Auwahi **Wind**

August 1, 2024

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Via Email

SUBJECT: Auwahi Wind Farm Project Habitat Conservation Plan FY 2024 (Year 12) Annual Report

Dear Ms. Gary and Ms. McEachern:

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, 2023, through June 30, 2024. 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 (808) 633-6509 or via email at gakau@invenergy.com.

Sincerely,

George Akau

Project Biologist/Auwahi Wind Farm

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Auwahi Wind Farm Habitat Conservation Plan FY 2024 Annual Report

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

Submitted To:

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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, which was amended in 2019 (Tetra Tech 2019a), and the associated incidental take permit (ITP; TE64153A-1) from the U.S. Fish and Wildlife Service (USFWS) and amended 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) 2024 (July 1, 2023, to June 30, 2024). 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 2024, standardized carcass searches were performed around all eight turbines 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 2024.

Other permits also required for compliance include a Migratory Bird Special Purpose Utility permit for handling migratory bird carcasses, which was renewed and reissued by USFWS under MBPER9893900 effective April 1, 2024, and a State Protected Wildlife Permit (WL22-03) for handling native bird and bat carcasses, which was renewed and reissued by DOFAW on July 1, 2024, under 240216115307-WILD.

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 each turbine. 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).

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 Downed Wildlife Observations

Twenty-nine fatalities were documented and reported in FY 2024; 21 of these fatalities were documented during standardized carcass searches (within the search area and during a scheduled search) and eight were detected incidentally (outside of the search area or outside of a scheduled search; Table 2-1). Seven of the recorded fatalities were species protected under the Migratory Bird Treaty Act (MBTA). Eleven of the recorded fatalities were Covered Species—all Hawaiian hoary bats (Table 2-1). For each of the protected 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 2024

Species	Legal Status[1]	Found Date	Location (Nearest Turbine)	Type of Detection[2]	Outside Search Area	Outside Scheduled Search
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	8/14/2023	2	Incidental Finding	X	
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	9/18/2023	1	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	9/18/2023	3	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	9/18/2023	7	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	9/25/2023	2	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	9/25/2023	3	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	10/2/2023	1	Carcass Survey		
Eurasian Skylark (*Alauda arvensis*)	MBTA	10/23/2023	8	Carcass Survey		

Species	Legal Status[1]	Found Date	Location (Nearest Turbine)	Type of Detection[2]	Outside Search Area	Outside Scheduled Search
Gray Francolin (*Ortygornis pondicerianus*)	None	12/1/2023	2	Incidental Finding		X
White-tailed Tropicbird (*Phaethon lepturus*)	MBTA	1/29/2024	6	Carcass Survey		
Gray Francolin (*Ortygornis pondicerianus*)	None	1/29/2024	8	Carcass Survey		
Black Francolin (*Francolinus francolinus*)	None	2/5/2024	1	Carcass Survey		
Great Frigatebird (*Fregata minor*)	MBTA	2/5/2024	6	Carcass Survey		
Spotted Dove (*Spilopelia chinensis*)	None	2/12/2024	4	Carcass Survey		
House Sparrow (*Passer domesticus*)	None	2/14/2024	1	Incidental Finding	X	X
Common Myna (*Acridotheres tristis*)	None	3/11/2024	1	Incidental Finding	X	
Eurasian Skylark (*Alauda arvensis*)	MBTA	3/18/2024	3	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	3/25/2024	3	Carcass Survey		
House Sparrow (*Passer domesticus*)	None	3/25/2024	1	Incidental Finding	X	X
House Sparrow (*Passer domesticus*)	None	3/25/2024	1	Incidental Finding	X	X
Western Sandpiper (*Calidris mauri*)	MBTA	4/1/2024	7	Carcass Survey		
Black Francolin (*Francolinus francolinus*)	None	4/1/2024	3	Carcass Survey		
Black Francolin (*Francolinus francolinus*)	None	4/1/2024	4	Carcass Survey		

Species	Legal Status[1]	Found Date	Location (Nearest Turbine)	Type of Detection[2]	Outside Search Area	Outside Scheduled Search
Great Frigatebird (*Fregata minor*)	MBTA	5/2/2024	3	Incidental Finding[3]		X
Cattle Egret (*Bubulcus ibis*)	MBTA	5/3/2024	4	Incidental Finding		X
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	5/6/2024	2	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	5/6/2024	2	Carcass Survey		
Great Frigatebird (*Fregata minor*)	MBTA	5/20/2024	2	Carcass Survey		
Zebra Dove (*Geopelia striata*)	None	6/3/2024	2	Carcass Survey		
Hawaiian Hoary Bat (*Lasiurus semotus*)	T&E	6/10/2024	8	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 .
3. This observation was not a fatality, but rather a recovered injured bird that was taken to the Makawao Veterinary Hospital.

2.3 Carcass Persistence Trials

Sixty-Eight CPTs were conducted across quarterly intervals during FY 2024 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*) and black francolins (*Francolinus francolinus*) 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 2024 (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 53 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 0.886 in FY 2024 (Table 2-2). The probability that a large bird carcass would persist until the next search was 0.946 in FY 2024 (Table 2-2).

Table 2-2. Carcass Persistence Estimates for Systematic Searches in FY 2024

Carcass Size Class	N	Probability of Carcass Persistence until Next Search	95 Percent Confidence Interval	Search Interval (days)
Bats	47	0.886	[0.816, 0.942]	7
Large Birds	21	0.946	[0.899, 0.972]	7

2.4 Searcher Efficiency

Fifty-seven SEEF trials were conducted during FY 2024 (Table 2-3). 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 2024, 38 SEEF trials were performed for bats and 19 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 2024

Carcass Size Class	Search Method	Carcasses Available	Carcasses Found	Average Searcher Efficiency	95 Percent Confidence Interval
Bats	Canine	38	38	1.000	[0.936, 1.000]
Large birds	Canine	19	19	1.000	[0.878, 1.000]

2.5 Take Estimates

2.5.1 Direct Take Estimates

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 the EoA to model past Project take using PCMM data collected over the past 11 years for the Hawaiian hoary bat and Hawaiian petrel (Table 2-4; Attachment 1). To date no Hawaiian goose fatalities have been observed, so no take estimate has been created for the Hawaiian goose. 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, 2024, through June 30, 2024, representing 2024 (Year 12). Therefore, input values differ from those reported for the full FY 2024 in the sections above.

Table 2-4. Summary of PCMM Data at the Project, From the Start of the Project through June 2024 (2013–2024)

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	0.47	0.57	0.28	8	1 (0.47)
2014	No	No	4	0.94	5	0.74	0.52	0.55	16	1 (0.74)
2015	Yes	No	1	0.76	3	0.76	0.68	0.45	18	1 (0.74)
2016	Yes	No	7	0.76	3	0.86	0.69	0.55	34	4 (3.03)
2017[5]	Yes	No	3	0.76	3–4	0.91	0.67	0.59	39	5 (4.25)
2018	Yes	No	1	0.76	3–7	0.70	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	5	0.77	7	0.93	1.00	0.71	59	7 (6.03)
2021	Yes	Yes	5	0.77	7	0.87	0.97	0.66	67	7 (6.25)
2022	Yes	Yes	5	0.77	7	0.90	1.00	0.69	74	8 (7.45)
2023	Yes	Yes	8	0.77	7	0.87	1.00	0.66	88	8 (7.90)
2024[6]	Yes	Yes	4	0.77	7	0.86	1.00	0.65	94	9(8.44)
Hawaiian Petrel										
2013	No	No	0	0.91	9	0.79	0.74	0.66	0	0[7]
2014	No	No	1	0.91	5	1.00	0.75	0.84	2	1 (0.19)[7]
2015	Yes	No	0	0.56	3	1.00	0.89	0.55	2	1 (0.19)[7]
2016	Yes	No	0	0.56	3	0.96	0.95	0.48	3	1 (0.19)[7]
2017	Yes	No	0	0.56	3	1.00	0.97	0.55	3	1 (0.19)[7]
2018	Yes	No	0	0.56	7	1.00	1.00	0.55	3	1 (0.38)[7]
2019	Yes	Yes	0	0.54	7	1.00	1.00	0.53	3	1 (0.38)[7]
2020	Yes	Yes	0	0.54	7	1.00	1.00	0.54	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	0.98	1.00	0.53	3	1 (0.38)[7]
2023	Yes	Yes	0	0.54	7	0.98	1.00	0.52	3	1 (0.38)[7]
2024[6]	Yes	Yes	0	0.54	7	0.94	1.00	0.50	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 2024 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 51 bat fatalities detected during fatality searches and 12 fatalities detected incidentally during 11.5 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 94 Hawaiian hoary bats. Based on results from the EoA, up to 31 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 11.5 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 Estimates

It is assumed that take of an adult bird or female 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 the 63 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 31 unknown sex bats. Indirect take was estimated as 8.44 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 based on monitoring data collected to date (as calculated using EoA) is estimated as 161 bats (interquartile range: 151 to 171 bats) in the last year of expected operations, 2032.

The estimated Baseline Fatality Rate calculated by EoA is 7.67 (95-percent confidence interval, 5.71 to 9.93), 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]	7.67
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 78 contractors and new staff in FY 2024.

2.8 Avoidance and Minimization

Avoidance and minimization measures outlined in the HCP continue to be implemented in FY 2024. 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, in June of 2020 Auwahi Wind installed NRG ultrasonic acoustic deterrents at all Project turbines. 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 investigated additional minimization measures and submitted a revised Adaptive Management Plan for review in March 2024, see Attachment 3. The meteorological tower was taken down at the site as an adaptive management action in February 2023. The bat fatality rate will be re-evaluated in February 2025 to assess the effectiveness of this action. 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 2024, 87 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 2024. The presence of BSM was detected during monthly surveys at the Project in FY 2024, but no translocations of BSM were necessary.

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 2019b). Ongoing mitigation efforts by Auwahi Wind are for the Hawaiian petrel and Hawaiian bat and described below.

3.1 Hawaiian Petrel Mitigation

Auwahi Wind continues to implement Hawaiian Petrel Mitigation as outlined in the HCP. In the 2023 management season, 79 burrows were protected, and 30 Hawaiian petrel chicks successfully fledged from the Kahikinui Petrel Management Area (PMA). Results of the 2023 management season are reported in FY 2024 since the management season splits both fiscal years. 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 2023 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 37 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).

Monthly visits to monitor burrow activity began on January 10, 2023. Monitoring of active burrows ended on November 27, 2023, at which time all the burrows had ceased to be active. Of the 79 petrel burrows monitored, 37 showed signs of activity during the breeding season, and 30 burrows were active throughout the breeding season (see Auwahi Wind FY2017 Attachment 2, Table 1 for definitions). By the end of the breeding season, 30 burrows had successfully fledged a chick. The remaining 7 burrows that were active either failed or showed signs of occupation or prospecting by a non-breeder. The number of consistently active burrows has remained relatively constant across all years monitored, with the total number of active burrows ranging between 25 to 37.

Two Hawaiian petrel carcasses were incidentally found at the Kahikinui PMA during the 2023 management season. Both carcasses were found on November 22, 2023, and were in the later stages of decomposition. One was an adult that showed signs of predation and the other was a juvenile with no signs of predation. Predators were observed at burrows in the 2023 management season, although no predation was documented on camera. Additional foothold traps were deployed at Kahikinui PMA in response to the observed predation event.

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 35 DOC250 kill traps, 39 Goodnature A24 traps, 8 Victor foothold traps (equipped with Reconyx cellular cameras), and 36 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 2023 management season included 7 rats and 32 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 79 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 and 3 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, so details are not provided here (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 1 through 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. Tier 5 mitigation planning is underway, and Auwahi Wind continues to work with USFWS and DOFAW staff to finalize the program.

3.2.1 Tier 1 Mitigation

Auwahi Wind is in its 9th 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. No repairs to the 2.4-meter-tall ungulate exclusion fence surrounding the parcel were needed in FY 2024; the parcel remains ungulate-free. Other management activities in FY 2024 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 2024 identified storm damage to the roads that access the fence, but there was no damage to the fences themselves. Fallen trees were removed from the roads to access the mitigation sites. Ungulates were not observed within the mitigation area in FY 2024.

Vegetation management of the restoration site performed in FY 2024 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.

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. Quarterly inspections, maintenance, and improvements to the fences occurred in FY 2024. In addition to quarterly inspections, supplemental surveys are also conducted using a DJI drone after major weather events. A total of 154 acres have been planted with approximately 7,500 native seedlings within the fenced areas through FY 2024. 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 barbed wire 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 2024. Three malaise traps were checked semi-annually in FY 2024. A complete report of the monitoring can be found in Attachment 5. Per the HCP Amendment, insect monitoring is schedule to occur in years 0 (baseline) 1, 2, 3, 5, 7, 9, and 11. To date years 1-3 have been completed. Since FY 2025 falls in year 4, no insect monitoring will occur in the upcoming fiscal year. Monitoring will resume in the second quarter of FY 2026.

Acoustic monitoring in the Tier 4 mitigation site is scheduled to occur in years 0 (baseline), 1, 2, 3, 5, 7, 9, and 11. The third year of acoustic monitoring was completed in FY 2024 and an updated report is provided (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 4.

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
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 sixth draft of the Tier 5 Site Specific Mitigation Implementation Plan (SSMIP) for the Hawaiian hoary bat in FY 2024. The first draft of the SSMIP was submitted to DOFAW and USFWS in November of 2021. Auwahi Wind continues to coordinate closely with DOFAW and USFWS in the finalization of the Auwahi Wind Tier 5 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.

3.2.3.1 Baseline Monitoring (Pre-Trigger Baseline Monitoring)

Auwahi Wind deployed two acoustic detectors in May 2021, to gather preliminary baseline information on bat acoustic activity in the proposed Tier 5 mitigation area at Kamehamenui Forest Reserve. Detectors continued to collect data throughout FY 2024 and a report of the second year of monitoring can be found in Attachment 7.

4.0 Adaptive Management

4.1 Post-Construction Mortality Monitoring

Auwahi Wind investigated bat fatality events at Project turbines in FY 2024. 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 7.67 bats per year in this report. As part of understanding adaptive management opportunities 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.

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. The meteorological tower was demolished in February 2023 and the bat fatality rate will be re-evaluated in February 2025. Auwahi Wind continues to investigate additional minimization measures as described in Attachment 3.

Auwahi Wind has not seen a reduction in the fatality rate of Hawaiian hoary bats as a result of installing acoustic deterrents. Contrary to the expectation of a significant reduction in fatality rates after installing acoustic deterrents, Hawaiian hoary bat fatalities have been observed in months where no fatalities have previously been recorded. 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 2024.

6.0 Auwahi Wind Community Involvement

Highlights of Auwahi Winds community involvement in FY 2024 are:

- Provided support to the Maui Nui Seabird Recovery Project with banding of Ua'u kani breeding colonies on Maui.
- Supported DOFAW Maui efforts to monitor bat populations on Maui by loaning them Wildlife Acoustics SM4 bat acoustic detectors. DOFAW Maui Forestry Supervisor was loaned detectors to continue monitoring bat activity on DOFAW lands that were part of the Hawaiian Hoary Bat Distribution and Occupancy Study.
- Participate in Haleakala National Park climate change planning process by evaluating current management goals at Haleakala National Park and providing input on new management, monitoring, and research actions to attain goals.

7.0 Annual Workplan and Schedule

A work plan for FY 2025 is provided in Attachment 8. 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 2024 is provided in Attachment 9. This summary lists costs (including staff labor) that Auwahi Wind has expended toward fulfilling the terms of the HCP for FY 2024, 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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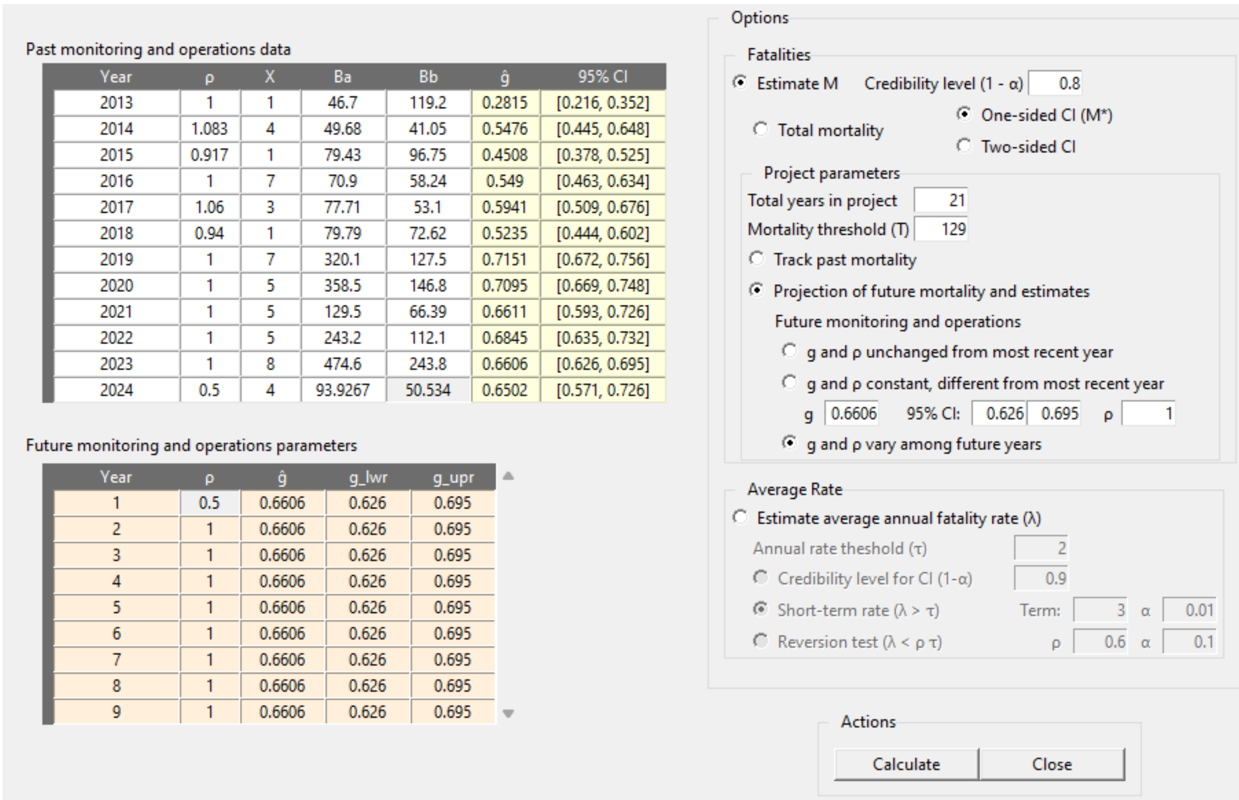
Figure 1. Evidence of Absence Inputs for Hawaiian Hoary Bat Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017).).



