

Kahuku Wind Power
Habitat Conservation Plan
Annual Report: FY 2018



Kahuku Wind Power, LLC
56-1050 Kamehameha Hwy
Kahuku, Hawai'i 96731
August, 2018

ITL-10 BO# 2010-F-0190

I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate and complete.

A handwritten signature in cursive script, reading "Mitchell Craig".

Hawai'i HCP Manager
TerraForm Power, LLC

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Executive Summary

Kahuku Wind Power, LLC (KAH) has been implementing a Habitat Conservation Plan (HCP) since approval in May 2010. A federal Biological Opinion (BO 2010-F-0190) and a Hawai'i Incidental Take License (ITL-10) were approved in May and June 2010, respectively. The project includes twelve 2.5 MW wind turbine generators and began commercial operations on March 23, 2011. This report summarizes work performed by KAH for the State of Hawai'i fiscal year (FY) 2018, July 1, 2017 - June 30, 2018. Species covered under the HCP include the Hawaiian stilt, Hawaiian coot, Hawaiian duck, Hawaiian moorhen, Newell's shearwater, Hawaiian petrel, Hawaiian hoary bat and the Hawaiian short-eared owl.

Terraform Power, LLC now operates KAH. Because of this ownership change the federal loan guarantee with U. S. Department of Energy is paid and DOE no longer regulates activities under the BO; however, the U.S. Fish and Wildlife Service has determined that the BO Incidental Take Statement associated with the BO remains in effect with a letter dated November 19, 2014. The HCP and ITL remain unchanged and in the project's name, Kahuku Wind Power, LLC.

Fatality monitoring plots were reduced to 35-meter (m) radius plots searched once weekly beginning in April 2015. Deborah Wilson and her canine Murphy provided canine-assisted searching in FY 2018. No visual searching occurred in FY 2018. Mean and standard deviation (SD) of search interval in days is 7.0 and 0.44, respectively. The FY 2018 search area density weighted proportion (DWP) of the predicted total fall distribution for the bat and medium sized birds is approximately 70% and 36%, respectively, based on ballistics modeling by Hull and Muir (2010).

No HCP covered species were found in FY 2018. Three great frigatebirds (*Fregata minor*) and one cattle egret (*Bulbulcus ibis*) were the Migratory Bird Treaty Act covered species found dead in FY 2018. No Hawaiian hoary bats have been found since August 29, 2014. The total estimated direct take for the four observed bats at an 80% credibility level is nine adults (five unobserved direct take) and the indirect take is three adults (converted using the juvenile to adult survival rate). The total estimated take at the end of FY 2018 is 12 adult bats. At the end of FY 2017 the reported total estimated adult take was 11 bats. No other covered species have been found at Kahuku since operations began.

Thirty-one searcher efficiency trials with four medium size birds and 27 small size rats and four 28-day carcass retention trials with four medium size birds and 20 small size rats were conducted in FY 2018. The results for searcher efficiency for small rats is 92.6 % and for medium birds is 100 %. The mean and SD for small rat carcass retention in days is 13.4 (SD = 11.4) and for medium birds is 28.0 (SD = 0.0).

Twelve Wildlife Acoustics SM2BAT+™ ultrasonic detectors with one SMX-U1™ microphone each located 50 meters from seven of Kahuku's 12 wind turbine generators and 6.5 meters above the ground detected Hawaiian hoary bats on 0.8 % of total detector nights in FY 2018. Bats were detected at six of seven locations and only in August through November.

Baseline mitigation for Newell's shearwater and Hawaiian petrel was completed in FY 2017 quarter 2. Baseline mitigation for waterbirds, pueo and bat are complete. KAH provided abbreviated quarterly summary reports for FY 2018 quarters 1-3. The Endangered Species Recovery Committee reviewed the FY 2017 annual HCP report on January 24, 2018.

Introduction

This report summarizes work performed by Kahuku Wind Power, LLC (KAH) under the terms of the approved Habitat Conservation Plan (HCP) dated May 27, 2010 and pursuant to the project's Incidental Take License (ITL-10) and Biological Opinion (BO# 2010-F-0190) at the conclusion of the State of Hawaii FY 2018 (July 1, 2017 – June 30, 2018). KAH has previously submitted annual HCP progress reports for FY 2011 through FY 2017 to the U.S. Fish and Wildlife Service (USFWS) and the Department of Land and Natural Resources- Division of Forestry and Wildlife (DOFAW) (Kahuku Wind Power 2011, 2012, 2013, 2014, 2015, 2016 and 2017).

The BO and ITL were issued for the project in May and June, 2010, respectively, for 20-year periods. The ITL and BO cover seven federally-listed threatened and endangered species and one state-listed endangered species: the Hawaiian stilt or ae'ō (*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*), Newell's shearwater or 'a'o (*Puffinus newelli*), Hawaiian petrel or 'ua'u (*Pterodroma sandwichensis*), Hawaiian hoary bat or 'ope'ape'a (*Lasiurus cinereus semotus*) and the Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*), respectively.

Terraform Power, LLC now operates KAH. Because of this ownership change the U.S. Department of Energy no longer regulates activities under the BO, however USFWS has determined in a letter dated November 19, 2014 that the BO Incidental Take Statement remains in effect. The HCP and ITL remain unchanged and in the project's name, Kahuku Wind Power, LLC.

Downed Wildlife Monitoring

KAH biologists have implemented a year-round monitoring program to document downed (i.e., injured or dead) wildlife incidents involving HCP-listed and non-listed species on the project site since operations began in January 2011 (commercial operations officially began on March 23, 2011). Fatality monitoring plots were reduced from initial intensive monitoring (twice weekly to 64-meter (m) radius circular plots centered on each wind turbine generator (WTG) and every two weeks to 96m radius) on September 15, 2014 to only 64m radius searched twice weekly. The KAH HCP indicates that after three years of intensive monitoring the search plot area could be reduced as an adaptive management action with agency agreement. Both USFWS and DOFAW agreed to this proposed reduction in an e-mail dated September 8, 2014.

In the December 16, 2014 meeting of the Endangered Species Recovery Committee (ESRC) members proposed KAH temporarily proceed with the "interim monitoring" plan until all monitoring data to date was compiled and presented at the next ESRC meeting. Interim monitoring had been proposed by KAH in keeping with the KAH HCP plan as monthly searches of all WTGs to 30m radius circular plots. From December 2014 through March 2015 plots were searched monthly to 35m radius. At the March 31, 2015 ESRC meeting, after review of monitoring data, members agreed to "encourage the applicant to work with the statistical experts and researchers to develop an alternative more efficient and focused monitoring strategy which still meets the committees expressed preference for continuation of annual monitoring". Interim monitoring was then discontinued and intensive monitoring within a reduced area commenced. Downed wildlife monitoring searches beginning in April 2015 have been conducted weekly, year-round, within 35m radius circular plots centered on each WTG (Figure 1).

