Kaheawa Wind Power
Habitat Conservation Plan
FY 2023 Annual Report

Prepared for:

Kaheawa Wind Power, LLC
3000 Honoapiʻilani Highway
Wailuku, Hawaiʻi 96768

Prepared by:

Tetra Tech, Inc.
737 Bishop Street, Suite 2340
Honolulu, Hawaiʻi 96813

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Incidental Take License ITL-08/ Incidental Take Permit TE118901-1

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Executive Summary

This report summarizes work performed by Kaheawa Wind Power, LLC (KWP I), owner of the Kaheawa Wind Power I Project (Project), during the State of Hawai‘i fiscal year (FY) 2023 (July 1, 2022 – June 30, 2023) under the terms of the approved Habitat Conservation Plan (HCP). The HCP was approved in January 2006 and describes KWP I’s compliance obligations under Project’s state Incidental Take License (ITL-08) and federal Incidental Take Permit (TE118901-1). Species covered under the HCP include four federally and state-listed threatened and endangered species (Covered Species). The 20-turbine Project was constructed in 2005 and 2006 and has been operating since June 22, 2006.

Wildlife fatality monitoring in FY 2023 continued within search plots limited to cleared areas within 70-meters of each Wind Turbine Generator (WTG). Canine-handler teams searched each of the fatality monitoring search 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 (carcass persistence) and the probability that an available carcass would be found (searcher efficiency) by a canine search team. In FY 2023, mean probabilities of a carcass persisting until the next search were 0.92 (bat surrogates), 1.00 (nēnē surrogates), and 0.99 (seabird surrogates); searcher efficiency was 0.95 for surrogates of the ‘ōpe‘ape‘a (the Hawaiian hoary bat) and 1.00 for surrogates of each of the other two species groups.

Four fatalities of Covered Species were detected in FY 2023. One ‘ōpe‘ape‘a was detected in March 2023. Three nēnē fatalities were detected (two incidental finds detected during a scheduled search but outside of the defined search area) in January 2023 while one fatality was detected during a scheduled search and within the defined search plot in April 2023. Since the commencement of operations, the Project’s total observed direct take of Covered Species has been 13 ‘ōpe‘ape‘a , 34 nēnē, and 8 ‘ua‘u. The fatality estimates using the Evidence of Absence estimator at the upper 80 percent credibility level are 28 ‘ōpe‘ape‘a , 52 nēnē, and 18 ‘ua‘u. Rounded up indirect take estimates for the Covered Species are four ‘ōpe‘ape‘a , two nēnē, and five ‘ua‘u. Combining these values, there is an approximately 80 percent chance that cumulative take of Covered Species at the Project since the beginning of operations through FY 2023 was less than or equal to 32 ‘ōpe‘ape‘a , 54 nēnē, and 23 ‘ua‘u.

The bat acoustic monitoring program captured bat activity across the Project at five detector locations throughout FY 2023. Between July 2022 and June 2023, the ‘ōpe‘ape‘a were detected on 214 nights out of 1,778 detector-nights sampled (12.0 percent). Detection rates were highest between the months of August and October during the lactation and post-lactation reproductive periods, with the peak in activity (proportion of nights with detections, 0.31) occurring in October.

Mitigation obligations have been met for three of the four Covered Species. The ‘ōpe‘ape‘a baseline (Tier 1) and Higher level of take (Tier 2) mitigation funding obligations were met prior to this fiscal year; current estimated take remains within Higher levels of take (Tier 2). In FY 2023, both USFWS and DOFAW provided concurrence that the Tier 1 mitigation obligation for the ‘a‘o had been met

based on outcomes of the 2022 breeding season at Makamakaʻole. To date, KWP I has not had observed take of the ʻaʻo. USFWS provided concurrence that the Tier 2 mitigation obligation had been met for the ʻuaʻu based on outcomes of the 2022 breeding season on Lānaʻi; KWP I awaits similar documentation from DOFAW. KWP I's nēnē current estimate of take remains within Tier 1. Tier 1 mitigation is ongoing as propagation efforts at the Haleakalā Ranch nēnē release pen. KWP I is exploring opportunities for additional mitigation projects to address lagging mitigation credits.

KWP I communicated actively with USFWS and DOFAW throughout FY 2023. The communication was conducted through conference calls, submittal of quarterly reports, and email communications related to the Project's HCP. The purpose of these communications included required semi-annual and annual HCP implementation meetings and focused discussions of all components of mitigation.

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1.0 Introduction

The Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) and U.S. Fish and Wildlife Service (USFWS) approved the Kaheawa Wind Project I (Project) Habitat Conservation Plan (HCP) in 2006. Kaheawa Wind Power, LLC (KWP I) was issued a federal Incidental Take Permit (ITP; ITP- TE118901-1) from the U.S. Fish and Wildlife Service (USFWS) and a state Incidental Take License (ITL; ITL-08) from the DLNR in January of 2006. The ITP and ITL cover the incidental take of four federally and state-listed threatened and endangered species (referred to as the Covered Species) over a 20-year permit term.

The Covered Species include the:

- ʻŌpeʻapeʻa (Hawaiian hoary bat; *Lasiurus cinereus semotus*);
- Nēnē (Hawaiian goose; *Branta sandvicensis*);
- ʻUaʻu (Hawaiian petrel, *Pterodroma sandwichensis*); and
- ʻAʻo (Newell's shearwater, *Puffinus newelli*).

The HCP frames take levels and mitigation as "Baseline Take" and "Higher Take." Hereafter, this document refers to Baseline Take as Tier 1 and Higher Take as Tier 2.

The Project was constructed in 2005 and 2006 and was commissioned to begin operating on June 22, 2006. Brookfield Renewable Partners, LP acquired the Project's LLC through acquisition of a controlling interest TerraForm, LLC in 2017; the Project continues to be operated by KWP I.

On behalf of KWP I, Tetra Tech, Inc. (Tetra Tech) prepared this progress report to describe the work performed for the Project during the State of Hawaiʻi 2023 fiscal year (FY 2023; July 1, 2022 – June 30, 2023) pursuant to the terms and obligations of the approved HCP, ITL, and ITP. KWP I has previously submitted annual HCP progress reports for FY 2007 through FY 2022 to the USFWS and DOFAW (KWP I 2007, KWP I 2008, KWP I 2009, KWP I 2010, KWP I 2011, KWP I 2012, KWP I 2013, KWP I 2014, KWP I 2015, KWP I 2016, KWP I 2017, KWP I 2018, Tetra Tech 2019, Tetra Tech 2020, Tetra Tech 2022a, Tetra Tech 2022b).

2.0 Fatality Monitoring

The Project has implemented a year-round intensive fatality monitoring program to document downed (i.e., injured or dead) wildlife incidents involving Covered Species and other species at the Project since operations began in June 2006. 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 established in April 2015. The last modifications were in 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." The evolution of the searched areas in which fatality monitoring occurred (search plots) included:

- In June 2006, search plots were 180-meter by 200-meter rectangles centered on each of the Project's 20 wind turbine generators (WTG).
- On October 1, 2010, search plots were reduced to 73-meter radius circular plots centered on each WTG, except where steep slopes prohibited visual searching.
- Since April 2015, search plots were reduced to the graded WTG pads and access roads that fall within a 70-meter radius circle centered on each of the Project's 20 WTGs (Figure 1). This search area continues to be used for monitoring in FY 2023.

In FY 2023, all 20 WTGs were searched for fatalities once per week. The FY 2023 mean search interval for all WTGs was 7.0 days (*SD* = 0.24). The search plots were searched by a canine search team which included a trained detector dog accompanied by a handler. Should search conditions prevent the use of dogs (e.g., weather, injury, availability of canine search team, etc.), search plots would be visually surveyed by Project staff. In FY 2023, all searches were conducted by canine teams and no visual searches occurred.

Four fatalities of Covered Species were detected in FY 2023. One ʻōpeʻapeʻa was detected in March 2023 (Section 7.1.1). Three nēnē fatalities were detected; two in January 2023, incidentally during a scheduled search but outside of the defined search area, and one detected in April 2023 during a scheduled search (Section 7.2.1). Fatalities of other species are reported in Section 7.4.

Precautions have been taken to prevent potential canine interactions with wildlife, particularly the nēnē. If nēnē were present in the search area, the canine handler immediately retrieved and restrained the dog, avoided disturbing the birds, postponed searching in the vicinity of the birds, worked on leash away from wildlife and/or temporarily skipped canine searches in the proximity of the nēnē. A total of 50 observations of 111 (non-distinct) individual nēnē were made over 23 days between August 2022 and June 2023. Observations were made in August 2022 and in each month from October 2022 to June 2023. In each case, the canine handler moved the dog to a different WTG search area away from the nēnē and returned to finish the search later in the day. No canine searcher-wildlife interactions occurred in FY 2023.

Figure 1. HCP Implementation Components

3.0 Carcass Persistence Trials

Trials used black rats (*Rattus rattus*) for ʻōpeʻapeʻa surrogates (i.e., small carcass), large chickens (*Gallus gallus*) for nēnē surrogates (i.e., large birds), and wedge-tailed shearwater (*Ardenna pacifica*) carcasses as surrogates for the ʻuaʻu and the ʻaʻo (i.e., medium birds; Covered Seabird Species). One 28-day carcass persistence trial was conducted in each quarter of FY 2023, for a total of four trials and 40 carcasses (20 small, 10 medium, and 10 large). For FY 2023, the probability that a carcass persisted until the next search was 0.92 for all bat surrogate carcasses (95 percent Confidence Interval [CI] = 0.86, 0.96; N=20), 1.00 for nēnē surrogates (95 percent CI = 0.97, 1.00; N=10), and 0.99 for seabird surrogates (95 percent CI = 0.89, 1.00; N=10).

4.0 Searcher Efficiency Trials

A total of 60 searcher efficiency trial carcasses were placed over 18 trial days during FY 2023. Similar to the carcass persistence trials, black rats were used as surrogates for bats and chickens were used as surrogates for the nēnē. Surveyors used wedge-tailed shearwaters and other medium-sized birds collected 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 throughout the year; 100 percent were conducted with canine search teams in FY 2023. Of the 61 trial carcasses placed, one bat surrogate was lost to scavenging. All other carcasses were available for detection. For FY 2023, the probability that a canine search team would find a carcass was 0.95 for bat surrogates (95 percent CI = 0.84, 0.99; N=38), 1.00 for nēnē surrogates (95 percent CI = 0.82, 1.00; N=12), and for ʻuaʻu surrogates (95 percent CI = 0.78, 1.00; N=10).

5.0 Vegetation Management

In order to maximize fatality monitoring efficiency and minimize impacts to native plants without compromising soil stability, KWP I 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 activity 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 of 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 of DOFAW-Maui 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 of DOFAW-Maui 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. Additional woody vegetation removal was approved to occur within a one-meter buffer of select turbine access roads with all work completed between April 1 and October 31 and in conjunction with a biological monitor.

In FY 2023, vegetation management was implemented at the Project in Q1, Q2, and Q4. During these quarters, 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 14 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 I 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, trapping included the use of 24 DOC250 body grip traps and 18 live traps placed throughout the Project. This level of effort is consistent with the increased level of effort employed in FY 2022 and resulted in an average of 40 trap nights per quarter for cage traps, and 91 trap nights per quarter for the DOC250s. In FY 2023, the scavenger trapping program removed 30 mongooses (*Herpestes auropunctatus*), and three 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

Four fatalities of Covered Species were detected in FY 2023. One ʻōpeʻapeʻa was detected in March 2023 (Section 7.1.1). Three nēnē fatalities were detected, with two incidental finds outside of the defined search area in January 2023 and one detected during a scheduled search and within the defined search plot in April 2023. All observed downed wildlife were handled and reported in accordance with the Downed Wildlife Protocol provided by USFWS and DOFAW (USFWS and DOFAW 2020). 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 search 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 search plot 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. As no changes to search plot dimensions have been made since FY 2016, the estimate of the density weighted proportion (DWP) of the carcass distribution searched (Appendix 1) has remained the same as described in the FY 2017 annual report (KWP I 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. Estimated Unobserved direct take (UDT); and
3. Estimated Indirect take.

