Kaheawa Wind Project II

Habitat Conservation Plan

FY 2023 Annual Report

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Incidental Take License ITL-15 / Incidental Take Permit TE27260A-1

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Executive Summary

This report summarizes work performed by Kaheawa Wind Power II, LLC (KWP II), owner of the Kaheawa Wind Project II (Project), during the State of Hawai‘i fiscal year 2023 (FY 2023; July 1, 2022– June 30, 2023) under the terms of the approved Habitat Conservation Plan (HCP). The original HCP was dated December 2011 and described KWP II's compliance obligations under the Project's state Incidental Take License ITL-15 and federal Incidental Take Permit ITP-TE27260A-1. In 2019, the HCP was amended to address higher than expected take of two species (‘ōpe‘ape‘a [Hawaiian hoary bat] and nēnē [Hawaiian goose]) at the Project; the Project operates under the resulting and updated versions of the ITL and ITP, as amended. Species covered under the amended HCP (hereafter HCP; Covered Species) include four federally and state-listed threatened and endangered species. The 14-turbine Project was constructed in 2011– 2012 and has been operating since July 2, 2012.

Fatality monitoring at the Project in FY 2023 continued within search plots limited to cleared areas within 70 meters of each Wind Turbine Generator. Canine teams searched each of the fatality monitoring plots once per week year-round. Bias correction trials were conducted quarterly at the Project to measure the probability that a carcass would persist until the next search and the probability that an available carcass would be found. In FY 2023, probabilities of a carcass persisting until the next search were 0.93 (bat surrogates), 1.00 (nēnē surrogates), and 1.00 (seabird surrogates). Searcher efficiency was 1.00 for surrogates of all three groups (bat, nēnē, seabirds).

No fatalities of Covered Species were found at KWP II during FY 2023. Through FY 2023 and excluding incidental detections, the Project's total observed direct take of Covered Species has been three ‘ōpe‘ape‘a and nine nēnē. No Covered seabird Species (‘ua‘u [Hawaiian petrel] and ‘a‘o [Newell's shearwater]) have been detected as fatalities at the Project to date. The fatality estimates using the Evidence of Absence estimator at the upper 80 percent credibility level remain at 11 for the ‘ōpe‘ape‘a and 25 for the nēnē (plus one gosling fatality attributable to Project operation, but not related to the effects of wind turbine operation analyzed using the Evidence of Absence estimator). Indirect take estimates for the Covered Species are one adult equivalent for the ‘ōpe‘ape‘a and one adult equivalent for the nēnē. Combining direct and indirect take estimate values, there is an approximately 80 percent chance that cumulative take of Covered Species at the Project from the start of operations through FY 2023 was less than or equal to 12 ‘ōpe‘ape‘a and 27 nēnē (including one gosling attributable to non-turbine collision Project risk).

The bat acoustic monitoring program data captured bat activity across the Project at five detector locations throughout FY 2023. The ‘ōpe‘ape‘a were detected on 197 of 1,727 detector-nights (11.4 percent of detector-nights). The seasonal pattern of detection rates was similar to FY 2022 with an activity increase in January.

Mitigation commitments to offset the take of Covered Species are ongoing. Current estimated take for the ‘ōpe‘ape‘a is within the Tier 3 limit of the HCP. Tier 3 mitigation has been fully funded and

began in FY 2018 through a contract with the U.S. Geological Survey's Hawaiian Hoary Bat Research Group to conduct bat ecological research on Hawai'i Island. This project is expected to be complete in December 2023. Current estimated take for the nēnē is within the Tier 2 limit of the HCP. Kaheawa I Wind Project (KWP I) and KWP II jointly assumed management of the mitigation program at the Haleakalā Ranch release pen in mid-December 2022. In FY 2023, a total of five nēnē offspring fledged from the Haleakalā Ranch release pen. KWP I and KWP II are actively working with DOFAW and USFWS to determine how to attribute these mitigation benefits. No observed take has occurred for Covered Seabird Species; therefore, both species are within the Tier 1 limit of the HCP. Tier 1 mitigation was completed in FY 2023 through the implementation of a comprehensive plan for seabird colony management at the Makamaka'ole Seabird Mitigation Site as well as implementation of predator control and burrow monitoring at a 'ua'u breeding colony on Lāna'i.

KWP II communicated actively with USFWS and DOFAW throughout FY 2023. Communication was conducted through conference calls, quarterly reports, and emails related to the Project's HCP. One in-person meeting between Brookfield, DOFAW and USFWS was conducted in FY 2023, otherwise all meetings were conducted via teleconference. Communications content primarily focused on mitigation, including the development of new mitigation projects, mitigation funding, and the evaluation of mitigation benefits.

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1.0 Introduction

The Hawai‘i Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW) and U.S. Fish and Wildlife Service (USFWS) approved the Kaheawa Wind Project II (Project) Habitat Conservation Plan (HCP) in 2012. In January 2012, the Project received a federal incidental take permit (ITP; ITP-TE27260A-0) from the USFWS and a state incidental take license (ITL; ITL-15) from DOFAW. In 2019, DOFAW and USFWS approved an HCP Amendment to (hereafter HCP; SWCA 2019) to address the higher-than-expected take of two species, and the ITP and ITL were reissued (ITP-TE27260A-1; September 2019 and amended ITL-15; November 2019). The ITP and ITL cover the incidental take of four federally and state-listed, threatened and endangered species (the Covered Species) over a 20-year permit term.

The Covered Species include:

- ‘Ōpe‘ape‘a (Hawaiian hoary bat, *Lasiurus cinereus semotus*)[1];
- Nēnē (Hawaiian goose, *Branta sandvicensis*)[1];
- ‘Ua‘u (Hawaiian petrel, *Pterodroma sandwichensis*); and
- ‘A‘o (Newell’s shearwater, *Puffinus newelli*).

The Project was constructed in 2011 and 2012 and was commissioned on July 2, 2012. Brookfield Renewable Partners, LP acquired the Project’s LLC through acquisition of a controlling interest in TerraForm, LLC in 2017; the Project continues to be operated by Kaheawa Wind Power II, LLC (KWP II).

On behalf of KWP II, Tetra Tech, Inc. (Tetra Tech) has prepared this progress report to describe the work performed for the Project during the State of Hawai‘i 2023 fiscal year (FY 2023; July 1, 2022–June 30, 2023) pursuant to the terms and obligations of the approved HCP, ITL, and ITP. The Project has previously submitted annual HCP progress reports to DOFAW and USFWS for FY 2013 through FY 2022 (KWP II 2013, KWP II 2014, KWP II 2015, KWP II 2016, KWP II 2017, KWP II 2018, Tetra Tech 2019, Tetra Tech 2020, Tetra Tech 2022a, Tetra Tech 2022b).

2.0 Fatality Monitoring

Since operations began in July 2012, the Project has implemented a year-round intensive monitoring program to document downed (i.e., injured or dead) wildlife incidents involving Covered Species and other species. In consultation with USFWS, DOFAW, and the Endangered Species Recovery Committee (ESRC), fatality search areas have evolved over time from the start of operations through the initiation of the current approach in 2015. The last modifications were in

[1] Among other modifications, increased take and mitigation for impacts to the nēnē and ‘ōpe‘ape‘a were addressed in the 2019 approved HCP Amendment.

response to the March 31, 2015 ESRC meeting wherein members agreed to "encourage the applicant to work with the statistical experts and researchers to develop an alternative more efficient and focused monitoring strategy which still meets the committee's expressed preference for continuation of annual monitoring." Initially, monitoring occurred within the entirety of 70-meter radius circular plots centered on each wind turbine generator (WTG). Beginning in July 2015, with agreement from the agencies, the search area was reduced to the WTG graded pads and access roads cleared of vegetation that fall within a 70-meter radius circle centered on each of the Project's 14 WTGs (Figure 1). This search area continued to be used for monitoring in FY 2023.

In FY 2023, all 14 WTGs were searched for fatalities once per week. The FY 2023 mean search interval for all WTGs was 6.98 days (Standard Deviation = 0.3 days); no search dates were missed. All search plots were inspected by a canine search team which included a trained detector dog accompanied by a handler; no visual-only searches occurred in FY 2023.

Special precautions have been taken to eliminate any potential canine interactions with wildlife, with a focus on the nēnē. If nēnē were present nearby, the canine handler immediately retrieved and restrained the dog to avoid disturbing the birds, and either postponed searching in the vicinity of the birds, worked on leash away from any geese, or temporarily skipped canine searches in the vicinity. A total of 47 observations of 189 (non-distinct) individual nēnē were made by the canine handler over 29 days between October 2022 and May 2023. In each case, the handler moved the canine to a different WTG search area and returned to finish the disrupted search later in the day. No canine-wildlife interactions were observed.

3.0 Carcass Persistence Trials

One 28-day carcass persistence trial was conducted in each quarter of FY 2023, for a total of four trials. Each trial tested five black rats (*Rattus rattus*) for ʻōpeʻapeʻa surrogates, two to three large chickens (*Gallus gallus*) for nēnē surrogates (i.e., large birds), and two to three wedge-tailed shearwater (*Ardenna pacifica*) carcasses as surrogates for the ʻuaʻu and ʻaʻo (i.e., medium birds; Covered Seabird Species).

In FY 2023, the probability that a carcass persisted until the next search was 0.93 for all bat surrogates (95 percent Confidence Interval [CI] = 0.87, 0.97; N=20), 1.00 for large birds (95 percent CI = 0.97, 1.00; N=10), and 0.97 for medium-sized birds (95 percent CI = 0.87, 0.99; N=10).

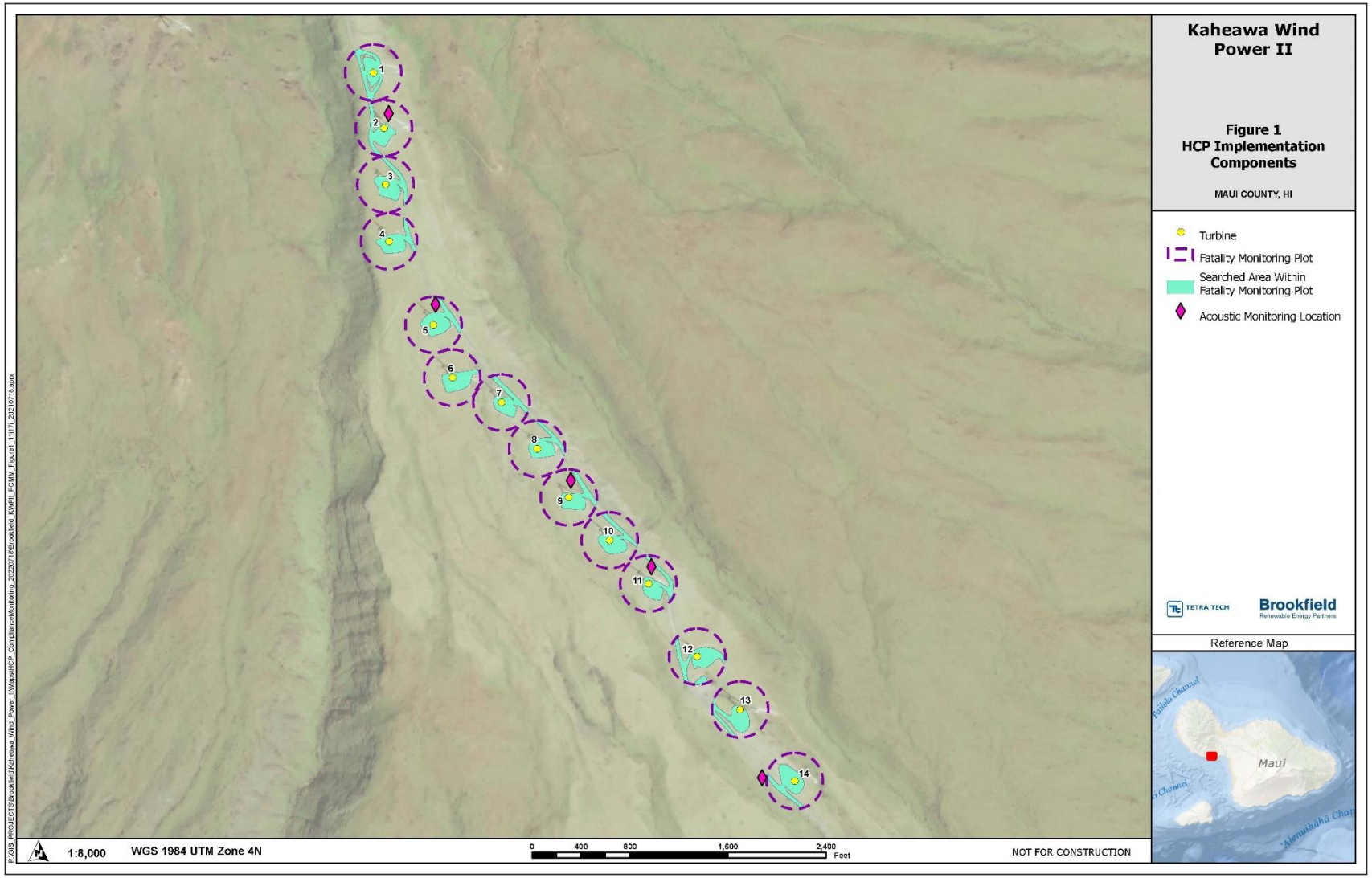

Figure 1. HCP Implementation Components

4.0 Searcher Efficiency Trials

A total of 65 individual searcher efficiency carcasses (trial carcasses) over 19 trial dates were administered during FY 2023. Similar to the carcass persistence trials, black rats were used as surrogates for bats and large chickens were used as surrogates for the nēnē. Surveyors used wedge-tailed shearwaters and other medium-sized birds collected or procured under the Project's Special Purpose Utility Permit (MBPER0055564-0 valid through 03-31-2025) and Protected Wildlife Permit (WL21-18, valid through 01-24-2024) as surrogates for Covered Seabird Species. Searcher efficiency trials occurred approximately twice monthly throughout the year; all trials tested canine search teams in FY 2023 (no visual only searches occurred in FY 2023). Of the 65 trial carcasses placed, seven bat surrogates and two wedge-tailed shearwaters were not available for detection (e.g., scavenged prior to the search).

For FY 2023, the probability that a canine search team would find a carcass was 1.00 for bat surrogates (95 percent CI = 0.94, 1.00; N=38), 1.00 for large birds (95 percent CI = 0.78, 1.00; N=10), and 1.00 for medium-sized birds (95 percent CI = 0.74, 1.00; N=8).

5.0 Vegetation Management

In order to maximize fatality monitoring efficiency and minimize impacts to native plants without compromising soil stability, KWP II performs vegetation management at the Project. Vegetation management activities have evolved over time, and account for management activity restrictions during the nēnē nesting season. The evolution of vegetation management includes:

- Initial vegetation management activities within the search plots were limited to between April 1 and October 31 to minimize risk during the nēnē nesting season.
- In November 2016, Stephanie Franklin (DOFAW-Maui) verbally approved using hand management tools (spray packs and weed whackers) during the nēnē nesting season if the activity was within the current search area and did not disturb wildlife.
- In March 2017, Stephanie Franklin verbally approved the removal of Christmas berry (*Schinus terebinthifolius*) within 70 meters of the WTGs to reduce potential nēnē nesting habitat in the vicinity.
- In September 2021, Stephanie Franklin verbally approved the continuation of the quarterly management program and woody vegetation removal using hand and power tools, and manual application of herbicide on cut stumps as necessary, in proximity to select turbines. Verbal approval was also given for additional woody vegetation removal within a 1-meter buffer of select turbine access roads noting that all woody vegetation removal work must be completed between April 1 and October 31 and in conjunction with a biological monitor.

In FY 2023, quarterly vegetation management was implemented at the Project. During these quarters, a glyphosate-based herbicide treatments using a boom sprayer were applied to the cleared areas within each search plot, supplemented by weed whacking to maintain consistency of the extent of the cleared area within 70 meters of each WTG. In each quarter that vegetation management occurred, the herbicide was applied after the areas were deemed clear of nēnē activity by a biological monitor. Additionally, in Q1, woody vegetation removal in the vicinity of WTG 8 was conducted. Target species for removal included ironwood (*Casuarina equisetifolia*), Christmas berry, lantana (*Lantana camara*), and koa haole (*Leucaena leucocephala*) using cut stump/basal treatment methods. Additionally, all debris piles were removed and scattered with the use of a woodchipper onsite.

