Auwahi **Wind**

January 2, 2024

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Via Email

SUBJECT: Auwahi Wind Farm Project Habitat Conservation Plan FY 2023 (Year 11) Annual Report

Dear Ms. Gosliner and Ms. Girald-Perez:

Please find the attached annual report for the Auwahi Wind Farm Project Habitat Conservation Plan (HCP), prepared in compliance with the U.S. Fish and Wildlife Service Incidental Take Permit (ITP) TE64153A-1 and Department of Land and Natural Resources Incidental Take License (ITL) ITL-17. This annual report covers monitoring and mitigation activities conducted from July 1, 2022, through June 30, 2023. The report identifies each HCP requirement and ITP and ITL condition completed, ongoing requirements and conditions, compliance status, and basis for determining compliance. Also, in compliance with HCP monitoring requirements, a post-construction mortality monitoring update is included.

Should you have any questions on this annual report, please feel free to contact me at (630) 658-9115 or via email at wgreene@invenergy.com.

Sincerely,

Wendy Greene

Director, Environmental Compliance & Strategy | Invenergy

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Auwahi Wind Farm Habitat Conservation Plan FY 2023 Annual Report

Incidental Take Permit TE64153A-1/ Incidental Take License ITL-17

Submitted To:

AEP Renewables / Auwahi Wind

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December 2023

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1.0 Introduction

Auwahi Wind Energy, LLC (Auwahi Wind) finalized a Habitat Conservation Plan (HCP) for the construction and operation of the Auwahi Wind Farm Project (Project) on east Maui, Hawai‘i in 2012 (Tetra Tech 2012a). The HCP and associated incidental take permit (ITP; TE64153A-1) from the U.S. Fish and Wildlife Service (USFWS) and incidental take license (ITL; ITL-17) from the Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) authorize incidental take (hereafter take) for the Hawaiian petrel (*Pterodroma sandwichensis*), Hawaiian goose (*Branta sandvicensis*), Hawaiian hoary bat (*Lasiurus cinereus semotus*), and Blackburn’s sphinx moth (*Manduca blackburni*), collectively referred to as the Covered Species. This report provides a summary of monitoring and mitigation activities that have occurred during Fiscal Year (FY) 2023 (July 1, 2022, to June 30, 2023). This report includes an overview of post-construction mortality monitoring (PCMM) and mitigation activities, addresses other required annual reporting items as identified in the HCP, reviews an annual work plan for the upcoming year, and details annual cost expenditures as required under the ITP and ITL.

2.0 Post-Construction Mortality Monitoring

The HCP includes a detailed description of the monitoring protocol. In FY 2023, standardized carcass searches were performed around all eight turbines and the meteorological tower every 7 days using a canine search team consisting of a dog and handler. Bias trials consisting of carcass persistence trials (CPT) and searcher efficiency (SEEF) trials were conducted throughout FY 2023.

Other permits also required for compliance include a Migratory Bird Special Purpose Utility permit (MB92518A-1) for handling migratory bird carcasses, which was reissued by USFWS on April 1, 2021, and a State Protected Wildlife Permit (WL22-03) for handling native bird and bat carcasses, which was reissued by DOFAW on January 27, 2022.

2.1 Fatality Monitoring

2.1.1 Systematic Carcass Searches

The canine search team searched for downed wildlife along all pads and roads within a 100-meter radius of the turbines and within 10 meters of the meteorological tower.[1] Based on carcass fall distributions compiled by Tetra Tech, Inc. (Tetra Tech) from 25 publicly available studies at other wind facilities, the areas searched at the Project represented a total of 54 percent of the large bird fall distribution and 77 percent of the bat fall distribution (Sempra Energy 2015). These values are consistent with results based on a theoretical carcass distribution model (Hull and Muir 2010).

[1] Searches of the meteorological tower were discontinued after their removal.

2.1.2 *Detections Outside of Designated Searches and Searched Areas*

Project staff, contractors, and ranch personnel with access to the Project area may detect downed wildlife during their regular activities. The USFWS protocol for incidental detections (USFWS 2018) is applied to determine if the detections should be included in Project fatality estimates depending on the location of the recovered animal or carcass relative to the search area, the timing of the detection relative to the next search, and the likelihood of detection based on estimates of carcass persistence from Project-specific bias correction trials.

2.2 2Downed Wildlife Observations

Fourteen fatalities were documented and reported in FY 2023; 11 of these fatalities were documented during standardized carcass searches (within the search area and during a scheduled search) and three were detected incidentally (outside of the search area or outside of a scheduled search; Table 2-1). Three of the recorded fatalities were species protected under the Migratory Bird Treaty Act (MBTA). Six of the recorded fatalities were Covered Species—all Hawaiian hoary bats (Table 2-1). For each of the fatalities, USFWS and DOFAW were notified within 24 hours, with follow-up fatality reports and take estimates, as required by the ITP and ITL.

Table 2-1. Documented Fatalities in FY 2023

Species	Legal Status[1]	Found Date	Location (Turbine)	Type of Detection[2]	Outside Search Area	Outside Scheduled Search
Wedge-tailed Shearwater (*Ardenna pacifica*)	MBTA	7/20/2022	6	Incidental Finding	X	
Wedge-tailed Shearwater (*Ardenna pacifica*)	MBTA	9/19/2022	6	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	9/26/2022	2	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	10/3/2022	7	Incidental Finding	X	
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	10/31/2022	1	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	10/31/2022	2	Carcass Survey		
Eurasian Skylark (*Alauda arvensis*)	MBTA	12/12/2022	7	Carcass Survey		
Spotted Dove (*Spilopelia chinensis*)	None	3/20/2023	3	Incidental Finding	X	
African Silverbill (*Euodice cantans*)	None	3/27/2023	2	Carcass Survey		

Species	Legal Status[1]	Found Date	Location (Turbine)	Type of Detection[2]	Outside Search Area	Outside Scheduled Search
Spotted Dove (*Spilopelia chinensis*)	None	3/27/2023	4	Carcass Survey		
Spotted Dove (*Spilopelia chinensis*)	None	5/1/2023	8	Carcass Survey		
Spotted Dove (*Spilopelia chinensis*)	None	5/8/2023	3	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	6/5/2023	5	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	6/19/2023	6	Carcass Survey`		

1. T&E = Federally endangered and State endangered, MBTA=Protected under the Migratory Bird Treaty Act.
2. *Incidental Finding* indicates the observation was detected outside the scheduled search or outside the search area. *Carcass Survey* indicates the species was observed within the search area and during a scheduled search .

2.3 Carcass Persistence Trials

Sixty-three CPTs were conducted quarterly during FY 2023 and are summarized by carcass size class in Table 2-2. The objective of these trials is to estimate the likelihood that carcasses persist to the next search at the Project. For CPTs, Gray francolins (*Ortygornis pondicerianus*) were used as surrogates for HCP-covered bird species, and small sized black rats (*Rattus rattus*) were used as surrogates for Hawaiian hoary bats.

Surrogate carcasses were placed at randomly generated points on turbine pads and roads within search plots. Carcasses were typically checked twice weekly in FY 2023 (every Monday during canine team searches and one additional check weekly) until carcasses were no longer detectable or the trial period was complete. Trial periods were up to 44 days in length. Changes in carcass condition were tracked and documented with photos. Probability of carcass persistence with 95 percent confidence intervals for each carcass category were estimated using the single class module of Evidence of Absence software (EoA; Dalthorp et al. 2017). The probability that a bat carcass would persist until the next search was 0.868 in FY 2023 (Table 2-2). The probability that a large bird carcass would persist until the next search was 0.99 in FY 2023 (Table 2-2).

Table 2-2. Carcass Persistence Estimates for Systematic Searches in FY 2023

Carcass Size Class	N	Probability of Carcass Persistence until Next Search	95 Percent Confidence Interval	Search Interval (days)
Bats	41	0.868	[0.816, 0.906]	7
Large Birds	22	0.999	[0.986, 1.000]	7

2.4 Searcher Efficiency

Sixty-four SEEF trials were conducted during FY 2023 (

Table 2-33). The objective of these trials was to assess the effectiveness of the canine search team at finding downed wildlife. Each trial was conducted by the Project biologist or environmental technician (tester) on site. The canine search team had no prior knowledge of the trials; every fatality search day was treated as if it had the potential to be a SEEF trial day. During FY 2023, 42 SEEF trials were performed for bats and 22 for large birds. Species used for SEEF trials included the same as used for carcass persistence trials. SEEF carcasses were placed at randomly generated points on turbine pads and roads within search plots. Carcasses found during SEEF trials were left in place and were then monitored for carcass persistence (Section 2.3). Estimates of searcher efficiency and 95 percent confidence intervals for each carcass category were calculated using the single class module of EoA (Table 2-3; Dalthorp et al. 2017). Searcher efficiency was 100 percent for both bats and large birds (Table 2-3).

Table 2-3. Searcher Efficiency Estimates for Wildlife Fatality Searches in FY 2023

Carcass Size Class	Search Method	Carcasses Available	Carcasses Found	Average Searcher Efficiency	95 Percent Confidence Interval
Bats	Canine	42	42	1.000	[0.942, 1.000]
Large birds	Canine	22	22	1.000	[0.893, 1.000]

2.5 Take

2.5.1 Direct Take

Auwahi Wind evaluated Project compliance under the ITL and ITP by estimating unobserved take using EoA software. The EoA analysis incorporated observed fatalities, results of bias correction trials (SEEF and CPT), search intervals, and proportions of the carcass distributions searched. EoA provides an estimate of total mortality for a given level of credibility to help evaluate if the number of fatalities has exceeded a given threshold of take. An 80-percent credibility level has been required by USFWS and DOFAW to assess compliance with an ITP and ITL so that there is only a 20 percent probability that actual take exceeds estimated take.

Auwahi Wind used EoA to model past Project take using PCMM data collected over the past 10.5 years for the Hawaiian hoary bat and Hawaiian petrel (Table 2-4; Attachment 1). Because the FY does not coincide with the Project's operational year, the observed fatalities, carcass persistence, searcher efficiency, and detection bias values in Table 2-4 represent values for calendar years, with the period from January 1, 2023, through June 30, 2023 representing 2023 (Year 11). Therefore, values differ from those reported for the full FY 2023 in the sections above.

Table 2-4. Summary of PCMM Data at the Project, From the Start of the Project through June 2023 (2013–2023)

Calendar Year	Low-wind Speed Curtailment (5 m/s)	Low-wind Speed Curtailment (6.9 m/s)[1]	Number of Fatalities Detected	Proportion of Carcass Distribution Searched	Average Search Interval (days)	Probability of Carcass Persistence	Average Searcher Efficiency	Detection Bias[2]	Cumulative Direct Take Estimate[3]	Cumulative Indirect Take Estimate in Adult Equivalents[4]
Hawaiian Hoary Bat										
2013	No	No	1	0.97	9	0.44	0.57	0.28	8	1 (0.47)
2014	No	No	4	0.94	5	0.75	0.52	0.55	16	1 (0.74)
2015	Yes	No	1	0.76	3	0.73	0.68	0.45	18	1 (0.74)
2016	Yes	No	7	0.76	3	0.76	0.76	0.55	34	4 (3.03)
2017[5]	Yes	No	3	0.76	3–4	0.88	0.67	0.60	39	5 (4.25)
2018	Yes	No	1	0.76	4–7	0.77	1.00	0.52	41	5 (4.25)
2019	Yes	Yes	7	0.77	7	0.93	1.00	0.72	52	6 (5.05)
2020	Yes	Yes	4	0.77	7	0.93	1.00	0.71	59	7 (6.03)
2021	Yes	Yes	6	0.77	7	0.87	0.97	0.66	67	7 (6.34)
2022	Yes	Yes	4	0.77	7	0.79	1.00	0.60	70	8 (7.49)
2023[6]	Yes	Yes	2	0.77	7	0.91	1.00	0.69	77	8 (7.73)
Hawaiian Petrel										
2013	No	No	0	0.91	9	0.79	0.74	0.67	0	0[7]
2014	No	No	1	0.91	5	0.98	0.75	0.84	2	1 (0.19)[7]
2015	Yes	No	0	0.56	3	0.99	0.89	0.55	2	1 (0.19)[7]
2016	Yes	No	0	0.56	3	0.96	0.96	0.48	3	1 (0.19)[7]
2017	Yes	No	0	0.56	3–4	0.99	0.96	0.55	3	1 (0.19)[7]
2018	Yes	No	0	0.56	4–7	0.99	1.00	0.55	3	1 (0.38)[7]
2019	Yes	Yes	0	0.54	7	0.99	1.00	0.53	3	1 (0.38)[7]
2020	Yes	Yes	0	0.54	7	1.00	1.00	0.53	3	1 (0.38)[7]
2021	Yes	Yes	0	0.54	7	0.99	1.00	0.52	3	1 (0.38)[7]
2022	Yes	Yes	0	0.54	7	0.91	1.00	0.47	3	1 (0.38)[7]
2023[6]	Yes	Yes	0	0.54	7	0.99	1.00	0.53	3	1 (0.38)[7]

1. 6.9 m/s curtailment from August 1 to November 1; Section 2.8.1.
2. Detection bias calculated using EoA software (Dalthorp et al. 2017).
3. Estimate of direct take based on EoA single class module; values represent the upper 80 percent confidence interval (see Attachment 1).
4. Estimate of indirect take based on USFWS 2016 guidance. Take estimates subject to change pending genetic analysis of observed fatalities. The actual value is presented in parentheses and the value rounded up to the nearest whole number is presented first.
5. Detection bias calculated using pooled data with custom search interval in single class module from EoA software.
6. Calendar year 2023 includes the dates from January 1 through June 30.
7. Estimate of indirect take based on calculations in the HCP. The actual value is presented in parentheses and the value rounded up to the nearest whole number is presented first.

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2.5.1.1 Hawaiian Hoary Bat

Based on the 41 bat fatalities detected during fatality searches and 11 fatalities detected incidentally during 10.5 years of PCMM, this analysis can be interpreted to mean that there is an 80 percent probability that actual direct take at the Project was less than or equal to 77 Hawaiian hoary bats. Based on results from the EoA, up to 25 undetected bat fatalities may also have occurred.

2.5.1.2 Hawaiian Petrel

Based on the one Hawaiian petrel fatality detected during fatality surveys and one fatality detected incidentally during 10.5 years of PCMM, this analysis can be interpreted to mean that there is an 80 percent probability that actual direct take at the Project was less than or equal to three Hawaiian petrels.

2.5.2 Indirect Take

It is assumed that take of an adult bird or bat during the breeding season may result in the indirect loss of a dependent young. Thus, for every petrel or bat carcass detected during the breeding season, modifiers are applied to estimate indirect take based on average reproductive success to account for: 1) the likelihood that a given adult is reproductively active, and 2) the likelihood that the loss of a reproductively active adult results in the loss of its young (Tetra Tech 2012a: Section 5.2).

2.5.2.1 Hawaiian Hoary Bat

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 breeding period when females may be pregnant or supporting dependent young. The seasonal timing and sex of all observed fatalities (those observed in fatality monitoring and incidentally) is used to calculate indirect take. USFWS (2016) guidance was used for fatalities that lacked verified sex information. Of 52 bat fatalities, 46 had genetically verified sex information provided in Pinzari and Bonaccorso (2018). In addition, the take estimate at the 80-percent credibility limit suggests that there may be unobserved direct take of up to 25 unknown sex bats. Indirect take was estimated as 7.73 adult Hawaiian Hoary bats (Attachment 2).

2.5.2.2 Hawaiian Petrel

Two Hawaiian petrel fatalities have been observed within the breeding season (May 1 through September 30) at the Project. The one Hawaiian petrel observed on site during systematic fatality monitoring was found in 2014. One Hawaiian petrel was observed incidentally (outside of the search plot) in 2018. Based on estimates from EoA, up to one additional petrel fatality may have occurred and been undetected. The detection of an adult Hawaiian petrel recorded during the breeding season is assumed to result in the loss of one chick (Tetra Tech 2012a). The average reproductive success for Hawaiian petrels on Maui was previously estimated at 63 percent (Simons and Bailey 2020). The final assessment of indirect take at the end of the permit term will round up to the nearest whole number.

Indirect take is estimated to account for the potential loss of individuals (i.e., offspring) that may occur as the result of the loss of their parents. Both parents of the Hawaiian petrel care for their young until fledging (Simons and Bailey 2020). The point during the breeding season when an adult is taken determines to what extent offspring may be affected. Indirect take was calculated as 1.26 juveniles (observed take of 2 adults during the breeding season * 0.63 average reproductive success) or 0.38 adults (1.26 juveniles * 0.3 surviving to adulthood).

2.6 Take Projection and Estimated Fatality Rates for Hawaiian Hoary Bat

Auwahi Wind used EoA to estimate the Hawaiian hoary bat direct take projected for the remainder of the permit term based on past monitoring data. The direct take estimate does not account for indirect take, which is based on agency guidance and the seasonal timing and gender of observed fatalities. Auwahi Wind reports the direct take projection at the 80-percent credibility level as required by USFWS and DOFAW to assess compliance with an ITP and ITL. The take authorization is based on a direct take estimate of 129 bats. The median take projection (as calculated using EoA) is estimated as 143 bats (interquartile range: 133 to 154 bats) in the last year of expected operations, 2032.

The estimated Baseline Fatality Rate calculated by EoA is 6.84 (95-percent confidence interval, 4.90 to 9.09), which currently exceeds the Threshold Value of 6.45 (Table 2-5), as specified in the HCP. The Project began implementing its Adaptive Management Plan in FY2020, has updated the Adaptive Management Plan to incorporate additional minimization measures (see Attachment 3), and is working with USFWS and DOFAW to approve a Tier 5 mitigation plan (Section 3.2.3).

Table 2-5. EoA Estimated Hawaiian Hoary Bat Baseline Annual Fatality Rate

Source	Metric	Take Value
Value calculated from EoA analysis of PCMM data	Baseline Annual Fatality Rate[1]	6.84
Comparison values from the HCP	Annual Threshold Value	6.45
	Average annual take rate to remain within Tier 5	5.75

1. Estimating the Baseline Fatality Rate partially through the sampling year may skew results by estimating bias correction trial results with smaller data sets than would be available after a full year of study.

2.7 Wildlife Education and Incidental Reporting

Auwahi Wind continues to implement a wildlife education and incidental reporting program for contractors, Project staff members, and ʻUlupalakua Ranch staff who are on site regularly. Annual training enables staff to identify the Covered Species that may occur in the Project area, record observations of these species, and take appropriate steps for documenting and reporting any species encountered during the operation of the Project. Auwahi Wind trained 27 contractors and new staff in FY 2023.

2.8 Avoidance and Minimization

Avoidance and minimization measures outlined in the HCP continue to be implemented in FY 2023. Actions taken for avoidance and minimization measures for Hawaiian hoary bat and Blackburn's sphinx moth are described below.

2.8.1 Hawaiian hoary bat

Auwahi Wind continues to implement low-wind speed curtailment (LWSC) at cut-in speeds of 5 meters per second (m/s) from November through July. From August through October, LWSC cut-in speeds are increased to 6.9 m/s. For all periods, LWSC is implemented from 30 minutes before sunset to 30 minutes after sunrise. In addition to LWSC, Auwahi Wind installed NRG ultrasonic acoustic deterrents at all Project turbines in June of 2020. Ultrasonic acoustic deterrents operate, at a minimum, from 1 hour before sunset until 1 hour after sunrise, year-round.

Due to the ineffectiveness of the installed deterrents in reducing bat fatalities, Auwahi Wind submitted additional minimization measures in March 2023 as part of the Adaptive Management Plan, see Attachment 3. The meteorological tower was taken down at the site as an adaptive management action. Thermal cameras were set up to document bat behavior at the met tower prior to demolition. The data from the thermal cameras was able to confirm that bats were using the area around the met tower upwind of Turbine 6. Auwahi Wind has also continued to monitor bat use at Project turbines using thermal cameras (Section 4.1).

2.8.2 Blackburn's Sphinx Moth

Areas within 10 meters of roadsides and edges of turbine pads are targeted for tree tobacco (*Nicotiana glauca*) removal because these areas may present a proximity hazard for the Blackburn's Sphinx Moth (BSM) due to exposure to dust, possible trampling, and increased chance of vehicle collisions (USFWS and DOFAW; email instructions Feb 7, 2014). Through continued implementation of this removal approach, there has been a decrease in tree tobacco plants occurring within hazard areas. During FY 2023, 140 tree tobacco plants were removed from the Project, most of which were in the immature vegetative state. The removal of the plants followed USFWS guidance for take avoidance and minimization (USFWS 2022). Auwahi continued monthly field surveys for BSM in FY 2023 following the survey protocol described in Auwahi Wind's state Native Invertebrate Research Permit (Endorsement #I1303; NPS 2019). The presence of BSM was detected during monthly surveys at the Project in FY 2023.

3.0 Mitigation

Auwahi Wind has fulfilled mitigation obligations for Blackburn's sphinx moth, Hawaiian goose, and red ʻilima (*Abutilon menziesii*), details of which are provided in previous annual reports (Tetra Tech 2012b, Sempra Energy 2016, Tetra Tech 2019). Ongoing mitigation efforts by Auwahi Wind for the Hawaiian petrel and Hawaiian bat are described below.

3.1 Hawaiian Petrel Mitigation

Auwahi Wind continues to implement Hawaiian Petrel Mitigation as outlined in the HCP. In the 2022 management season, 78 burrows were protected, and 15 Hawaiian petrel chicks successfully fledged from the Kahikinui Petrel Management Area (PMA). Beginning in August 2013, Auwahi Wind implemented its Hawaiian Petrel Management Strategy (Tetra Tech 2012c) in the Kahikinui PMA to increase the survival of Hawaiian petrels and the reproductive success of the breeding colony. As in previous years, the objectives of the 2022 Kahikinui PMA management season were to monitor Hawaiian petrel burrows and determine the number of active burrows, evaluate reproductive success, and continue to implement the current predator control strategy.

3.1.1 Petrel Burrow Monitoring

Auwahi Wind monitors petrel burrows using two methods 1) burrow checks, and 2) game cameras. The cameras also document activity by predators and goats. Burrows were classified into categories of seasonal status (see Auwahi Wind FY2017 Attachment 2, Table 1 for definitions) based on the activity patterns observed during the burrow checks and from footage captured at 34 burrows using game cameras. Auwahi Wind included burrows in the reproductive success calculations based on each burrow's seasonal status. For all calculations of reproductive success, it was assumed there was a maximum of one egg or fledgling per burrow, and burrows categorized as prospecting or seasonally inactive were excluded. Metrics of reproductive success are described in previous reports (e.g., Tetra Tech 2020b).

Results of the 2022 management season are reported in FY 2023 since the management season splits both fiscal years. Monthly visits to monitor burrow activity began on January 20, 2022. Monitoring of active burrows ended on December 16, 2022, at which time all the burrows had ceased to be active. Of the 78 petrel burrows monitored, 34 showed signs of activity during the breeding season, and 28 burrows were active throughout the breeding season (see Auwahi Wind FY2017 Attachment 2, Table 1 for definitions). By the end of the breeding season, 15 burrows had successfully fledged a chick. All the fledglings were documented via game camera. The remaining 13 burrows that were active either failed or showed signs of occupation or prospecting by a non-breeder. There were images that showed cat visitations at burrows in the 2022 management season, although no signs of predation were documented on camera or observed in the field. Cat detections were most likely a single cat passing through the colony and visiting burrows that might have been removed by neighboring predator trapping programs managed by DOFAW, HALE, and MNSRP. The number of consistently active burrows has remained relatively constant throughout all years of monitoring with the total number of active burrows ranging between 25 to 37 across all years monitored.

3.1.1.1 Predator Monitoring and Control

Auwahi Wind continues to implement predator control year-round using traps deployed within the nesting seabird colony. Trap placement is informed by game camera data. Staff used a combination of four trap types including 49 DOC250 kill traps, 44 Goodnature A24 traps, three Victor foothold traps (equipped with Reconyx cellular cameras), and 39 KaMate traps. Auwahi Wind deployed foothold traps when cats were observed on game cameras. Other traps are open year-round and checked monthly. Predator trapping results from the 2022 management season included 2 rats and 31 mice.

3.1.1.2 Benefits

Auwahi Wind Hawaiian Petrel mitigation is on track to fully offset impacts to the Hawaiian petrel based on the agreed upon model described in the HCP and updated in concurrence with USFWS and DOFAW. Auwahi Wind continues to protect 78 petrel burrows through predator control. Additionally, petrel take projections for the life of the Project are significantly less than the Tier 1 take authorization. Petrel management activities will be considered successful if: (1) predator control is successfully implemented, and (2) mitigation efforts result in an increase in reproduction that offsets authorized take, as outlined in the Hawaiian Petrel Management Plan (Tetra Tech 2012c) approved by USFWS and the DOFAW. Auwahi Wind has measured reproductive success of Hawaiian petrels and predator activity within Kahikinui PMA. Auwahi Wind, USFWS, and DOFAW have discussed the benefit of Auwahi Wind’s mitigation actions. The measures of success and the implementation status are on track to be completed, and mitigation efforts will result in one more fledgling or adult than required to compensate for the requested take of the required tier.

3.2 Hawaiian Hoary Bat Mitigation and Monitoring

Tier 1 bat mitigation is ongoing at the Puʻu Makua parcel of the Waihou Mitigation Area on ʻUlupalakua Ranch. Tier 1 mitigation consists of restoration of native forest on ranch land (including installation of an ungulate proof fence, ungulate removal, and native reforestation). This parcel was placed into a conservation easement and will be protected for bat habitat in perpetuity. Tier 2 and3 mitigation consisted of funding Hawaiian hoary bat research to contribute to the overall knowledge of the Hawaiian hoary bat on Maui and was completed and reported upon in FY 2020 (Tetra Tech 2020a). Tier 4 mitigation is ongoing and focuses on protecting, managing, and enhancing habitat suitable for bat foraging and roosting on a 709-hectare parcel within ranch land. Tiers 1through 4 of mitigation actions have been funded and either are completed or are still being implemented in accordance with mitigation plans approved by USFWS and DOFAW. A summary of all ongoing or completed measures of success relating to habitat-based Hawaiian hoary bat mitigation is provided in the sections below.

