

# **Kawailoa Wind Project Habitat Conservation Plan FY 2018 Annual Report**



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## EXECUTIVE SUMMARY

This report summarizes work performed by Kawailoa Wind, LLC (Kawailoa Wind), owner of Kawailoa Wind Project (Project), during the State of Hawai'i fiscal year 2018 (FY 2018; July 1, 2017 – June 30, 2018) under the terms of the approved Habitat Conservation Plan (HCP), dated October 27, 2011, and pursuant to the obligations contained in the Project's state Incidental Take License ITL-14 (ITL) and federal Incidental Take Permit TE-59861A-0 (ITP). The Project was constructed in 2011 and 2012, and was commissioned to begin operating on November 2, 2012. Species covered under the HCP include six federally-listed threatened and endangered species and one state-listed endangered species. Kawailoa Wind is currently developing an HCP Amendment, in collaboration with the U.S. Fish and Wildlife Service (USFWS) and Hawai'i Division of Forestry and Wildlife (DOFAW), to 1) support a request to increase the amount of take for the Hawaiian hoary bat beyond the take authorized under the current ITP/ITL, and 2) add the endangered Hawaiian petrel as a Covered Species.

Fatality monitoring at the Project continued throughout FY 2018 within the 35-meter radius circular search plots. These plots are centered on the wind turbine generators (WTGs) and searched twice per week. Searches of the two meteorological (met) towers were conducted once per week. The mean search interval for turbines and met towers in FY 2018 was 3.5 days and 7.0 days, respectively.

Four 28-day carcass persistence trials were conducted in FY 2018, using 60 bat surrogates and 12 medium-sized bird carcasses (surrogate for the Hawaiian short-eared owl and listed seabirds and waterbirds). For FY 2018, the probability that a carcass persisted until the next search was 0.90 (95% CI = [0.818, 0.945]) for all bat surrogate carcasses, and 0.91 (95% CI = [0.009, 0.999]) for medium-sized bird carcasses.

Searcher efficiency trials were conducted over 25 trial days with 92 trial carcasses in FY 2018. The overall searcher efficiencies in FY 2018 for bat surrogate (N = 80) and medium-sized bird (N = 12 carcass trials) were 90.0 percent (95% CI = [0.82, 0.952]) and 92.3 percent (95% CI = [0.672, 0.991]), respectively.

Kawailoa Wind continued the scavenger control program used to increase the probability that fatalities at the wind facility have the opportunity to be discovered by searchers. Twenty-two DOC-250s and 21 A24 self-resetting traps were used in FY 2018. Overall, the scavenger control program documented the removal of 130 mongooses, 7 rats, and 2 cats in FY 2018 at the Project.

Five Hawaiian hoary bat fatalities were found in FY 2018. The Project's total observed bat take from November 2012 through FY 2018 is 35. Because two of the 35 bats were found outside of fatality search plots and classified as incidental observations, data used to estimate bat fatalities have been adjusted to 33 bats. The fatality estimate for 33 non-incidental observed bats using the Evidence of Absence estimator (Dalthorp et al. 2017) at the upper 80 percent credibility level is 66 and the total indirect take for this estimate is 7 adult equivalents. Combining these values, there is an approximately 80 percent chance that actual take of Hawaiian hoary bats at the Project was less

than or equal to 73 adults. As a result of this level of take, Kawailoa Wind is incorporating additional minimization and mitigation measures in the forthcoming HCP Amendment.

One endangered bird fatality was found in FY 2018. In July 2017, a Hawaiian petrel was observed incidentally within the Project Area by a canine search team. The Hawaiian petrel was not originally included as a Covered Species in the HCP and ITP/ITL (see Section 7.1). Based on the observed fatality at the Project and recent surveys documenting Hawaiian petrel occurrence on O'ahu, Kawailoa Wind is requesting that their HCP Amendment also add the Hawaiian petrel as a Covered Species.

Non-listed bird fatalities found at the Project in FY 2018 included two species protected by the Migratory Bird Treaty Act (MBTA): white-tailed tropicbird (1 bird), and sooty tern (1 bird). Bird species observed as fatalities that are not covered by the MBTA were: rock dove (1 bird) spotted dove (9 birds), scaly-breasted munia (5 birds), common myna (32 birds), common waxbill (19 birds), black francolin (1 bird), zebra dove (3 birds), red-vented bulbul (1 bird), red-crested cardinal (1 bird), and gray francolin (1 bird).

During FY 2018, four Wildlife Acoustics SM2BAT+ ultrasonic detectors each with one SM3-U1 microphone were managed at the Project. These were located at WTG's 1, 10, 21, and 25. Between July 2017-June 2018, Hawaiian hoary bats were detected on 275 of 1,421 detector-nights (19.4 percent of detector-nights).

The 'Uko'a Wetland mitigation program for Tier 1 mitigation continued for waterbirds and bats through FY 2018 including invasive vegetation control, predator control and monitoring, fence maintenance, bat lane construction, and bat acoustic monitoring. Hawaiian hoary bat research projects funded for Tier 2 and 3 bat mitigation and conducted by USGS and WEST continued in FY 2018. Tier 1 seabird mitigation was completed in FY 2015. Tier 1 pueo or Hawaiian short-eared owl mitigation was completed in FY 2017.

Wildlife Education and Observation Program (WEOP) trainings continue to be conducted on an as-needed basis to provide on-site personnel with the information they need to be able to respond if they observe a listed species or encounter a fatality while on-site. Fourteen WEOP trainings were conducted in FY 2018.

Kawailoa Wind and Tetra Tech conducted nine meetings with USFWS and DOWAF staff in FY 2018. The purposes of these meetings varied, and included required semi-annual meetings and discussions regarding the HCP Amendment. In addition, Kawailoa Wind and Tetra Tech met with the Endangered Species Recovery Committee on January 24, 2018 to review the FY 2017 HCP annual report.

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## 1.0 Introduction

The Habitat Conservation Plan (HCP) for the Kawailoa Wind Project (Project) was approved by the Hawai'i Division of Forestry and Wildlife (DOFAW) in 2012. Kawailoa Wind, LLC (Kawailoa Wind) was issued a federal incidental take permit (ITP) from the U.S. Fish and Wildlife Service (USFWS) and a state incidental take license (ITL) from the Hawai'i Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) for the Project on December 8, 2011 and January 6, 2012, respectively. The ITP and ITL cover the incidental take of six federally-listed threatened and endangered species, and one state-listed endangered species (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 chloropus sandvicensis*), 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 2011 and 2012, and was commissioned to begin operating on November 2, 2012. It is owned and operated by Kawailoa Wind, a wholly-owned subsidiary of DESRI IV, LLC, which is an investment fund managed by D.E. Shaw Renewable Investments, LLC.

This report summarizes work performed for the Project during the State of Hawai'i 2018 fiscal year (FY 2018; July 1, 2017-June 30, 2018) pursuant to the terms and obligations of the approved HCP, ITL, and ITP. Kawailoa Wind is currently developing a HCP Amendment in collaboration with USFWS and DOFAW. The purpose of the HCP Amendment is to 1) support a request to increase the amount of take for the Hawaiian hoary bat beyond the take authorized under the current ITP/ITL, and 2) add the endangered Hawaiian petrel or 'ua'u (*Pterodroma sandwichensis*) as a Covered Species.

## 2.0 Fatality Monitoring

In FY 2018, all 30 wind turbine generators (WTGs) were searched for fatalities twice per week, and the two meteorological (met) towers were searched once per week. Search plots consisted of a 35-meter radius circular plot centered on each WTG, and 50-meter radius plot centered on the two unguyed met towers. The FY 2018 mean search interval for WTGs was 3.5 days (standard deviation [SD] = 0.0 day), and the mean search interval for met towers was 7.0 days (SD = 1.0 day).

The search plots were primarily searched by trained dogs accompanied by their handlers. When conditions limited the use of dogs (e.g., weather, injury, availability of canine search team, etc.), search plots were visually surveyed by Project staff. Overall, canine teams conducted 95.3 percent of the searches in FY 2018. Vegetation within the search plots was managed (e.g., mowed) to maximize searcher efficiency (Sections 4.0 and 5.0).

### 3.0 Carcass Persistence Trials

Four 28-day carcass persistence trials were conducted in FY 2018 using bat surrogates (black rat) and wedge-tailed shearwater carcasses. Wedge-tailed shearwaters are medium-sized birds and are suitable surrogates for the listed bird species covered in the HCP (see above), as well as the listed Hawaiian petrel. For FY 2018, the probability that a carcass persisted until the next search was 0.90 (95% CI = [0.818, 0.945]) for all bat surrogate carcasses (N=60), and was 0.91 (95% CI = [0.009, 0.999]) for medium-sized bird carcasses (N=12).

### 4.0 Searcher Efficiency Trials

Tetra Tech personnel (non-searchers) administered 92 searcher efficiency trials on 25 trial days during FY 2018. Similar to the carcass persistence trials, wedge-tailed shearwaters were used as surrogates for listed bird species, and black rats were used as surrogates for bats. Searcher efficiency trials occurred throughout the year, and 100 percent were conducted on canine search teams in FY 2018 due to infrequent use of human searchers. Vegetation category (short vs. medium) of the search plot was documented at the time the carcasses were placed and when they were found. The overall searcher efficiency (i.e., combined vegetation classes) in FY 2018 was 90.0 percent (95% CI = [0.82, 0.952]) for bat surrogates (N = 80) and 92.3 percent (95% CI = [0.672, 0.991]) for medium-sized bird (N = 12) carcasses.

