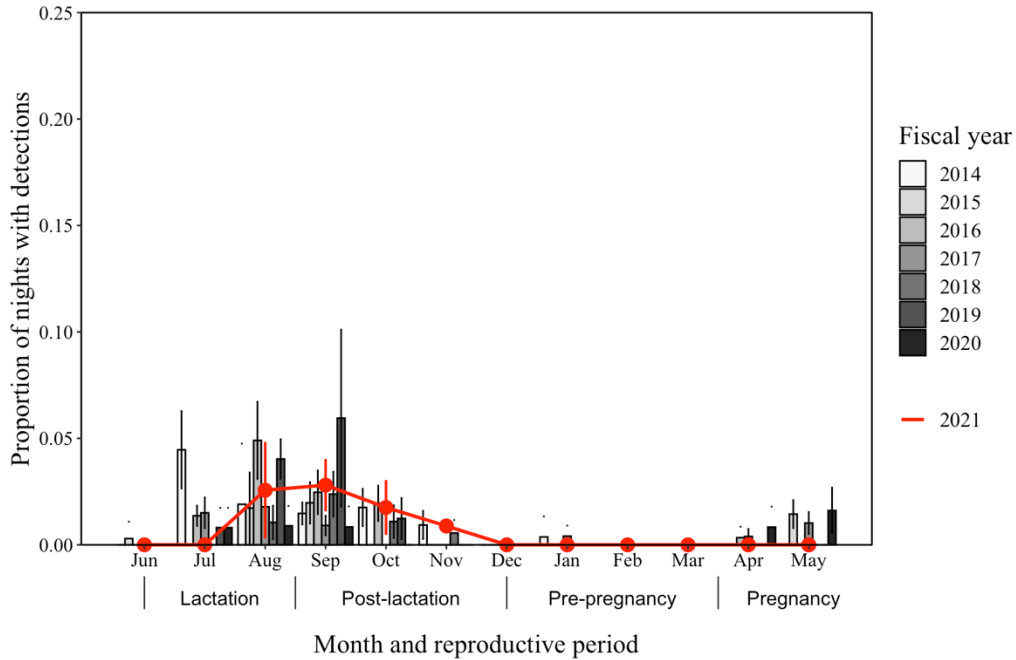


Figure 3. Monthly Bat Acoustic Activity at Kahuku for FY 2014 through FY 2021 with Corresponding Reproductive Periods

9.1.2 Kahikinui Forest Reserve Mitigation

The Baseline (Tier 1) Mitigation obligation for the Hawaiian hoary bat is complete. Kahuku Wind paid the full obligation of \$150,000 for Tier 1 bat mitigation 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 (Landon 2015).

9.1.3 Tier 2 Mitigation Planning

Mitigation planning for a Higher Level of Take (Tier 2) was initiated in FY 2021 prior to the Project’s bat take estimate surpassing 75 percent of take within Tier 1 (a threshold identified in previous discussions with the agencies as appropriate for subsequent tier planning). Planning discussions with DOFAW and USFWS yielded differing agency conclusions regarding the allocation of a mitigation credit of 2.63 bats for funding of the Hawai’i Island Hawaiian hoary bat ecological research study (Hawaiian Hoary Bat Research Group) exceeding the \$1.7M required to mitigate for identified portions of Brookfield’s Kaheawa I and II wind projects’ mitigation obligations. DOFAW agreed with KAH’s interpretation that Brookfield’s funding of costs beyond that required for the Kaheawa I and II wind projects mitigation obligations could represent a partial fulfillment of KAH’s Tier 2 bat obligation; USFWS did not agree. Based on input from USFWS and DOFAW, KAH is working with the Department of Land and Natural Resources (DLNR) to identify and fund

management actions beneficial to bats at one of DLNR’s recent bat mitigation property acquisitions on O’ahu.

Due to the relatively low level of take identified in Tier 2 (8 bats), the relatively short timeline for fulfillment of mitigation obligations, KAH is targeting a mitigation program that restores and enhances bat habitat within the Project’s permit term. KAH continues to discuss a framework for the Tier 2 mitigation plan with DOFAW and USFWS that takes into account the scale of the mitigation requirement and necessary timeline for fulfillment of the obligation.

9.2 Other Covered Species

Mitigation efforts for waterbirds were completed as of FY 2015 and no further reporting is required (Kahuku Wind 2016). All mitigation efforts for Newell’s shearwater and Hawaiian petrel were completed as of FY 2017; no further reporting is required (Kahuku Wind 2017, Pacific Cooperative Studies Unit and DOFAW 2017). Mitigation efforts for the Hawaiian short-eared owl were completed as of FY 2017 and no further reporting is required (Kahuku Wind 2017).