Past monitoring and operations data

Year	ρ	X	Ba	Bb	ĝ	95% CI
2013	1	1	46.7	119.2	0.2815	[0.216, 0.352]
2014	1.083	4	49.68	41.05	0.5476	[0.445, 0.648]
2015	0.917	1	79.43	96.75	0.4508	[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	0.5941	[0.509, 0.676]
2018	0.94	1	79.79	72.62	0.5235	[0.444, 0.602]
2019	1	7	320.1	127.5	0.7151	[0.672, 0.756]
2020	1	5	358.5	146.8	0.7095	[0.669, 0.748]
2021	1	5	129.5	66.39	0.6611	[0.593, 0.726]
2022	1	5	243.2	112.1	0.6845	[0.635, 0.732]
2023	1	8	474.6	243.8	0.6606	[0.626, 0.695]
2024	0.5	4	93.9267	50.534	0.6502	[0.571, 0.726]

Future monitoring and operations parameters

Year	ρ	ĝ	g_lwr	g_upr
1	0.5	0.6606	0.626	0.695
2	1	0.6606	0.626	0.695
3	1	0.6606	0.626	0.695
4	1	0.6606	0.626	0.695
5	1	0.6606	0.626	0.695
6	1	0.6606	0.626	0.695
7	1	0.6606	0.626	0.695
8	1	0.6606	0.626	0.695
9	1	0.6606	0.626	0.695

Figure 2. Evidence of Absence Total Mortality Output for Hawaiian Hoary Bat Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017).

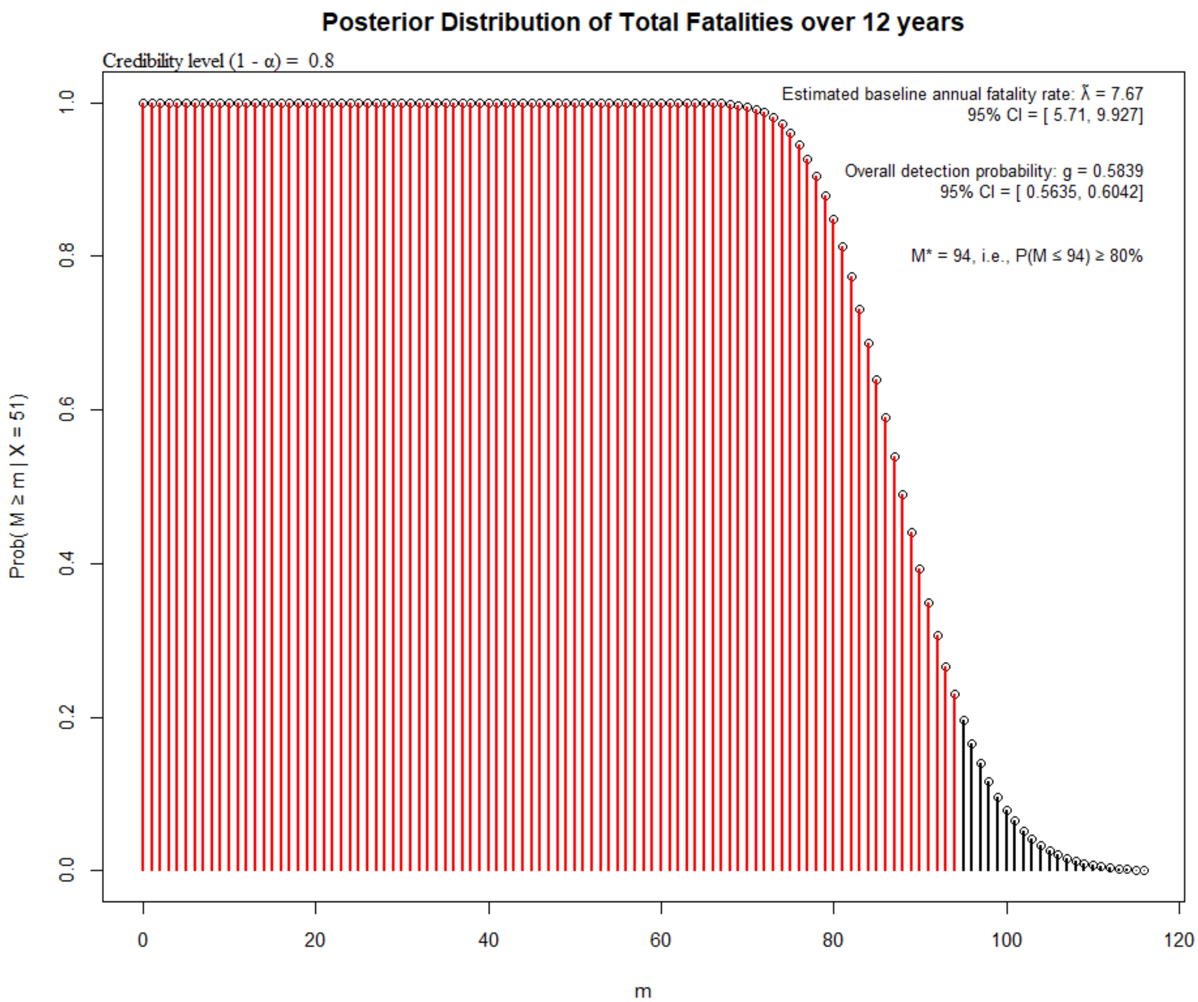


Figure 3. Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Hoary Bat Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017)

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================================================================================
Summary statistics from posterior predictive distributions for 10000 simulated projects
------------------------------------
Estimated annual baseline fatality rate (lambda for rho = 1): mean = 7.67, 95% CI = [5.71, 9.93]

Projected fatalities and fatality estimates...
p(M > Tau within 21 years) = 0.948  [exceedance]
p(M* > Tau within 21 years) = 0.9893  [triggering]
M* based on credibility level 1 - alpha = 0.8

Among projects with triggering (98.91%), mean(M) = 126.82 at time of triggering, with median = 126 and IQR = [120, 133]
Among projects with no triggering (1.09%), mean(M) = 127.53 at end of 21 years, with median = 127 and IQR = [121, 132]

Years of operations without triggering:
 Mean = 17.71, with median =  18 and IQR = [17, 19]

----------------------------------------
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      91.5   98.3    79    81    86    91    97   102   106 |    94    96    96    97    99   103   103
2      99.2  106.1    85    88    93    99   105   111   115 |    98   100   102   105   109   112   116
3     106.8  114.0    92    95   100   106   113   119   123 |   104   106   109   113   118   123   127
4     114.5  121.8    98   101   107   114   121   128   132 |   109   112   115   121   128   133   136
5     122.1  129.6   105   108   114   122   129   137   141 |   115   118   123   128   135   142   147
6     129.8  137.5   111   115   121   129   138   145   150 |   121   124   129   136   145   151   156
7     137.5  145.3   117   121   129   137   146   154   159 |   125   130   137   144   154   162   167
8     145.1  153.2   123   128   136   145   154   163   169 |   131   137   143   152   162   172   177
9     152.8  161.1   129   134   143   152   162   172   178 |   138   143   151   161   171   181   188

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

Governing parameters: Tau = 129, alpha = 0.2

Data for 12 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   8 0.6606 0.6253 0.6959  1  88
          2024   4 0.6502 0.5711 0.7293  0.5  94

Parameters for future monitoring and operations:
  Number of years:  9
 yr    g       glwr   gupr   rho
 13  0.6606  0.6260 0.6950  0.5
 14  0.6606  0.6260 0.6950  1
 15  0.6606  0.6260 0.6950  1
 16  0.6606  0.6260 0.6950  1
 17  0.6606  0.6260 0.6950  1
 18  0.6606  0.6260 0.6950  1
 19  0.6606  0.6260 0.6950  1
 20  0.6606  0.6260 0.6950  1
 21  0.6606  0.6260 0.6950  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 2024 (Dalthorp et al. 2017)

```
Summary statistics for mortality estimates through 12 years
------------------------------------
Results

M* = 94 for 1 - α = 0.8, i.e., P(M <= 94) >= 80%
Estimated overall detection probability: g = 0.584, 95% CI = [0.563, 0.604]
   Ba = 1315.3, Bb = 937.38
Estimated baseline fatality rate (for rho = 1): lambda = 7.673, 95% CI = [5.71, 9.93]

Cumulative Mortality Estimates
                                                 mean
Year           X    g      M*  median  95% CI  lambda        95% CI
2013           1 0.281     8     4     [1, 13]  5.455   [0.3851, 17.29]
2014           5 0.420    16    12     [6, 22]  13.21   [4.524, 26.68]
2015           6 0.429    18    14     [8, 25]  15.22   [5.814, 29.19]
2016          13 0.459    34    28     [19, 42]  29.49   [15.79, 47.55]
2017          16 0.487    38    33     [23, 46]  33.93   [19.46, 52.47]
2018          17 0.493    40    35     [25, 49]  35.55   [20.79, 54.31]
2019          24 0.525    52    46     [35, 60]  46.74   [29.98, 67.25]
2020          29 0.548    59    53     [41, 67]  53.89   [36.11, 75.24]
2021          34 0.560    67    61     [49, 76]   61.6   [42.66, 84.02]
2022          39 0.573    74    68     [55, 83]  68.99   [49.05, 92.33]
2023          47 0.581    88    81     [67, 97]  81.81   [60.08, 106.9]
2024          51 0.584    94    87     [73, 104]  88.24   [65.66, 114.2]


Annual Mortality Estimates
                                                 mean
Year           X    g      M*  median  95% CI  lambda        95% CI
2013           1 0.281     8     4     [1, 13] 5.4550   [0.3851, 17.2900]
2014           4 0.548    10     7     [4, 13] 8.3330   [2.4530, 17.9500]
2015           1 0.451     4     2     [1, 7] 3.3620   [0.2398, 10.5600]
2016           7 0.549    16    13     [8, 21] 13.7900   [5.6610, 25.7100]
2017           3 0.594     7     5     [3, 9] 5.9380   [1.4200, 13.7100]
2018           1 0.524     3     2     [1, 6] 2.8910   [0.2065, 9.0690]
2019           7 0.715    12    10     [7, 14] 10.5000   [4.3740, 19.2900]
2020           5 0.709     9     7     [5, 11] 7.7610   [2.6870, 15.4900]
2021           5 0.661     9     7     [5, 12] 8.3520   [2.8800, 16.7400]
2022           5 0.684     9     7     [5, 11] 8.0510   [2.7840, 16.0900]
2023           8 0.661    14    12     [8, 17] 12.8800   [5.7190, 22.9200]
2024           4 0.650     8     6     [4, 10] 6.9600   [2.0720, 14.8200]


Test of assumed relative weights (rho) and potential bias
              Fitted rho
Assumed rho     95% CI
      1     [0.045, 1.885]
   1.08     [0.302, 2.066]
  0.917     [0.031, 1.265]
      1     [0.767, 2.855]
   1.06     [0.190, 1.640]
   0.94     [0.030, 1.075]
      1     [0.583, 2.299]
      1     [0.348, 1.799]
      1     [0.375, 2.088]
      1     [0.345, 1.953]
      1     [0.683, 2.682]
    0.5     [0.243, 1.754]

p = 0.47977 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 1.033

================================================================================
Input
Year (or period)  rho    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             1.000   8  474.6  243.8 0.661 [0.626, 0.695]
2024             0.500   4  93.93  50.53 0.650 [0.571, 0.726]
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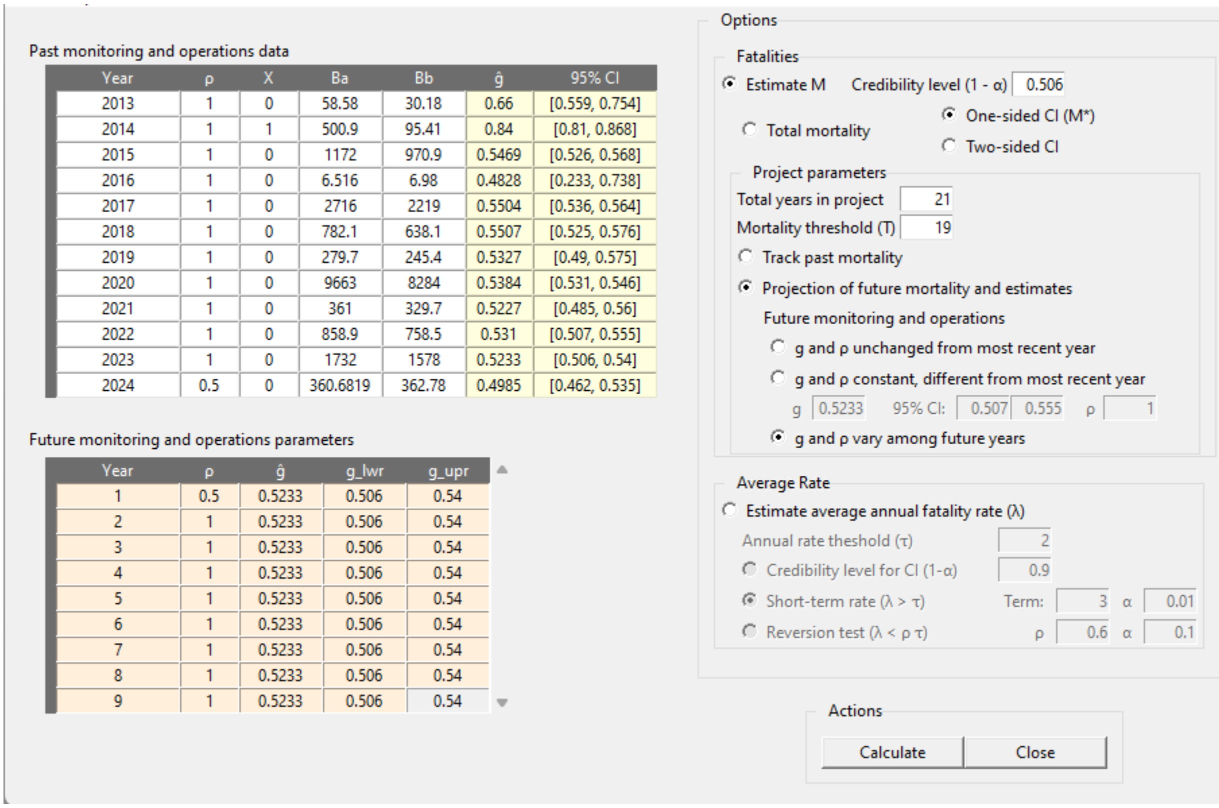
Figure 4. Evidence of Absence Inputs for Hawaiian Petrel Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017)



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	0.5469	[0.526, 0.568]
2016	1	0	6.516	6.98	0.4828	[0.233, 0.738]
2017	1	0	2716	2219	0.5504	[0.536, 0.564]
2018	1	0	782.1	638.1	0.5507	[0.525, 0.576]
2019	1	0	279.7	245.4	0.5327	[0.49, 0.575]
2020	1	0	9663	8284	0.5384	[0.531, 0.546]
2021	1	0	361	329.7	0.5227	[0.485, 0.56]
2022	1	0	858.9	758.5	0.531	[0.507, 0.555]
2023	1	0	1732	1578	0.5233	[0.506, 0.54]
2024	0.5	0	360.6819	362.78	0.4985	[0.462, 0.535]

Future monitoring and operations parameters

Year	ρ	ĝ	g_lwr	g_upr
1	0.5	0.5233	0.506	0.54
2	1	0.5233	0.506	0.54
3	1	0.5233	0.506	0.54
4	1	0.5233	0.506	0.54
5	1	0.5233	0.506	0.54
6	1	0.5233	0.506	0.54
7	1	0.5233	0.506	0.54
8	1	0.5233	0.506	0.54
9	1	0.5233	0.506	0.54

Figure 5. Evidence of Absence Total Mortality Output for Hawaiian Petrel Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017)

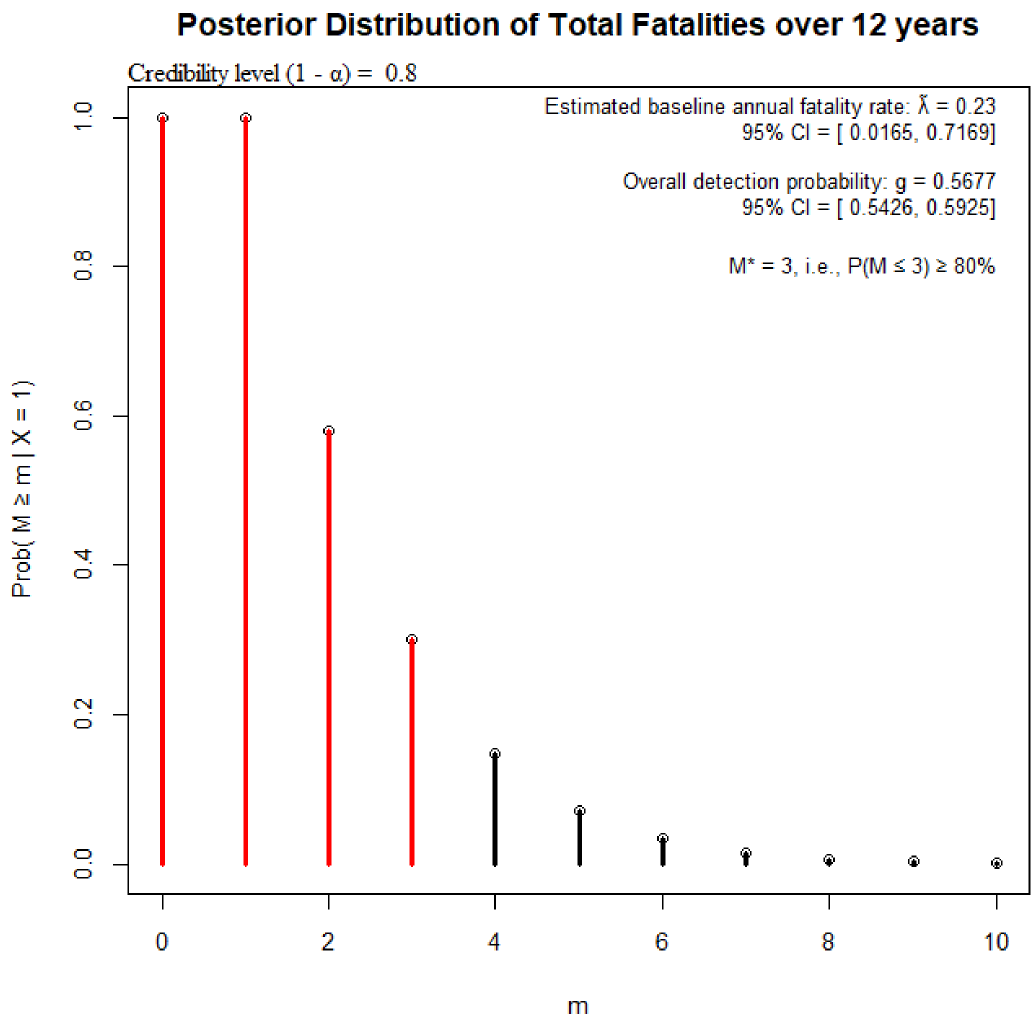


Figure 6. Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Petrel Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017)