The mean searcher efficiencies in FY 2018 for bat surrogate (N = 65) and medium-sized bird (N = 7) carcass trials in short vegetation were 92.3 percent and 100.0 percent, respectively. The mean searcher efficiencies in FY 2018 for bat surrogate (N= 15) and medium-sized bird (N= 5) carcass trials in medium vegetation were both 80.0 percent.

### 5.0 Vegetation Management

Vegetation in the search plots consists mainly of Guinea grass (*Megathyrsus maximus*), Bermuda grass (*Cynodon dactylon*), and sensitive plant (*Mimosa pudica*). All search plots around the WTGs and met towers were mowed regularly to increase visibility during fatality searches. All plots were mowed to a height of 3 to 4 inches, depending on the type of mower used, and were cut every 3 to 4 weeks. There were no unsearchable areas or rock lined swales within the 35-meter radius search plots.

### 6.0 Scavenger Trapping

Active trap locations in FY 2018 covered the same general area where traps were deployed at the end of FY 2017. The scavenger control program documented the removal of 130 mongoose, seven



rats, and two cats in FY 2018. Traps deployed at the Project in FY 2018 include 22 Doc-250 and 21 GoodNature A24 traps. All traps were active throughout FY 2018 and new boxes were constructed and installed on all Doc-250 traps.

## **7.0 Documented Fatalities and Take Estimates**

All observed downed wildlife were handled and reported in accordance with the Downed Wildlife Protocol provided by USFWS and DOFAW. One Hawaiian petrel fatality and five Hawaiian hoary bat fatalities were found in FY 2018, as described below. No injured (live) downed wildlife were observed at the Project in FY 2018.

### **7.1 Hawaiian Petrel**

On July 21, 2017, a single medium-sized seabird (procellariid) carcass was observed incidentally within the Project Area, and later identified through genetic analysis as a Hawaiian petrel. The carcass was observed approximately 67 meters from the base of WTG 19 by a canine search team. The Hawaiian petrel was not originally included as a Covered Species in the HCP and ITP/ITL. When the approved HCP was developed, the Hawaiian petrel was not known to occur regularly on O'ahu. Very few individuals have been recorded on the island in the last several decades, and when found were often grounded and assumed to have been disoriented vagrants from other islands (Young et al. in prep). The most recent evidence of a population on O'ahu was limited to sub-fossil remains primarily on the 'Ewa plains, which precede European contact (Pyle and Pyle 2017). The species was considered very unlikely to transit the Project Area; therefore, take was thought to be highly unlikely. The decision to exclude the Hawaiian petrel from the approved HCP and ITP/ITL was consistent with technical advice received from USFWS and DOFAW at the time of permitting.

Based on the observed fatality at the Project and recent surveys documenting Hawaiian petrel occurrence on O'ahu (Young et al. in prep), Kawailoa Wind is requesting authorization for incidental take of the Hawaiian petrel in the upcoming HCP Amendment.

### **7.2 Hawaiian Hoary Bat**

Five Hawaiian hoary bat fatalities were documented during FY 2018 (see Table 1 and Appendix 1). These fatalities were all found within the 35-meter fatality search plots. All bat carcasses were transferred to U.S. Geological Survey (USGS) for genetic testing.

A total of 35 Hawaiian hoary bat fatalities have been observed at the Project since operations began on November 2, 2012. These include fatalities in each year since the initiation of commercial operations: FY 2013 (5), FY 2014 (9), FY 2015 (9), FY 2016 (5), FY 2017 (2), and FY 2018 (5) (Table 2). Two of these 35 bats were found outside of fatality search plots and classified as incidental observations.

**Table 1. Observed Fatalities of Hawaiian Hoary Bats at the Project in FY 2018.**

Age	Sex	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
Adult	Unknown	August 22, 2017	30	11	278
Adult	Unknown	August 22, 2017	30	5	160
Adult	Unknown	August 28, 2017	2	29	192
Adult	Unknown	August 28, 2017	14	28	330
Adult	Unknown	January 5, 2018	30	16	190

**Table 2. Hawaiian Hoary Bat Fatalities Observed Since Operations Began and Annual Take Estimates**

Fiscal Year	Number of Observed Fatalities <sup>1</sup>	Annual Total Take Estimate <sup>2</sup>
2013	4	11
2014	9	17
2015	9	14
2016	4	7
2017	2	9
2018	5	15
<b>Total</b>	<b>33</b>	<b>73</b>

1 Does not include bat fatalities found outside of the search areas (i.e., incidental observations).

2 Total take is the sum of the annual direct take estimated from Evidence of Absence estimator (Dalthorp et al. 2017) plus the annual indirect take calculated using USFWS (USFWS 2016) guidance.

An upper credible limit of take is estimated from three components: (1) observed direct take (ODT) during protocol (standardized) surveys, (2) unobserved direct take (UDT), and (3) indirect take. The Evidence of Absence software program (EoA; Dalthorp et al. 2017), the agency-approved analysis tool for analyzing direct take, uses results from bias correction trials and ODT to generate an upper credible limit (UCL) of direct take (i.e., ODT + UDT). The USFWS and DOFAW have requested that these calculations be reported at the 80 percent upper credible limit. 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 observations of the spatial distribution of bat fatalities at the Project and life history characteristics of, or assumed to be representative of, the Hawaiian hoary bat as described in the Project's approved HCP.

The estimated direct take (ODT + UDT) for the 33 Hawaiian hoary bat fatalities found between the start of operation (November 2, 2012) and end of FY 2018 (June 30, 2018) is less than or equal to

66 bats (80 percent UCL; Appendix 2). Because two of the 35 observed bat fatalities were found outside of the search areas (i.e., were incidental observations), 33 fatalities were used in the analysis, and the two incidental observations are accounted for in the estimated value of UDT. The two incidental observations were not found during FY 2018.

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

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

Based on the USFWS methodology (2016), the estimate of cumulative indirect take in FY 2018 is calculated as:

- **Total juvenile take calculated from observed female take (April 1 – September 15)**
  - $2 \text{ (observed females)} * 1.8 \text{ (pups per female)} = 3.6 \text{ juveniles}$
- **Total juvenile take calculated from observed unknown sex take (April 1 – September 15)**
  - $11 \text{ (observed unknown sex)} * 0.5 \text{ (assumed sex ratio)} * 1.8 \text{ (pups per female)} = 9.9 \text{ juveniles}$
- **Total juvenile take calculated from unobserved take**
  - $33 \text{ (unobserved direct take)} * 0.5 \text{ (assumed sex ratio)} * 0.25 \text{ (proportion of calendar year females could be pregnant or have dependent pups)} * 1.8 \text{ (pups per female)} = 7.4 \text{ juveniles}$
- **Total Calculated Juvenile Indirect Take = 20.9 (3.6 + 9.9 + 7.4)**
- **Total Adult Equivalent Indirect Take = 0.3 (juvenile to adult conversion factor) \* 20.9 = 6.28**

Therefore, the estimated indirect take based on the UCL of Hawaiian hoary bat direct take at the Project is seven adults (rounded up from 6.28).

The UCL for Project take of the Hawaiian hoary bat at the 80 percent credibility level is 73 adult bats (66 estimated direct take + 7 estimated indirect take). That is, there is an approximately 80 percent probability that actual take at the Project at the end of FY 2018 is less than or equal to 73. The forthcoming HCP Amendment addresses the exceedance of the currently authorized bat take limit in the approved HCP through the identification of additional avoidance and minimization measures, as well as additional compensatory mitigation for the Hawaiian hoary bat.

Table 2 presents the annual total take estimate per FY since operations began. Total take is the sum of the annual direct take estimated from Evidence of Absence estimator (Dalthorp et al. 2017) plus the annual indirect take calculated using USFWS (2016) guidance.

### **7.3 Non-listed Species**

Seventy-five bird fatalities representing 12 species were documented at WTGs at the Project site in FY 2018. No fatalities have been observed at either of the two met towers. Two of the species observed in FY 2018 are protected by the Migratory Bird Treaty Act (MBTA): white-tailed tropicbird (one bird; *Phaethon lepturus*), and sooty tern (one bird; *Onychoprion fuscatus*). In addition, 73 fatalities of non-native introduced birds without MBTA protection were documented: common waxbill (19 birds; *Estrilda astrild*), common myna (32 birds; *Acridotheres tristis*), spotted dove (nine birds; *Spilopelia chinensis*), zebra dove (three birds; *Geopelia striata*), scaly-breasted munia (five birds; *Lonchura punctulata*), rock dove (one bird; *Columba livia*), red-vented bulbul (one bird; *Pycnonotus cafer*), red-crested cardinal (one bird, *Paroaria coronata*), gray francolin (one bird; *Francolinus pondicerianus*), and black francolin (one bird; *Francolinus francolinus*). For a complete list of fatalities for FY 2018 see Appendix 1.