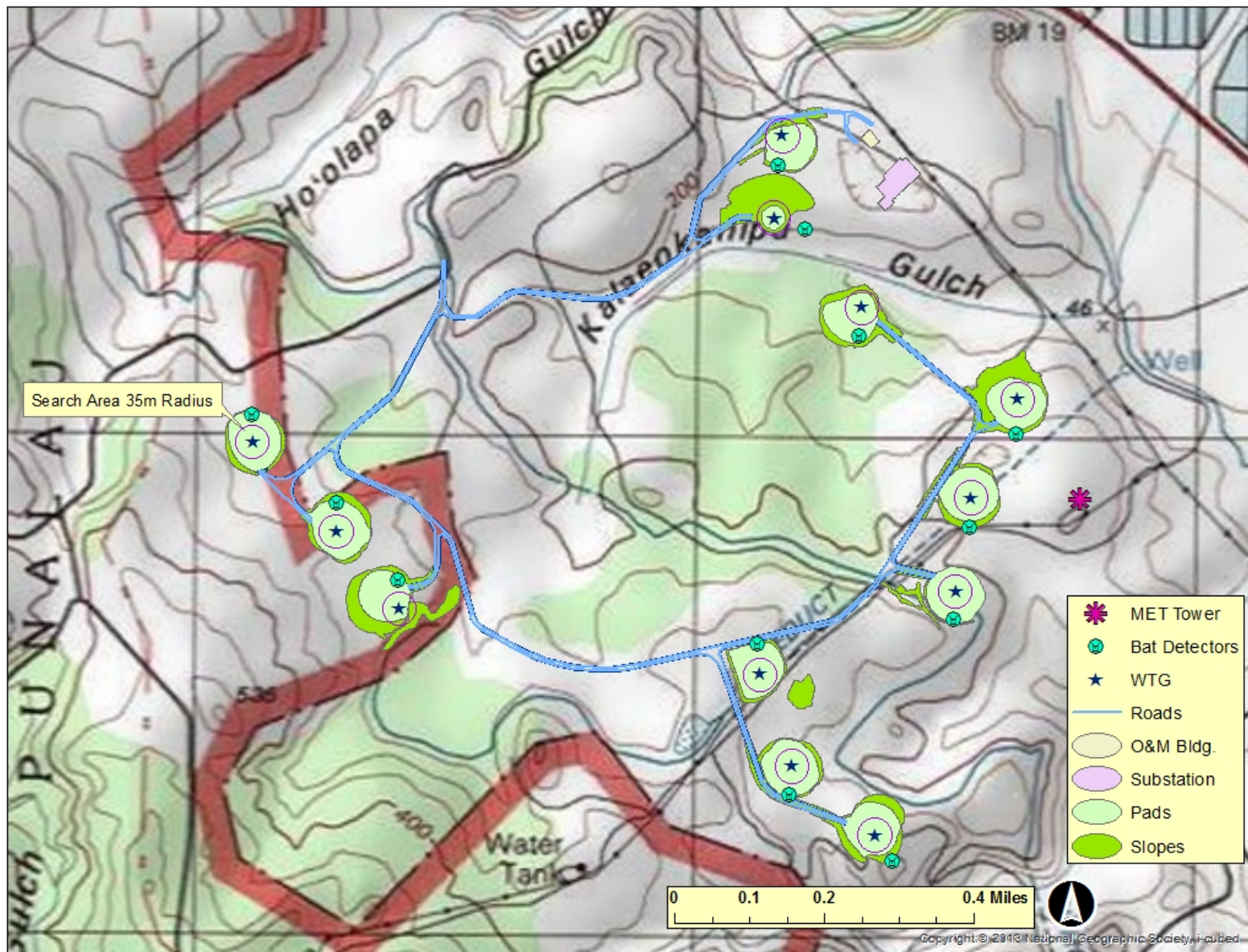


Figure 1. KAH roads, WTG's, MET tower, fatality monitoring plots and bat detector locations.

The density weighted proportion (DWP) of the predicted total fall distribution is one of the measured variables used to estimate the total take for each HCP listed species (see Estimated Adjusted Take). The DWP has also been called the density weighted area (DWA). No wind farms on O’ahu have WTGs with a nacelle height like KAH (80m) and the limited number of observed fatalities at KAH are insufficient to create a reliable fatality distribution from observed carcasses. Therefore, we base the DWP for the 35m radius circular plots at KAH on the ballistics modelling of Hull and Muir (2010). Hull and Muir consider WTGs with an 80m nacelle height to be “medium” height WTGs. The DWP of the total predicted fall distribution for bats at a medium height WTG and in a search area of 35m radius circular plots would be approximately 70% (Figure 2, Table 5 in Hull and Muir (2010)). Hull and Muir (2010) models that 38m radius includes 80% of the total predicted fatality distribution for bats.

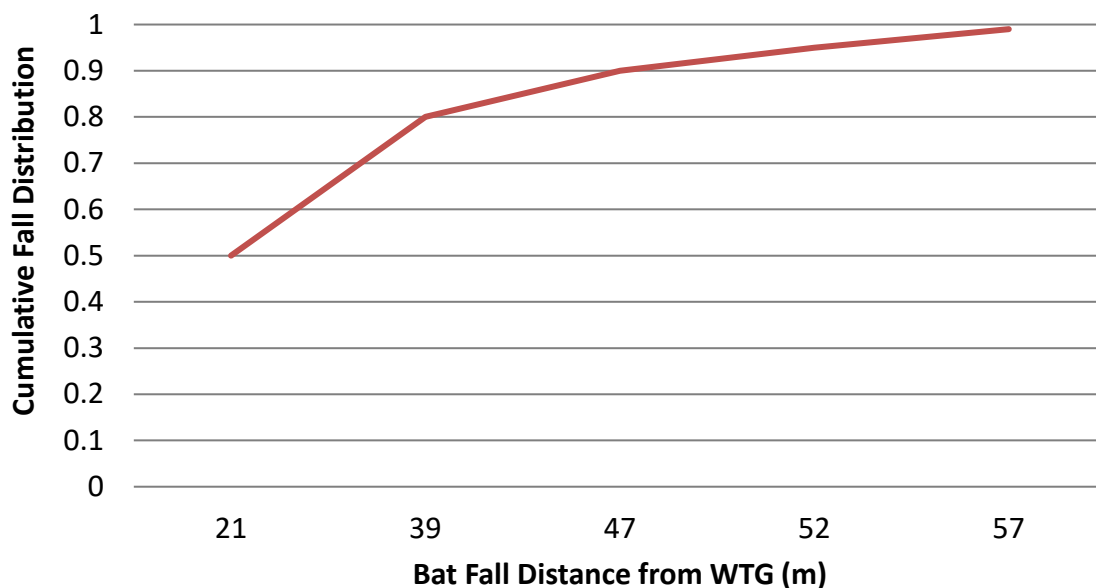


Figure 2. The cumulative fall distribution of bats struck by distance from WTG (based on Hull and Muir (2010) for a medium height WTG).

All searches for a specific week usually occurred on the same day, Wednesday (Appendix 1). Search interval mean and standard deviation (SD) in days for KAH in FY 2018 is 7.0 and 0.44, respectively. Canine-assisted searching began at KAH in August 2012. Deborah Wilson and her canine Murphy were contracted again to provide canine-assisted searching in FY 2018. Canine-assisted searching was the primary search method, with visual searching by HCP staff if canine-assisted searching was not available. No visual searches were required in FY 2018.

No HCP covered species’ fatalities were found in FY 2018. The total observed take for HCP covered species at KAH is four bats, with the last bat take observed August 29, 2014. Four Migratory Bird Treaty Act protected birds, three great frigatebirds (*Fregata minor*) and one cattle egret (*Bulbulcus ibis*), were found dead in FY 2018, on October 25, November 2, April 11 and June 21, respectively (Appendices 2, 3, 4, 5). No non-native introduced species were found. All incidents were reported to DOFAW and USFWS within 24 hours. KAH submitted downed wildlife incident reports to DOFAW and USFWS within three days of each discovery.

As prescribed in the HCP, KAH had initiated adaptive management (see Adaptive Management below) measures to reduce bat fatalities at the site on April 27, 2012.

Vegetation Management

Fatality monitoring plots around the WTG's are mowed every 2-3 weeks only within the 35m reduced search radius. The vegetation within 35m is primarily bare ground and short grass that reaches 4-6 inches before management.

Carcass Retention Trials

Four 28-day carcass retention (CARE) trials with four medium size birds (wedge-tailed shearwaters) and 20 small size rats were conducted in FY 2018, one trial in each quarter (Appendix 6). The mean medium bird carcass retention in days is 28.0 (SD = 0.0) and for small rat is 13.4 (SD = 11.4).

Searcher Efficiency Trials

Four medium size bird and 27 small rat searcher efficiency (SEEF) trials were successfully proctored for the canine-assisted searcher by the KAH HCP manager (Appendix 7). The searcher efficiency results for medium birds and small rats in FY 2017 is 100% and 92.6%, respectively.