The Evidence of Absence software program (EoA; Dalthorp et al. 2017), the agency-approved analysis tool for estimating 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: there is an 80 percent probability that actual direct take at the Project over the analysis period was less than or equal to the 80 percent UCL. Indirect take calculations are based on the HCP (KWP I 2006) 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 for the ʻōpeʻapeʻa (e.g., USFWS 2016).

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, long term projections may have limited utility. Nevertheless, they do help gauge the likelihood of permit 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 13 ʻōpeʻapeʻa fatalities have been observed at the Project since monitoring began in June 2006. Of the 13 observed, 10 were found inside of fatality search plots and are used to estimate UDT. Three bat fatalities were classified as incidental observations. All bat carcasses prior to FY 2023 were transferred to the U.S. Geological Survey for genetic sexing. Genetic sexing is used to refine estimates of indirect take. On March 28, 2023, one adult male[1] ʻōpeʻapeʻa carcass was observed during a scheduled search 1 meter from Turbine 16. The carcass was fresh with no visible signs of trauma and, following permission from DOFAW Maui, was stored in an onsite freezer until being transferred to DOFAW Maui personnel on April 5, 2023. This fatality occurred under the implementation of Low Wind Speed Curtailment (LWSC; see Section 10.0).

The observed ʻōpeʻapeʻa fatalities by fiscal year are listed in Table 1.

Table 1. Observed ʻŌpeʻapeʻa Fatalities at KWP I Through FY 2023

Fiscal Year	ʻŌpeʻapeʻa Observed Direct Take	ʻŌpeʻapeʻa Incidental Fatality Observations	Total
2007	0	0	0
2008	0	0	0
2009	0	1	1
2010	0	0	0
2011	0	1	1
2012	0	0	0
2013	2	0	2
2014	4	0	4
2015	0	0	0
2016	0	0	0
2017	1	1	2
2018	1	0	1
2019	1	0	1
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	1	0	1
Total	**10**	**3**	**13**

[1] Sex determined based on visible external genitalia.

The estimated direct take (ODT + UDT) for the 13 ʻōpeʻapeʻa fatalities found between the start of fatality monitoring in June 2006 and end of FY 2023 (June 30, 2023) is less than or equal to 28 bats (80 percent UCL; Appendix 1a).

Indirect take is estimated to account for the potential loss of individuals (offspring) that may occur indirectly as the result of the loss of an adult (breeding) female through direct take during the period that females may be pregnant or supporting dependent young. The seasonal timing and sex of all observed fatalities (those observed in fatality monitoring as well as incidental to fatality monitoring) is used in the estimate of indirect take. Cumulative indirect take is calculated as 3.17 adults (Appendix 2a).

The UCL for cumulative Project take of the ʻōpeʻapeʻa at the 80 percent credibility level is 32 adult bats (28 [estimated direct take] + 4 [estimated indirect take, rounded up from 3.17]). That is, there is an approximately 80 percent probability that cumulative take at the Project at the end of FY 2023 is less than or equal to 32 bats (Appendix 1a).

7.1.2 Projected Take

KWP I projected ʻōpeʻapeʻa take through the end of the permit term using the fatality monitoring data collected through FY 2023. The objective of this analysis was 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 3). For this analysis, the detection probability for future years is conservatively assumed to match the detection probability of FY 2021 (0.436; 95 percent CI 0.354, 0.521), 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 ODT. Based on historical Project data, KWP I assumed total indirect take for the Project over the permit term would be a maximum of six adult equivalents (approximately 20 juveniles based on assumed ʻōpeʻapeʻa survival rates; USFWS 2016), or 12 percent of the permitted take. Currently, the proportion of total take that is attributable to indirect take is roughly 10.2 percent (3.17 [adult bat equivalents estimated from indirect take] / 31.17 [bats estimated combining the direct and indirect take]), making the assumption of indirect take of six adult bats conservative. Assuming six adult bat equivalents are attributed to the Project as indirect take, the permitted direct take under the Project's ITP and ITL would be 44 bats (50 bats [permitted by ITL and ITP] minus 6 bats [estimated as attributed to indirect take] = 44 bats estimated direct take maximum).

Based on the analysis, there is an approximately 99.3 percent probability that the 80 percent UCL of cumulative take at the Project *will not* exceed permitted Tier 2 take during the permit term (Appendix 3). EoA projected a median estimate of 20 years of Project operation without a direct take estimate exceeding 44 bats. Therefore, based on these projections the Project is likely to remain below the permitted take limit of 50 ʻōpeʻapeʻa for the permit term.

7.2 Nēnē

7.2.1 Estimated Take

A total of 34 nēnē fatalities attributable to the Project have been observed at the Project since monitoring began in June 2006. Twenty-seven of the 34 geese were found inside of fatality search plots and are used to estimate direct take, while seven were considered incidental detections. The observed nēnē fatalities by fiscal year are listed in Table 2.

Table 2. Observed Nēnē Fatalities at KWP I Through FY 2023

Fiscal Year	Nēnē Observed Direct Take	Nēnē Incidental Fatality Observations	Total
2007	0	0	0
2008	2	1	3
2009	1	0	1
2010	1	0	1
2011	5	0	5
2012	1	0	1
2013	4	0	4
2014	3	0	3
2015	4	0	4
2016	1	0	1
2017	0	1	1
2018	1	1	2
2019	2	0	2
2020	0	0	0
2021	0	2[1]	2
2022	1	0	1
2023	1	2	3
Total	**27**	**7**	**34**

1. Includes one juvenile fatality found outside of search area. Based on estimated age and carcass condition at discovery, it is unknown if carcass was attributed to Project operations or other circumstances.

On January 3, 2023, one adult nēnē carcass was incidentally observed during a scheduled search 44 meters from Turbine 17 but outside of the cleared search area (Figure 1). On January 17, 2023, one adult nēnē carcass was incidentally observed during a scheduled search 43 meters from Turbine 7, again outside of the cleared search area. On April 25, 2023, one adult nēnē carcass was observed during a scheduled search 10 meters from Turbine 16.

The estimated direct take (ODT + UDT) for the 27 nēnē fatalities (within the search area) found between the start of operation (June 5, 2006) and end of FY 2023 (June 30, 2023) is less than or equal to 52 geese (80 percent UCL; Appendix 1b).

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 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. Cumulative indirect take was 3.43 juveniles (1.76 adults, assuming a 0.8 annual survival rate and 3 years from fledging to adult; Appendix 2b).[2]

The UCL for cumulative Project take of the nēnē at the 80 percent credibility level is 54 geese (52 [estimated direct take] + 2 [estimated indirect take, rounded up from 1.76]). That is, there is an approximately 80 percent probability that cumulative take at the Project at the end of FY 2023 is less than or equal to 54 adult geese.

In FY 2022 Brookfield's Kaheawa II Wind Project (KWP II), USFWS, and DOFAW reached consensus on mitigation credits attributable to the Project through FY 2021; however, consensus has not been reached on mitigation credit through FY 2023. The total mitigation credits assigned through FY 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 estimates 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 (KWP 2006). USFWS and DOFAW have agreed that the Project will not accrue lost productivity for nēnē take that occurred prior to calendar year 2011, the year the release pen was constructed. Six nēnē fatalities were documented at the Project prior to January 1, 2011. Accrued lost productivity is not currently calculable without mitigation credit data, an assessment of which will be determined in consultation with agencies.

7.2.2 Projected Take

KWP I projected nēnē take through the end of the permit term using the fatality monitoring data collected through FY 2023. The objective of this analysis was to evaluate the potential for the Project to exceed the Tier 1 take limit (described as Baseline Take in the Project's HCP) at the 80 percent UCL prior to the end of the permit term (Appendix 3). For this analysis, the detection probability for future years is assumed to match the estimated overall detection probability of FY 2021 (0.336; 95 percent CI 0.315, 0.357), 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 ODT. Based on historical Project data, KWP I assumed total indirect take for the Project over the permit

[2] No indirect take was attributed to the observed juvenile fatality observed in FY 2021, as a juvenile could not have dependent young.

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; KWP I 2006), or 3.3 percent of the Tier 1 take. Currently, the proportion of total take that is attributable to indirect take is 3.3 percent (1.76 [adult goose equivalents estimated from indirect take]/ 53.76 [adult geese estimated, combining the direct and indirect take]), making the assumption of two indirect take on par with the data. Assuming two adult nēnē are attributed to the Project as indirect take, the permitted direct take under Tier 1 of the Project's ITP and ITL would be 58 nēnē (60 geese [permitted by ITL and ITP for Tier 1] minus 2 geese [estimated attributed to indirect take] = 58 geese estimated direct take maximum).

Based on the analysis described above, there is a 24.5 percent chance that the 80 percent UCL of cumulative take *will not* exceed the Tier 1 take limit during the permit term (Appendix 3). EoA projected a median estimate of 20 years of Project operation without a direct take estimate exceeding 58 geese. Estimated take at the 80 percent UCL at the Project has surpassed 75 percent of allowable take in the current tier take and KWP I has consulted with agencies throughout FY 2023 regarding adjustments to the mitigation program needed to meet obligations, including the required process authorizing Tier 2 level of take (described as Higher Take) and clarification of the regulatory standard for measuring take as it is applied to KWP I.

Finally, KWP I has taken actions to minimize the threats to the nēnē at the Project and anticipates continuing to work with USFWS, DOFAW, and technical experts to further reduce risks of take (Sections 5.0, 10.0).

7.3 ʻUaʻu

7.3.1 Estimated Take

A total of eight ʻuaʻu fatalities have been observed at the Project since monitoring began in June 2006. Seven of the eight petrels were found inside of fatality search plots and were used to estimate direct take. The FY 2013 fatality was found outside of the designated search areas and is treated as an incidental observation. The observed ʻuaʻu fatalities by fiscal year are listed in Table 3.

Table 3. Observed ʻUaʻu Fatalities at KWP I Through FY 2023

Fiscal Year	ʻUaʻu Observed Direct Take	ʻUaʻu Incidental Fatality Observations	Total
2007	0	0	0
2008	1	0	1
2009	0	0	0
2010	0	0	0
2011	0	0	0
2012	2	0	2
2013	0	1	1
2014	1	0	1

Fiscal Year	ʻUaʻu Observed Direct Take	ʻUaʻu Incidental Fatality Observations	Total
2015	2	0	2
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	1	0	1
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
Total	**7**	**1**	**8**

The estimated direct take (ODT + UDT) for the seven ʻuaʻu fatalities found between the start of operation (June 5, 2006) and end of FY 2023 (June 30, 2023) is less than or equal to 18 petrels (80 percent UCL; Appendix 1c).

Indirect take is estimated to account for the potential loss of individuals that may occur as the result of the loss their parents. Both parents for the ʻuaʻu care for their young until fledging. The point during the breeding season when an adult is taken determines to what extent offspring may be affected. Cumulative indirect take was calculated at 13.59 juveniles (4.08 adults assuming a 0.3 survival rate from fledging to adult; Appendix 2c).

The Project may cause a net loss in productivity if take outpaces the number of individuals produced from mitigation efforts. The life history lag between production of the ʻuaʻu through mitigation efforts and the take of petrels at the Project drives the estimates 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 0.15 to account for the probability that those unmitigated petrels would have produced young (KWP I 2006). Each year's lost productivity is accumulated until mitigation occurs for the estimated adult take. Lost productivity information is provided in Appendix 2c.