## **8.0 Wildlife Education and Observation Program**

Wildlife Education and Observation Program (WEOP) trainings continue to be conducted on an as-needed basis to provide on-site personnel with the information they need to be able to respond appropriately in the event they observe a listed species or encounter a fatality while on-site. Tetra Tech biologists conducted 14 WEOP trainings in FY 2018.

## **9.0 Mitigation**

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

### **9.1 Hawaiian Hoary Bats**

For the Hawaiian hoary bat, mitigation is required based on where the estimated Project take falls with respect to tiers identified in the approved HCP. Management activities for Tier 1 mitigation continued at 'Uko'a Wetland during FY 2018 (see Section 9.1.2). USFWS and DOFAW approved implementation of selected bat research projects for Tiers 2/3 mitigation in February 2017, and

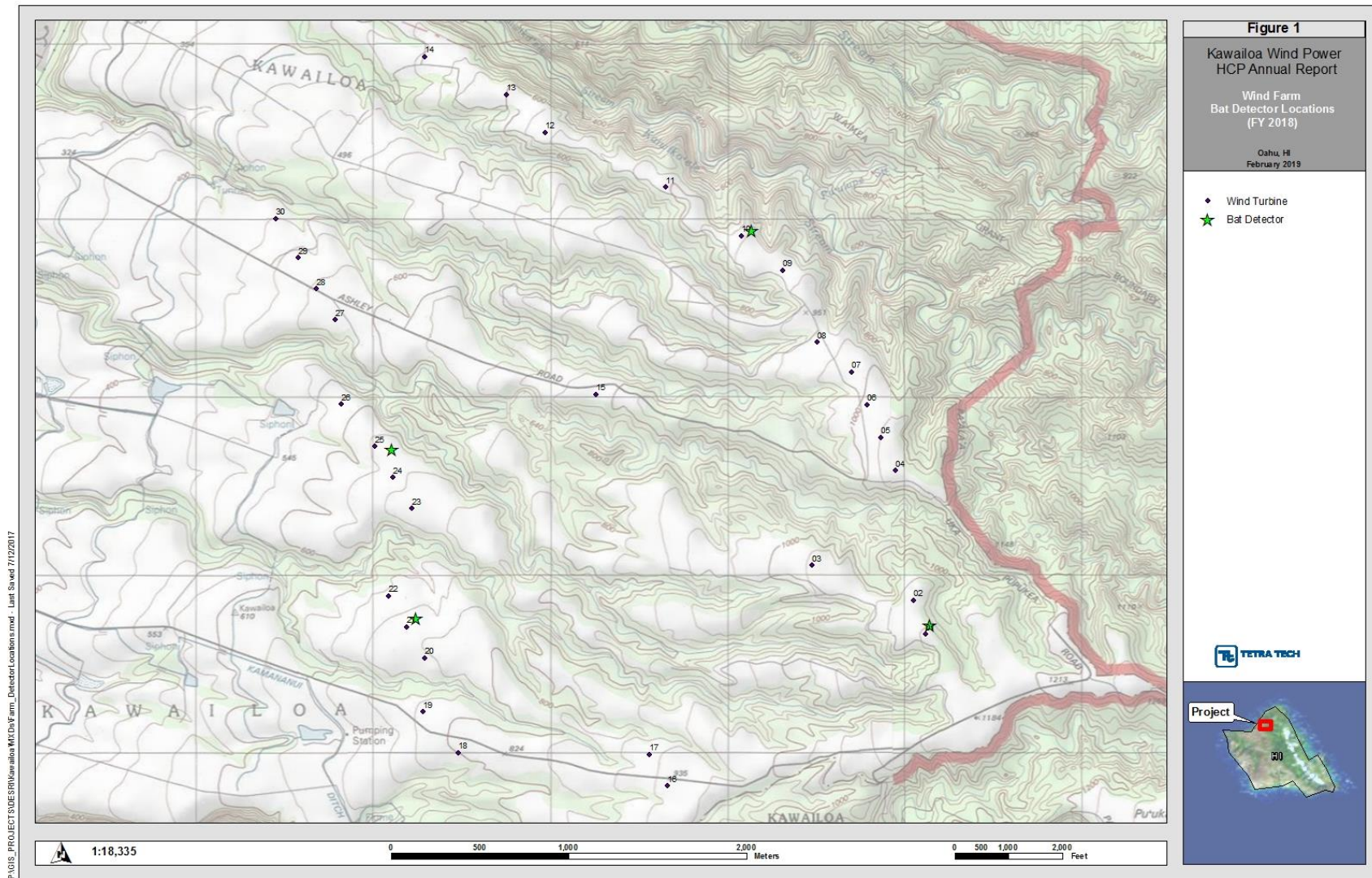
Kawailoa Wind continued to fund these three studies in FY 2018 as described in Section 9.1.3. Kawailoa Wind's bat mitigation for additional bat take will consist of contributing to the purchase and long-term maintenance of the Helemano Wilderness Area, as described in Section 9.1.5 below.

### ***9.1.1 Onsite Acoustic Surveys***

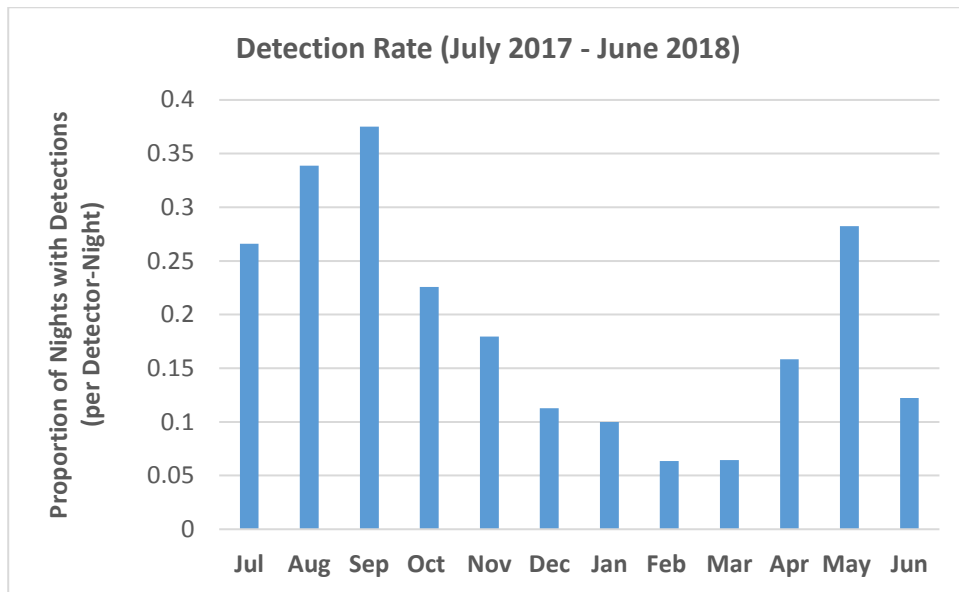
Based on commitments in the approved HCP, bat activity was intensively monitored throughout the Project during the first three years of systematic fatality monitoring (2012–2015). Having identified no significant findings through 3 years of intensive acoustic monitoring at the Project, in the second quarter of FY 2017, Kawailoa Wind reduced the acoustic monitoring effort at the Project to four stationary ground-based units distributed throughout the Project at WTGs 1, 10, 21, and 25 (see Figure 1). These locations were randomly chosen after eliminating detectors with high or low detection rates. Each site contains one Wildlife Acoustics TM SM2BAT+ ultrasonic detector (SM2) with one SM3-U1 ultrasonic microphone located 6.5 meters (21 feet) above ground.

In FY 2018, Hawaiian hoary bats were detected on 275 of 1,421 detector-nights (19.4 percent of detector-nights) at these four WTGs (Figure 2). This represents a slight increase from the previous fiscal year, which documented detections on 12.6 percent of detector-nights (Tetra Tech 2017).