3.2.1 Tier 1 Mitigation

Auwahi Wind is in its 8th year of habitat restoration efforts at the Puʻu Makua mitigation site. The habitat restoration includes ungulate fence installation, ungulate removal, invasive plant species removal, and plantings of native trees and shrubs. The ungulate fence, which was installed in 2013, is in good condition. The 2.4-meter-tall ungulate exclusion fence surrounding the parcel was repaired in FY 2023 after storm damage was identified; the parcel remains ungulate-free. Other management activities in FY 2023 include targeted invasive plant species removal and outplanting of native species. Expanding habitat restoration efforts in the surrounding Tier 4 mitigation lands has added additional ungulate barriers to this parcel. The landowner, ʻUlupalakua Ranch, continues cattle grazing on the surrounding ranch lands including the Tier 4 mitigation lands.

3.2.1.1 Management

Quarterly fence checks in FY 2023 identified storm damage to the roads that access the fence. Fallen trees were removed from the roads to access the mitigation sites. Ungulates were not observed within the mitigation area in FY 2023.

Vegetation management of the restoration site performed in FY 2023 included targeted weed surveys and treatments of tropical ash (*Fraxinus uhdei*), bocconia (*Bocconia frutescens*), black wattle (*Acacia mearnsii*), and Monterey pine (*Pinus radiata*) as identified in the HCP (Tetra Tech 2012a). Additional native species were outplanted in the remnant grasslands and koa (*Acacia koa*) plots. Auwahi Wind worked with Maui Plant Extinction program to collect plant information within the fenced area, specifically for naio (*Myoporum spp.*).

3.2.1.2 Benefits

The measures of success as defined in the HCP and current status of each measure of success are presented in Table 3-1.

Table 3-1. Hawaiian Hoary Bat Tier 1 Measures of Success and Implementation Status

Measures of Success	Implementation Status
After 6 years, mitigation fencing is completed, and ungulates have been removed from within the fenced area.	Completed
Over the 25-year permit term, the fence is maintained, and the area is kept free of ungulates.	Ongoing
After 25 years, the cover of invasive species (excluding kikuyu grass) in the managed areas is less than 50 percent.	Ongoing
After 25 years, reforested areas within the Waihou mitigation area have greater than 50 percent canopy cover dominated by native woody species.	Ongoing

3.2.2 Tier 4 Mitigation

Tier 4 Mitigation is located on 709 hectares (1,752 acres) of ʻUlupalakua Ranch land. The objective of the Tier 4 Mitigation is to protect, manage, and enhance habitat that is suitable for bat foraging and roosting through the addition of features necessary for those stages of the Hawaiian hoary bat life cycle. The final conservation easement was fully executed on December 7, 2020. Detailed progress regarding milestones for Tier 4 mitigation management and monitoring activities per FY quarter are provided in Attachment 4.

3.2.2.1 Management

Auwahi Wind completed fence construction for the outplanting areas in FY 2022. Maintenance and improvements to the fences occurred in FY 2023. Quarterly fence inspections began in FY 2021 and were conducted using a DJI drone. A total of 115 acres have been planted with approximately 3,000 native seedlings within the fenced areas in FY 2023. The constructed 50,000-gallon capacity ponds were monitored for bat activity in FY 2022 (Tetra Tech 2022, Attachment 6). Bat activity was documented at the pond locations, both of which are fenced and outplanted with native plants. No barbwire was used in the construction of new fences within the Tier 4 mitigation area.

3.2.2.2 Monitoring

Auwahi Wind continued insect monitoring in the Tier 4 mitigation site in FY 2023. Three malaise traps were checked semi-annually in FY 2023. A complete report of the monitoring can be found in Attachment 5.

The second year of acoustic monitoring was completed for the Tier 4 mitigation site and a final report was submitted in FY 2023. The average number of Hawaiian hoary bat detections throughout the study area remained stable to increasing in the second year of monitoring (see Attachment 6).

3.2.2.3 Benefits

The success measure's definitions (as defined in the HCP) and current statuses are presented in Table 3-2, with additional details provided in Attachment 5.

Table 3-2. Hawaiian Hoary Bat Tier 4 Mitigation Measures of Success and Implementation Status

Measures of Success	Implementation Status
Protect the mitigation parcel in perpetuity through a conservation easement with oversight of the parcel by Hawaiian Islands Land Trust (or other appropriate conservation entity).	Completed
Install two additional ponds in the Mitigation Area according to the HCP, or other number as specified through adaptive management.	Completed

Measures of Success	Implementation Status
Increase forest cover to 20 percent within the pasture parcels through hedgerow reforestation at approximately 500 trees per hectare, or other cover and parcels as specified through adaptive management.	Ongoing
Record an increase in bat activity through acoustic monitoring over the baseline monitoring year(s). The statistical power with which the increase is recorded will also be reported.	Ongoing
Summarize and report the results of monitoring in annual reports.	Ongoing

3.2.3 Tier 5 Mitigation

Auwahi Wind submitted a fourth and fifth draft of the Tier 5 Site Specific Mitigation Implementation Plan (SSMIP) for the Hawaiian hoary bat in FY 2023. The first draft of the SSMIP was submitted to DOFAW and USFWS in November of 2021. Auwahi Wind will continue to coordinate closely with DOFAW and USFWS in the development of the Auwahi Wind SSMIP. Once a plan has been approved and a Memorandum of Understanding is in place with DOFAW, Auwahi Wind will implement additional actions as identified in the latest draft of the SSMIP (see Attachment 7).

3.2.3.1 Baseline Monitoring (Prebaseline monitoring)

Auwahi Wind deployed two acoustic detectors in May 2021, to gather baseline information on bat acoustic activity in the proposed Tier 5 mitigation area at Kamehamenui Forest Reserve. Detectors were regularly checked in FY 2023 to ensure they were functioning properly. A report of the first year of monitoring can be found in Attachment 8.

4.0 Adaptive Management

4.1 Post-Construction Mortality Monitoring

Auwahi Wind investigated bat fatality events at Project turbines in FY 2023. Hawaiian hoary bats continue to be detected as fatalities at the Project despite implementation of acoustic bat deterrents on all Project turbines year-round from 1 hour before sunset to 1 hour after sunrise. Although not significant, the fatality rate has increased from 6.28 bats per year in the FY 2019 annual report to 6.84 bats per year in the FY 2023 report. Auwahi Wind staff continued to collect thermal camera data from the turbines after the completion of the U.S. Geological Survey study (Gorresen et al. 2020) and after ultrasonic acoustic deterrents had been installed at all Project turbines. Wildlife Imaging Systems subsequently analyzed data collected in FY 2023 and found one possible fatality detected via thermal camera.

4.2 Minimization

Auwahi Wind, in coordination with USFWS and DOFAW, updated the Adaptive Management Plan for minimization measures implemented at the Project. An additional minimization measure of removing the meteorological tower was approved by USFWS and DOFAW; see Attachment 3 for more details. The meteorological tower was demolished in February 2023.

Auwahi Wind has not seen a reduction in the fatality rate of Hawaiian hoary bats as a result of installing acoustic deterrents. Contrary to expectation, Hawaiian hoary bat fatalities have been observed in months where no fatalities have been recorded previously after installing acoustic deterrents. Auwahi Wind has used thermal monitoring to attempt to elucidate patterns of behavior that would indicate that deterrents are working, however thermal monitoring shows bats continuing to utilize the rotor-swept zone despite deterrents being active.

5.0 Changed or Unforeseen Circumstances

No changed or unforeseen circumstances occurred in FY 2023.

6.0 Auwahi Wind Community Involvement

Highlights of Auwahi Winds community involvement in FY 2023 are:

- Provided support to the Maui Nui Seabird Recovery Project with banding of Ua'u kani breeding colonies on Maui, predator control in Nakula/Kahikinui, and SOS program.
- Supported the Maui Forest Bird Recovery Project in conducting Hawai'i forest bird surveys.
- Supported Leeward Haleakala Watershed Partnership
- Continued to loan DOFAW bat acoustic detectors and support in collecting bat acoustic data.
- Provided support to DHHL Kahikinui families.
- Provided support to the Auwahi Forest Restoration Project to conduct volunteer outplanting trips and establish a program nursery.
- Supported HARC in establishing native tree plantings on 'Ulupalakua ranch.
- Supported MNBG in Ohia seed collecting on 'Ulupalakua ranch.
- Supported Maui PEP program in collecting samples and gathering data of native plants on 'Ulupalakua Ranch.
- Assisted Maui DOFAW in survey of anchialine pond.

7.0 Annual Workplan and Schedule

A work plan for FY 2023 will be provided in Attachment 9. This work plan identifies major monitoring and mitigation activities and their associated timelines.

8.0 Cost Expenditures and Budget

A summary of HCP-related expenditures for FY 2023 will be provided in Attachment 10. This summary lists costs (including staff labor) that Auwahi Wind has expended toward fulfilling the terms of the HCP in FY 2023, as well as cumulatively, and compares them against the budgeted amounts specified in the HCP.

9.0 References

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Attachment 1

Evidence of Absence Software Inputs and Outputs – Fatality Estimation

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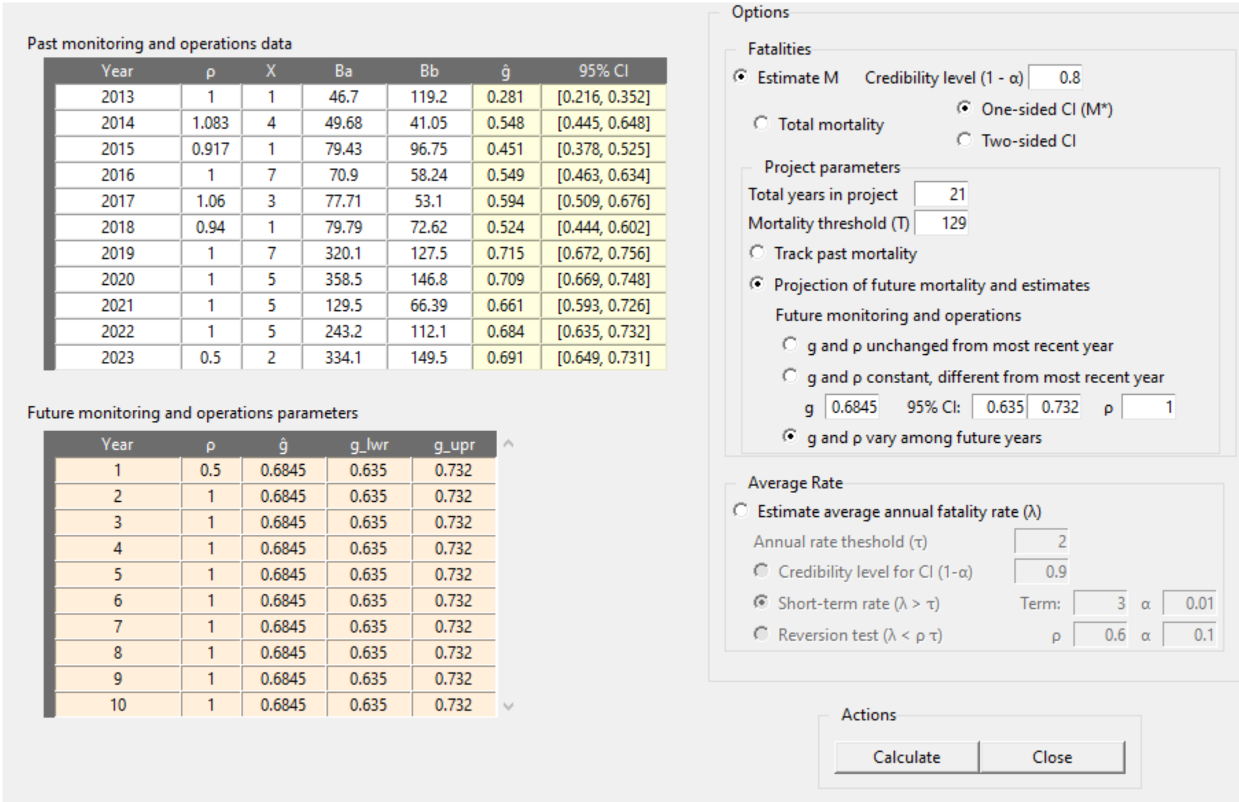
Figure 1. Evidence of Absence Inputs for Hawaiian Hoary Bat Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017).



Past monitoring and operations data

Year	ρ	X	Ba	Bb	ĝ	95% CI
2013	1	1	46.7	119.2	0.281	[0.216, 0.352]
2014	1.083	4	49.68	41.05	0.548	[0.445, 0.648]
2015	0.917	1	79.43	96.75	0.451	[0.378, 0.525]
2016	1	7	70.9	58.24	0.549	[0.463, 0.634]
2017	1.06	3	77.71	53.1	0.594	[0.509, 0.676]
2018	0.94	1	79.79	72.62	0.524	[0.444, 0.602]
2019	1	7	320.1	127.5	0.715	[0.672, 0.756]
2020	1	5	358.5	146.8	0.709	[0.669, 0.748]
2021	1	5	129.5	66.39	0.661	[0.593, 0.726]
2022	1	5	243.2	112.1	0.684	[0.635, 0.732]
2023	0.5	2	334.1	149.5	0.691	[0.649, 0.731]

Future monitoring and operations parameters

Year	ρ	ĝ	g_lwr	g_upr
1	0.5	0.6845	0.635	0.732
2	1	0.6845	0.635	0.732
3	1	0.6845	0.635	0.732
4	1	0.6845	0.635	0.732
5	1	0.6845	0.635	0.732
6	1	0.6845	0.635	0.732
7	1	0.6845	0.635	0.732
8	1	0.6845	0.635	0.732
9	1	0.6845	0.635	0.732
10	1	0.6845	0.635	0.732

Figure 2. Evidence of Absence Total Mortality Output for Hawaiian Hoary Bat Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017).

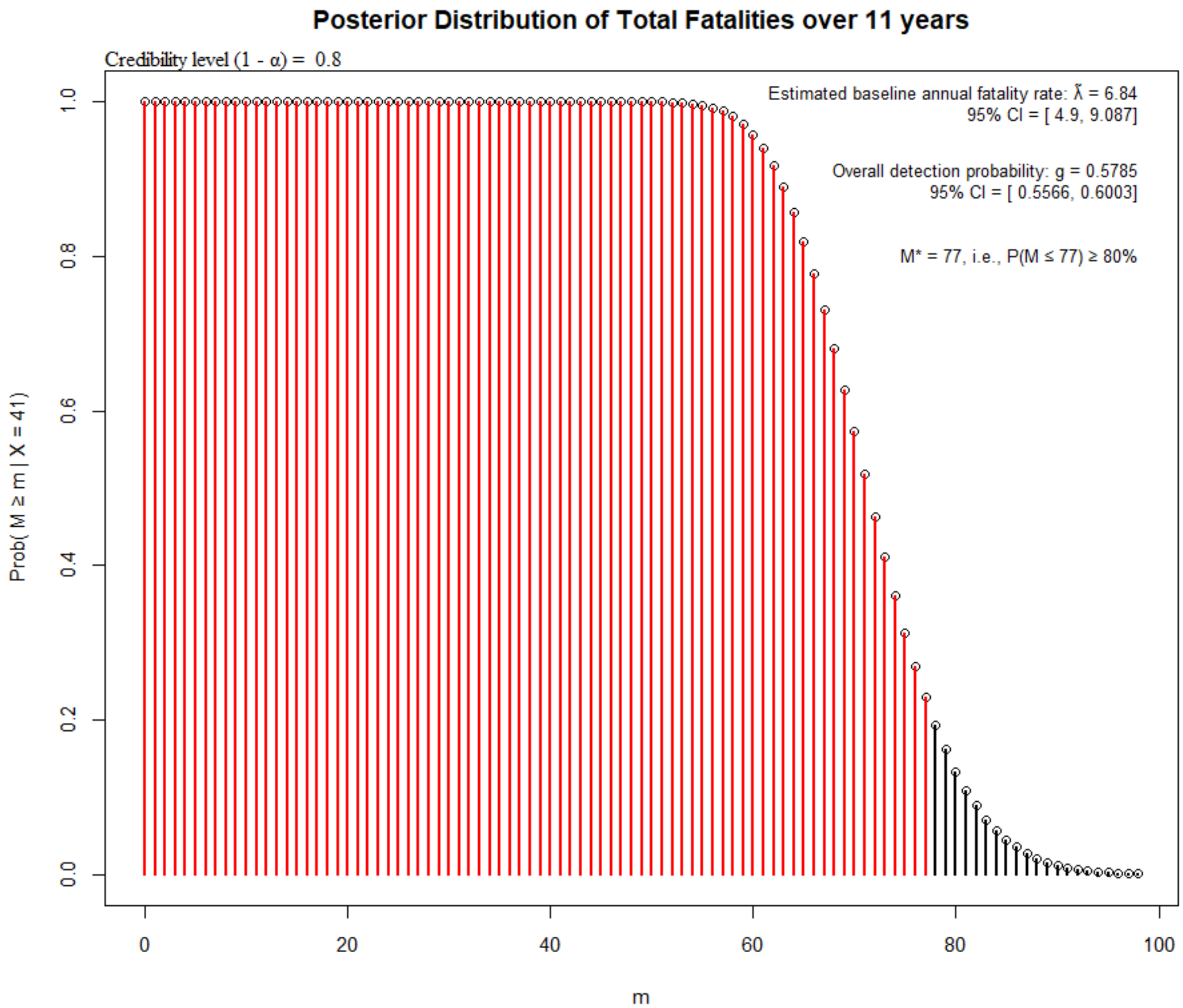


Figure 3. Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Hoary Bat Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017)

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================================================================================
Summary statistics from posterior predictive distributions for 10000 simulated projects
------------------------------------
Estimated annual baseline fatality rate (lambda for rho = 1): mean = 6.84, 95% CI = [4.9, 9.09]

Projected fatalities and fatality estimates...
p(M > Tau within 21 years) = 0.666  [exceedance]
p(M* > Tau within 21 years) = 0.8227  [triggering]
M* based on credibility level 1 - alpha = 0.8

Among projects with triggering (82.27%), mean(M) = 125.48 at time of triggering, with median = 125 and IQR = [119, 132]
Among projects with no triggering (17.73%), mean(M) = 119.68 at end of 21 years, with median = 120 and IQR = [113, 126]

Years of operations without triggering:
 Mean = 19.41, with median =  19 and IQR = [18, 21]

----------------------------------------
Summary statistics for projection years
----------------------------------------------------------------------------------------------------
Yr   Mean             quantiles of M                         | quantiles of M*
        M       M*  0.05  0.10  0.25  0.50  0.75  0.90  0.95 |  0.05  0.10  0.25  0.50  0.75  0.90  0.95
----------------------------------------------------------------------------------------------------
1      74.7   80.8    63    65    69    74    79    85    88 |    77    77    78    80    82    84    86
2      81.6   87.8    69    72    76    81    87    92    96 |    81    82    84    88    91    95    97
3      88.4   94.8    75    77    82    88    94   100   104 |    85    87    90    94    99   104   106
4      95.2  101.7    80    83    89    95   101   107   112 |    89    91    96   101   106   113   115
5     102.1  108.7    86    89    95   102   109   115   120 |    93    97   102   109   115   121   126
6     108.9  115.7    91    95   101   109   116   123   128 |    99   103   108   115   123   130   135
7     115.8  122.6    97   101   107   115   124   131   136 |   104   107   114   122   130   139   144
8     122.6  129.7   102   106   114   122   131   139   145 |   110   113   120   130   138   148   153
9     129.4  136.7   108   112   120   129   139   147   153 |   114   119   127   135   145   155   162
10    136.2  143.7   113   117   126   136   146   156   161 |   120   123   133   143   154   164   171

================================================================================

Governing parameters: Tau = 129, alpha = 0.2

Data for 11 years of monitoring:
            yr    x    g     glwr   gupr  rho  M*
           2013   1 0.2815 0.2119 0.3511  1   8
           2014   4 0.5476 0.4436 0.6515  1.08  16
           2015   1 0.4508 0.3761 0.5256  0.917  18
           2016   7 0.5490 0.4618 0.6363  1  34
           2017   3 0.5941 0.5085 0.6796  1.06  38
           2018   1 0.5235 0.4429 0.6042  0.94  40
           2019   7 0.7151 0.6725 0.7578  1  52
           2020   5 0.7095 0.6691 0.7498  1  59
           2021   5 0.6611 0.5936 0.7286  1  67
           2022   5 0.6845 0.6353 0.7337  1  74
           2023   2 0.6909 0.6489 0.7329  0.5  77

Parameters for future monitoring and operations:
  Number of years:  10
 yr    g       glwr   gupr   rho
 12  0.6845  0.6350 0.7320  0.5
 13  0.6845  0.6350 0.7320  1
 14  0.6845  0.6350 0.7320  1
 15  0.6845  0.6350 0.7320  1
 16  0.6845  0.6350 0.7320  1
 17  0.6845  0.6350 0.7320  1
 18  0.6845  0.6350 0.7320  1
 19  0.6845  0.6350 0.7320  1
 20  0.6845  0.6350 0.7320  1
 21  0.6845  0.6350 0.7320  1

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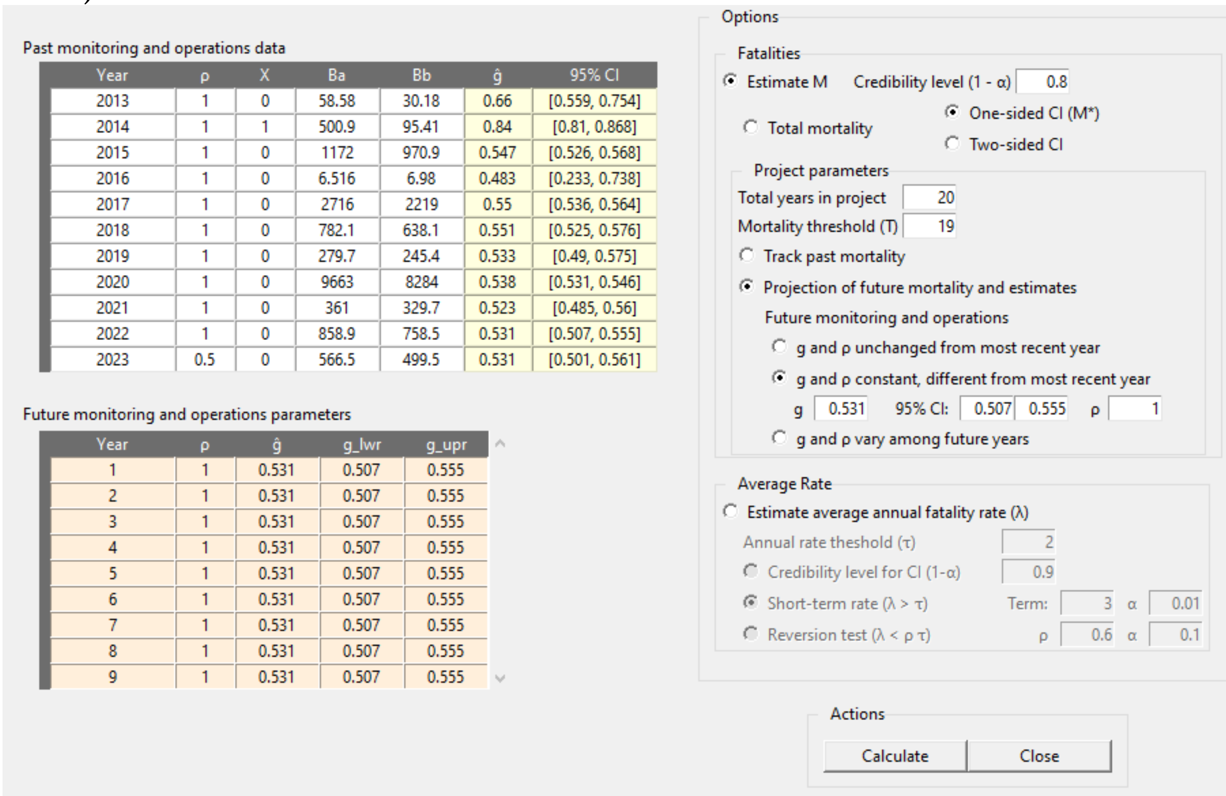
Figure 3 (Continued). Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Hoary Bat Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017)

```
*************************************************************************************
Summary statistics for mortality estimates through 11 years
------------------------------------
Results
Totals through 11 years

M* = 77 for 1 - alpha = 0.8, i.e., P(M <= 77) >= 80%
Estimated overall detection probability: g = 0.579, 95% CI = [0.557, 0.6]
    Ba = 1137.5, Bb = 828.76
Estimated baseline fatality rate (for rho = 1): lambda = 6.836, 95% CI = [4.9, 9.09]

Cumulative Mortality Estimates
Year          M*   median   95% CI   mean(lambda) 95% CI
2013           8     4      [1, 13]  5.4550   [0.3851,  17.29]
2014          16    12      [6, 22]  13.2100   [ 4.524,  26.68]
2015          18    14      [8, 25]  15.2200   [ 5.814,  29.19]
2016          34    28      [19, 42]  29.4900   [ 15.79,  47.55]
2017          38    33      [23, 46]  33.9300   [ 19.46,  52.47]
2018          40    35      [25, 49]  35.5500   [ 20.79,  54.31]
2019          52    46      [35, 60]  46.7400   [ 29.98,  67.25]
2020          59    53      [41, 67]  53.8900   [ 36.11,  75.24]
2021          67    61      [49, 76]  61.6000   [ 42.66,  84.02]
2022          74    68      [55, 83]  68.9900   [ 49.05,  92.33]
2023          77    71      [58, 86]  71.7700   [  51.5,  95.41]

Annual Mortality Estimates
Year          M*   median   95% CI   mean(lambda) 95% CI
2013           8     4      [1, 13]  5.4550   [0.3851,  17.29]
2014          10     7      [4, 13]  8.3330   [ 2.453,  17.95]
2015           4     2      [1, 7]  3.3620   [0.2398,  10.56]
2016          16    13      [8, 21]  13.7900   [ 5.661,  25.71]
2017           7     5      [3, 9]  5.9380   [  1.42,  13.71]
2018           3     2      [1, 6]  2.8910   [0.2065,  9.069]
2019          12    10      [7, 14]  10.5000   [ 4.374,  19.29]
2020           9     7      [5, 11]  7.7610   [ 2.687,  15.49]
2021           9     7      [5, 12]  8.3520   [  2.88,  16.74]
2022           9     7      [5, 11]  8.0510   [ 2.784,  16.09]
2023           4     3      [2, 6]  3.6230   [0.6015,  9.312]


Test of assumed relative weights (rho) and potential bias              Fitted rho
Assumed rho     95% CI
      1     [0.052, 2.035]
   1.08     [0.340, 2.202]
  0.917     [0.027, 1.299]
      1     [0.810, 3.241]
   1.06     [0.186, 1.733]
   0.94     [0.031, 1.253]
      1     [0.641, 2.552]
      1     [0.398, 2.069]
      1     [0.417, 2.112]
      1     [0.387, 2.109]
    0.5     [0.068, 1.222]

p = 0.64088 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 1.027

================================================================================
Input
Year (or period) rel_wt  X    Ba     Bb   ghat    95% CI
2013             1.000   1   46.7  119.2 0.281 [0.216, 0.352]
2014             1.083   4  49.68  41.05 0.548 [0.445, 0.648]
2015             0.917   1  79.43  96.75 0.451 [0.378, 0.525]
2016             1.000   7   70.9  58.24 0.549 [0.463, 0.634]
2017             1.060   3  77.71   53.1 0.594 [0.509, 0.676]
2018             0.940   1  79.79  72.62 0.524 [0.444, 0.602]
2019             1.000   7  320.1  127.5 0.715 [0.672, 0.756]
2020             1.000   5  358.5  146.8 0.709 [0.669, 0.748]
2021             1.000   5  129.5  66.39 0.661 [0.593, 0.726]
2022             1.000   5  243.2  112.1 0.684 [0.635, 0.732]
2023             0.500   2  334.1  149.5 0.691 [0.649, 0.731]
```