6.0 Scavenger Trapping

KWP II implements periodic scavenger trapping at the Project to extend carcass persistence times and contribute to a high probability of a carcass persisting until the next search. The program includes a once-quarterly intensive trapping effort followed by ongoing biweekly (every other week) trapping effort. In FY 2023, the number of traps in use for each effort was 17 DOC250 and 14 cage traps. This level of effort is consistent with the increased level of effort employed in FY 2022 to address reduced probabilities of carcasses persisting the next search and provide additional protections to the nēnē and resulted in 160 trap nights per year for cage traps, and 364 trap nights per year for the DOC250s. In FY 2023, the scavenger trapping program removed 13 mongooses (*Herpestes auropunctatus*) and 7 feral cats (*Felis cattus*). No non-target animals were trapped. This program also benefits the resident wildlife, including the nēnē, by reducing the potential for predation.

7.0 Documented Fatalities and Take Estimates

No take of any HCP Covered Species was documented in FY 2023. No injured (live) downed wildlife was observed at the Project in FY 2023.

To calculate take estimates, the number of observed fatalities is scaled to account for fatalities that are not detected (unobserved). Unobserved fatalities are the result of three primary factors:

- Carcasses may be scavenged before searchers can find them;
- Carcasses may be present, but not detected by searchers; and
- Carcasses may fall outside of the searched area.

Carcass persistence and searcher efficiency (bias correction; see Sections 3.0 and 4.0) measure the effect of the first two factors. The third factor, the number of carcasses that fall outside of the searched area, is dependent upon the proportion of the carcass distribution that is searched. The search area for fatalities at the Project has evolved over time (Section 2.0); therefore, the

proportion of the carcass distribution searched has varied historically. However, no change to the search plots has been made since FY 2016 (Section 2.0). Thus, the estimate of the proportion of the carcass distribution searched (DWP; Appendix 1) has remained the same as described in the FY 2017 annual report (KWP II 2017).

Cumulative take at an upper credible limit (UCL) of 80 percent was calculated for each Covered Species for which documented fatalities have occurred, per request of USFWS and DOFAW. The UCL is estimated from three components:

1. Observed direct take (ODT) during protocol (standardized) fatality monitoring;
2. Unobserved direct take (UDT); and
3. Indirect take.

The Evidence of Absence software program (EoA; Dalthorp et al. 2017), the agency-approved analysis tool for analyzing direct take, uses results from bias correction trials and ODT to generate a UCL of direct take (i.e., ODT + UDT). Direct take values from this analysis can be interpreted as an 80 percent probability that actual direct take at the Project over the analysis period was less than or equal to the 80 percent UCL. Indirect take calculations are based on the HCP and agency guidance. Indirect take is estimated based on factors such as the breeding season in which fatalities are observed, sex, and age characteristics of Covered Species fatalities found at the Project, their associated life history characteristics as described in the Project's approved HCP, and current agency guidance (e.g., USFWS 2016 for the ʻōpeʻapeʻa).

Additionally, EoA includes a module that allows users to project future estimates of mortality based on results of past fatality monitoring. Due to the inherent uncertainty of these projections (including the potential future contribution of indirect take) and the amplification of this uncertainty resulting from the use of the 80 percent UCL as the estimate of take for regulatory compliance, it is important to note that long-term projections have limited utility. Nevertheless, they do help gauge the likelihood of permitted take exceedance and may help operators in their mitigation planning, assuming future management and monitoring conditions can be reasonably estimated.

7.1 ʻŌpeʻapeʻa

7.1.1 Estimated Take

A total of four ʻōpeʻapeʻa fatalities have been observed at the Project since operation began in July 2012, with no take observed in FY 2023. Three observed bat fatalities have been found within the search area and are used to estimate UDT. One of the fatalities was classified as an incidental observation. All bat carcasses were transferred to the U.S. Geological Survey for genetic sexing (Pinzari and Bonaccorso 2018). The ʻōpeʻapeʻa fatalities by fiscal year are listed in Table 1.

Table 1. Observed ʻŌpeʻapeʻa Fatalities at KWP II through FY 2023

Fiscal Year	ʻŌpeʻapeʻa Observed Direct Take	ʻŌpeʻapeʻa Incidental Fatality Observations	Total
2013	1	0	1
2014	2	0	2
2015	0	0	0
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	1	1
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
Total	**3**	**1**	**4**

The estimated direct take (ODT + UDT) for the four ʻōpeʻapeʻa fatalities found between the start of operation (July 2012) and end of FY 2023 (June 30, 2023) is less than or equal to 11 bats (80 percent UCL; Appendix 1a).

Indirect take is estimated to account for the potential loss of individuals that may occur indirectly as the result of the loss of an adult female through direct take during the period that females may be pregnant or supporting dependent young. The timing and sex of all observed fatalities (those observed in fatality monitoring as well as incidental to fatality monitoring) is used in the calculation of indirect take. Cumulative indirect take through FY 2023 remained the same as in FY 2022 at 0.47 adults (Appendix 2a).

The UCL for Project take of the ʻōpeʻapeʻa at the 80 percent credibility level is 12 adult bats (11 estimated direct take + one estimated indirect take, rounded up from 0.47). That is, there is an approximately 80 percent probability that actual take at the Project at the end of FY 2023 is less than or equal to 12 bats (Appendix 1a). This value has not changed since the FY 2022 Annual Report (Tetra Tech 2022a).

7.1.2 Projected Take

KWP II has projected ʻōpeʻapeʻa take through the end of the permit term using the fatality monitoring data collected through FY 2023 to evaluate the potential for the Project to exceed the permitted take limit at the 80 percent UCL prior to the end of the permit term (Appendix 3a). For this analysis, the detection probability for future years is conservatively assumed to match the detection probability of FY 2021 (0.408; 95 percent CI 0.333, 0.486), and the fatality rate is unaltered for all future years (rho=1). Future indirect take is unknown and will potentially vary

based on the timing of any ODT. Therefore, based on historical Project data, Tetra Tech assumed a total indirect take for the Project over the permit term would be a maximum of two adult equivalents (approximately six juveniles based on assumed ʻōpeʻapeʻa survival rates; or 5.3 percent of the permitted take; USFWS 2016). Currently, the proportion of total take that is attributable to indirect take is 4.1 percent (0.47 [adult bat equivalents estimated from indirect take] / 11.47 bats [bats estimated combining the direct and indirect take]), making the assumption of indirect take of two adult bats conservative. Assuming two adult bat equivalents are attributed to the Project as indirect take, direct take allowable under the HCP would be 36 bats (38 bats [permitted take] minus 2 bats [estimated as attributed to indirect take] = 36 bats [estimated direct take maximum]).

Based on the analysis described above and presented in Appendix 3a, there is a 98.55 percent chance that the 80 percent UCL of cumulative take *will not* be exceeded during the permit term. In addition, the median years of operations without exceeding this direct take threshold is 20, suggesting that even with an indirect take contribution of two adult equivalents, the Project is unlikely to exceed a cumulative take estimate of 38 bats (permitted take). Appendix 3a also indicates that the Tier 3 threshold of 30 bats is unlikely to be exceeded during permit term. Therefore, the Project is likely to remain below both Tier 3 of ʻōpeʻapeʻa take threshold of 30 bats *and* the permitted take limit of 38 bats for the permit term.

7.2 Nēnē

7.2.1 Estimated Take

A total of 14 adult nēnē fatalities and 1 gosling fatality have been observed at the Project since the beginning of operation, with no observed take in FY 2023. Nine of the 14 observed adult fatalities have been found within the search area and are used to estimate UDT. Five of the 14 observed fatalities were classified as incidental observations. One gosling was detected in FY 2018; as the gosling was not capable of flight, it is accounted for independently of the analysis of take associated with collision risk. The observed nēnē fatalities by fiscal year are listed in Table 2.

Table 2. Observed Nēnē Fatalities at KWP II through FY 2023

Fiscal Year	Nēnē Observed Direct Take	Nēnē Incidental Fatality Observations	Total
2013	1	0	1
2014	0	0	0
2015	2	0	2
2016	1	0	1
2017	0	0	0
2018	1	3[1]	4[1]
2019	0	1	1
2020	3	0	3
2021	0	0	0

Fiscal Year	Nēnē Observed Direct Take	Nēnē Incidental Fatality Observations	Total
2022	1	1	2
2023	0	0	0
Total	**9**	**5[1]**	**14[1]**

1. Excludes one gosling detected in FY 2018 attributable to wind farm operations other than turbines.

The estimated direct take (ODT + UDT) for the 14 nēnē fatalities found between the start of operation (July 2012) and end of FY 2023 is less than or equal to 25 geese (80 percent UCL; Appendix 1b).

The gosling was then added as a single additional juvenile fatality, adjusted to an adult based on estimated survival rates ($1*0.8^3$); the gosling fatality translates to 0.512 adult equivalents. The gosling was added to the estimate of 25 geese at the 80 percent UCL that resulted from the EoA analysis for a total estimated direct take of 25.512.

Indirect take is estimated to account for the potential loss of individuals that may occur as the result of the loss of their parents. Both parents for the nēnē care for young post-fledging (Banko et al. 2020). The point during the breeding season when an adult is taken determines to what extent offspring may be affected (SWCA 2011). Cumulative indirect take through FY 2023 was 1.59 fledglings (0.82 adult equivalents, assuming a 0.8 annual survival rate and 3 years from fledging to adult; Appendix 2b).

Thus, the UCL for cumulative Project take of the nēnē at the 80 percent credibility level is 27 geese (25 [estimated direct take from EoA] + 1 observed gosling fatality*0.512 adults/gosling + 0.82 [estimated adult equivalent indirect take], rounded up). That is, there is an approximately 80 percent probability that actual take at the Project at the end of FY 2023 is less than or equal to 27 adult geese. This value is the same as was reported in the FY 2022 Annual Report (Tetra Tech 2022b).

In FY 2022 KWP II, USFWS, and DOFAW reached consensus on mitigation credits attributable to the Project through 2021; however consensus has not been reached on mitigation credit through FY 2023. The total mitigation credits assigned through 2021 are distributed annually as indicated in rows K and L of Appendix 2b, as agreed to in FY 2022. Per the HCP, the Project may cause a net loss in productivity in the event that take outpaces the number of individuals produced from mitigation efforts. The lag between production of geese through mitigation efforts and the take of geese at the Project drive the estimate of lost productivity. Accrued lost productivity at a given point in time is calculated as the cumulative take less the number of individuals generated from mitigation efforts to date, and then adjusted by a factor of 0.1 to account for the probability that those unmitigated birds would have produced young (SWCA 2011). Accrued lost productivity is not calculable without mitigation credit data, an assessment of which will be determined in consultation with agencies.

7.2.2 Projected Take

KWP II has projected nēnē take through the end of the permit term using the fatality monitoring data collected through FY 2023 to evaluate the potential for the Project to exceed the permitted take limit at the 80 percent UCL prior to the end of the permit term (Appendix 3b). For this analysis, the detection probability for future years is conservatively assumed to match the detection probability of FY 2021 (0.361; 95 percent CI 0.339, 0.384), and the fatality rate is unaltered for all future years (rho=1). Future indirect take is unknown and will potentially vary based on the timing of any ODT. Based on historical Project data, we assumed total indirect take for the Project over the permit term would be a maximum of two adult equivalents (approximately four juveniles based on an assumed nēnē survival rate from juvenile to adult of 0.512; SWCA 2011), or 4.54 percent of the permitted take limit in the HCP. Currently, the proportion of total take that is attributable to indirect take is 3.11 percent (0.82 adult geese equivalents estimated from indirect take / 26.33 geese estimated combining the direct and indirect take) making the assumption of two adult indirect take conservative.

The permitted take limit for the nēnē is 44. Future indirect take is unknown and will potentially vary based on the timing of ODT. Assuming two adult nēnē equivalents are attributed to the Project as indirect take, the permitted direct take under the HCP would be 42 nēnē (44 geese [permitted take] minus 2 geese [estimated indirect take = 42 geese [estimated direct take maximum]).

Based on the analysis, there is approximately 44 percent probability that the 80 percent UCL of cumulative take at the Project *will not* exceed the permitted amount during the permit term (Appendix 3); EoA calculated a median estimate of 18.65 years of Project operation without a direct take estimate exceeding 42 geese. Estimated take at the 80 percent UCL at the Project has surpassed 75 percent of allowable take in the current tier take. KWP II has also taken actions to minimize the threats to the nēnē at the Project and continues to work with USFWS, DOFAW, and technical experts to address mitigation and further reduce risk (Section 10.0). Given the conservative assumptions used in the analysis and the recent implementation of risk minimization measures, it is likely the risk of permit exceedance is over-estimated.

7.3 Non-listed Species

Three non-listed bird species were documented as WTG-related fatalities at the Project site in FY 2023: black francolin (*Francolinus francolinus*; one fatality), white-tailed tropicbird (*Phaethon lepturus*; one fatality), and cattle egret (*Bubulcus ibis*; one fatality). Black francolin and cattle egret are non-native, introduced birds, while white-tailed tropicbird in a native seabird, however both cattle egret and the white-tailed tropicbird are Migratory Bird Treaty Act (MBTA)-protected species. For details of these fatalities for FY 2023, see Appendix 4.

8.0 Wildlife Education and Observation Program

The wildlife education and observation program (WEOP) helps to ensure the safety and well-being of native wildlife in work areas and along site access roadways. The training provides useful information to assist staff, contractors, and visitors to be able to conduct their business in a manner consistent with the requirements of the HCP, the Conditional Use Permit, land use agreements and applicable laws. Personnel are trained to identify Covered Species and other species of wildlife that may be found on-site and what protocol to follow, as determined in the HCP and through relevant agency guidance (e.g., USFWS and DOFAW 2020), when downed wildlife is found. The trainees are also made aware of driving conditions and receive instruction on how to drive and act around wildlife. Records of wildlife observations by WEOP-trained staff are also used by the HCP program to identify the patterns of wildlife use of the site.

WEOP trainings were provided over six dates in FY 2023 training total of 29 people. WEOP trainings will continue to be conducted on an as-needed basis to provide on-site personnel with the information required to respond appropriately in the event they observe a Covered Species or encounter downed wildlife while on-site.

9.0 Mitigation

The Project's mitigation requirements are described in Section 6.0 of the HCP (SWCA 2011, SWCA 2019).

9.1 ʻŌpeʻapeʻa

9.1.1 Mitigation

Mitigation for Tier 1 and Tier 2 estimated bat take has been completely funded at Kahikinui State Forest Reserve (KWP II 2018). The habitat management program founded through Project mitigation funding continues under DOFAW management (DOFAW 2021). Mitigation for Tier 3 estimated take (19 bats within Tier 3) was contracted to the U.S. Geological Survey (USGS) Hawaiian Hoary Bat Research Group. Bat ecological research on Hawaiʻi Island began in FY 2018 and is intended to better inform future bat habitat restoration and conservation. KWP II's contract with USGS was completely funded in FY 2021 (Tetra Tech 2022a). The research project is expected to be completed in December 2023 with final publication, technical results, and data releases. The Project in combination with Brookfield's Kaheawa I Wind Project (KWP I) had a total funding obligation of $1.7M to allocate to portions of each Project's mitigation requirement. KWP II, in combination with KWP I, exceeded its funding obligation by $131,500 over the original cost, for a total combined expenditure of $1,831,500.

Assuming the current take rate and search conditions remain unchanged through the remainder of the permit term, Tier 4 mitigation will not be necessary.

9.1.2 Acoustic Monitoring at the Project

The HCP commits KWP II to acoustic monitoring for bat activity throughout the 20-year permit period. Acoustic monitoring has been conducted continuously beginning in 2012. In October 2013 (FY 2014) eight Song Meter SM2BAT+ ultrasonic recorders (SM2) were deployed, replacing Anabat SD2 bat detectors. Each SM2 unit is equipped with one SMX-U1 ultrasonic microphone (Wildlife Acoustics, Maynard, MA, USA) positioned horizontally, facing southwest (away from the prevailing NE trade winds), 6.5 meters above ground level. In October 2019 (FY 2020) the Pali brush fires burned across most of the Project destroying six SM2 units. For the remainder of the FY 2020 (October 2019 to June 2020) only two sites (WTGs 9 and 11) were monitored for acoustic bat activity. To continue with the objectives of the monitoring program and address gaps in the spatial coverage of SM2 units resulting from the brush fire, the monitoring regime was redesigned in July 2020 with the deployment of five SM2 units (WTGs 2, 5, 9, 11, and 14; Figure 1). Additionally, because of differences in the equipment used prior to FY 2014, data collected in FY 2023 is only comparable to data collected between FY 2014 and FY 2022.

The objective of bat acoustic monitoring is to better understand the annual and seasonal variation in bat activity at the Project. Analysis of variance (ANOVA) and a Tukey's Honest Significant Difference (HSD) post-hoc test were used to test for interannual differences in detection rates between sampling years. A linear model (LM) was constructed to test for a change in detection rates across all sampling years. FY 2014 was removed from the analysis because it did not represent a full sampling year and excluded months known to have high detection rates (July, August, and September). All data were normalized with an Ordered Quantile Normalization transformation using the 'bestNormalize' package in R (Peterson 2021). The distribution of residuals from the LM were examined to check for violations of model assumptions. All tests were two-tailed, employed an alpha value of 0.05, and were conducted in R version 4.2.3 (R Core Team 2023).