10.0 Adaptive Management

Kahuku Wind 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 adjustments in vegetation management and scavenger control efforts to maintain a high probability of detecting Project-related wildlife fatalities and implementing a Project-wide LWSC regime. LWSC of all turbines at wind speeds of up to 5 meters per second 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

KAH communicated actively with USFWS and DOFAW throughout FY 2021 through video teleconference, conference calls, submittal of quarterly reports, and e-mail communications related to the Project’s HCP (Table 3). These communications included focused discussions of Hawaiian hoary bat Tier 2 mitigation funding and strategy.

Table 3. Summary of Agency Coordination and Communication in FY 2021

Date	Communication	Participants
October 20, 2020	Annual HCP implementation review meeting (via teleconference)	KAH, Tetra Tech, USFWS, DOFAW
November 2, 2020	Submittal of FY2021 Q1 report	Submitted to USFWS, DOFAW by Tetra Tech

Date	Communication	Participants
January 19, 2021	USGS Research as Bat Mitigation update	KAH, Tetra Tech, USGS, USFWS, DOFAW
January 27, 2021	Annual HCP implementation review by ESRC	KAH, Tetra Tech, ESRC
January 29, 2021	Submittal of FY 2021 Q2 report	Submitted to USFWS, DOFAW by Tetra Tech
April 6, 2021	USGS Bat Research as Mitigation credit transfer meeting	KAH, USFWS, DOFAW
April 27, 2021	Submittal of FY 2021 Q3 report	Submitted to USFWS, DOFAW by Tetra Tech
April 29, 2021	Submittal of Request Memo for Adaptive Management of the Bat Mitigation Program	Submitted to DOFAW, USFWS
May 5, 2021	Semi-annual HCP implementation meeting (via teleconference)	KAH, USFWS, DOFAW
June 8, 2021	USFWS response letter to Bat Mitigation Credit Memo	Sent to Brookfield from USFWS

12.0 Expenditures

Total HCP-related expenditures for the Project in FY 2021 were \$170,000 (Table 4).

Table 4. HCP-Related Expenditures at the Project in FY 2021

Category	Amount
Permit compliance	\$48,500
Fatality monitoring	\$42,000
Acoustic monitoring for bats	\$9,000
Scavenger control	\$13,500
Vegetation management	\$40,000
Equipment and supplies	\$1,7000
Staff labor ¹	--
Total Cost for FY 2021	\$170,000
1. Staff labor costs are included in the overall costs for each other category.	

13.0 Literature Cited

Arnett, E., M. Huso, M. Schirmacher, and J. Hayes. 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. *Ecol. Environ.* 9(4) pp 209-214.

- Dalthorp, D., M. Huso, and D. Dail. 2017. Evidence of absence (v2.0) software user guide: U.S. Geological Survey Data Series 1055, 109 p., <https://doi.org/10.3133/ds1055>.
- DOFAW (Hawai'i Division of Forestry and Wildlife) and USFWS (U.S. Fish and Wildlife Service). 2020. Standard Protocol for Holders of a State of Hawai'i Incidental Take license and U.S. Fish and Wildlife Service Incidental Take Permit Responding to Dead or Injured Birds and Bats that are Threatened and Endangered Species or MBTA species.
- Good, R. E., W. Erickson, A. Merrill, S. Simon, K. L. Murray, K. Bay, and Chris Fritchman. 2011. Bat monitoring studies at the Fowler Ridge Wind Energy Facility Benton County, Indiana, April 13 – October 15, 2010. Prepared for Fowler Ridge Wind Farm, Fowler, Indiana. Prepared by Western EcoSystems Technology, Inc. Cheyenne WY.
- Gorresen, P.M., Bonaccorso, F., Pinzari, C., Todd, C., Montoya-Aiona, K. and Brinck, K. 2013. A Five Year Study of Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) Occupancy on the Island of Hawaii. Hawai'i Cooperative Studies Unit. Technical Report HCSU-041.
- Hein, C. D., A. Prichard, T. Mabee, and M. R. Schirmacher. 2014. Efficacy of an operational minimization experiment to reduce bat fatalities at the Pinnacle Wind Farm, Mineral County, West Virginia, 2013. An annual report submitted to Edison Mission Energy and the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, TX, USA.
- Kahuku Wind (Kahuku Wind Power, LLC). 2011. Kahuku Wind Power Habitat Conservation Plan FY-2011 Annual Report- Year 1. August 2011.
- Kahuku Wind. 2012. Kahuku Habitat Conservation Plan- ITL 10 FY-2012 Annual Report- Year 2. August 2012.
- Kahuku Wind. 2013. Kahuku Wind Power Habitat Conservation Plan FY-2013 Annual Report- Year 3. August 2013.
- Kahuku Wind. 2014. Kahuku Habitat Conservation Plan - FY-2014 Annual Report Year 4. August 2014.
- Kahuku Wind. 2015. Kahuku Habitat Conservation Plan Annual Report FY 2015. August 2015.
- Kahuku Wind. 2016. Kahuku Wind Power Habitat Conservation Plan Annual Report FY 2016. August 2016.
- Kahuku Wind. 2017. Kahuku Wind Power Habitat Conservation Plan Annual Report: FY 2017. August 2017.
- Kahuku Wind. 2018. Kahuku Wind Power Habitat Conservation Plan Annual Report: FY 2018. August 2018. Kahuku Wind Power.
- Landon, P. 2015. Hawaiian Hoary Bat Mitigation for Kahuku Wind Power, Island of Maui: FY 2015. Prepared for Kahuku Wind Power, LLC. Prepared by Division of Forestry and Wildlife. August 2015.