Estimated Adjusted Take

The estimators used in this report were developed by USGS (Huso *et al.* 2015 and Dalthorp *et al.* 2017) and have been recommended by the agencies. The USGS Evidence of Absence estimator's output is a value that represents the number of fatalities that has not likely been exceeded during the survey period given a user-selected credibility level. Values can be generated for varying levels of "credibility" (confidence), expressed as a percentage (e.g., 50%, 80%, etc.) - the higher the desired level of credibility, the more conservative (higher) the estimated value. At the request of the agencies the more conservative 80% credibility level is reported. At the 80% level there is a 20% chance that the results of the estimator underestimates the number of fatalities that would be expected to be found under perfect searching conditions.

A stipulation of the estimator model is that only fatalities observed within the search area are included in the take estimation. Fatalities observed outside of the designated search area or incidental to searches are considered in the estimation calculation to have already been represented in the un-searched portion of the total expected fatality distribution. The latest protocol that explains how any observed fatality is to be considered is Appendix 8. No HCP covered species were found outside of the designated search area.

The total estimated direct take at the 80% credibility level, is nine; four observed and five unobserved direct take (Appendix 9). Observed direct take (ODT) is the only take that has been documented and confirmed at the site. However, for the purposes of estimating potential take for permitting and mitigation, the Evidence of Absence estimator calculates additional take that may have occurred but that was not observed. This unobserved direct take (UDT) attempts to account for fatalities that may have fallen outside of search plots, were missed by searchers within search plots, or were removed by scavengers or environmental factors such as high winds.

In addition to ODT and UDT, indirect take (IDT) is estimated separately for both ODT and UDT and represents the possible or known take of offspring that have been negatively affected by the direct take of their parents. For bats, only females care for their offspring and the bat breeding season designated by the USFWS and DOFAW is from April 1 – September 15. Any ODT of an adult female or sex unknown (conservatively assumed to be female) bat fatalities found during the breeding season are assumed to have dependent young, and a loss of 1.8 juveniles is calculated per female or unknown sex observed take (2 pups X 0.9 survival rate to weaning per pup). All four ODT (1 female and 3 unknowns) were found during the breeding season. Thus, the

IDT from the four ODT found during the breeding season would 7.2 juveniles ($4 \times 1.8 = 7.2$) (Appendix 10). The sex of all bats found during the breeding period will be determined in FY 2019 and IDT recalculated.

IDT estimated from bat UDT is calculated assuming 50% of unobserved take would be female and that for each female there is an average probability that she would be pregnant or lactating for three months in a year. Bats fly through the project area throughout the year and the probability of an individual female bat having dependent young during a 12-month period is assumed to be 25% (three out of 12 months). The average period of dependence is based on the information that Hawaiian hoary bats have one brood a year, and that hoary bats in North America have an average 56-day gestation period followed by parental care to weaning averaging 34 days or approximately three months for gestation and parental care (Hayssen *et al* 1993, Hayes and Wiles 2013, and NatureServe 2015 for *Lasiurus cinereus*). There is not enough information for hoary bats from Hawaii to determine the gestation and pre-weaning dependent period. Consequently, indirect take is assessed to bats lost through “unobserved direct take” at the rate of 0.225 juveniles/bat ($0.5 \times 0.25 \times 1.8 = 0.225$). The IDT for the unobserved direct take considering the 80% credibility level is 1.35 juveniles ($9 \text{ estimated} - 4 \text{ observed} = 5 \text{ unobserved} \times 0.225 = 1.125$).

The estimated rate of survival of young to reproductive age assumed from available data is 0.30 (extrapolated from *Myotis lucifugus* and *Eptesicus fuscus*, little and big brown bats; Humphrey 1982, Humphrey and Cope 1976). Bat IDT of 8.325 ($7.20 + 1.125 = 8.325$) converts to 2.5 or three adults rounded up ($8.325 \times 0.3 = 2.498$). The total estimated bat take at 80% credibility is not more than 12 adults. Eight years of the 20-year permit have been completed at the end of FY 2018 (although all WTGs were not operational from August 1, 2013 to September 1, 2014). The Tier 1 20-year take limit of 15 adults (12 adults and nine juveniles (converted to three adults)) has not been exceeded but has reached 75% of the Tier 1 take limit ($11.5/15 \times 100 = 76.7\%$). However, it is likely at least one of the three bats whose sex is unknown is not a female and if true would reduce the total estimated take by approximately half a bat. Mitigation planning, implementation, and funding for Tier 2 level take will occur in FY 2019. The total 20-year projected take is 28 adult bats and the permitted take is 23 adults (Appendix 11). Tier 2 mitigation will be for eight adult bats. Assuming the bat take rate and search conditions continue similarly, the total take estimate is expected to be less than the permitted take.

Hawaiian Hoary Bat Monitoring

Seven Wildlife Acoustics SM2BAT+™ ultrasonic bat detectors with one SMX-U1™ microphone (mic) each located 50m from seven of the project’s 12 WTG’s at 6.5m above the ground detected Hawaiian hoary bats on 0.8 % of detector nights (11 of 1315) in FY 2018 (Table 1). Bats were detected at six of seven locations and in August through November (Figure 3). Prior to October 2013 Titley Anabat™ detectors had been deployed around the site near WTGs beginning in 2011 (KAH 2013).

Table 1. Hawaiian hoary bat nights with detections and total detection nights at KAH in FY 2018.

| WTG Location | Detection Nights | Nights with Detections | Ratio |
|--------------|------------------|------------------------|---------------|
| 2 | 325 | 1 | 0.003 |
| 4 | 124 | 2 | 0.016 |
| 5 | 187 | 2 | 0.011 |
| 7 | 164 | 0 | 0 |
| 8 | 123 | 3 | 0.024 |
| 11 | 123 | 1 | 0.008 |
| 12 | 147 | 1 | 0.007 |
| Total | 1315 | 11 | 0.0083 |

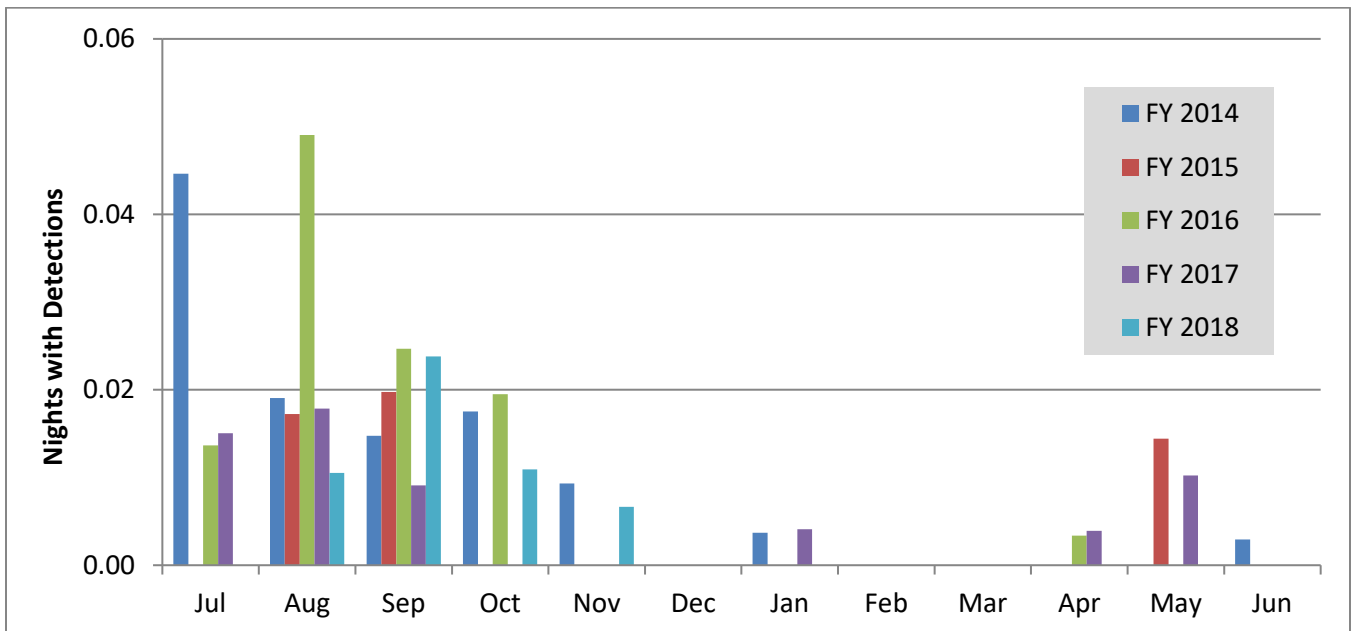


Figure 3. Proportion of total nights with bat detections at KAH in FY 2014-2018 (when Wildlife Acoustics SM2-BAT detectors were used).