The UCL for cumulative Project take of the ʻuaʻu at the 80 percent credibility level is 23 petrels (18 [estimated direct take] + 5 [estimated indirect take, rounded up from 4.08]). That is, there is an approximately 80 percent probability that cumulative take at the Project at the end of FY 2023 is less than or equal to 23 petrels.

7.3.2 Projected Take

KWP I projected ʻuaʻu take through the end of the permit term using the fatality monitoring data collected through FY 2023. The objective of this analysis was 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 3). For this analysis, the detection probability for future years is assumed to match the estimated overall detection probability of FY 2023, 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 ODT. Based on historical Project data, KWP I assumed total indirect take for the Project over the permit term would be a maximum of eight adult equivalents (approximately 27 juveniles based on an assumed ʻuaʻu survival rate of 0.3 from fledging to adult; KWP I 2006), or 21.1 percent of the permitted take. Currently, the proportion of total take that is attributable to indirect take is 18.5 percent (4.08 [adult petrel equivalents estimated from indirect take]/ 22.08 [adult petrel estimated combining the direct and indirect take]), making the assumption of eight indirect take upwardly conservative.

Assuming eight adult ʻuaʻu equivalents are attributed to the Project as indirect take, the permitted direct take under the Project's ITP and ITL would be 30 petrels (38 petrels [permitted by ITL and ITP] minus 8 petrels [estimated to be attributed to indirect take] = 30 ʻuaʻu estimated direct take maximum).

Based on the analysis described above and presented in Appendix 3, there is a 99.88 percent chance that the 80 percent UCL of cumulative take *will not* be exceeded during the permit term. Specifically, the estimated direct take threshold of 30 exceeds more than 99 percent of the projected mortality estimates (Appendix 3). EoA projected a median estimate of 20 years of Project operation without a direct take estimate exceeding 30 petrels. Therefore, the Project is likely to remain below the permitted take limit of 38 ʻuaʻu for the permit term.

7.4 Non-listed Species

In addition to the three nēnē fatalities and one ʻōpeʻapeʻa fatality, six non-listed bird fatalities representing four species were documented at WTGs at the Project in FY 2023. One of the four species observed in FY 2023 is protected by the Migratory Bird Treaty Act (MBTA): the northern mockingbird (*Mimus polyglottos*, one individual). Five fatalities of three non-native (introduced) species without MBTA protection were also detected: the black francolin (*Francolinus francolinus*; three individuals), gray francolin (*Francolinus pondicerianus;* one individual), and warbling white-eye (*Zosterops japonicus*; one individual). For a complete list of 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 6 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 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 5.0 of the approved HCP (KWP I 2006).

9.1 ʻŌpeʻapeʻa

9.1.1 Mitigation

Mitigation for Tier 1 take of 20 bats was funded in 2006 and completed. An HCP minor amendment approved by USFWS in October 2015 and DOFAW in January 2016 authorized take of up to an additional 30 ʻōpeʻapeʻa under Tier 2 which had been identified in the HCP but not included on the ITP and ITL.

A mitigation project that mitigates for 15 of the additional 30 bats began May 2017 and was completed in FY 2020 (KWP I 2017, Tetra Tech 2020). This mitigation project consisted of ʻōpeʻapeʻa ecological research in East Maui, contracted to H.T. Harvey Ecological Consultants. The contract total cost was $750,000.

Mitigation funding for the remaining 15 bats in Tier 2 was provided to the U.S. Geological Survey Hawaiian Hoary Bat Research Group starting in FY 2018 to conduct bat ecological research on Hawaiʻi Island to better inform future bat habitat restoration and conservation. The funding obligation was completed in FY 2022 and the research project is expected to be completed in December 2023 with final publication, technical results, and data releases. The Project, in combination with KWP II, had a total funding obligation of $1.7M to allocate to portions of each Project's mitigation requirement. KWP I, in combination with KWP II exceeded this funding obligation by $131,500 over the original cost, for a total combined expenditure of $1,831,500.

9.1.2 Acoustic Monitoring at the Project

Acoustic monitoring for bat activity at the Project has been conducted continuously since August 2008. Acoustic monitoring after the HCP-required initial 12-month period is a voluntary measure. In October 2013 (FY 2014), nine Song Meter SM2BAT+ ultrasonic recorders (SM2) were deployed, replacing the previously used Anabat SD2 bat detectors (Titley Electronics, Brendale, QLD, Australia). Each SM2 was equipped with one SMX-U1 ultrasonic microphone (Wildlife Acoustics,

Maynard, MA, USA) positioned horizontally, facing southwest (away from the prevailing northeast trade winds), 6.5 meters above ground level. In October 2019 (FY 2020), the Pali brush fires burned across most of the Project, destroying four SM2 units. In order to continue with the objectives of the monitoring program and address gaps in the spatial coverage of SM2's introduced by the brush fire, the monitoring regime was redesigned in July 2020 with the deployment of five SM2 units (WTGs 1, 5, 13, 15, and 20; Figure 1). This type of unit has been continuously used since October 2013. 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).

Over the course of the FY 2023 monitoring period (July 2022 to June 2023), the ʻōpeʻapeʻa were detected on 214 nights out of 1,778 detector-nights sampled (12.0 percent, Table 4). Detection rates were highest between the months of August and October during the lactation and post-lactation reproductive periods[3], with the peak in activity (proportion of nights with detections) occurring during the month of October (0.31, Figure 2). Following the initial peak in October, detection rates fluctuated monthly (between 0.06 and 0.09) throughout the post-lactation and pre-pregnancy reproductive periods (November to March). Detection rates slightly increased in April and May (0.13 and 0.12), at the beginning of the pregnancy reproductive period, followed by subsequent decline and the lowest detection rates (0.01) in July (Figure 2). The temporal pattern in detection rates during FY 2023 were similar to the detection rates observed in FY 2022 (Figure 3). However, the annual trend in detection rates observed in FY 2022 and FY 2023 differs from the bimodal trend 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.

Throughout the FY 2015 – FY 2023 dataset of the Project's monitoring program, there were only marginal fluctuations in the interannual detection rates (Table 4). Across analyzed monitoring years, there is an increasing trend in the annual detection rates. Although the annual detection rates in FY 2023 were greater than FY 2022 (by 2.5 percent), they were not significantly different (ANOVA: $F_{8,99} = 2.2$, $P < 0.033$; Tukey's HSD: $P > 0.999$). Furthermore, the more conservative Tukey's HSD post-hoc analysis, which accounts for accumulated type I errors in the ANOVA (Tian et

al. 2018), found no significant differences in annual detection rates among any years between FY 2015 and FY 2023 (Tukey's HSD: $P > 0.143$). Overall, across analyzed monitoring years (FY 2015 – FY 2023), there is a significant increasing trend in the annual detection rates (LM: $R^2 = 9.05$ percent; $F_{1,106} = 10.55$, P[3] < 0.002; Figure 4).

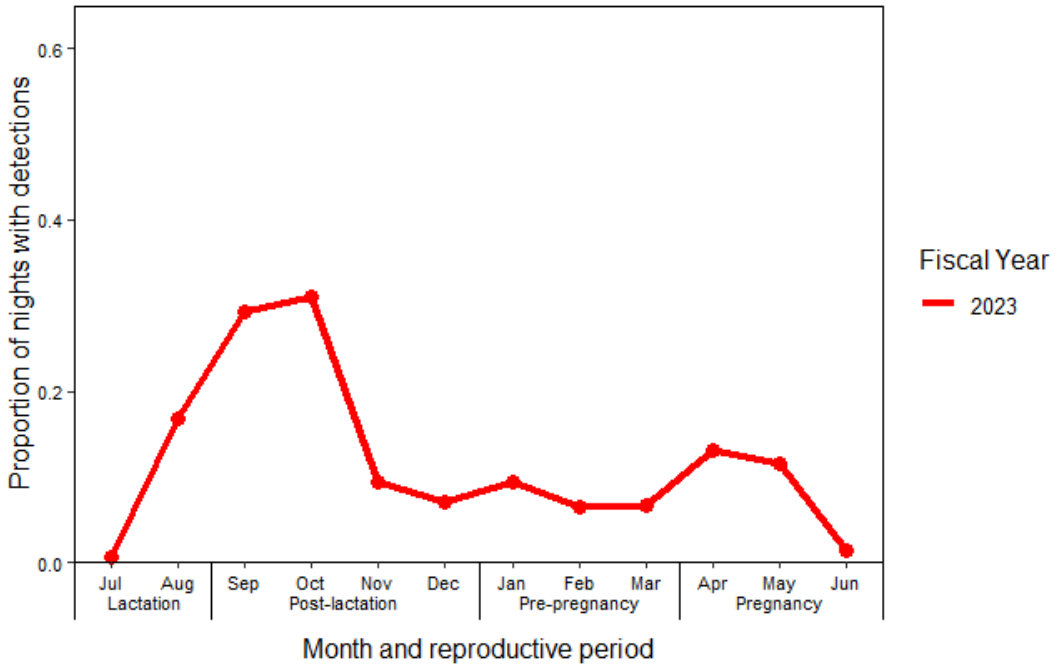

Figure 2. Monthly Detection Rates at the Project in FY 2023 with Corresponding Reproductive Periods

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

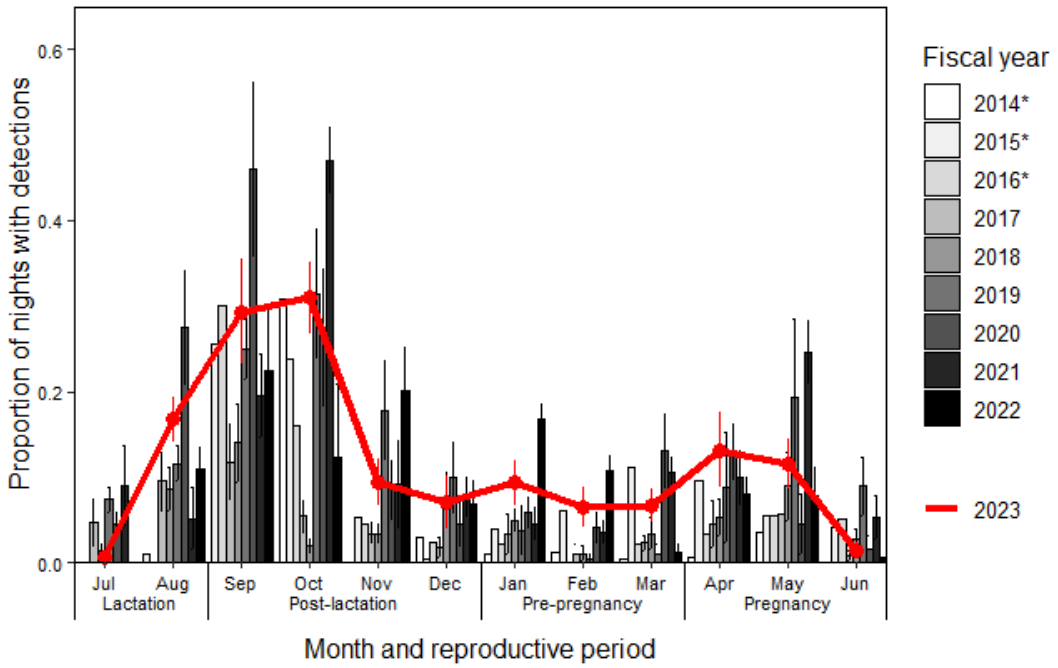

Figure 3. Monthly Bat Detection Rates at the Project for FY 2014 to FY 2023 with Corresponding Reproductive Periods[4]