In FY 2023, 'ōpe'ape'a were detected on 197 out of 1,727 detector-nights sampled (11.4 percent; Table 3). Detection rates (proportion of nights with detections) increased during the lactation and post-lactation reproductive periods[2], reaching a peak in September (0.36) and then declined in October, November, and December (Figure 2). In January, at the beginning of the pre-pregnancy reproductive period, a second peak in detection rates occurred (0.17) and then quickly declined again in February and March. A third smaller peak in activity (0.08) occurred in April at the beginning of the pregnancy reproductive period, followed by a decline in May and June (Figure 2). This seasonal pattern of detection rates in FY 2023 was similar to FY 2022. However, the annual trend in detection rates observed in FY 2022 and FY 2023 differs from the bimodal trend frequently observed among previous monitoring years (Figure 3). Detection rates during the lactation and first half of the post-lactation reproductive periods were within range of detection rates observed among the previous sampling years. The cause(s) for the larger January peak observed in FY 2022 and FY 2023 are unknown.

[2] Corresponding reproductive periods defined by Gorresen et al. (2013).

The annual detection rate in FY 2023 (11.4 percent) was marginally higher than the annual detection rate in FY 2022 (9.2 percent). Annual detection rates varied between all monitoring years (Table 3) but were not significantly different (ANOVA: $F_{8,99} = 1.98$, $P > 0.057$). Across all monitoring years (FY 2015 to FY 2023) there is a significant increasing trend in the annual detection rate (LM: $r^2 = 5.66$ percent; $F_{1,106} = 6.35$, $P < 0.014$; Figure 4).

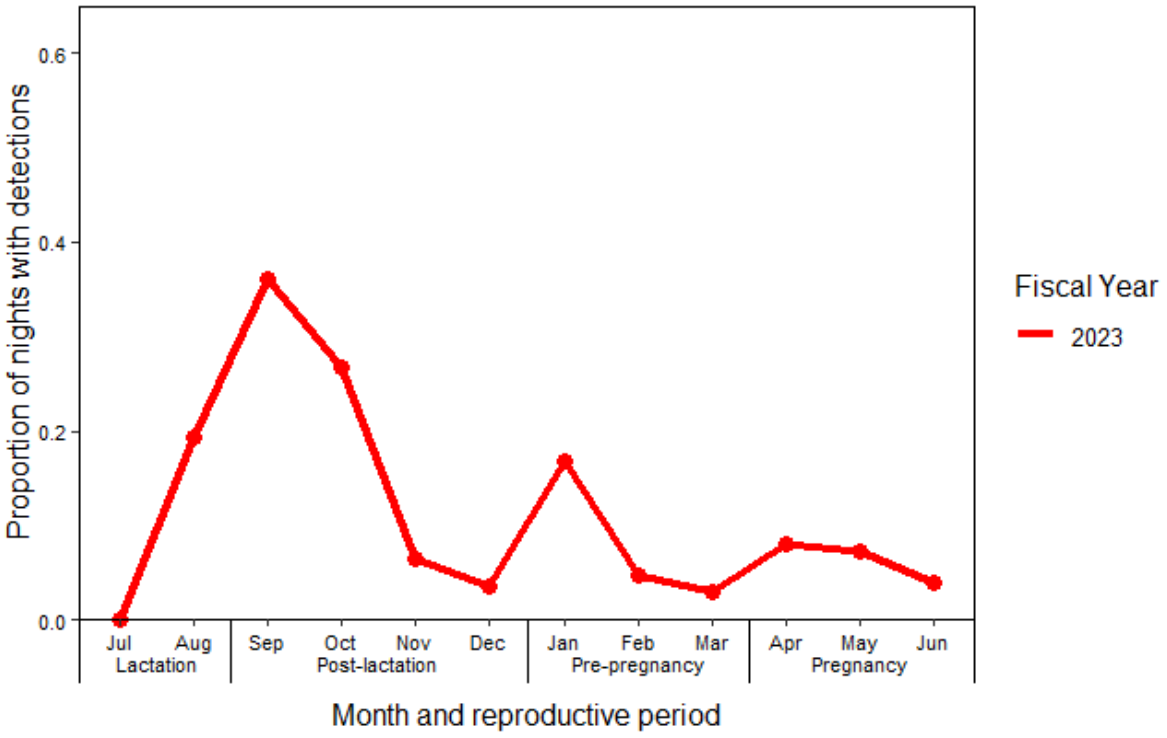

Figure 2. Monthly Detection Rates at the Project in FY 2023 with Corresponding Reproductive Periods

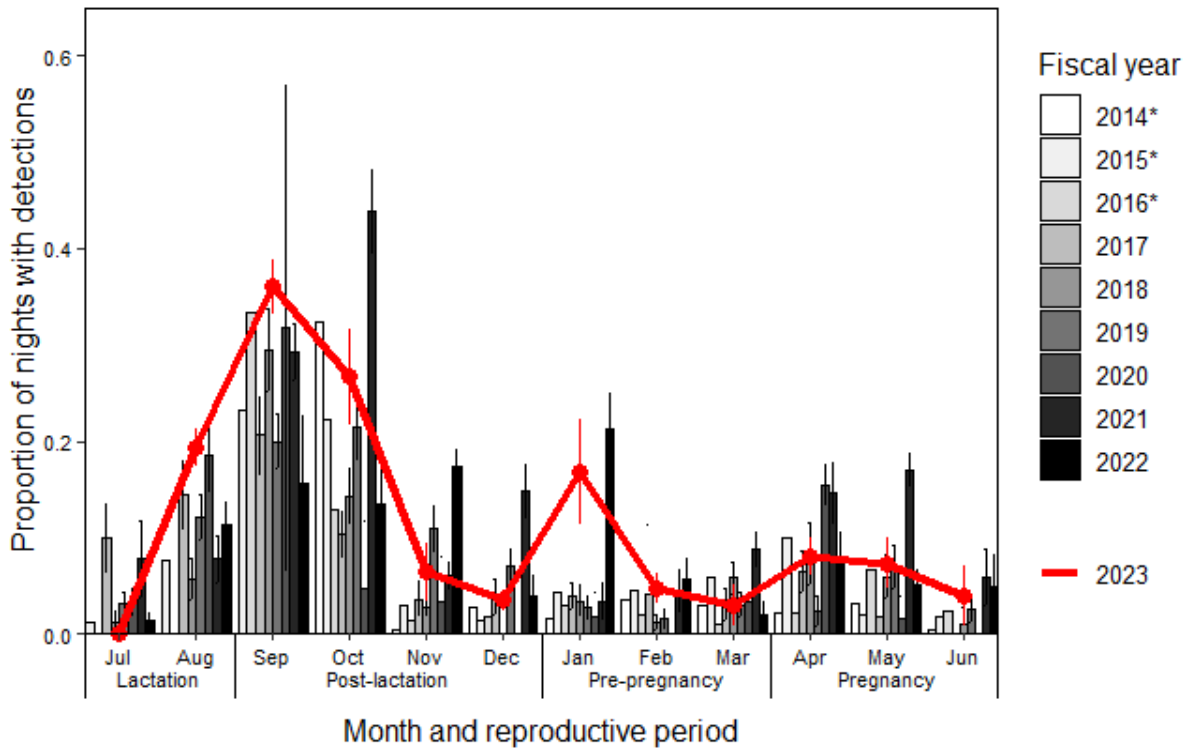

Figure 3. Monthly Bat Detection Rates at the Project for FY 2014 to FY 2023 with Corresponding Reproductive Periods[3]

[3] Error bars (SE) not available for fiscal years 2014, 2015, and 2016.

Table 3. Number of Nights Sampled, Number of Nights with Detections, and Proportion of Nights with Bat Detections Between FY 2014 and FY 2023

Dates[1]	No. of Nights Sampled	No. of Nights with Detections	Proportion of Nights with Detections
FY 2014 (October 2013 - June 2014)	2,183	85	0.039
FY 2015 (July 2014 - June 2015)	2,864	204	0.071
FY 2016 (July 2015 - June 2016)	2,038	110	0.054
FY 2017 (July 2016 - June 2017)	2,217	166	0.075
FY 2018 (July 2017 - June 2018)	2,103	386	0.183
FY 2019 (July 2018 - June 2019)	2,549	211	0.083
FY 2020 (July 2019 - June 2020)	1,146	117	0.102
FY 2021 (July 2020 - June 2021)	1,671	232	0.139
FY 2022 (July 2021 - June 2022)	1,780	163	0.092
FY 2023 (July 2022 - June 2023)	1,727	197	0.114

1. Number of monitoring sites: FY 2014 – 2019 (n = 8), FY 2020 starting October 2019 (n = 2), FY 2021 – 2023 (n = 5)

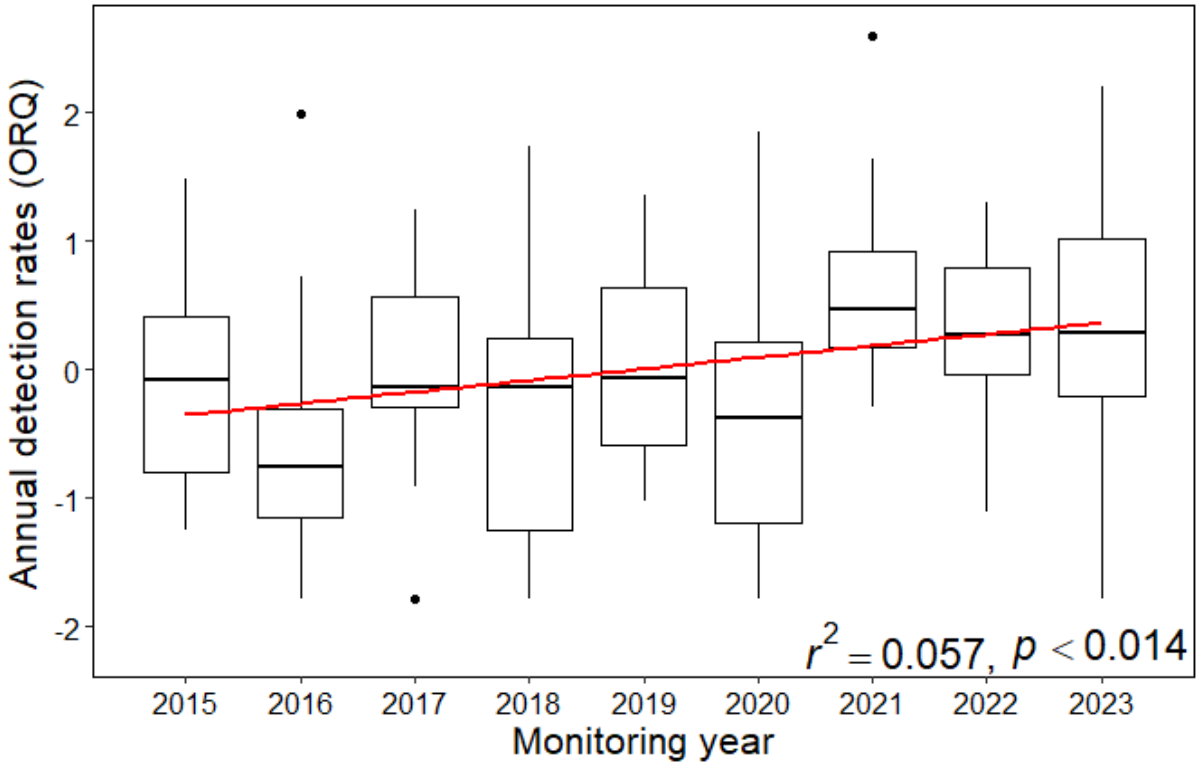

Figure 4. Box-plot with Linear Regression Showing the Increasing Trend in the Annual Detection Rate at the Project Between FY 2015 and FY 2023[4]

9.2 Nēnē

The Project provided funds to DOFAW in FY 2017 for management of Maui-based nēnē release pens with significant activity or nesting. Specifically, the funding supported predator control, fence maintenance, vegetation management and monitoring of a nēnē release pen at Piʻiholo Ranch in FY 2017, FY 2018, and part of FY 2019. The Project also provided funding for a technician at the Haleakalā Ranch release pen from October 2018 through February 2019. In May 2020, the Project provided $112,682 to fund nēnē mitigation activities performed by DOFAW at the Piʻiholo Ranch release pen. DOFAW was unable to process these funds in May 2020 when they were received due to internal limitations (pers. comm., A. Siddiqi, DOFAW, June 16, 2021). In 2021 the Piʻiholo Ranch was sold and the release pen was no longer available for mitigation. While DOFAW communicated intent to return the funds to KWP II in 2021, this action was not taken. Mitigation benefit has not yet been attributed to KWP II for FY 2021, or FY 2022. The total mitigation credit accrued through 2020 is 9.09 adult equivalents (Smith 2021, LeBlanc 2022).

[4] Ordered Quantile normalization transformation (ORQ). All data were normalized using this transformation

In mid-December 2022 at DOFAW's request, KWP II and KWP I took on management of the Haleakalā Ranch release pen. During the 2022/2023 breeding season, three nests fledged five nēnē offspring (Appendix 5). KWP II is in discussion with DOFAW and USFWS regarding splitting the resulting mitigation benefit with KWP I, and is currently working with the agencies to assess the benefit using the agreed-upon framework for mitigation credits (see Section 7.2.1 and Appendix 2b). It is important to note that the cumulative increases in adult and juvenile survival and productivity achieved by KWP II's mitigation projects have not been sufficient to fully offset the mitigation obligations of Tier 1 or Tier 2, and KWP II is actively working with agencies to address its nēnē mitigation deficit.

9.3 Seabirds

KWP II is committed to seabird protection and recovery on Maui and within Maui Nui. In FY 2023, KWP II completed its mitigation obligation for both the ʻaʻo and ʻuaʻu, as described below.

9.3.1 ʻAʻo Survey – East Maui

KWP II funded surveys for potential mitigation sites on east Maui, which were completed in September 2015 (KWP II 2016). These surveys identified potential colony locations, estimated the numbers of birds present, assessed predator activity, and evaluated management feasibility at the colony locations.

9.3.2 ʻAʻo – Makamakaʻole

Mitigation efforts at Makamaka'ole began with the construction of the two predator exclosures completed in September 2013. Mitigation efforts at Makamaka'ole involved predator monitoring and trapping, artificial burrow checks and monitoring using game cameras, seabird social attraction using decoys and sound systems, and ongoing maintenance, including vegetation management, of both enclosures.

In 2022, continued mitigation efforts at Makamakaʻole were contracted to Maui Nui Seabird Recovery Project (MNSRP) through the 2022 calendar year breeding season (hereafter, 2022 breeding season). Project staff visited the enclosures with MNSRP to ensure consistent oversight. MNSRP conducted approximately bi-weekly visitations to the site. During these visits MNSRP staff, checked burrows and game cameras for activity, checked traps, conducted vegetation management, and performed repair and maintenance of the predator exclosures.[5]

Seabird breeding activity was assessed using game cameras, burrow scoping, checking for removal or displacement of toothpicks placed at burrow entrances, as well as checks for evidence of visitation including guano, feathers, and scent presence around burrows. During the 2022 breeding

[5] After the transfer of management of Makamakaʻole to DOFAW in February 2023, DOFAW informed Brookfield that portions of the predator exclosures at the site required repair or replacement. DOFAW provided a quote assessing the damages of the fence at Makamakaʻole with the use of the original materials from which they were constructed. Brookfield is internally consulting and will discuss this issue with DOFAW and USFWS during FY 2024.

season, 22 burrows in Enclosure A were consistently active with ʻaʻo activity. A burrow is considered consistently active if it produced a chick or an egg, if ʻaʻo appeared entering on camera, if there was more than one type of bird activity evidence during more than one burrow check, or if there was evidence of bird presence inside the burrow box at the end of the season (Appendix 6). In Enclosure B, 6 burrows had primarily ʻaʻo and limited Bulwer's petrel (*Bulweria bulwerii*) activity with four burrows demonstrating consistent ʻaʻo breeding activity. A total of 14 burrows had reproductive activity, producing a total of 18 eggs and one fledged chick (Appendix 6).

Mitigation Obligation Completed

On December 5, 2022, DOFAW provided a letter assessing that after the 2022 breeding season at Makamakaʻole, credit for 148 adults and 2 fledglings translated into 8.53 ʻaʻo mitigation credits for KWP II (in conjunction with KWP I), and that KWP II had completed its mitigation obligation for the ʻaʻo. On December 8, 2022, USFWS provided a letter assessing credit for 149 adults and 2 fledglings, translating to an ʻaʻo mitigation credit of 8.54, and that the mitigation obligation for KWP II (in conjunction with KWP I) had been met.