Figure 4. Evidence of Absence Inputs for Hawaiian Petrel Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017)



Past monitoring and operations data

Year	ρ	X	Ba	Bb	ĝ	95% CI
2013	1	0	58.58	30.18	0.66	[0.559, 0.754]
2014	1	1	500.9	95.41	0.84	[0.81, 0.868]
2015	1	0	1172	970.9	0.547	[0.526, 0.568]
2016	1	0	6.516	6.98	0.483	[0.233, 0.738]
2017	1	0	2716	2219	0.55	[0.536, 0.564]
2018	1	0	782.1	638.1	0.551	[0.525, 0.576]
2019	1	0	279.7	245.4	0.533	[0.49, 0.575]
2020	1	0	9663	8284	0.538	[0.531, 0.546]
2021	1	0	361	329.7	0.523	[0.485, 0.56]
2022	1	0	858.9	758.5	0.531	[0.507, 0.555]
2023	0.5	0	566.5	499.5	0.531	[0.501, 0.561]

Future monitoring and operations parameters

Year	ρ	ĝ	g_lwr	g_upr
1	1	0.531	0.507	0.555
2	1	0.531	0.507	0.555
3	1	0.531	0.507	0.555
4	1	0.531	0.507	0.555
5	1	0.531	0.507	0.555
6	1	0.531	0.507	0.555
7	1	0.531	0.507	0.555
8	1	0.531	0.507	0.555
9	1	0.531	0.507	0.555

Figure 5. Evidence of Absence Total Mortality Output for Hawaiian Petrel Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017)

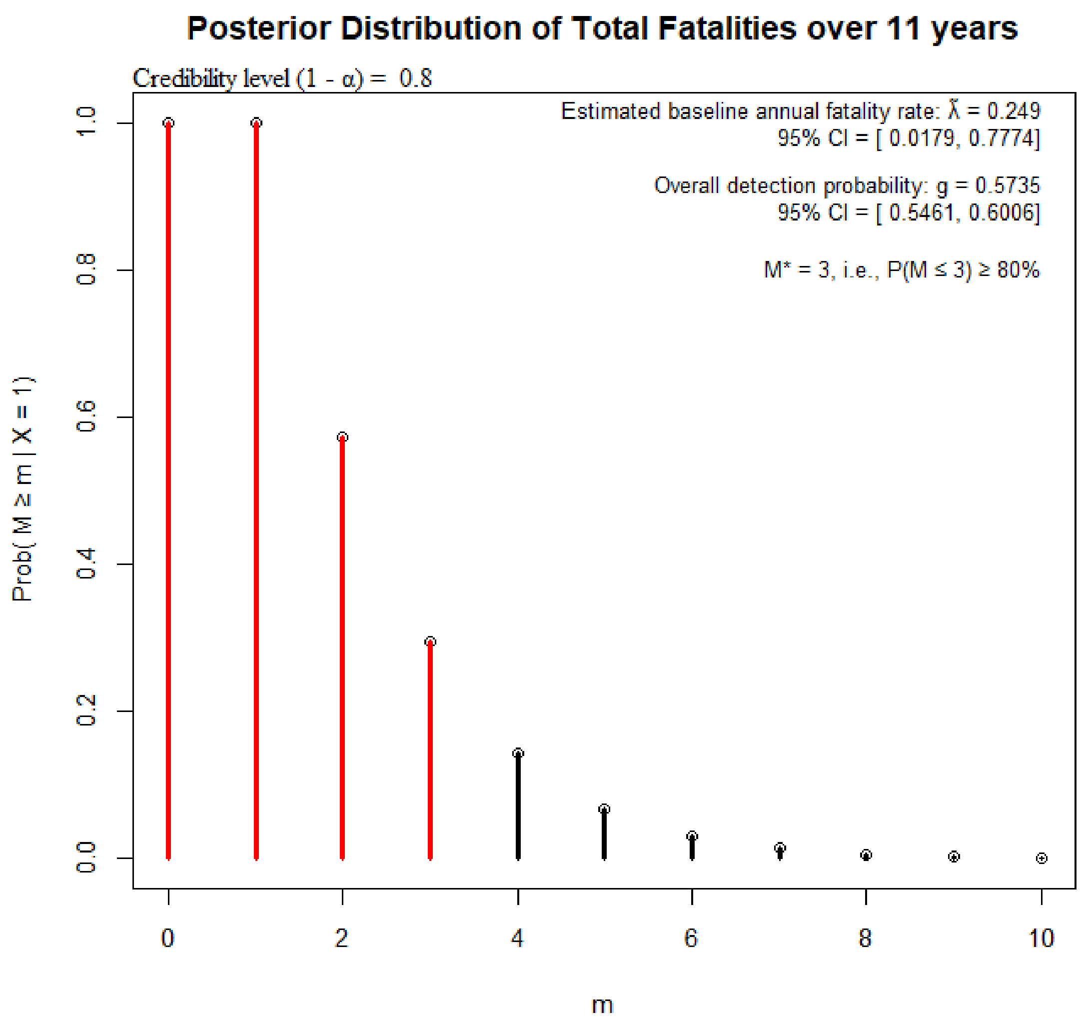


Figure 6. Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Petrel Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017)

```
================================================================================
Summary statistics from posterior predictive distributions for 10000 simulated projects
------------------------------------
Estimated annual baseline fatality rate (lambda for rho = 1): mean = 0.249, 95% CI = [0.0179, 0.777]

Projected fatalities and fatality estimates...
p(M > Tau within 20 years) = 4e-04  [exceedance]
p(M* > Tau within 20 years) = 0.0044  [triggering]
M* based on credibility level 1 - alpha = 0.8

Among projects with triggering (0.44%), mean(M) = 14.39 at time of triggering, with median = 14 and IQR = [12, 16]
Among projects with no triggering (99.56%), mean(M) = 4.30 at end of 20 years, with median = 4 and IQR = [2, 6]

Years of operations without triggering:
 Mean = 20.00, with median =  20 and IQR = [20, 20]

----------------------------------------
Summary statistics for projection years
----------------------------------------------------------------------------------------------------
Yr   Mean          quantiles of M                       | quantiles of M*
       M      M*  0.05  0.10  0.25  0.50  0.75  0.90  0.95 |  0.05  0.10  0.25  0.50  0.75  0.90  0.95
----------------------------------------------------------------------------------------------------
1      2.4   3.3     1     1     1     2     3     4     5 |     3     3     3     3     3     5     5
2      2.6   3.5     1     1     1     2     3     5     6 |     3     3     3     3     3     5     5
3      2.9   3.8     1     1     2     2     4     5     6 |     3     3     3     3     5     5     7
4      3.1   4.1     1     1     2     3     4     6     7 |     3     3     3     3     5     7     7
5      3.4   4.3     1     1     2     3     4     6     7 |     3     3     3     3     5     7     9
6      3.6   4.6     1     1     2     3     5     7     8 |     3     3     3     3     5     7     9
7      3.9   4.9     1     1     2     3     5     7     8 |     3     3     3     5     5    10    10
8      4.1   5.2     1     1     2     4     5     8     9 |     3     3     3     5     7    10    12
9      4.3   5.7     1     1     2     4     6     8    10 |     3     3     3     5     8    10    12

================================================================================

Governing parameters: Tau = 19, alpha = 0.2

Data for 11 years of monitoring:
            yr    x      g   glwr   gupr  rho  M*
          2013    0 0.6600 0.5600 0.7600   1   0
          2014    1 0.8400 0.8100 0.8700   1   2
          2015    0 0.5469 0.5254 0.5684   1   2
          2016    0 0.4828 0.2203 0.7453   1   3
          2017    0 0.5504 0.5362 0.5645   1   3
          2018    0 0.5507 0.5243 0.5771   1   3
          2019    0 0.5327 0.4892 0.5762   1   3
          2020    0 0.5384 0.5310 0.5459   1   3
          2021    0 0.5227 0.4847 0.5606   1   3
          2022    0 0.5310 0.5062 0.5558   1   3
          2023    0 0.5314 0.5009 0.5620  0.5   3

Parameters for future monitoring and operations:
  Number of years:  9
  g = 0.531, 95% CI  [0.507, 0.555]
  Relative weight (rho): 1
*****************************************************************************************
```

Figure 6 (Continued). Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Petrel Multi-Year Analysis in FY 2023 (Dalthorp et al. 2017)

```
Summary statistics for mortality estimates through 11 years
------------------------------------
Results
Totals through 11 years

M* = 3 for 1 - alpha = 0.8, i.e., P(M <= 3) >= 80%
Estimated overall detection probability: g = 0.573, 95% CI = [0.546, 0.601]
    Ba = 723.75, Bb = 538.34
Estimated baseline fatality rate (for rho = 1): lambda = 0.2493, 95% CI = [0.0179, 0.777]

Cumulative Mortality Estimates
Year         M*   median   95% CI   mean(lambda) 95% CI
2013          0     0      [0, 1]  0.7642   [0.0007638,  3.851]
2014          2     1      [1, 3]  2.0040   [0.1439,  6.252]
2015          2     1      [1, 4]  2.2000   [0.1582,  6.862]
2016          3     2      [1, 4]  2.3830   [0.1708,  7.451]
2017          3     2      [1, 4]  2.4430   [0.1753,   7.63]
2018          3     2      [1, 5]  2.4840   [0.1784,  7.755]
2019          3     2      [1, 5]  2.5260   [0.1815,  7.882]
2020          3     2      [1, 5]  2.5550   [0.1836,  7.971]
2021          3     2      [1, 5]  2.5870   [0.1859,  8.068]
2022          3     2      [1, 5]  2.6080   [0.1875,  8.134]
2023          3     2      [1, 5]  2.6180   [0.1882,  8.163]

Annual Mortality Estimates
Year         M*   median   95% CI   mean(lambda) 95% CI
2013          0     0      [0, 1]  0.7642   [0.0007638,  3.851]
2014          2     1      [1, 2]  1.7860   [0.1285,  5.569]
2015          1     0      [0, 2]  0.9145   [0.0009128,  4.596]
2016          1     0      [0, 3]  1.1940   [0.001072,  6.304]
2017          1     0      [0, 2]  0.9085   [0.0009072,  4.565]
2018          1     0      [0, 2]  0.9085   [0.0009069,  4.566]
2019          1     0      [0, 2]  0.9409   [0.0009376,  4.731]
2020          1     0      [0, 2]  0.9285   [0.0009264,  4.665]
2021          1     0      [0, 2]  0.9583   [0.0009559,  4.818]
2022          1     0      [0, 2]  0.9421   [0.0009399,  4.735]
2023          1     0      [0, 2]  0.9419   [0.0009394,  4.734]


Test of assumed relative weights (rho) and potential bias              Fitted rho
Assumed rho     95% CI
      1     [0.004, 3.353]
      1     [0.147, 5.028]
      1     [0.005, 4.025]
      1     [0.009, 4.553]
      1     [0.003, 3.932]
      1     [0.006, 3.715]
      1     [0.004, 4.007]
      1     [0.004, 3.904]
      1     [0.005, 3.811]
      1     [0.004, 3.796]
    0.5     [0.005, 4.026]

p = 0.95008 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 1.023

================================================================================
Input
Year (or period) rel_wt  X    Ba     Bb   ghat    95% CI
2013             1.000   0  58.58  30.18 0.660 [0.559, 0.754]
2014             1.000   1  500.9  95.41 0.840 [0.810, 0.868]
2015             1.000   0   1172  970.9 0.547 [0.526, 0.568]
2016             1.000   0  6.516   6.98 0.483 [0.233, 0.738]
2017             1.000   0   2716   2219 0.550 [0.536, 0.564]
2018             1.000   0  782.1  638.1 0.551 [0.525, 0.576]
2019             1.000   0  279.7  245.4 0.533 [0.490, 0.575]
2020             1.000   0   9663   8284 0.538 [0.531, 0.546]
2021             1.000   0    361  329.7 0.523 [0.485, 0.560]
2022             1.000   0  858.9  758.5 0.531 [0.507, 0.555]
2023             0.500   0  566.5  499.5 0.531 [0.501, 0.561]
```

Attachment 2

Indirect Take Calculations for Hawaiian Hoary Bat at the Project in FY 2023

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Label	Description	Calendar Year											Total
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	
A	Observed Breeding Female Take	0	0	0	2	2	1	2	1	1	2	0	**11**
B	Indirect Take from Observed Breeding Female Take (A x 1.8)	0	0	0	3.6	3.6	1.8	3.6	1.8	1.8	3.6	0	**19.80**
C	Observed Breeding Unknown Sex Take	0	0	0	0	0	0	0	0	0	0	1	**1**
D	Indirect Take from Observed Breeding Unknown Sex Take (C * 0.48 * 1.8)	0	0	0	0	0	0	0	0	0	0	0.83	**0.83**
E	All Observed Take (Search and Incidental)	1	3	2	7	5	3	10	5	6	8	2	**52**
F	Estimated Take Multiplier (70 / 46)	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	**1.48**
G	Estimated Direct Take (E x F)	1.48	4.44	2.96	10.37	7.40	4.44	14.81	7.40	8.88	11.85	2.96	**77.00**
H	Unobserved Direct Take (G - E)	0.48	1.44	0.96	3.37	2.40	1.44	4.81	2.40	2.88	3.85	0.96	**25.00**
I	Indirect Take Calculated from Unobserved Take (H * 0.48 * 0.25 * 1.8)	0.10	0.30	0.20	0.69	0.50	0.30	0.99	0.50	0.59	0.79	0.20	**5.16**
Total Indirect Take (B + D + I; juveniles)													**25.78**
Total Indirect Take (B + D + I)*0.3 (adults)													**7.73**

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Attachment 3

Auwahi Wind Adaptive Management Plan 2023

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Auwahi Wind	Adaptive Management Plan 2023	
	REVISION NUMBER:	5
	EFFECTIVE DATE:	3/6/2023
	REVISION DATE:	3/6/2023
	REVIEWED DATE:	2/28/2023
	REVIEW CYCLE:	12 MONTHS

1. Introduction

This Adaptive Management Plan (AMP) was initially approved in the Auwahi Wind Farm (Project) Habitat Conservation Plan (HCP) Final Amendment (HCP Amendment); Incidental Take Permit (ITP) Number: TE64153A-1 issued September 4, 2019 and Incidental Take License (ITL) Number: ITL-17 issued August 23, 2019. The HCP Amendment identifies specific measures that Auwahi Wind Energy LLC (Auwahi Wind) will implement if the estimated fatality rate exceeds the Threshold Value (TV) needed to ensure compliance with the permitted take value over the permit term. As discussed in Section 4.1.7 of the HCP Amendment, Auwahi Wind implemented baseline minimization measures in 2018 and will continue to apply these measures for the duration of the permit, unless specific adaptive management triggers are reached that would initiate an adaptive management action. The original AMP will be in effect upon permit issuance and until it is superseded by subsequent revisions to the AMP or other adaptive management triggers. The AMP is periodically revised using the results of the ongoing risk analysis (Section 7.4.1.3 of the HCP Amendment) and updates will be provided to the U.S. Fish and Wildlife Service (USFWS) and State of Hawaiʻi Department of Land and Natural Resources: Division of Forestry and Wildlife (DOFAW) for review. The deadline for the first revision was April 30, 2020, and the revision history for this living document is provided on the signature page. All terms and acronyms are defined in the Auwahi Wind HCP Amendment.

2. Evaluation Schedule

The effectiveness of the minimization measures in place at the Project will be evaluated on a routine basis to ensure compliance with the permitted take value (Table 1). These evaluations will take place as part of routine reporting tasks and scheduled agency reviews, as well as in response to observed take.

Table 1. Schedule for Regular Evaluation of Minimization Measures

Period	Action	Timeframe
Immediate Evaluations	Summary of Take Report	Due within 3 weeks of observed take
Semi-Annual Evaluation	HCP Semi-Annual Compliance Report	Due January 31
Annual Evaluations	HCP Annual Compliance Report	Due August 1
	AMP Review	Scheduled with USFWS and DOFAW after Annual Report
Scheduled Evaluations	Adaptive Management Action Review	Due February 28
	If adaptive management actions are required, implement adaptive management actions[1]	Due March 31
1. See Follow-up Evaluation in Section 2.4.		

To track compliance, Auwahi Wind will use Evidence of Absence (EoA) to evaluate the Post-Construction Mortality Monitoring (PCMM) data and calculate the Baseline Fatality Rate (BFR). The BFR will then be compared to the TV. The TV for the Project is 6.45 based on analysis presented in Section 7.4.1.1 of the HCP Amendment.

Additionally, Auwahi Wind will track the BFR relative to each of the tiers of take (Table 2) to support agency discussions during routine reviews.

Table 2. Average Take Rates for Each Tier Over 20 Years

Tier	Maximum Take	Average BFR
4	Exceeded in 2022 ~~81~~	~~4.05~~
5	115	5.75
6	140	7.00

The details from the schedule are described in the following subsections.

2.1 Immediate Evaluations

Summary of Take Report (on Observed Fatalities): Auwahi Wind notifies USFWS and DOFAW of any bat fatality observed during PCMM or incidentally and submits a Summary of Take report within 3 weeks. The Summary of Take report is described in Appendix E of the HCP Amendment and will include the following items related to adaptive management (in addition to other reporting requirements):

- Direct take estimate;

- Direct take projection;
- Calculation of the BFR and comparison of BFR to TV; and
- Comparison of BFR to tier based rates.

2.2 Semi-Annual Evaluations

HCP Compliance Report: Auwahi Wind reports on activities and analyses associated with HCP compliance in a semi-annual report provided to USFWS and DOFAW in January each year. The semi-annual report includes the following items related to adaptive management (in addition to other reporting requirements):

- Direct take estimate;
- Direct take projection;
- Calculation of the BFR and comparison of BFR to TV; and
- Comparison of BFR to tier based rates.

2.3 Annual Evaluations

HCP Compliance Report: Auwahi Wind reports on activities and analyses associated with HCP compliance in an annual report provided to USFWS and DOFAW by August 1 each year. In a fall annual meeting, Auwahi Wind reviews the HCP compliance status summary and take estimate projections with USFWS and DOFAW. The annual reports will include the following items related to adaptive management (in addition to other reporting requirements):

- Direct take estimate;
- Direct take projection;
- Calculation of the BFR and comparison of BFR to TV;
- Comparison of BFR to tier based rates; and,
- Adaptive management actions triggered or taken during the reporting year.

AMP Review: The AMP is intended to be a living document and will be updated as new information becomes available. Auwahi Wind will review the current AMP during the annual meeting with USFWS and DOFAW. Prior to the annual meeting, Auwahi Wind will review and summarize new literature relating to the development and effectiveness of minimization measures for the Hawaiian hoary bat and similar bat species. Literature to be reviewed includes: site-specific data, peer-reviewed literature, annual reports, industry publications, literature recommended by

USFWS and DOFAW, or other sources. If Auwahi Wind determines, in consultation with USFWS and DOFAW, that new minimization measures are applicable and likely to be an improvement over those currently implemented or proposed in the AMP, the AMP will be updated to include the new measures and provided to the agencies for approval.

2.4 Scheduled Evaluations

Adaptive Management Action Review: Auwahi Wind will evaluate the PCMM data from the start of monitoring through December 31 of the preceding year (the most recent complete calendar year) to calculate the BFR using EoA in years 2020, 2025, and 2030. Auwahi Wind will then compare the BFR to the TV.

- If the BFR exceeds the TV, adaptive management actions, as described in Section 3 of the AMP, will be implemented no later than March 31 (see Follow-up Evaluation below).
- If the BFR does not exceed the TV, no action will be required.

Should a projection predict that the Project will exceed the permitted take authorization between scheduled evaluations, Auwahi Wind, in coordination with USFWS and DOFAW, will determine if adaptive management actions are warranted.

Follow-up Evaluation: When adaptive management actions are implemented, the effectiveness of the actions will be assessed after two years using PCMM data. At that time, the BFR will be compared to the TV to determine if additional adaptive management actions are warranted. Should the BFR exceed the TV at that time, adaptive management actions will be implemented as described in Section 3 of the AMP, and the BFR will be re-evaluated again at 2-year intervals until the BFR is equal to or less than the TV. Should adaptive management actions be implemented less than 2 years from a scheduled evaluation year (2025 or 2030), the next evaluation will occur 2 years after the adaptive management actions instead of at the scheduled evaluation.

3. Adaptive Management Actions

Since the initiation of Project development, Auwahi Wind has been collecting Project-specific information that can help inform minimization measures and adaptive management of minimization measures decisions. Table 3 summarizes Auwahi Wind's actions. In addition, since early in Project operations, Auwahi Wind has been implementing measures such as low-wind speed curtailment(LWSC) to reduce take of the Hawaiian hoary bat. Table 4 provides a timeline of actions taken.

Table 3. Adaptive Management Research Summary

Date	Action	Follow-up
2010	Preconstruction bat acoustic monitoring and radar studies performed to 2011	Low bat activity observed. Restrictions on tree cutting. Habitat loss in the upper elevation identified as main threat.
2012	Post construction mortality monitoring initiated	Bat fatality found in 2013. Increase carcass persistence, reduce search area, increase searcher efficiency
2013	Tetra Tech perform post construction acoustic monitoring study to 2015	Ground based monitors. Season and elevation trends. Bats found throughout the project site
2015	USGS perform bat acoustic activity, diet, and prey availability study to 2018	Detectors placed throughout project. Bat diet analysis performed. Multiple bats tagged at pond
2017	Two Bat carcasses sent to USGS for necropsy to determine cause of fatality	Cause of death not determined. List of island-wide fatalities from USGS provided for past fatalities i.e. pools, cats
2018	Bat carcasses provided to USGS for sexing	Site specific sex ratio calculated
	USGS and Natural Power perform thermal monitoring and acoustic monitoring at nacelle	No fatalities observed on camera. Bats heard and seen at different ratio than Kawailoa Wind Project study.
	LWSC at 6.9 m/s August – October at all turbines	BFR continue to increase
2019	Smart Curtailment study	Natural Power report show poor results of equipment and low evidence that would be beneficial at the site
	Partner with NRG to have Western EcoSystems Technology, Inc. (WEST) analyze thermal data from turbine mounted camera for multiple fatality events found with dog searcher	No bat fatality found in thermal data. Gleaning observed.
2020	Daytime observations recorded in DWM	Bat observation in mitigation area during daytime hours
2021	WIS confirm bat using 2 separate constructed water features	USGS confirm anecdotal observations of bats visiting water features (i.e., golf course ponds) in daytime hours.
	WEST perform Leeward Haleakalā and Tier 4 study with acoustic detectors within the project boundaries but not at turbines	Year round activity
2022	WIS performing study at turbine with 2 cameras, meteorological (met) tower, and turbine with water feature	Inform additional minimization measures

Date	Action	Follow-up
2023	Met tower removed	Activity documented at met tower prior to removal

Table 4. Adaptive Management of Minimization Measures Implementation Timeline.

Date	Trigger/Action	Follow-up
December 2012	HCP initiated	Restrictions on tree cutting
September 2014	PCMM results indicate higher bat take than expected	Investigate LWSC as option for minimization
January 2015	Increase LWSC to 5.0 m/s year round at all turbines	Increase in fatality rate. Investigate additional minimization measures.
August 2019	LWSC at 6.9 m/s August – October at all turbines	Increase in fatality rate. Investigate additional minimization measures.
February 2020	BFR exceeded TV	Deterrent installation
July 2020	Deterrents installed	Re-evaluate BFR in July 2022
February 2021	Updated AMP submitted to USFWS and DOFAW (rev 3)	Investigate additional minimization measures
January 2022	BFR 6.93 exceeds the TV of 6.45	Update AMP and prepare for implementation of adaptive management of minimization measures
February 2022	Updated AMP (rev 4) provided to USFWS and DOFAW; BFR exceeded TV	Submit final in March 2022
February 2023	Met tower removed	
March 2023	Updated AMP (rev 5) provided to USFWS and DOFAW	

3.1 Project Research and Observations to Inform Minimization

Auwahi Wind has continued to analyze Project-specific data and perform studies to better understand how to minimize bat fatalities.

These findings fall into three broad categories:

3.1.1 Bat activity

- Bat detections at the Project exhibit a unimodal distribution. The majority of bat activity occurs in the first 6 hours of the night with a peak in activity occurring 3.4 hours after sunset (Gorresen et al. 2020).