```
================================================================================
Summary statistics from posterior predictive distributions for 10000 simulated projects
------------------------------------
Estimated annual baseline fatality rate (lambda for rho = 1): mean = 0.23, 95% CI = [0.0165, 0.717]

Projected fatalities and fatality estimates...
p(M > Tau within 21 years) = 0  [exceedance]
p(M* > Tau within 21 years) = 3e-04  [triggering]
M* based on credibility level 1 - alpha = 0.506

Among projects with triggering (0.03%), mean(M) = 16.00 at time of triggering, with median = 16 and IQR = [14, 16]
Among projects with no triggering (99.97%), mean(M) = 4.08 at end of 21 years, with median = 4 and IQR = [2, 5]

Years of operations without triggering:
 Mean = 21.00, with median =  21 and IQR = [21, 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       2.3    2.1     1     1     1     2     3     4     5 |     2     2     2     2     2     2     4
2       2.5    2.3     1     1     1     2     3     5     6 |     2     2     2     2     2     4     4
3       2.7    2.5     1     1     1     2     4     5     6 |     2     2     2     2     2     4     4
4       3.0    2.8     1     1     2     3     4     5     6 |     2     2     2     2     4     4     5
5       3.2    3.0     1     1     2     3     4     6     7 |     2     2     2     2     4     5     5
6       3.4    3.2     1     1     2     3     4     6     7 |     2     2     2     2     4     5     7
7       3.6    3.4     1     1     2     3     5     7     8 |     2     2     2     2     4     5     7
8       3.9    3.6     1     1     2     3     5     7     8 |     2     2     2     4     4     5     7
9       4.1    3.8     1     1     2     4     5     7     9 |     2     2     2     4     5     7     9

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

Governing parameters: Tau = 19, alpha = 0.494

Data for 12 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   1
           2015   0 0.5469 0.5254 0.5684  1   1
           2016   0 0.4828 0.2203 0.7453  1   2
           2017   0 0.5504 0.5362 0.5645  1   2
           2018   0 0.5507 0.5243 0.5771  1   2
           2019   0 0.5327 0.4892 0.5762  1   2
           2020   0 0.5384 0.5310 0.5459  1   2
           2021   0 0.5227 0.4847 0.5606  1   2
           2022   0 0.5310 0.5062 0.5558  1   2
           2023   0 0.5233 0.5059 0.5406  1   2
           2024   0 0.4985 0.4614 0.5357  0.5   2

Parameters for future monitoring and operations:
  Number of years:  9
 yr    g      glwr   gupr   rho
 13  0.5233  0.5060 0.5400  0.5
 14  0.5233  0.5060 0.5400  1
 15  0.5233  0.5060 0.5400  1
 16  0.5233  0.5060 0.5400  1
 17  0.5233  0.5060 0.5400  1
 18  0.5233  0.5060 0.5400  1
 19  0.5233  0.5060 0.5400  1
 20  0.5233  0.5060 0.5400  1
 21  0.5233  0.5060 0.5400  1

*****************************************************************************************
```

Figure 6 (Continued). Evidence of Absence Cumulative Mortality (Estimated and Projected) Output for Hawaiian Petrel Multi-Year Analysis in FY 2024 (Dalthorp et al. 2017)

```
Summary statistics for mortality estimates through 12 years
------------------------------------
Results

M* = 3 for 1 - α = 0.8, i.e., P(M <= 3) >= 80%
Estimated overall detection probability: g = 0.568, 95% CI = [0.543, 0.593]
   Ba = 858.23, Bb = 653.65
Estimated baseline fatality rate (for rho = 1): lambda = 0.2299, 95% CI = [0.0165, 0.717]

Cumulative Mortality Estimates
                                               mean
Year          X    g     M*  median  95% CI  lambda       95% CI
2013          0 0.660    0     0     [0, 1] 0.7642   [0.0007638, 3.851]
2014          1 0.750    2     1     [1, 3]  2.004   [0.1439, 6.252]
2015          1 0.682    2     1     [1, 4]    2.2   [0.1582, 6.862]
2016          1 0.632    3     2     [1, 4]  2.383   [0.1708, 7.451]
2017          1 0.616    3     2     [1, 4]  2.443   [0.1753, 7.63]
2018          1 0.605    3     2     [1, 5]  2.484   [0.1784, 7.755]
2019          1 0.595    3     2     [1, 5]  2.526   [0.1815, 7.882]
2020          1 0.588    3     2     [1, 5]  2.555   [0.1836, 7.971]
2021          1 0.581    3     2     [1, 5]  2.587   [0.1859, 8.068]
2022          1 0.576    3     2     [1, 5]  2.608   [0.1875, 8.134]
2023          1 0.571    3     2     [1, 5]   2.63   [0.1891, 8.2]
2024          1 0.568    3     2     [1, 5]  2.644   [0.1901, 8.244]


Annual Mortality Estimates
                                               mean
Year          X    g     M*  median  95% CI  lambda       95% CI
2013          0 0.660    0     0     [0, 1] 0.7642   [0.0008, 3.8510]
2014          1 0.840    2     1     [1, 2] 1.7860   [0.1285, 5.5690]
2015          0 0.547    1     0     [0, 2] 0.9145   [0.0009, 4.5960]
2016          0 0.483    1     0     [0, 3] 1.1940   [0.0011, 6.3040]
2017          0 0.550    1     0     [0, 2] 0.9085   [0.0009, 4.5650]
2018          0 0.551    1     0     [0, 2] 0.9085   [0.0009, 4.5660]
2019          0 0.533    1     0     [0, 2] 0.9409   [0.0009, 4.7310]
2020          0 0.538    1     0     [0, 2] 0.9285   [0.0009, 4.6650]
2021          0 0.523    1     0     [0, 2] 0.9583   [0.0010, 4.8180]
2022          0 0.531    1     0     [0, 2] 0.9421   [0.0009, 4.7350]
2023          0 0.523    1     0     [0, 2] 0.9557   [0.0010, 4.8030]
2024          0 0.499    1     0     [0, 2] 1.0050   [0.0010, 5.0520]


Test of assumed relative weights (rho) and potential bias
              Fitted rho
Assumed rho     95% CI
      1     [0.003, 3.396]
      1     [0.136, 5.293]
      1     [0.005, 4.006]
      1     [0.003, 4.813]
      1     [0.004, 3.737]
      1     [0.007, 4.102]
      1     [0.003, 3.908]
      1     [0.003, 3.793]
      1     [0.006, 4.211]
      1     [0.005, 4.412]
      1     [0.005, 3.905]
    0.5     [0.006, 4.834]