Table 4. 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)	2,700	101	0.037
FY 2015 (July 2014 - June 2015)	3,203	249	0.078
FY 2016 (July 2015 - June 2016)	2,426	175	0.072
FY 2017 (July 2016 - June 2017)	2,827	131[2]	0.046
FY 2018 (July 2017 - June 2018)	2,989	162	0.054
FY 2019 (July 2018 - June 2019)	2,906	372	0.128
FY 2020 (July 2019 - June 2020)	1,853	280	0.151
FY 2021 (July 2020 - June 2021)	1,680	225	0.134

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

Dates[1]	No. of Nights Sampled	No. of Nights with Detections	Proportion of Nights with Detections
FY 2022 (July 2021 - June 2022)	1,756	167	0.095
FY 2023 (July 2022 - June 2023)	1,778	214	0.120

1. Number of monitoring sites: FY 2014 - 2019 (n = 9), FY 2020 - 2023 (n = 5).

2. Number erroneously reported as 129 in previous years' annual compliance reports (FY 2020 – FY 2022).

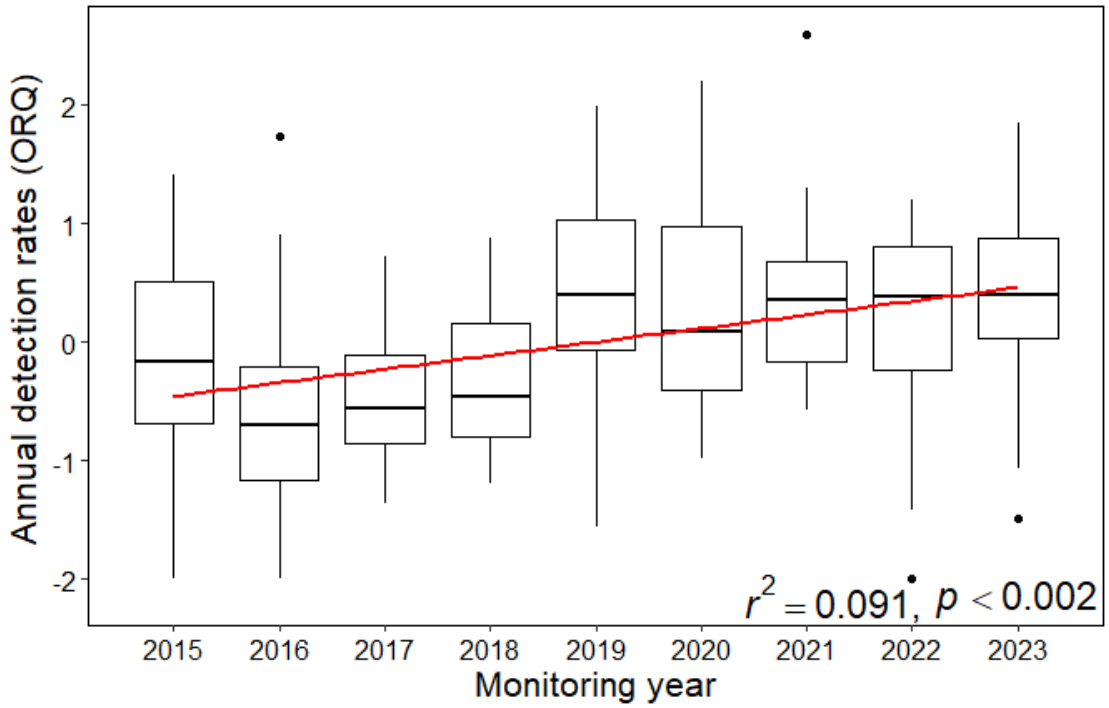

Figure 4. Box-plot with Linear Regression Showing the Increasing Trend in the Annual Detection Rate at the Project Between FY 2015 and FY 2023[5]

9.2 Nēnē – Haleakalā Ranch Release Pen

In 2009, the Project provided $264,000 to DOFAW to fund construction and management of the Haleakalā Ranch nēnē release pen as part of Project nēnē mitigation. DOFAW completed construction of the release pen three years later. Funding has been used by DOFAW to perform fence maintenance, predator control, vegetation management, and monitoring at the Haleakalā Ranch pen. Nēnē have been translocated from Kauaʻi to the Haleakalā Ranch pen since 2011, and several potential benefits have accrued based on the effects of these actions including production of fledglings and increases adult survival rates.

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

In May 2020, the Project provided $140,852 to DOFAW to fund nēnē mitigation activities performed by DOFAW at the Haleakalā Ranch release pen. Receipt of this amount was acknowledged via email by L. Taylor (DOFAW) on June 10, 2020. On August 27, 2021, A. Siddiqi (DOFAW) notified the Project via email that current funding of $114,863 was available for the Haleakalā Ranch release pen which should last for 23 months if the management effort continued with the same staff and assumed full time. KWP I assumed management of the Haleakalā Ranch release pen in mid-December 2022 while KWP I, KWP II and DOFAW worked toward agreement on an MOU for this management. On July 12, 2023, K. McEachern (DOFAW) notified the Project via email that DOFAW has used only $26,432.74 of KWP I provided funding of $134,145 between April 1, 2020 and February 28, 2022. This was the first time the Project was notified that previously provided funding was not being used to support predator control and other management actions at the Haleakalā Ranch because the technician could not work due to an injury.

The outcome of the 2021 – 2022 breeding season included 10 fledglings (Appendix 5), while the outcome of the 2022 – 2023 breeding season included 5 fledglings (Appendix 6). Through 2022, DOFAW has confirmed 76 fledglings produced in the pen from the translocated birds. Through FY 2023, a total of 81 fledglings have been produced (see Appendix 2b for quantification of mitigation credits associated with the Project). KWP I will work with DOFAW (inclusive of USFWS) to address funding issues and inconsistencies, and how they translate to the assessment of mitigation credit.

KWP I acknowledges the Project is lagging in mitigation credits, and is working with DOFAW and USFWS to adaptively manage the nēnē mitigation program. Cumulatively, the increases in adult and juvenile survival and productivity achieved by KWP I's mitigation project have not been sufficient to fully offset the mitigation obligations of Tier 1, and challenges in the application of provided funds to performance of mitigation tasks have provided additional limits. KWP I continues to explore and vet potential mitigation opportunities with USFWS and DOFAW to address lagging credits. As previously mentioned, in FY 2023, KWP I assumed Haleakalā Ranch release pen's management tasks in conjunction with the KWP II Wind Project, in lieu of providing direct funding to DOFAW. In FY 2024, KWP I will continue to work with DOFAW and USFWS to adaptively manage nēnē mitigation.

9.3 Seabirds

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

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 I 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 ʻUaʻu and 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.[6]

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 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 the 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 7). In Enclosure B, six 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 7).

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 I (in conjunction with KWP II), and that KWP I 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 a ʻaʻo mitigation credit of 8.54 adult equivalents, and that the mitigation obligation for KWP I (in conjunction with KWP II) had been met.

Brookfield worked with DOFAW throughout FY 2023 to transfer the management of Makamakaʻole to DOFAW. On September 5th, 2023, L. McEachern provided Brookfield with video footage and photos of the fence condition as of August 2023, including estimated costs to repair the existing structure of $699, 505.16, and requested funding from Brookfield in a subsquent meeting. Brookfield is still working internally toward resolution, has requested additional pertinent documentation from DOFAW, and anticipates further discussions with DOFAW. Although

[6] After the transfer of management of Makamakaʻole to DOFAW in February 2023, Brookfield became aware that portions of the predator exclosures at the site required repair or replacement. Brookfield will discuss this issue with DOFAW and USFWS during FY 2024 to learn more about the nature and extent of the potential problem.

Makamaka'ole has been managed to benefit the ʻuaʻu, as well as the ʻaʻo, no ʻuaʻu activity has been detected at burrows within the enclosures since 2017.

9.3.3 Lānaʻi ʻUaʻu Protection Project

The ʻuaʻu have not been observed occupying the Makamaka'ole mitigation site since 2017. Therefore, both KWP projects have worked together with USFWS an DOFAW to adaptively manage mitigation efforts for this species to ensure that its 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 8) 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 8).

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 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 KWPs. KWP I's Tier 2 ʻuaʻu mitigation obligation per the ITP is 38 ʻuaʻu (including adults, subadults, fledglings, nestlings, and eggs). In the

March 27 letter, USFWS acknowledges that KWP I has meet its ʻuaʻu mitigation obligation. DOFAW has yet to provide similar documentation.

10.0 Adaptive Management

In accordance with the HCP, the Project began implementing LWSC at all WTGs up to wind speeds of 5 meters per second (m/s) on July 29, 2014. LWSC is expected to reduce risk of bat take (Section 7.12). LWSC was increased to 5.5 m/s on August 4, 2014 in response to bat take occurring at the Project and at KWP II on March 13, 2013 and February 26, 2014. Curtailment at 5.5 m/s is in effect from sunset to sunrise, annually, from February 15 through December 15. The Project continues site-wide bat activity assessment via acoustic monitoring after the initial HCP-required 12-month monitoring period (Section 9.1.2).

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 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 I has taken practicable actions to minimize the threats to the nēnē. In FY 2023, KWP I 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 I 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 I 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, ESRC review of the annual report, focused discussions regarding mitigation projects, mitigation credits for the nēnē and seabird mitigation programs, and nēnē mitigation opportunities. A summary of agency coordination is presented in Table 5.

Table 5. 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 I, 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	KWPs ʻuaʻu mitigation credit - calculation of adult survival credit discussion (via teleconference)	KWP I, Tetra Tech, USFWS, DOFAW
October 4, 2022	Haleakalā Ranch Scope of Work	KWP I, Tetra Tech, Haleakalā Ranch, S. Franklin (DOFAW)
October 12, 2022	Annual HCP implementation review meeting (via teleconference)	KWP I, Tetra Tech, USFWS, DOFAW
October 13, 2022	Email to agencies requesting input on lost productivity accounting in authorized take limit	Submitted to USFWS, DOFAW by Tetra Tech
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 1, 2022	Email request for input on lost productivity accounting in authorized take limit	Submitted to USFWS, DOFAW by Tetra Tech
December 14, 2022	Haleakalā Ranch Nēnē Release Pen draft MOU clarification discussion (via teleconference)	Tetra Tech, DOFAW
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 I, Tetra Tech, DOFAW, USFWS
February 13, 2023	Makamakaʻole Newell's Shearwater Mitigation Credit Fufillment and Project Transition memo, Final	Submitted to DOFAW, USFWS by Tetra Tech
February 28, 2023	ʻUaʻu 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

Date	Communication	Participants
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 I, Tetra Tech, DOFAW Maui
May 11, 2023	Semi-annual HCP implementation review meeting	KWP I, Tetra Tech, USFWS, DOFAW
May 31, 2023	Nēnē release pen mitigation projects discussion	Tetra Tech, A. Siddiqi (DOFAW)
June 28, 2023	Submission of nēnē potential tier transition and Mitigation Obligations memo	Tetra Tech, USFWS, DOFAW

12.0 Expenditures

Total HCP-related expenditures for the Project in FY 2023 were $451,708 (Table 6).

Table 6. 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 Hawaiian Petrel Protection Project [2]	$140,915
Haleakalā Release Pen [2]	$44,246
Total Cost for FY 2023	**$451,708**

1. Staff labor costs are included in the overall costs for each category except for Equipment and Supplies.
2. Mitigation project are co-funded by KWP I and KWP II.