- Temperature has not been found to predict bat activity at the Project (Gorresen et al. 2020, Natural Power 2019).
- Bats may be active outside of nighttime hours. Natural Power reported bat acoustic detections during daytime hours, as late as 10 am at the Project (Natural Power 2019; see Section 3.1.3 for more detail on this data). Auwahi Wind personnel have recorded bat observations in daytime hours on 'Ulupalakua Ranch property in the Waihou Mitigation Area (10 am). Wildlife Imaging Systems (WIS) noted the occurrence of bat activity up to 1 hour after sunrise in September 2020 thermal monitoring data (USGS 2020). USGS provided examples of bat activity during daytime hours, as late as 9:15 am, observed anecdotally (pers. comm.. Corinna Pinzari, USGS, emailed October 7, 2020).
- Bat activity at the Project is logarithmically negatively correlated with wind speed (Gorresen et al. 2020). In other words, as wind speed increases fewer bats are observed for equivalent increases in wind speed. "The KS test statistic D, defined as the maximum value of the absolute difference between the two cumulative distribution functions, was located at a wind speed value of 6.6 m/s, corresponding to approximately 81 percent of cumulative bat detection events."
- **Thermal monitoring:** Auwahi Wind began monitoring bat activity using thermal cameras in 2018. Monitoring of bat activity with the use of thermal cameras is ongoing and used to investigate correlations between patterns of bat activity and fatalities.
    - Thermal data collected at the Project in 2019 – 2021 found that periods with increased insect activity were positively correlated with an increase in detections of bats (USGS 2019, WEST 2021, WIS 2021).
    - Bat activity at the Project is characterized as having "long and unpredictable time periods between consecutive detection events, both within and among nights" (Gorresen et al. 2020). This unpredictability leads to difficulty in predictive algorithms used for "smart" curtailment.
    - Auwahi has documented bats drinking and foraging at constructed ponds (WIS 2021). The presence of two water troughs at turbines 1 and 6 warrants further investigation as mainland bats have been observed to utilize water troughs for foraging (Taylor and Tuttle 2007). These water troughs at the Project are only filled when cattle are present (see Section 3.1.2 for discussion of grazing at the Project).

- Between 2018 and 2022, dog searches at the Project, as part of the PCMM, found 26 bat fatalities. However, during this same period no bat fatalities due to collision with a turbine structure were observed with thermal imaging at turbines 2, 4, 5, and 7.
- Analysis of thermal data from the Project by Gorresen et al. 2020, WEST 2021, and WIS 2021; all noted bats at the Project approaching the turbine tower and nacelle or "touch-and-go" behaviors. Other studies have associated these behaviors with foraging (Foo et al. 2017) or olfactory marking (Guest et al. 2022). The purpose of this behavior at the Project is not known.

- **Acoustic Monitoring:**
  - Auwahi Wind contracted Western EcoSystems Technology, Inc. (WEST) to perform acoustic Monitoring across leeward Haleakalā. High rates of occupancy (as measured by acoustic activity) across the study area were positively correlated with reproductive season and increasing elevation. (Thompson and Starcevich 2021)
  - Acoustic data from nacelle mounted detectors at the Project demonstrated August was month with highest activity, data collected August 2018 – October 2019 (Natural Power 2019). Bat activity is "primarily in the first few hours after sunset (around 6 pm), with relatively low activity after midnight." Microphones facing the rear of nacelle consistently detected more bat calls than microphones facing rotor.

3.1.2 Bat Fatalities

- The months of May through October represent the highest continuous months of observed downed bat observations. Of these months August, September and October have 68 percent (34 of 50) of observed fatalities. Bat fatalities have been observed in 11 out of 12 months at the Project, no fatalities have been observed in December.
- Of the 46 bat fatalities with confirmed genetic identification 22 are female and 24 are male or 48 percent female and 52 percent male (Pinzari and Bonaccorso 2018).
- Disproportionate number of bat fatalities observed at turbines 1, 2, and 6, accounting for 72 percent (36 of 50) observed bat fatalities. At least one bat fatality has been detected at each of the other turbines: 3, 4, 5, 7, and 8.
- Through January 2022, bat fatalities at Turbine 6 accounted for 10 of 44 observed fatalities over 9 years and an average of 1.1 fatalities per year while low risk turbines (3, 4, 5, 7, and 8) average 0.27 bats per year (12 bats over 45 turbine years). Through January 2023 the Project had a meteorological (met) tower upwind of Turbine 6. Guest et al. (2022)

describes observations of increased feeding buzzes at met towers. This suggests bats transiting through the rotor swept zone if flying from Turbine 6 to the met tower could have been at increased risk of collision.

- Through January 2022 when comparing observed bat fatalities to grazing records, 7 of 44 observed bat fatalities have occurred while cattle are actively grazing at the wind farm. An additional 6 fatalities had occurred during the 30 days post grazing. When combined, these 13 fatalities accounted for 29 percent of observed fatalities, suggesting no strong correlation between grazing and increased risk of fatalities. In addition to domestic cattle, feral deer and goats are common in large numbers at the Project, and are managed by Ulupalakua Ranch throughout the Project area. Ungulate excretions including cattle dung are present year round at the Project. In Europe, *Pipistrellus* spp. are found to forage over livestock (Ancillotto et al. 2017). USGS looked at bat activity in relation to goat and sheep herds but found no correlation with bat activity (Montoya-Aiona et al. 2020). It is unknown if ungulate within the project area change the risk to bats associated with wind turbines.

- Pinzari et al. (2019) found "The female bat found in August under a turbine at the Auwahi Wind Energy facility, had the most diverse diet of the eight bats examined, including all six orders identified by PCR. About a third of [operational taxonomic units] (OTUs) in this sample were from the dung beetle *Digitonthophagus gazella*." Additionally, guano from bats found at the Project contained more diverse diets; lower proportions of moths, and included Coleoptera, Diptera, Hemiptera, and Blattodea.

3.1.3 Minimization measures

- Increasing LWSC thresholds and installation of deterrents has not been associated with a decrease in fatalities at the Project. Conversely, the average of observed, and estimated fatalities have increased in years of implementation. This observation is preliminary given the small sample sizes and variability in the data, however it warrants careful consideration of LWSC and deterrents as a minimization measure applied at the Project.

- Despite the installation of deterrents, bats are still recorded near turbines and nacelles through thermal monitoring (WEST 2021, WIS 2021)

- Gorresen et al. (2020) found that bats were likely to be present at the Project when the turbine blades were moving slowly or stopped. However, Gorresen et al. (2020) also demonstrated that variability in wind speed and turbine blade rotation intermittency were positively related to bat detection probability. An increase of detections was associated with starting and stopping the wind turbines blade rotation.

- Auwahi Wind contracted Natural Power to perform a smart curtailment study in 2019 (Natural Power 2019). Overall, the study found no actionable minimization measures. Monitoring equipment failed for most of the study period. Natural Power's smart curtailment technology is not ready to implement.

A number of key assumptions have been built into the previously implemented minimization measures and are continuing to be evaluated:

1. Bat activity (acoustic, or thermal) is correlated with bat fatality rates;
2. Bat fatalities are equally likely throughout the night and no bat fatalities occur during daytime hours;
3. The bat population is not changing;
4. Previously implemented minimization measures have been effective at reducing bat fatalities.

Despite increasing minimization measures, Auwahi Wind has observed a general increasing fatality rate from 2013 to 2021 at the Project. The USFWS, DOFAW, and Endangered Species Recovery Committee have assumed that the bat population is stable (ESRC 2020). If true, the increased fatality rates at the Project may be related to an increased attraction to the site, possibly through the installation of deterrents or implementation of additional LWSC measures. Alternatively, if the bat population is increasing the increase in observed fatality rates may be a result of increasing numbers of bats in the population.

3.2 Adaptive Management Options

Adaptive management actions will be required if, at a Scheduled Evaluation or Follow-up Evaluation, the BFR exceeds the TV. If adaptive management actions are required, Auwahi Wind will implement adaptive management actions in the order listed below.

Currently available options:

1. Spatial redistribution of Curtailment Nights (see definition in Section 7.4.1.1 of the HCP Amendment): A higher proportion of fatalities have been observed at turbines 1, 2, and 6 than at the other turbines. Redistribution of Curtailment Nights from low risk turbines to turbines with higher risk would be the second adaptive management action. The redistribution will allocate Curtailment Nights from low risk turbines to high risk turbines

either nightly or seasonally. Selection of nightly or seasonal application would be based on post-construction monitoring results.

2. Temporal redistribution of Curtailment Nights: Curtailment at 6.9 m/s would be continued for the first 6 hours of the night for the months of August through October. Cut-in speeds for the remaining hours of the night would be 5.0 m/s. This would provide an additional 704 Curtailment Nights, with cut- in speeds of 6.9 m/s for the first 6 hours of the night, to be redistributed. These additional Curtailment Nights would be applied May 5 through July 31 to address the intermediate risk months.

3.2.1 Future adaptive management options worth further investigation

1. Minimize the amount of start and stop of blade rotations at turbines, this type of turbine operation is correlated with increased bats detection events (Gorresen et al. 2020).
2. Modification of ranching operations subject to approval of ʻUlupalakua Ranch:
    - Risks to bats from wind turbines may have complex interactions with the timing of grazing warranting further investigation. Should implementable management actions be determined to have scientifically justified reductions in risk to bats, Auwahi Wind will discuss the practicability of implementation with ʻUlupalakua Ranch.
    - The presence of water troughs at Turbines 1 and 6, which have water available when cattle are present, may modify bat activity at the Project. Further investigation is necessary to determine if bats utilize these water troughs. If bats are utilizing these water troughs, modification or movement of the water troughs may reduce risk to bats. Auwahi Wind will continue to look for evidence of actions that could reduce risk to bats associated with these water troughs. Should implementable management actions be determined to have scientifically justified reductions in risk to bats, Auwahi Wind will discuss the practicability of implementation with ʻUlupalakua Ranch.
3. Apply any practicable and scientifically-supported new deterrent technology that becomes commercially available (e.g. smart curtailment system, deterrent units affixed to turbine blades, application of olfactory bat deterrents to reduce bat activity around the wind turbine structures).

3.3 Previously implemented Adaptive Management:

An adaptive management action was triggered at the February 2020 Scheduled Evaluation (Table 4). Auwahi Wind implemented an acoustic deterrent system. DOFAW and USFWS were notified the adaptive management action had been triggered and were in support of Auwahi Wind installing NRG bat deterrents (March 9, 2020). Adaptive management was implemented in July of 2020 with the finalization of the NRG installation of bat deterrent systems at all turbines.

The continued utilization of near-turbine airspace, and the detection of bat fatalities despite the implementation of deterrents, and the inability to detect a reduction in fatality rates resulting from deterrents raise concerning questions regarding the suitability of NRG deterrents as a minimization measure for bats at the Project. The increase of bat fatalities at the Project suggests the need to test LWSC and deterrent effectiveness to determine if these strategies have no effect, or possibly increase the risk bat collision with wind turbines at the Project.

An adaptive management action was triggered at the February 2022 Scheduled Evaluation (Table 4). Auwahi Wind removed the met tower in February 2023. DOFAW and USFWS were notified the adaptive management action had been triggered and were in support of Auwahi Wind removing the met tower (March 30, 2022). The next Follow-up Evaluation will occur in February 2025 (See Section 2.4). However, Auwahi Wind continues is actively investigating additional measures to reduce take at the Project.

4. Adaptive Management of Baseline Minimization

The suite of minimization measures available to reduce the risk to bats may change over time because of ongoing industry research and development of new technology. Auwahi Wind may propose a change to baseline minimization measures identified in the HCP Amendment (Section 4.2.7) or adaptive management actions in the AMP, such as replacement of low wind speed curtailment with bat deterrent technology. Such a change would be subject to review and approval by USFWS and DOFAW prior to being implemented at the Project.

5. 2023 Literature Review

Auwahi Wind contacted Public, non-profit, and private researchers recognized for their work in wind and wildlife minimization for the latest available science of minimization measures to provide future guidance on available options. The following publications were provided however none of the literature provided included research that was mature enough or suitable to revise the adaptive management plan.

Anderson, A. M., Jardine, C. B., Zimmerling, J. R., Baerwald, E. F., & Davy, C. M. (2022). Effects of turbine height and cut-in speed on bat and swallow fatalities at wind energy facilities. FACETS. https://www.facetsjournal.com/doi/full/10.1139/facets-2022-0105

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Auwahi **Wind**	**Adaptive Management Plan 2023**	
	REVISION NUMBER:	5
	EFFECTIVE DATE:	3/6/2023
	REVISION DATE:	3/6/2023
	REVIEWED DATE:	2/28/2023
	REVIEW CYCLE:	12 MONTHS

REVISION HISTORY LOG			
Rev.	**Date**	**Description**	**By Initials**
0	7/29/2019	Auwahi Wind Habitat Conservation Plan Amendment	MVZ
1	3/20/2020	Edits, Additions, Formatting	GA
2	4/2/20	Remove the term "Interim" for clarification and update HCP annual report due date to reflect ITP due dates	GA
3	6/10/20	Adding ITL permit number	GA
4	2/28/2022	Revised to incorporate additional observations and new minimization measures	GA, MWS
5	2/28/2023	Update on minimization measure timeline and 2023 literature review added	GA

X *George Akau*

George Akau
Auwahi Wind Biologist

X

DOFAW Protected Species Habitat Conserva...

X

USFWS Alternative Energy Program/HCP Co...

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Attachment 4

Tier 4 Mitigation Checklist

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Auwahi Wind HCP Tier 4 Bat Mitigation Actions	Current Status	FY23 Q4	FY20-FY23 Q2 Total	HCP Total Required	Notes
Provide a copy of the conservation easement to USFWS and DOFAW	Complete	N/A	N/A	N/A	Provided copy to USFWS/DOFAW on 12/12/2020
Letter of credit in the amount of $4,013,047 payable to DOFAW	Complete	N/A	N/A	N/A	Reduced LOC based on implemented mitigation per concurrence from USFWS/DOFAW in 2021.
Record the conservation easement for the Leeward Haleakala Mitigation Project land to preserve it in perpetuity.	Complete	N/A	N/A	N/A	HILT recorded with State of Hawaii Bureau of Conveyances 12/7/2020
Install Ponds	Complete	N/A	2 pond installed	2 ponds installed	1 pond completed in 2020. Second pond completed 3/5/2021.
Install acoustic detectors	Complete	N/A	58 acoustic detectors installed	58 acoustic detecors installed	Tier 4 mitigation area detectors installed and maintained
Install wildlife egress structures in all troughs within the mitigation area	Complete	N/A	Strucutres installed in 10 troughs	All troughs (10)	Photos taken for documentation
Consider and install understory with hedgerow canopy	Complete	N/A	5 acres planted	None required	A'ali'i, maile and mamaki added
Quarterly insect monitoring for the baseline monitoring period	Complete	N/A	3 malaise traps checked quarterly	3 malaise traps checked quarterly	Data analyzed. TT report provided
Fence ponds	Complete	N/A	2 ponds fenced	2 ponds fenced	Koa, ohia, olopua, ulei, maile, halapepe added to perimeter area

Use thermal cameras to document the behavior of bats at ponds and/or water troughs.	Complete	data collected from 1 thermal camera	Thermal camera installed at pond	Document the behavior of bats at ponds or troughs	Data collected documenting bat behavior of pond. Data shared with USFWS/DOFAW
Remove barbed wire from the mitigation area	Complete	N/A	67 acres of barbed fencing removed	Removal of wire as found	Ranch utilizing volunteers to remove. Barb wire near elk fence removed by contractors.
Install hedgerow fencing	Complete	N/A	311 acres	311 acres	Next 31 acre area about 20% complete
Install hedgerow plantings	In Progress	1 acres	115 acres	311 acres	Planting in new fenced area in Auwahi
Quarterly detector checks	In Progress, Ongoing	38 acoustic detectors checked	38 acoustic detectors checked	38 acoustic detectors checked quarterly in yrs 0, 1, 2, 3, 5, 7, 9, 11	Years 0-2 complete. West report provided
Annually analyze acoustic monitoring data to ensure units working properly	In Progress, Ongoing	Ordering supplies from wildlife acoustics	data from 38 acoustic detectors analyzed	38 acoustic detector data analyzed annually in monitoring years	Some units need repair, parts and mics on order.
Quarterly pond monitoring	In Progress, Ongoing	2 ponds checked	2 ponds checked	Quarterly checks of ponds in years 1, 2, 3, 5, 7, 9, and 11	Ponds intact
Quarterly fence inspections	In Progress, Ongoing	2 ponds checked	fencelines checked	None required	Fencelines intact. Improvements to fences initiated.
Twice annual insect monitoring in years 1, 2, 3, 5, 7, 9, and 11	In Progress, Ongoing	2 ponds checked	3 malaise traps checked twice annually	3 malaise traps checked twice annually	Years 0-2 complete. Tetra tech report provided

Attachment 5

Tier 4 Bat Mitigation Insect Monitoring Results

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TETRA TECH

MEMO

To:	George Akau, AEP Energy
Cc:	Matt Stelmach, AEP Energy
From:	Tetra Tech, Inc.
Date:	August 11, 2023
Correspondence #	TTCES-PTLD-2023-081
Subject:	Tier 4 Bat Mitigation: Insect Monitoring Results

1.0 Introduction

Auwahi Wind is currently conducting Tier 4 Bat Mitigation to increase and enhance bat foraging and night-roosting habitat by adding resource features and augmenting the landscape to connect areas that provide bat habitat. To achieve this objective, Auwahi Wind has created water resources and begun the out planting of forested linear landscape features, which consist of hedgerows and active cattle grazing pasture. These are anticipated to provide foraging areas, night-roosting substrate, and travel corridors for bats by providing a patchwork of open, edge, and closed canopy habitat, thus increasing the availability of insect prey (primarily moths and beetles).

As part of the Tier 4 Bat Mitigation monitoring efforts, Auwahi Wind incorporated insect sampling as a tool to better understand the effects of the management actions on the foraging resources of bats, and guide adaptive management actions, if required. Baseline monitoring of insects was conducted using malaise traps from July 2020 to June 2021 (state fiscal year 2021). Here we present and compare results from Monitoring Years 1 (July 2021 to June 2022) and 2 (July 2022 to June 2023) to the results of the baseline monitoring year.

2.0 Methods

Monitoring of insects was conducted at three separate habitats: pond, hedgerow, and pasture. using Townes-style malaise traps. Insect monitoring was conducted twice annually, consisting of a single sample during the first (July – August) and fourth quarter (March – June) of Monitoring Year 1 (July 2021 to June 2022) and in the second quarter (September – December) and fourth quarter of Monitoring Year 2 (July 2022 to June 2023). Sampling quarters were selected to align with the bats' reproductive periods (lactation, post-lactation, pre-pregnancy, and pregnancy) as defined by Gorresen et al. (2016; see Table 1).

Following sampling, insects greater than 10 millimeters in the orders Lepidoptera and Coleoptera were identified and counted. Insect Capture Rate (number of insects/number of trap nights) was used as a metric to standardize efforts among sampling events. No insects in the order Coleoptera were observed during the sampling periods, therefore we only report results as they pertain to Lepidoptera > 10 millimeters.

Insect capture rates across all pooled sites for each quarterly sampling period during Monitoring Year 1 and 2 are compared to the baseline monitoring year and are characterized by median ($\tilde{x}$) and interquartile range (IQR). Insect Capture Rates at the site level for each sampling period in Monitoring Years 1 and 2 (represented by a single sample) are compared to insect Capture Rates ($\tilde{x}$ and IQR) from the baseline monitoring year. T-tests were used to test for differences between quarterly sampling periods in Monitoring Years 1 and 2 to that of the baseline monitoring year. All statistical tests were two-tailed, employed an α value of 0.05, and were conducted in R version 4.3.1 (R Core Team 2023).

3.0 Results

In Monitoring Year 1, insect Capture Rates declined across pooled sites during the first quarter (July – August) and fourth quarter (March – June) sampling periods, compared to similar sampling periods from the baseline monitoring year (Figure 1 and Table 1). However, the decline in insect Capture Rates between Monitoring Year 1 and the baseline was not statistically significant for either the first quarter ($t_{2,9}$ = 1.43, $P > 0.194$) or the fourth quarter ($t_{2,8}$ = 0.37, $P > 0.722$) sampling periods. Declines in insect Capture Rates were observed among all sites in Monitoring Year 1 except for the hedgerow in the fourth quarter sampling period (Table 1, Figure 2). The most prominent declines in insect capture rates were observed at the pasture site in both the first and fourth quarter sampling periods.

In Monitoring Year 2, there was a slight increase, although not significant ($t_{2,12}$ = 0.14, $P > 0.891$), in insects Capture Rates across pooled sites during the second quarter sampling period compared to the baseline monitoring year (Table 1, Figure 1). However, at the site level increase in insect Capture Rates were only observed at the ponds site with declines in insect Capture Rates observed at the pasture and hedgerow sites (Table 1, Figure 2). During the fourth quarter sampling period insect Capture Rates declined across pooled sites compared to the baseline, although not significant ($t_{2,9}$ = 1.21, $P > 0.292$). Declines in insects Capture Rates were observed among all sites in the fourth quarter compared to the baseline and the fourth quarter of Year 1, for the exception of the Pasture site which increased between Year 1 and Year 2 (Table 1, Figure 2).

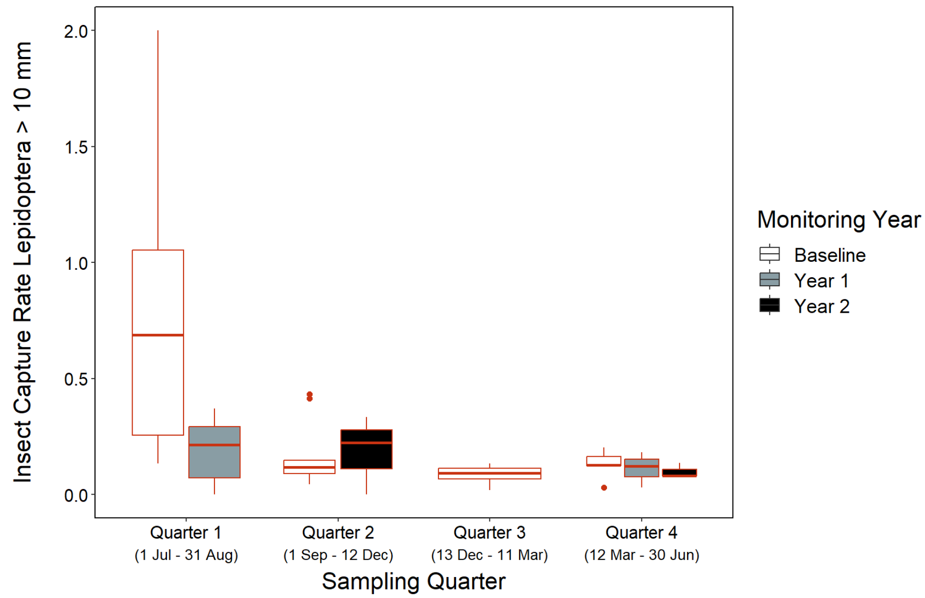

Figure 1. Box-Plot for Insect Capture Rate During Each Quarter Among All Pooled Sites[1]

Table 1. Insect Capture Rate During Each Sampling Quarter Between 2021 and 2023

Sampling Period	Sampling location	Insect Capture Rate for Lepidoptera > 10 mm		
		Baseline (July 2020 - June 2021) Median and IQR	Monitoring Year 1 (July 2021 - June 2022)	Monitoring Year 2 (July 2022 - June 2023)
Quarter 1 (1 Jul - 31 Aug)	Ponds	0.64 (0.38 - 0.89)	0.25	Not Collected
	Pasture	1.38 (1.08 - 1.69)	0.01	Not Collected
	Hedgerow	0.37 (0.26 - 0.49)	0.3	Not Collected
	All sites	0.69 (0.26 - 1.05)	0.19	Not Collected
Quarter 2 (1 Sep - 12 Dec)	Ponds	0.10 (0.07 - 0.12)	Not Collected	0.22
	Pasture	0.41 (0.27 - 0.42)	Not Collected	0.33
	Hedgerow	0.09 (0.07 - 0.12)	Not Collected	0
	All sites	0.12 (0.09 - 0.15)	Not Collected	0.17
Quarter 3 (13 Dec - 11 Mar)	Ponds	0.13 (0.12 - 0.13)	Not Collected	Not Collected
	Pasture	0.09 (0.09 - 0.09)	Not Collected	Not Collected
	Hedgerow	0.04 (0.03 - 0.04)	Not Collected	Not Collected
	All sites	0.09 (0.07 - 0.11)	Not Collected	Not Collected
Quarter 4	Ponds	0.13 (0.12 - 0.13)	0.12	0.08

[1] Summary statistics of the boxplot include the median, lower and upper quartiles, and whiskers (IQR*1.5).

Sampling Period	Sampling location	Insect Capture Rate for Lepidoptera > 10 mm		
		Baseline (July 2020 - June 2021) Median and IQR	Monitoring Year 1 (July 2021 - June 2022)	Monitoring Year 2 (July 2022 - June 2023)
(12 Mar - 30 Jun)	Pasture	0.20 (0.20 - 0.20)	0.03	0.14
	Hedgerow	0.10 (0.06 - 0.13)	0.18	0.08
	All sites	0.13 (0.12 - 0.16)	0.11	0.10

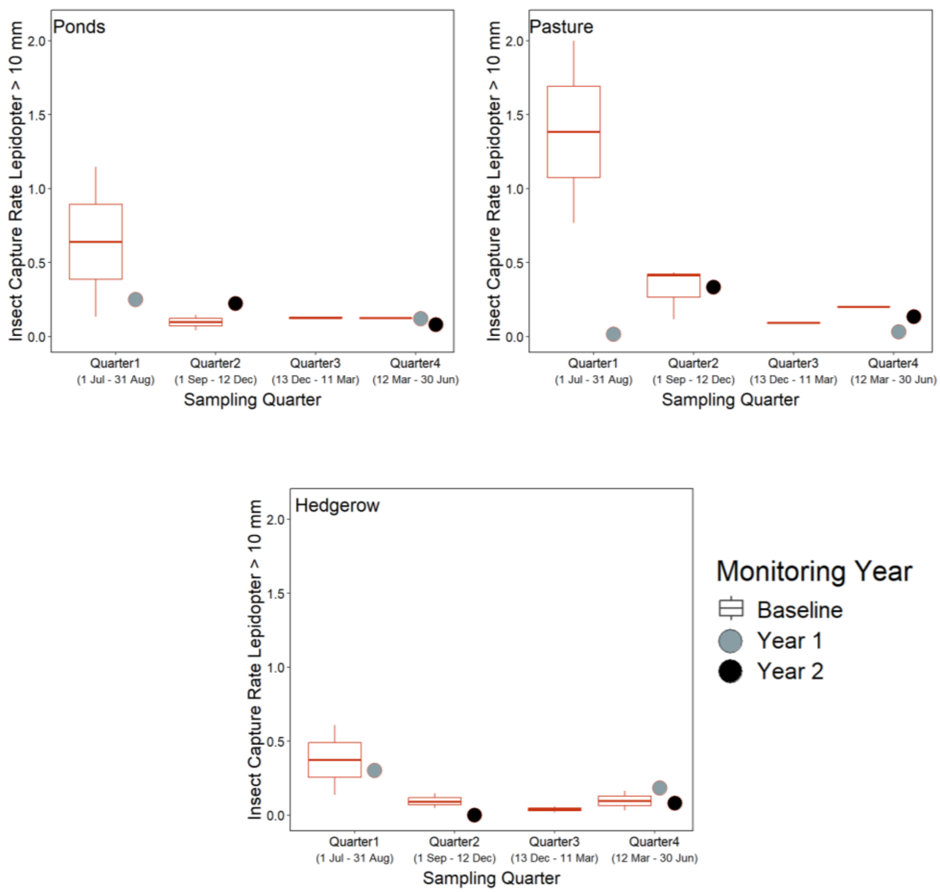

Figure 2. Comparison of Quarterly Insect Capture Rate by Year

4.0 Future Work

Insect sampling is scheduled to continue twice per year and will be conducted during the second and fourth quarter of Monitoring Year 3. Results will continue to be compared to the baseline values established during state fiscal year 2021 sampling to inform adaptive mitigation measures, if required.