p = 0.96689 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 1.019

================================================================================
Input
Year (or period)  rho    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             1.000   0   1732   1578 0.523 [0.506, 0.540]
2024             0.500   0  360.7  362.8 0.499 [0.462, 0.535]
```

Attachment 2

Indirect Take Calculations for Hawaiian Hoary Bat at the Project through FY 2024

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Label	Description	Calendar Year												
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024[1]	Total
A	**Observed Breeding Female Take**	0	0	0	2	2	1	2	1	1	2	0	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	0	**19.80**
C	**Observed Breeding Unknown Sex Take**	0	0	0	0	0	0	0	0	0	0	1	2	**3**
D	**Indirect Take from Observed Breeding Unknown Sex Take (C * 0.43 * 1.8)**	0	0	0	0	0	0	0	0	0.00	0.00	0.78	1.55	**2.33**
E	**All Observed Take (Search and Incidental)**	1	3	2	7	5	3	10	5	6	8	9	4	**63**
F	**Estimated Take Multiplier (94 /63)**	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
G	**Estimated Direct Take (E x F)**	1.49	4.48	2.98	10.44	7.46	4.48	14.92	7.46	8.95	11.94	13.43	5.97	**94.00**
H	**Unobserved Direct Take** (G - E)	0.49	1.48	0.98	3.44	2.46	1.48	4.92	2.46	2.95	3.94	4.43	1.97	**31.00**
I	**Indirect Take Calculated from Unobserved Take (H * 0.43 * 0.25 * 1.8)**	0.10	0.29	0.19	0.67	0.48	0.29	0.96	0.48	0.57	0.76	0.86	0.38	**6.02**
Total Indirect Take (B + D + I; juveniles)														**28.15**
Total Indirect Take (B + D + I)*0.3 (adults)														**8.44**

[1]Total indirect take numbers calculated through June 2024.

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Attachment 3

Auwahi Wind Adaptive Management Plan 2024

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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 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 original AMP went in effect upon permit issuance and has since been superseded by several revisions, including this document (see revision history on signature page below).

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 determine when adaptive management measures may need to be implemented, Auwahi Wind uses Evidence of Absence (EoA) to evaluate the Post- Construction Mortality Monitoring (PCMM) data and calculate the Baseline Fatality Rate (BFR). The BFR is then compared to the TV to determine whether an adaptive management threshold has been met. The TV for the Project is 6.45 bat direct take/year (lambda from EoA) based on analysis presented in Section 7.4.1.1 of the HCP Amendment. The HCP Amendment dictates that these evaluations occur every five years (i.e., 2020, 2025, and 2030). However, since the Project moved into adaptive management beginning in 2020, assessment now occurs more frequently, to determine if adaptive management measures are reducing take.

Additionally, Auwahi Wind tracks the BFR relative to each of the tiers of cumulative 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
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 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.

2.2 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 a living document and will be updated as new information becomes available. Auwahi Wind reviews the current AMP during the annual meeting with USFWS and DOFAW. Prior to the annual meeting, Auwahi Wind reviews and summarizes 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 evaluates 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. As dictated by the HCP this evaluation was to occur in years 2020, 2025, and 2030. Auwahi Wind then compares the BFR to the TV. If adaptive management is triggered, follow up evaluations occur, as described below.

- 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. Since the Project triggered adaptive management in 2020 there have essentially been ongoing re-evaluations to determine if adaptive management actions have resulted in a reduction in take.

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 performs 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
2023	WIS perform thermal monitoring of meteorological tower	WIS document bat activity at met tower

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	Re-evaluate BFR in February 2025
March 2023	Updated AMP (rev 5) provided to USFWS and DOFAW	Investigate additional minimization measures
February 2024	AMP review	BFR 7.44 reported in semi-annual report

3.1 Project Research and Observations to Inform Minimization

Auwahi Wind has and will continue 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 ʻUlupalakua 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.
- WIS detected a bat fatality from data collected at turbine 2 on 10/28/22. The fatality was reported at the very bottom of the rotor sweep (Brogan Morton 2023).

- **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 the 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.
  - Tier 4 acoustic monitoring performed by WEST indicates steady to increasing bat activity in and around the mitigation areas.
  - Tier 5 acoustic monitoring performed by WEST results show high levels of year-round bat activity at the mitigation area.

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).

- A disproportionate number of bat fatalities has been 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 averages 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 was not ready to implement.
- As of September 2023, the Auwahi Wind facility is performing a wholesale analysis of the history of the Project (i.e., above information), Project operational measures, and potential changes to bat minimization options.

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 not observed a decrease in 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 fatality rates at the Project may be related to an ongoing 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 region.

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).
4. Modification to deterrent set up. Adding additional deterrent units to lower rotor swept zone.

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 of 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 to actively investigate 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. 2024 Literature review

In March 2024 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.

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Seewagen, Chad L., Julia Nadeau-Gneckow, Amanda M. Adams. Far-reaching displacement effects of artificial light at night in a North American bat community, Global Ecology and Conservation, Volume 48, 2023, e02729, ISSN 2351-9894, https://doi.org/10.1016/j.gecco.2023.e02729.

Werber, Y., Hareli, G., Yinon, O., Sapir, N. and Yovel, Y. (2023), Drone-mounted audio-visual deterrence of bats: implications for reducing aerial wildlife mortality by wind turbines. Remote Sens Ecol Conserv, 9: 404-419. https://doi.org/10.1002/rse2.316.

Auwahi Wind	Adaptive Management Plan 2024
	REVISION NUMBER: 6
	EFFECTIVE DATE: 3/31/2024
	REVISION DATE: 3/8/2024
	REVIEWED DATE: 3/27/2024
	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
6	2/29/2024	Update on minimization measure timeline and 2024 literature review added	GA

X *Wendy Greene*

Wendy Greene
Director, Environmental Compliance and Strategy

X

DOFAW Protected Species Habitat Conservation Planning

X

USFWS Alternative Energy Program/HCP Conservation Planning

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Attachment 4

Tier 4 Mitigation Checklist

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Auwahi Wind HCP Tier 4 Bat Mitigation Actions	Current Status	FY20-FY24 Total	HCP Total Required	Notes
Provide a copy of the conservation easement to USFWS and DOFAW	Complete	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	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	HILT recorded with State of Hawaii Bureau of Conveyances 12/7/2020
Install Ponds	Complete	2 pond installed	2 ponds installed	1 pond completed in 2020. Second pond completed 3/5/2021
Install acoustic detectors	Complete	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	Strucutres installed in 10 troughs	All troughs (10)	Photos taken for documentation
Consider and install understory with hedgerow canopy	Complete	5 acres planted	None required	Understory species added
Quarterly insect monitoring for the baseline monitoring period	Complete	3 malaise traps checked quarterly	3 malaise traps checked quarterly	Data analyzed. TT report provided
Fence ponds	Complete	2 ponds fenced	2 ponds fenced	Native plant species outplanted within fenced area
Use thermal cameras to document the behavior of bats at ponds and/or water troughs.	Complete	Thermal camera installed at pond	Document the behavior of bats at ponds or troughs	Data collected documenting bat behavior at pond. Data shared with USFWS/DOFAW
Remove barbed wire from the mitigation area	Complete	67 acres of barbed fencing removed	Removal of wire as found	Ranch utilized volunteers to remove barbed wire within mitigation area
Install hedgerow fencing	Complete	311 acres	311 acres	Hedgerow fencing completed and intact.
Install hedgerow plantings	In Progress	154 acres	311 acres	Collecting more diversity of native seeds for nursery to grow
Quarterly detector checks	In Progress, Ongoing	38 acoustic detectors checked	38 acoustic detectors checked quarterly in yrs 0, 1, 2, 3, 5, 7, 9, 11	Detectors checked and data sent to West for analysis. West performed analysis and provided report
Annually analyze acoustic monitoring data to ensure units working properly	In Progress, Ongoing	data from 38 acoustic detectors analyzed	38 acoustic detector data analyzed annually in monitoring years	Repairs and maintenance completed
Quarterly pond monitoring	In Progress, Ongoing	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	fencelines checked	None required	Fencelines checked and intact
Twice annual insect monitoring in years 1, 2, 3, 5, 7, 9, and 11	In Progress, Ongoing	3 malaise traps checked twice annually	3 malaise traps checked twice annually	Tetra tech performed analysis and provided report for years 1,2,3

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Attachment 5

Tier 4 Bat Mitigation Insect Monitoring Results

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TETRA TECH

MEMO

To:	George Akau, Invenergy
Cc:	Brad Romano, Invenergy
From:	Tetra Tech, Inc.
Date:	June 28, 2024
Correspondence #	TTCES-PTLD-2024-051
Subject:	Tier 4 Bat Mitigation: HCP FY 2024 (July1 – June30) 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 in a way which connects areas that provide habitat for the Hawaiian hoary bat. 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 mitigation 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), 2 (July 2022 to June 2023), and 3 (July 2023 to June 2024) 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, the second quarter (September – December) and fourth quarter of Monitoring Year 2, and the second and fourth quarter of Monitoring Year 3. Data collected during the second quarter of Monitoring

Year 3 is not included in this report's analysis due to malfunction of the malaise traps. 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 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, 2, and 3 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, 2, and 3 (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, 2, and 3 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 2024).

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 (Table 1, Figure 1). However, the decline in Insect Capture Rates between Monitoring Year 1 and the baseline year was not statistically significant for either the first quarter ($\underline{t}_{2,12}$ = 1.43, P > 0.194) or the fourth quarter ($\underline{t}_{2,8}$ = 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 ($\underline{t}_{2,12}$ = 0.14, P > 0.891), in Insect 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, increases in Insect Capture Rates were only observed at the pond 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 significantly ($\underline{t}_{2,8}$ = 1.21, P > 0.292). Declines in Insect 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).

Insect Capture Rates significantly increased across pooled sites during the fourth quarter sampling period of Monitoring Year 3 compared to the fourth quarter sampling period of the Baseline

Monitoring Year ($t_{2,8}$ = 2.62, P < 0.04; Table 1, Figure 1). At the site level, increases in Insect Capture Rates were observed at all sites, most notably at the pasture and hedgerow sites (Table 1, Figure 2).

Table 1. Insect Capture Rate During Each Sampling Quarter Between 2021 and 2024

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)	Monitoring Year 3 (July 2023 - June 2024)
Quarter 1 (1 Jul - 31 Aug)	Ponds	0.64 (0.38 - 0.89)	0.25	NA	NA
	Pasture	1.38 (1.08 - 1.69)	0.01	NA	NA
	Hedgerow	0.37 (0.26 - 0.49)	0.3	NA	NA
	All sites	0.69 (0.26 - 1.05)	0.19	NA	NA
Quarter 2 (1 Sep - 12 Dec)	Ponds	0.10 (0.07 - 0.12)	NA	0.22	NA
	Pasture	0.41 (0.27 - 0.42)	NA	0.33	NA
	Hedgerow	0.09 (0.07 - 0.12)	NA	0	NA
	All sites	0.12 (0.09 - 0.15)	NA	0.17	NA
Quarter 3 (13 Dec - 11 Mar)	Ponds	0.13 (0.12 - 0.13)	NA	NA	NA
	Pasture	0.09 (0.09 - 0.09)	NA	NA	NA
	Hedgerow	0.04 (0.03 - 0.04)	NA	NA	NA
	All sites	0.09 (0.07 - 0.11)	NA	NA	NA
Quarter 4 (12 Mar - 30 Jun)	Ponds	0.13 (0.12 - 0.13)	0.12	0.08	0.26
	Pasture	0.20 (0.20 - 0.20)	0.03	0.14	1.84
	Hedgerow	0.10 (0.06 - 0.13)	0.18	0.08	0.94
	All sites	0.13 (0.12 - 0.16)	0.11	0.1	1.01

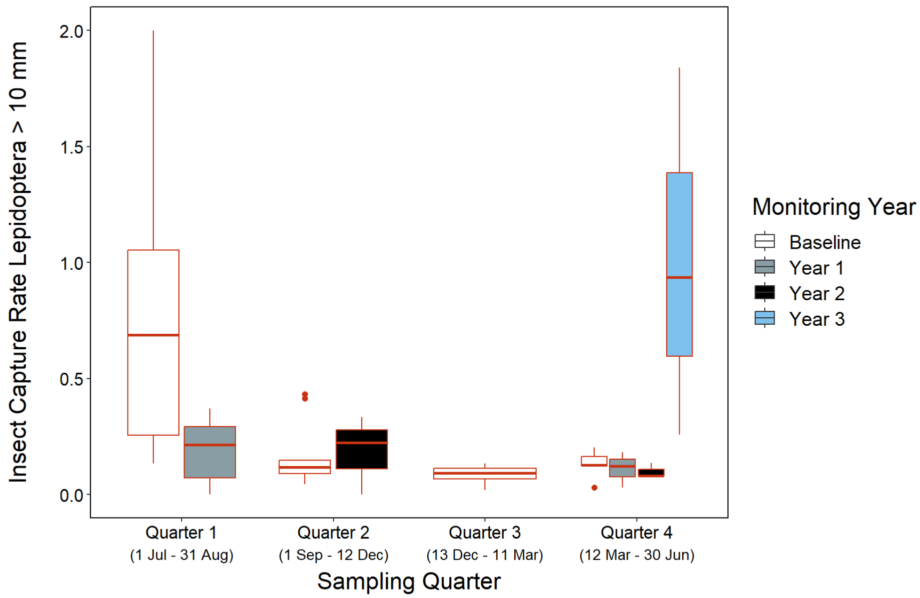

Figure 1. Box-Plot for Insect Capture Rate During Each Quarter Among All Pooled Sites[1]

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

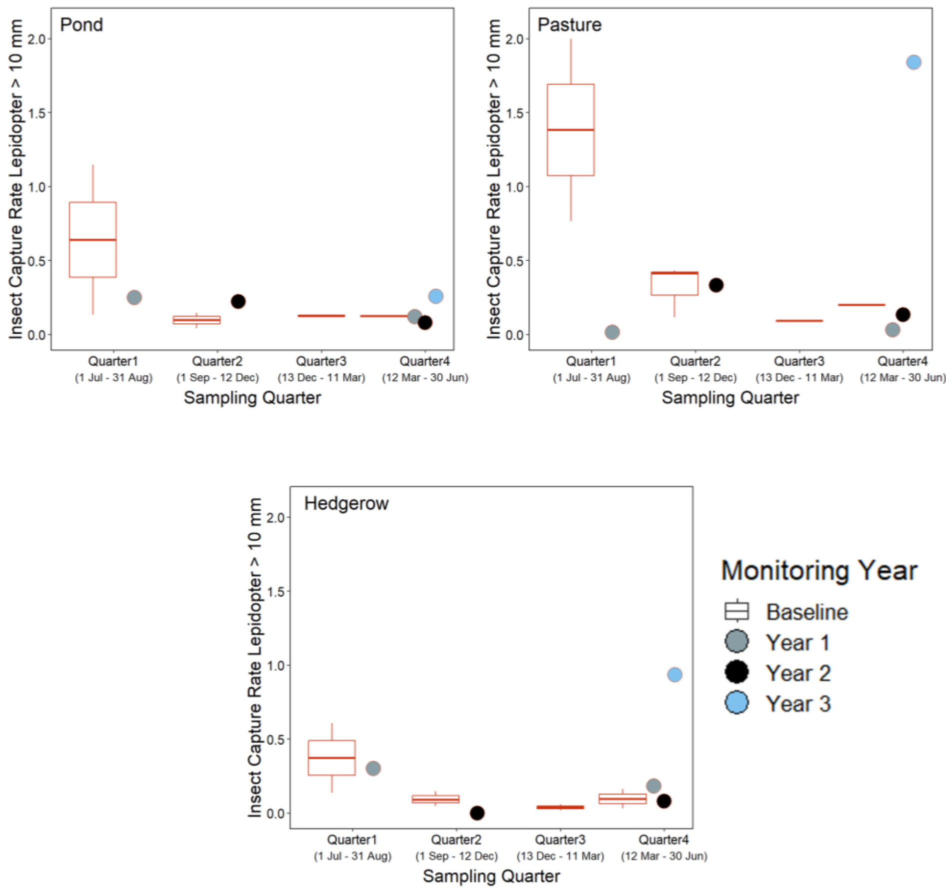

Figure 2. Comparison of Quarterly Insect Capture Rate by Site for Each Monitoring Year

4.0 Future Work

Insect sampling will not be conducted during Monitoring Year 4 (Fiscal Year 2025) and is scheduled to resume in Monitoring Year 5 (Fiscal Year 2026). Insect sampling in Monitoring Year 5 will be conducted twice per year during the second and fourth quarter, and results will continue to be compared to the baseline values established during state Fiscal Year 2021 sampling to inform adaptive mitigation measures, if required at the conclusion of the monitoring period.

5.0 References

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R Core Team 2024 R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. www.R-project.org/.

Attachment 6

Tier 4 Bat Mitigation Monitoring: Interim Monitoring Summary for February 2020–April 2024

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Tier 4 Bat Mitigation Monitoring: Interim Monitoring Summary for February 2020 – April 2024

Auwahi Wind Energy LLC
Maui, Hawaii

Prepared by:
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July 2024

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Nicholas Faraco-Hadlock	Statistical Analysis