Brookfield worked with DOFAW throughout FY 2023 to transfer the management of Makamakaʻole to DOFAW, and continues this process in FY 2024 in order to complete the transfer. Although Makamaka'ole has been managed to benefit the ʻuaʻu, as well as ʻaʻo, no ʻuaʻu activity has been detected at burrows within the enclosures since 2017.

9.3.3 ʻUaʻu – Lānaʻi ʻUaʻu Protection Project

The ʻuaʻu have not been observed occupying the Makamaka'ole mitigation site since 2017. Therefore, both KWP projects have worked with USFWS an DOFAW to adaptively manage mitigation efforts for this species to ensure that their mitigation obligations are met.

Beginning in the 2018 ʻuaʻu breeding season, both KWP projects worked with USFWS and DOFAW to adaptively manage ʻuaʻu mitigation efforts in an interim fashion. As a result of this adaptive management, KWP I provided funding to Pūlama Lānaʻi to supplement ʻuaʻu breeding colony protection efforts on Lānaʻi in 2018. The success of this program and difficulties in attracting petrels to Makamaka'ole suggested that both KWP projects could benefit the ʻuaʻu and make progress on mitigation obligations by continuing support for the Lānaʻi petrel breeding program.

From FY 2021 to FY 2023 (two breeding seasons), the two KWP projects adaptively managed their seabird mitigation programs by providing funding to Pūlama Lānaʻi. (Appendix 7) For the 2022 breeding season, this effort included predator control as well as burrow monitoring and evaluation in the densely occupied ʻuaʻu nesting area composed of the four distinct ridges of East Puʻu Aliʻi, Kanalo, West Hiʻi, and Hiʻi Center Ridge (known as the Greater Hiʻi area) totaling approximately 150 acres.

Based on mitigation funding, a total of 9 cats and a minimum of 228 rodents were removed from the greater Hiʻi area during the 2022 breeding season (Appendix 7). In concurrence on approach with USFWS and DOFAW, the number of fledglings produced in the area was estimated using a

standardized sampling design across the colony, developed from a power analysis and assessment completed in partnership with biologists and statisticians with the Zoological Society of San Diego (Schuetz et al. 2020; pers. comm. E. Gosliner, USFWS, October 31, 2022 and P. Radley, DOFAW, November 16, 2022). This estimation used the proportions of inactive, prospecting, and breeding status burrows, along with reproductive success rates of a given area to determine an estimated proportion of burrows with breeding attempts. This information was used to estimate the number of fledglings produced. In the 2022 breeding season, 224 known burrows yielded an outcome of 78 ʻuaʻu chicks above baseline (Appendix 7).

On December March 27, 2023, USFWS provided a letter assessing that after the 2022 breeding season, the total estimated benefit provided for the ʻuaʻu from ʻuaʻu breeding colony protection efforts on Lānaʻi was 89.20 credits based on a previously agreed upon assessment framework (pers. comm. E. Gosliner, USFWS, October 31, 2022 and P. Radley, DOFAW, November 16, 2022). Additionally, based on ʻuaʻu activity at Makamakaʻole in 2016 and 2017, in their March 27th letter, USFWS approved an estimated benefit for the ʻuaʻu of 0.56. Thus, the total mitigation benefit achieved across mitigation projects is 89.72 adult ʻuaʻu for both KWP II and KWP I. KWP II's ʻuaʻu mitigation obligation per the ITP is 43 ʻuaʻu (including adults, subadults, fledglings, nestlings, and eggs). In the March 27 letter, USFWS acknowledges that KWP II has meet its ʻuaʻu mitigation obligation. DOFAW has yet to provide similar documentation.

10.0 Adaptive Management

In accordance with the HCP, low wind speed curtailment (LWSC) was implemented from the start of Project operations at wind speeds of up to 5 meters per second at all WTGs for the months of April through November. LWSC is expected to reduce bat take, as explained in the HCP. This curtailment period was extended to begin mid-February and continue through December 15 in response to bat fatalities documented at the Project on March 13, 2013 and February 26, 2014, and a fatality at the KWP I Project on December 14, 2013. On June 6, 2014, the Project proposed an additional adaptive management measure to the USFWS and DOFAW, increasing the LWSC cut-in speed. On July 29, 2014 the LWSC was raised to 5.5 m/s between February 15 and December 15 from sunset to sunrise. The Project continues its site-wide bat activity assessment as committed to in the approved HCP Amendment.

The Project has previously implemented a variety of actions to minimize risk to the nēnē, which continued in FY 2023. Scavenger trapping efforts implemented at the Project to improve persistence of carcasses during fatality monitoring have likely reduced the risk of predation of the resident nēnē and safety measures to avoid interactions between nēnē and canine search teams have been identified and are implemented as needed. In response to the current projections of potential take of the nēnē at the Project, KWP II has taken practicable actions to minimize the threats to the nēnē. In FY 2023, KWP II implemented a vegetation management plan developed with concurrence from the agencies reducing the amount of woody vegetation on site. The goal is to minimize the attractiveness of onsite habitat to the nēnē (Section 5.0). KWP II will continue to

monitor nēnē activity on site to inform vegetation management success, and continue to work with USFWS, DOFAW, and technical experts to further reduce risk to the species.

11.0 Agency Meetings, Consultations, and Visits

KWP II communicated actively with USFWS and DOFAW throughout FY 2023 through conference calls, submittal of quarterly reports, and email communications related to the Project's HCP. The purpose of these communications included the required annual and semi-annual HCP implementation meetings, focused discussions regarding mitigation projects, mitigation credits for the nēnē and seabird mitigation programs, and ESRC review of the annual report. A summary of agency coordination is presented in Table 4.

Table 4. Summary of Agency Coordination and Communication in FY 2023

Date	Communication	Participants
July 21, 2022	Haleakalā Ranch Nēnē Release Pen Management Scope of Work	Submitted to DOFAW, USFWS by Tetra Tech
August 16, 2022	Haleakalā Ranch Nēnē Release Pen Management Scope of Work discussion (via teleconference)	KWP II, Tetra Tech, DOFAW, USFWS
September 19, 2022	Haleakalā Ranch Nēnē Release Pen Management Scope of Work, revised draft	Submitted to DOFAW by Tetra Tech
September 29, 2022	KWP ʻuaʻu mitigation credit - calculation of adult survival credit discussion (via teleconference)	KWP II, Tetra Tech, USFWS, DOFAW
October 4, 2022	Haleakalā Ranch Scope of Work	KWP II, Tetra Tech, Haleakalā Ranch, S. Franklin (DOFAW)
October 12, 2022	Annual HCP implementation review meeting (via teleconference)	KWP II, Tetra Tech, USFWS, DOFAW
October 24, 2022	Submittal of Final HCP FY 2022 annual report	Submitted to DOFAW, USFWS by Tetra Tech
October 27, 2022	Submittal of FY 2023 Q1 report	Submitted to DOFAW, USFWS by Tetra Tech
October 31, 2022	Haleakalā Ranch Nēnē Release Pen Management draft Scope of Work and draft MOU	Submitted to DOFAW, USFWS by Tetra Tech
November 12, 2022	Makamakaʻole Newell's Shearwater Mitigation Credit Fufillment memo and supplemental dataset.	Submitted to DOFAW, USFWS by Tetra Tech
December 14, 2022	Haleakalā Ranch Nēnē Release Pen draft MOU clarification discussion (via teleconference)	Tetra Tech, DOFAW

Date	Communication	Participants
December 22, 2022	Haleakalā Ranch Nēnē Release Pen Management Final Scope of Work and draft MOU	Submitted to DOFAW by Tetra Tech
January 9, 2022	Annual HCP implementation review by ESRC	KAH, Tetra Tech, ESRC
January 30, 2023	Submittal of FY 2023 Q2 report	Submitted to DOFAW, USFWS by Tetra Tech
February 9, 2023	Mitigation credit assessment for work completed 2022-2023 breeding season	KWP II, Tetra Tech, DOFAW, USFWS
February 13, 2023	Makamakaʻole Newell's Shearwater Mitigation Credit Fulfillment and Project Transition memo, Final	Submitted to DOFAW, USFWS by Tetra Tech
February 28, 2023	Hawaiian Petrel Mitigation Credit Fulfillment Memo and request for agency concurrence	Submitted to DOFAW, USFWS by Tetra Tech
March 2, 2023	HCP Compliance topics	Brookfield, DOFAW
March 2, 2023	HCP Compliance topics	Brookfield, USFWS
April 24, 2023	Submittal of FY 2023 Q3 report	Submitted to DOFAW, USFWS by Tetra Tech
May 4, 2023	Nēnē release pen mitigation projects discussion	KWP II, Tetra Tech, DOFAW Maui,
May 11, 2023	Semi-annual HCP implementation review meeting	KWP II, Tetra Tech, USFWS, DOFAW
May 31, 2023	Nēnē release pen mitigation projects discussion	Tetra Tech, A. Siddiqi (DOFAW)

12.0 Expenditures

Total HCP-related expenditures for the Project in FY 2023 were $493,754 (Table 5).

Table 5. HCP-related Expenditures at the Project in FY 2023

Category[1]	Amount
Permit Compliance	$59,801
Fatality Monitoring	$85,387
Acoustic Monitoring for Bats	$15,920
Vegetation Management and Scavenger Trapping	$78,861
Equipment and Supplies	$5,413
Makamakaʻole Mitigation Project [2]	$21,165
Lānaʻi ʻUaʻu Mitigation Project [2]	$140,915

Category[1]	Amount
Haleakalā Ranch Release Pen Project [2]	$86,292
Total Cost for FY 2023	**$493,754**

1. Staff labor costs are included in the overall costs for each category.
2. This total is co-funded with KWP I and includes staff oversight and internal reporting.

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Appendix 1. Dalthorp et al. (2017) Fatality Estimation for the ʻŌpeʻapeʻa and Nēnē at the Project through FY 2023

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Appendix 1a. Dalthorp et al. (2017) Fatality Estimation for the ʻŌpeʻapeʻa at the Project through FY 2023

Modelling Parameter		Modelling Period										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11 (current)**
FY		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022
LWSC		5.0 m/s	5.0 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s
Date Range	Begin	7/1/2012	7/1/2013	7/1/2014	7/1/2015	7/1/2016	7/1/2017	7/1/2018	7/1/2019	7/1/2020	7/1/2021	7/1/2022
	End	6/30/2013	6/30/2014	6/30/2015	6/30/2016	6/30/2017	6/30/2018	6/30/2019	6/30/2020	6/30/2021	6/30/2022	6/30/2023
Period length (span)		364	364	364	364	364	364	364	362	364	364	364
% of Year (rho)		1	1	1	1	1	1	1	1	1	1	1
Search Interval (days)		7	7	7	7	7	7	7	7.1	7	7	7
Number of Searches in Modelling period		52	52	52	52	52	52	52	51	52	52	52
Observed fatality (X)		1	2	0	0	0	0	0	0	0	0	0
K		0.7	0.7	0.7	1[1]	1[1]	1[1]	1[1]	1[1]	1[1]	1[1]	1[1]
DWP		1	1	1	0.562	0.562	0.562	0.56	0.56	0.56	0.56	0.56
ĝ	ĝ	0.443	0.359	0.336	0.362	0.442	0.375	0.372	0.476	0.409	0.354	0.517
	min	0.241	0.235	0.187	0.27	0.374	0.287	0.304	0.437	0.333	0.271	0.481
	max	0.656	0.493	0.503	0.46	0.511	0.467	0.440	0.516	0.486	0.441	0.553
B	Ba	9.08	18.5	10.95	35.09	87.96	41.22	74.23	289.1	63.53	42.51	383.0
	Bb	11.41	33.02	21.68	61.84	111.1	68.77	125.3	318.1	92.00	77.67	358.0
M*[3]		5	12	12	12	11	12	12	11	11	11	11

1. Searches performed by canine teams increases the probability that a missed carcass will be detected on the next search.
2. Search area reduced to graded and cleared portions of and roads within 70-meter radius from turbine.
3. Cumulative value representing estimate of total direct take from the start of operations through the identified monitoring period at the 80 percent UCL.

Appendix 1b. Dalthorp et al. (2017) Fatality Estimation for Nēnē at the Project through FY 2023

Modelling parameter		Modelling Period										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11 (current)**
FY		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Date Range	Begin	7/1/2012	7/1/2013	7/1/2014	7/1/2015	7/1/2016	7/1/2017	7/1/2018	7/1/2019	7/1/2020	7/1/2021	7/1/2022
	End	6/30/2013	6/30/2014	6/30/2015	6/30/2016	6/30/2017	6/30/2018	6/30/2019	6/30/2020	6/30/2021	6/30/2022	6/30/2023
Period length (days)		364	364	364	365	364	364	364	362	364	364	364
% of Year		1	1	1	1	1	1	1	1	1	1	1
Search Interval (days)		7	7	7	7	7	7	7	7.1	7	7	7
Number of Searches in Modelling period		52	52	52	52	52	52	52	51	52	52	52
Observed fatality (X)		1	0	2	1	0	1	0	3	0	1	1
K		1	1	1	1	1	1	1	1	1	1	1
DWP		0.7	0.7	0.7	0.372	0.372	0.372	0.372	0.372	0.372	0.372	0.372
$\hat{g}$	$\hat{g}$	0.654	0.653	0.681	0.358	0.361	0.36	0.361	0.347	0.361	0.368	0.367
	min	0.503	0.474	0.583	0.288	0.294	0.285	0.295	0.319	0.338	0.355	0.343
	max	0.791	0.812	0.771	0.431	0.43	0.437	0.429	0.375	0.384	0.381	0.391
B	Ba	26.32	18.94	62.8	61.66	68.06	54.62	70.09	380.2	633.1	1811	567.7
	Bb	13.91	10.05	29.46	110.5	120.7	97.27	124.2	717	1120	3110	980.2
M*[2]		3	3	6	9	10	13	13	21	22	25	25

1. Search area reduced to graded and cleared portions of and roads within 70-meter radius from turbine.
2. Cumulative value representing estimate of total direct take from the start of operations through the identified monitoring period at the 80 percent UCL.

Appendix 2. Indirect Take for the ʻŌpeʻapeʻa and Nēnē at the Project in FY 2023

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Appendix 2a. Indirect Take for the ʻŌpeʻapeʻa at the Project in FY 2023

Parameter	Description	Fiscal Year											
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
A	Observed Breeding Female Take	0	0	0	0	0	0	0	0	0	0	**0**	**0**
B	Indirect Take from Observed Breeding Female Take (A x 1.8)	0	0	0	0	0	0	0	0	0	0	**0**	**0**
C	Observed Breeding Unknown Sex Take	0	0	0	0	0	0	0	0	0	0	**0**	**0**
D	Indirect Take from Observed Breeding Unknown Sex Take (C * 0.5 * 1.8)	0	0	0	0	0	0	0	0	0	0	**0**	**0**
E	All Observed Take (Search and Incidental)	1	2	0	0	0	0	1	0	0	0	**0**	**4**
F	Estimated Take Multiplier (11/4=2.75)	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	–
G	Estimated Direct Take (E x F)	2.75	5.5	0	0	0	0	2.75	0	0	0	**0**	**11**
H	Unobserved Direct Take (G - E)	1.75	3.5	0	0	0	0	1.75	0	0	0	**0**	**7**
I	Indirect Take Calculated from Unobserved Take (H * 0.5 * 0.25 * 1.8)	0.39	0.79	0	0	0	0	0.39	0	0	0	**0**	**1.58**
Total Indirect Take (B + D + I; juveniles)													**1.58**
Total Indirect Take (B + D + I)*0.3 (adults)													**0.47**

Appendix 2b. Indirect Take and Lost Productivity for the Nēnē at the Project in FY 2023

Parameter	Description	Fiscal Year												
		2013	2014	2015	2016	2017	2018		2019	2020	2021	2022		2023	Total
A	Observed Take	1	0	2	1	0	2	2	1	3	0	1	1	0	14
A1	Observed Take (Goslings) Not Attributable to Wind Farm Operation	0	0	0	0	0	0	1	0	0	0	0	0	0	1
B	Estimated Take Multiplier (25/14=1.79)	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	–
C	Estimated Direct Take (A x B)	1.79	0	3.57	1.79	0	3.57	3.57	1.79	5.36	0	1.79	1.79	0	25
D	Observed Indirect Take Multiplier (Season Defined)	0.04	0	0.09	0.09	0	0	0.09	0.09	0.09	0	0.04	0.09	0	–
E	Observed Indirect Take (A x D)	0.04	0	0.18	0.09	0	0	0.18	0.09	0.27	0	0.04	0.09	0	0.98
F	Unobserved Direct Take (C - A)	0.79	0	1.57	0.79	0	1.57	1.57	0.79	2.36	0	0.79	0.79	0	11
G	Unobserved Indirect Take (F x 0.06)	0.04	0	0.09	0.04	0	0.09	0.18	0.04	0.13	0	0.04	0.04	0	0.62
H	Accrued Adult Take (Previous Year's Accrued C + J2 - L -N)	0.00	1.79	1.85	5.61	7.52	7.63		16.24	18.41	24.74	21.53		N/C[1]	–
I	Lost Productivity from accrued adult take (Current year's H x 0.1) (fledglings)	0.00	0.18	0.19	0.56	0.75	0.76		1.62	1.84	2.47	2.15		N/C[1]	N/C[1]
J	Indirect Take + Lost Productivity (E + G + I + A1)(fledglings)	0.08	0.18	0.45	0.70	0.75	2.12		1.76	2.24	2.47	2.37		N/C[1]	–
J2	Indirect Take + Lost Productivity as Adult (2 year's previous J x 0.9^2) (annual survival rate is 0.9)	–	–	0.07	0.14	0.37	0.56		1.72	0.00	1.42	1.82		N/C[1]	–
K	Mitigation fledglings produced (fledglings)	0.00	0.00	0.00	0.00	0.00	3.00		11.56	0.00	0.00	0.00		N/A[2]	N/C[1]
L	Mitigation adult survival (adults)	0.00	0.00	0.00	0.00	0.33	0.69		0.61	0.00	0.00	0.00		N/A[2]	1.63
M	Net fledglings remain (Current Year K - J)	-0.08	-0.18	-0.45	-0.70	-0.75	0.88		9.81	-2.24	-2.47	-2.37		N/C[1]	N/A[1]
N	Net adults 3 yrs. later (Three year's previous M x 0.512)	---	---	---	-0.04	-0.09	-0.23		-0.36	-0.39	0.45	5.02		N/C[1]	N/A[1]
Total Direct Take from Collisions with WTGs (adults; C)															**25**
Total Direct Take from Non-Collision Causes (adults; A1 x 0.512)															**0.51**
Total Indirect Take (fledglings; E + G)															**1.59**
Total Indirect Take (adults; [E + G] x 0.512)															**0.82**
Total Lost Productivity (fledglings; I)															**N/C[1]**
Total Lost Productivity (adults; I x 0.512)															**N/C[1]**

1. Not calculable without mitigation credit data.
2. Not available. To be determined in consultation with USFWS and DOFAW.