- Pacific Cooperative Studies Unit and DOFAW. 2017. Nonnative Avian Predator Control Annual Activity Report: FY 2017. Prepared for Kahuku Wind Power, LLC. Prepared by Pacific Cooperative Studies Unit and Division of Forestry and Wildlife. FY 2017
- Pinzari, C.A. and Bonaccorso, F.J., 2018, Hawaiian Islands Hawaiian Hoary Bat Genetic Sexing 2009-2019 (ver. 6.0, January 2021): U.S. Geological Survey data release, <https://doi.org/10.5066/P9R7L1NS>.
- Starcevich, L. A., J. Thompson, T. Rintz, E. Adamczyk, and D. Solick. 2019. Oahu Hawaiian Hoary Bat Occupancy and Distribution Study – Project Update and First-Year Analysis. Prepared for the Hawaii Endangered Species Research Committee. Prepared by Western EcoSystems Technology, Inc. Cheyenne WY. March 1, 2019.
- Tetra Tech (Tetra Tech, Inc.). 2019. Kahuku Wind Power Habitat Conservation Plan Annual Report: FY 2019. August 2019. Prepared for TerraForm Power, finalized December 2019.
- Tetra Tech (Tetra Tech, Inc.). 2020. Kahuku Wind Power Habitat Conservation Plan Annual Report: FY 2020. September 2020. Prepared for TerraForm Power.
- Todd, C. M. 2012. Effects of prey abundance on seasonal movements of the Hawaiian hoary bat (*Lasiurus cinereus semotus*). Master's Thesis, University of Hawai'i at Hilo.
- USFWS (U.S. Fish and Wildlife Service). 2016. Wildlife agency guidance for calculation of Hawaiian hoary bat indirect take. USFWS Pacific Islands Field Office. Honolulu, HI. October 2016.