Andy Valencia	Technical Editor

REPORT REFERENCE

Thompson, J. and K. Hammond-Rendon. 2024. Tier 4 Bat Mitigation Monitoring: Interim Monitoring Summary for February 2020 – April 2024. Prepared for Auwahi Wind LLC, Chicago, Illinois. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. July 25, 2024. 14 pages + appendices.

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FIGURES

APPENDICES

1 INTRODUCTION

Auwahi Wind Energy LLC (Auwahi Wind) established a Tier 4 Mitigation Site (Mitigation Site) to mitigate the take of Hawaiian hoary bat (*Aeorestes semotus*; HAHOBA) at their Auwahi Wind Energy Facility (Project) in Maui, Hawaii. 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 objective of the monitoring is to document changes in HAHOBA activity over time using designated call metrics (call abundance and call nightly detection) to assess the impact of management actions on bat activity within the Mitigation Site. In spring 2020, Auwahi Wind deployed acoustic detectors to begin baseline (Year 0) monitoring of HAHOBA activity in and adjacent the Mitigation Site (Figure 1.1).

Mitigation measures, including the installation of two new ponds and planting of some hedgerows, have been partially implemented and are ongoing; however, the measures have not matured to a point likely to have a significant impact on bat use. For instance, the ponds that were newly constructed approximately halfway through Year 1 have yet to accumulate any bottom silt and remain largely devoid of vegetation. As such, these ponds provide new water sources for drinking, but are unlikely to provide a significant amount of insect activity compared to the other pond (near site AW237) that was constructed many years ago and is fully vegetated and has a bottom of silt versus the still exposed liner of the newly constructed pond. Acoustic data is being collected at one of the two newly constructed ponds (Pond1) and will ideally track the stages of pond maturation and provide insight into how long such features need to be in place prior to providing the desired net benefit to bats.

Similarly, planted hedgerows are only 1–2 years of age and are generally in the range of 10-foot tall or less. At this point, they have yet to mature to a point that provides roost sites or substantial relief from strong winds that may enhance foraging opportunities. Detectors associated with the hedgerows were still classified as pasture sites in this data summary. As these sites mature and more data are collected, they will be reclassified as hedgerow sites. At that time, it will be possible to assess changes in bat activity metrics at specific locations that have transitioned from one feature type (e.g., pasture) to another (e.g., hedgerow).

This interim report provides a summary of the cumulative dataset for acoustic data collected and analyzed for the period spanning February 26, 2020, through March 30, 2023, although limited data are provided for four detectors through April 16, 2024.

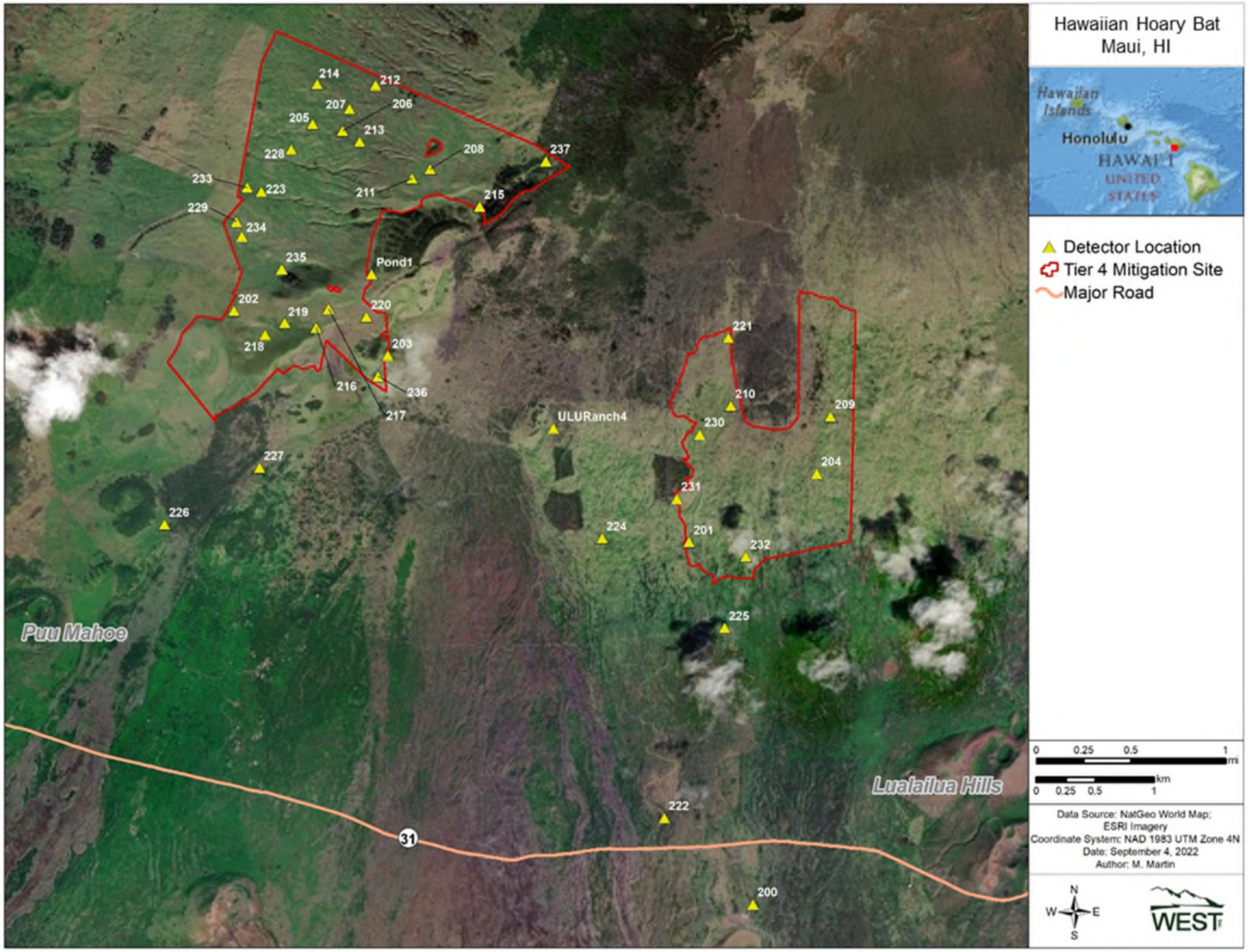

Figure 1.1. Location of the Auwahi Wind Tier 4 Hawaiian hoary bat Mitigation Site and acoustic bat detector locations, Maui, Hawaii.

2 ENVIRONMENTAL SETTING

The Mitigation Site consists of two parcels of Ulupalakua ranch lands totaling 1,752 acres on the leeward slopes of Haleakala, Maui, Hawaii (Figure 1.1). The Mitigation Site sits at mid- to upper elevations ranging from approximately 3,600 to 5,000 feet and is protected by a Hawaiian Islands Land Trust bat conservation easement. The two sites consist primarily of open grasslands used for cattle grazing (i.e., pasture), with a few small forest patches, otherwise trees are rare in the western parcel and widely dispersed in the eastern parcel (Figure 1.1). Perennial water is scarce within the Mitigation Site, with primary water sources consisting of Waihou Spring, a few stock ponds, seasonal water troughs for cattle, and small intermittent streams.

3 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 1.1); however, ULURanch4 suffered equipment issues that compromised the data and has been excluded from the analysis and 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-meter 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). Detectors were subset into three habitat feature subtypes for future management activities within the Mitigation Site: pasture, hedgerow, and water trough/pond. Detectors were also placed outside of the Mitigation Site and distributed among similar habitat features (i.e., pasture, trough, and hedgerow) to serve as controls when assessing trends in bat activity within the Mitigation Site following mitigation activities. The Pond1 detector was added to the sample at a newly constructed pond within the Mitigation Site in 2021, part way through Year 1 of monitoring.

A baseline habitat condition was identified for each detector station. The baseline (i.e., Year 0) conditions for the 39 sampling stations included 25 pasture, 12 trough/pond locations (10 troughs and two ponds), and two hedgerows (Appendix A). As mitigation activities are completed and hedgerows are installed and mature, it is anticipated that pasture stations located within 30 feet of installed features will transition to hedgerow stations for future analyses. 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 HCP (Tetra Tech 2019).

Auwahi Wind provided all acoustic monitoring equipment and associated accessories (e.g., microphones, solar panels, and batteries) and managed all aspects of the field study, including the ongoing maintenance of the detectors and data retrieval. Once collected in the field, Auwahi Wind transferred the raw data to Western EcoSystems Technology, Inc. (WEST) for quality assurance, quality control, and analysis.

Once data was received from Auwahi Wind, WEST reviewed and verified its completeness and conducted 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 Pro 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 the 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, determine 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). To ensure consistent organization and comparability of data across years and studies, data handling procedures were consistent with those used by WEST during review of data collected during the first 2 years of monitoring and other acoustic studies conducted by WEST in Hawaii (e.g., Leeward Haleakala and Oahu occupancy studies; Thompson and Starcevich 2021, 2022).

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 (a detector-night was defined as one detector operating for one night);
2. **Call nightly detection** = total nights with bat calls/total active detector-nights; and
3. **Activity minutes per night** = total number of minutes during an active detector-night with at least one bat call.

A second set of metrics was generated based on feeding buzzes only, with a feeding buzz defined as the tightly spaced series of sequential echolocation pulses used to home in on prey and indicative of active feeding:

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.

Call abundance and nightly detection for all calls and feeding buzzes are the metrics identified in the HCP (Tetra Tech 2019) for monitoring purposes. Activity minutes per night was not included as a required monitoring metric in the HCP but has been included here based on additional discussion and request from the Hawaii Endangered Species Recovery Committee (ESRC). Data are summarized for the entirety of the monitoring period (i.e., cumulative dataset) and by year for comparison purposes. Years were defined as years 0–3, with Year 0 being the initial year of monitoring. Data from Year 3 (4^{th} year of monitoring) are presented but are not used in comparisons due to the sparseness of the Year 3 dataset.

4 RESULTS AND DISCUSSION

Bat calls were recorded at all 39 detectors during the February 26, 2020, through April 16, 2024, sampling period. Sampling effort exceeded 41,000 detector nights during the period and more than 461,000 bat calls were recorded. However, due primarily to rapidly escalating microphone

failures in late 2022 that continued through much of 2023, many recorded detector nights resulted in very low or zero bat detections towards the end of Year 2 and throughout Year 3 (Table 4.1; Appendix A). Due to availability issues from the supplier, microphones were not readily available and were not swapped out entirely until early 2024. Given the data quality issues, annual data from years 2 and 3 are only presented for the detectors that appeared to be properly recording bat calls and were functional for a majority of the sampling period (greater than 180 days each year). While all detectors were included for Year 0 and Year 1, only 24 detectors were included in Year 2, and only four detectors in Year 3 (Table 4.1). Data for Year 3 are included in tables and appendices but are not appropriate for annual comparisons given the paucity of data (i.e., data was limited to four detectors).

Mean call abundance, averaged across all functional detectors each year, varied across the first 3 years of monitoring. Mean call abundance was lowest in Year 0 (11.22 calls/ detector night) compared to years 1 and 2 (14.02 and 12.38, respectively; Table 4.1). Mean nightly detection was lowest in Year 2 (60% of nights), compared to years 0 and 1 (76% and 72%, respectively; Table 4.1). Like mean call abundance, the average number of minutes per night with bat activity was lowest in Year 0 (7.46 minutes/night), compared to years 1 and 2 (8.95 and 8.16, respectively; Table 4.1).

Mean feeding buzz abundance was also lower in Year 0 (0.02) compared to years 1 and 2 (both 0.06; Table 4.1). Mean feeding buzz nightly detection followed a similar pattern and was also lower in Year 0 (0.01) compared to years 1 and 2 (0.04 and 0.05, respectively; Table 4.1).

Table 4.1. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from February 26, 2020, to April 16, 2024.

Year	# of Detectors	# of Bat Calls	Detector-nights with Bat Calls	Total Detector-Nights	Mean Call Abundance (Bat Calls/ Detector-nights)	Mean Nightly Detection (Nights Bats Detected/Total Detector-nights)	Average Bat Minutes/ Detector Night
All Calls							
0	38	155,173	10,814	14,281	11.22	0.76	7.46
1	39	193,658	9,625	13,380	14.02	0.72	8.95
2	24[b]	105,261	4,407	7,563	12.38	0.60	8.16
3	4[c]	5,514	882	1,288	4.45	0.65	4.31
Feeding Buzz Calls							
0	38	214	166	14,281	0.02	0.01	NA
1	39	789	546	13,380	0.06	0.04	NA
2	24[a]	491	364	9,184	0.06	0.05	NA
3	4[b]	78	75	1,288	0.07	0.07	NA

[a] 15 detectors recorded for <50% of nights during the year and/or had microphone issues and were excluded.

[b] Only four of 39 detectors appeared to be functioning properly for a majority of the sampling period.

4.1 CALL ABUNDANCE

4.1.1 All Calls

Call abundance varied widely among detectors and across years and habitat feature types (Table 4.2; Figure 4.1; Appendix A). Among habitat feature types, call abundance was on average lowest at troughs, followed by pastures, hedgerows, and ponds (Table 4.2). However, it must be noted that AW215, classified as a pasture site, was a substantial outlier within the group. With this data point removed, mean call abundance at pasture sites was similar to that at trough sites (Table 4.2).

Mean call abundance was slightly higher at pasture and hedgerow sites in years 1 and 2 compared to Year 0, but lower in years 1 and 2 at pond sites (Figure 4.1). Mean call abundance at troughs was higher in Year 1 than Year 0 but lower in Year 2 (Figure 4.1). This may be due to a steep decline in the sample size as only three trough detectors had good quality data in Year 2 compared to 10 trough detectors in years 0 and 1, although the decline was consistent across the three detectors that were operational (Table 4.2).

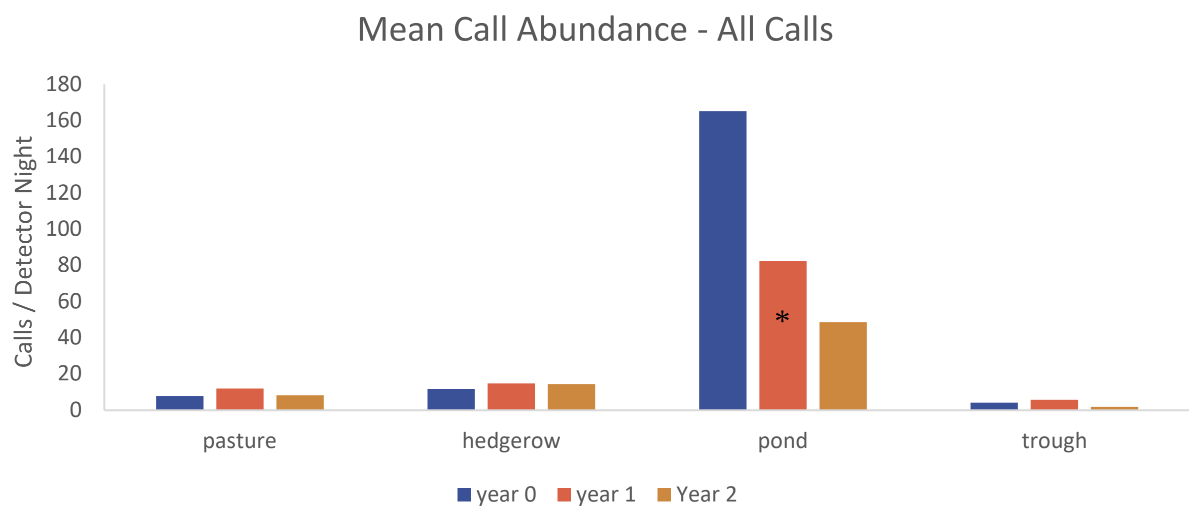

Figure 4.1. Mean number of bat calls per detector night for all acoustic detectors by habitat feature type and year in the Auwahi Wind Tier 4 mitigation area, Maui, Hawaii.

* One new pond site was added part way through Year 1, significantly influencing the overall mean for ponds.

Table 4.2. Call abundance and nightly detection for all Hawaiian hoary bat calls recorded during acoustic surveys associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from February 26, 2020, to March 30, 2023.

Station	Associated Habitat Feature	Call Abundance (Bat Calls/Detector-night)			Nightly Detection (Nights Bats Detected/ Total Detector-nights)		
		Year 0	Year 1	Year 2	Year 0	Year 1	Year 2
AW201	Pasture	1.57	2.98	NA	0.48	0.59	NA
AW202	Pasture	4.61	6.06	NA	0.72	0.63	NA
AW203	Pasture	6.89	3.64	3.80	0.84	0.48	0.40
AW204	Pasture	2.35	2.87	NA	0.71	0.63	NA
AW209	Pasture	2.27	4.16	NA	0.73	0.85	NA
AW210	Pasture	2.51	4.29	2.79	0.72	0.80	0.53
AW211	Pasture	4.57	6.56	NA	0.87	0.65	NA
AW212	Pasture	3.39	6.11	4.48	0.80	0.84	0.84
AW213	Pasture	5.49	7.21	5.02	0.88	0.86	0.87
AW214	Pasture	4.40	7.03	5.42	0.81	0.88	0.86
AW215	Pasture	101.96	183.86	117.80	0.97	0.98	0.94
AW216	Pasture	7.69	11.07	8.87	0.90	0.89	0.81
AW217	Pasture	6.05	8.85	5.09	0.82	0.87	0.62
AW218	Pasture	4.67	0.97	3.90	0.65	0.38	0.79
AW219	Pasture	3.04	1.96	1.15	0.62	0.58	0.44
AW220	Pasture	8.79	9.94	4.54	0.91	0.90	0.49
AW221	Pasture	3.74	6.03	3.91	0.85	0.91	0.62
AW222[c]	Pasture	0.81	0.66	NA	0.39	0.30	NA
AW223	Pasture	3.94	3.51	NA	0.77	0.69	NA
AW224[c]	Pasture	2.30	2.65	1.00	0.64	0.63	0.34
AW225[c]	Pasture	1.91	1.72	NA	0.57	0.50	NA
AW228	Pasture	3.51	5.93	0.62	0.70	0.72	0.39
AW229	Pasture	5.15	1.01	0.61	0.82	0.48	0.25
AW230	Pasture	2.54	3.36	3.26	0.72	0.82	0.72
AW232	Pasture	2.41	3.53	4.21	0.64	0.70	0.52
Average[a]	**Pasture**	**7.86 (3.9[b])**	**11.84 (4.7[b])**	**10.38 (3.7[b])**	**0.74 (0.73[b])**	**0.70 (0.69[b])**	**0.61 (0.59[b])**
AW226[c]	Hedgerow	12.71	16.35	13.20	0.95	0.87	0.77
AW227[c]	Hedgerow	10.81	13.23	15.63	0.92	0.84	0.69
Average[a]	**Hedgerow**	**11.76**	**14.79**	**14.42**	**0.94**	**0.86**	**0.73**
AW237	Pond	165.06	153.99	93.52	0.94	0.96	0.7
Pond1	Pond	NA	10.74	3.52	NA	0.8	0.51
Average[a]	**Pond**	**165.06**	**82.37**	**48.52**	**0.94**	**0.88**	**0.61**
AW200[c]	Trough	0.93	1.20	NA	0.43	0.43	NA
AW205	Trough	4.10	6.29	NA	0.83	0.82	NA
AW206	Trough	5.19	6.65	NA	0.87	0.85	NA
AW207	Trough	4.36	7.19	1.84	0.87	0.87	0.33
AW208	Trough	3.96	11.32	NA	0.74	0.95	NA
AW231	Trough	2.57	1.63	NA	0.65	0.37	NA
AW233	Trough	4.69	3.87	NA	0.80	0.41	NA
AW234	Trough	4.62	5.10	3.33	0.72	0.73	0.76
AW235	Trough	5.84	5.73	NA	0.73	0.73	NA
AW236	Trough	5.05	7.62	0.68	0.8	0.79	0.22
Average[a]	**Trough**	**4.13**	**5.66**	**1.95**	**0.74**	**0.70**	**0.44**

Note: Stations with <50% of sample nights or that were malfunctioning (e.g., bad microphones) were excluded (NA).
[a] Average of individual detectors to account for unbalanced design (i.e., differing number of detector-nights).
[b] Average excluding AW215 outlier.
[c] Detector located outside the Mitigation Site.
NA=no data.

4.1.2 Feeding Buzzes