Appendix 3. FY 2023 ʻŌpeʻapeʻa and Nēnē 20-year Projected Cumulative Mortality at the Project

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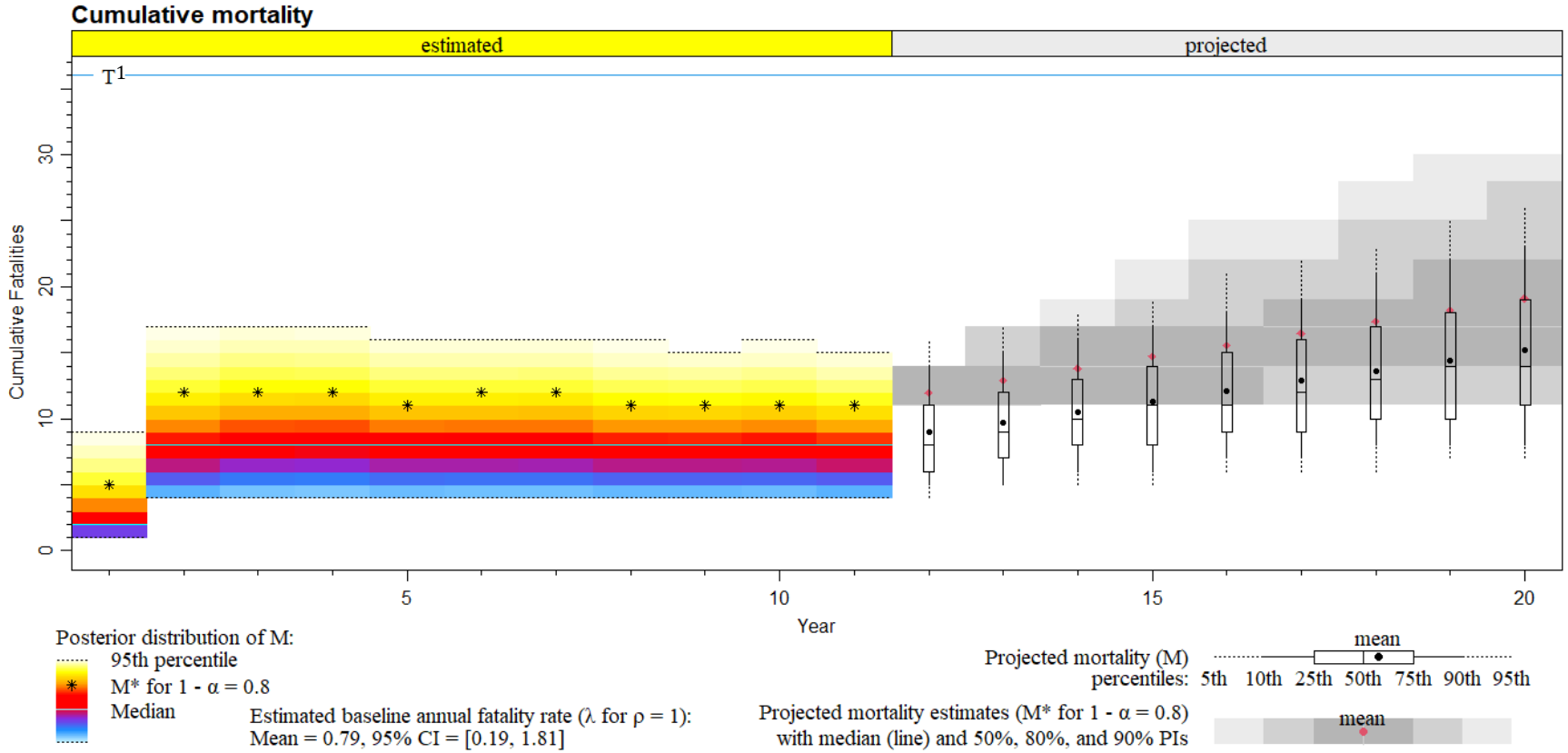
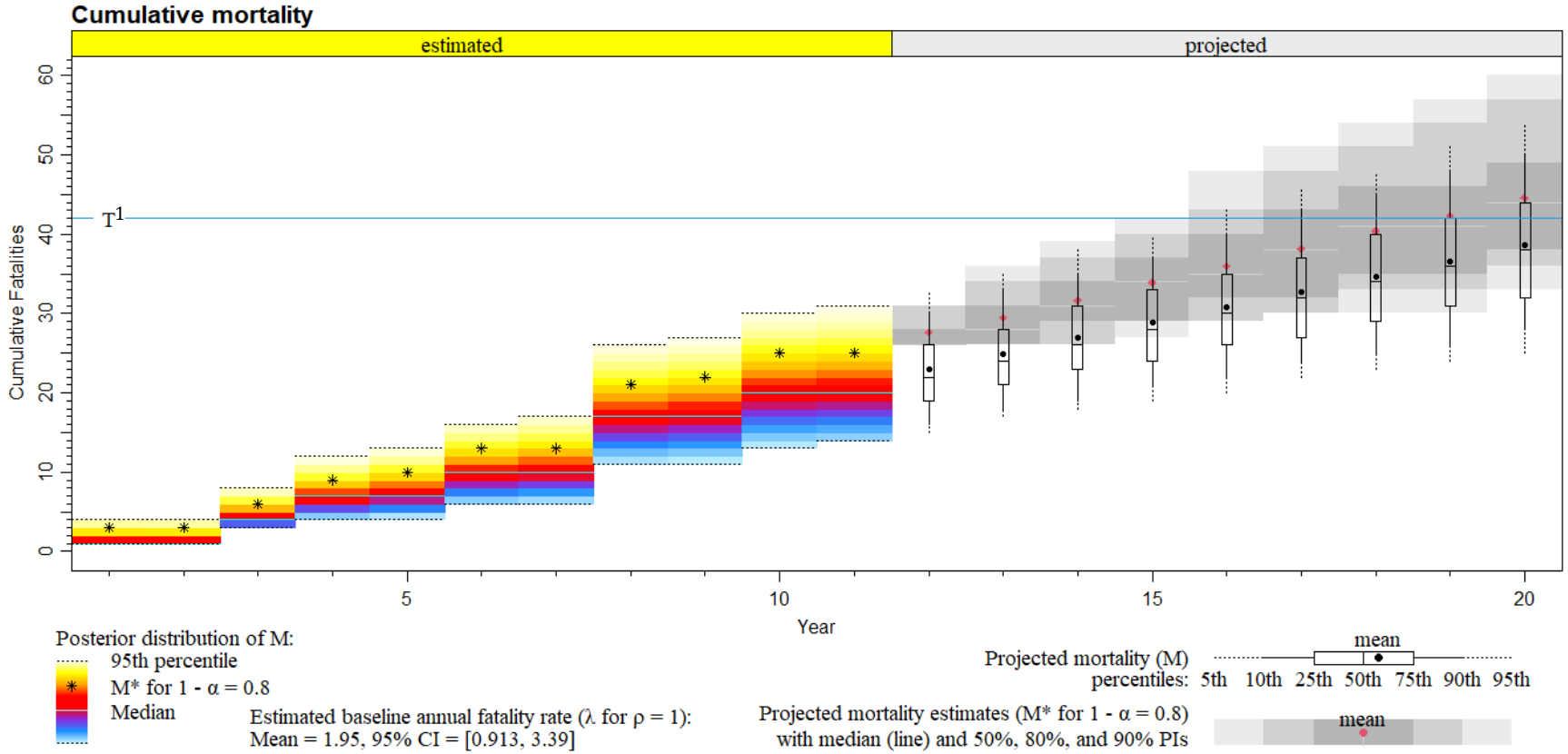
Appendix 3a. Projected Cumulative Mortality for the ʻŌpeʻapeʻa at the Project



1. Permitted take for the ʻōpeʻapeʻa at the Project is 38 in the HCP. Take, however, as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 36 is shown, representing permitted bat take (38) minus 2 adult equivalents of indirect take (5.3 percent of the requested authorized limit). Currently, the proportion of total take that is attributable to indirect take is 4.1 percent.

Appendix 3b. Projected Cumulative Mortality for the Nēnē at the Project



1. Permitted take for the nēnē at the Project is 44; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 42 is shown, representing requested authorized nēnē take (44) minus 2 adult equivalents of indirect take (4.5 percent of the requested authorized limit). Currently, the proportion of total take that is attributable to indirect take is 3.1 percent.

Appendix 4. Documented Fatalities at the Project during FY 2023

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Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
Francolinus francolinus (black francolin)	07/13/22	10	1	22
Phaethon lepturus (white-tailed tropicbird)[1,2]	03/12/23	14	24	213
Bubulcus ibis (cattle egret)[1,2]	05/24/23	6	83	63

1. Incidental detection.
2. Protected under the Migratory Bird Treaty Act.

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Appendix 5. Haleakalā Ranch Nēnē Release Pen Program Annual Report FY 2023

TETRA TECH

MEMO

To:	Myrna Girald-Perez, John Medeiros; DOFAW
Cc:	Emma Gosliner; USFWS
From:	Tetra Tech, on behalf of Brookfield Renewable Partners
Date:	June 28, 2023
Correspondence #	TTCES-PTLD-2023-062
Subject:	Haleakala Ranch Nēnē Release Pen Program Annual Report FY2023

1.0 Introduction

In May 2011, the Hawai'i Department of Land and Natural Resources—Division of Forestry and Wildlife (DOFAW), with funding from the Kaheawa Wind Power I (KWP I) project, established a Nēnē Introduction Program (Program) at Haleakala Ranch (Ranch), Maui. The purpose of this Program was to establish a population of the endangered nēnē, or Hawaiian goose (*Branta sandvicensis*), at the Ranch. The Program contributes to the mitigation requirements for the nēnē as identified in the KWP I and Kaheawa Wind Power II (KWP II; collectively, the Projects) Habitat Conservation Plans (KWP I 2006, SWCA 2019). As part of the Program, Haleakala Ranch, LLC committed to maintaining or improving the Ranch premises, which are considered to provide a significant amount of habitat that may be suitable for nēnē, for renewable periods of 10 years over the 50-year term of the Haleakala Ranch Safe Harbor Agreement (SHA; USFWS et al. 2019). The Program has successfully produced fledglings at the Ranch since 2012.

In 2021, DOFAW requested that the Projects assume direct management of the release pen. While the Projects and DOFAW finalize a Memorandum of Understanding (MOU), both parties have agreed that the Projects assumed management activities on December 8, 2022. The Projects contracted Aloha Environmental Services (AES) to conduct the work as laid out in the SOW, to be appended to the MOU. Key needs for establishing a population of nēnē at the Ranch were identified in the SHA as nest monitoring, pen maintenance, habitat management, and predator control. This report and the activities described herein are in compliance with the Ranch's SHA (USFWS et al. 2019). This report provides detail of the 2022 – 2023 breeding season at the Ranch through the end of Fiscal Year (FY) 2023 (June 30, 2023). Table 1 shows the expenditures during FY 2023.

Table 1. Expenditures During December 8, 2022 – June 30, 2023

Expenditure Type	KWP I Funded Amount	KWP II Funded Amount
Road Improvement	$5,000	$5,000
Nēnē Monitoring	$4,709.50	$4,709.50
Pen Maintenance	$3,953.50	$3,953.50
Habitat Management	$4,728	$4,728
Predator Control	$8,002	$8,002
Data Collection, Analysis and Reporting	$3,953	$3,953
Adaptive Management Actions[1]	0	0
Total Cost for FY 2023	**$30,346.50**	**$30,346.50**

1. Costs for supplemental vegetation clearing required upon the assumption of management responsibilities not quantified (see Section 2.8).

2.0 Mitigation Actions

2.1 Road Improvement

The road to the pen was maintained periodically by AES staff, as needed, by moving rocks and backfilling holes with dirt and rocks. Per Right of Entry agreement with Haleakala Ranch, LLC, the Projects provided $10,000 to the ranch for road repair activities (see Table 1).

2.2 Nēnē Monitoring

2.2.1 Sightings

Weekly observations and monitoring were conducted by AES personnel at the Ranch from December 8, 2022 to April 30, 2023 when weather permitted and Ranch personnel approved access. Biweekly (every 2 weeks) observation and monitoring was conducted from May 1 to June 30, 2023.

Observations of banded and unbanded birds were recorded at the Ranch to monitor movements, distribution, and survival of nēnē using both visual, binocular surveys, as well as footage from three strategically placed game cameras within the pen. In FY 2023, 13 distinct banded adults and, at minimum, three unique un-banded adults were observed at the Ranch.

2.2.2 Nesting

During nesting season, records were kept on mated pairs and the breeding status of females found at the Ranch. Nests found at the Ranch were marked using GPS and checked weekly to determine their status. Nesting activities, nest outcomes, hatching, and fledgling success were recorded for the

nesting season. Survey methods for nesting activity/success included both weekly visual (binocular) surveys, as well as daily data collection by on site game cameras.

Three nests or nesting attempts were located within the Ranch open-top release pen this year (Table 2). All three of these nests were successful. Six nēnē hatched, and five successfully fledged from the Ranch open-top release pen this season. AES personnel confirmed the fledging of all five goslings by compiling data from both visual observations, as well as by daily photo documentation taken by game cameras between February 16 and June 30, 2023 (Appendix A). No nests were observed outside of the nēnē pen in the 2022 – 2023 breeding season.

Table 2. Nēnē Nesting Summary for 2022 – 2023 Breeding Season

Parameter	Number
Nests	
Located in open-top pen	3
Successful	3
Abandoned	0
Depredated	0
Failed (other reason)	0
Renests	0
Eggs	
Known	6
Destroyed naturally	0
Depredated	0
Salvaged	0
Hatched	6
Goslings/Fledglings	
Known goslings	6
Goslings depredated	0
Goslings died (other reason)	1 (Unknown)
Fledglings fledged from pen (credited for mitigation)	5

2.3 Pen Maintenance

The open-top pen's fence line was continuously monitored and maintained since AES began pen management in December 2023. The fence line was weed-whacked and mowed for weed control, and trees were trimmed along the exterior boundary to prevent bridge entry by predators. The large pond was cleaned and flushed twice a month, and smaller baths were cleaned and maintained weekly. The water system's shutoff valve was replaced after it was found to be leaking. New electric fence insulators, solar batteries, and grounding stakes/wires were installed to get electric fence perimeter back up and running (AES found the electric fence was non-operational in December

2022 upon beginning operations). A large storm event on December 18, 2022, damaged many surrounding trees, the pen entrance door, and the water catchment/mower shed. Downed trees, damaged sections of fence, the pen door, and the shed were mended, with unusable damaged materials removed from the site and disposed of by AES personnel.