Wildlife Education and Observation Program

Sixteen new personnel or long-term contractors required WEOP training orientation to be administered in FY 2018.

Mitigation

Newell's Shearwater and Hawaiian Petrel

As part of KAH's seabird mitigation obligation KAH funded the Kaua'i Endangered Seabird Recovery Project (KESRP) to deploy and then analyze data from Wildlife Acoustics SM2™ Songmeters at multiple locations in Kaua'i's remote mountains to survey for Newell's shearwater and Hawaiian petrel nesting colonies. These were deployed in August 2013, April 2014, and April 2015 via helicopter and were retrieved in October 2013, August 2014, and August 2015, respectively. Songs were analyzed and results summarized by Conservation Metrics, Inc. (Kahuku Wind Power 2016).

Additional mitigation for Newell's shearwater and Hawaiian petrel on Kaua'i began in FY 2015 Q4 and was completed in FY 2017 Q2. KAH funded DOFAW to conduct a barn owl predator control project on Kaua'i and Lehua Island, Ni'ihau at the chosen seabird colonies. Total funding for these projects has been \$349,000.

Waterbirds

KAH has completed its obligation for Hawaiian stilts, moorhens, and coot with funding already provided to DOFAW for four years of waterbird mitigation at Hamakua Marsh. Quarterly and annual reports of progress and results were submitted by DOFAW (Kahuku Wind Power 2012, 2013, 2014, 2015, 2016). Waterbird mitigation included four years of predator and vegetation control and productivity assessment. Total Coot, Moorhen and Stilt fledgling production from FY2012 through FY2015 was 13, 141 and 24, respectively. The total funding for this project was \$457,000.

Pueo

Total funding for pueo mitigation is complete and was \$75,000. \$25,000 funded the Hawaii Wildlife Center and \$50,000 has been provided to DOFAW for population research. Pueo population research began in FY 2017 investigates pueo population size, distribution, and habitat use on O'ahu (see <https://pueoproject.com>).

Hawaiian Hoary Bat

KAH has paid the full obligation of \$150,000 for ongoing Tier 1 bat mitigation being conducted by DOFAW at Kahikinui Forest Reserve on Maui. These funds were used for 2,500m of ungulate fencing around a 280-acre enclosed restoration area.

Adaptive Management

The third of the four total Hawaiian hoary bat fatalities occurred April 23, 2012. According to fatality estimate calculations the Baseline annual take of four was exceeded then, triggering Adaptive Management. In accordance with the HCP, low wind speed curtailment of all turbines up to a wind speed of five meters per second began April 27, 2012 and continues to be implemented between sunset and sunrise from April through November. Curtailment includes blades feathered to minimize rotation.

Agency Site Visits and Reporting

KAH provided abbreviated quarterly summary reports for FY 2018 quarters 1-3. The Endangered Species Recovery Committee reviewed the FY 2017 annual HCP report on January 24, 2018.

Expenditures

KAH total HCP related expenditures in FY 2018 were \$57,935 (Table 2).

Table 2. KAH total HCP related expenditures in FY 2018.

| Category | Cost (\$) |
|------------------------|------------------|
| Permit Compliance | 900 |
| Fatality Monitoring | 16,335 |
| Equipment and Supplies | 200 |
| Staff Labor | 40,500 |
| Total Cost | 57,935 |

Citations

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Appendix 1. Kahuku FY2018 Fatality Monitoring Plot Search Dates.

| Search Schedule | | | | | |
|------------------|-----------|------------|------------|------------|------------|
| July | 7/5/2017 | 7/11/2017 | 7/19/2017 | 7/25/2017 | |
| August | 8/2/2017 | 8/9/2017 | 8/16/2017 | 8/23/2017 | 8/30/2017 |
| September | 9/6/2017 | 9/13/2017 | 9/20/2017 | 9/28/2017 | |
| October | 10/4/2017 | 10/11/2017 | 10/18/2017 | 10/26/2017 | |
| November | 11/1/2017 | 11/8/2017 | 11/15/2017 | 11/22/2017 | 11/29/2017 |
| December | 12/6/2017 | 12/13/2017 | 12/20/2017 | 12/27/2017 | |
| January | 1/3/2018 | 1/10/2018 | 1/17/2018 | 1/24/2018 | 1/31/2018 |
| February | 2/7/2018 | 2/14/2018 | 2/21/2018 | 2/28/18 | |
| March | 3/7/2018 | 3/14/2018 | 3/21/2018 | 3/28/2018 | |
| April | 4/4/2018 | 4/11/2018 | 4/17/2018 | 4/25/2018 | |
| May | 5/2/2018 | 5/9/2018 | 5/16/2018 | 5/23/2018 | 5/30/2018 |
| June | 6/6/2018 | 6/13/2018 | 6/20/2018 | 6/27/2018 | |

**Appendix 2. Kahuku FY2018 -Downed Wildlife Incident Report
Great Frigatebird 10-25-2017.**

| | |
|--|--|
| Date Discovered: | October 25, 2017 |
| Type of Discovery (shade one): | Search <input checked="" type="checkbox"/> Incidental <input type="checkbox"/> |
| Discovered by: | Deborah Wilson |
| Affiliation: | Contract dog handler |
| Species (Common name): | <i>Fregata minor</i> (Great frigatebird) |
| Time Discovered (HST): | 5:55 |
| Time Initially Reported to Agencies (HST): | 18:30 |
| Time Agency Responders Arrive/Advise (HST): | N/A |
| Location Description: | WTG 1 |
| GPS Coordinates: | 21° 40' 54" N, 157° 59' 04" W |
| Date Last Surveyed: | October 18, 2017 |
| Distance of Animal to Base of Nearest WTG: | 51 m |
| Bearing of Animal from Base of Nearest WTG: | 287° (west) |
| Ground Cover Type: | Low shrub |
| Wind Direction and Speed (mph): | West 1-4 |
| Cloud Cover (%): | 100 |
| Cloud Deck (magl): | Low |
| Precipitation: | none |
| Temperature: (°F) | 73 |
| Condition of Specimen: Only one large wing, very old, scavenged, rank odor. No other parts found nearby. | |
| Probable Cause of Injuries and Supportive Evidence: Proximity to WTG suggests blade collision. Found at edge of graded pad. | |
| Sequence of Events: Wing collected and stored temporarily at Kahuku Wind Power. | |



Photo 1. Location of wing relative to WTG 1.



Photo 2. Wing as found in low shrub.



Photo 3. Wing on bare ground near found location.

**Appendix 3. Kahuku FY2018 -Downed Wildlife Incident Report
Great Frigatebird 11-1-2017.**

| | | | |
|--|--|------------|--|
| Date Discovered: | November 1, 2017 | | |
| Type of Discovery (shade one): | Search | Incidental | |
| Discovered by: | Deborah Wilson | | |
| Affiliation: | Canine contractor | | |
| Species (Common name): | <i>Fregata minor</i> (Great frigatebird) | | |
| Age/sex | Adult female | | |
| Time Discovered (HST): | 08:15 | | |
| Time Initially Reported to Agencies (HST): | 16:49 | | |
| Time Agency Responders Arrive/Advise (HST): | N/A | | |
| Location Description: | WTG 7 | | |
| GPS Coordinates: | N 21° 40' 42", W 157° 58' 27" | | |
| Date Last Surveyed: | October 25, 2017 | | |
| Distance of Animal to Base of Nearest WTG: | 30 m | | |
| Bearing of Animal from Base of Nearest WTG: | 234° | | |
| Ground Cover Type: | Bare/Short grass | | |
| Wind Direction and Speed (mph): | SE 3-6 | | |
| Cloud Cover (%): | 10 | | |
| Cloud Deck (magl): | >1000 | | |
| Precipitation: | 0 | | |
| Temperature: (°F) | 78 | | |
| Condition of Specimen: Fresh, pliable, bill cracked, neck broken? | | | |
| Probable Cause of Injuries and Supportive Evidence: Proximity suggests turbine strike. | | | |



Photo 1. Great frigatebird as found with WTG 7 in background.