Feeding buzz abundance varied among detectors and across years and habitat feature types but averaged less than 0.5 feeding buzzes/detector night at all feature types across all years (Table 4.2; Figure 4.2; Appendix B). Among habitat feature types, call abundance was on average lowest at troughs, followed by pastures, hedgerows, and ponds (Table 4.3, Figure 4.2). However, it must be noted again that AW215 was a substantial outlier within the pasture group, and with this data point removed, mean call abundance at pasture sites was similar to that at trough sites (Table 4.3).

Mean feeding buzz abundance was higher at all four feature types in years 1 and 2 compared to Year 0, although the peak was in Year 1 for ponds and troughs and in Year 2 for pastures and hedgerows (Figure 4.2).

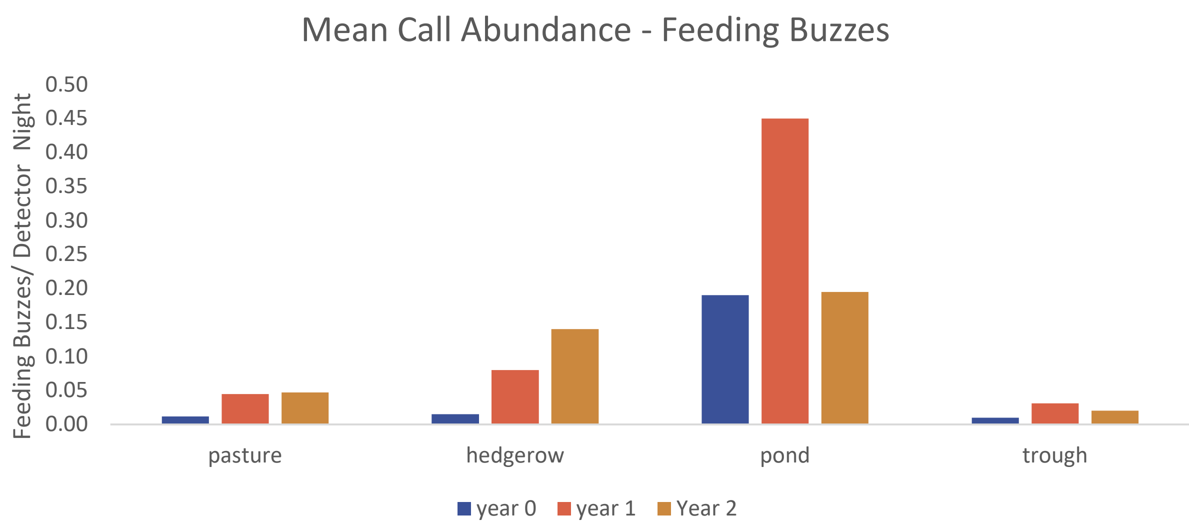

Figure 4.2. Mean number of feeding buzzes per detector night for all acoustic detectors by habitat feature type and year in the Auwahi Wind Tier 4 mitigation area, Maui, Hawaii.

Table 4.3. Feeding buzz abundance and feeding buzz nightly detection for Hawaiian hoary bats recorded during acoustic surveys associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from February 26, 2020, to March 30, 2023.

Station	Associated Habitat Feature	Feeding Buzz Abundance (Feeding Buzzes/Detector-night)			Feeding Buzz Nightly Detection (Nights with Feeding Buzzes /Detector-nights)		
		Year 0	**Year 1**	**Year 2**	**Year 0**	**Year 1**	**Year 2**
AW201	pasture	0	0.01	NA	<0.01	0.01	NA
AW202	pasture	0	0.01	NA	<0.01	0.01	NA
AW203	pasture	0.01	0.02	0.03	0.01	0.02	0.03
AW204	pasture	0	0.02	NA	<0.01	0.02	NA
AW209	pasture	0.02	0.03	NA	0.02	0.03	NA
AW210	pasture	0	0.05	0.05	<0.01	0.05	0.04
AW211	pasture	0	0.02	NA	<0.01	0.02	NA
AW212	pasture	0	0.02	0.02	<0.01	0.02	0.02
AW213	pasture	0	0.04	0.04	<0.01	0.03	0.04
AW214	pasture	0	0.04	0.03	<0.01	0.03	0.03
AW215	pasture	0.18	0.35	0.34	0.12	0.20	0.20
AW216	pasture	0.01	0.08	0.08	0.01	0.07	0.07
AW217	pasture	0.02	0.04	0.04	0.02	0.04	0.04
AW218	pasture	0.02	<0.01	0.02	0.02	<0.01	0.02
AW219	pasture	0	0.01	0.01	<0.01	0.01	0.01
AW220	pasture	0.03	0.09	0.06	0.03	0.07	0.05
AW221	pasture	0	0.03	0.03	<0.01	0.03	0.03
AW222[c]	pasture	0	<0.01	NA	<0.01	<0.01	NA
AW223	pasture	0	0.01	NA	<0.01	0.01	NA
AW224[c]	pasture	0	0.02	0	<0.01	0.02	0
AW225[c]	pasture	0	0.02	NA	<0.01	0.02	NA
AW228	pasture	0	0.03	0.01	<0.01	0.03	0.01
AW229	pasture	0	<0.01	0	<0.01	<0.01	0
AW230	pasture	0	0.02	0.02	<0.01	0.02	0.02
AW232	pasture	0	0.02	0.02	<0.01	0.02	0.02
Average[a]	**pasture**	**0.01 (0.0[b])**	**0.04 (0.03[b])**	**0.05 (0.03[b])**	**0.03 (0.02[b])**	**0.04 (0.30[b])**	**0.04 (0.03[b])**
AW226[c]	hedgerow	0.02	0.09	0.23	0.02	0.08	0.19
AW227[c]	hedgerow	0.01	0.07	0.05	0.01	0.06	0.05
Average[a]	**hedgerow**	**0.02**	**0.08**	**0.14**	**0.02**	**0.07**	**0.12**
AW237	pond	0.19	0.62	0.29	0.11	0.29	0.19
Pond1	pond	NA	0.28	0.10	NA	0.14	0.07
Average[a]	**pond**	**0.19**	**0.45**	**0.20**	**0.11**	**0.22**	**0.13**
AW200[c]	trough	0	0.02	NA	<0.01	0.02	NA
AW205	trough	0.01	0.04	NA	0.01	0.04	NA
AW206	trough	0.01	0.04	NA	0.01	0.04	NA
AW207	trough	0.01	0.05	0.02	0.01	0.04	0.02
AW208	trough	0.02	0.06	NA	0.02	0.05	NA
AW231	trough	0	0.01	NA	<0.01	0.01	NA
AW233	trough	0	0.02	NA	<0.01	0.02	NA
AW234	trough	0.01	0.02	0.02	0.01	0.02	0.02
AW235	trough	0.02	0.02	NA	0.02	0.02	NA
AW236	trough	0.02	0.03	<0.01	0.02	0.03	<0.01
Average[a]	**trough**	**0.01**	**0.03**	**0.02**	**0.01**	**0.03**	**0.02**

Note: Stations with <50% of sample nights or that were malfunctioning (e.g., bad microphones) were excluded.
[a] Average of individual detectors to account for unbalanced design (i.e., differing number of detector-nights).
[b] Average excluding AW215 outlier.
[c] Detector located outside the Mitigation Site.
NA=no data. 0=data but no feeding buzzes.

4.1.3 Discussion

Mean call abundance followed similar trends for all calls and feeding buzzes, although the number of feeding buzzes recorded was substantially lower than the total number of calls and averaged less than 0.5 feeding buzzes per detector night. While the objective of the monitoring study is to ultimately measure an increase in bat activity within the Mitigation Site, the current data set is limited in regard to making any inference at this point. With 3 years of data, there are only two datapoints to assess changes (i.e., Year 0–1 and Year 1–2). Given the potential for annual variability, more years of data will be necessary before any meaningful inference can be made.

It must also be noted that hedgerows and ponds were only represented by two stations at this point, and of those, both hedgerow sites are outside the Mitigation Site boundary and meant to serve as controls. Some hedgerows have been planted within the Mitigation Site, but those hedgerows have not yet become established and the nearby sampling stations are still considered pasture sites. As hedgerows become more established, these sampling locations will change from pasture to hedgerows and allow for comparisons before and after their installation, which cannot be done at this point.

Two new ponds have also been constructed but neither are at locations that had a detector previously; therefore, neither have any baseline data for the specific location prior to construction and only one (Pond1) was monitored after its construction. Pond1 was built part way through Year 1 and is, therefore, starkly different from the pre-existing pond in the dataset (AW237). Pond1 is largely devoid of vegetation and has a liner bottom, whereas AW237 is decades old, has silted in, and is full of aquatic vegetation. As such, AW237 likely provides both high quality foraging and drinking opportunities for bats, while Pond1 may largely be limited to drinking as it has not matured to a point that likely provides for an abundance of aquatic insects; the water is still clear and the pond liner plainly visible. Due to the stark difference in pond “maturity”, averages among the pond category are dramatically influenced by the addition of the new pond part way through Year 1. The large decline in mean abundance in the pond category is due to this new pond, not a decrease in overall bat abundance. As more data are gathered and mitigation features mature, annual comparisons should become more meaningful as more robust comparisons are made that may include trends at individual detectors in addition to the feature covariates.

4.2 CALL NIGHTLY DETECTION

4.2.1 All Calls

Mean nightly detection for all bat calls varied among detectors and across years and habitat feature types and trended consistently downward from Year 0 to Year 2 at all habitat feature types (Figure 4.3, Table 4.2; Appendix A). Among feature types, mean nightly detection was on average similar and lower at troughs and pasture sites compared to hedgerows and ponds (Figure 4.3). Mean nightly detection was consistently higher at hedgerows and ponds than at troughs and pastures across all years (Figure 4.3).

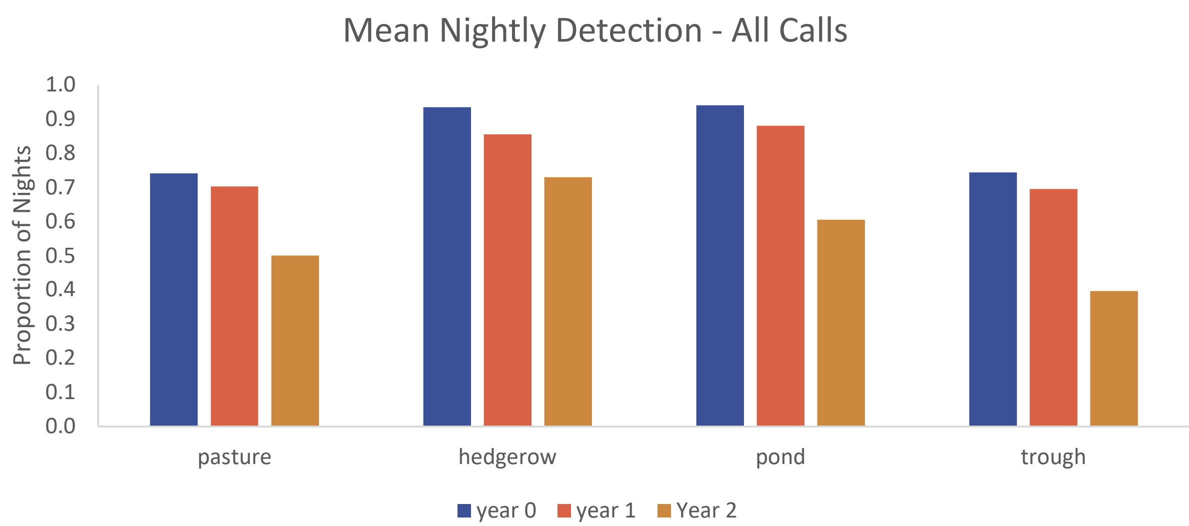

Figure 4.3. The proportion of nights with bat calls for all acoustic detectors by habitat feature type and year in the Auwahi Wind Tier 4 mitigation area, Maui, Hawaii.

4.2.2 Feeding Buzzes

Mean feeding buzz nightly detection also varied among detectors and across years and habitat feature types (Figure 4.4, Table 4.3; Appendix B) but did not follow a pattern similar to that of all bat calls (Figure 4.3). Buzz nightly detection rates followed different trends among habitat feature types, being similar in all years at pasture sites, increasing year over year at hedgerows, and fluctuating yearly at ponds and troughs (Figure 4.4). Among feature types, mean nightly detection was on average lower at troughs and pastures sites compared to hedgerows and ponds (Figure 4.4). While AW215 was a substantial outlier among the pasture sites related to call abundance, this sites' influence on mean nightly detection was not substantial (Table 4.3).

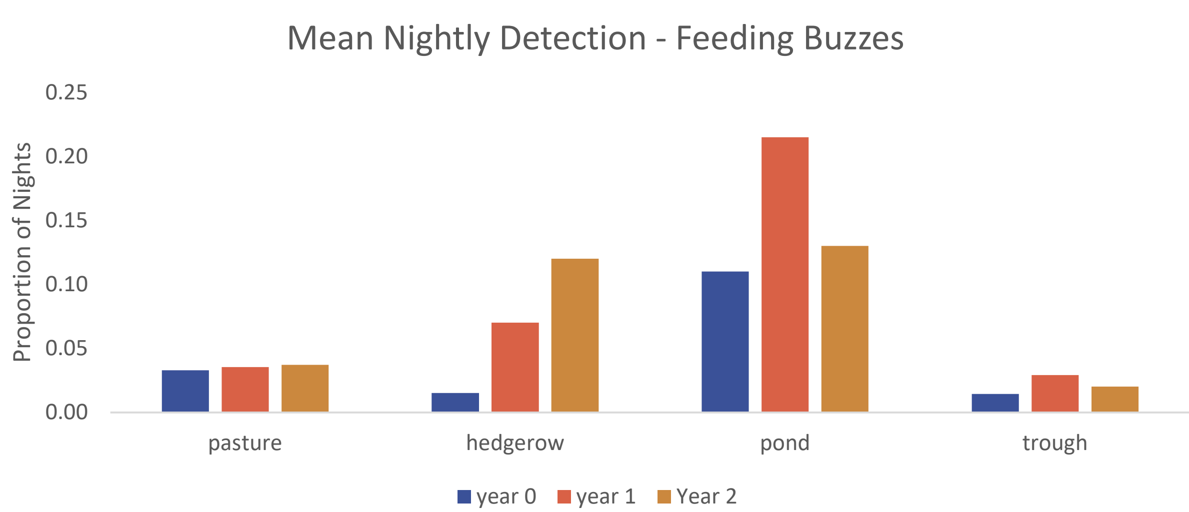

Figure 4.4. The proportion of nights with feeding buzzes for all acoustic detectors by habitat feature type and year in the Auwahi Wind Tier 4 mitigation area, Maui, Hawaii.

4.2.3 Discussion

Unlike call abundance, mean nightly detection did not follow similar trends over time for all calls and feeding buzzes (Figures 4.3 and 4.4). For all calls, nightly detection rates showed consistent declines over time (Figure 4.3) whereas there were no consistent patterns over time for buzz nightly detection (Figure 4.4). However, despite the variability, it's worth noting that feeding buzz nightly detection was consistently low, averaging 22% or fewer nights across feature types (Figure 4.4), with the maximum percentage of nights with feeding buzzes being 29% at detector AW237, the oldest pond site within the Mitigation Site (Table 4.3). It's also worth noting that while AW215 was a substantial outlier among the pasture sites related to call abundance, this sites' influence on mean nightly detection was not substantial for all bat calls or feeding buzzes (Table 4.3). While the dataset is limited given only two datapoints related to changes over time (i.e., Year 0–1 and Year 1–2), the consistent decline in call nightly detection combined with relatively more stable call abundance estimates suggests that bat activity at detector locations was greater (i.e., more calls recorded) on nights bats were present versus bats being present on more nights. However, more use on those nights when present cannot be directly tied to any specific mitigation actions at this time, as mitigation actions (i.e., pond and hedgerow installations) have not matured to the point that they would likely influence bat activity to any large degree.

As noted previously, with only 3 years of data and two datapoints to assess changes, the current data set is limited regarding inferences at this time. More years of data will be necessary to assess the correlation between habitat feature types and the two metrics being measured (call abundance and nightly detection). As more data are gathered and mitigation features mature, annual comparisons among the metrics should become more meaningful as more robust comparisons are made that include trends at individual detector stations in combination with the habitat feature covariates.

4.3 MINUTES OF ACTIVITY

4.3.1 All Calls

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 39 detectors (Table 4.2; Appendix C). The number of bat activity minutes averaged ranged from 7.46–8.95 minutes per detector night during the 3 years (years 0–2) of monitoring with good data (see Table 4.1). While the average minutes per night varied little (less than 1.5 minutes/detector night) on average across the 3 years, this metric was similar to call abundance in that it was slightly higher in Year 1 than Year 0, but then declined slightly in Year 2. While annual patterns were not apparent, minutes with activity showed clear seasonal patterns, with substantially more minutes containing bat calls recorded during the late spring through fall (Figure 4.5).

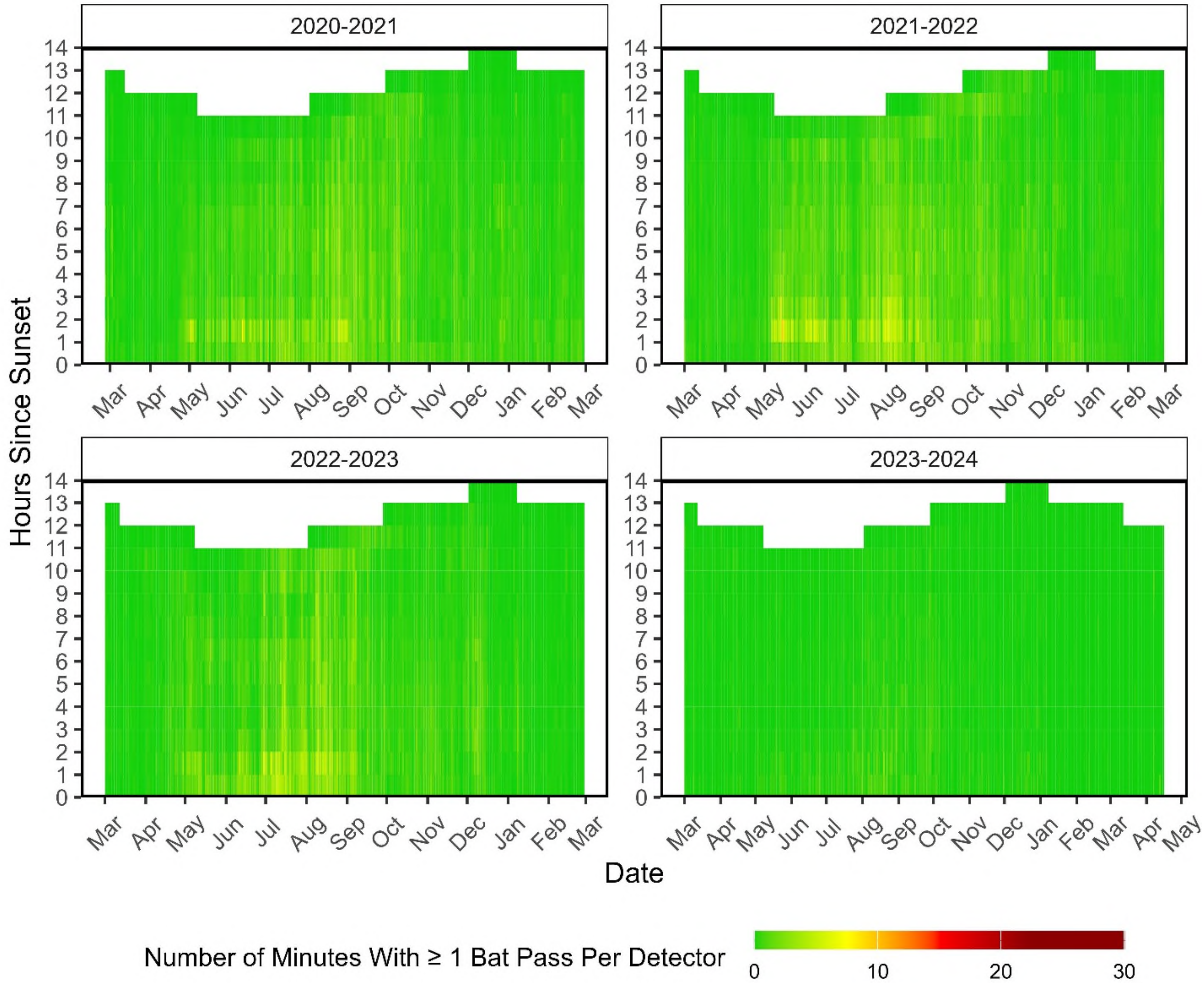

Figure 4.5. Bat activity patterns relative to sunset (hour zero) illustrated by the number of minutes with one or more bat calls averaged across acoustic sampling stations within Auwahi Wind's Tier 4 Mitigation Site from February 16, 2020, to April 16, 2024, Maui, Hawaii.

4.3.2 Discussion

The seasonal pattern in call minutes was apparent and consistent across years, even though minutes with activity were lower in years 2 and 3 due to equipment failure (Figure 4.5). While data were sparse in the later part of Year 2 due to equipment failures (Figure 4.5, lower left panel), the higher minutes clearly continue through the fall as illustrated by the yellow bars visible in Figure 4.5. Although only four detectors provided good data in Year 3 (Figure 4.5, lower right panel), this pattern was still apparent with more yellow bars (representing more minutes) visible in the summer and fall period. While seasonal estimates were not calculated for call abundance and call nightly detection, it is assumed that call abundance at minimum would likely follow a similar seasonal pattern, consistent with the seasonal patterns of HAHOBA activity reported by others (e.g., Menard 2001, Gorresen et al. 2013, Thompson and Starcevich 2022).

5 CONCLUSION

The primary objective of the Tier 4 mitigation monitoring is to document changes in HAHOBA activity over time using the designated activity metrics (call abundance and call nightly detection) to assess the impact of management actions on bat activity within the Mitigation Site. While Year 3 (April 2023 – March 2024) of monitoring was largely lost due to ongoing issues with equipment, all detector microphones have been updated as of spring 2024. Additional monitoring of bat activity in and surrounding the Mitigation Site is planned over the next 8 years (Years 4–11). As mitigation activities continue to become established, more formal analyses to assess trends in activity in response to the mitigation actions will be completed.

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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’s Tier 4 Mitigation Monitoring, Maui, Hawaii, from February 26, 2020, to April 16, 2024.

Appendix A1. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from February 26, 2020, to 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)
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
AW209	Pasture	886	287	391	2.27± 0.13	0.73
AW210	Pasture	967	277	385	2.51± 0.16	0.72
AW211	Pasture	1,749	333	383	4.57± 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	386	4.40± 0.23	0.81
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	367	4.67± 0.35	0.65
AW219	Pasture	1,108	227	365	3.04± 0.24	0.62
AW220	Pasture	3,155	325	359	8.79± 0.43	0.91
AW221	Pasture	1,344	305	359	3.74± 0.21	0.85
AW222[b]	Pasture	285	138	352	0.81± 0.08	0.39
AW223	Pasture	1,513	294	384	3.94± 0.25	0.77
AW224[b]	Pasture	810	227	352	2.30± 0.17	0.64
AW225[b]	Pasture	674	199	352	1.91± 0.20	0.57
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
AW232	Pasture	943	251	392	2.41± 0.18	0.64
AW226[b]	Hedgerow	4,538	339	357	12.71± 0.72	0.95
AW227[b]	Hedgerow	3,859	330	357	10.81± 0.57	0.92
AW237	Pond	58,266	331	353	165.06±12.16	0.94
Pond1	Pond	NA	NA	NA	NA	NA
AW200[b]	Trough	329	152	353	0.93± 0.08	0.43
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
AW231	Trough	1,011	255	393	2.57± 0.19	0.65
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
Total		**155,173**	**10,814**	**14,281**	**11.22**[c]	**0.76**[c]

[a] Estimate ± bootstrapped standard error.

[b] Indicates detector location is outside the Tier 4 Mitigation Site.

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

NA indicates no applicable data were collected (i.e., detector not deployed or not operational).

Appendix A2. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from April 1, 2021, to 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)