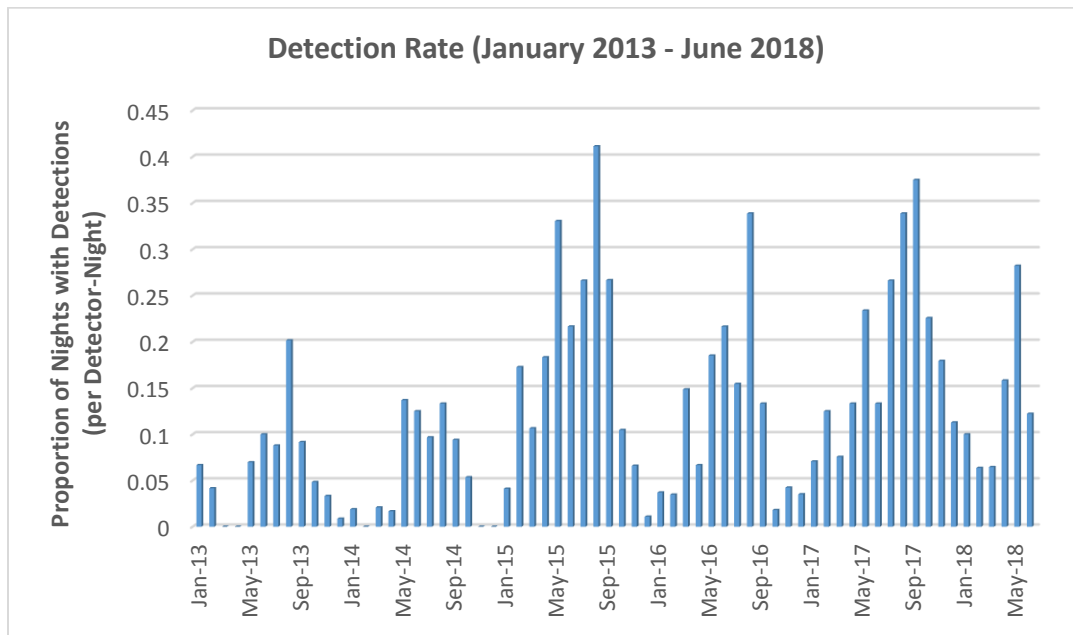
Temporal patterns of ground-based detection rates in FY 2018 were relatively similar to previous years (Figure 3), with elevated activity levels in the dry season (roughly April through October) compared to the remainder of the year (Tetra Tech 2016, Tetra Tech 2017). Spatially, the majority of bat activity occurred at WTG 25 compared to the other locations. The decrease in activity in June 2018 is possibly due to a microphone failure at WTG 25 for the entire month; however, during the month of June in previous years detections have also dropped.



**Figure 1: Bat Acoustic Detector Locations throughout the Project site in FY 2018.**



**Figure 2: Bat Acoustic Activity at 4 Detectors throughout the Project during FY 2018.**



**Figure 3: Bat Acoustic Activity at 4 Detectors throughout the Project, January 2013 – June 2018.**

### **9.1.2 'Uko'a Wetland (Tier 1)**

Mitigation for bats and waterbirds continued at 'Uko'a Wetland during FY 2018. In FY 2016 (March 2016), USFWS and DOFAW provided written confirmation permitting adaptive management for the original bat and waterbird mitigation proposed at 'Uko'a Wetland. This included the following:

1. Reduction from 40 acres of vegetation removal to assumed open water areas, as outlined in Figure 2 of the approved 'Uko'a Wetland Hawaiian Hoary Bat Mitigation Management Plan (H.T. Harvey and SWCA 2014);
2. Omit replanting of natives with assumption of natural recruitment after invasive plant species are removed;
3. Omit mosquitofish removal component; and
4. Tie success criteria for bats to completion of all other management and monitoring components instead of increased bat activity.

In FY 2018, activities associated with Tier 1 bat mitigation included invasive vegetation removal, predator control, monitoring predator presence, fence monitoring and maintenance, bat lane construction, and bat acoustic monitoring. Additional details for each are provided below. Based on the approved 'Uko'a Wetland Hawaiian Hoary Bat Mitigation Management Plan (H.T. Harvey and SWCA 2014), bat acoustic monitoring will continue for 3 to 5 years post-restoration. Based on the approved 'Uko'a Wetland Management Plan for Waterbirds 2012–2032 (SWCA 2012), vegetation management, predator and ungulate control, and fence maintenance will continue for the permit term (20 years).

#### **Invasive vegetation removal:**

In FY 2018, Hapa Landscaping conducted quarterly maintenance visits to remove any areas of water hyacinth (*Eichhornia crassipes*) that regenerated in the previously cleared open water area. Scheduled visits were modified as needed to accommodate staff schedules and avoid disturbing moorhen nests and chicks in the area.





**Figure 4: Ongoing Removal of Water Hyacinth at 'Uko'a Wetland in FY 2018.**

**Predator control and monitoring predator presence:**

The Project contracted Grey Boar Wildlife Services, LLC (Grey Boar) to conduct predator and ungulate removal at 'Uko'a Wetland, as well as to monitor and repair the fence. Predator control first began at 'Uko'a Wetland in June 2014. The following trap types are used throughout at 'Uko'a Wetland: four pig corral and two pig box traps, 100 GoodNature A24s, 12 live cages, 24 Doc-250s and 25 body grip traps (Coni-boxes). In FY 2018, a total of 205 predators were removed from 'Uko'a Wetland including 29 pigs, 139 mongoose, 10 cats, 24 rats, and three mice (Grey Boar 2017a, Grey Boar 2017b, Grey Boar 2018a, Grey Boar 2018b). One hunting dog was removed by security during FY 2018.

Tracking tunnels were set on four dates during FY 2018 to assess the presence of rodents, mongoose, and cats within the wetland. A total of 27 tracking tunnels were used to detect predator presence. The cards were baited with fish paste and collected one day after setting. Tracks were then counted and recorded. Percent activity (the number of cards with tracks divided by the total number of cards set out) is shown in Table 3. Mongoose and cat percent activity was zero for three out of the four tunnel set dates. Rat percent activity was reduced to 14.8 percent in March 2018. Overall, tracking tunnel data since 2014 shows a general reduction in predator presence, specifically mongoose, since the predator program was initiated.

**Table 3. Percent Activity Based on Tracking Tunnels at 'Uko'a Wetland during FY 2018.**

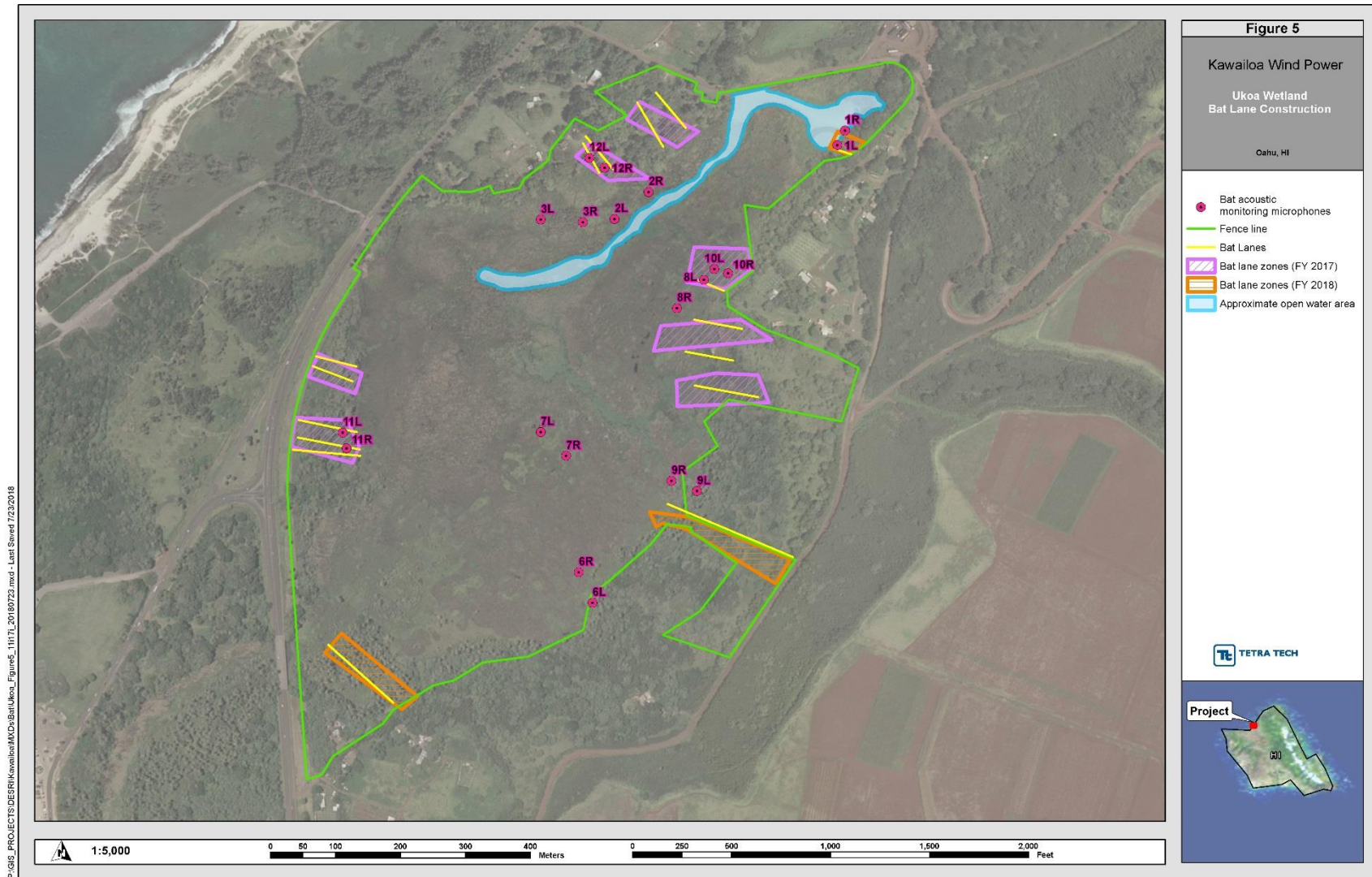
Date	Rats	Mongoose	Mice	Cats
2017-08-26	11.5%	0.0%	7.7%	0.0%
2017-10-28	20.0%	4.0%	20.0%	4.0%
2017-12-16	19.2%	0.0%	0.0%	0.0%
2018-03-17	14.8%	0.0%	3.7%	0.0%

**Fence monitoring and maintenance:**

Fence inspections were conducted by Grey Boar while checking predator control traps. The fence was visually inspected for any signs of ungulate disturbance, damage, or vandalism. During FY 2018, several sections of fence were repaired. Causes of the fence damage were damage by trespassers and a fallen tree. Trespassers continue to cut the fence in various locations.