2.4 Habitat Management

Short grass habitat was maintained at the open-top release pen. During the breeding season (December 8th – May 1st), the 1-acre open-top pen was mowed once a week and the area around the outside of the pen was maintained as needed. During the non-breeding season (May 1st – June 30th), the open-top pen and the surrounding perimeter was mowed every other week and non-native/overgrown vegetation was cleared around potential nesting areas as needed. A total of 25.5 acres[1] was mowed this year to maintain nēnē short grass habitat. Approximately 0.5 acres of alien vegetation was mechanically removed, including lantana (*Lantana camara)*, strawberry guava (*Psidium cattleianum*), Bocconia *(Bocconia frutescens),* fireweed (*Senecio madagascariensis*), and bur from both open top pens and covered secondary enclosures.

2.5 Predator Control

Predator traps are used to control rats (*Rattus rattus*), mongoose (*Herpestes javanicus)*, and feral cats (*Felis catus*) that may pose a threat to nēnē and their nesting sites. Traplines were baited and checked weekly at the Ranch during the breeding season, and biweekly during non-breeding season using 16 Tomahawk live traps, 10 DOC 200 traps, and five A24s.

This year at the Ranch, nine mongoose and three rats were removed through predator trapping. Five of the nine mongoose were trapped by Doc 200s inside of the nēnē pen, and two of the five were caught while nēnē were actively sitting on nests between the months of December and February (Table 3). No avian predators were controlled this season at the Ranch.

Multiple observations were made of two pueo, (Hawaiian short-eared owl, *Asio flammeus sandwichensis*) pairs hunting above and around the nēnē pen during nesting season. The first observations of pueo near the pen were made on March 18, 2023. Additionally, a single gosling from pair AL/- -, ACJ/AL was confirmed missing on March 10. No gosling carcass or remains of any kind were recovered after extensive searching, indicating cause of predation may be avian. There is currently no formal program in place for the removal of avian predators.

[1] One acre inside pen mowed 23 times plus 0.25 acres of pen exterior mowed 10 times.

Table 3. Traps Deployed and Predators Removed during 2022 – 2023

Location	Trap Type	Trap nights	Mongoose	Cat	Rat
Outside pen	DOC200 (5)	204	1	0	1
	Cage (16)	154 [1]	4	0	0
Inside pen	DOC200 (5)	204	5	0	0
	A24 (5)	204	0	0	0

1. Live traps were closed and moved inside after all goslings were confirmed fledged. Traps were moved to avoid damage by cattle moved to the area for grazing.

2.6 Relocations

According to records provided by DOFAW (pers. comm. Colton Loque via email on 3/21, 4/26, and 6/22/2023), three nēnē were relocated to the open-top release pen by DOFAW personnel in FY 2023. All were injured birds that were captured, treated, and relocated to the pen. On March 21, 2023, a bird with a broken wing from the Big Island was released inside of the pen (AL 798-24941/$3T8)[2], On April 18, 2023 a bird missing its right foot (#1158-78271/--) was released inside of pen, and on June 22, 2023 a bird with an injured left wing (*ECN/AL #1158-78275)[3] was released inside of pen. None of the released birds bred at the pen this year, and none of the released birds were regularly documented visitors of the pen after the initial release date.

2.7 Injury, Fatalities, Disease

The only nēnē death that occurred this season at the Ranch was of a single gosling due to unknown causes.

2.8 Adaptive Management Actions

High amounts of rainfall during the breeding season led to the access road becoming impassable for numerous weeks on end, making regular visitations challenging at times. An apparent lapse in vegetation management between the end FY 2022 and the Projects' assuming management activities through AES resulted in grass lengths becoming too tall for a standard lawn mower to handle. Extensive grass management via weed-whacker has been required throughout the FY to get most short grass habitat back to manageable levels. Based on the length of the grass upon taking on management activities, the on-site riding mower was not able to be used due to lack of mower deck clearance. Grass management has included an estimated additional 64 hours between December 8, 2022 and June 30, 2023 to reduce grass length throughout the pen and around the perimeter (Appendix A [see images 11 – 14]).

[2] $ denotes birds banded from 1994- present.
[3] * denotes birds banded from 1990-1994.

2.9 Nēnē Produced (Mitigation Credit)

Five nēnē were produced and successfully fledged at the pen during the 2022 – 2023 breeding season. These fledglings, and the opportunity for increased adult survival for the 13 banded and three unbanded occupants of the pen will contribute to mitigation credits for the Projects.

3.0 Literature Cited

KWP I (Kaheawa Wind Power, LLC). 2006. Kaheawa Pastures Wind Energy Generation Facility Habitat Conservation Plan. January 2006.

SWCA (SWCA Environmental Consultants). 2019. Kaheawa Wind Power II Wind Energy Generation Facility Habitat Conservation Plan Amendment. Prepared for Kaheawa Wind Power II, LLC. 2019.

USFWS (U.S. Fish and Wildlife Service), Haleakala Ranch, and Department of Land and Natural Resources (DLNR). 2019. Safe Harbor Agreement for Nēnē at Haleakala Ranch, Island of Maui.

Appendix A. Photolog

Image 1. *CCU/AL sitting on newly hatched gosling.

Image 2. AL/-- ,*ACJ/AL nest reared two goslings.

Image 3. Pair $K10/AL(female) , AL/$K08(male) with single gosling (first to hatch).

Image 4. Pair AL/*AYY, *CCU/AL three goslings (second to hatch).

Image 5. Pair AL/--, *ACJ/AL two goslings (third to hatch).

Image 6. Panoramic view of perimeter and interior of pen post grass mowing.

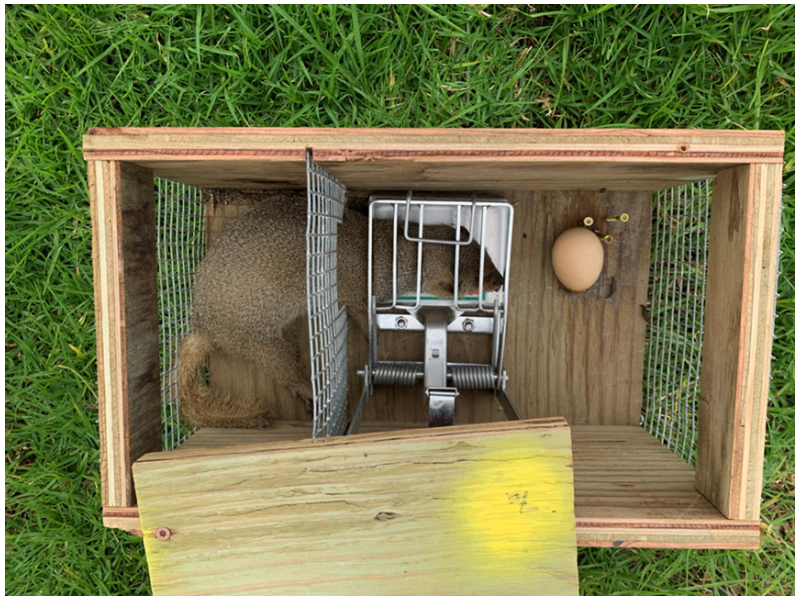

Image 7. DOC 200 Mongoose catch inside nēnē enclosure.

Image 8. Tomahawk live trap along outside perimeter.

Image 9. A24 rat trap with bird excluder attachment.

Image 10. Last photo captured of both AL/- -, ACJ/AL goslings. 2/26 at 10:59am.

Image 11. Clearing of overgrown grass to return short grass habitat.

Image 12. Overgrown grass surrounding non-functional trap as observed on December 8, 2022.

Image 13. Weed-whacked area cleared around water trough with surrounding unmanaged grass, December 8, 2022.

Image 14. Fence line after exterior grass cutting on December 8, 2023.

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Appendix 6. Makamakaʻole Seabird Mitigation Area 2022 Annual Report

Makamakaʻole Threatened and Endangered Seabird Mitigation Project: Exclosures and Artificial Burrows Annual Summary Report

Reporting Period: January 1, 2022 – December 16, 2022
Monitored and Reported by Maui Nui Seabird Recovery Project for Brookfield Renewables and Tetra Tech

Overall Summary: The Makamakaʻole seabird mitigation site consists of 2 predator-proof exclosures, each housing 50 artificial seabird burrows with nest boxes. Since 2016, social attraction mechanisms including seabird models and nighttime auditory playback have been in place to attract Newell's shearwaters (*Puffinus newelli*, NESH) in exclosure A, and Hawaiian petrels (*Pterodroma sandwichensis*, HAPE) in exclosure B (the NESH auditory playback has been inactive since 2020 due to regularly attending NESH adults). MNSRP began monitoring Makamakaʻole in May 2020 and continued standardized methodology through the 2021 and 2022 breeding seasons. This year we report a total of 18 NESH eggs produced at 14 burrows, 1 of which hatched a successfully fledged chick (Figure 1). This is an increase of 2 total NESH eggs at three additional burrows since 2021, although the fledged chick count remains the same as last year. Twenty-eight burrows were consistently active, an increase of three over 25 in 2021. Bulwer's petrels (*Bulweria bulwerii*, BUPE*)* were present in two burrows in exclosure B. No HAPE were detected inside the exclosures.

Genetic analysis of blood and feather samples from 14 adult NESH in nest boxes collected in August and September revealed sampled birds are female. Females may attend new colonies before males or be more likely to occupy artificial burrows in August and September. Additional sampling is needed to understand the sex ratio of colonizing birds at Makamakaʻole.

Trapping and baits deployed in bait stations to remove predators is consistent and ongoing. Mongooses were captured only outside the exclosures, but rats and mice were removed from inside and outside the exclosures. Poison bait consumption remained relatively low throughout the year, peaking in the winter months.

Maintenance and refurbishment of the exclosure fences and other infrastructure continues as time and resources allow.

Vegetation Control:
Vegetation is cleared and regularly maintained throughout the season around the inside and outside of the exclosure fences, around burrow boxes and burrow entrances, around traps and bait stations, and along interior pathways and between exclosures. Hand-pulling is used around burrow entrances and game cameras, and weed whackers are used along fences and trails. Keeping these areas clear is critical for allowing fence inspection, burrow entrance and egress by the birds, and staff access to critical areas during monitoring activities. Because of the rapid rate of growth of the dominant grass species, hand trimming and pulling occurs around the burrows during every visit, and weed-whacking occurs 2-3 times per month. Weed cloth was installed under some game cameras to keep grasses from interfering with motion detection action.

Figure 1. NESH chick being weighed by Kupu ʻĀina Corps member Joshua DeCambra on 9/27/22.

Exclosure Fence – Status and Activities:
Fence and infrastructure activities focused on prepping the existing structure for installation of the new mesh. New posts were installed, new belly bands were installed, erosion control structures were put in place, and dirt was moved to reestablish foundations. Further fence work including use of the new mesh will proceed during the winter months, outside of the normal seabird breeding season.

Sound Playback System – Status and Activities:
The sound playback system for HAPE in exclosure B was started on April 21. The NESH playback system in exclosure A was tested and found operational but remained off.

Artificial Burrow Checks:
All burrow boxes were opened to check activity status at the start of the season on 3/2/2022. Pictures were captured and contents and box integrity were noted. One BUPE was found in burrow 50B at that time. Two boxes were rebuilt and 6 lids were replaced. A BUPE egg was discovered in 50B in April cracked and non-viable.

Seabird activity is assessed at each burrow every other week during the breeding season by checking for removal or displacement of toothpicks erected at the entrance, searching for guano and feathers, and by noting bird scent. Motion-activated game cameras are deployed at all burrows suspected as active. NESH first appeared on game camera on 3/30/22 at 48A. NESH activity for the 2022 season was first noted during monitoring on 4/5/22. Bird sign and game

camera activity continued consistently throughout the season until the single NESH chick fledged from 25A on 10/12/22. A total of 22 burrows in A (including one natural burrow – 51A) and 6 burrows in B were considered consistently active in 2022. A burrow is considered consistently active if it produced a chick or an egg, or if NESH appeared entering on camera, or if there was more than one type of bird activity evidence during more than one burrow check, or if evidence inside the burrow box (e.g. NESH feathers, nest cups, guano) at the end of the season suggested activity when compared to the start of the season. See Table 1 for results from active burrows. All nest boxes were opened on 9/28 or 9/29/22 to check for bird activity, and to assess the condition of the boxes (see Table 2). No new natural sites were discovered this season.

On 5/10/22 the next boxes were opened to check reproductive status. Two NESH eggs were discovered in 48A. By the end of the season, a total of 18 NESH eggs were produced (16 in Exclosure A and 2 in Exclosure B), one of which produced a viable chick. Two boxes in Exclosure A each produced 2 eggs, and one box produced 3. Compared to 2021, most of the eggs did not appear cracked or damaged (likely due to the addition of the sand), yet were still nonviable. On 8/11, 8/19, and 9/09 all active burrows were opened to band adult NESH and collect samples for genetic analysis, which were sent to Kenneth Hayes, the director of the Pacific Center for Molecular Biodiversity at the Bishop Museum in Honolulu. Two out of the 14 adult were recaptures (banded in 2020). Results indicate that sampled individuals are female. This sampling and analysis was funded by the Native Ecosystems Protection & Management (NEPM) program of the Maui branch Divivion of Forestry& Wildlife. Adults from burrow 25A, which produced the chick were not sampled. To date, 22 individual adults and 2 chicks have been banded, all from Exclosure A.

Table 1. 2022 summary of visitation and production of active burrow boxes.

Burrow/ Exclosure	4/5/22	4/21/22	5/10/22	6/6/22	6/22/22	7/5/22	7/20/22	8/4/22	8/19/22	9/9/22	9/28/22	camera activity	box activity	Consistently active
8A	no_sign	no_sign	entered, guano	entered, guano	entered, guano	entered, feathers	entered, guano, feathers, odor	entered, guano	entered, guano, feathers	entered, feathers	entered, guano, feathers	2x NESH	NESH egg	X
9A	entered	no_sign	entered, guano	entered, guano, feathers, odor	entered, guano, feathers	entered	no sign	no sign	no sign	entered	entered	NESH		X
10A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	guano	no_sign	no_sign	no_sign	NESH		X
11A	no_sign	no_sign	no_sign	entered	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign			
12A	no_sign	no_sign	no_sign	entered, guano, odor	entered	no sign	no sign	entered		no_sign	entered		NESH egg	X
14A	no_sign	entered, guano, odor	entered, guano	entered, guano, odor	no sign	entered, feathers	entered, guano, feathers, odor	entered, guano, feathers	entered, guano, feathers	entered, guano, odor	entered, feathers	2x NESH		X
20A	no_sign	entered, guano	entered	entered, guano, odor	entered, guano	entered, guano	entered, guano, odor	entered	entered, feathers	entered	entered, feathers	2x NESH	2x NESH egg	X
21A	no_sign	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano, feathers	entered, guano, feathers, odor	entered, guano, feathers, odor	entered, guano, feathers	entered, guano, feathers	entered, guano, odor	2x NESH		X
22A	entered, guano	entered, guano	entered, guano	entered, guano	entered	entered, guano	entered, guano	entered, guano, feathers	entered, guano, feathers	entered, guano	entered, feathers	3x NESH	NESH egg	X
23A	no_sign	no_sign	entered	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign			
24A	no_sign	entered	entered	entered, guano	entered, feathers	entered, guano, feathers, odor	entered, guano, odor	entered, guano, odor	entered, guano, feathers	entered	entered, guano, feathers, odor	2x NESH	NESH egg	X
25A	no_sign	entered, guano, odor	entered, guano	entered, guano, odor	entered, guano	entered, guano, feathers	entered, guano, feathers, odor	entered, guano, odor	entered, guano, feathers, odor	entered, guano	entered, guano, feathers, odor	2x NESH, aggressions	NESH CHICK	X

Burrow/ Exclosure	4/5/22	4/21/22	5/10/22	6/6/22	6/22/22	7/5/22	7/20/22	8/4/22	8/19/22	9/9/22	9/28/22	camera activity	box activity	Consistently active
26A	no_sign	entered, guano, odor	entered, guano	entered	entered, guano	entered, guano	entered, guano	entered, guano	entered, odor	entered	entered, feathers	NESH	3x NESH egg	X
29A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered	entered, guano, feathers, odor	no_sign	entered	entered, guano, odor			X
30A	no_sign	no_sign	no_sign	no_sign	entered	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign			
32A	no_sign	entered, guano	entered, feathers	entered, guano	entered	entered, feathers, odor	entered	entered	entered	no_sign	no_sign	2x NESH	NESH egg	X
33A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered	no_sign	no_sign	no_sign	no_sign			X (see note)
34A	no_sign	no_sign	no_sign	no_sign	no_sign	entered, feathers	entered	entered	no_sign	no_sign	no_sign	NESH		X
35A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered	no_sign	no_sign	no_sign	no_sign			
36A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered, guano	no_sign	no_sign	no_sign	no_sign			
37A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered, guano	no_sign	no_sign	no_sign	no_sign			
39A	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered, guano, odor	entered, guano, feathers, odor	no_sign	entered, feathers	no_sign	2x NESH		X
40A	no_sign	no_sign	no_sign	entered	no_sign	no_sign	entered	entered, feathers	no_sign	no_sign	no_sign			X
42A	no_sign	no_sign	no_sign	entered, guano	entered, guano	entered, guano	entered	entered, feathers	no_sign	no_sign	no_sign			X
43A	entered, guano	entered	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano, feathers, odor	entered, feathers, odor	entered, guano, odor	entered, feathers ,odor	entered, guano,feathers, odor	NESH	NESH egg	X
44A	no_sign	no_sign	guano	entered, guano, feathers odor	entered, guano	entered, guano	entered, guano	entered, feathers	no_sign	no_sign	feathers	NESH	NESH egg	X