13.0 Literature Cited

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

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

Modeling Period	FY	Dates		Period Length (days)	% Year	LWSC	Search Interval (days)	Number of Searches in Modeling Period	Observed Fatalities (X)	K[1]	Canine Searches	DWP[2]	ĝ			B		M*[3]
		Begin	Ending										ĝ	95% LCI	95% UCI	Ba	Bb	
1	2007	6/22/2006	6/30/2007	373	1.02	no	9	41	0	0.7	No	1	0.445	0.261	0.638	11.21	13.96	1
2	2008	7/1/2007	6/30/2008	365	1	no	9	41	0	0.7	No	1	0.442	0.258	0.636	11.06	13.94	1
3	2009	7/1/2008	6/30/2009	364	1	no	7	52	0	0.7	No	1	0.501	0.312	0.69	12.70	12.64	1
4	2010	7/1/2009	6/30/2010	364	1	no	7	52	0	0.7	No	1	0.45	0.272	0.634	12.37	15.14	1
5	2011	7/1/2010	6/30/2011	364	1	no	7	52	0	0.7	No	1	0.505	0.257	0.752	7.145	7.007	1
6	2012	7/1/2011	6/30/2012	365	1	no	7	52	0	0.7	No	1	0.345	0.149	0.574	6.089	11.56	1
7	2013	7/1/2012	6/30/2013	364	1	no	7	52	2	0.7	No	1	0.414	0.183	0.669	5.894	8.335	7
8	2014	7/1/2013	6/30/2014	364	1	no	7	52	4	0.7	No	1	0.484	0.332	0.638	19.23	20.47	18
9	2015	7/1/2014	6/30/2015	364	1	5.5 m/s	7	52	0	0.7	No	1	0.217	0.128	0.321	14.76	53.30	19
10	2016	7/1/2015	6/30/2016	365	1	5.5 m/s	7	52	0	1	Yes	0.4922	0.44	0.408	0.472	407.9	520.1	19
11	2017	7/1/2016	6/30/2017	364	1	5.5 m/s	7	52	1	1	Yes	0.4922 or 0.573	0.524	0.499	0.549	816.1	741.0	21
12	2018	7/1/2017	6/30/2018	364	1	5.5 m/s	7	52	1	1	Yes	0.573	0.459	0.386	0.533	80.67	95.13	23
13	2019	7/1/2018	6/30/2019	364	1	5.5 m/s	7	52	1	1	Yes	0.573	0.368	0.289	0.45	50.35	86.64	26
14	2020	7/1/2019	6/30/2020	365	1	5.5 m/s	7	53	0	1	Yes	0.573	0.466	0.405	0.529	115.3	132.0	26
15	2021	7/1/2020	6/30/2021	364	1	5.5 m/s	7	52	0	1	Yes	0.573	0.437	0.351	0.522	58.18	75.11	26
16	2022	7/1/2021	6/30/2022	364	1	5.5 m/s	7	52	0	1	Yes	0.573	0.477	0.414	0.54	115.1	126.2	26
17 (current)	2023	7/1/2022	6/30/2023	364	1	5.5 m/s	7	52	1	1	Yes	0.573	0.52	0.486	0.555	418.7	386.2	28

1. Searches performed by canine teams increases the probability that a missed carcass will be detected on the next search.
2. Where two values are represented, the searched area changed within the modeled period. Detection probability represents the cumulative detection for the year. See annual reports for details.
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 the Nēnē at Project Through FY 2023

Modeling Period	FY	Dates		Period Length (days)	% Year	LWSC	Search Interval (days)	Number of Searches in Modeling Period	Observed Fatalities (X)	K	Canine Searches	DWP[1]	ĝ			B		M*[2]
		Begin	Ending										ĝ	95% LCI	95% UCI	Ba	Bb	
1	2007	6/22/2006	6/30/2007	373	1.02	no	9	41	0	1	No	0.95	0.923	0.871	0.962	120.8	10.14	0
2	2008	7/1/2007	6/30/2008	365	1	no	9	41	2	1	No	0.95	0.923	0.871	0.962	120.8	10.14	2
3	2009	7/1/2008	6/30/2009	364	1	no	7	52	1	1	No	0.95	0.928	0.886	0.961	162.5	12.60	4
4	2010	7/1/2009	6/30/2010	364	1	no	7	52	1	1	No	0.95	0.928	0.886	0.961	162.5	12.60	5
5	2011	7/1/2010	6/30/2011	364	1	no	7	52	5	1	No	0.95 or 0.7	0.773	0.748	0.797	889.3	261.5	11
6	2012	7/1/2011	6/30/2012	365	1	no	7	52	1	1	No	0.7	0.678	0.633	0.72	299.4	142.5	13
7	2013	7/1/2012	6/30/2013	364	1	no	7	52	4	1	No	0.7	0.666	0.58	0.748	79.75	39.93	18
8	2014	7/1/2013	6/30/2014	364	1	no	7	52	3	1	No	0.7	0.683	0.626	0.737	183.9	85.39	23
9	2015	7/1/2014	6/30/2015	364	1	5.5 m/s	7	52	4	1	No	0.7	0.691	0.658	0.722	548.7	245.9	28
10	2016	7/1/2015	6/30/2016	365	1	5.5 m/s	7	52	1	1	Yes	0.29	0.284	0.265	0.302	661.2	1671	32
11	2017	7/1/2016	6/30/2017	364	1	5.5 m/s	7	52	0	1	Yes	0.29 or 0.35	0.327	0.314	0.341	1474.3	3031	34
12	2018	7/1/2017	6/30/2018	364	1	5.5 m/s	7	52	1	1	Yes	0.35	0.344	0.336	0.352	4420	8438	37
13	2019	7/1/2018	6/30/2019	364	1	5.5 m/s	7	52	2	1	Yes	0.35	0.339	0.282	0.399	84.70	165.3	42
14	2020	7/1/2019	6/30/2020	365	1	5.5 m/s	7	53	0	1	Yes	0.35	0.33	0.301	0.359	337.8	686.5	43
15	2021	7/1/2020	6/30/2021	365	1	5.5 m/s	7	52	0	1	Yes	0.35	0.336	0.315	0.357	674.4	1280	45
16	2022	7/1/2021	6/30/2022	364	1	5.5 m/s	7	52	1	1	Yes	0.35	0.345	0.315	0.375	327.5	622.8	49
17 (current)	2023	7/1/2022	6/30/2023	364	1	5.5 m/s	7	52	1	1	Yes	0.35	0.345	0.323	0.368	598.0	1133	52

1. Where two values are represented, the searched area changed within the modeled period. Detection probability represents the cumulative detection for the year. See annual reports for details.

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 1c. Dalthorp et al. (2017) Fatality Estimation for ʻUaʻu at Project Through FY 2023

Modeling Period	FY	Dates		Period Length (days)	% Year	Search Interval (days)	Number of Searches in Modeling Period	Observed Fatalities (X)[1]	K	Canine Searches	DWP[2]	$\hat{g}$			B		M*[3]
		Begin	Ending									$\hat{g}$	95% LCI	95% UCI	Ba	Bb	
1	2007	6/22/2006	6/30/2007	545	1.02	9	61	0	0.9	No	1	0.807	0.602	0.948	14.64	3.512	0
2	2008	7/1/2007	6/30/2008	365	1	9	41	1	0.9	No	1	0.786	0.593	0.928	16.78	4.580	2
3	2009	7/1/2008	6/30/2009	364	1	7	52	0	0.9	No	1	0.847	0.717	0.942	31.55	5.682	2
4	2010	7/1/2009	6/30/2010	364	1	7	52	0	0.9	No	1	0.861	0.706	0.963	22.06	3.566	2
5	2011	7/1/2010	6/30/2011	364	1	7	52	0	0.9	No	1 or 0.75	0.798	0.752	0.841	244.5	61.78	2
6	2012	7/1/2011	6/30/2012	365	1	7	52	2	0.9	No	0.75	0.581	0.431	0.724	24.57	17.70	5
7	2013	7/1/2012	6/30/2013	364	1	7	52	0	0.9	No	0.75	0.646	0.511	0.77	32.73	17.93	5
8	2014	7/1/2013	6/30/2014	364	1	7	52	1	0.9	No	0.75	0.714	0.668	0.758	281.2	112.6	6
9	2015	7/1/2014	6/30/2015	364	1	7	52	2	0.9	No	0.75	0.65	0.555	0.74	65.57	35.30	10
10	2016	7/1/2015	6/30/2016	365	1	7	52	0	1	Yes	0.204	0.197	0.18	0.214	414.2	1690	10
11	2017	7/1/2016	6/30/2017	364	1	7	52	0	1	Yes	0.204 or 0.246	0.232	0.221	0.243	1272	4216	11
12	2018	7/1/2017	6/30/2018	364	1	7	52	0	1	Yes	0.246	0.24	0.203	0.28	114.8	362.8	12
13	2019	7/1/2018	6/30/2019	364	1	7	52	1	1	Yes	0.246	0.239	0.196	0.284	85.2	272	14
14	2020	7/1/2019	6/30/2020	365	1	7	53	0	1	Yes	0.246	0.218	0.192	0.244	210.7	757.7	15
15	2021	7/1/2020	6/30/2021	365	1	7	52	0	1	Yes	0.246	0.2096	0.12	0.316	13.62	51.37	16
16	2022	7/1/2021	6/30/2022	364	1	7	52	0	1	Yes	0.246	0.24	0.224	0.25	808.5	756.0	17
17 (current)	2023	7/1/2022	6/30/2023	364	1	7	52	0	1	Yes	0.246	0.239	0.221	0.256	532.9	1701	18

1. FY 2013 fatality was mistakenly included in previous analyses. Based on the contemporaneous fatality report, the carcass was recovered outside of the designated search plots.
2. Where two values are represented, the searched area changed within the modeled period. Detection probability represents the cumulative detection for the year. See annual reports for details.
3. Cumulative value representing estimate of total direct take from the start of operations through the identified monitoring period at the 80 percent UCL.

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Appendix 2. Indirect Take for the ʻŌpeʻapeʻa, Nēnē, and ʻUaʻu 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															
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 (current)	Total
A	Observed Breeding Female Take	0	0	0	0	1	0	0	2	0	0	0	1	0	0	0	0	0	**4**
B	Indirect Take from Observed Breeding Female Take (A x 1.8)	0	0	0	0	1.8	0	0	3.6	0	0	0	1.8	0	0	0	0	0	**7.2**
C	Observed Breeding Unknown Sex Take	0	0	0	0	0	0	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	0	0	0	0	0	**0**
E	All Observed Take (Search and Incidental)	0	0	1	0	1	0	2	4	0	0	2	1	1	0	0	0	1	**13**
F	Estimated Take Multiplier (28/13=2.15)	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	
G	Estimated Direct Take (E x F)	0	0	2.15	0	2.15	0	4.31	8.62	0	0	4.31	2.15	2.15	0	0	0	2.15	**28**
H	Unobserved Direct Take (G - E)	0	0	1.15	0	1.15	0	2.31	4.62	0	0	2.31	1.15	1.15	0	0	0	1.15	**15**
I	Indirect Take Calculated from Unobserved Take (H * 0.5 * 0.25 * 1.8)	0	0	0.26	0	0.26	0	0.52	1.04	0	0	0.52	0.26	0.26	0	0	0	0.26	**3.38**
Total Indirect Take (B + D + I; juveniles)																			**10.58**
Total Indirect Take (B + D + I)*0.3 (adults)																			**3.17**