**Bat lane construction:**

Oahu Tree Works, LLC resumed bat lane construction in FY 2018 after the 2017 Hawaiian hoary bat pupping season (June 1, 2017-September 15, 2017). During FY 2018, three bat lanes were created in three separate zones, and construction was completed in December 2017. In total, there are 16 bat lanes within 10 zones throughout 'Uko'a Wetland (Figure 5). Trees were cut down within the 5-meter wide lanes, with smaller limbs and branches chipped on-site. Stumps were treated with an herbicide to prevent re-sprouting. Figure 6 shows one of the bat lanes constructed. Bat lane maintenance is expected to occur in FY 2019.



**Figure 5: Bat Lanes and Bat Acoustic Detectors at 'Uko'a Wetland.**





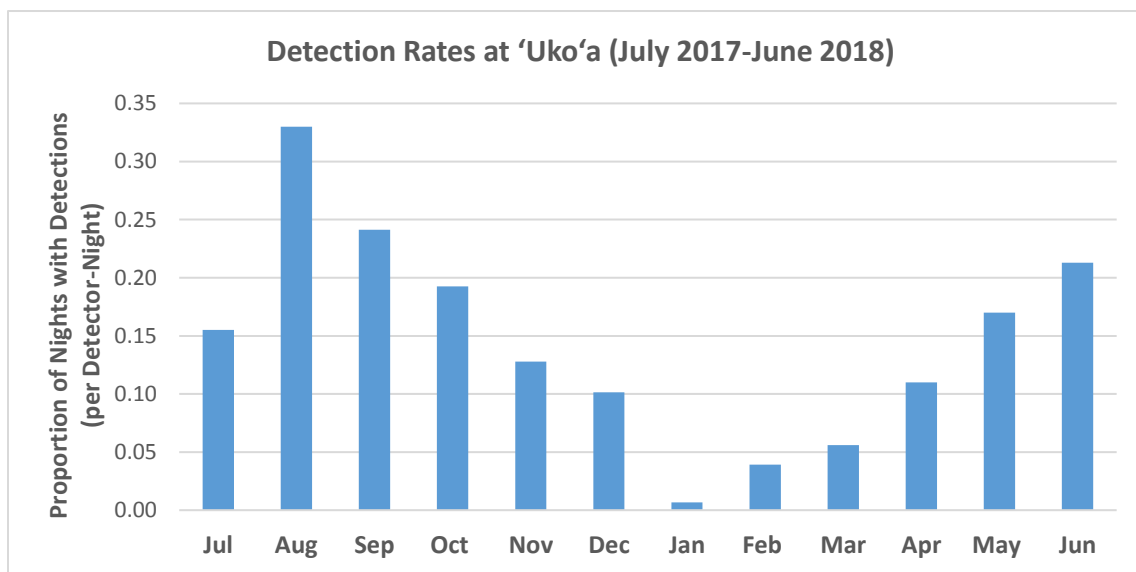
**Figure 6: Bat Lane Created at 'Uko'a Wetland Adjacent to Open Water.**

**Bat acoustic surveys at 'Uko'a:**

In June 2017, following clearing of invasive vegetation in the open water area and while the bat lanes were being created, ten Wildlife Acoustics SM2+BAT detectors were installed in the same historical locations where detectors were deployed between 2012 and 2015. To maintain consistent methods among all years of study, two microphones were connected to each detector

and bat activity levels were quantified using the proportion of detector-nights containing a bat pass (any call file containing two or more bat echolocation pulses; Gannon et al. 2003).

In FY 2018, Hawaiian hoary bats were detected on 496 of 3,381 detector-nights at 'Uko'a (yielding a proportion of 0.147 detections per detector-night). The detections exhibited a seasonal pattern similar to detections recorded at the Project, with an increase in activity in the summer months (dry season) followed by a decrease in activity in the winter months (wet season; Figure 7). Using the proportion of nights with detections generally provides an adequate overall measure of activity for species with low detection rates (i.e., Hawaiian hoary bats); however, this metric does not always sufficiently describe the intensity of activity on specific nights. Detections were relatively consistent across detectors; however, a relatively high number of bat passes were recorded at Detector #1. In December 2017, 781 passes were recorded at this detector over a period of a few days, which is greater than the total number of passes recorded at all 10 detectors over the previous 3 years combined. This detector is located near a bat lane and near the open water (see Figure 5).

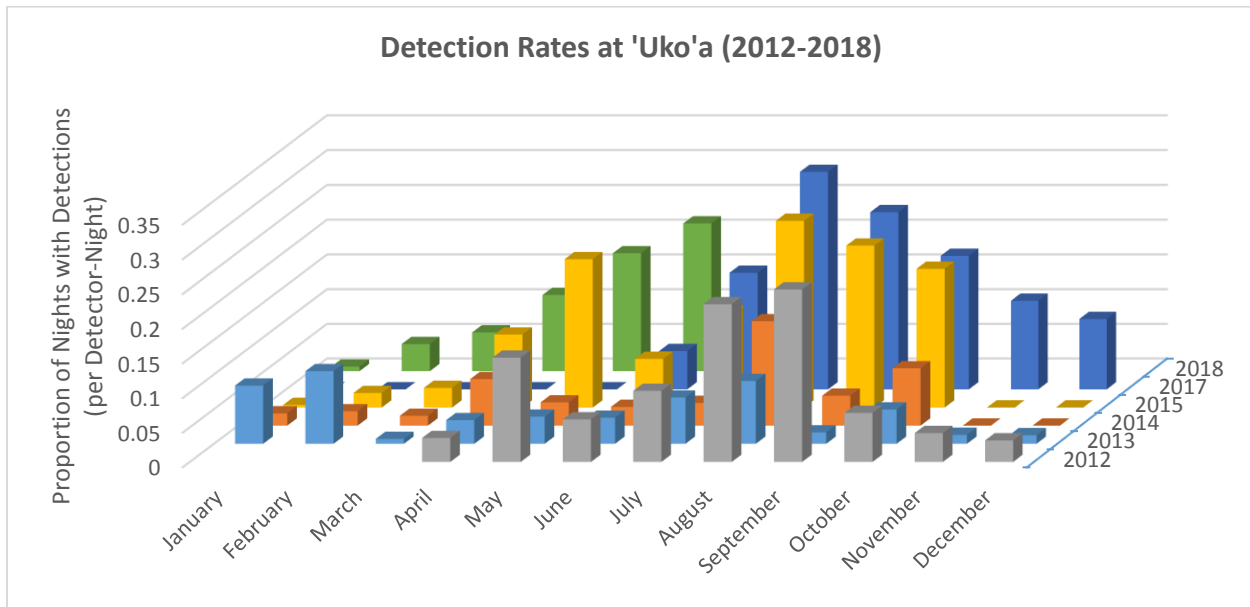


**Figure 7: Hawaiian hoary bat acoustic activity rates at 'Uko'a Wetland in FY 2018.**

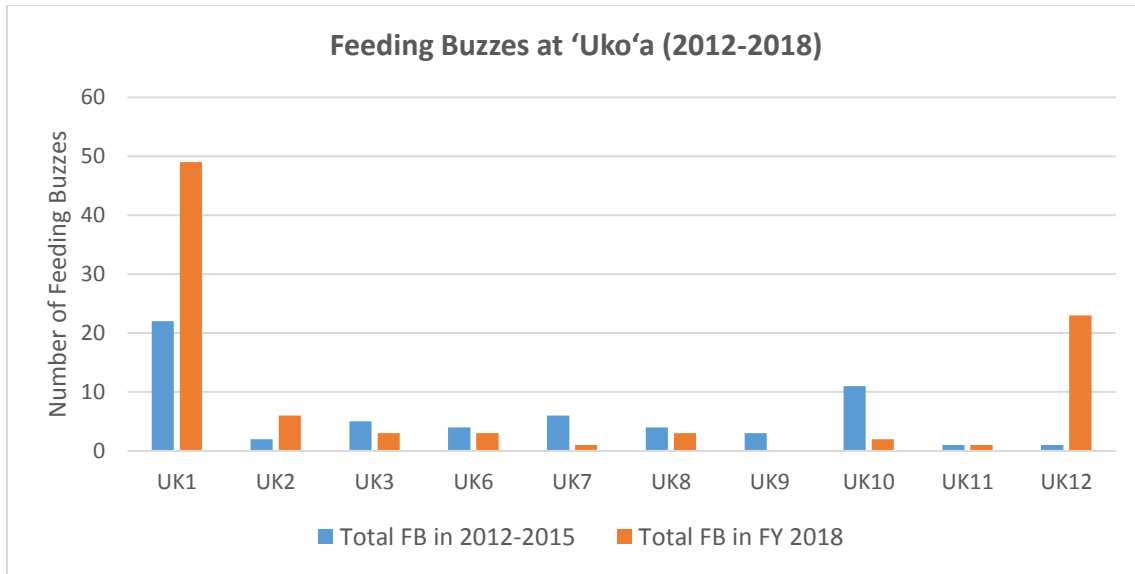
Table 4 and Figure 8 show the proportion of nights with bat detections between April 2012 and June 2018. The highest proportion of nights with bat detections was recorded in 2017. However, it is important to note that the number of nights sampled and the sampling time period is not consistent across years. Years when sampling occurred primarily during the summer months (e.g., 2012 and 2017) are expected to have a higher portion of detections compared to years when sampling occurred primarily during the winter months (e.g., 2018).