Burrow/ Exclosure	4/5/22	4/21/22	5/10/22	6/6/22	6/22/22	7/5/22	7/20/22	8/4/22	8/19/22	9/9/22	9/28/22	camera activity	box activity	Consistently active
48A	entered, guano	guano, feathers	entered	entered, guano	entered	entered, guano	entered	entered, guano	entered, guano	entered	no_sign	2x NESH	2x NESH egg	X
51A	no_sign	no_sign	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano	entered, guano	NESH	NESH egg	X

Burrow/ Exclosure	4/5/22	4/21/22	5/10/22	6/6/22	6/23/22	7/5/22	7/20/22	8/4/22	8/19/22	9/9/22	9/29/22	camera activity	box activity	Consistently active
2B	no_sign	no_sign	no_sign	no_sign	entered, guano	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign			
4B	entered	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign			
20B	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered, feathers	no_sign	no_sign	no_sign			
22B	entered	entered, feather	entered, guano	entered	entered	entered, guano	entered, guano	entered, guano	entered, guano, feathers	entered, guano, feathers	entered, guano, feathers	2x NESH, BUPE	NESH egg	X
23B	no_sign	no_sign	no_sign	no_sign	entered	no_sign	no_sign	entered, feathers	no_sign	no_sign	no_sign	NESH		X
24B	no_sign	no_sign	no_sign	no_sign	entered, feathers, odor	entered, guano	entered, guano	entered	no_sign	entered	no_sign			X
25B	no_sign	no_sign	no_sign	no_sign	no_sign	entered, guano	no_sign	no_sign	no_sign	no_sign	no_sign			
26B	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered	no_sign	no_sign	no_sign			
36B	no_sign	entered, feather	no_sign	no_sign	entered, feathers	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign			X
38B	no_sign	no_sign	no_sign	entered	entered, guano, odor	entered	entered	entered	no_sign	entered	no_sign			X
50B	entered, feathers	entered	entered	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	no_sign	entered	BUPE	BUPE egg, NESH egg	X

Note: Grey shaded cells indicate no activity during monitoring on that date. Blue shaded cells in the camera activity column indicate burrow boxes with game cameras deployed. Burrow 33A is considered consistently active based on box contents at the end of the season. See table 2.

Table 2. 2022 internal activity summary for all nest boxes.

Exclosure	Box	Start of season bird sign (03/02/2022)	Burrow box actions	End of season bird sign (09/28/2022)	End of season burrow box notes
A	1	A few wisps of grass		No sign	
	2	No sign		No sign	Box and lid damaged
	3	A few wisps of grass		No sign	
	4	No sign		No sign	Box damaged
	5	No sign		No sign	
	6	A few wisps of grass		A few wisps of grass	Lid damaged
	7	No sign		No sign	
	8	Feathers, veg and toothpicks in a nest cup		Feathers, veg and toothpicks in a nest cup	Box and lid damaged
	9	Scattered toothpicks, feathers, and veg fragments		Feathers, veg and toothpicks in a nest cup	Lid damaged
	10	Minimal veg		Feather	
	11	uluhe bits and grass		Veg	Lid damaged
	12	Scattered toothpicks, veg fragments, and a few small feathers		Feathers, veg and toothpicks in a nest cup	
	13	Scattered grass and a toothpick		Veg	
	14	Feathers and toothpicks	New sand added 03/09	Feathers and toothpicks	
	15	Grass bedding arranged as a nest		Grass bedding arranged as a nest	
	16	Scattered grass bits		Minimal veg	Box and lid damaged
	17	A couple wisps of grass		No sign	
	18	A few toothpicks, feathers, and some grass	Replaced lid 05/17	Toothpicks	Box damage
	19	No sign		No sign	
	20	Lots of feathers and veg scraps	New sand added 03/09	Feathers, veg and toothpicks in a nest cup	Lid damaged
	21	Feathers, veg and toothpicks in a nest cup		Feathers, veg and toothpicks in a nest cup	Lid damaged
	22	Lots of feathers and veg arranged in a nest bowl	New sand added 03/09	Feathers, veg and toothpicks in a nest cup	
	23	A few tiny feathers		No sign	

Exclosure	Box	Start of season bird sign (03/02/2022)	Burrow box actions	End of season bird sign (09/28/2022)	End of season burrow box notes
A	24	Feathers, toothpicks and veg arranged in nest cup	New sand added 03/09	Feathers, veg and toothpicks in a nest cup	
	25	Some feathers and veg bits arranged in nest cup		Feathers, veg and toothpicks in a nest cup	
	26	Feathers and veg bits arranged in a nest bowl	New sand added 03/09, replaced lid 05/25	Feathers, veg and toothpicks in a nest cup	
	27	No sign		No sign	
	28	No sign		No sign	
	29	Scattered veg bits, toothpicks, and feathers		Feathers, veg and toothpicks in a nest cup	
	30	No sign		No sign	
	31	No sign		No sign	Lid damaged
	32	Toothpicks, feathers, and lots of veg bits arranged in a nest bowl		Feathers, veg and toothpicks in a nest cup	Lid damaged
	33	A few toothpicks and scattered veg bits	New sand added 03/09	Toothpicks, feathers, guano	
	34	No sign		Toothpics and veg in a small nest cup	
	35	No sign	Replaced lid 05/17	Minimal veg	Box damaged
	36	No sign		Feathers	Box warping, fungus
	37	No sign		No sign	
	38	No sign		1 toothpick	
	39	No sign	Replaced box 05/26	Feathers	
	40	Two tiny feathers		Feathers	Box damaged
	41	A few wisps of grass and a tiny feather		No sign	Lid damaged
	42	A concentrated pile of feathers and veg bits		Feathers	
	43	Lots of toothpicks and feathers arranged in a nest bowl with veg bits	New sand added 03/09	Feathers, veg and toothpicks in a nest cup	
	44	No sign		Feathers	Hole in box side
A	45	*Obliterated box with grass and ohia leaves arranged in a bowl	Replaced box 05/25	No sign	

Exclosure	Box	Start of season bird sign (03/02/2022)	Burrow box actions	End of season bird sign (09/28/2022)	End of season burrow box notes
	46	No sign	Replaced lid 05/17	No sign	
	47	No sign		No sign	Lid damaged
	48	Toothpicks, wood chunks, and bits of veg arranged in a nest bowl	New sand added 03/09	Feathers, veg and toothpicks in a nest cup	Lid and box damaged
	49	No sign	Replaced lid 05/17	No sign	
	50	No sign	Replaced lid 05/17	No sign	Box damaged
B		**Start of season bird sign (03/02/2022)**		**End of season bird sign (9/29/2022)**	**End of season burrow box notes**
	1	No sign		No sign	
	2	No sign		No sign	
	3	No sign		No sign	Fungus, lid damaged
	4	No sign		No sign	
	5	No sign		No sign	
	6	No sign		No sign	
	7	No sign		No sign	
	8	No sign		No sign	
	9	No sign		No sign	
	10	No sign		No sign	
	11	No sign		No sign	
	12	No sign		No sign	
	13	No sign		No sign	
	14	No sign		No sign	
	15	One feather		No sign	
	16	No sign		No sign	
	17	No sign		No sign	
	18	Substantial grass carpet		Scattered veg pieces	
	19	Two small feathers		No sign	
	20	3 small feathers		3 feathers inside	
	21	Grass bed and several small feathers		Veg pieces arranged in nest cup, feathers	Lid, box cover damaged
	22	Nest bowl with feathers and grass		Lots of feathers, toothpicks, nest cup, abandoned NESH egg	
	23	Several small feathers		Feathers	
	24	Several small feathers		Few scattered pieces of veg	

Exclosure	Box	Start of season bird sign (03/02/2022)	Burrow box actions	End of season bird sign (09/28/2022)	End of season burrow box notes
B	25	Couple small feathers		Few scattered pieces of veg and feathers	
	26	No sign		No sign	
	27	No sign		No sign	
	28	No sign		No sign	
	29	Grass, paint chips, feather		Few scattered pieces of veg, toothpick, feather	
	30	No sign		No sign	
	31	No sign		No sign	
	32	No sign		No sign	
	33	No sign		No sign	
	34	No sign		No sign	
	35	No sign		No sign	
	36	One tiny feather		Few scattered pieces of veg	Cover destroyed, lid damaged
	37	No sign		No sign	
	38	No sign		Nest cup	Fungus
	39	No sign		No sign	
	40	No sign		No sign	
	41	One feather		Feather	
	42	Ohia leaves and grass		Nest and nest cup	
	43	A few feathers		No sign	
	44	No sign		No sign	
	45	One small feather		No sign	
	46	No sign		No sign	
	47	No sign		No sign	
	48	No sign		No sign	
	49	No sign		No sign	
	50	BUPE Inside!		Toothpicks, nest cup, abandoned BUPE egg and NESH egg	

Nighttime Seabird Surveys:
No nighttime auditory and visual surveys were conducted during the 2022 breeding season. These surveys were not included in the 2022 scope of work for the Makamakaʻole Seabird Enclosures monitoring.

Predator Removal: DOC200 traps (10 inside and 22 outside) and snap traps (20 inside and 20 outside) are deployed at the exclosures. Baits typically used are eggs for DOC200s and peanut butter for snap traps. Have-a-heart live traps are left intermittently outside exclosure A and on the path between exclosure A and B. Three mongooses were captured this year in live traps. Total catches this year to date are; 36 mongooses outside, 28 rats outside, 26 rats inside, 5 mice outside, and 11 mice inside. The overall catch rate in kill traps for the year was 0.005 (catches/trap night). Catch rate was higher at exclosure B compared to A (0.006 vs. 0.004) and higher outside of the exclosures compared to inside (0.005 vs. 0.004). See Table 3 for a summary of trapping.

Table 3. Summary of trap nights and catches, inside and outside exclosures by trap type (Jan. 1 – Dec.14, 2022).

Exclosure	Placement	Trap Type	Trap Nights	Mongoose catch	Rat catch	Mouse catch
A	Outside	DOC200	3579	**16**	**12**	**2**
		Snap Trap	3307	0	**4**	**3**
	Inside	DOC200	1715	0	**1**	0
		Snap Trap	3085	0	**7**	**1**
B	Outside	DOC200	3292	**16**	**10**	0
		Snap Trap	2571	**1**	**2**	0
	Inside	DOC200	1343	0	**7**	0
		Snap Trap	3035	0	**11**	**10**

Poison bait stations targeting rodents are deployed throughout both exclosures (24 in A, 22 in B). They are checked monthly and re-baited as needed with Ramik poison bait bars. The average amount of bait consumed in both exclosures is low throughout the summer (Figure 2).

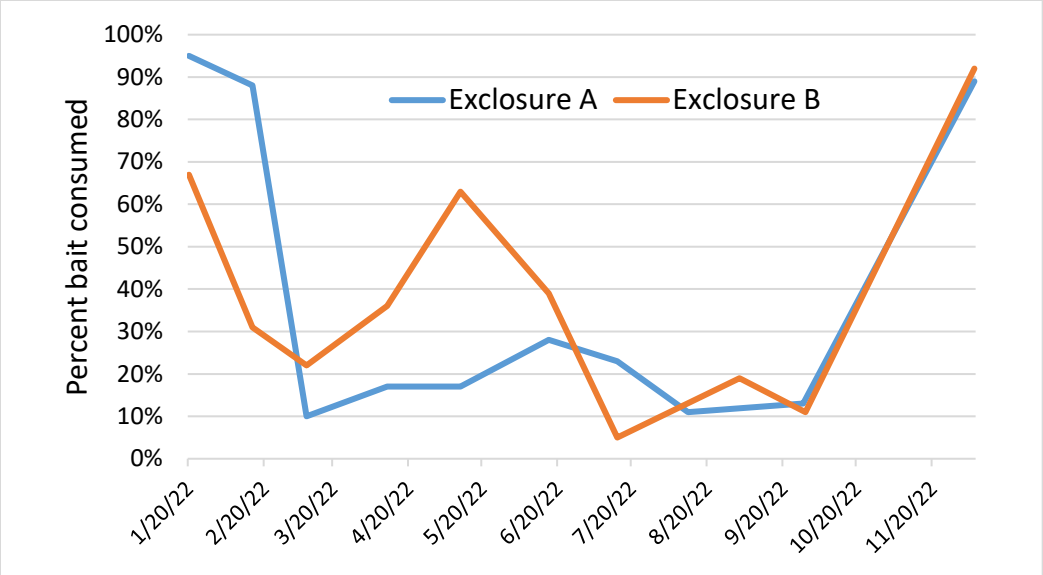

Figure 2. Average amount of poison bait consumed in each exclosure (2022).

Predator Tracking: Tracking cards baited with peanut butter were used to assess rodent and mongoose activity within the exclosures (10 each in A and B). Tracking cards are deployed for 24 hours and checked for rodent activity, then checked again after 72 hours for mongooses. In 2021, predator tracking cards were deployed in January, April, August, and November. No mongooses were detected on tracking cards. Rat tracks were seen more frequently in Exclosure B than in Exclosure A. Rodent presence decreases throughout the summer, as suggested by bait consumption (see Table 4).

Table 4. Predator tracking results by month. Results of mouse detection as the percent of cards with mouse tracks. Rat results list specific rat detection locations.

	Percent cards with mice		Percent cards with rats	
Month	A	B	A	B
March	60%	10%	0%	10%
June	0%	10%	0%	20%
September	80%	60%	0%	0%

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Appendix 7. Lānaʻi ʻUaʻu Mitigation; Final Report - 2022

Lānaʻi Hawaiian Petrel Mitigation
Final Report - 2022

Prepared for Brookfield Renewable Partners

Dr. Rachel Sprague
Director of Conservation

Pūlama Lānaʻi
Preservation. Progress. Sustainability.

February 2023

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Objective

The goal of this mitigation work was to improve reproductive success of Hawaiian petrels (*Pterodroma sandwichensis*) in a high-priority colony area on Lānaʻi, where maintenance of previous mitigation work is at risk. Support from this mitigation effort provided nesting petrels protection from predator pressure and resulted in reproductive success well above baseline levels within the project area.

Project Background

In 2018, Brookfield Renewable Partners provided support to Pūlama Lānaʻi to partially meet the regulatory requirements of Kaheawa Wind Power's Habitat Conservation Plan (HCP). With that mitigation project, predator control and monitoring were extended to protect the endangered Hawaiian petrel colony beyond the scope of the work the Pūlama Lānaʻi Conservation Department was conducting at the time.

In 2019, Pūlama Lānaʻi was able to maintain the predator control and monitoring with internal funding. In 2020, the COVID-19 pandemic caused the Pūlama Lānaʻi Conservation Department to constrict and focus on triage of priority activities. Some cat control was continued, and rodent traps were rebaited in January 2021, but the Conservation Department struggled to complete the work with fewer staff, and the department's other endangered species efforts were completely sidelined during that time.

For 2021 and 2022, mitigation funding support from Brookfield Renewable Partners supported efforts on Lānaʻi to maintain the 2018 level of predator control and Hawaiian petrel monitoring that was at risk due to post-COVID impacts.

Mitigation Actions

The mitigation project area consists of 4 distinct ridges, East Puʻu Aliʻi, Kanalo, West Hiʻi, and Hiʻi Center Ridge, totaling approximately 150 acres (~60 ha). The density of birds in this area is also extremely high, and at least 224 burrows have since been found across these ridges (Figure 1), out of 650 burrows known across Lānaʻi Hale.