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

Parameter	Description	Fiscal Year																				
		2007	2008	2009	2010	2011		2012	2013	2014		2015		2016	2017	2018	2019	2020	2021	2022	2023		Total
A1	Observed Adult Take	0	3	1	1	3	2	1	4	2	1	3	1	1	1	2	2	0	1	1	2	1	**33**
A2	Observed Juvenile Take	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**
B	Estimated Take Multiplier (52/33= 1.58)	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	
C	Estimated Adult Direct Take (A1 x B)	0.00	4.73	1.58	1.58	4.73	3.15	1.58	6.30	3.15	1.58	4.73	1.58	1.58	1.58	3.15	3.15	0.00	1.58	1.58	3.15	1.58	**52**
D	Observed Indirect Take Multiplier (Season Defined)	0	0.09	0	0	0.09	0	0.09	0.09	0.09	0	0.09	0.04	0.09	0.04	0.09	0.09	0	0.09	0.09	0.09	0.04	
E	Observed Indirect Take (D x A1)	0.00	0.27	0.00	0.00	0.27	0.00	0.09	0.36	0.18	0.00	0.27	0.04	0.09	0.04	0.18	0.18	0.00	0.09	0.09	0.18	0.04	**2.37**
F	Unobserved Direct Take (C – A1)	0.00	1.73	0.58	0.58	1.73	1.15	0.58	2.30	1.15	0.58	1.73	0.58	0.58	0.58	1.15	1.15	0.00	0.58	0.58	1.15	0.58	**19**
G	Unobserved Indirect Take (F x 0.06)	0.00	0.097	0.032	0.032	0.097	0.065	0.032	0.13	0.065	0.032	0.097	0.032	0.032	0.032	0.065	0.065	0.00	0.032	0.032	0.065	0.032	**1.07**
H	Accrued Adult Take ([Previous Year's Accrued C]- N - L) (beginning 1/1/2011)							3.05	4.73	10.86		14.92		19.35	19.23	19.88	20.98	20.81	21.31	22.76	N/C[1]		
I	Lost Productivity from accrued adult take (Current year's H x 0.1) (fledglings)							0.31	0.47	1.09		1.49		1.94	1.92	1.99	2.10	2.08	2.13	2.28	N/C[1]		**N/C[1]**
J	(Indirect Take) + Lost Productivity ([E + G]+ I +A3), for fledglings							0.43	0.96	1.36		1.93		2.06	1.99	2.23	2.34	2.08	2.25	2.40	N/C[1]		
K	Mitigation fledglings (fledglings)							1.61	4.29	4.29		3.22		5.90	7.50	0.54	1.36	10.00	1.00	10.00	N/A[2]		**N/C[1]**
L	Mitigation adult survival (adults)							0.10	0.10	0.17		0.07		0.17	0.20	0.27	0.08	0.50	0.37	0.62	N/A[2]		**N/C[1]**
M	Net fledglings remain (Current Year K - J)					0.00		1.18	3.33	2.92		1.29		3.84	5.51	-1.70	-0.98	7.92	-1.25	7.60	N/C[1]		**N/A[1]**
N	Net adults 3 yrs. later (3 Years' Previous M*0.512)							0.00	0.00	0.00		0.60		1.70	1.50	0.66	1.96	2.82	-0.87	-0.50	N/C[1]		**N/A[1]**
Total Direct Take from Collisions with WTGs (adults; C)																							**52.00**
Total Indirect Take (fledglings; E + G)																							**3.43**
Total Indirect Take (adults; [E + G] x 0.512)																							**1.76**
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 2c. Indirect Take for the ʻUaʻu at the Project in FY 2023

Parameter	Description	Fiscal Year																		
		2007	2008	2009	2010	2011	2012		2013	2014	2015		2016	2017	2018	2019	2020	2021	2022	2022	Total
A	Observed Take	0	1	0	0	0	1	1	1	1	1	1	0	0	0	1	0	0	0	0	**8**
B	Estimated Take Multiplier (16/8=2)	0	2.25	0	0	0	2.25	2.25	2.25	2.25	2.25	2.25	0	0	0	2.25	0	0	0	0	
C	Estimated Direct Take (A x B)	0	2.25	0	0	0	2.25	2.25	2.25	2.25	2.25	2.25	0	0	0	2.25	0	0	0	0	**18**
D	Observed Indirect Take Multiplier (Season defined)	0	0.66	0	0	0	0.66	0.5	0.89	0.89	0.89	0.66	0	0	0	0.89	0	0	0	0	
E	Observed Indirect Take (A x D)	0	0.66	0	0	0	0.66	0.5	0.89	0.89	0.89	0.66	0	0	0	0.89	0	0	0	0	**6.04**
F	Unobserved Direct Take (C - A)	0	1.25	0	0	0	1.25	1.25	1.25	1.25	1.25	1.25	0	0	0	1.25	0	0	0	0	**10**
G	Unobserved Indirect Take (D x F)	0	0.83	0	0	0	0.83	0.63	1.11	1.11	1.11	0.83	0	0	0	1.11	0	0	0	0	**7.55**
Total Indirect Take (E + G) chicks/eggs																					**13.59**
Total Indirect Take (E + G) x 0.3 adults																					**4.08**

Appendix 3. ʻŌpeʻapeʻa, Nēnē and ʻUaʻu 20-year Projected Take at the Project in FY 2023

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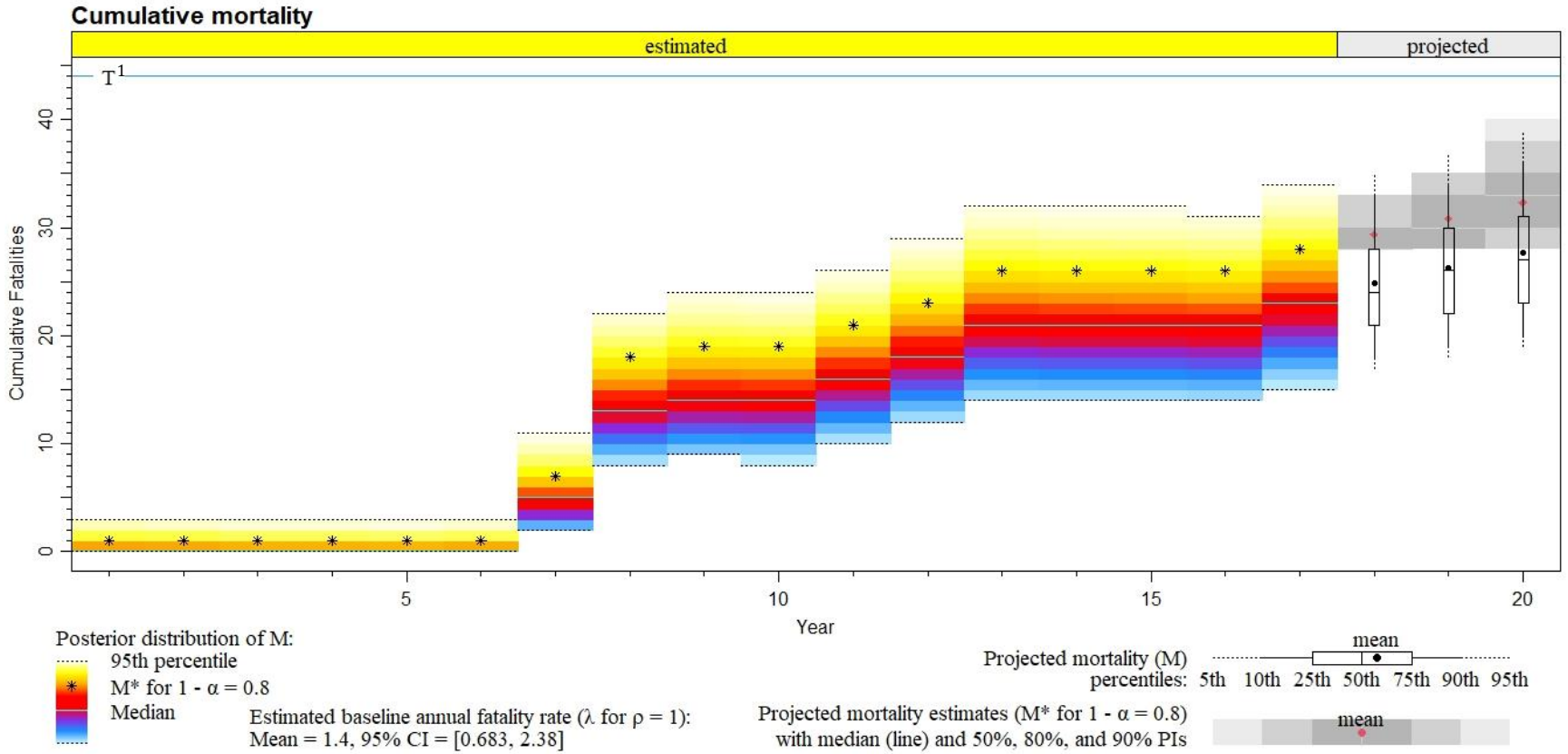
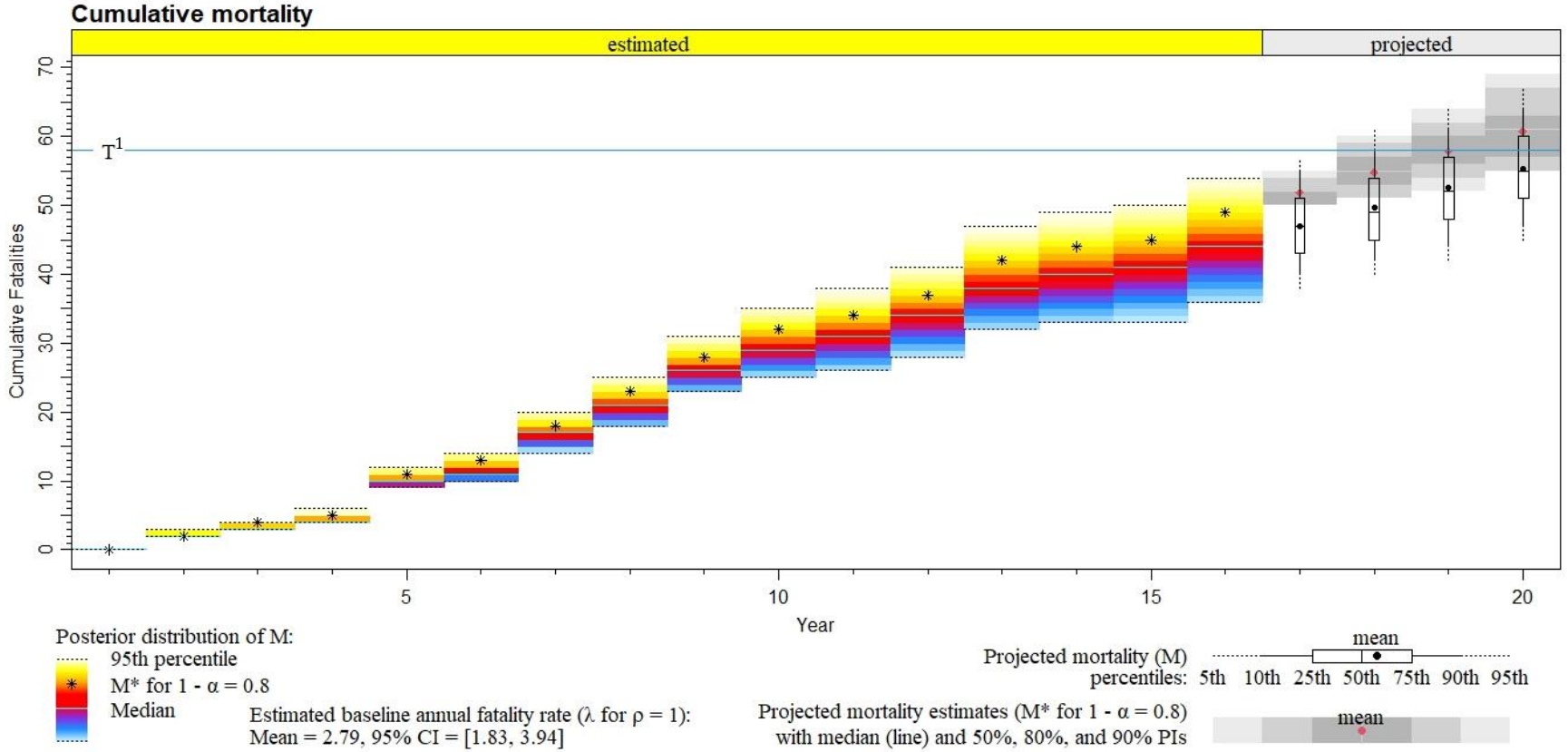
Appendix 3a. Projected Cumulative Mortality for the ʻŌpeʻapeʻa at the Project