Photo 2. Ventral and head/beak.



Photo 3. Dorsal view.



Photo 4. Cracked beak.

**Appendix 4. Kahuku FY2018 -Downed Wildlife Incident Report
Great Frigatebird 4-11-2018.**

Observer Name: Deborah Wilson (contract dog-handler)
Date of Incident: April 11, 2018
Date of Report: April 12, 2018
ID Number: 20180411_Kahuku_T12_GRFR
Species (Common Name): *Fregata minor* (Great Frigatebird)
Age: Adult
Sex (if known): Male
Incidental or Routine Search: Routine
Time Observed (HST): 10:45
Time initially Reported (HST): 11:07
Time Responders Arrive (HST): N/A
General Location: Near Turbine 12
GPS Coordinates: Latitude: 21.68722
Longitude: -157.974166
WGS 84 Hawaii State Plane Zone 2
Date Last Surveyed: April 4, 2018
Closest Structure (eg Turbine #): Turbine 12
Distance to base of closest structure: 53 m
Bearing from base of closest structure (degrees): 210°
Ground Cover Type: Short grass
Wind Direction and Speed: East 20mph
Cloud Cover (%): 25%
Cloud Deck: High
Precipitation: None
Temperature: 78°F
Condition of Specimen: Dead, fresh, pliable, no insects,
right wing broken, possible broken neck
Probable Cause of Injuries: Collision with turbine blade



Figure 1. A photo of the relative to the turbine.



Figure 2. A photo of the as found.

**Appendix 5. Kahuku FY2018 -Downed Wildlife Incident Report
Cattle Egret 6-21-2018.**

Observer Name: Tanner Nail (Terraform Power Operations)

Date of Incident: June 21, 2018

Date of Report: June 22, 2018

ID Number: 20180622_Kahuku_T02_CAEG

Species (Common Name): *Bulbulcus ibis* (Cattle Egret)

Age: Adult

Sex (if known): Unknown

Incidental or Routine Search: Incidental

Time Observed (HST): 11:39

Time initially Reported (HST): June 22, 9:03

Time Responders Arrive (HST): N/A

General Location: Near Turbine 2

GPS Coordinates: Latitude: 21.6803 N

Longitude: 157.9825 W

WGS 84 Hawaii State Plane Zone 2

Date Last Surveyed: June 20, 2018

Closest Structure (eg Turbine #): Turbine 2

Distance to base of closest structure: 12 m

Bearing from base of closest structure (degrees): 203°

Ground Cover Type: Bare ground

Wind Direction and Speed: Northeast 15mph

Cloud Cover (%): 10%

Cloud Deck: High

Precipitation: None

Temperature: 85°F

Condition of Specimen: Dead, fresh, pliable, no insects, right wing severed, possible broken neck

Probable Cause of Injuries: Collision with turbine blade



Photo 1. Cattle Egret relative to WTG 2.



Photo 2. Cattle Egret as found.



Photo 3. Missing wing.

Appendix 6. Kahuku FY2018 CARE Trials AF, AG, AH, and AI.

| CARE AF FY2018 | | Trial 1 | | Trial 2 | | Trial 3 | | Trial 4 | | Trial 5 | | Trial 6 | |
|------------------|--------|-------------------------|-------|---------|-------|---------|-------|---------|-------|---------|-------|---------|-------|
| Carcass Type | | Rat | | Bird | | Rat | | Rat | | Rat | | Rat | |
| WTG | | 1 | | 3 | | 5 | | 7 | | 9 | | 11 | |
| Vegetation | | Short Grass/Bare Ground | | | | | | | | | | | |
| Distance (m) | | 15 | | 21 | | 26 | | 19 | | 28 | | 20 | |
| Day | Date | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes |
| 0 | 29-Aug | P | | P | | P | | P | | P | | P | |
| 1 | 30-Aug | P | H | P | | P | L,S,D | P | | P | A,L | P | A,C |
| 2 | 31-Aug | P | L | P | | P | | A | | P | S,H | P | |
| 3 | 1-Sep | P | S,D | P | | P | H | | | P | D | P | L |
| 4 | 2-Sep | P | | P | | P | S | | | P | | P | |
| 5 | 3-Sep | P | | P | B,D | P | | | | P | | P | D,S |
| 6 | 4-Sep | P | | P | | P | | | | P | | P | |
| 7 | 5-Sep | P | | P | | P | | | | P | | P | |
| 8 | 6-Sep | P | | P | | P | | | | P | | P | |
| 9 | 7-Sep | P | | P | | P | | | | P | | P | |
| 10 | 8-Sep | P | | P | | P | | | | P | | P | |
| 11 | 9-Sep | P | | P | | P | | | | P | | P | |
| 12 | 10-Sep | P | | P | | P | | | | P | | P | |
| 13 | 11-Sep | P | | P | | P | | | | P | | P | |
| 14 | 12-Sep | P | | P | | P | | | | P | | P | |
| 21 | 19-Sep | P | | P | | P | | | | P | | P | |
| 28 | 26-Sep | A | | P | | P | | | | P | | P | |
| Retention (days) | | 21 | | 28 | | 28 | | 1 | | 28 | | 28 | |

| | | | |
|------|---------------|---|---------------|
| A | ants | L | fly larvae |
| B | body feathers | M | moved |
| C | dirt covered | P | present |
| D | desiccated | A | absent |
| F | feathers | S | skeleton |
| H | hair loss | W | wing feathers |
| Scav | Scavenged | | |

Appendix 6 (cont.).

| CARE AG FY2018 | | Trial 1 | | Trial 2 | | Trial 3 | | Trial 4 | | Trial 5 | | Trial 6 | |
|------------------|--------|-------------------------|-------|---------|---------|---------|-------|---------|-------|---------|-------|---------|-------|
| Carcass Type | | Rat | | Bird | | Rat | | Rat | | Rat | | Rat | |
| WTG | | 2 | | 4 | | 6 | | 8 | | 10 | | 12 | |
| Vegetation | | Short Grass/Bare Ground | | | | | | | | | | | |
| Distance (m) | | 26 | | 24 | | 23 | | 24 | | 26 | | 24 | |
| Day | Date | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes |
| 0 | 15-Nov | P | | P | | P | | P | | P | | P | |
| 1 | 16-Nov | P | | P | | P | | P | | P | | P | |
| 2 | 17-Nov | P | A | P | Scav, F | P | A | P | | P | | P | |
| 3 | 18-Nov | P | | P | B,W | P | | P | A,L | P | A | P | |
| 4 | 19-Nov | | | | | | | | | | | | |
| 5 | 20-Nov | A | | P | | A | | A | | P | L | P | A,L |
| 6 | 21-Nov | | | P | | | | | | P | | P | |
| 7 | 22-Nov | | | P | | | | | | P | S,D | P | S,D |
| 8 | 23-Nov | | | P | | | | | | P | | P | |
| 9 | 24-Nov | | | P | | | | | | P | | P | |
| 10 | 25-Nov | | | P | | | | | | P | | P | |
| 11 | 26-Nov | | | P | | | | | | P | | P | |
| 12 | 27-Nov | | | P | | | | | | P | | P | |
| 13 | 28-Nov | | | P | | | | | | P | | P | |
| 14 | 29-Nov | | | P | | | | | | P | | P | |
| 21 | 6-Dec | | | P | | | | | | P | | P | |
| 28 | 13-Dec | | | P | >10B | | | | | P | | P | |
| Retention (days) | | 3 | | 28 | | 3 | | 3 | | 28 | | 28 | |