5.0 References

Gorresen, P.M., F. Bonaccorso, C. Pinzari, C. Todd, K. Montoya-Aiona, and K. Brinck. 2016. A five-year study of Hawaiian hoary bat (*Lasiurus cinereus semotus*) occupancy on the Island of Hawaii.

R Core Team 2023 R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. www.R-project.org/.

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Attachment 6

Tier 4 Bat Mitigation Monitoring: 2-Year Baseline Monitoring Summary for February 2020–March 2022

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ENVIRONMENTAL & STATISTICAL CONSULTANTS
2725 NW Woodland Blvd, Corvallis, OR 97330
Phone: 307-214-2799 ◆ www.west-inc.com ◆ Fax: 307-637-6981

TECHNICAL MEMORANDUM

Date: September 16, 2022

To: George Akau – Auwahi Wind

From: Joel Thompson and Kristina Hammond-Rendon–WEST, Inc.

Subject: Tier 4 Bat Mitigation Monitoring: 2-Year Baseline Monitoring Summary for February 2020–March 2022

INTRODUCTION

Auwahi Wind Energy LLC (Auwahi Wind) established a Tier 4 Mitigation Site (Mitigation Site) to mitigate the take of Hawaiian hoary bat (HAHOBA) at their Auwahi Wind Energy Facility. Within the Mitigation Site, Auwahi Wind is implementing management actions to improve habitat conditions for HAHOBA and will monitor bat activity within the Mitigation Site over a period of 12 years to assess the success of the management activities. Consistent with the monitoring timeline presented in Auwahi Wind's Habitat Conservation Plan (HCP; Tetra Tech 2019), baseline monitoring was considered Year 0, with successive years of monitoring spanning Years 1–11. The primary goal of the monitoring is to document changes in HAHOBA activity over time in order to assess the impact of management actions on bat activity within the Mitigation Site.

In spring 2020, Auwahi Wind deployed acoustic bat detectors to begin baseline (Year 0) monitoring of HAHOBA activity in and adjacent the Mitigation Site (Figure 1). Auwahi Wind provided all acoustic monitoring equipment and associated accessories (e.g., microphones, solar panels, and batteries). Auwahi Wind staff are responsible for managing all aspects of the field study, including the ongoing maintenance of the detectors and swapping of data cards.

Once collected in the field, Auwahi Wind staff provided the raw data for QAQC and analysis by Western EcoSystems Technology, Inc. (WEST). This Technical Memorandum (Memo) provides a summary of the cumulative acoustic monitoring dataset spanning the first two years (Year 0 and Year 1) of acoustic monitoring at the Mitigation Site, from February 2020–March 2022.

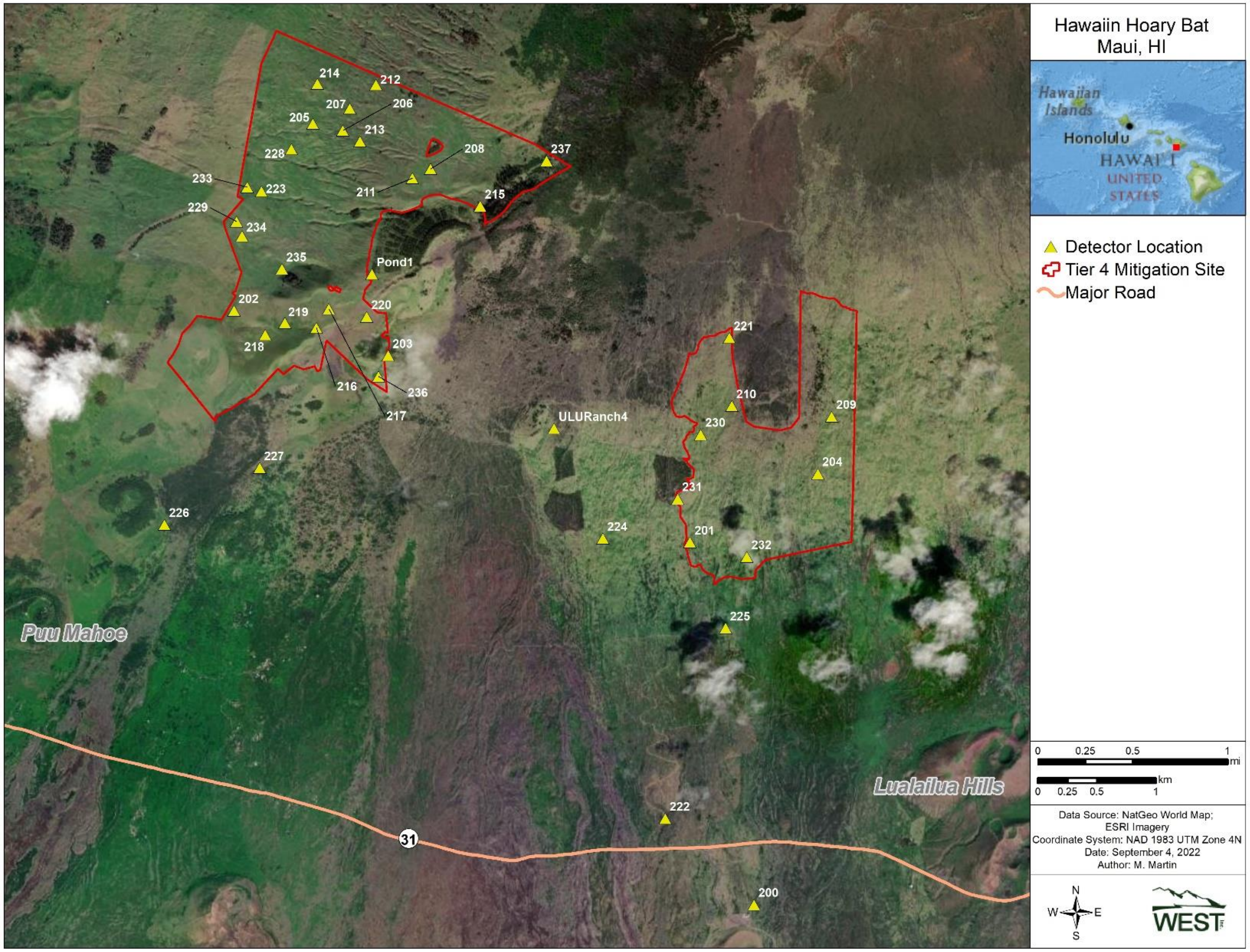

Figure 1. Overview of the Auwahi Wind Tier 4 Hawaiian hoary bat mitigation site and acoustic bat detector locations, Maui, Hawaii.

METHODS

Thirty-eight Wildlife Acoustics SM4Bat full spectrum bat detectors (Wildlife Acoustics, Maynard, Massachusetts) were deployed across the Mitigation Site in spring 2020. In fall 2021, two additional acoustic detectors (Pond1 and ULURanch4) were added to the monitoring effort (Figure 1); however, data collected at ULURanch4 was compromised due to apparent equipment issues and therefore not included in the analysis of Year 1 metrics reported on herein. Sampling locations throughout the Mitigation Site were selected using a spatially balanced (Generalized Random Tessellation Sampling; Stevens and Olsen [2004]) design based on a grid of 100 x 100 meter grid cells. Within selected grid cells, there was leeway to place detectors according to the habitat subtype requirements of Auwahi Wind's HCP (Tetra Tech 2019). Thirty detectors were subset into three habitat subtypes for future management activities within the Mitigation Site: pasture, hedgerow, and water trough/pond. Eight additional detectors were placed outside of the Mitigation Site and spread among similar habitat features (i.e., pasture, trough, and hedgerow). These eight locations are meant to serve as controls when conducting analyses to assess increasing trends in bat activity within the Mitigation Site following mitigation activities, although it is not known how distant from the Mitigation Site the impacts on bat acoustic activity may be observed. The two detectors added in fall 2021 were located near a trough (ULURanch4) located outside the Mitigation Site, and at a newly created pond (Pond1) located within the Mitigation Site;

A baseline habitat condition was identified for each detector station. The baseline (i.e., Year 0) conditions for the 30 initial sampling stations within the Mitigation site included 20 pasture and 10 trough/pond locations (nine trough and one pond; Table 1). As mitigation activities are completed and hedgerows and ponds are installed, it is anticipated that pasture stations located within 100 meters of installed features will transition to hedgerow or pond stations during future analyses. The nine detectors located outside the Mitigation Site include two trough, two hedgerow, and five pasture locations (Table 1). The Pond1 detector was added in fall 2021 at a newly created pond site that was not sampled prior to pond development. Additional details on the sampling design and mitigation requirements can be found in Auwahi Wind's amended HCP (Tetra Tech 2019).

Acoustic data from the acoustic bat detectors was collected by Auwahi Wind staff and transferred to WEST. Once downloaded and verified for completeness, WEST completed a quality check of the summary and acoustic files to ensure detectors and microphones were functioning properly. Full spectrum data were then processed and converted to zero-cross data using the software package Kaleidoscope Pro (version 5.1.0; Wildlife Acoustics), reducing the overall file sizes for storage and further analysis. During the conversion process, Kaleidoscope filtered zero-cross files suspected to be noise into a folder separate from the other zero-cross files. Once converted and filtered, all zero-cross files, including suspect noise files, were reviewed as digital sonograms and labeled by a bat biologist using program Analook (Titley Scientific). This process was used to confirm the presence of sufficient echolocation pulses (a minimum of two) to qualify as a bat call, consistency with the call parameters of HAHOBA (both call frequency and pattern), and to classify the call type (i.e., searching/location calls or feeding buzzes). Data handling procedures were consistent with those used by WEST for other acoustic studies conducted in Hawaii (e.g., Oahu and Leeward Haleakala occupancy studies; Thompson and Starcevich 2021a, 2021b) to ensure consistent organization and comparability of data across studies.

Once all call files were reviewed and bat presence verified, the call data were used to calculate the bat use metrics requested by Auwahi Wind:

1. **Call abundance** = total bat calls / total active detector-nights; and
2. **Call nightly detection** = total nights with bat calls / total active detector-nights.

A second set of metrics was generated based on feeding buzzes only:

1. **Feeding buzz abundance** = total feeding buzzes / total active detector-nights; and
2. **Feeding buzz nightly detection** = total nights with feeding buzzes / total active detector-nights.

A detector-night was defined as one detector operating for one full night.

RESULTS

Cumulative Data (Years 0 and 1 Combined)

All calls

Bat calls were recorded at all 39 detectors used in analyses. For the period February 26–March 30, 2022, the number of detector nights totaled 27,390, and ranged from 168 to 757 among the 39 detectors monitored (Table 1). Among the 39 detectors, the number of bat calls recorded ranged from a low of 572 calls at station AW222 to a high of 117,019 calls at station AW237 (Table 1). Bat call abundance at these same 39 detectors averaged 12.36 calls/detector night across all stations during the survey period, and varied from a low of 0.74 at station AW222 to a high of 156.44 at station AW237 (Table 1; Figure 2). Call nightly detection averaged 0.74 at the 39 stations during the survey period, and varied from a low of 0.34 at detector AW222 to a high of 0.98 at detector AW215 (Table 1). Bat calls were recorded on more than 50% of all detector nights at 38 of the 39 detectors with bat calls and more than 75% of detector nights at 21 of the 39 detectors with bat calls.

Feeding Buzz Calls

Feeding buzzes were recorded at all 39 (100%) detectors; however, 50% of all feeding buzzes were recorded at only two detectors, AW215 and AW237 (Table 2). Feeding buzz abundance averaged 0.04 buzzes/detector night and varied from a low of <0.01 buzzes/detector night detectors to a high of 0.42 at stations AW237 (Table 2). The feeding buzz nightly detection rate was consistently low, averaging 0.03 across all stations (Table 2). With the exception of detectors AW215, AW237, and Pond1, which recorded feeding buzzes on 21%, 16%, and 15% of detector nights, respectively, feeding buzzes were recorded on 5% or fewer detector nights (Table 2).

Table 1. Results of acoustic surveys conducted at monitoring stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from February 26, 2020–March 30, 2022. Calls are separated by total number of bat calls, the number of detector-nights bats were detected, total number of detector-nights, call abundance, and nightly detection rate.

Station	Associated Habitat Feature	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector-Nights	Call Abundance[a] (Bat Calls/ Detector-Night)	Nightly Detection (Nights Bats Detected/Total Detector-Nights)
AW200[c]	trough	767	308	717	1.07±0.10	0.43
AW201	pasture	1,701	402	757	2.25±0.11	0.53
AW202	pasture	3,717	471	697	5.33±0.28	0.68
AW203	pasture	3,400	424	618	5.50±0.30	0.69
AW204	pasture	1,915	499	738	2.59±0.13	0.68
AW205	trough	3,868	612	734	5.27±0.24	0.83
AW206	trough	4,427	640	734	6.03±0.25	0.87
AW207	trough	4,298	647	734	5.86±0.24	0.88
AW208	trough	3,792	476	586	6.47±0.36	0.81
AW209	pasture	2,401	598	755	3.18±0.12	0.79
AW210	pasture	2,473	558	736	3.36±0.16	0.76
AW211	pasture	4,137	571	731	5.66±0.25	0.78
AW212	pasture	3,515	605	731	4.81±0.22	0.83
AW213	pasture	4,720	644	731	6.46±0.24	0.88
AW214	pasture	4,138	618	732	5.65±0.24	0.84
AW215	pasture	104,076	698	713	145.97±8.83	0.98
AW216	pasture	6,842	648	715	9.57±0.34	0.91
AW217	pasture	5,435	610	715	7.60±0.35	0.85
AW218	pasture	1,983	345	631	3.14±0.24	0.55
AW219	pasture	1,820	437	713	2.55±0.14	0.61
AW220[c]	pasture	6,769	647	707	9.57±0.37	0.92
AW221[c]	pasture	3,462	625	710	4.88±0.18	0.88
AW222[c]	pasture	527	246	716	0.74±0.05	0.34
AW223	pasture	2,683	523	700	3.83±0.19	0.75
AW224[c]	pasture	1,741	447	703	2.48±0.14	0.64
AW225[c]	pasture	1,300	380	716	1.82±0.12	0.53
AW226[c]	hedgerow	10,481	651	708	14.80±0.55	0.92
AW227[c]	hedgerow	8,669	634	708	12.24±0.55	0.90
AW228	pasture	3,408	519	731	4.66±0.28	0.71
AW229	pasture	2,327	481	731	3.18±0.18	0.66
AW230	pasture	2,175	570	743	2.93±0.12	0.77
AW231	trough	1,584	386	744	2.13±0.13	0.52
AW232	pasture	2,227	505	756	2.95±0.17	0.67
AW233	trough	2,797	416	621	4.50±0.28	0.67
AW234	trough	3,613	543	746	4.84±0.24	0.73
AW235	trough	4,407	552	746	5.91±0.35	0.74
AW236	trough	4,793	607	751	6.38±0.28	0.81
AW237	pond	117,019	712	748	156.44±8.23	0.95
Pond1	pond	1,967	142	168	11.71±1.17	0.85
Total		**351,374**	**20,397**	**27,371**	**12.36±0.49**[b]	**0.75**

[a] estimate ± bootstrapped standard error

[b] average of individual detectors to account for unbalanced design (i.e., differing number of detector nights)

[C] indicates detector location is outside the Tier 4 Mitigation Site

Table 2. Results for feeding buzz detections during acoustic surveys conducted at 40 stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from February 26, 2020–March 30, 2022. Calls are separated by number of feeding buzz calls, detector-nights buzz calls were detected, total detector-nights, feeding buzz abundance, and feeding buzz nightly detection rate.

Station	Baseline Habitat Type	# of Feeding Buzzes	Detector-Nights with Feeding Buzz Calls	Total Detector - Nights	Feeding Buzz Abundance[a] (Feeding Buzzes Calls/ Detector-Night)	Feeding Buzz Nightly Detection (Nights Feeding Buzz detected/Total Detector-Nights)
AW200[c]	trough	7	6	717	0.01±0.00	0.01
AW201	pasture	3	3	757	0.00±0.00	0.00
AW202	pasture	4	3	697	0.01±0.00	0.00
AW203	pasture	9	9	618	0.01±0.00	0.01
AW204	pasture	9	8	738	0.01±0.00	0.01
AW205	trough	16	16	734	0.02±0.01	0.02
AW206	trough	18	18	734	0.02±0.01	0.02
AW207	trough	19	15	734	0.03±0.01	0.02
AW208	trough	19	16	586	0.03±0.01	0.03
AW209	pasture	17	17	755	0.02±0.01	0.02
AW210	pasture	19	17	736	0.03±0.01	0.02
AW211	pasture	9	8	731	0.01±0.00	0.01
AW212	pasture	7	7	731	0.01±0.00	0.01
AW213	pasture	12	11	731	0.02±0.01	0.02
AW214	pasture	13	12	732	0.02±0.01	0.02
AW215	pasture	193	116	713	0.27±0.03	0.16
AW216	pasture	31	27	715	0.04±0.01	0.04
AW217	pasture	21	20	715	0.03±0.01	0.03
AW218	pasture	7	7	631	0.01±0.00	0.01
AW219	pasture	3	3	713	0.00±0.00	0.00
AW220[c]	pasture	42	36	707	0.06±0.01	0.05
AW221[c]	pasture	13	12	710	0.02±0.01	0.02
AW222[c]	pasture	1	1	716	0.00±0.00	0.00
AW223	pasture	4	3	700	0.01±0.00	0.00
AW224[c]	pasture	6	6	703	0.01±0.00	0.01
AW225[c]	pasture	6	6	716	0.01±0.00	0.01
AW226[c]	hedgerow	40	35	708	0.06±0.01	0.05
AW227[c]	hedgerow	30	26	708	0.04±0.01	0.04
AW228	pasture	10	9	731	0.01±0.00	0.01
AW229	pasture	1	1	731	0.00±0.00	0.00
AW230	pasture	9	8	743	0.01±0.00	0.01
AW231	trough	5	5	744	0.01±0.00	0.01
AW232	pasture	6	6	756	0.01±0.00	0.01
AW233	trough	5	4	621	0.01±0.00	0.01
AW234	trough	9	9	746	0.01±0.00	0.01
AW235	trough	15	15	746	0.02±0.00	0.02
AW236	trough	17	17	751	0.02±0.01	0.02
AW237	pond	316	160	748	0.42±0.04	0.21
Pond1		52	26	168	0.31±0.11	0.15
Total		**1,023**	**724**	**27,371**	**0.04±0.00**[b]	**0.03**

[a] estimate ± bootstrapped standard error

[b] average of abundance estimates for individual detectors to account for unbalanced design (i.e., differing number of detector nights)

[C] indicates detector location is outside the Tier 4 Mitigation Site

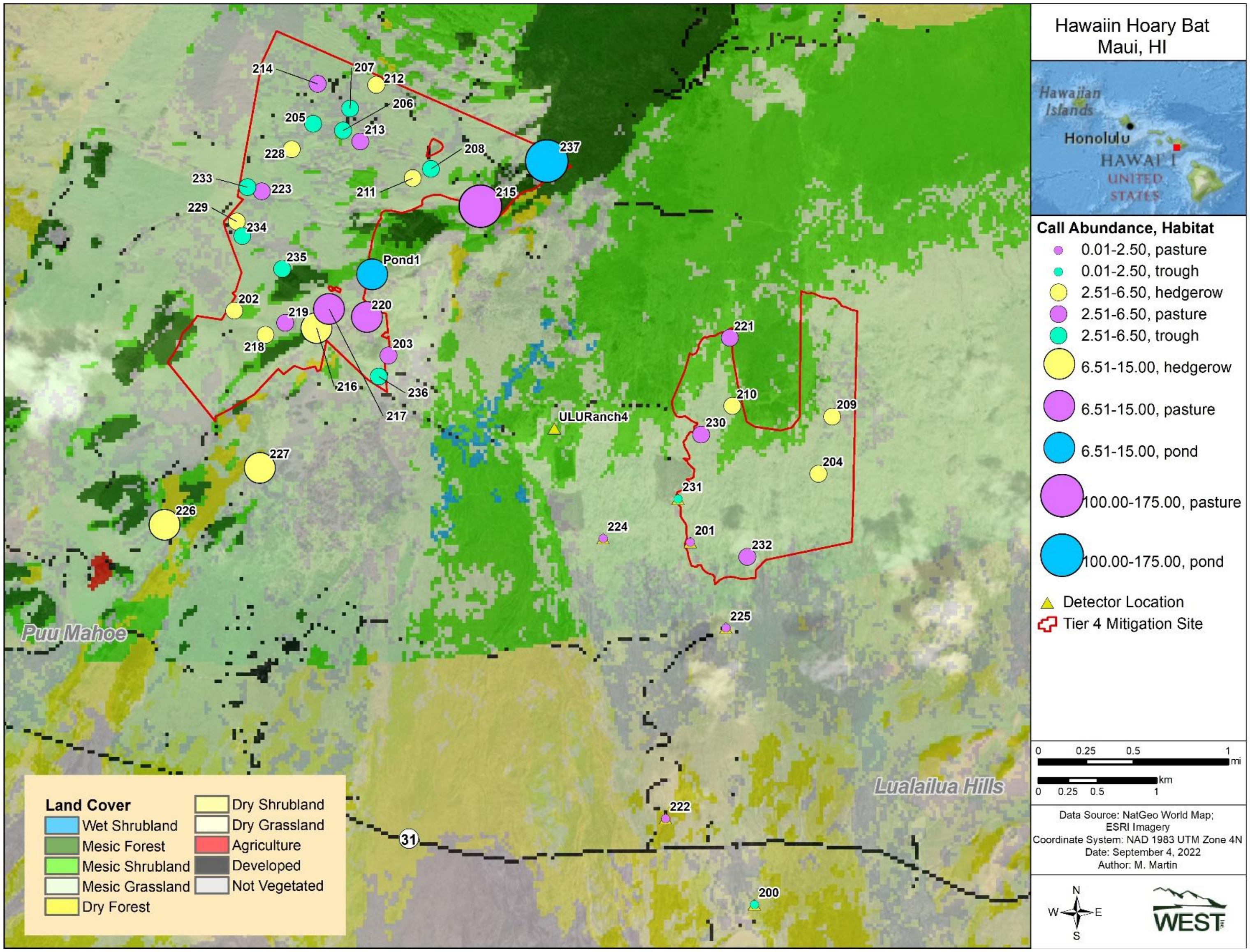

Figure 2. Call abundance by habitat feature type at Auwahi Wind's Tier 4 Hawaiian hoary bat mitigation site for the period February 26, 2020–March 30, 2022.

Annual Data

All Bat Calls

Bat calls were recorded at all detectors in both years (Appendix A1 and A2) of the study. For Year 0 (February 26, 2020–March 31, 2021), the number of detector nights sampled totaled 14,327 and the number of bat calls recorded totaled 158,054, for an overall average call abundance of 10.90 bat calls/detector night (Appendix A1). Bat call abundance varied from a low of 0.81 at station AW222 to a high of 152.86 at station AW237 (Appendix A1). Call nightly detection averaged 0.76 at the 38 stations during the survey period, and varied from a low of 0.39 at detector AW222 to a high of 0.97 at detector AW215 (Appendix A1). Bat calls were recorded on more than 50% of all detector nights at 35 of the 38 detectors and more than 75% of detector nights at 20 of the 38 detectors.

For Year 1 (April 1, 2021–March 30, 2022), the number of detector nights sampled totaled 9,536 and the number of bat calls recorded totaled 193,320, for an overall average call abundance of 14.57 bat calls/detector night (Appendix A2). Bat call abundance varied from a low of 0.66 at station AW222 to a high of 192.13 at station AW215 (Appendix A2). Call nightly detection averaged 0.73 at the 39 stations evaluated during the survey period, and varied from a low of 0.30 at detector AW222 to a high of 0.99 at detector AW215 (Appendix A2). Bat calls were recorded on more than 50% of all detector nights at 32 of the 39 detectors and more than 75% of detector nights at 20 of the 38 detectors (Appendix A2).

Feeding Buzz Calls

In Year 0, feeding buzzes were recorded at 25 of 38 (66%) detectors; however, 65% of all feeding buzzes were recorded at only two stations, AW215 and AW237 (Appendix B1). Feeding buzz abundance averaged 0.02 buzzes/detector night and varied from a low of zero at several detectors to a high of 0.22 at AW237 (Appendix B1). The feeding buzz nightly detection rate was consistently low, averaging 0.01 across all stations (Appendix B1). With the exception of detectors AW215 and AW237, which recorded feeding buzzes on 12% and 14% of detector nights, respectively, feeding buzzes were only recorded on 3% or fewer detector nights (Appendix B1).