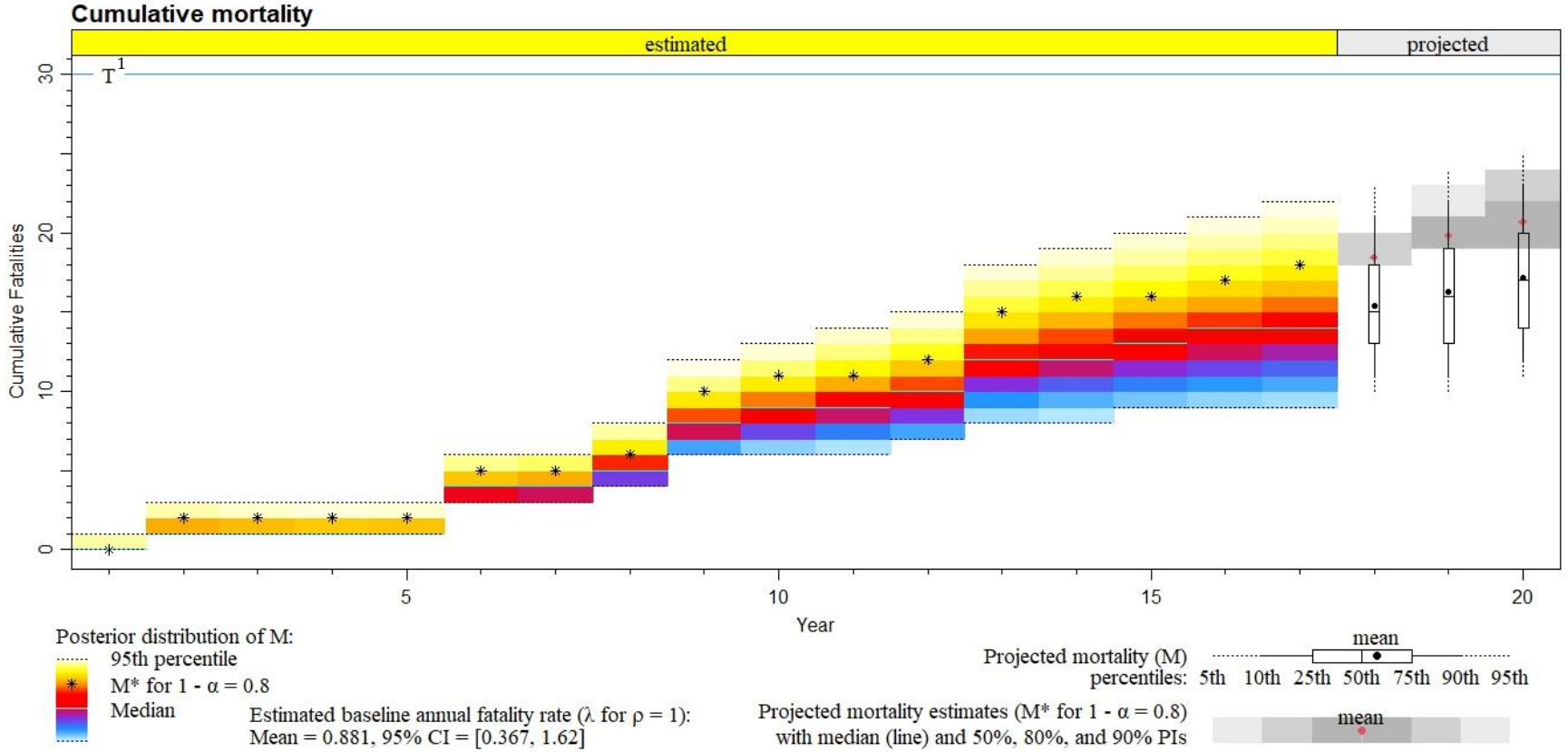
1. Permitted take for the ʻōpeʻapeʻa at the Project is 50; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 44 is shown, representing authorized bat take (50) minus 6 adult equivalents of indirect take (12.0 percent of the authorized limit). Currently, the proportion of total take that is attributable to indirect take is 10.2 percent.

Appendix 3b. Projected Cumulative Mortality for the Nēnē at the Project with Tier 1 Threshold



1. Permitted take for Tier 1 of the nēnē at the Project is 60; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 58 is shown, representing permitted nēnē take (60) minus 2 adult equivalents of indirect take (3.3 percent of the requested authorized limit). Currently, the proportion of total take that is attributable to indirect take is 3.3 percent.

Appendix 3c. Projected Cumulative Mortality for the ʻUaʻu at the Project



1. Permitted take for the ʻUaʻu at the Project is 38; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 30 is shown, representing authorized petrel take (38) minus 8 adult equivalents of indirect take (21.1 percent of the authorized limit). Currently, the proportion of total take that is attributable to indirect take is 18.5 percent.

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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)
Mimus polyglottos (Northern mockingbird)[1]	08/02/22	19	25	8
Francolinus francolinus (Black francolin)	10/18/22	1	1	357
Branta sandvicensis (nēnē, Hawaiian goose)[2]	01/03/23	17	44	197
Francolinus pondicerianus (Gray francolin)	01/10/23	8	1	30
Branta sandvicensis (nēnē, Hawaiian goose)[2]	01/17/23	7	43	9
Francolinus francolinus (Black francolin)	01/24/23	20	1	127
Lasiurus cinereus semotus (ʻōpeʻapeʻa, Hawaiian hoary bat)	03/28/23	16	1	5
Zosterops japonicus (Warbling white-eye)	04/18/23	5	1	40
Branta sandvicensis (nēnē, Hawaiian goose)[2]	04/25/23	16	10	120
Francolinus francolinus (Black francolin)	05/02/23	18	1	33

1. MBTA-protected species.
2. Covered Species.

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Appendix 5. Nēnē Monitoring and Predator Control Management at Haleakalā Ranch, Maui Annual Report, FY 2022

NĒNĒ MONITORING AND PREDATOR CONTROL MANAGEMENT AT HALEAKALĀ RANCH, MAUI

ANNUAL REPORT

FY 2022 (JULY 1, 2021 through JUNE 30, 2022)

1.0 Introduction

Since May 2011, the Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW), funded by the Kaheawa Wind Power projects, is managing a Nēnē Monitoring and Predator Control Management Program (Program) at Haleakalā Ranch (Ranch), Maui. The purpose of this Program is 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 Kaheawa Pastures Wind Energy Generation Facility (KWP I) and Kaheawa Wind Power II (KWP II) Habitat Conservation Plans (KWP I 2006, SWCA 2011).

This report summarizes the population establishment efforts for FY 2022. This report and the activities described herein are in compliance with the Haleakalā Ranch SHA (Haleakalā Ranch et al. 2019).

2.0 Mitigation Actions

2.1 Road Improvement

The road to the pen was maintained periodically, as needed, by moving rocks and backfilling holes with dirt and rocks. Approximately, twenty (20) feet of road was repaired this year.

2.2 Nēnē Monitoring

2.2.1 Sightings

Weekly observations and monitoring were conducted throughout the year on the Ranch. Observations of banded and unbanded birds were recorded at the Ranch to monitor movements, distribution, and survival of Nēnē. In FY2022, thirty-one (31) banded birds were sighted at the Ranch. Twenty-nine (29) were wild Maui Nēnē and two (2) were from the Kauai translocation. An island-wide annual Nēnē survey was conducted on September 27, 2012. During this survey, four (4) birds were seen at the Ranch.

2.2.2 Nesting

During nesting season, records were kept on mated pairs and the gravid levels of females found at the Ranch. Nests found on 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.

Ten (10) nests were located at the Ranch this year, nine (9) inside the Ranch's open-top release pen and one (1) outside the pen in the water unit. Five (5) of these nests were successful in producing twelve (12) goslings. Ten (10) Nēnē fledged from the Ranch open-top release pen this season.

Table 1. Nēnē Nesting Summary for 2021-2022 Breeding Season at Haleakalā Ranch, Maui

Total Number of Nests	
Located at the Ranch	**10**
Located in open-top pen	**9**
Successful	**6**
Abandoned	**1**
Depredated	**0**
Failed (unknown reason)	**3**
Renests	**0**
Total Number of Eggs	
Known	**27**
Depredated	**0**
Abandoned (later scavenged)	**1**
Salvaged	**0**
Outcome unknown	**14**
Hatched	**12**
Total Number of Goslings/Fledglings	
Known goslings	**12**
Goslings died (impact injuries)	**2**
Fledglings fledged from pen (credited for mitigation)	**10**

2.3 Banding

Fourteen (14) birds were banded this year, ten (10) fledglings and four (4) adults.

2.4 Pen Maintenance

The open-top pen's fence line was continuously checked and maintained throughout the year with holes being patched as needed. A total of five (5) feet of fence was repaired along the pen. The entire fence line was weedeated monthly, as needed, for a total of four and a half (4.5) acres for the year. The water unit was checked monthly, and the pond and automatic waterers were cleaned and maintained monthly. The door on the water until was replaced, and the rain gutter and gutter screens were replaced.

2.5 Habitat Management

Short grass habitat was maintained at the open-top release pen. A total of twenty-eight and a quarter (28.25) acres was mowed this year to maintain Nēnē short grass habitat. Twelve and a quarter (12.25) acres of alien vegetation, including lantana, guava, tomato, fireweed, and bur, were also removed.

2.6 Predator Control

Predator traps were used to control rats, mongoose, feral cats, and dogs that may pose a threat to Nēnē and their nesting sites. Traplines using thirty (30) Tomahawk live traps, thirty (30), and ten (10) A24s were baited and checked at the Ranch throughout the year.

This year at the Ranch, eight (8) mongoose were removed through predator trapping. No avian predators were controlled this season on the Ranch. No cats or cat sign were seen at the pen. Rats may likely be more abundant. Wild dogs have been seen on the ranch, but not specifically near the pen.

Table 2. Traps Deployed and Predators Removed during 2021-2022 at Haleakalā Ranch, Maui

Predator Type Removed	Trap Type		
	Tomahawk Live Trap (30)	Sherman Trap (30)	A24 Traps (10)
Cats	**0**	**0**	**0**
Dogs	**0**	**0**	**0**
Mongoose	**8**	**0**	**0**
Rats	**0**	**0**	**0**
Mice	**0**	**0**	**0**

Table 3. Avian Predator Control during 2021-2022 at Haleakalā Ranch, Maui

Predator Type Removed	Control Effort		
	(Describe Type 1) (Quantify level of effort)	(Describe Type 2) (Quantify level of effort)	(Describe Type 3) (Quantify level of effort)
Barn owls	**0**	**0**	**0**
Cattle egrets	**0**	**0**	**0**

2.7 Relocations

No relocations or releases were done this year.

2.8 Injury, Fatalities, Disease

One (1) adult nene was found at the pen with a broken right wing. It was taken to the vet and later euthanized due to the severity of the injury. Two (2) goslings that died from impact injuries (one (1) to the head and one (1) to the wing) were found during the nesting season.

2.9 Adaptive Management Actions

N/A

3.0 Literature Cited

Haleakalā Ranch Company, DLNR, USFWS. 2019. Safe Harbor Agreement for Nēnē at Haleakalā Ranch, Island of Maui.

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

SWCA (SWCA Environmental Consultants). 2011. Kaheawa Wind Power II Wind Energy Generation Facility Habitat Conservation Plan. Prepared for Kaheawa Wind Power II, LLC. December 2011.