**Table 4. Proportion of Nights with Bat Detections Between 2012 and 2018**

Dates	No. of Nights Sampled	Proportion of Nights with Detection(s)
2012 (April 2012-December 2012)	1381	0.123
2013 (January 2013- December 2013)	2176	0.045
2014 (January 2014-October 2014)	2528	0.046
2015 (January -October 2015)	2550	0.125
2017 (June 2017-December 2017)	1801	0.188
2018 (January 2018- June 2018)	1743	0.101

**Figure 8: Detection rates at 'Uko'a Wetland between 2012 and 2018.**

In addition to overall bat activity levels, feeding buzzes were also documented and compared to previous years. A feeding buzz is classified as a burst of pulses at a very high rate with less than 11 milliseconds between pulses (Griffin et al. 1960). Although it has only been a year since detectors have been redeployed, elevated levels of feeding buzzes were recorded at Detector #1 and Detector #12 (Figure 9). The total feeding buzzes recorded during FY 2018 (3,381 total detector nights) already exceed the total feeding buzzes from FY 2012-2015 (8,635 total detector nights) at some detector locations (Figure 9), which suggests more foraging activity occurred in FY 2018 after construction of the bat lanes.



**Figure 9: Hawaiian hoary bat feeding buzzes (FB) before (FY 2012-2015) and after (FY 2018) water hyacinth removal and bat lane creation.**

### 9.1.3 Studies (Tier 2/3)

Kawailoa Wind finalized contracts with WEST and USGS in FY 2017 to conduct three multi-year studies as Tier 2/3 Hawaiian hoary bat mitigation. These studies were recommended to Kawailoa Wind by USFWS and DOWAF. The total funding for the three projects is over \$1.6M. Kawailoa Wind continued to fund these studies in FY 2018. A summary of the work completed for these studies during FY 2018 is provided below.

USGS' *Modeling Foraging Habitat Suitability of the Hawaiian Hoary Bat* study began in February 2017. The primary objective of this study was to investigate the use of multi-state occupancy modeling to quantify foraging habitat suitability and use by Hawaiian hoary bats. During FY 2018, USGS analyzed bat acoustic and video data and insect samples for patterns of occurrence and distribution. All field work and analyses were completed by April 2018. A manuscript was submitted for peer review to the Journal PLOS One and will be published in FY 2019.

The objectives of the *Hawaiian Hoary Bat Conservation Genetics* study were to improve the understanding of the genetic diversity of the Hawaiian hoary bat, identify bat prey items, and identify the sex of bat carcasses and any sex-specific food habits. Data on these topics will help inform conservation planning and improve host-plant selection for future habitat restoration efforts. This research determined the sex of Hawaiian hoary bat tissue samples using genotyping, which allows for more reliable evaluation of the ratio of males to females affected by wind-related fatalities. As part of the research, DNA will be extracted from any new tissue samples from bats (as acquired), and sex determination of additional bat carcasses will continue. USGS will release data and a technical report from this study in FY 2019.

The goal of WEST's *Hawaiian Hoary Bat Acoustic Surveys* study was to examine the distribution and seasonal occupancy of the Hawaiian hoary bat on O'ahu. The specific objectives for Year 1 of the multi-year study were to: 1) provide information on bat occupancy, distribution, and detection probabilities for O'ahu, 2) examine seasonal changes in distribution by estimating seasonal changes in occupancy, and 3) collect data that could be used later to assess habitat use relationships. During Year 1 of the study (June 8, 2017 to June 29, 2018), WEST recorded a total of 5,135 bat detections at 83 detectors deployed across the island (Starcevich et al. 2018). At least one Hawaiian hoary bat detection was recorded at 51 of the 83 detectors (61% of the sites). Data collection and analysis will continue in Year 2, and habitat variables such as elevation, human population density, and percent forest as may be incorporated as predictors in the occupancy analyses to assess Hawaiian hoary bat habitat selection (Starcevich et al. 2018).

#### **9.1.4 Waimea Native Forest (Tier 3)**

Funding the above-listed Tier 2/3 studies leaves an outstanding obligation of \$353,702 for Tier 3 bat mitigation. Based on USFWS and DOFAW guidance, there are no remaining research funding gaps for joint agency sub-committee approved projects (pers. comm. Glenn Metzler, DOFAW, August 2, 2017). To fulfill the remaining uncommitted funding obligation, Kawailoa Wind will contribute the remaining funds towards the purchase of the 3,716-acre Waimea Native Forest. The land will be acquired through a partnership with The Trust for Public Land (TPL) and DOFAW, as well as other funding partners. This mitigation aligns with current USFWS and DOFAW guidance which identifies land acquisition as an appropriate mitigation approach for the Hawaiian hoary bat (DLNR 2015). On April 27, 2018, USFWS expressed via email that they were in support of the Waimea Native Forest project (pers. comm. Jiny Kim, USFWS, April 27, 2018).

#### **9.1.5 Helemano Wilderness Area Mitigation**

In response to exceedance of the authorized bat take limit under the ITP/ITL (Section 7.2), Kawailoa Wind has initiated planning for, and implementation of, additional bat mitigation in coordination with the USFWS and DOFAW. This additional mitigation will be proposed in the forthcoming draft HCP Amendment. Kawailoa Wind will contribute \$2,750,000 to TPL toward the purchase and long-term protection of the nearly 2,900-acre Helemano Wilderness Area (HWA). TPL's anticipated timeline for closing the acquisition is August 2018. Following purchase of the lands by TPL, the land would be transferred to DOFAW and managed for multiple uses, including for the benefit of the Hawaiian hoary. In addition to protecting existing bat roosting and foraging habitat, DOFAW will develop a long-term management strategy to restore and improve degraded habitat. Acquisition of the HWA would ensure protection of Hawaiian hoary bat habitat from future development, meeting USFWS and DLNR long-term conservation goals described in the Endangered Species Recovery Committee Bat guidance (DLNR 2015), the Hawaiian hoary bat recovery plan (USFWS 1998), and the USFWS 5-year review (USFWS 2011). Further details of this additional bat mitigation will be provided in the forthcoming HCP Amendment.



## 9.2 Waterbirds

As stated above, USFWS and DOFAW provided written confirmation permitting adaptive management for the original bat and waterbird mitigation. Some activities completed for waterbird mitigation at 'Uko'a Wetland overlap with bat mitigation requirements and are summarized in Section 9.1.2 above.

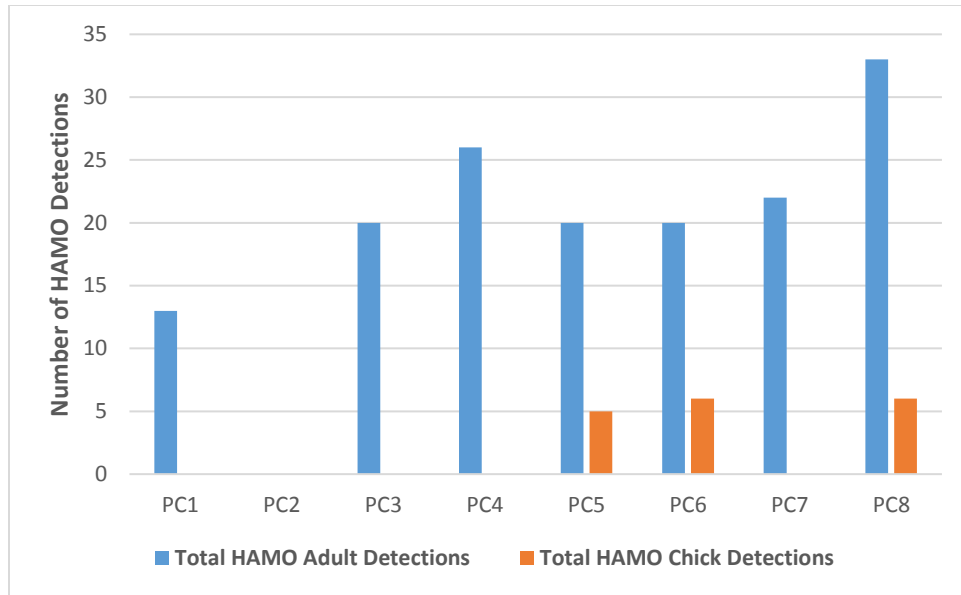
Prior to each vegetation maintenance event, a biologist conducted waterbird surveys to identify if nests or chicks were present in the vicinity of the planned work area. These surveys are required as a Best Management Practice (BMP) when contractors are working at the site to minimize impacts to endangered Hawaiian waterbirds.