In Year 1, feeding buzzes were recorded at all 39 (100%) detectors monitored; however, 45% of all feeding buzzes were again recorded at only two stations, AW215 and AW237 (Appendix B2). Newly added detector Pond1 accounted for another almost 7% of feeding buzzes Feeding buzzes at Pond1 totaled 52 buzzes over a much shorter sampling period of only 168 detector nights compared to 348 nights each at AW215 and AW237. Feeding buzz abundance averaged 0.06 buzzes/detector night and varied from a low of <0.01 buzzes/detector night at several detectors to a high of 0.65 at station AW237 (Appendix B2). The feeding buzz nightly detection rate in Year 1 was again consistently low, averaging 0.04 across all stations (Appendix B2). With the exception of detectors Pond1, AW215, AW237, which recorded feeding buzzes on 15%, 21%, and 30% of detector nights, respectively, feeding buzzes were recorded on only 8% or fewer detector nights (Appendix B1).

DISCUSSION

Based on the data collected during the monitoring period, HAHOBA were regularly active throughout the Mitigation Site, with bat activity recorded at all 39 functional stations monitored during the 2-year study period. In addition, bat activity was recorded and on most nights (74% of nights on average across all detectors). Only one (AW222) out of 39 detectors averaged less than one call per detector night during the cumulative study period, while 90% averaged more than two calls per detector night.

Relative to the baseline (Year 0) survey results, call abundance estimates appeared generally consistent with or slightly elevated at most stations in Year 1 (Figure 3), with an overall mean call abundance up from 10.9 in Year 0 to 14.6 in Year 1 (Figure 4). Detectors AW237 and Pond1 are the only detectors located in close proximity to ponds. Detector AW237 had the highest feeding buzz abundance rate in both Year 0 and Year 1 (0.22 and 0.65 buzzes/detector night, respectively), while Pond1 had the third highest feeding buzz abundance rate in Year 1 (0.31), its first year of monitoring (Appendix B). Detector AW237 also had the highest overall call abundance rate (152.86 calls/detector night) in Year 0 and the second highest overall abundance rate in Year 1 (160.55), while Pond1 ranked 5th in overall call abundance (11.71), substantially lower than that at AW237 (Figure 4; Appendix A).

While AW237 was located in close proximity to a pond, it was also among the highest elevation sites and was located in a small opening within the largest area of mesic forest land cover within or adjacent the Mitigation Site (Figure 2). The higher elevation and proximity to the larger mesic forest patch are two characteristics also shared with detector AW215, which exhibited the second highest activity rate (145.97 calls/detector night) over the full monitoring period, and the highest rate (192.13) in Year 1. This pattern of activity was consistent with that recorded in the Leeward Haleakala occupancy study conducted in 2019–2020 immediately east of the Mitigation Site (Thompson and Starcevich 2021b), which also found higher activity rates at upper elevation sites associated with mesic land cover types. The USGS study conducted in the Waihou Mitigation Area from 2015–2018 (Pinzari et al. 2019) also documented substantially higher activity rates (based on mean monthly detection rate) at their two upper most sample sites, which were located in roughly the same areas as AW215 and AW237. The Pond1 detector is also located at upper elevations within the Mitigation Site, although still at least 1,000 ft lower than detectors AW215 and AW237. While feeding buzz rates at the two pond sites (AW237 and Pond1) were among the highest of all detectors in this dataset, ongoing monitoring will provide additional data to better evaluate activity rates at ponds located at different elevational gradients and in differing land cover types. Additional monitoring will also allow for assessing changes in activity rates at ponds over time, as they mature and show increased aquatic vegetation growth and a likely commensurate increase in insect activity.

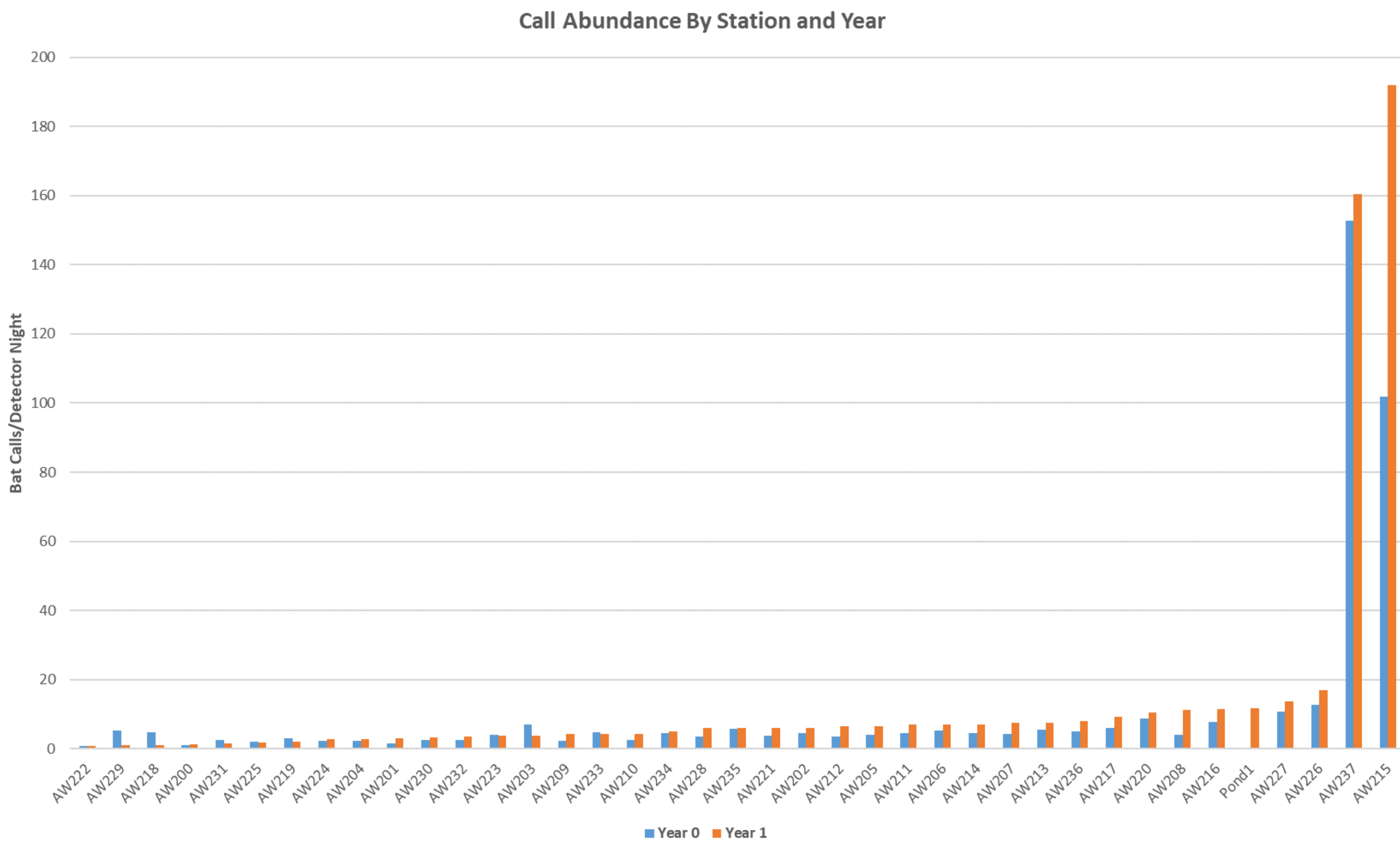

Figure 3. Call abundance (bat calls/detector night) by station and year based on acoustic surveys conducted at 39 sampling stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from February 26, 2020–March 30, 2022. Year 0 spans February 26, 2020–March 31, 2021, and Year 1 spanned April 30, 2021–March 30, 2022.

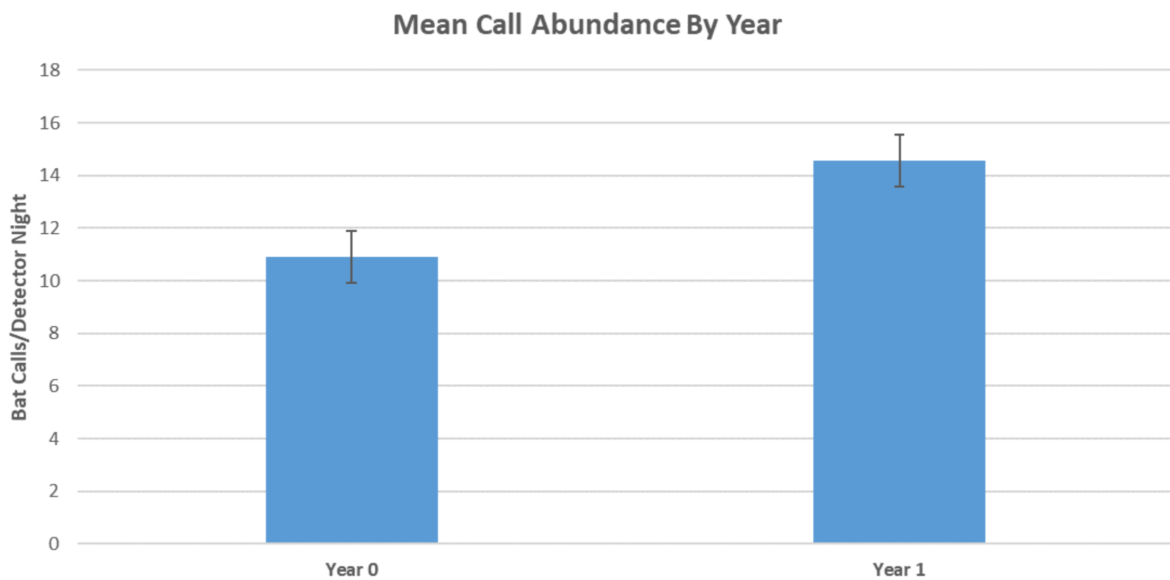

Figure 4. Mean call abundance (bat calls/detector night) for all stations combined by year based on acoustic surveys conducted at 39 sampling stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from February 26, 2020–March 30, 2022. Year 0 spans February 26, 2020–March 31, 2021, and Year 1 spanned April 30, 2021–March 30, 2022.

Overall call abundance and feeding buzz activity rates during the second-year of monitoring (Year 1) were generally consistent with or slightly elevated, on average, relative to the baseline year (Year 0) monitoring. Additionally, with the exception of detectors AW215 and AW237, activity rates in and around the Mitigation Site were also generally consistent with the activity rates measured in the Leeward Haleakala study at similar elevations (approximately 2–18 bat calls/detector night; Thompson and Starcevich 2021b).

Monitoring of bat activity in and surrounding the Mitigation Site is planned for the another 10 years Years 2-11) as mitigation activities (e.g., hedgerow plantings, water source installations) continue to be implemented. The goal of the ongoing monitoring is to quantify bat activity rates both spatially and temporally relative to the mitigation activities, and ideally provide a robust means of determining mitigation success (i.e., did the mitigation actions increase bat abundance/use, as measured by bat activity rates within the Mitigation Site relative to areas outside the Mitigation Site). While data are limited at this point, given only one of year of post-baseline data collection, the initial indication is that bat activity rates associated with the Mitigation Site increased slightly from Year 0 to Year 1 (see Figures 3 and 4). However, additional collected in future years will provide a more robust dataset for evaluating trends in activity over time.

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Appendix A: Hawaiian Hoary Bat Call Abundance and Call Nightly Detection by Year for 39 Acoustic Monitoring Stations Associated with Auwahi Wind Energy's Tier-4 Mitigation Monitoring, Maui, Hawaii from February 26, 2020–March 30, 2022.

Appendix A1. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from February 26, 2020–March 31, 2021 (Year 0).

Station	Associated Habitat Feature	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector-Nights	Call Abundance[a] (Bat Calls/ Detector-Night)	Nightly Detection (Nights Bats Detected/Total Detector-Nights)
AW200[c]	trough	329	152	353	0.93± 0.08	0.43
AW201	pasture	617	189	393	1.57± 0.12	0.48
AW202	pasture	1,613	252	350	4.61± 0.35	0.72
AW203	pasture	2,315	281	336	6.89± 0.40	0.84
AW204	pasture	918	279	391	2.35± 0.14	0.71
AW205	trough	1,585	320	387	4.10± 0.23	0.83
AW206	trough	2,010	335	387	5.19± 0.32	0.87
AW207	trough	1,689	337	387	4.36± 0.24	0.87
AW208	trough	1,527	287	386	3.96± 0.27	0.74
AW209	pasture	886	287	391	2.27± 0.13	0.73
AW210	pasture	967	277	385	2.51± 0.16	0.72
AW211	pasture	1,750	334	384	4.56± 0.23	0.87
AW212	pasture	1,302	306	384	3.39± 0.23	0.80
AW213	pasture	2,107	337	384	5.49± 0.30	0.88
AW214	pasture	1,697	314	385	4.41± 0.23	0.82
AW215	pasture	37,215	354	365	101.96± 8.14	0.97
AW216	pasture	2,823	329	367	7.69± 0.45	0.90
AW217	pasture	2,222	301	367	6.05± 0.39	0.82
AW218	pasture	1,713	240	366	4.68± 0.35	0.66
AW219	pasture	1,108	227	365	3.04± 0.24	0.62
AW220[c]	pasture	3,155	325	359	8.79± 0.43	0.91
AW221[c]	pasture	1,344	305	359	3.74± 0.21	0.85
AW222[c]	pasture	285	138	352	0.81± 0.08	0.39
AW223	pasture	1,513	294	384	3.94± 0.25	0.77
AW224[c]	pasture	810	227	352	2.30± 0.17	0.64
AW225[c]	pasture	674	199	352	1.91± 0.20	0.57
AW226[c]	hedgerow	4,538	339	357	12.71± 0.72	0.95
AW227[c]	hedgerow	3,859	330	357	10.81± 0.57	0.92
AW228	pasture	1,349	268	384	3.51± 0.22	0.70
AW229	pasture	1,976	313	384	5.15± 0.28	0.82
AW230	pasture	994	281	392	2.54± 0.16	0.72
AW231	trough	1,011	255	393	2.57± 0.19	0.65
AW232	pasture	943	251	392	2.41± 0.18	0.64
AW233	trough	1,873	319	399	4.69± 0.29	0.80
AW234	trough	1,843	289	399	4.62± 0.31	0.72
AW235	trough	2,329	292	399	5.84± 0.51	0.73
AW236	trough	2,019	321	400	5.05± 0.31	0.80
AW237	pond	61,146	377	400	152.86±10.95	0.94
Pond1	pond	NA	NA	NA	NA	NA
Total		**158,054**	**10,861**	**14,327**	**10.90± 0.58**	**0.76**

[a] estimate ± bootstrapped standard error
[b] average of individual detectors to account for unbalanced design (i.e., differing number of detector nights)
[c] indicates detector location is outside the Tier 4 Mitigation Site

Appendix A2. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from April 1, 2021–March 31, 2022 (Year 1).

Station	Associated Habitat Feature	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector-Nights	Call Abundance[a] (Bat Calls/ Detector-Night)	Nightly Detection (Nights Bats Detected/Total Detector-Nights)
AW200[c]	trough	438	156	364	1.20± 0.18	0.43
AW201	pasture	1,084	213	364	2.98± 0.21	0.59
AW202	pasture	2,104	219	347	6.06± 0.47	0.63
AW203	pasture	1,085	143	282	3.85± 0.40	0.51
AW204	pasture	997	220	347	2.87± 0.21	0.63
AW205	trough	2,283	292	347	6.58± 0.47	0.84
AW206	trough	2,417	305	347	6.97± 0.39	0.88
AW207	trough	2,609	310	347	7.52± 0.41	0.89
AW208	trough	2,265	189	200	11.32± 0.88	0.95
AW209	pasture	1,515	311	364	4.16± 0.20	0.85
AW210	pasture	1,506	281	351	4.29± 0.27	0.80
AW211	pasture	2,387	237	347	6.88± 0.43	0.68
AW212	pasture	2,213	299	347	6.38± 0.37	0.86
AW213	pasture	2,613	307	347	7.53± 0.37	0.88
AW214	pasture	2,441	304	347	7.03± 0.41	0.88
AW215	pasture	66,861	344	348	192.13±15.00	0.99
AW216	pasture	4,019	319	348	11.55± 0.58	0.92
AW217	pasture	3,213	309	348	9.23± 0.49	0.89
AW218	pasture	270	105	265	1.02± 0.10	0.40
AW219	pasture	712	210	348	2.05± 0.15	0.60
AW220[c]	pasture	3,614	322	348	10.39± 0.56	0.93
AW221[c]	pasture	2,118	320	351	6.03± 0.28	0.91
AW222[c]	pasture	242	108	364	0.66± 0.07	0.30
AW223	pasture	1,170	229	316	3.70± 0.30	0.72
AW224[c]	pasture	931	220	351	2.65± 0.20	0.63
AW225[c]	pasture	626	181	364	1.72± 0.16	0.50
AW226[c]	hedgerow	5,943	312	351	16.93± 0.99	0.89
AW227[c]	hedgerow	4,810	304	351	13.70± 0.85	0.87
AW228	pasture	2,059	251	347	5.93± 0.50	0.72
AW229	pasture	351	168	347	1.01± 0.08	0.48
AW230	pasture	1,181	289	351	3.36± 0.18	0.82
AW231	trough	573	131	351	1.63± 0.15	0.37
AW232	pasture	1,284	254	364	3.53± 0.34	0.70
AW233	trough	924	97	222	4.16± 0.58	0.44
AW234	trough	1,770	254	347	5.10± 0.38	0.73
AW235	trough	2,078	260	347	5.99± 0.44	0.75
AW236	trough	2,774	286	351	7.90± 0.41	0.81
AW237	pond	55,873	335	348	160.55±11.86	0.96
Pond1	pond	1,967	142	168	11.71± 1.20	0.85
Total		**193,320**	**9,536**	**13,044**	**14.57± 0.85**	**0.73**

[a] estimate ± bootstrapped standard error
[b] average of individual detectors to account for unbalanced design (i.e., differing number of detector nights)
[c] indicates detector location is outside the Tier 4 Mitigation Site

Appendix B: Hawaiian Hoary Bat Feeding Buzz Abundance and Feeding Buzz Nightly Detection by Year for 39 Acoustic Monitoring Stations Associated with Auwahi Wind Energy's Tier-4 Mitigation Monitoring, Maui, Hawaii from February 26, 2020–March 30, 2022.

Appendix B1. Results for feeding buzz detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from February 26, 2020–March 31, 2021 (Year 0).

Station	Associated Habitat Feature	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector-Nights	Call Abundance[a] (Bat Calls/ Detector-Night)	Nightly Detection (Nights Bats Detected/Total Detector-Nights)
AW200[c]	trough	0	0	353	0.00±0.00	0.00
AW201	pasture	0	0	393	0.00±0.00	0.00
AW202	pasture	0	0	350	0.00±0.00	0.00
AW203	pasture	4	4	336	0.01±0.01	0.01
AW204	pasture	1	1	391	0.00±0.00	0.00
AW205	trough	2	2	387	0.01±0.00	0.01
AW206	trough	3	3	387	0.01±0.00	0.01
AW207	trough	2	2	387	0.01±0.00	0.01
AW208	trough	7	7	386	0.02±0.01	0.02
AW209	pasture	6	6	391	0.02±0.01	0.02
AW210	pasture	1	1	385	0.00±0.00	0.00
AW211	pasture	1	1	384	0.00±0.00	0.00
AW212	pasture	0	0	384	0.00±0.00	0.00
AW213	pasture	1	1	384	0.00±0.00	0.00
AW214	pasture	0	0	385	0.00±0.00	0.00
AW215	pasture	65	43	365	0.18±0.03	0.12
AW216	pasture	2	2	367	0.01±0.00	0.01
AW217	pasture	6	6	367	0.02±0.01	0.02
AW218	pasture	6	6	366	0.02±0.01	0.02
AW219	pasture	1	1	365	0.00±0.00	0.00
AW220[c]	pasture	10	10	359	0.03±0.01	0.03
AW221[c]	pasture	1	1	359	0.00±0.00	0.00
AW222[c]	pasture	0	0	352	0.00±0.00	0.00
AW223	pasture	1	1	384	0.00±0.00	0.00
AW224[c]	pasture	0	0	352	0.00±0.00	0.00
AW225[c]	pasture	0	0	352	0.00±0.00	0.00
AW226[c]	hedgerow	6	6	357	0.02±0.01	0.02
AW227[c]	hedgerow	3	3	357	0.01±0.01	0.01
AW228	pasture	0	0	384	0.00±0.00	0.00
AW229	pasture	0	0	384	0.00±0.00	0.00
AW230	pasture	1	1	392	0.00±0.00	0.00
AW231	trough	0	0	393	0.00±0.00	0.00
AW232	pasture	0	0	392	0.00±0.00	0.00
AW233	trough	0	0	399	0.00±0.00	0.00
AW234	trough	3	3	399	0.01±0.00	0.01
AW235	trough	8	8	399	0.02±0.01	0.02
AW236	trough	7	7	400	0.02±0.01	0.02
AW237	pond	89	54	400	0.22±0.04	0.14
Pond1	pond	NA	NA	NA	NaN± NA	NA
Total		**237**	**180**	**14,327**	**0.02±0.00[b]**	**0.01**

[a] estimate ± bootstrapped standard error
[b] average of individual detectors to account for unbalanced design (i.e., differing number of detector nights)
[c] indicates detector location is outside the Tier 4 Mitigation Site

Appendix B2. Results for feeding buzz detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind Energy's tier 4 mitigation monitoring, Maui, Hawaii from April 1, 2021–March 31, 2022 (Year 1).

Station	Associated Habitat Feature	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector-Nights	Call Abundance[a] (Bat Calls/ Detector-Night)	Nightly Detection (Nights Bats Detected/Total Detector-Nights)
AW200[c]	trough	7	6	364	0.02±0.01	0.02
AW201	pasture	3	3	364	0.01±0.00	0.01
AW202	pasture	4	3	347	0.01±0.01	0.01
AW203	pasture	5	5	282	0.02±0.01	0.02
AW204	pasture	8	7	347	0.02±0.01	0.02
AW205	trough	14	14	347	0.04±0.01	0.04
AW206	trough	15	15	347	0.04±0.01	0.04
AW207	trough	17	13	347	0.05±0.02	0.04
AW208	trough	12	9	200	0.06±0.02	0.05
AW209	pasture	11	11	364	0.03±0.01	0.03
AW210	pasture	18	16	351	0.05±0.01	0.05
AW211	pasture	8	7	347	0.02±0.01	0.02
AW212	pasture	7	7	347	0.02±0.01	0.02
AW213	pasture	11	10	347	0.03±0.01	0.03
AW214	pasture	13	12	347	0.04±0.01	0.03
AW215	pasture	128	73	348	0.37±0.05	0.21
AW216	pasture	29	25	348	0.08±0.02	0.07
AW217	pasture	15	14	348	0.04±0.01	0.04
AW218	pasture	1	1	265	0.00±0.00	0.00
AW219	pasture	2	2	348	0.01±0.00	0.01
AW220[c]	pasture	32	26	348	0.09±0.02	0.07
AW221[c]	pasture	12	11	351	0.03±0.01	0.03
AW222[c]	pasture	1	1	364	0.00±0.00	0.00
AW223	pasture	3	2	316	0.01±0.01	0.01
AW224[c]	pasture	6	6	351	0.02±0.01	0.02
AW225[c]	pasture	6	6	364	0.02±0.01	0.02
AW226[c]	hedgerow	34	29	351	0.10±0.02	0.08
AW227[c]	hedgerow	27	23	351	0.08±0.02	0.07
AW228	pasture	10	9	347	0.03±0.01	0.03
AW229	pasture	1	1	347	0.00±0.00	0.00
AW230	pasture	8	7	351	0.02±0.01	0.02
AW231	trough	5	5	351	0.01±0.01	0.01
AW232	pasture	6	6	364	0.02±0.01	0.02
AW233	trough	5	4	222	0.02±0.01	0.02
AW234	trough	6	6	347	0.02±0.01	0.02
AW235	trough	7	7	347	0.02±0.01	0.02
AW236	trough	10	10	351	0.03±0.01	0.03
AW237	pond	227	106	348	0.65±0.08	0.30
Pond1	pond	52	26	168	0.31±0.12	0.15
Total		**786**	**544**	**13,044**	**0.06±0.00[b]**	**0.04**

[a] estimate ± bootstrapped standard error
[b] average of individual detectors to account for unbalanced design (i.e., differing number of detector nights)
[c] indicates detector location is outside the Tier 4 Mitigation Site

Attachment 7

Hawaiian Hoary Bat Tier 5 Site-Specific Mitigation Implementation Plan

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Draft Auwahi Wind Tier 5 Site Specific Mitigation Implementation Plan (SSMIP)

Presenters: George Akau, Matt Stelmach

In collaboration with: United States Fish and Wildlife Service (USFWS)/Department of Forestry and Wildlife (DOFAW) Habitat Conservation Plan (HCP)staff, DOFAW-Maui, Haleakala Ranch, American Electric Power (AEP), Endangered Species Recovery Committee (ESRC)

Date: March 29, 2023

2019 HCP Amendment identifies Kamehamenui Forest for Tier 5/6

Auwahi Wind Farm Project   Habitat Conservation Plan Amendment

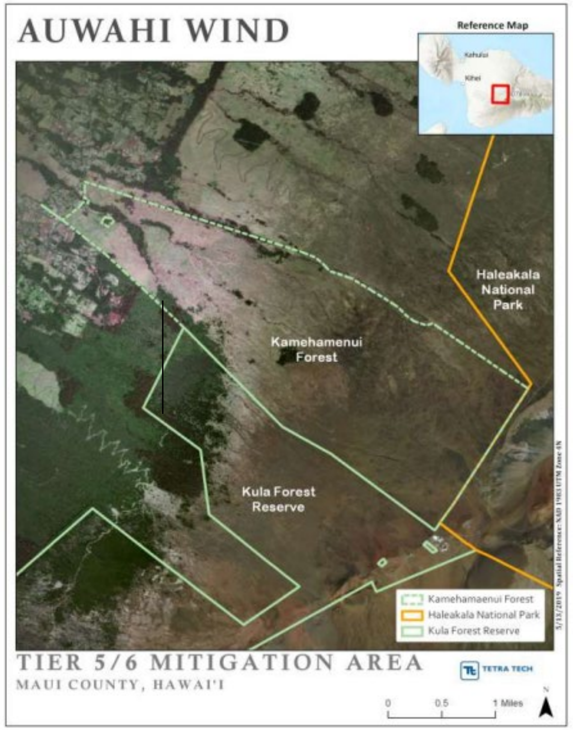


Figure 6-8. Location and Aerial Imagery of Kamehamenui Forest

6-37

Intended Management: Tier 5 and 6 mitigation is based on criteria similar to that used for Tier 4 mitigation, and targets many of the same management goals and actions known to have positive benefits for bats, as previously described

Commitment: Improve 690 acres of habitat in Tier 5

ESRC Requirements for Approval of the HCP Amendment:

- October 2018 – Require sufficient specificity in Tier 5 mitigation to have certainty what actions would occur and where.