Appendix 6 (cont.).

| CARE AH FY2018 | | Trial 1 | | Trial 2 | | Trial 3 | | Trial 4 | | Trial 5 | | Trial 6 | |
|------------------|--------|-------------------------|-------|-------------|------------|---------|-------|---------|-------|---------|-------|---------|-------|
| Carcass Type | | Rat | | Medium Bird | | Rat | | Rat | | Rat | | Rat | |
| WTG | | 2 | | 4 | | 6 | | 8 | | 10 | | 12 | |
| Vegetation | | Short Grass/Bare Ground | | | | | | | | | | | |
| Distance (m) | | 30 | | 25 | | 25 | | 30 | | 20 | | 30 | |
| Day | Date | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes |
| 0 | 1-Mar | P | | P | | P | | P | | P | | P | |
| 1 | 2-Mar | P | | P | | P | | P | A | P | M | P | |
| 2 | 3-Mar | P | | P | | P | A | P | C,H | P | | P | A |
| 3 | 4-Mar | P | | P | | P | H | P | | A | | P | |
| 4 | 5-Mar | P | | P | | P | | P | | | | P | M,H |
| 5 | 6-Mar | P | L | P | | P | | P | | | | P | |
| 6 | 7-Mar | P | | P | | P | | P | | | | P | |
| 7 | 8-Mar | P | | P | | P | | P | | | | P | D,S |
| 8 | 9-Mar | P | | P | | P | D | P | | | | P | |
| 9 | 10-Mar | P | | P | | P | | P | | | | A | |
| 10 | 11-Mar | P | | P | SCAV,M,B,W | P | | P | | | | | |
| 11 | 12-Mar | P | | P | | P | | P | | | | | |
| 12 | 13-Mar | P | | P | | P | | P | | | | | |
| 13 | 14-Mar | A | | P | | P | | P | S,D | | | | |
| 14 | 15-Mar | | | P | | A | H | P | | | | | |
| 21 | 22-Mar | | | P | | | | P | S | | | | |
| 28 | 29-Mar | | | P | B,W | | | A | | | | | |
| Retention (days) | | 12 | | 28 | | 13 | | 21 | | 2 | | 8 | |

Appendix 6 (cont.).

| CARE AI FY2018 | | Trial 1 | | Trial 2 | | Trial 3 | | Trial 4 | | Trial 5 | | Trial 6 | |
|------------------|--------|-------------------------|--------|---------|-------|---------|-------|---------|-------|---------|-------|---------|-------|
| Carcass Type | | Bird | | Rat | | Rat | | Rat | | Rat | | Rat | |
| WTG | | 1 | | 3 | | 5 | | 7 | | 9 | | 11 | |
| Vegetation | | Short Grass/Bare Ground | | | | | | | | | | | |
| Distance (m) | | 21 | | 24 | | 21 | | 28 | | 24 | | 15 | |
| Day | Date | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes | P/A | Notes |
| 0 | 4-Jun | P | | P | | P | | P | | P | | P | |
| 1 | 5-Jun | P | | P | | P | A | P | | P | A | P | |
| 2 | 6-Jun | P | | P | | P | | P | L | P | | P | |
| 3 | 7-Jun | P | L | P | | P | M | A | H | P | C,H | P | L |
| 4 | 8-Jun | P | SCAV,W | A | | P | | | | A | C,S | P | |
| 5 | 9-Jun | P | | | | A | | | | | | P | |
| 6 | 10-Jun | P | | | | | | | | | | P | D,S |
| 7 | 11-Jun | P | | | | | | | | | | P | M |
| 8 | 12-Jun | P | | | | | | | | | | P | |
| 9 | 13-Jun | P | | | | | | | | | | P | |
| 10 | 14-Jun | P | W,B | | | | | | | | | P | |
| 11 | 15-Jun | P | | | | | | | | | | P | |
| 12 | 16-Jun | P | | | | | | | | | | P | |
| 13 | 17-Jun | P | | | | | | | | | | P | |
| 14 | 18-Jun | P | | | | | | | | | | P | |
| 21 | 25-Jun | P | | | | | | | | | | P | |
| 28 | 2-Jul | P | | | | | | | | | | P | |
| Retention (days) | | 28 | | 3 | | 4 | | 2 | | 3 | | 28 | |

Appendix 7. Kahuku FY2018 SEEF Trials.

| Date | WTG | Vegetation Class | Carcass Type | Found |
|------------|-----|------------------|--------------|-------|
| 8/2/2017 | 12 | Short | Bird | 1 |
| 2/14/2018 | 12 | Short | Bird | 1 |
| 3/21/2018 | 11 | Short | Bird | 1 |
| 6/6/2018 | 4 | Short | Bird | 1 |
| 8/2/2017 | 6 | Short | Rat | 1 |
| 8/2/2017 | 6 | Short | Rat | 1 |
| 8/2/2017 | 7 | Short | Rat | 1 |
| 8/2/2017 | 11 | Short | Rat | 1 |
| 8/16/2017 | 10 | Short | Rat | 1 |
| 8/16/2017 | 12 | Short | Rat | 1 |
| 9/28/2017 | 6 | Short | Rat | 1 |
| 9/28/2017 | 10 | Short | Rat | 1 |
| 9/28/2017 | 12 | Short | Rat | 1 |
| 10/26/2017 | 4 | Short | Rat | 1 |
| 10/26/2017 | 5 | Short | Rat | 1 |
| 10/26/2017 | 11 | Short | Rat | 1 |
| 12/6/2017 | 3 | Short | Rat | 1 |
| 12/6/2017 | 9 | Short | Rat | 0 |
| 1/17/2018 | 2 | Short | Rat | 1 |
| 1/17/2018 | 7 | Short | Rat | 1 |
| 1/17/2018 | 9 | Short | Rat | 1 |
| 2/14/2018 | 1 | Short | Rat | 1 |
| 2/14/2018 | 3 | Short | Rat | 1 |
| 2/14/2018 | 11 | Short | Rat | 1 |
| 3/21/2018 | 1 | Short | Rat | 1 |
| 3/21/2018 | 4 | Short | Rat | 1 |
| 3/21/2018 | 6 | Short | Rat | 1 |
| 5/9/2018 | 11 | Short | Rat | 1 |
| 5/9/2018 | 12 | Short | Rat | 1 |
| 6/6/2018 | 6 | Short | Rat | 0 |
| 6/6/2018 | 12 | Short | Rat | 1 |

Wildlife agency standardized protocols for wildlife fatalities found outside the designated search area or discovered incidentally outside of a routine search

Evidence of Absence software (Dalthorp et al 2017; <https://pubs.er.usgs.gov/publication/ds1055>) utilizes the number of observed carcasses and the detection probability to produce a probability distribution of the number of fatalities that may have occurred based on imperfect detection. The number of carcasses entered as “Observed” assumes that the carcasses were found in the designated search area and during a routine search. In January 2018, the wildlife agencies discussed the need for establishing a standardized protocol for fatalities of protected wildlife species that are modeled with Evidence of Absence Ver. 2.0.6. but fail to meet the input criteria required by the model. Such exceptions may include carcasses found outside of the designated search area during a routine search, or carcasses incidentally discovered outside of a routine search day. “Rules” for treating these exceptions in the Evidence of Absence model should recognize and encumber the best science in order to maintain the validity of the software’s output and not purposefully violate the basic mathematical assumptions that drive the model.

To best accommodate these types of Observed carcasses, the wildlife agencies provide the following standardized guidance. For the purposes of this guidance, assume the carcass found is of the species you are modeling.

Fatality found outside of the designated reduced search area

This situation would only apply to projects that have a carcass search area that has been reduced below where a carcass could potentially fall.

The Downed Wildlife Protocol and accompanying reporting procedures should be followed for carcasses found outside of the reduced routine search area. The carcass will be considered accounted for in the Unobserved take by the Evidence of Absence model. The report should clearly note the measured location of the carcass and relationship to the area searched in addition to the standard data required on the downed wildlife report. Measurements reported in meters will be based on distance from the turbine base or nearest structure. Such measurement should be conducted with a tape measure and with GPS. Project reports should also clearly identify the carcasses that fall in this category.