**Appendix 1. Dalthorp et al. (2017) Fatality Estimation for
Hawaiian hoary bats at the Project through FY 2021**

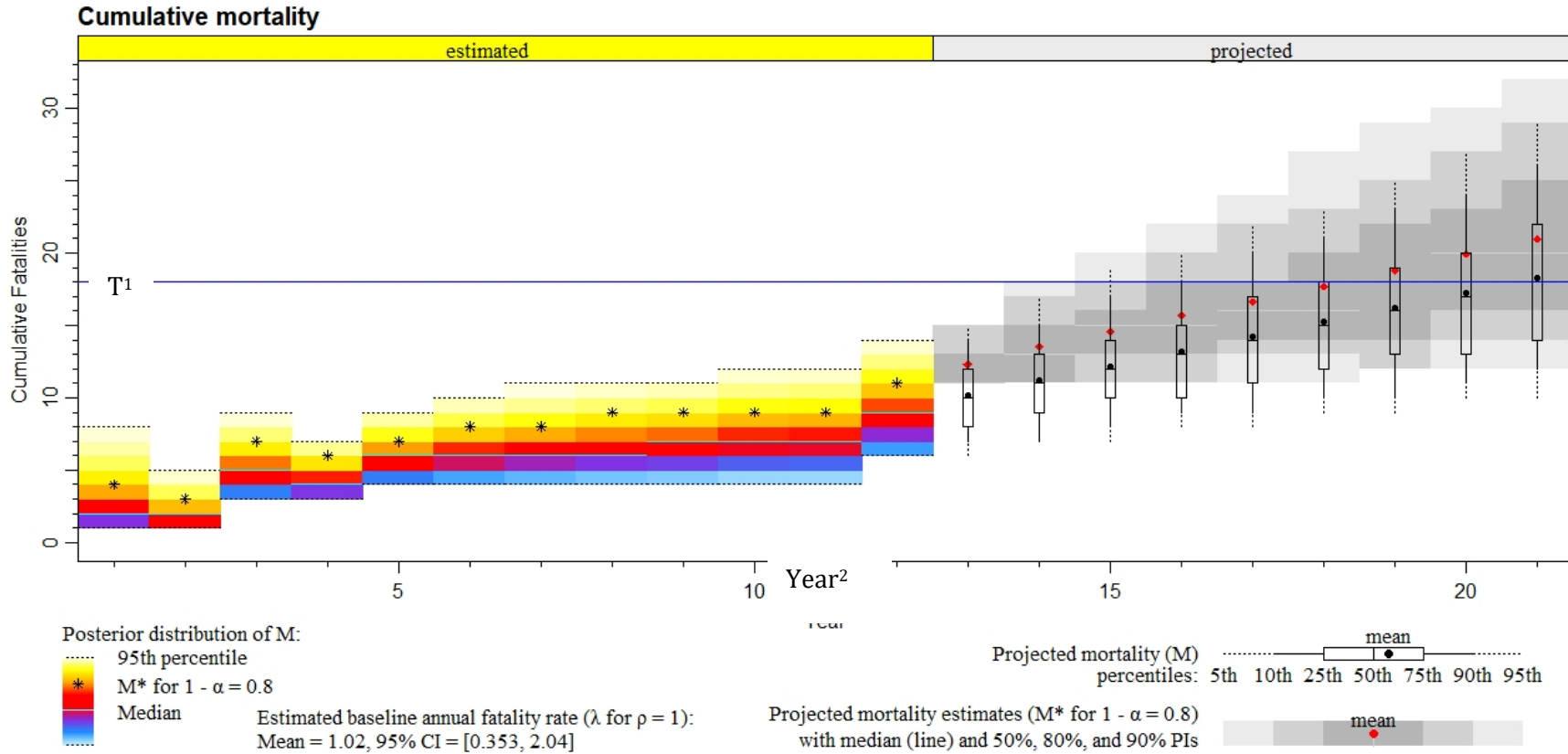
This page intentionally left blank

Modelling parameter		Modelling Period											
		1	2	3	4	5	6	7	8	9	10	11	12 (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	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	7/1/2019	7/1/2020
	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	7/1/2019	6/30/2020	6/30/2021
Period length (days)		273	182	122	333	91	150	456	364	364	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	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	7.0	7.0
Number of Searches in Modelling period		77	72	34	94	25	4	64	51	51	52	52	52
Observed fatalities (X)		1	0	2	0	1	0	0	0	0	0	0	1
K		0.7	0.7	0.7	0.7	0.7	0.7	1 ¹	1 ¹	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	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	0.411	0.527	0.632
	95% LCI	0.262	0.675	0.611	0.647	0.460	0.166	0.486	0.465	0.464	0.326	0.434	0.549
	95% UCI	0.672	0.894	0.861	0.955	0.850	0.554	0.642	0.595	0.605	0.618	0.618	0.714
B	Ba	9.841	39.66	33.65	17.27	13.94	7.456	87.01	119.5	101.7	50.73	58.89	86.42
	Bb	11.38	10.18	11.43	3.528	6.853	14.05	67.09	105.8	88.60	72.82	52.93	50.40
M* ³		4	3	7	6	7	8	8	9	9	9	9	11
<p>1. Searches performed by canine teams.</p> <p>2. Reduced search area (See FY 2018 Annual Report for detailed analysis).</p> <p>3. Cumulative value representing estimate of total direct take from the start of operations through the identified monitoring period at the 80 percent UCL.</p>													

This page intentionally left blank

**Appendix 2. Hawaiian Hoary Bat 20-Year Projected Take at the
Project in FY 2021**

This page intentionally left blank



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 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.

This page intentionally left blank

**Appendix 3. Documented Fatalities at the Project during FY
2021**

This page intentionally left blank

Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
<i>Lasiurus cinereus semotus</i> (Hawaiian hoary bat) ²	7/22/2020	1	29	305
<i>Garrulax canorus</i> (hwamei)	8/5/2020	1	29	33
<i>Fregata minor</i> (great frigatebird, 'Iwa) ¹	9/11/2020	9	84	263
<i>Pluvialis fulva</i> (Pacific golden-plover, Kōlea) ¹	11/19/2020	6	1	355
<i>Puffinus pacificus</i> (wedge-tailed shearwater, 'Ua'u kani) ¹	12/02/2020	9	33	300
<i>Bubulcus ibis</i> ¹ (cattle egret)	12/22/2020	12	30	300
<i>Bubulcus ibis</i> ¹ (cattle egret)	2/17/2021	10	5	45
<i>Lonchura atricapilla</i> (chestnut munia)	5/5/2021	11	16	210
2. Species protected under the MBTA.				

This page intentionally left blank