ESRC Comments:

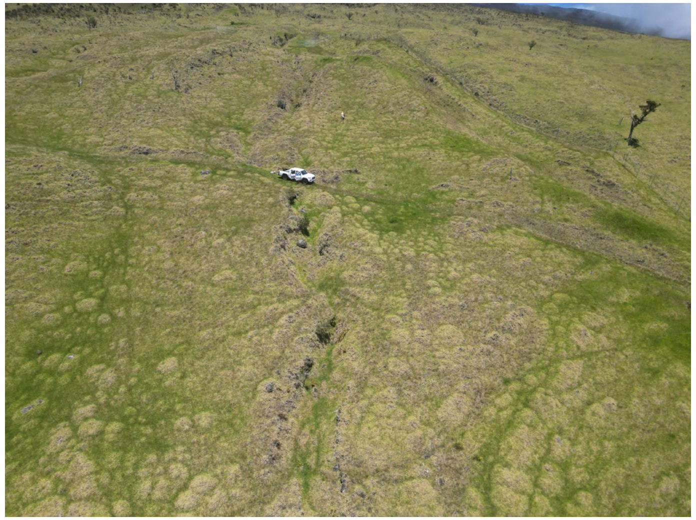
- "I feel that this generally sounds like a good strategy but it really depends on how well the Tier 4 management progresses and if the monitoring can detect any change as a result of these management actions" – ESRC Member

Tier 1 and 4 Mitigation Implementation

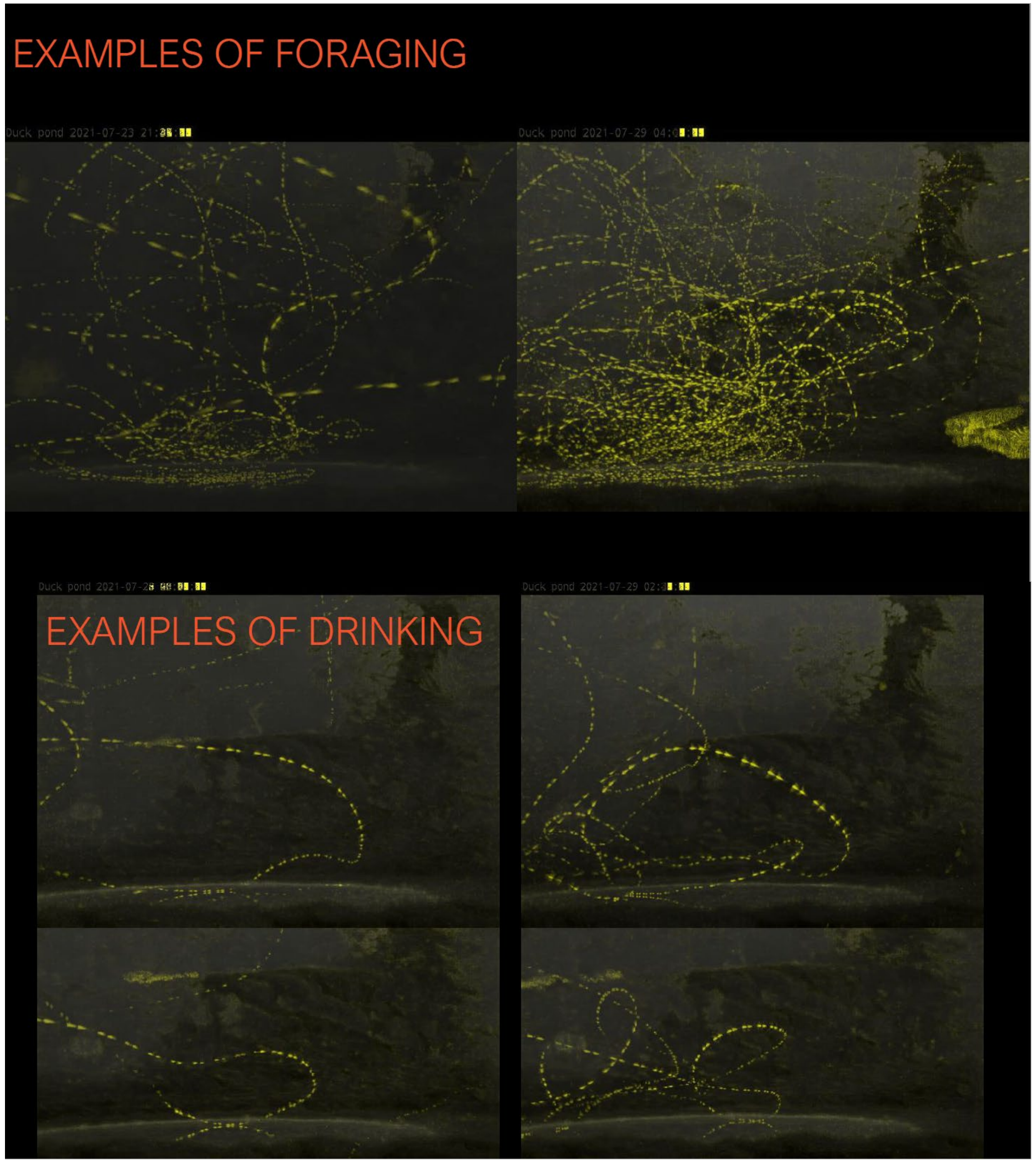
Hawaiian Hoary Bat Tier 5
Site-Specific Mitigation Implementation Plan

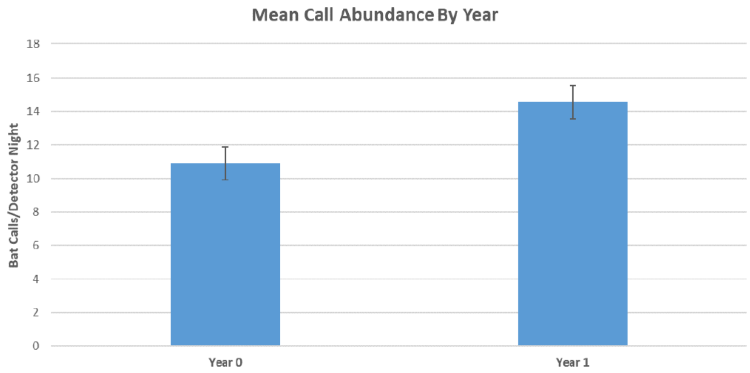
Photo 2. Pu'u Makua Forest Cover June 2018

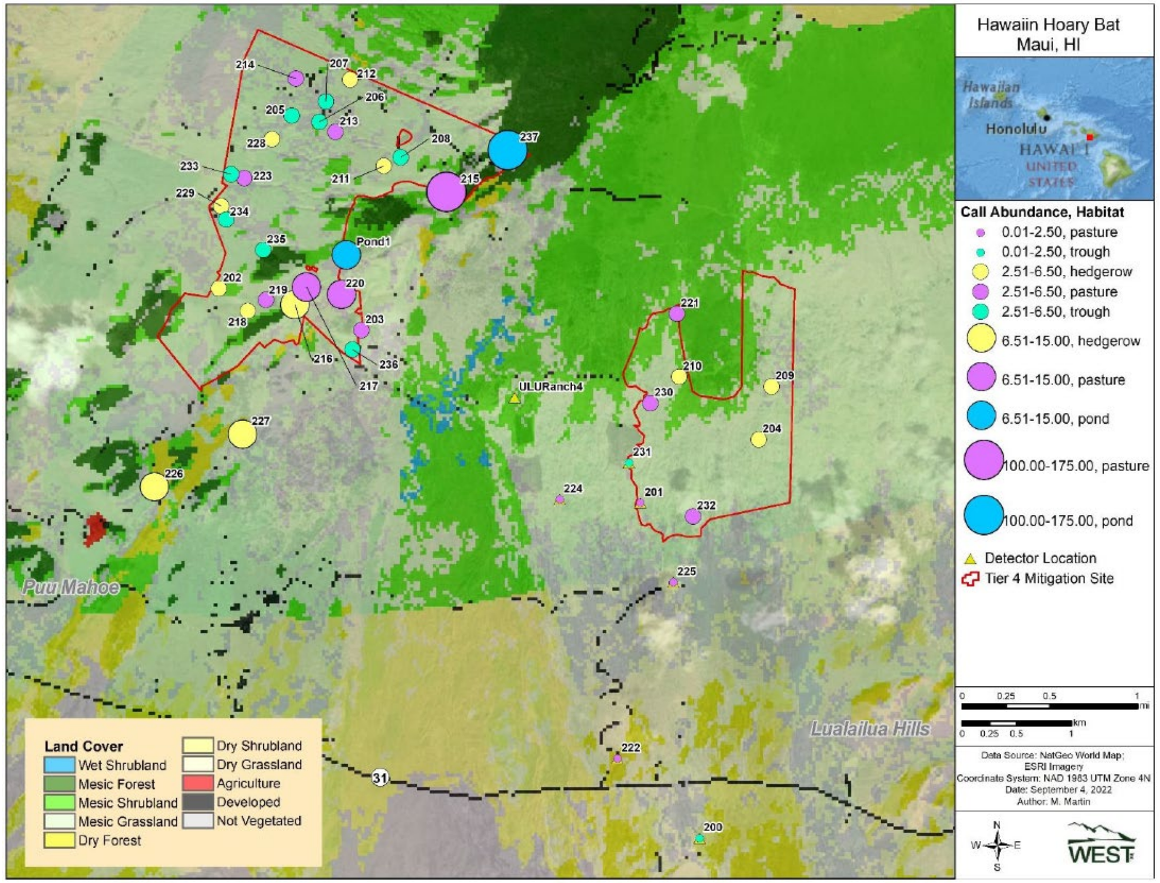
Photo 3. Pu'u Makua Forest Cover October 2021



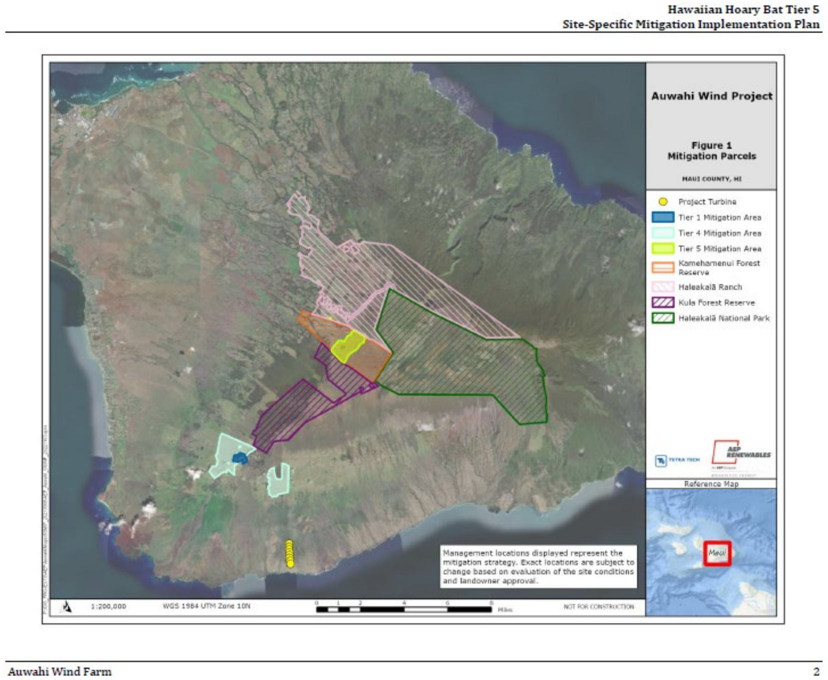
Tier 4 Results to Date







HCP Commitments for Tier 5



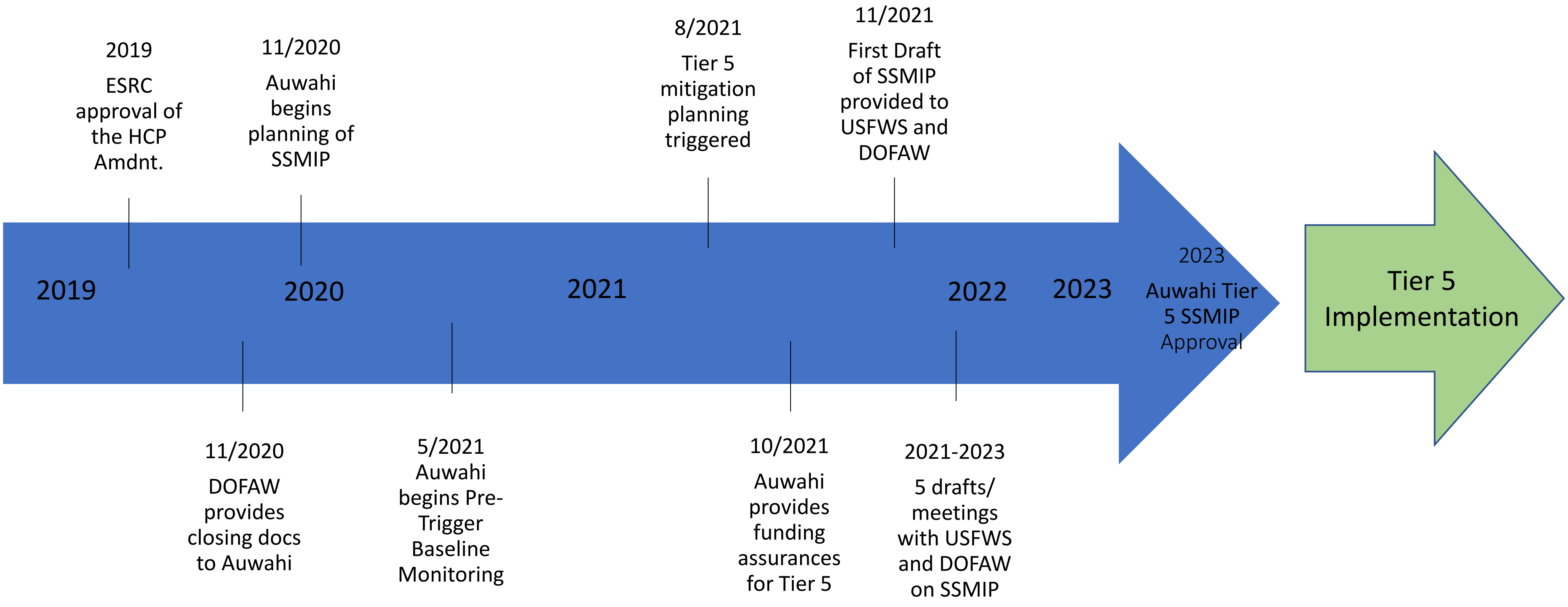
- **Goal:** Increase bat roosting, foraging habitat, and/or prey availability
- **Management actions:**
  - Out-planting of native tree species, which will help build the vertical vegetative structure and canopy cover that is necessary for bat roosting.
  - The creation of water features,
  - Removing invasive plant and animal species
- **Monitoring**:
  - Acoustic monitoring at nine locations no less than every other year for the remaining permit term
  - Insect sampling
- **Success Criteria:**
  - A USFWS and DOFAW-approved SSMIP is developed and implemented;
  - A mitigation monitoring program; and
  - Acoustic monitoring for bat activity
  - Acoustic data are analyzed, and the results show that the success criteria identified in the SSMIP have been achieved.

SSMIP relative to HCP Commitments

The SSMIP will address the following topics in detail:

- ❑ Baseline habitat conditions;
- ❑ Specific location(s) of mitigation actions;
- ❑ Specific type(s) of mitigation actions;
- ❑ Timing of mitigation action implementation;
- ❑ Success criteria;
- ❑ Monitoring of mitigation implementation and success, and presence of Hawaiian hoary bat;
- ❑ Adaptive management;
- ❑ Demonstration of how the mitigation will offset take; and
- ❑ Cost estimates

SSMIP Development Timeline



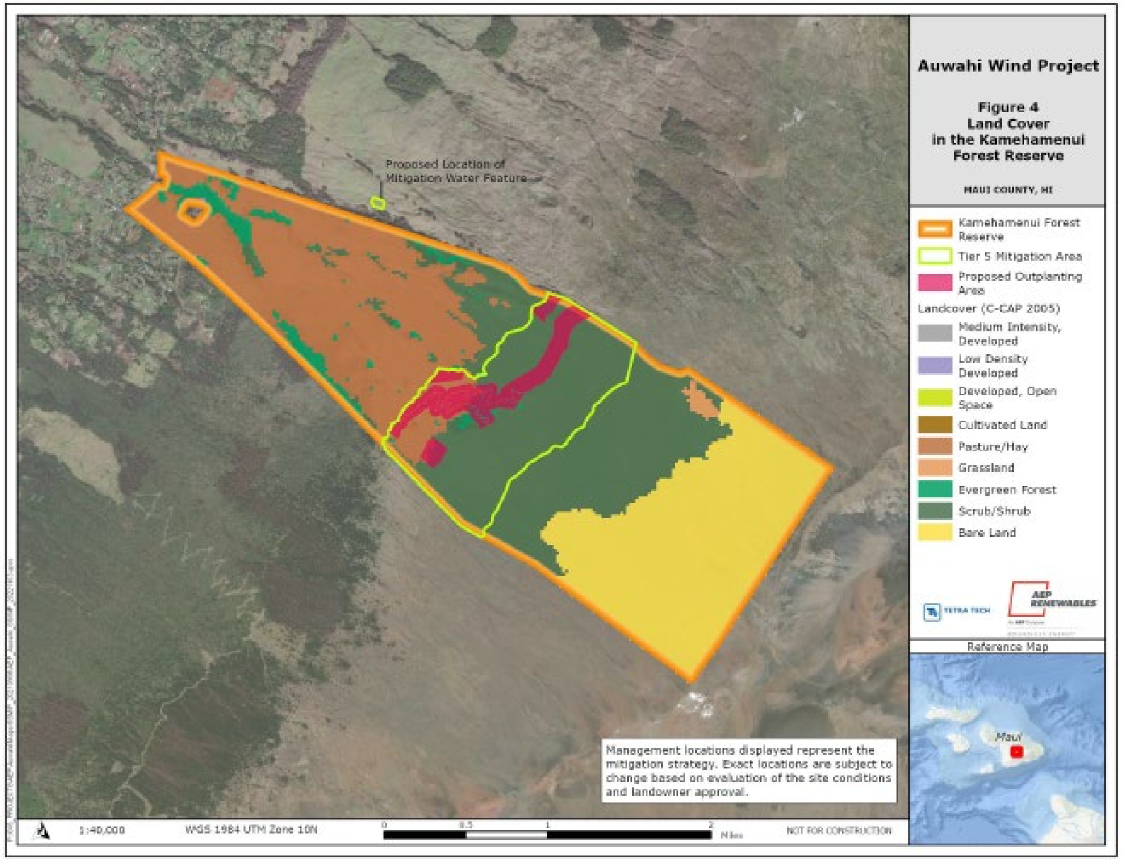
Mitigation Area/Baseline Conditions

- 690 acres of Kamehamenui Forest Reserve
- Between 4,900– 7,600 feet elevation
- The majority of the area below 6,500 feet is dominated by pasture with vast areas of open grassland and non-native species
- Existing grazing, and feral ungulates

Land Cover	Tier 5 Mitigation Area[1]	
	Acres	Percentage
Scrub Shrub	563	82
Pasture/Hay	105	15
Evergreen	22	3
TOTAL	690[1]	100

[1]The final Mitigation Area will total 690 acres and will include lands from both the KFR and an approximately 2-acre parcel on Haleakalā Ranch, within which a pond will be constructed. This area will be located within the larger area summarized here.

Hawaiian Hoary Bat Tier 5
Site-Specific Mitigation Implementation Plan



Auwahi Wind Farm 12

Commitments in the Tier 5 SSMIP

- **Goal:** increase bat roosting, foraging habitat, and/or prey availability
- **Management actions:**
  - Out-planting of native tree species, which will help build the vertical vegetative structure and canopy cover that is necessary for bat roosting.
  - the creation of water features,
  - removing invasive plant and animal species
- **Monitoring**:
  - Pre-Trigger Baseline Monitoring (implemented)
  - Acoustic monitoring at 14 locations no less than every other year for the remaining permit term
  - Forest cover monitoring
  - Thermal monitoring of water features
  - Thermal monitoring of forests
  - Insect Monitoring

Success Criteria

1. **Acoustic monitoring** for bat activity is successfully implemented at the Mitigation Area. The data are analyzed and reported.

2. **Ungulate fencing** is maintained, and ungulate removal efforts are sufficient to allow for establishment of outplantings.

3. Record an **increase in bat activity** through acoustic monitoring or other method over the Baseline Monitoring year(s). The statistical power with which the increase is recorded will also be reported.

4. **Increase forest cover** of the 690 acres of Mitigation Area to 20 percent following the completion of planting, using outplanting, to increase edge habitat

5. **Install egress structures** at purchased or installed water features used by bats.

6. **Install at least one pond** that will enhance bat habitat, by providing a source of water and supporting insect populations.

7. Utilize **thermal camera monitoring techniques** to document bat use and behavior at constructed pond.

8. **Summarize and report the results** of monitoring in annual reports.

SSMIP Implementation Timeline

Action	Monitoring Year[1, 2]									
	1	2	3	4	5	6	7	8	9	10
	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Complete ungulate exclusion	X									
Complete feral ungulate removal	X	X								
Install pond		X								
Complete plantings in Outplanting Area				X						
Acoustic monitoring in Mitigation Area (Section 6.2)	B	B	B	B	B		I		I	
Thermal monitoring in Outplanting Area (Section 6.4)	B		B		B		I		I	
Acoustic monitoring at new pond	B		I		I		I		I	
Thermal monitoring at new pond and existing water feature			I							
Quarterly baseline insect monitoring	B	B								
Twice yearly insect monitoring			I		I		I		I	
Assess percent forest cover of Mitigation Area (Section 6.3)	B				B	I	I	I	I	I

X = Action will be completed; B = Baseline monitoring; I – Implementation monitoring

1. The timeline for the associated actions described are Auwahi Wind's best estimate based on current information; however, timing of approvals, logistical challenges, or other factors may affect the precise scheduling of actions (e.g., the installation of the pond). Changes in the timing of a mitigation action are also likely to affect the associated monitoring. The commitments to the timing of mitigation actions and associated monitoring are described in sections 4.0, 6.0, and their respective subsections.

2. Ten-year timeline presented aligns with the remaining planned operational life of the Project, through 2032 (Section 1.1 in Tetra Tech 2019).

Adaptive Management

- Alternative outplanting species if seed is not available
- Alter outplanting species if indicated by acoustic and insect monitoring
- Other actions needed to increase acoustic bat activity
  - Informed by monitoring results
  - Increase in forest cover
  - Increase in ponds/water features

SSMIP relative to HCP Commitments

The SSMIP will address the following topics in detail:

✓ Baseline habitat conditions;

✓ Specific location(s) of mitigation actions;

✓ Specific type(s) of mitigation actions;

✓ Timing of mitigation action implementation;

✓ Success criteria;

✓ Monitoring of mitigation implementation and success, and presence of Hawaiian hoary bat;

✓ Adaptive management;

✓ Demonstration of how the mitigation will offset take; and

✓ Cost estimates.

Thank you for your contributions

Attachment 8

Tier 5 Baseline Bat Mitigation Monitoring

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ENVIRONMENTAL & STATISTICAL CONSULTANTS

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Phone: 307-214-2799 ◆ www.west-inc.com ◆ Fax: 307-637-6981

TECHNICAL MEMORANDUM

Date: December 2, 2022

To: George Akau – Auwahi Wind

From: Joel Thompson – Western EcoSystems Technology, Inc.

Subject: Tier 5 Bat Mitigation Monitoring: Baseline Monitoring Summary for May 11, 2021–June 22, 2022

INTRODUCTION

Auwahi Wind Energy LLC (Auwahi Wind) has established a Tier 5 Mitigation Site (Mitigation Site) within the Kamehamenui Forest Reserve to mitigate take of Hawaiian hoary bat (HAHOBA) at their Auwahi Wind Energy Facility (Figure 1). Within the Mitigation Site, Auwahi Wind will implement management actions to improve habitat conditions for HAHOBA and will monitor bat activity within the Mitigation Site to assess bat activity levels and the success of mitigation actions. Auwahi's Tier 5 monitoring obligations consist of pre-trigger baseline acoustic monitoring at two detector locations, followed by baseline acoustic monitoring at a minimum of 14 detectors prior to initiating conservation actions (i.e., habitat enhancements) and post-mitigation monitoring (Tetra Tech 2022). The primary goal of the acoustic monitoring is to document changes in HAHOBA activity over time to assess the impact of management actions on bat activity within the Mitigation Site.

In spring 2021, Auwahi Wind deployed two acoustic bat detectors to begin their pre-trigger baseline monitoring effort. Auwahi Wind provided the acoustic monitoring equipment and associated accessories (e.g., microphones, solar panels, and batteries), and was responsible for managing the field study, including maintenance of detectors and data collection.

Once collected from the field, Auwahi Wind staff provided raw data to Western EcoSystems Technology, Inc. (WEST) for QAQC and analysis. This Technical Memorandum provides a summary of the pre-trigger acoustic monitoring dataset from May 11, 2021–June 22, 2022.