Comprehensive weekly waterbird surveys were conducted throughout 'Uko'a Wetland in FY 2018 from December to September. A qualified biologist conducted surveys at eight point count (PC) stations set up in the vicinity of the open water and in areas with previous waterbird sightings. In addition to the PC stations, independent waterbird observations are recorded while walking between stations. The detailed protocols for these surveys were provided in the FY 2017 Annual Report (Tetra Tech 2017).

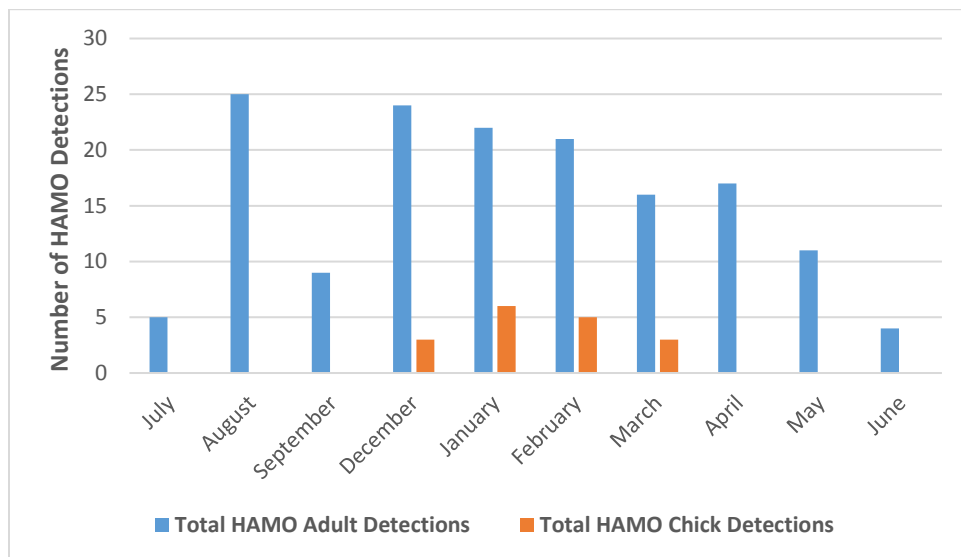
A total of 39 waterbird surveys were completed in FY 2018. The Hawaiian moorhen was the listed waterbird species most frequently detected during weekly surveys. In FY 2018, moorhen were recorded at all PC stations, except for PC station 2 (Figure 10). Moorhen (either adults or chicks) were observed or heard on all survey dates, except one survey date in June (Figure 11). Fewer moorhen were seen or heard in FY 2018 compared to FY 2017.

Moorhen breeding activity (e.g., nests or chicks) was observed at three PC stations between December 2017 and April 2018 (Figure 11). Chicks were seen at three PC stations (PC 5, 6, and 8) between December and March 2018 (Figure 11). Two nests were observed in April, one at PC 8 and one at PC 5. It is believed that no moorhen chicks successfully fledged from the breeding events observed at 'Uko'a Wetland in FY 2018. At least six chicks were believed to successfully fledge during the previous FY.

Hawaiian moorhen are cryptic and vegetation and water level conditions make 'Uko'a a challenging place to survey for this species. The fewer detections of moorhen and successful fledging in FY 2018 compared to FY 2017 could be due to reduced rainfall and water levels in FY 2018. The removal of water hyacinth in the open water area has altered habitat available to moorhen, and the birds may be using areas of the wetland that are not surveyed.



**Figure 10: Number of Hawaiian Moorhen (HAMO) Detections at Point Count Stations in FY 2018.**



**Figure 11: Number of Hawaiian Moorhen (HAMO) Detections by Month at Point Count Stations in FY 2018.**

No Hawaiian coot were seen in FY 2018. Twenty-seven detections of adult Hawaiian stilt were made on 11 survey dates in FY 2018. Stilt have been observed at four of the eight PC stations, as well as flying overhead between PC stations. No Hawaiian stilt breeding activity was observed in FY 2018.

### **9.3 Seabirds**

Tier 1 mitigation for Newell's shearwater is complete.

### **9.4 Hawaiian Short-eared Owls or Pueo**

Mitigation for the pueo or Hawaiian short-eared owl is complete. The Project contributed \$12,500 to Hawai'i Wildlife Center in February 2012, prior to the initiation of commercial operations. This was the first installment of its funding commitment for pueo mitigation under Tier 1. An additional \$12,500 was provided to DOFAW in FY 2017 to complete the mitigation obligation for pueo. This funding, in combination with funding from other wind projects, was utilized by DOFAW to hire a pueo researcher for the Pueo Project to investigate the population size, distribution, and habitat use of pueo throughout O'ahu.

## **10.0 Adaptive Management**

Kawailoa Wind has implemented multiple adaptive management steps to understand and reduce the risk to the Hawaiian hoary bat including modifying the low wind speed curtailment (LWSC) regime, implementing innovative approaches to post-construction mortality monitoring, and supporting development of the latest technologies that could reduce turbine collision risk to bats. In response to the Project's exceedance of the authorized bat take limit, Kawailoa Wind has proactively implemented additional measures to minimize take and has been investigating other potential minimization measures that could further reduce bat take. Based on the Project's wind regime and recognizing the operational limitations associated with Project's Power Purchase Agreement (PPA) requirements, Kawailoa Wind has implemented the following operational adaptive management actions in FY 2018 and beginning of FY 2019 to minimize the risk to the Hawaiian hoary bat:

1. Extend LWSC with a cut-in speed of 5.0 meters/second at all turbines to year-round from sunset to sunrise. This step was initiated on February 6, 2018.
2. Increase LWSC cut-in speed to 5.2 m/s through a 0.2 meters/second hysteresis to increase the "down time" of the WTGs and reduce the number of stop/start events per night by extending the rolling average time from 10 to 20 minutes. Hysteresis is a LWSC regime that offsets the "cut-out" and "cut-in" speeds such that it will take a higher average wind speed (raised cut-in speed) for the turbines to return to operation after stopping due to LWSC. LWSC at Kawailoa results in turbines being removed from service with feathering (blades rotated to a pitch of 82 degrees due mechanical specifications), resulting in a rotor speed of 1 revolution per minute or less. All Project WTGs are programmed to shut off when wind speeds are 5.0 meters/second or lower and to start up again when wind speeds reach 5.2 meters/second, thereby increasing the cut-in speed and extending the period during which collision risk for bats is minimized. Hysteresis was initiated on June 24, 2018. The rolling average was extended from 10 minutes to 20 minutes on July 25, 2018.

3. Conduct an ultrasonic acoustic bat deterrent “proof of concept” test, in collaboration with NRG Systems. NRG Systems installed an ultrasonic acoustic bat deterrent system at WTG 30, where the most bat fatalities (16 percent) have been detected, to evaluate effectiveness of the deterrent specific to Hawaiian hoary bats. The deterrent was deployed in July 2018. Effectiveness at reducing bat activity levels will be evaluated in collaboration with Bat Conservation International, Inc., using thermal imaging to document the bat approach paths and activity in relation to the rotor swept area at WTG 30. This proof of concept test at the Project will supplement the results of NRG System’s ongoing testing at wind farms on the Continental U.S., and will be used to inform future operational adaptive management at the Project.

The adaptive management actions identified above were presented to USFWS and DOFAW in May 2018, and both agencies were supportive of these measures. Further details will be provided in the forthcoming HCP Amendment.

## **11.0 Agency Meetings, Consultations, and Visits**

Kawailoa Wind and Tetra Tech conducted or participated in nine meetings with USFWS and DOFAW staff in FY 2018. The purpose of these meetings varied and included required semi-annual meetings, as well as discussions regarding the HCP Amendment and the Project’s adaptive management strategy to reduce the risk to the Hawaiian hoary bat.

Meetings took place on:

- September 12, 2017—USFWS and DOFAW— HCP semi-annual meeting;
- February 6, 2018—USFWS—Wind Energy Programmatic Environmental Impact Statement (PEIS) conference call;
- March 6, 2018—USFWS—Wind Energy PEIS conference call;
- March 27, 2018—USFWS and DOFAW— HCP semi-annual meeting;
- April 3, 2018—USFWS—Wind Energy PEIS conference call;
- May 1, 2018—USFWS—HCP amendment and adaptive management
- May 2, 2018—DOFAW—HCP amendment and adaptive management
- May 2, 2018—USFWS—Wind Energy PEIS meeting; and
- June 7, 2018—USFWS—Wind Energy PEIS conference call.

In addition, Kawailoa Wind and Tetra Tech met with the Endangered Species Recovery Committee on January 24, 2018 to review the FY 2017 HCP annual report.

## 12.0 Expenditures

Total HCP-related expenditures for the Project in FY 2018 were \$812,330 (Table 5).