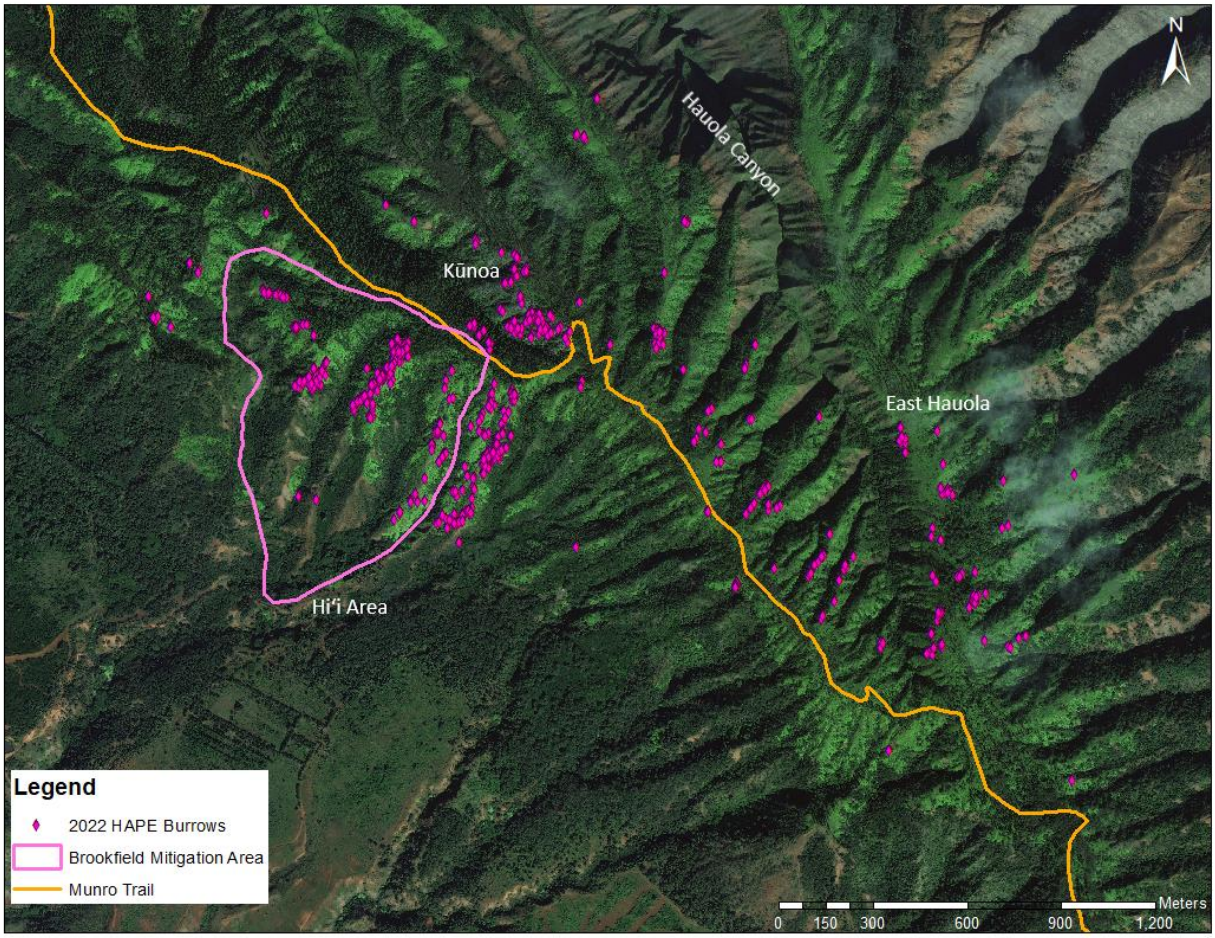

Figure 1. Map of area supported by Brookfield Renewable Partners mitigation funding for 2022, relative to the known Hawaiian petrel burrows on Lānaʻi Hale. The area is approximately 150 acres, and encompasses nearly 35% of the known Hawaiian petrel burrows on Lānaʻi.

Predator Control

Predator control for cats (*Felis catus*) and rats (*Rattus spp.*) was expanded within and around this area in 2018 as part of the mitigation for Kaheawa Wind Power I (Brookfield Renewable Partners). Today, those cat trap locations remain above these ridges on the Munro Trail and below on the lower Kapano and Kōʻele trap lines, which lie behind Lānaʻi City (Figure 2). During 2022, we captured 9 cats within ½ mile of the mitigation area.

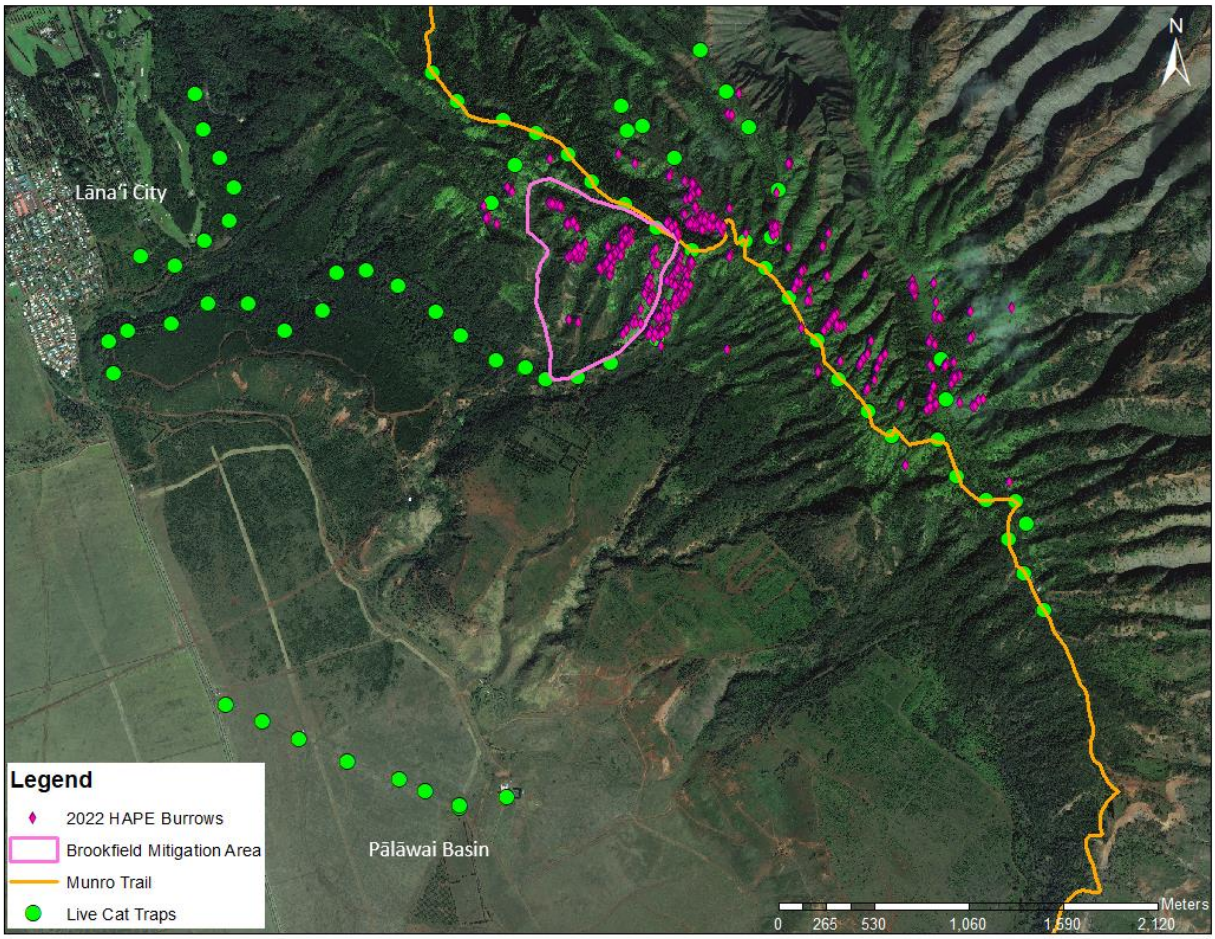

Figure 2. Locations of the landscape-level cat trap stations in the grid protecting the Hawaiian petrel colony on Lānaʻi Hale.

Throughout the 2022 season, 190 self-resetting rat traps (A24s) were active across the 150-acre native habitat area encompassing the burrows. These rat trap lines run down the ridges and through challenging canyon drainages (Figure 3). Mitigation funding provided by Brookfield supported rebaiting and maintenance of the A24 traps in the Greater Hiʻi area – this area is fully 25% of the nearly 800-trap A24 grid on Lānaʻi Hale and is the most technical terrain to traverse.

The Pūlama Lānaʻi Conservation team checked and rebaited the A24 automatic traps twice during the 2022 seabird breeding season, utilizing long-lasting automatic lure pumps (ALPs). During this time, we removed a minimum of 208 rodents,which is understood to be an extreme *under*estimate. This estimation is derived from incidental counts of skulls or carcasses found in the immediate vicinity of the A24 traps at the time of rebaiting. We also captured another 20 rats in live cat traps or other types of traps set up near cat trapping stations.

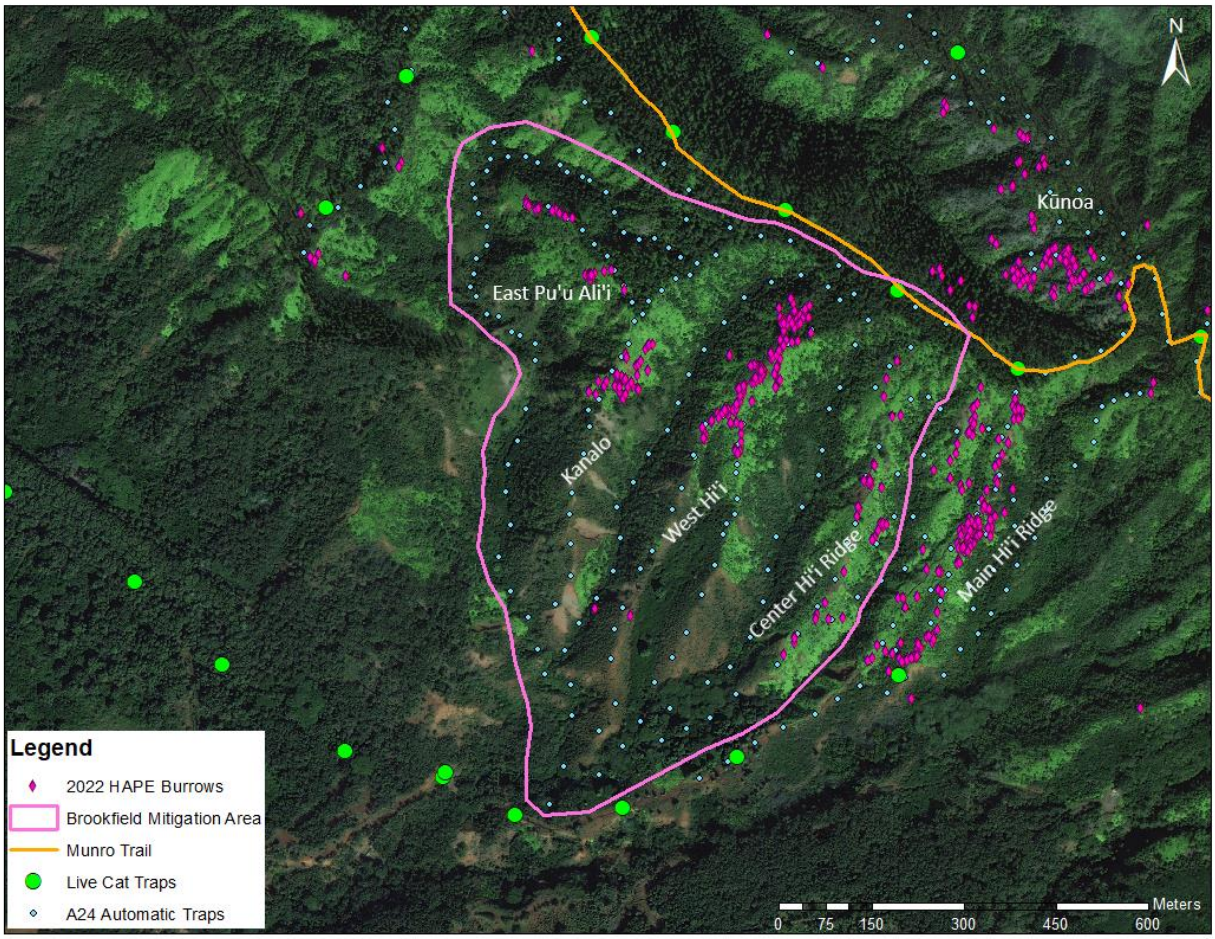

Figure 3. Locations of A24 self-resetting rat traps in the area supported by Brookfield Renewable Partners mitigation funding.

Monitoring/Evaluation

We used 64 motion-activated cameras to monitor a subset of burrows within the project area. Burrows were selected from 2 panels, a set that remains relatively constant over time (static) and a set that changes every year (rotating). All selected burrows were consistently camera monitored, from before the start of the season until after fledging or failure. This sample of monitored burrows was then used to determine apparent reproductive success and relative proportions of inactive burrows, new prospecting pairs, non-breeding pairs, etc. for all known Hawaiian petrel burrows in the monitoring area (Table 1). Any new burrows found were added to the pool of burrows to be randomly selected from for monitoring the following year.

Table 1. Number of known burrows and monitoring outcomes in the Greater Hiʻi area from 2017 to 2022.

	2017	2018	2019	2020	2021	2022
Known Burrows	59	124	189	193	196	224
Monitored Burrows	59	121	176	50	64	64
*Monitored with Cameras**	18	56	52	50	64	64
Monitored without Cameras	41	65	124	0	0	0
Inactive	2	3	2	3	3	0
Active, unknown status	14	17	33	4	5	0
Active, non-breeding	7	14	13	4	1	15
Active, breeding confirmed	36	87	129	39	55	49
unknown outcome	*14*	*4*	*10*	*0*	*0*	*0*
fledged	*13*	*59*	*110*	*32*	*44*	*41*
failed	*9*	*24*	*18*	*7*	*11*	*8*
Chicks produced per pair (w/known outcome)	**0.591**	**0.711**	**0.859**	**0.821**	**0.800**	**0.837**
Proportion of monitored burrows with known status and outcome	0.525	0.826	0.813	0.920	0.922	1.000
Proportion of monitored burrows with breeding and outcome confirmed	0.373	0.686	0.727	0.780	0.859	0.766

**Note that from 2017-2019, cameras were moved around between burrows during the season, and burrows with likely breeding or activity were prioritized, so they were not unbiased, random samples.*

Baseline Reproductive Success

The baseline success rate without predator control on Lānaʻi was calculated at 38.2% in communication with USFWS and Hawaiʻi DOFAW. In short, we averaged the 2016 and 2017 reproductive success estimates in colony areas with limited or no predator control.

Impact of Mitigation Project

Burrow Monitoring – Reproductive Success

As of December 31, 2022, there were 224 known burrows on the 4 ridges in the Greater Hiʻi area (East Puʻu Aliʻi, Kanalo, West Hiʻi and Hiʻi Center Ridge), and 64 burrows were monitored on those ridges as part of our 2022 monitoring plan (Figure 1). We confidently determined the breeding status and outcome of 100% of the monitored burrows, and 76.6% of the monitored burrows had confirmed breeding attempts (Table 1).

Of the burrows with breeding attempts, 83.7% successfully fledged a chick (n = 49). Causes of nest failure included 6 abandoned eggs, and 2 failures at the egg stage for unknown cause (no depredation detected). Review of photos from the 64 burrow monitoring cameras (~1.7 million photos) did not detect any feral cat visits to burrows.

Net Fledgling Outcomes

Our monitoring program uses a standardized random selection of Hawaiian petrel burrows to monitor, allowing for application of the proportions of inactive, prospecting, breeding, status burrows and reproductive success rates to be applied to all known burrows in a given area. Calculation of the net benefit uses the monitored set of burrows in 2022 to determine: 1) the proportion of burrows that have confirmed breeding (i.e., estimated active nests), and 2) the apparent reproductive success rate for burrows in the Greater Hi‘i area. The estimated number of fledglings produced from the known burrows minus the calculated baseline determines the net fledglings produced as a result of the mitigation actions:

*(# known burrows * proportion with confirmed breeding * 2022 success rate)*

– *(# known burrows * proportion with confirmed breeding * baseline success rate)*

= *net fledglings produced*

In 2022, the calculated benefit of predator control in the Greater Hi‘i area was 78 Hawaiian petrel chicks above baseline, given the currently known number of burrows (Table 2).

Table 2. Calculated increase in 2022 Hawaiian petrel fledgling production in response to predator control in the proposed mitigation area.

	2022
# Known Burrows	224
Estimated number of burrows w/breeding attempts *(based on 0.77 proportion of burrows monitored with breeding attempts; Table 1)*	172
Apparent Reproductive Success Rate	0.837
Benefit of predator control above 0.382 baseline (net fledglings produced)	78

Conclusion

Support from this mitigation effort provided nesting petrels protection from predator pressure and resulted in reproductive success well above baseline levels within the project area.

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