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	298	3.64± 0.39	0.48
AW204	Pasture	997	220	347	2.87± 0.21	0.63
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	364	6.56± 0.42	0.65
AW212	Pasture	2,224	306	364	6.11± 0.35	0.84
AW213	Pasture	2,623	313	364	7.21± 0.35	0.86
AW214	Pasture	2,441	304	347	7.03± 0.41	0.88
AW215	Pasture	66,924	358	364	183.86±14.64	0.98
AW216	Pasture	4,031	324	364	11.07± 0.57	0.89
AW217	Pasture	3,223	316	364	8.85± 0.48	0.87
AW218	Pasture	273	106	281	0.97± 0.09	0.38
AW219	Pasture	712	210	364	1.96± 0.15	0.58
AW220	Pasture	3,619	327	364	9.94± 0.53	0.90
AW221	Pasture	2,118	320	351	6.03± 0.28	0.91
AW222[b]	Pasture	242	108	364	0.66± 0.07	0.30
AW223	Pasture	1,170	229	333	3.51± 0.29	0.69
AW224[b]	Pasture	931	220	351	2.65± 0.20	0.63
AW225[b]	Pasture	626	181	364	1.72± 0.16	0.50
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
AW232	Pasture	1,284	254	364	3.53± 0.34	0.70
AW226[b]	Hedgerow	5,951	316	364	16.35± 0.97	0.87
AW227[b]	Hedgerow	4,814	307	364	13.23± 0.83	0.84
AW237	Pond	56,051	348	364	153.99±11.44	0.96
Pond1	Pond	1,976	147	184[d]	10.74± 1.10	0.80
AW200[b]	Trough	438	156	364	1.20± 0.18	0.43
AW205	Trough	2,289	297	364	6.29± 0.44	0.82
AW206	Trough	2,421	308	364	6.65± 0.38	0.85
AW207	Trough	2,618	317	364	7.19± 0.39	0.87
AW208	Trough	2,265	189	200	11.32± 0.88	0.95
AW231	Trough	573	131	351	1.63± 0.15	0.37
AW233	Trough	924	97	239	3.87± 0.53	0.41
AW234	Trough	1,770	254	347	5.10± 0.38	0.73
AW235	Trough	2,084	264	364	5.73± 0.44	0.73
AW236	Trough	2,774	286	364	7.62± 0.39	0.79
Total		**193,658**	**9,625**	**13,380**	**14.02[c]**	**0.72[c]**

[a] Estimate ± bootstrapped standard error.

[b] Indicates detector location is outside the Tier 4 Mitigation Site.

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

[d] Detector deployed September 28, 2021.

Appendix A3. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from April 1, 2022, to March 31, 2023 (Year 2).

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)
AW203	Pasture	1,250	133	329	3.80± 0.35	0.40
AW210	Pasture	624	119	224	2.79± 0.37	0.53
AW212	Pasture	1,632	305	364	4.48± 0.21	0.84
AW213	Pasture	1,828	315	364	5.02± 0.29	0.87
AW214	Pasture	1,367	216	252	5.42± 0.31	0.86
AW215	Pasture	42,881	343	364	117.80±12.10	0.94
AW216	Pasture	1,853	169	209	8.87± 0.57	0.81
AW217	Pasture	1,666	202	327	5.09± 0.35	0.62
AW218	Pasture	1,420	288	364	3.90± 0.22	0.79
AW219	Pasture	418	160	364	1.15± 0.10	0.44
AW220	Pasture	1,377	149	303	4.54± 0.38	0.49
AW221	Pasture	872	139	223	3.91± 0.34	0.62
AW224[b]	Pasture	259	87	259	1.00± 0.15	0.34
AW228	Pasture	157	99	252	0.62± 0.07	0.39
AW229	Pasture	154	64	252	0.61± 0.10	0.25
AW230	Pasture	826	183	253	3.26± 0.24	0.72
AW232	Pasture	1,065	132	253	4.21± 0.48	0.52
AW226[b]	Hedgerow	2,759	160	209	13.20± 0.91	0.77
AW227[b]	Hedgerow	5,690	250	364	15.63± 1.09	0.69
AW237	Pond	34,042	254	364	93.52± 9.88	0.70
Pond1	Pond	1,282	187	364	3.52± 0.34	0.51
AW207	Trough	668	121	364	1.84± 0.17	0.33
AW234	Trough	713	163	214	3.33± 0.23	0.76
AW236	Trough	246	81	364	0.68± 0.09	0.22
Total		**105,261**	**4,407**	**7,563**	**12.38[c]**	**0.60[c]**

[a] Estimate ± bootstrapped standard error.

[b] Indicates detector location is outside the Tier 4 Mitigation Site.

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

Appendix A4. Results for all bat detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from April 1, 2023, to April 16, 2024 (Year 3).

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)
AW212	Pasture	1,580	234	262	6.03±0.33	0.89
AW213	Pasture	1,215	198	262	4.64±0.32	0.76
AW214	Pasture	1,804	248	382	4.72±0.27	0.65
AW218	Pasture	915	202	382	2.40±0.17	0.53
Total		**5,514**	**882**	**1,288**	**4.45[b]**	**0.65[b]**

[a] Estimate ± bootstrapped standard error.

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

Appendix B: Hawaiian Hoary Bat Feeding Buzz Abundance and Feeding Buzz Nightly Detection by Year for 39 Acoustic Monitoring Stations Associated with Auwahi Wind's Tier 4 Mitigation Monitoring, Maui, Hawaii, from February 26, 2020, to April 16, 2024.

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

Station	Associated Habitat Feature	# of Feeding Buzzes	Detector-nights with Feeding Buzzes	Total Detector-nights	Feeding Buzz Abundance (Feeding Buzzes/ Detector-nights)	Feeding Buzz Nightly Detection (Nights with Feeding Buzzes /Total Detector-nights)
AW201	Pasture	0	0	393	0	<0.01
AW202	Pasture	0	0	350	0	<0.01
AW203	Pasture	4	4	336	0.01	0.01
AW204	Pasture	1	1	391	0	<0.01
AW209	Pasture	6	6	391	0.02	0.02
AW210	Pasture	1	1	385	0	<0.01
AW211	Pasture	1	1	383	0	<0.01
AW212	Pasture	0	0	384	0	<0.01
AW213	Pasture	1	1	384	0	<0.01
AW214	Pasture	0	0	386	0	<0.01
AW215	Pasture	65	43	365	0.18	0.12
AW216	Pasture	2	2	367	0.01	0.01
AW217	Pasture	6	6	367	0.02	0.02
AW218	Pasture	6	6	367	0.02	0.02
AW219	Pasture	1	1	365	0	<0.01
AW220	Pasture	10	10	359	0.03	0.03
AW221	Pasture	1	1	359	0	<0.01
AW222[a]	Pasture	0	0	352	0	<0.01
AW223	Pasture	1	1	384	0	<0.01
AW224[a]	Pasture	0	0	352	0	<0.01
AW225[a]	Pasture	0	0	352	0	<0.01
AW228	Pasture	0	0	384	0	<0.01
AW229	Pasture	0	0	384	0	<0.01
AW230	Pasture	1	1	392	0	<0.01
AW232	pasture	0	0	392	0	<0.01
AW226[a]	Hedgerow	6	6	357	0.02	0.02
AW227[a]	Hedgerow	3	3	357	0.01	0.01
AW237	Pond	66	40	353	0.19	0.11
Pond1	Pond	0	0	NA	NA	NA
AW200[a]	Trough	0	0	353	0	<0.01
AW205	Trough	2	2	387	0.01	0.01
AW206	Trough	3	3	387	0.01	0.01
AW207	Trough	2	2	387	0.01	0.01
AW208	Trough	7	7	386	0.02	0.02
AW231	Trough	0	0	393	0	<0.01
AW233	Trough	0	0	399	0	<0.01
AW234	Trough	3	3	399	0.01	0.01
AW235	Trough	8	8	399	0.02	0.02
AW236	Trough	7	7	400	0.02	0.02
Total		**214**	**166**	**14,281**	**0.02[b]**	**0.01[b]**

[a] Indicates detector location is outside the Tier 4 Mitigation Site.

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

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

Station	Associated Habitat Feature	# of Feeding Buzzes	Detector-nights with Feeding Buzzes	Total Detector-nights	Feeding Buzz Abundance (Feeding Buzzes/ Detector-nights)	Feeding Buzz Nightly Detection (Nights with Feeding Buzzes /Detector-nights)
AW201	Pasture	3	3	364	0.01	0.01
AW202	Pasture	4	3	347	0.01	0.01
AW203	Pasture	5	5	298	0.02	0.02
AW204	Pasture	8	7	347	0.02	0.02
AW209	Pasture	11	11	364	0.03	0.03
AW210	Pasture	18	16	351	0.05	0.05
AW211	Pasture	8	7	364	0.02	0.02
AW212	Pasture	8	8	364	0.02	0.02
AW213	Pasture	13	11	364	0.04	0.03
AW214	Pasture	13	12	347	0.04	0.03
AW215	Pasture	128	73	364	0.35	0.20
AW216	Pasture	29	25	364	0.08	0.07
AW217	Pasture	15	14	364	0.04	0.04
AW218	Pasture	1	1	281	<0.01	<0.01
AW219	Pasture	2	2	364	0.01	0.01
AW220	Pasture	32	26	364	0.09	0.07
AW221	Pasture	12	11	351	0.03	0.03
AW222[a]	Pasture	1	1	364	<0.01	<0.01
AW223	Pasture	3	2	333	0.01	0.01
AW224[a]	Pasture	6	6	351	0.02	0.02
AW225[a]	Pasture	6	6	364	0.02	0.02
AW228	Pasture	10	9	347	0.03	0.03
AW229	Pasture	1	1	347	<0.01	<0.01
AW230	Pasture	8	7	351	0.02	0.02
AW232	Pasture	6	6	364	0.02	0.02
AW226[a]	Hedgerow	34	29	364	0.09	0.08
AW227[a]	Hedgerow	27	23	364	0.07	0.06
AW237	Pond	227	106	364	0.62	0.29
Pond1	Pond	52	26	184[c]	0.28	0.14
AW200[a]	Trough	7	6	364	0.02	0.02
AW205	Trough	14	14	364	0.04	0.04
AW206	Trough	15	15	364	0.04	0.04
AW207	Trough	17	13	364	0.05	0.04
AW208	Trough	12	9	200	0.06	0.05
AW231	Trough	5	5	351	0.01	0.01
AW233	Trough	5	4	239	0.02	0.02
AW234	Trough	6	6	347	0.02	0.02
AW235	Trough	7	7	364	0.02	0.02
AW236	Trough	10	10	364	0.03	0.03
Total		**789**	**546**	**13,380**	**0.06[b]**	**0.04[b]**

[a] Indicates detector location is outside the Tier 4 Mitigation Site.

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

[c] Detector deployed September 28, 2021.

Appendix B3. Results for feeding buzz detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from April 1, 2022, to March 31, 2023 (Year 2).

Station	Associated Habitat Feature	# of Feeding Buzzes	Detector-nights with Feeding Buzzes	Total Detector-nights	Feeding Buzz Abundance (Feeding Buzzes/ Detector-nights)	Feeding Buzz Nightly Detection (Nights with Feeding Buzzes /Total Detector-nights)
AW203	Pasture	11	11	329	0.03	0.03
AW210	Pasture	11	8	224	0.05	0.04
AW212	Pasture	6	6	364	0.02	0.02
AW213	Pasture	14	13	364	0.04	0.04
AW214	Pasture	8	7	252	0.03	0.03
AW215	Pasture	124	71	364	0.34	0.20
AW216	Pasture	16	15	209	0.08	0.07
AW217	Pasture	13	12	327	0.04	0.04
AW218	Pasture	8	7	364	0.02	0.02
AW219	Pasture	2	2	364	0.01	0.01
AW220	Pasture	17	16	303	0.06	0.05
AW221	Pasture	6	6	223	0.03	0.03
AW224[a]	Pasture	0	0	259	0	0
AW228	Pasture	3	3	252	0.01	0.01
AW229	Pasture	0	0	252	0	0
AW230	Pasture	4	4	253	0.02	0.02
AW232	Pasture	5	5	253	0.02	0.02
AW226[a]	Hedgerow	49	39	209	0.23	0.19
AW227[a]	Hedgerow	20	17	364	0.05	0.05
AW237	Pond	107	68	364	0.29	0.19
Pond1	Pond	36	24	364	0.10	0.07
AW207	Trough	8	7	364	0.02	0.02
AW234	Trough	4	4	214	0.02	0.02
AW236	Trough	1	1	364	<0.01	<0.01
Total		**491**	**364**	**9,184**	**0.06**[b]	**0.05**[b]

[a] Indicates detector location is outside the Tier 4 Mitigation Site.

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

Appendix B4. Results for feeding buzz detections during acoustic surveys conducted at 39 stations associated with Auwahi Wind's Tier 4 mitigation monitoring, Maui, Hawaii, from April 1, 2023, to April 16, 2024 (Year 3).

Station	Associated Habitat Feature	# of Feeding Buzzes	Detector-nights with Feeding Buzzes	Total Detector-nights	Feeding Buzz Abundance (Feeding Buzzes/ Detector-nights)	Feeding Buzz Nightly Detection (Nights Feeding Buzzes /Total Detector-nights)
AW212	Pasture	27	27	262	0.10	0.10
AW213	Pasture	22	20	262	0.08	0.08
AW214	Pasture	19	18	382	0.05	0.05
AW218	Pasture	10	10	382	0.03	0.03
Total		**78**	**75**	**1,288**	**0.07**[a]	**0.07**[a]

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

Appendix C: Minutes per Detector-night Containing Hawaiian Hoary Bat Calls by Year for 39 Acoustic Monitoring Stations Associated with Auwahi Wind's Tier 4 Mitigation Monitoring, Maui, Hawaii, from February 26, 2020, to April 16, 2024.

Appendix C1. Minutes of the night with bat detections during acoustic surveys at acoustic stations within the Auwahi Wind's Tier 4 mitigation area, Maui, Hawaii from February 26, 2020, to March 31, 2021 (Year 0).

Station	Associated Habitat Feature	Total Detector-nights	Total Minutes with Bat Calls	Average Minutes per Detector-night with Bat Calls
AW201	Pasture	393	583	1.48
AW202	Pasture	350	1,312	3.75
AW203	Pasture	336	1,978	5.89
AW204	Pasture	391	864	2.21
AW209	Pasture	391	825	2.11
AW210	Pasture	385	894	2.32
AW211	Pasture	383	1,648	4.30
AW212	Pasture	384	1,215	3.16
AW213	Pasture	384	1,938	5.05
AW214	Pasture	386	1,557	4.03
AW215	Pasture	365	22,154	60.70
AW216	Pasture	367	2,508	6.83
AW217	Pasture	367	1,980	5.40
AW218	Pasture	367	1,340	3.65
AW219	Pasture	365	945	2.59
AW220	Pasture	359	2,822	7.86
AW221	Pasture	359	1,259	3.51
AW222[a]	Pasture	352	263	0.75
AW223	Pasture	384	1,327	3.46
AW224[a]	Pasture	352	740	2.10
AW225[a]	Pasture	352	590	1.68
AW228	Pasture	384	1,247	3.25
AW229	Pasture	384	1,772	4.61
AW230	Pasture	392	945	2.41
AW232	Pasture	392	866	2.21
AW226[a]	Hedgerow	357	4,079	11.43
AW227[a]	Hedgerow	357	3,348	9.38
AW237	Pond	353	28,464	80.63
Pond1	Pond	NA	NA	NA
AW200[a]	Trough	353	306	0.87
AW205	Trough	387	1,432	3.70
AW206	Trough	387	1,833	4.74
AW207	Trough	387	1,567	4.05
AW208	Trough	386	1,437	3.72
AW231	Trough	393	915	2.33
AW233	Trough	399	1,672	4.19
AW234	Trough	399	1,617	4.05
AW235	Trough	399	1,804	4.52
AW236	Trough	400	1,786	4.47

[a] Indicates detector location is outside the Tier 4 Mitigation Site.

NA indicates no applicable data were collected (i.e., detector not deployed or not operational).

Appendix C2. Minutes of the night with bat detections during acoustic surveys at acoustic stations within the Auwahi Wind's Tier 4 mitigation area, Maui, Hawaii from April 1, 2021, to March 31, 2022 (Year 1).

Station	Associated Habitat Feature	Total Detector-nights	Total Minutes with Bat Calls	Average Minutes per Detector-night with Bat Calls
AW201	Pasture	364	961	2.64
AW202	Pasture	347	1,808	5.21
AW203	Pasture	299	1,011	3.38
AW204	Pasture	347	922	2.66
AW209	Pasture	364	1,405	3.86
AW210	Pasture	351	1,344	3.83
AW211	Pasture	365	2,215	6.07
AW212	Pasture	365	2,048	5.61
AW213	Pasture	365	2,395	6.56
AW214	Pasture	347	2,230	6.43
AW215	Pasture	365	33,983	93.10
AW216	Pasture	365	3,601	9.87
AW217	Pasture	365	2,885	7.90
AW218	Pasture	282	260	0.92
AW219	Pasture	365	657	1.80
AW220	Pasture	365	3,317	9.09
AW221	Pasture	351	1,953	5.56
AW222[a]	Pasture	364	227	0.62
AW223	Pasture	334	1,068	3.20
AW224[a]	Pasture	351	845	2.41
AW225[a]	Pasture	364	567	1.56
AW228	Pasture	347	1,840	5.30
AW229	Pasture	347	336	0.97
AW230	Pasture	351	1,116	3.18
AW232	Pasture	364	1,196	3.29
AW226[a]	Hedgerow	365	5,079	13.92
AW227[a]	Hedgerow	365	4,008	10.98
AW237	Pond	365	25,498	69.86
Pond1	Pond	185[b]	1,635	8.84
AW200[a]	Trough	364	375	1.03
AW205	Trough	365	2,069	5.67
AW206	Trough	365	2,202	6.03
AW207	Trough	365	2,397	6.57
AW208	Trough	200	2,000	10.00
AW231	Trough	351	516	1.47
AW233	Trough	240	813	3.39
AW234	Trough	347	1,610	4.64
AW235	Trough	365	1,700	4.66
AW236	Trough	365	2,505	6.86

[a] Indicates detector location is outside the Tier 4 Mitigation Site.

[b] Detector deployed September 28, 2021.

Appendix C3. Minutes of the night with bat detections during acoustic surveys at acoustic stations within the Auwahi Wind's Tier 4 mitigation area, Maui, Hawaii from April 1, 2022, to March 31, 2023 (Year 2).

Station	Associated Habitat Feature	Total Detector-nights	Total Minutes with Bat Calls	Average Minutes per Detector-night with Bat Calls
AW203	Pasture	329	1,172	3.56
AW210	Pasture	224	553	2.47
AW212	Pasture	365	1,536	4.21
AW213	Pasture	365	1,691	4.63
AW214	Pasture	253	1,253	4.95
AW215	Pasture	365	22,919	62.79
AW216	Pasture	209	1,690	8.09
AW217	Pasture	328	1,567	4.78
AW218	Pasture	365	1,261	3.45
AW219	Pasture	365	398	1.09
AW220	Pasture	303	1,294	4.27
AW221	Pasture	223	804	3.61
AW224[a]	Pasture	260	256	0.98
AW228	Pasture	253	149	0.59
AW229	Pasture	253	142	0.56
AW230	Pasture	254	789	3.11
AW232	Pasture	254	1,001	3.94
AW226[a]	Hedgerow	209	2,446	11.7
AW227[a]	Hedgerow	365	4,141	11.35
AW237	Pond	365	17,303	47.41
Pond1	Pond	365	1,007	2.76
AW207	Trough	365	622	1.7
AW234	Trough	214	658	3.07
AW236	Trough	365	240	0.66

[a] Indicates detector location is outside the Tier 4 Mitigation Site.

Appendix C4. Minutes of the night with bat detections during acoustic surveys at acoustic stations within the Auwahi Wind's Tier 4 mitigation area, Maui, Hawaii from April 1, 2023, to April 16, 2024 (Year 3).

Station	Associated Habitat Feature	Total Detector-nights	Total Minutes with Bat Calls	Average Minutes per Detector-night with Bat Calls
AW212	Pasture	365	1,536	4.21
AW213	Pasture	365	1,691	4.63
AW214	Pasture	253	1,253	4.95
AW218	Pasture	365	1,261	3.45

Attachment 7

Tier 5 Bat Mitigation Monitoring: Interim Monitoring Summary for May 2021 – March 2023

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Tier 5 Bat Mitigation Monitoring: Interim Monitoring Summary for May 2021 – March 2023

Auwahi Wind Energy LLC
Maui, Hawaii

Prepared by:
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July 2024