Fatality found outside of the designated “full” search area.

This situation would imply that the initial monitoring and search area based on turbine height and carcass size may have been undersized and will require expanding the area.

A designated “full” search area is expected to account for all carcasses. The lack of project specific data for small carcass sizes as resulted in the general adoption of the standards presented in Hull and Muir (2010). The wildlife agencies recommend an additional buffer zone of 20% be added to account for the wind effect on carcass fallout and uncertainty until adequate data is gathered for a site. The additional 20% buffer zone would need to be included in the routine searches. The buffer should be located on the down-wind side of the project if the wind is predominantly from one direction. The calculated area based on Hull and Muir plus the buffer area is designated as the “full” search area. Fatalities found during a routine search of the “full” search area (Hull & Muir predicted + 20% buffer zone) would be treated as an Observed fatality in the model.

If the carcass is found beyond this “full” monitoring area, the Downed Wildlife Protocol and accompanying reporting procedures should still be followed. In addition, the permittee should contact the appropriate wildlife agency personnel listed in the Downed Wildlife Protocol to discuss adjusting the size of the fall out area and if expanding the area searched is needed to account for all potential fallout.

Fatality found incidentally (not during a routine scheduled search) in the designated search area

The model takes into account the frequency of searches. If a carcass is found incidentally, then it must be determined if the carcass would have been found on the next routine search day and therefore counted as Observed, or if the carcass would have been missed or be gone on the next routine search and accounted for in the Unobserved portion of fatalities.” The Hawaiian hoary bat carcasses are important to ongoing genetic research, so leaving the listed carcass in place is not in the best interest for the species. If a carcass is found incidentally, in the designated search area the Downed Wildlife Protocol and reporting should be followed. The report should clearly indicate who found the carcass, and under what circumstances (turbine maintenance, weeding, mowing, etc). The report should also indicate the method of determining how to categorize the carcass. The three methods are:

- 1) Permittee chooses to include the carcass as Observed in the model, regardless of searcher efficiency.
- 2) Wildlife agencies will include the carcass as Observed in the model when the documented detection probability is sufficiently high so as to reasonably assume the carcass would have been found on a subsequent scheduled search. Specifically, this method makes the assumption that the search efficiency and k value are such that there is a high probability that the carcass would have been found on a subsequent search. This method will be used for all large and medium carcasses found. This method will also be used for smaller carcasses when it is reasonable to assume the carcass or carcass trace would have been found on a subsequent search. The wildlife agencies will assume a carcass would have been found when the documented searcher efficiency $\geq 75\%$ and k value ≥ 0.7 .

In the case of small carcasses where the searcher efficiency is less than 75% (based on permittee’s documented efficacy), a double-blind search with a replacement surrogate should be conducted to determine how the recovered carcass shall be categorized: Observed or Unobserved. That trial shall include the following criteria:

- a. The surrogate (typically a rat) should be identical to that used for search efficacy trials and similar in size to the carcass found.
- b. The surrogate carcass should be labeled as a surrogate for the specific carcass it is representing, and placed by a third party in the proximity of where the carcass that was recovered was found with label hidden.
- c. The placement of this carcass should be conducted by the same party responsible for placing carcasses for efficiency trials, whenever possible.

- d. Under no circumstances should the searcher conducting the routine search, be the one placing the surrogate or have knowledge of the surrogate's location or the timing of the placement.
- e. Routine fatality searches should be carried out following standard search procedures.
- f. The outcome of the trial should be reported in the compliance report and include the date the surrogate was placed and the date the carcass was found. If the carcass was never found, the third party should check on the status of the carcass. If the carcass is still present, leave it in place for subsequent searches. Include this information in the compliance report.
- g. If the surrogate was found, the original carcass should be reported as Observed. If the surrogate was not found, the original carcass should be reported as Unobserved.

Note: The wildlife agencies expect the permittee's to conduct thorough, fair, and impartial searches and not to purposefully conduct searches for carcasses outside of the scheduled routine fatality searches in an attempt to manipulate fatality documentation or calculation of take. The agencies also acknowledge the amount of effort it takes to conduct the thorough routine fatality searches and trials necessary to measure carcass retention and searcher efficiency. If a carcass is found outside of a routine search and a searcher efficiency trial is scheduled to be conducted within the next 30 days, it may be possible to include option 3 within that searcher efficiency trial. However, you must contact the wildlife agencies for approval.

Literature Cited

Dalthorp, Daniel, Huso, Manuela, and Dail, David, 2017, Evidence of absence (v2.0) software user guide: U.S. Geological Survey Data Series 1055, 109 p., <https://doi.org/10.3133/ds1055>.

Hull, C. L. and S. Muir (2010). Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. *Australasian Journal of Environmental Management* 17: 77-87.

Appendix 9. Kahuku FY2018 Hawaiian Hoary Bat Fatality Estimation.

| Period # | LWSC | Dates | | Period length | % year | Search interval in days | Total searches in period - 1 search | Search area observed fatality (X) | SEEF | | | | |
|---------------|-------|-----------|------------|---------------|--------|-------------------------|-------------------------------------|-----------------------------------|-------|--------|------|-------|-------|
| | | | | | | | | | Found | Placed | % | 95%CI | |
| 1 | N/A | 1/1/2011 | 10/1/2011 | 273 | 0.75 | 3.5 | 77 | 1 | 6 | 10 | 0.60 | 0.304 | 0.847 |
| 2 | N/A | 10/1/2011 | 3/31/2012 | 182 | 0.50 | 2.5 | 72 | 0 | 16 | 22 | 0.73 | 0.522 | 0.877 |
| 3 | N/A | 4/1/2012 | 8/1/2012 | 122 | 0.33 | 3.5 | 34 | 2 | 19 | 27 | 0.70 | 0.518 | 0.849 |
| No Operations | | 8/1/2012 | 9/1/2013 | 396 | 1.08 | | | | | | | | |
| 4 | 5 m/s | 9/1/2013 | 7/31/2014 | 333 | 0.91 | 3.5 | 94 | 0 | 56 | 66 | 0.85 | 0.748 | 0.919 |
| 5 | 5 m/s | 8/1/2014 | 10/31/2014 | 91 | 0.25 | 3.5 | 25 | 1 | 11 | 19 | 0.58 | 0.359 | 0.777 |
| 6 | 5 m/s | 11/1/2014 | 3/31/2015 | 150 | 0.41 | 30 | 4 | 0 | 6 | 7 | 0.86 | 0.499 | 0.984 |
| 7 | 5 m/s | 4/1/2015 | 6/30/2016 | 456 | 1.25 | 7 | 64 | 0 | 32 | 39 | 0.82 | 0.680 | 0.916 |
| 8 | 5 m/s | 7/1/2016 | 6/30/2017 | 364 | 1.00 | 7 | 51 | 0 | 37 | 38 | 0.97 | 0.884 | 0.997 |
| 9 | 5 m/s | 7/1/2017 | 6/30/2018 | 364 | 1.00 | 7 | 51 | 0 | 25 | 27 | 0.93 | 0.783 | 0.984 |

Appendix 9 (cont.).