**Table 5. HCP-related Expenditures at the Project in FY 2018.**

Category	Amount
Permit Compliance	\$141,000
Facility Vegetation Management	\$143,115
Fatality Monitoring	\$78,000
‘Uko’a Wetland Mitigation Compliance	\$144,945
Tier 2/3 Bat Research Projects	\$305,270
<b>Total Cost for FY 2018</b>	<b>\$812,330</b>

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## **APPENDIX 1**

### **DOCUMENTED FATALITIES AT THE PROJECT DURING FY 2018**



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**Appendix 1.** Documented Fatalities at the Project during FY 2018.<sup>1</sup>

Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
<i>Acridotheres tristis</i> (Common Myna)	7/3/2017	3	4	90
<i>Acridotheres tristis</i> (Common Myna)	7/6/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	7/10/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	7/13/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	7/13/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	7/17/2017	1	4	90
<i>Pterodroma sandwichensis</i> (Hawaiian Petrel)	7/21/2017	19	67	280
<i>Acridotheres tristis</i> (Common Myna)	7/27/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/1/2017	16	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/4/2017	16	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/7/2017	2	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/7/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/7/2017	2	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/10/2017	1	4	90
<i>Acridotheres tristis</i> (Common Myna)	8/14/2017	1	4	90
<i>Lasiurus cinereus semotus</i> (Hawaiian hoary bat)	8/22/2017	30	5	160
<i>Lasiurus cinereus semotus</i> (Hawaiian hoary bat)	8/22/2017	30	11	278
<i>Lasiurus cinereus semotus</i> (Hawaiian hoary bat)	8/28/2017	14	28	330
<i>Lasiurus cinereus semotus</i> (Hawaiian hoary bat)	8/28/2017	2	29	192
<i>Geopelia striata</i> (Zebra Dove)	9/14/2017	2	0	90
<i>Lonchura punctulata</i> (Nutmeg Mannikin)	9/26/2017	25	3	333
<i>Estrilda astrild</i> (Common Waxbill)	9/26/2017	30	0	99
<i>Estrilda astrild</i> (Common Waxbill)	10/5/2017	11	1	111
<i>Acridotheres tristis</i> (Common Myna)	10/9/2017	2	4	90
<i>Lonchura punctulata</i> (Nutmeg Mannikin)	10/10/2017	18	1	333
<i>Lonchura punctulata</i> (Nutmeg Mannikin)	10/12/2017	2	25	280
<i>Paroaria coronata</i> (Red Crested Cardinal)	10/26/2017	10	1	144
<i>Spilopelia chinensis</i> (Spotted Dove)	10/31/2017	17	1	5
<i>Geopelia striata</i> (Zebra Dove)	11/9/2017	2	1	310
<i>Spilopelia chinensis</i> (Spotted Dove)	11/28/2017	17	1	260
<i>Acridotheres tristis</i> (Common Myna)	12/1/2017	16	4	90
<i>Acridotheres tristis</i> (Common Myna)	12/19/2017	18	4	90
<i>Francolinus francolinus</i> (Black Francolin)	1/4/2018	3	1	2
<i>Lasiurus cinereus semotus</i> (Hawaiian hoary bat)	1/5/2018	30	16	190

Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
<i>Spilopelia chinensis</i> (Spotted Dove)	2/1/2018	9	1	110
<i>Estrilda astrild</i> (Common Waxbill)	2/5/2018	13	1	135
<i>Estrilda astrild</i> (Common Waxbill)	2/5/2018	1	3	90
<i>Onychoprion fuscatus</i> (Sooty Tern)	2/6/2018	20	33	135
<i>Lonchura punctulata</i> (Nutmeg Mannikin)	2/20/2018	21	3	340
<i>Estrilda astrild</i> (Common Waxbill)	2/20/2018	27	1	75
<i>Lonchura punctulata</i> (Nutmeg Mannikin)	2/22/2018	6	31	90
<i>Spilopelia chinensis</i> (Spotted Dove)	3/1/2018	8	1	180
<i>Geopelia striata</i> (Zebra Dove)	3/1/2018	14	1	90
<i>Columba livia</i> (Rock Dove)	3/6/2018	17	7	90
<i>Estrilda astrild</i> (Common Waxbill)	3/20/2018	23	0	245
<i>Spilopelia chinensis</i> (Spotted Dove)	3/20/2018	27	1	45
<i>Phaethon lepturus</i> (White-tailed Tropicbird)	3/22/2018	14	10	240
<i>Estrilda astrild</i> (Common Waxbill)	3/27/2018	17	1	45
<i>Acridotheres tristis</i> (Common Myna)	3/29/2018	7	3	45
<i>Spilopelia chinensis</i> (Spotted Dove)	3/29/2018	2	4	225
<i>Acridotheres tristis</i> (Common Myna)	3/30/2018	20	3	135
<i>Acridotheres tristis</i> (Common Myna)	4/2/2018	1	4	90
<i>Estrilda astrild</i> (Common Waxbill)	4/5/2018	3	1	45
<i>Estrilda astrild</i> (Common Waxbill)	4/5/2018	8	1	90
<i>Spilopelia chinensis</i> (Spotted Dove)	4/24/2018	24	11	250
<i>Estrilda astrild</i> (Common Waxbill)	4/24/2018	20	18	225
<i>Acridotheres tristis</i> (Common Myna)	4/27/2018	28	4	90
<i>Acridotheres tristis</i> (Common Myna)	4/27/2018	28	4	90
<i>Acridotheres tristis</i> (Common Myna)	5/1/2018	30	2	90
<i>Acridotheres tristis</i> (Common Myna)	5/1/2018	16	4	90
<i>Acridotheres tristis</i> (Common Myna)	5/4/2018	28	4	90
<i>Acridotheres tristis</i> (Common Myna)	5/8/2018	28	3	90
<i>Estrilda astrild</i> (Common Waxbill)	5/8/2018	23	8	55
<i>Acridotheres tristis</i> (Common Myna)	5/10/2018	3	3	90
<i>Estrilda astrild</i> (Common Waxbill)	5/10/2018	4	4	135
<i>Estrilda astrild</i> (Common Waxbill)	5/15/2018	21	6	170
<i>Estrilda astrild</i> (Common Waxbill)	5/15/2018	19	6	160
<i>Estrilda astrild</i> (Common Waxbill)	5/15/2018	26	20	300
<i>Spilopelia chinensis</i> (Spotted Dove)	5/22/2018	24	1	75

Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
<i>Acridotheres tristis</i> (Common Myna)	5/24/2018	3	3	90
<i>Acridotheres tristis</i> (Common Myna)	6/4/2018	4	4	90
<i>Estrilda astrild</i> (Common Waxbill)	6/5/2018	17	4	90
<i>Acridotheres tristis</i> (Common Myna)	6/18/2018	4	4	90
<i>Acridotheres tristis</i> (Common Myna)	6/18/2018	4	4	90
<i>Estrilda astrild</i> (Common Waxbill)	6/19/2018	20	8	200
<i>Pycnonotus cafer</i> (Red-vented Bulbul)	6/19/2018	18	1	145
<i>Estrilda astrild</i> (Common Waxbill)	6/19/2018	18	7	340
<i>Spilopelia chinensis</i> (Spotted Dove)	6/21/2018	4	3	90
<i>Estrilda astrild</i> (Common Waxbill)	6/28/2018	11	1	90

1. Covered Species are highlighted in yellow. Species protected by the MTBA are highlighted in gray.

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## **APPENDIX 2**

### **DALTHORP ET AL. (2017) FATALITY ESTIMATION FOR HAWAIIAN HOARY BATS AT PROJECT THROUGH FY 2018**

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## Appendix 2. Dalthorp et al. (2017) Fatality Estimation for Hawaiian hoary bats at Project through FY 2018.<sup>1</sup>

EoA, v2.0.3 - Multiple Years Module

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Past monitoring and operations data

Year	p	X	Ba	Bb	$\hat{g}$	95% CI
2013	0.67	4	27.15	23.31	0.538	[0.401, 0.672]
2014	1	9	181.7	91.14	0.666	[0.609, 0.721]
2015	1	9	390.9	102.7	0.7919	[0.755, 0.827]
2016	0.33	3	96.09	20.24	0.826	[0.752, 0.889]
2016	0.67	1	794.4	1082	0.4234	[0.401, 0.446]
2017	1	2	347.7	556.8	0.3844	[0.353, 0.416]
2018	1	5	502.2	871.9	0.3655	[0.34, 0.391]

Options

**Fatalities**

☒ Estimate M Credibility level (1 -  $\alpha$ )

☒ Total mortality ☒ One-sided CI ( $M^*$ )

☐ Two-sided CI

**Project parameters**

Total years in project

Mortality threshold (T)

☐ Track past mortality

☐ Projection of future mortality and estimates

Future monitoring and operations

☐ g and p unchanged from most recent year

☒ g and p constant, different from most recent year

g  95% CI:   p

☐ g and p vary among future years

**Average Rate**

☐ Estimate average annual fatality rate ( $\lambda$ )

Annual rate threshold ( $\tau$ )

☐ Credibility level for CI (1 -  $\alpha$ )

☒ Short-term rate ( $\lambda > \tau$ ) Term:   $\alpha$

☐ Reversion test ( $\lambda < p \tau$ ) p   $\alpha$

**Actions**

<sup>1</sup> Rho represents the portion of a year represented for each line of data. Year 2013 represents a partial year (November 2012 – June 2013) because the Project began operations in November; all remaining years except 2016 represent a full fiscal year. Year 2016 was parsed into two periods because of the change in search strategy that reduced the search area from 50 percent of the maximum blade tip height of the turbine to a 35-meter radius search plot.