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REPORT REFERENCE

Thompson, J. 2024. Tier 5 Bat Mitigation Monitoring: Interim Monitoring Summary for May 2021 – March 2023. Prepared for Auwahi Wind LLC, Chicago, Illinois. Prepared by Western EcoSystems Technology, Inc. (WEST), Corvallis, Oregon. July 31, 2024. 8 pages.

CONTENTS

TABLES

FIGURES

1 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 (*Aeorestes semotus;* HAHOBA) at their Auwahi Wind Energy Facility (Figure 1.1). Within the Mitigation Site, Auwahi Wind will implement management actions to improve habitat conditions for HAHOBA and will monitor bat activity levels to assess the success of mitigation actions over time. Auwahi Wind'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 management actions (i.e., habitat enhancements) and post-management monitoring (Tetra Tech 2022). The primary objective of the acoustic monitoring is to document changes in HAHOBA activity rates over time to assess the impact of management actions on bat activity within the Mitigation Site. This interim report provides a summary of the cumulative pre-trigger baseline monitoring dataset for acoustic bat data collected and analyzed for the period May 11, 2021, through March 30, 2023.

2 ENVIRONMENTAL SETTING

The Mitigation Site consists of approximately 700 acres of former ranchland at elevations ranging from approximately 6,200 – 7,600 feet on the north slopes of Haleakala, Maui, Hawaii (Figure 1.1). The Mitigation Site is centrally located in the Kamehamenui Forest Reserve and managed by the Hawaii Department of Forestry and Wildlife (DOFAW). Acquired by DOFAW in 2020, planned management for the Forest Reserve includes restoration of the pasturelands to native forest and mixed public use. The Mitigation Site consists primarily of open grasslands historically used for cattle grazing (i.e., pasture), with one approximately 25-acre stand of forest and scattered other trees (Figure 1.1). Perennial water is scarce within the Mitigation Site, with the primary water source limited to one cattle tank.

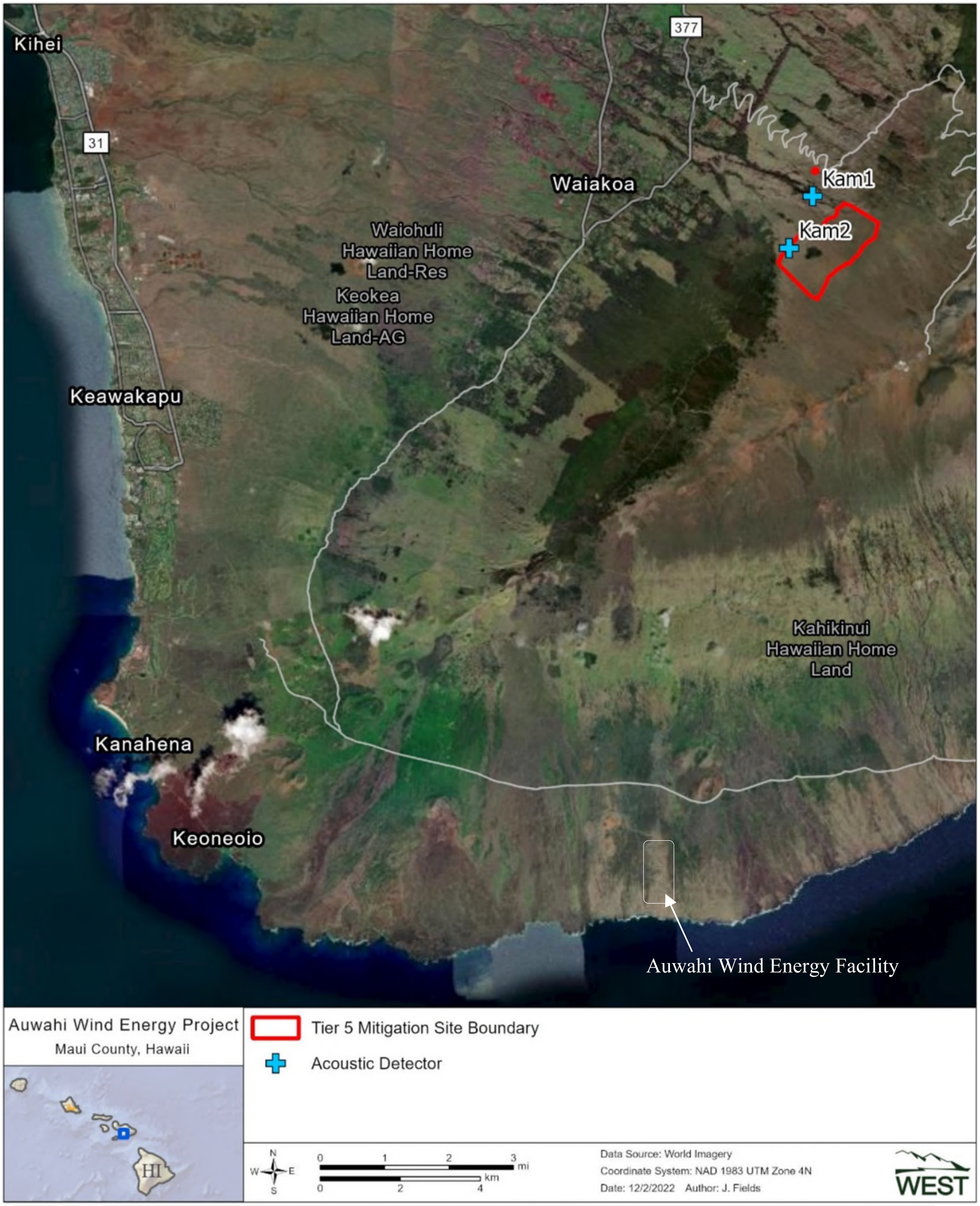

Figure 1.1. Location of Auwahi Wind's Tier 5 Hawaiian hoary bat Mitigation Site and acoustic bat detector locations, Maui, Hawaii.

3 METHODS

Two Wildlife Acoustics SM4Bat full spectrum bat detectors (Wildlife Acoustics, Maynard, Massachusetts) were deployed in May 2021 to begin pre-trigger baseline monitoring (Figure 1.1). Detector Kam1 is located within the Kamehamenui Forest Reserve, but outside the Mitigation Site. Its location outside the Mitigation Site is a result of its deployment prior to finalizing the boundaries of the Mitigation Site. Pre-trigger baseline data from Kam1 is considered representative of bat use within the area in general; however, because it is located outside the Mitigation Site, Kam1 would be considered a control site in future analyses to assess the effect of management actions within the Mitigation Site. Detector Kam 2 is located within the Mitigation Site.

Auwahi Wind provided all acoustic monitoring equipment and associated accessories (e.g., microphones, solar panels, and batteries) and managed all aspects of the field study, including the ongoing maintenance of the detectors and data retrieval. Once retrieved, data was transferred to Western EcoSystems Technology, Inc. (WEST) for analysis. Once data was received from Auwahi Wind, WEST reviewed and verified its completeness and conducted 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 Pro 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 the 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, determine 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). To ensure consistent organization and comparability of data across years and studies, data handling procedures were consistent with those used by WEST during review of data collected during the first 2 years of monitoring and other acoustic studies conducted by WEST in Hawaii (e.g., Leeward Haleakala and Oahu occupancy studies; Thompson and Starcevich 2021, 2022), as well as analyses of Auwahi's Tier 4 Mitigation Site data (Thompson and Hammond-Rendon 2024).

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 (a detector-night was defined as one detector operating for one night);
2. **Call nightly detection** = total nights with bat calls/total active detector-nights; and
3. **Activity minutes per night** = total number of minutes during an active detector-night with at least one bat call.

A second set of metrics was generated based on feeding buzzes only, with a feeding buzz defined as the tightly spaced series of sequential echolocation pulses used to home in on prey and indicative of active feeding:

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.

Call abundance and nightly detection for all calls and feeding buzzes are the metrics identified in the Auwahi Wind Habitat Conservation Plan (HCP; Tetra Tech 2019) for monitoring purposes. Activity minutes per night was not included as a required monitoring metric in the HCP but has been included here based on additional discussion and a request from the Hawaii Endangered Species Recovery Committee (ESRC). Data are summarized for each of the two detectors by year for comparison purposes. Year 0 is defined as the initial year of pre-trigger baseline monitoring and included the period May 11, 2021–March 31, 2022; Year 1 included the period April 1, 2022–March 30, 2023. Data are only presented for Years 0 and 1, as data for Year 2 is incomplete and therefore not readily comparable to that from Year 0 and Year 1. Data collection and analysis of the Tier 5 monitoring is ongoing and Year 2 data will be included in the next interim report after additional data is obtained and analyses completed.

4 RESULTS

4.1.1 All Bat Calls

The number of detector nights sampled during the period May 11, 2021–March 30, 2023, totaled 1,223 and resulted in 44,489 bat calls at the two Tier 5 sampling stations (Kam1 and Kam2; Table 4.1). Kam1 accounted for 81% of all recorded bat calls compared to 19% at Kam2 (Table 4.1). Bat call abundance was greater at station Kam1 in both years (32.75–71.61 calls/detector night) relative to Kam2 (11.37–18.99; Table 4.1); however, call abundance at Kam1 was greater in Year 1 compared to Year 0, whereas it was lower in Year 1 compared to Year 0 at Kam2 (Table 4.1). Call nightly detection was similar and high (94–95%) at both stations in Year 0 but varied in Year 1 (82-96%; Table 4.1).

Table 4.1. Results for all bat detections during acoustic surveys conducted at two stations (Kam1 and Kam2) within the Auwahi Wind's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–March 30, 2023.

Year	# 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)	Average Bat Minutes/ Detector Night
				Kam1		
0	10,644	309	325	32.75±2.70	0.95	25.04
1	25,638	344	358	71.61±6.60	0.96	39.02
				Kam2		
0	6,152	304	324	18.99±1.35	0.94	15.62
1	2,455	178	216	11.37±1.01	0.82	10.41

[a] ± bootstrapped standard error.
Year 0 = May 11, 2021–March 31, 2022
Year 1 = April 1, 2022–March 30, 2023

4.1.2 Feeding Buzzes

For the period May 11, 2021–March 30, 2023, 111 feeding buzzes were recorded (Table 4.2). The Kam1 detector accounted for 83% of all recorded feeding buzzes compared to 17% at Kam2 and feeding buzz abundance was greater at station Kam1 in both years (0.05–0.21 feeding buzzes/detector night) relative to Kam2 (0.02–0.06; Table 4.2). However, similar to call abundance for all calls, feeding buzz abundance at Kam1 was greater in Year 1 compared to Year 0, but was lower in Year 1 compared to Year 0 at Kam2 (Table 4.2). Feeding buzz nightly detection varied more than call nightly detection for all calls and ranged from 5-16% at Kam1 and from 2–5% at Kam2 (Table 4.2). While all metrics for all bat calls were lower in Year 1 compared to Year 0 at Kam2, feeding buzz abundance and feeding buzz nightly detection were both higher in Year 1 compared to Year 0 at Kam2, indicating that while bats may not have frequented Kam2 as often during periods when the detector was operational, feeding buzzes were recorded more frequently when bats were present.

Table 4.2. Results for feeding buzz detections during acoustic surveys conducted at two stations (Kam1 and Kam2) within Auwahi Wind's Tier 5 mitigation area, Maui, Hawaii from May 11, 2021–June 22, 2022.

Year	# of Feeding Buzzes	Detector-Nights with Feeding Buzzes	Total Detector-Nights	Feeding Buzz Abundance (Feeding Buzzes/ Detector-Nights[a])	Feeding Buzz Nightly Detection (Nights Bats Detected/Total Detector-Nights[b])
Kam1					
0	16	15	325	0.05±0.01	0.05
1	76	58	358	0.21±0.03	0.16
Kam2					
0	6	6	324	0.02±0.01	0.02
1	13	10	216	0.06±0.02	0.05

[a] ± bootstrapped standard error.
Year 0 = May 11, 2021–March 31, 2022
Year 1 = April 1, 2022–March 30, 2023

4.1.3 Minutes of Activity

The average number of minutes per night with bat activity followed the same pattern as call abundance and was greater at Kam1 than Kam2 in both years (see Table 4.1). Similarly, the minutes with activity metric was greater in Year 1 (39.02) than Year 0 (25.04) at Kam1, but lower in Year 1 (10.41) than Year 0 (15.62) at Kam2 (Table 4.1). While annual patterns were not apparent based on the two years of data, minutes with activity showed clear seasonal patterns, with substantially more minutes containing bat calls recorded during the summer and fall months (Figure 4.1).

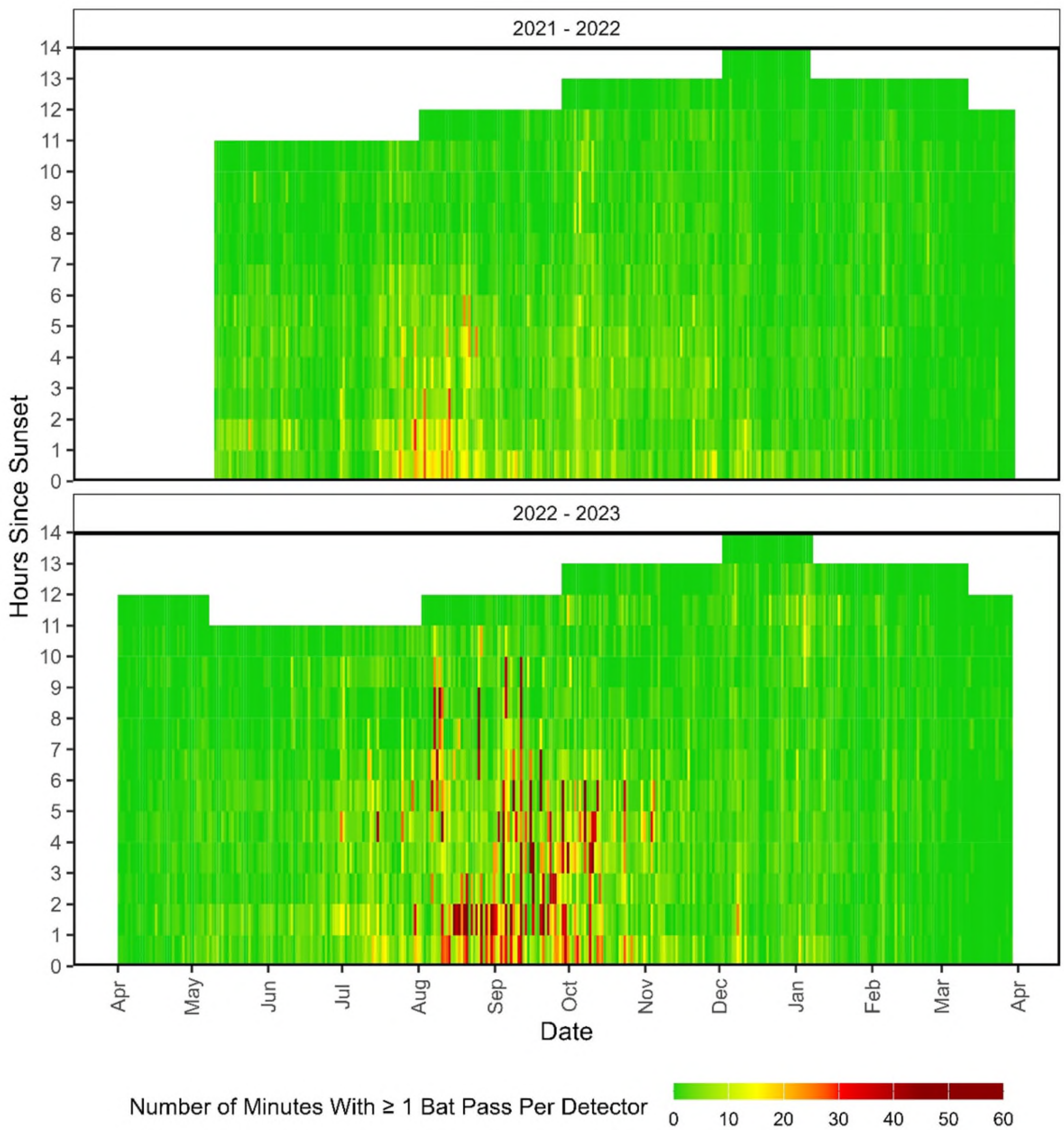

Figure 4.1. Bat activity patterns relative to sunset (hour zero) and time of year illustrated by the number of minutes with one or more bat calls averaged across the two acoustic sampling stations within Auwahi Wind's Tier 5 Mitigation Site May 11, 2021–March 30, 2023, Maui, Hawaii. Year 0 is represented in the top panel and Year 1 in the bottom panel.

5 DISCUSSION

Data available to date provides general insight into overall activity rates at the Mitigation Site and provides pre-trigger baseline data that can be used to assess monitoring study needs and to which future bat activity metrics can be compared. However, given equipment issues at detector Kam2 that resulted in decreased sampling effort during a high-use time of year (summer through fall; see Figure 4.1), all of the Year 1 activity metrics presented must be interpreted with caution in regard to year-to-year comparisons, as overall annual activity rates in Year 1 at Kam2 were likely biased low due to the lack of sampling during seasons that typically have higher bat activity.

Seasonal estimates were not calculated for the activity metrics, but it is assumed that call abundance, at minimum, would likely follow a seasonal pattern similar to the activity minutes and consistent with the seasonal patterns of HAHOBA activity reported by others (e.g., Menard 2001; Gorresen et al. 2013; Thompson and Starcevich 2021, 2022; Thompson and Hammond 2024).

While the objective of the long-term monitoring study is to measure changes in bat activity within the Mitigation Site over time in response to management activities, the current dataset presented herein represents only the pre-trigger baseline monitoring. Pre-trigger baseline monitoring was required to inform the long-term monitoring study design but also contributes to the baseline data to which future activity rates can be compared after management activities are implemented. Additional detectors will be deployed throughout the Mitigation Site (anticipated to occur in 2024) for baseline monitoring and additional data will be collected over the coming years to monitor the Mitigation Site and the response of bat activity metrics to management activities following their implementation.

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Attachment 8

FY 2025 Annual Work Plan and Timeline

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			2024						2025					
			July	Aug	Sept	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	Monthly Checks											
		Predator Assessment	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 Native Plants Outplanting											
		Ponds	Quarterly Checks											
		Water Troughs	Quarterly Checks											
		Accoustic Monitoring	Quarterly Checks											
		Insect Monitoring	Twice Yearly Checks											
	Tier 5	Pre-Baseline Acoustic Monitoring	Quarterly Checks											
		SSMIP	SSMIP Approval and Implementation											
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 9

FY 2024 Expenditures for HCP Implementation

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	Tier, Ongoing, or One-time	Event	Proposed Costs	Total Costs Incurred to Date (up to June 2024)	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)	Costs Incurred FY 24 (July 1, 2023- June 30, 2024)
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	N/A
	Ongoing	Downed Wildlife Post-Construction Monitoring and Reporting and Mitigation Monitoring	$1,810,000	$1,537,238	$100,000	$185,145	$152,901	$108,727	$96,700	$140,167	$154,185	$176,497	$90,225	$128,583	$102,800	$101,308
	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	N/A	N/A
		Subtotal General Measures	*$2,015,000*	*$1,586,663*	*$103,000*	*$186,645*	*$155,491*	*$108,727*	*$101,300*	*$148,267*	*$169,785*	*$184,297*	*$93,000*	*$132,043*	*$102,800*	*$101,308*
Hawaiian Hoary Bat	Tier 1	Retrofit fencing and restoration measures at the Waihou Mitigation Project	$522,000	$1,119,194	$314,900	$63,173	$128,410	$149,833	$126,463	$124,852	$137,337	$36,937	$26,238	$3,446	$3,549	$4,056
	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	N/A	N/A
	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	N/A	N/A
	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	N/A	N/A
	Tier 4	Ulupalakua Ranch Conservation Easement and Related Work	$4,013,047	$3,017,037	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$188,161	$881,452	$586,575	$974,695	$386,154
	Ongoing	Minimization Adaptive Management	N/A	$309,397	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$223,615	N/A	N/A	$20,000	$65,782
		Subtotal Bats	*$5,075,047*	*$5,239,306*	*$319,900*	*$137,316*	*$159,689*	*$446,944*	*$426,969*	*$206,370*	*$141,459*	*$448,713*	*$907,690*	*$590,021*	*$998,244*	*$455,992*
Hawaiian Petrel	Tier 1	Burrow Monitoring and Predator Control	$550,000	$1,378,064	$214,000	$74,572	$107,743	$56,410	$62,731	$116,885	$187,437	$76,083	$118,037	$88,106	$112,615	$163,445
		Subtotal Petrels	*$550,000*	$1,378,064	*$214,000*	*$74,572*	*$107,743*	*$56,410*	*$62,731*	*$116,885*	*$187,437*	*$76,083*	*$118,037*	*$88,106*	*$112,615*	*$163,445*
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	N/A	N/A
		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*	*N/A*	*N/A*
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	N/A	N/A
		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*	*N/A*	*N/A*
		Total HCP-related Expenditures	**$7,809,047**	**$8,373,033**	**$805,900**	**$398,533**	**$422,923**	**$612,081**	**$591,000**	**$471,522**	**$498,681**	**$709,093**	**$1,118,727**	**$810,170**	**$1,213,658**	**$720,744**