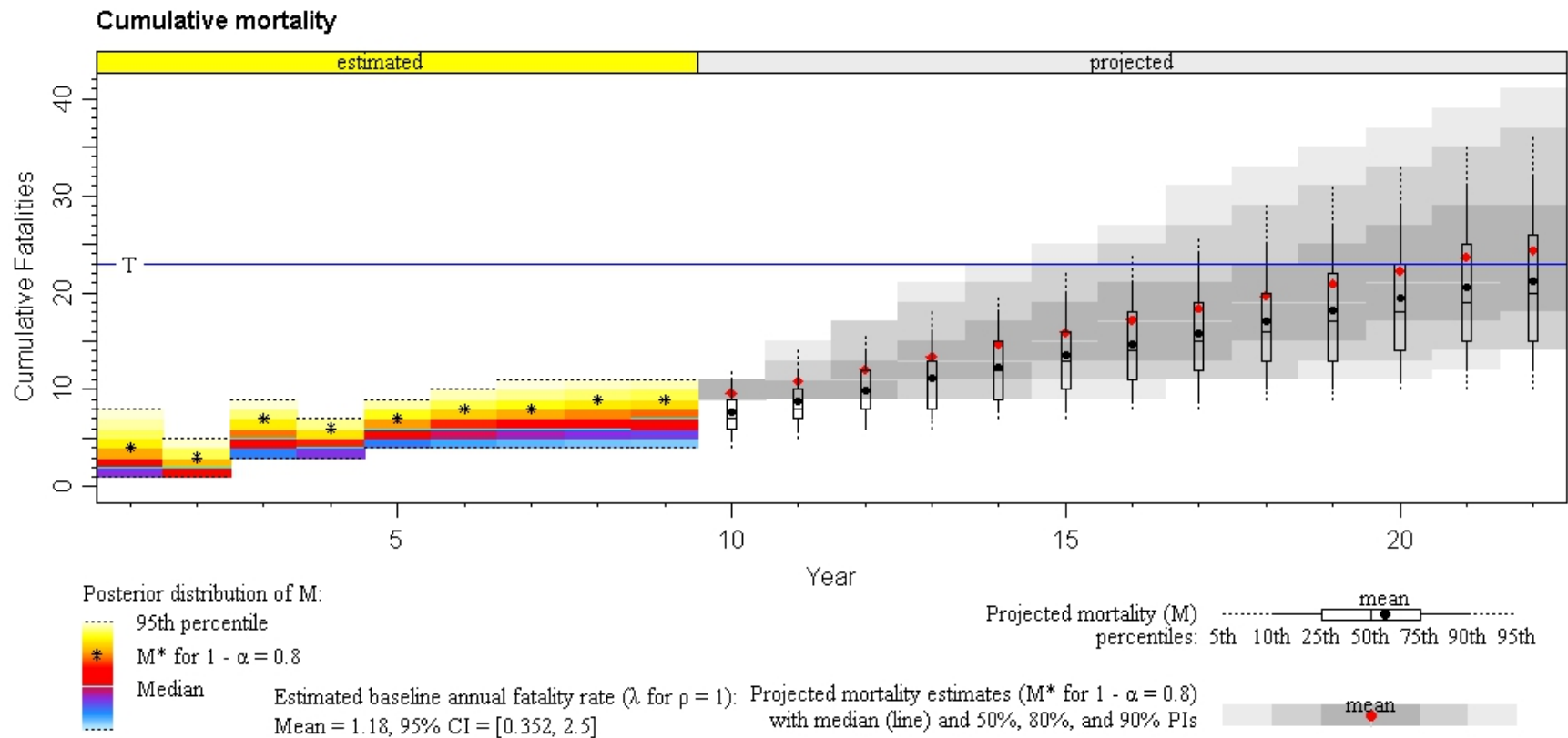
| Period # | CARE | | | | | | | | | | | |
|----------|------|------|------|--------------|-------|--------|------------------|--------|-------|--------------|-------|------|
| | # | Mean | SD | Distribution | Shape | Scale | 95% CI for scale | | r | 95% CI for r | | lr |
| 1 | 16 | 3.6 | 4.1 | exponential | | 4.348 | 2.504 | 7.547 | 0.687 | 0.539 | 0.800 | 3.5 |
| 2 | 26 | 8.3 | 5.4 | exponential | 0.080 | 12.493 | 7.688 | 20.300 | 0.906 | 0.854 | 0.941 | 2.5 |
| 3 | 16 | 8.2 | 5.4 | exponential | 0.074 | 13.594 | 6.927 | 26.680 | 0.882 | 0.785 | 0.937 | 3.5 |
| No ops. | | | | | | | | | | | | |
| 4 | 12 | 17.8 | 13.0 | LogNormal | 5.533 | 3.272 | 1.395 | 5.148 | 0.884 | 0.719 | 0.966 | 3.5 |
| 5 | 11 | 10.9 | 11.1 | LogNormal | 1.489 | 2.182 | 1.310 | 3.054 | 0.903 | 0.747 | 0.975 | 3.5 |
| 6 | | | | LogNormal | 1.489 | 2.182 | 1.310 | 3.054 | 0.415 | 0.222 | 0.648 | 30.0 |
| 7 | 15 | 13.7 | 10.1 | exponential | 0.042 | 23.691 | 11.580 | 48.450 | 0.866 | 0.751 | 0.931 | 7.0 |
| 8 | 21 | 10.5 | 9.4 | exponential | 0.076 | 13.221 | 8.078 | 21.640 | 0.776 | 0.669 | 0.854 | 7.0 |
| 9 | 20 | 13.4 | 11.4 | exponential | 0.067 | 15.020 | 9.005 | 25.037 | 0.799 | 0.695 | 0.872 | 7.0 |

| Period # | K (* canine search) | DWA (*reduced search area) | g | | | B | | M* | Unobserved Take (M*-Cumulative Observed Take) |
|----------|---------------------|----------------------------|-------|-------|-------|---------|---------|----|---|
| | | | g | min | max | Ba | Bb | | |
| 1 | 0.7 | 1 | 0.464 | 0.262 | 0.672 | 9.841 | 11.385 | 4 | 3 |
| 2 | 0.7 | 1 | 0.796 | 0.675 | 0.894 | 39.661 | 10.180 | 3 | 2 |
| 3 | 0.7 | 1 | 0.746 | 0.611 | 0.861 | 33.652 | 11.429 | 7 | 4 |
| No ops. | | | | | | | | | |
| 4 | 0.7 | 1 | 0.830 | 0.647 | 0.955 | 17.270 | 3.528 | 6 | 3 |
| 5 | 0.7 | 1 | 0.670 | 0.460 | 0.850 | 13.943 | 6.853 | 7 | 3 |
| 6 | 0.7 | 1 | 0.347 | 0.166 | 0.554 | 7.456 | 14.050 | 8 | 4 |
| 7 | 1* | 0.7* | 0.565 | 0.486 | 0.642 | 87.013 | 67.090 | 8 | 4 |
| 8 | 1* | 0.7* | 0.530 | 0.465 | 0.595 | 119.453 | 105.814 | 9 | 5 |
| 9 | 1* | 0.7* | 0.535 | 0.464 | 0.605 | 101.741 | 88.595 | 9 | 5 |

Appendix 10. Kahuku FY2018 Hawaiian Hoary Bat Indirect Take Calculation.

| Component | Input/Description | Result/Value |
|-----------|--|--------------|
| A | Total Estimated Direct take | 9 |
| B | Observed direct take (ODT) | 4 |
| C | Unobserved direct take (UDT) (A - B) | 5 |
| D | ODT female or unknown during Apr 1-Sep 15 (1 female, 3 unknown) | 4 |
| E | Proportion of UDT that could be female and probability a female is pregnant or lactating ($0.5 \times 3/12$) | 0.125 |
| F | Survival of twin pups to weaning (0.9×2 pups) | 1.8 |
| G | ODT IDT (D x F) | 7.2 |
| H | UDT IDT (C x E x F) | 1.125 |
| I | IDT total (G + H) | 8.325 |
| J | Survival of juvenile to adult | 0.3 |
| | IDT as adults (I x J) | 2.498 |
| | Total IDT rounded up | 3 |

Appendix 11. Hawaiian Hoary Bat 20-Year Projected Take at Kahuku in FY2018.



Note: The projected take displayed in Appendices 10 represents *only the direct take* and does not include any additional indirect take. The number of years displayed in this Appendix represents the number of unique periods used in the projection, not necessarily the number of years. In the Appendix the length of time displayed equals 19.5 years, the expected time operating turbines through the 20-year permit. The direct take estimate at the 80% credibility level is presented as M* (symbol * and \blacklozenge). The shaded gray bars are the probability intervals (PI) around the estimate at the 80% credibility level and do not represent any user chosen credibility level. The horizontal blue line (with a T) represents the baseline permitted take (including both direct and indirect take) for the Hawaiian hoary bat.