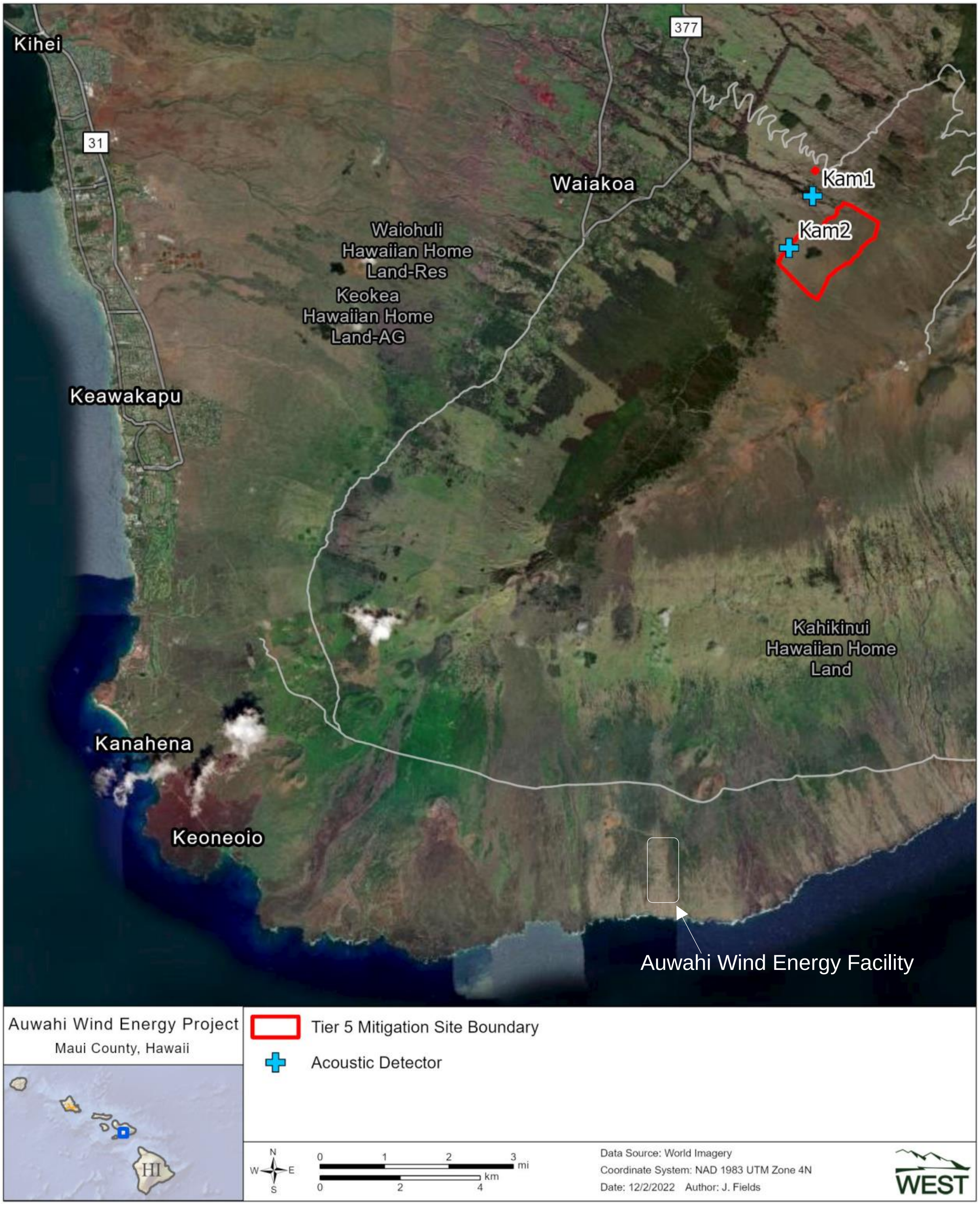

Figure 1. Location of the Tier 5 Mitigation Site and acoustic survey stations relative to the Auwahi Wind Energy Facility.

METHODS

Two Wildlife Acoustics SM4Bat full spectrum bat detectors (Wildlife Acoustics, Maynard, Massachusetts) were deployed in and adjacent to the Mitigation Site in spring 2021 (Figure 2). Acoustic data from the two detectors was collected by Auwahi Wind staff and transferred to WEST. Once downloaded and verified for completeness, WEST completed a quality check of the summary and acoustic call files to ensure detectors and microphones were functioning properly. Full spectrum data were then processed and converted to zero-cross data using the software package Kaleidoscope Pro (version 5.1.0; Wildlife Acoustics), reducing the overall file sizes for storage and further analysis. During the conversion process, Kaleidoscope filtered zero-cross files suspected to be noise into a folder separate from the other zero-cross files. Once converted and filtered, all zero-cross files, including suspect noise files, were reviewed as digital sonograms and labeled by a bat biologist using program Analook (Titley Scientific). This process was used to confirm the presence of sufficient echolocation pulses (a minimum of two) to qualify as a bat call, consistency with the call parameters of HAHOBA (both call frequency and pattern), and to classify the call type (i.e., searching/location calls or feeding buzzes). Data handling procedures were consistent with those used by WEST for other acoustic studies conducted in Hawaii (e.g., Oahu and Leeward Haleakala occupancy studies; Thompson and Starcevich 2021a, 2021b), as well as analyses of Auwahi's Tier 4 mitigation site data (Thompson and Hammond-Rendon 2022), to ensure consistent organization and comparability of data across studies.

Once all call files were reviewed and bat presence verified, the call data were used to calculate the bat use metrics requested by Auwahi Wind:

1. **Call abundance** = total bat calls / total active detector-nights;
2. **Call nightly detection** = total nights with bat calls / total active detector-nights; and
3. **Activity minutes per night =** total number of minutes during a detector night with at least one bat call.

A second set of metrics was generated based on feeding buzzes only:

1. **Feeding buzz abundance** = total feeding buzzes / total active detector-nights; and
2. **Feeding buzz nightly detection** = total nights with feeding buzzes / total active detector-nights.

A detector-night was defined as one detector operating for one full night.

Figure 2. Location of the two acoustic survey stations placed in and near the Tier 5 Mitigation Site.

RESULTS

All calls

For the period May 11, 2021–June 22, 2022, the number of detector nights sampled totaled 815 (Table 1). The number of bat calls recorded during the period totaled 18,559, with 63% of all calls recorded at station Kam1 and 37% at station Kam2 (Table 1). Bat call abundance was greater at station Kam1 than Kam2, and averaged 22.76 calls/detector night for both stations combined during the survey period (Table 1). Call nightly detection was similar at both stations and averaged 0.95 during the survey period (Table 1), indicating that even though call abundance was greater at Kam1, bats were recorded at both detector stations on almost all nights during the survey period.

Table 1. Results for all bat detections during acoustic surveys conducted at two stations within the Auwahi Wind Energy Project's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–June 22, 2022.

Station	Associated Habitat Feature	# of Bat Calls	Detector-Nights with Bat Calls	Total Detector-Nights	Call Abundance (Bat Calls/ Detector-Nights[a])	Nightly Detection (Nights Bats Detected/Total Detector-Nights[b])
Kam1	pasture	11,680	391	408	28.63 ± 2.24	0.96
Kam2	pasture	6,879	382	407	16.90 ± 1.03	0.94
Total		**18,559**	**773**	**815**	**22.76 ± 1.48**	**0.95[c]**

[a] ± bootstrapped standard error.
[b] average of abundance estimates for individual detectors to account for unbalanced design (i.e., differing number of detector nights)
[c] unweighted estimate (i.e., total calls for all detectors/total detector-nights).

Minutes of bat activity, defined as the number of minutes during a night that contained one or more bat calls, were also tabulated for the two detectors (Table 2). The number of bat activity minutes averaged approximately 18 minutes per night across both detectors during the monitoring period (Table 2). Consistent with total call counts, the number of nightly minutes with bat activity was greater at station Kam1, representing about 61% of the bat activity minutes recorded, compared to station Kam2 (Table 2)

Table 2. Minutes of the night with bat detections during acoustic surveys at two stations within the Auwahi Wind Energy Project's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–June 22, 2022.

Station	Associated Habitat Feature	Total Detector-Nights	Total Minutes with Bat Calls	Average Minutes per Night with Bat Calls[a]	Average % of Nightly Minutes with Bat Calls[a]
Kam1	Pasture	408	9,114	22.3	3.2
Kam2	Pasture	407	5,752	14.1	2.0
Total		**815**	**14,866**	**18.2**	**2.6**

[a] unweighted estimates (e.g., total minutes with calls/total minutes available).

Feeding Buzz Calls

Feeding buzzes were recorded at both detectors, totaling 22 feeding buzz calls (Table 3). Although feeding buzzes were recorded at both detectors, 73% of all feeding buzzes were recorded at Kam1 (Table 3). Feeding buzz abundance averaged 0.03 buzzes/detector night and the feeding buzz nightly detection rate was consistently low, averaging 0.03 for the two stations (Table 3).

Table 3. Results for feeding buzz detections during acoustic surveys at two stations within the Auwahi Wind Energy Project's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–June 22, 2022.

Station	Associated Habitat Feature	# of Feeding Buzzes	Detector-Nights with Feeding Buzz Calls	Total Detector-Nights	Feeding Buzz Abundance[a] (Feeding Buzzes/ Detector-Nights)	Feeding Buzz Nightly Detection (Nights Feeding Buzzes detected/Total Detector-Nights[b])
Kam1	Pasture	16	15	408	0.04 ± 0.01	0.04
Kam2	Pasture	6	6	407	0.01 ± 0.01	0.01
Total		**22**	**21**	**815**	**0.03 ± 0.01**	**0.03**[c]

[a] ± bootstrapped standard error.
[b] average of abundance estimates for individual detectors to account for unbalanced design (i.e., differing number of detector nights)
[c] unweighted estimate (i.e., total calls for all detectors/total detector-nights).

DISCUSSION

HAHOBA were regularly active in the two areas sampled within/near the Tier 5 Mitigation Site during the monitoring period, with bat activity recorded on most (94–96%) of the nights sampled. However, although bats were present on most nights, activity rates varied substantially throughout the year (Figure 3). Activity rates at both detector locations peaked in early August, when call abundance regularly exceeded 100 calls/detector night at station Kam1, with some nights 10-fold greater than the average for the monitoring period (Figure 3). Call abundance at Kam2 was lower than at Kam1 during this peak period, but was still well above the yearlong average (Figure 3). Call abundance rates were lowest during the late winter, from mid-February through early April (Figure 3).

The early August peak in bat activity was also evident in the summary of bat activity minutes for the study period (Figure 4). In addition to the seasonal peak in activity, the minute-by-minute analysis also illustrates a temporal pattern in activity during the night relative to sunset. During the peak activity period in early August, activity minutes were greatest during the early hours of the night, whereas activity was somewhat more widespread throughout the night during other times of the year (e.g., January–April; Figure 4).t

Bat activity at the two acoustic stations in and near the Tier 5 mitigation site was moderate and consistent with rates at mid-elevations detectors proximal to mesic forest patches in Auwahi's Tier 4 mitigation site (Thompson and Hammond-Rendon 2022), as well as mid-upper elevation sites sampled during a broader study on the leeward slopes of Haleakala (Thompson and Starcevich 2021b). This baseline acoustic monitoring data will form the basis for future monitoring efforts in the Tier 5 Mitigation Site. Ongoing monitoring at these two stations, along with monitoring at an additional 10-15 detectors to be deployed in 2023, will provide additional insight into the spatial and temporal use of the Mitigation Site by bats and trends in activity rates over time will be used to assess the effectiveness of habitat mitigation activities to be implemented over the coming years.

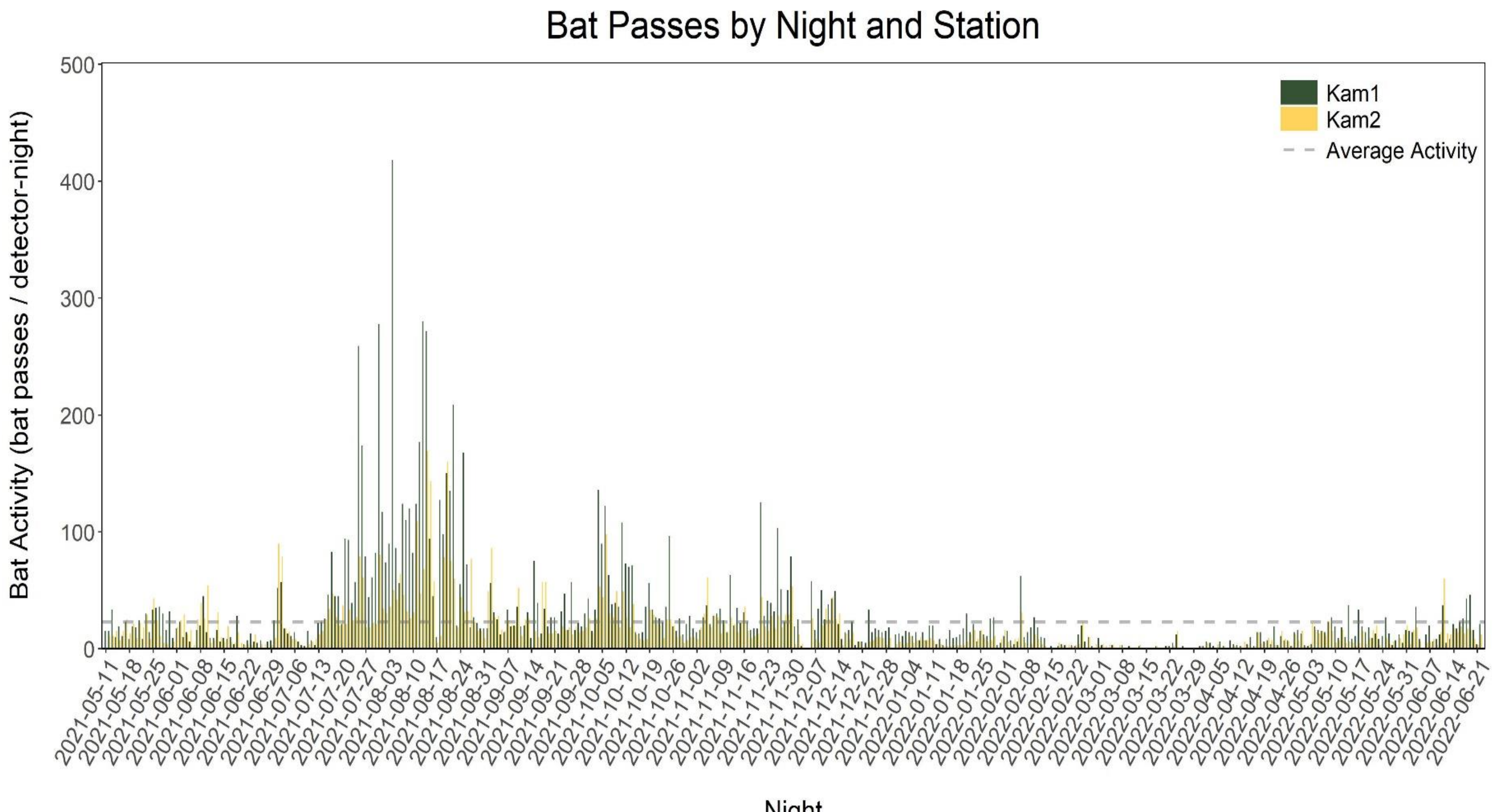

Figure 3. Call abundance (bat calls/detector night) by night and station based on acoustic surveys conducted from May 11, 2021–June 22, 2022 at two sampling stations within the Auwahi Wind Energy Project's Tier 5 mitigation area, Maui, Hawaii.

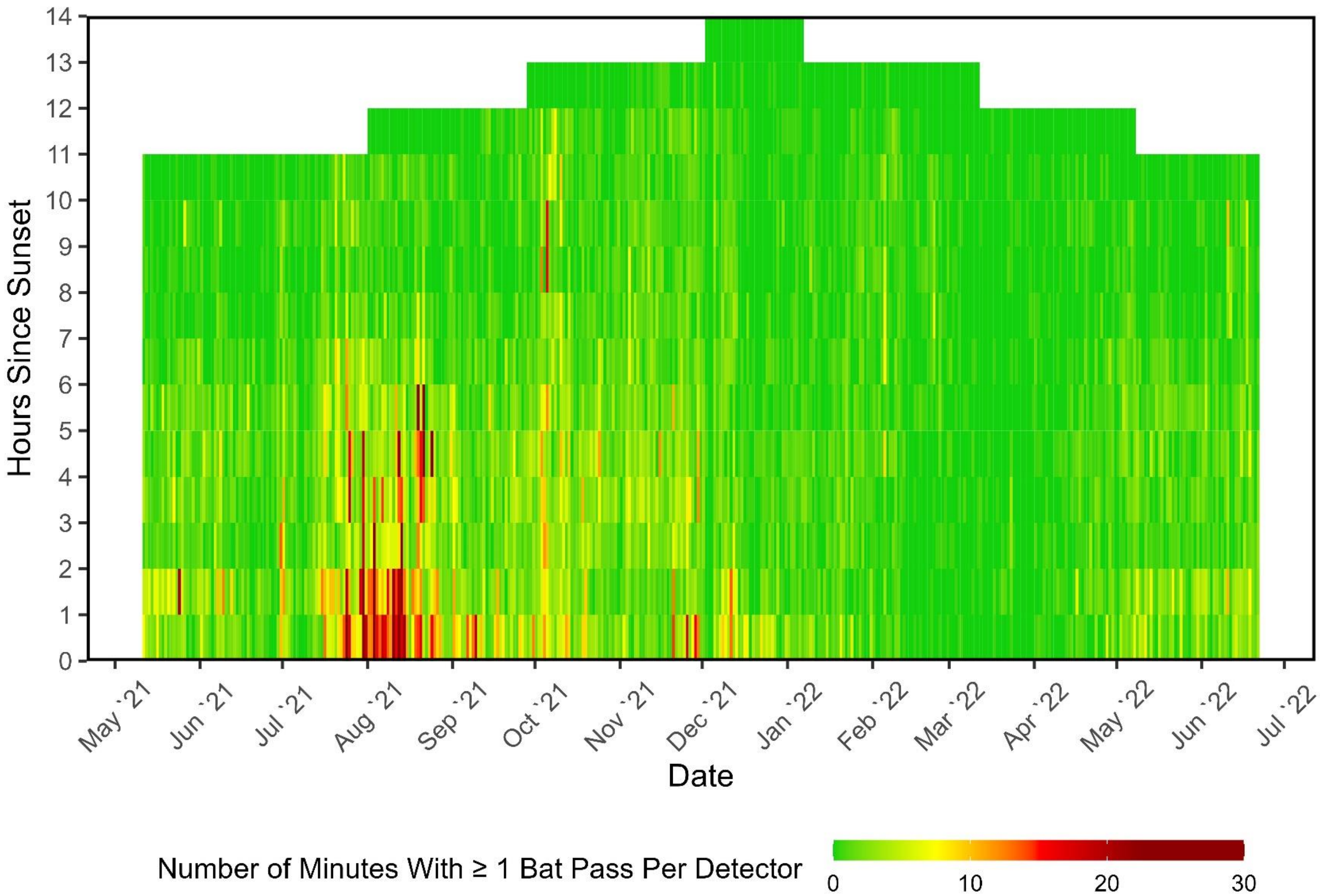

Figure 4. Bat activity patterns relative to sunset (hour zero) illustrated by the number of minutes with one or more bat calls summed across two acoustic sampling stations within the Auwahi Wind Energy Project's Tier 5 mitigation area from May 11, 2021–June 22, 2022, Maui, Hawaii

REFERENCES

Tetra Tech. 2022. Draft Hawaiian Hoary Bat Tier 5 and Tier 6 Site-Specific Mitigation Implementation Plan. Prepared for Auwahi Wind. Prepared by Tetra Tech. April 2022.

Thompson, J., and K. Hammond-Rendon. 2022. Tier 4 Bat Mitigation Monitoring: 2-Year Baseline Monitoring Summary for February 2020–March 2022. Technical Memorandum prepared for Auwahi Wind. Prepared by Western EcoSystems Technology, Inc. September 6, 2022.

Thompson, J., and L.A. Starcevich. 2021a. Hawaiian hoary bat distribution and occupancy study; Leeward Haleakala, Maui Hawaii. Final Report. Unpublished report prepared by Western EcoSystems Technology, Inc. for AEP Wind Holdings LLC. July 30, 2021. 26 pp.

Thompson, J., and L.A. Starcevich. 2021b. Oahu Hawaiian hoary bat occupancy and distribution study; project update and third year analysis: Prepared for Hawaii Endangered Species Committee. Prepared by Western EcoSystems Technology, Inc. May 28, 2021. 44 pp.

Attachment 9

FY 2024 Annual Work Plan and Timeline

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			2023						2024					
			July	**August**	**September**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**
PCMM		Fatality Searches	Weekly Canine-Assisted Searches											
		Searcher Efficiency Trials	Quarterly Trials											
		Carcass Persistence Trials	Quarterly Trials											
		Predator Control	Weekly Checks											
HAPE		HAPE Monitoring	Monthly Monitoring											
		Predator Control (Trap Checks and Maintenance)	Monthly Checks											
		Predator Assessment (Game Cameras Only)	Monthly Reviews											
		Reconyx Game Cameras Remote Monitoring	Monthly Reviews											
Bat	**Tier 1**	Vegetation Monitoring and Invasive Species Control	Targeted Weed Control											
	Tier 1 & 4	Ungulate Control	Quarterly Fence Inspection											
		Conservation Easement							Submit Annual Report to HILT					
		Barbed Wire Removal	Coordinated by Ranch on As Needed Basis											
	Tier 4	Fence Construction	Monthly Status Checks											
		Reforestation	Weekly Koa Outplanting											
		Ponds	Quarterly Checks											
		Water Troughs	Quarterly Checks											
		Accoustic Monitoring	Quarterly Checks											
		Thermal Camera Study (Pond)	Monthly Checks											Report submitted in FY22 HCP annual report
		Insect Monitoring	Twice Yearly Checks											
	Tier 5	Baseline Acoustic Monitoring of Kamehamenui Forest Reserve										Quarterly Checks		
		Pond Construction											Pond Constructed	
Reporting		ITP & ITL Conditions		Annual HCP Report Submitted			HCP FYQ1 Update Submitted		Incidental Take Summary Tables Submitted	Semiannual Progress Report Submitted			HCP FYQ3 Update Submitted	

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Attachment 10

FY 2023 Expenditures for HCP Implementation

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	Tier, Ongoing, or One-time	Event	Proposed Costs	Total Costs Incurred to Date (through June 2023)	Costs Incurred FY 13 (July 1, 2012 - June 30, 2013)	Costs Incurred FY 14 (July 1, 2013 -June 30, 2014)	Costs Incurred FY 15 (July 1, 2014 -June 30, 2015)	Costs Incurred FY 16 (July 1, 2015 -June 30, 2016)	Costs Incurred FY 17 (July 1, 2016 -June 30, 2017)	Costs Incurred FY 18 (July 1, 2017 - June 30, 2018)	Costs Incurred FY 19 (July 1, 2018 - June 30, 2019)	Costs Incurred FY 20 (July 1, 2019 - June 30, 2020)	Costs Incurred FY 21 (July 1, 2020 - June 30, 2021)	Costs Incurred FY 22 (July 1, 2021 - June 30, 2022)	Costs Incurred FY 23 (July 1, 2022 - June 30, 2023)
General Measures	Ongoing	Wildlife Education and Incidental Reporting Program	$5,000	$4,667	$3,000	$1,500	$167	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Ongoing	Downed Wildlife Post-Construction Monitoring and Reporting and Mitigation Monitoring	$1,810,000	$1,333,130	$100,000	$185,145	$152,901	$108,727	$96,700	$140,167	$154,185	$176,497	$90,225	$128,583	XX
	Ongoing	*DOFAW Compliance Monitoring (only if needed)	$200,000	$44,758	N/A	N/A	$2,423	N/A	4600	$8,100	$15,600	$7,800	$2,775	$3,460	XX
		Subtotal General Measures	*$2,015,000*	*$1,379,555*	*$103,000*	*$186,645*	*$155,491*	*$108,727*	*$101,300*	*$145,267*	*$169,785*	*$184,297*	*$93,000*	*$132,043*	*XX*
Hawaiian Hoary Bat	Tier 1	Retrofit fencing and restoration measures at the Waihou Mitigation Project	$522,000	$1,111,589	$314,900	$63,173	$128,410	$149,833	$126,463	$124,852	$137,337	$36,937	$26,238	$3,446	XX
	Tier 1	Acoustic Monitoring onsite	$40,000	$39,827	$5,000	$8,691	$14,663	$11,473	N/A	N/A	N/A	N/A	N/A	N/A	XX
	Tier 2	Telemetry Research	$250,000	$249,999	N/A	$32,726	$8,308	$142,819	$66,146	N/A	N/A	N/A	N/A	N/A	XX
	Tier 3	USGS Expanded Research	$250,000	$503,853	N/A	$32,726	$8,308	$142,819	$234,360	$81,518	$4,122	N/A	N/A	N/A	XX
	Tier 4	Ulupalakua Ranch Conservation Easement and Related Work	$4,013,047	$1,656,188	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$188,161	$881,452	$586,575	XX
	Ongoing	Minimization Adaptive Management	N/A	$223,615	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$223,615	N/A	N/A	XX
		Subtotal Bats	*$5,075,047*	*$3,785,071*	*$319,900*	*$137,316*	*$159,689*	*$446,944*	*$426,969*	*$206,370*	*$141,459*	*$448,713*	*$907,690*	*$590,021*	*XX*
Hawaiian Petrel	Tier 1	Burrow Monitoring and Predator Control	$550,000	$1,102,004	$214,000	$74,572	$107,743	$56,410	$62,731	$116,885	$187,437	$76,083	$118,037	$88,106	XX
		Subtotal Petrels	*$550,000*	$1,102,104	*$214,000*	*$74,572*	*$107,743*	*$56,410*	*$62,731*	*$116,885*	*$187,437*	*$76,183*	*$118,037*	*$88,106*	*XX*
Nene	One-Time	Research and Management Funding	*$25,000*	$25,000	$25,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	XX
		Subtotal Nene	*$25,000*	*$25,000*	*$25,000*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	N/A	XX
Backburn's Sphinx Moth	One-Time	Restoration of 6 acres of Dryland Forest	$144,000	$144,000	$144,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	XX
		Subtotal Moth	*$144,000*	*$144,000*	*$144,000*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	N/A	XX
		Total HCP-related Expenditures	**$7,809,047**	**$6,435,730**	**$805,900**	**$398,533**	**$422,923**	**$612,081**	**$591,000**	**$468,522**	**$498,681**	**$709,193**	**$1,118,727**	**$810,170**	**XX**

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