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Appendix 6. 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 deaths 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. Mitigation credits accrued with the 2022 – 2023 breeding year will be equally divided between KWP I and KWP II per the MOU.

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.

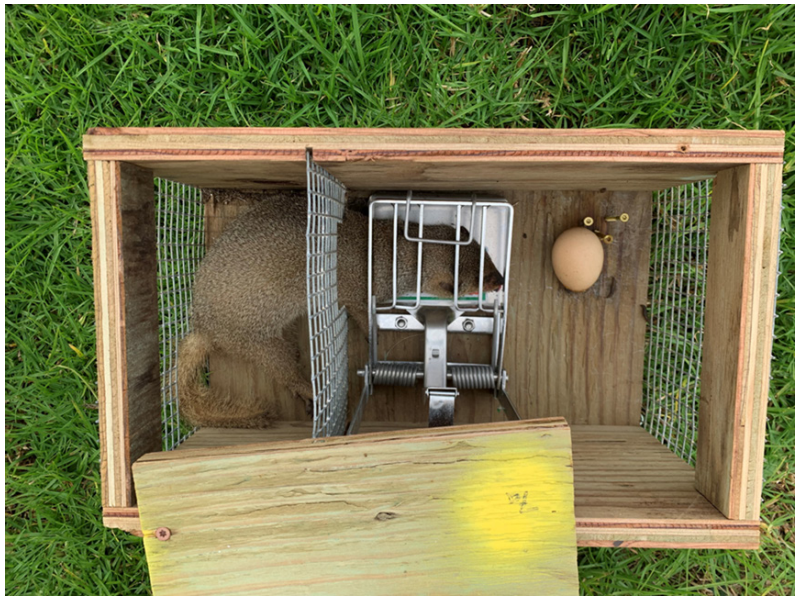

Image 7. DOC 200 Mongoose catch inside nēnē enclosure.

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 7. Makamakaʻole Seabird Mitigation Area 2022 Breeding Season 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).

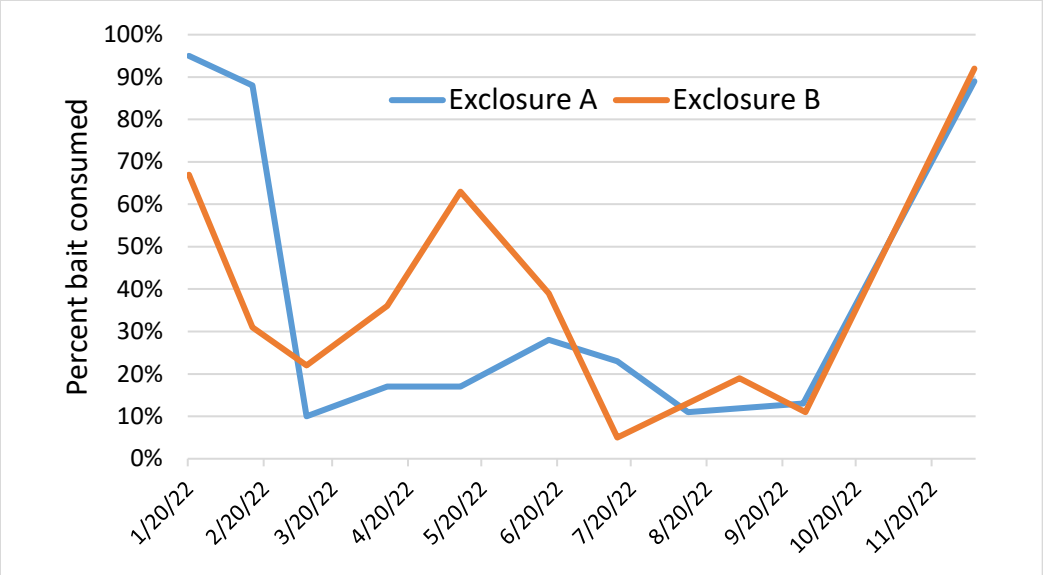

Figure 2. Average amount of poison bait consumed in each exclosure (2022).

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 8. 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.

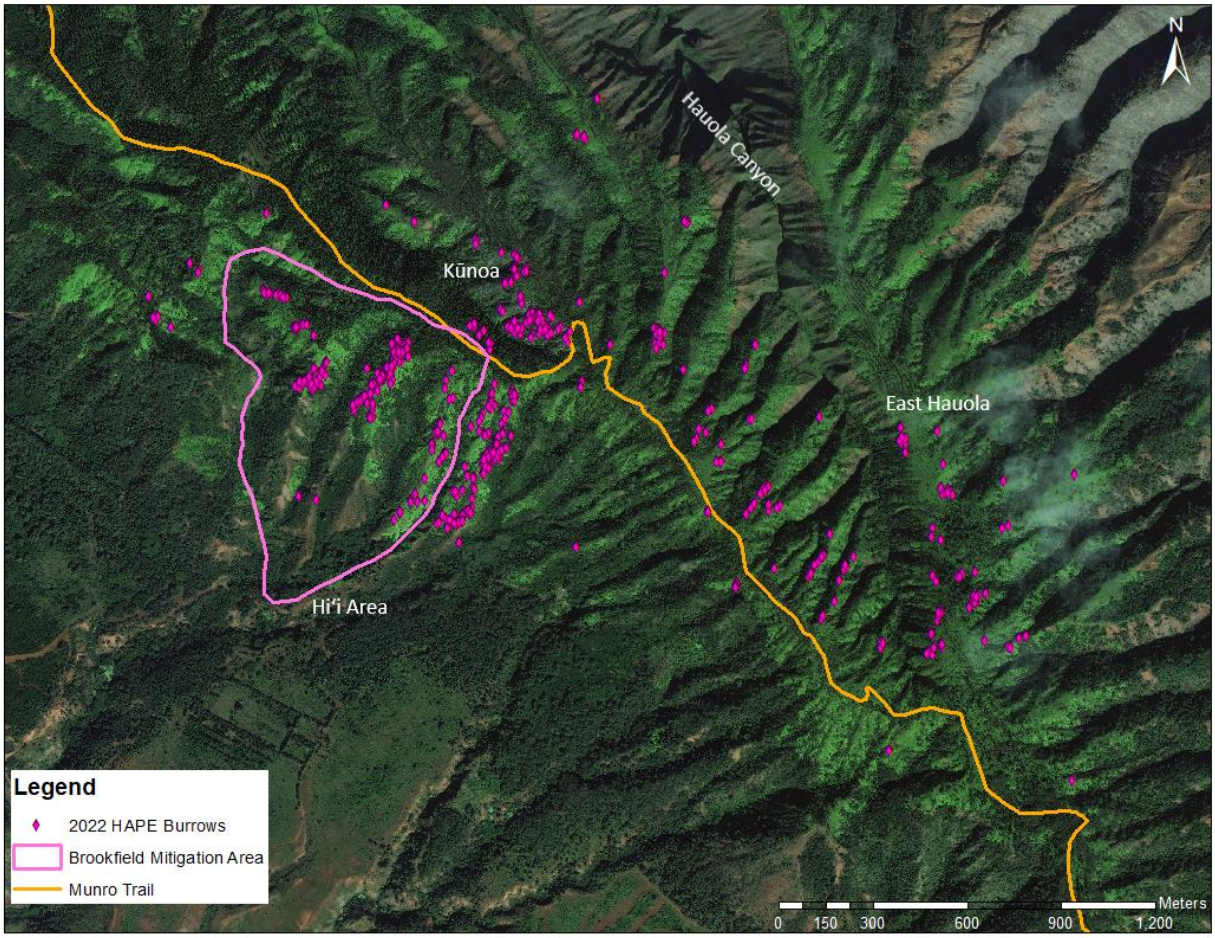

Figure 1. Map of area supported by Brookfield Renewable Partners mitigation funding for 2022, relative to the known Hawaiian petrel burrows on Lānaʻi Hale. The area is approximately 150 acres, and encompasses nearly 35% of the known Hawaiian petrel burrows on Lānaʻi.

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.

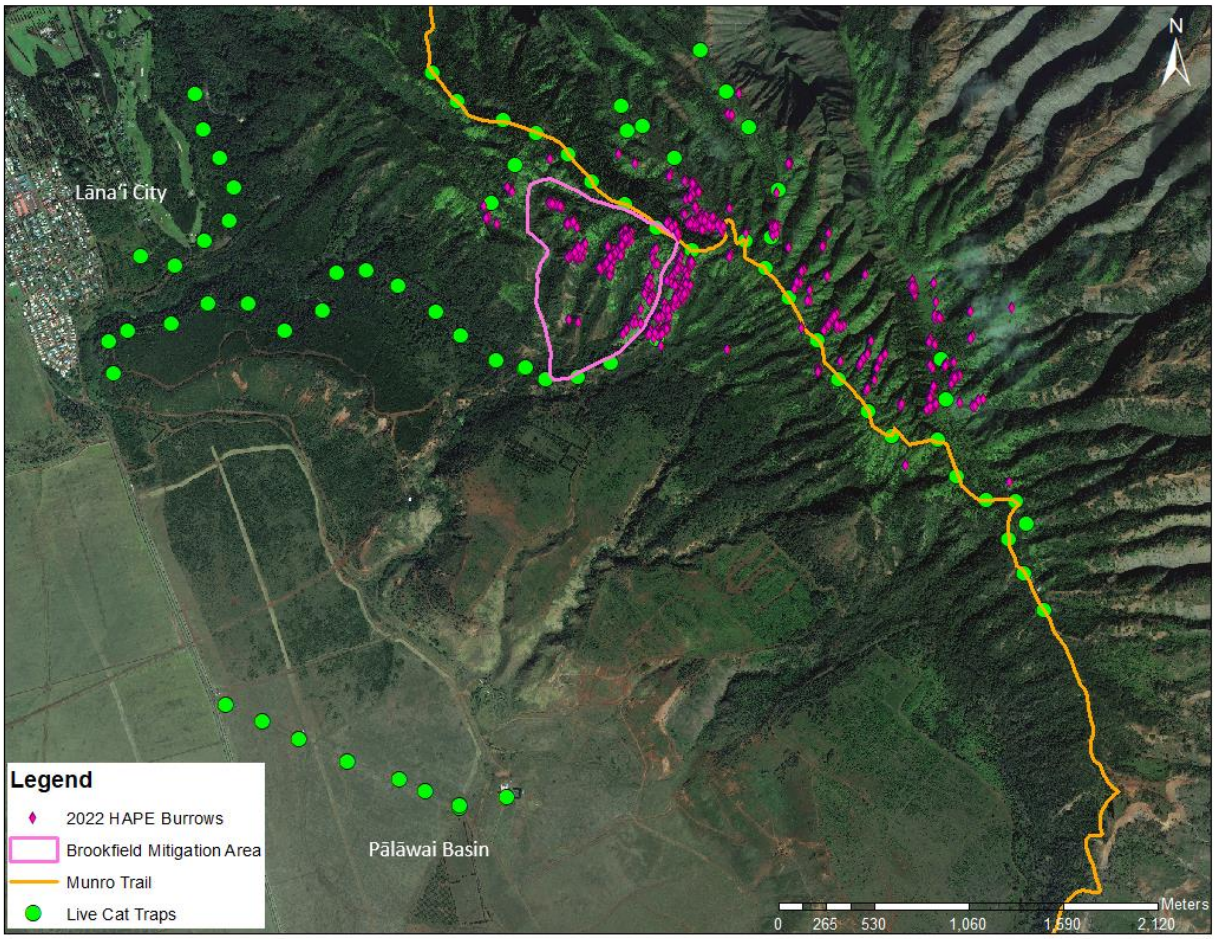

Figure 2. Locations of the landscape-level cat trap stations in the grid protecting the Hawaiian petrel colony on Lānaʻi Hale.

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.

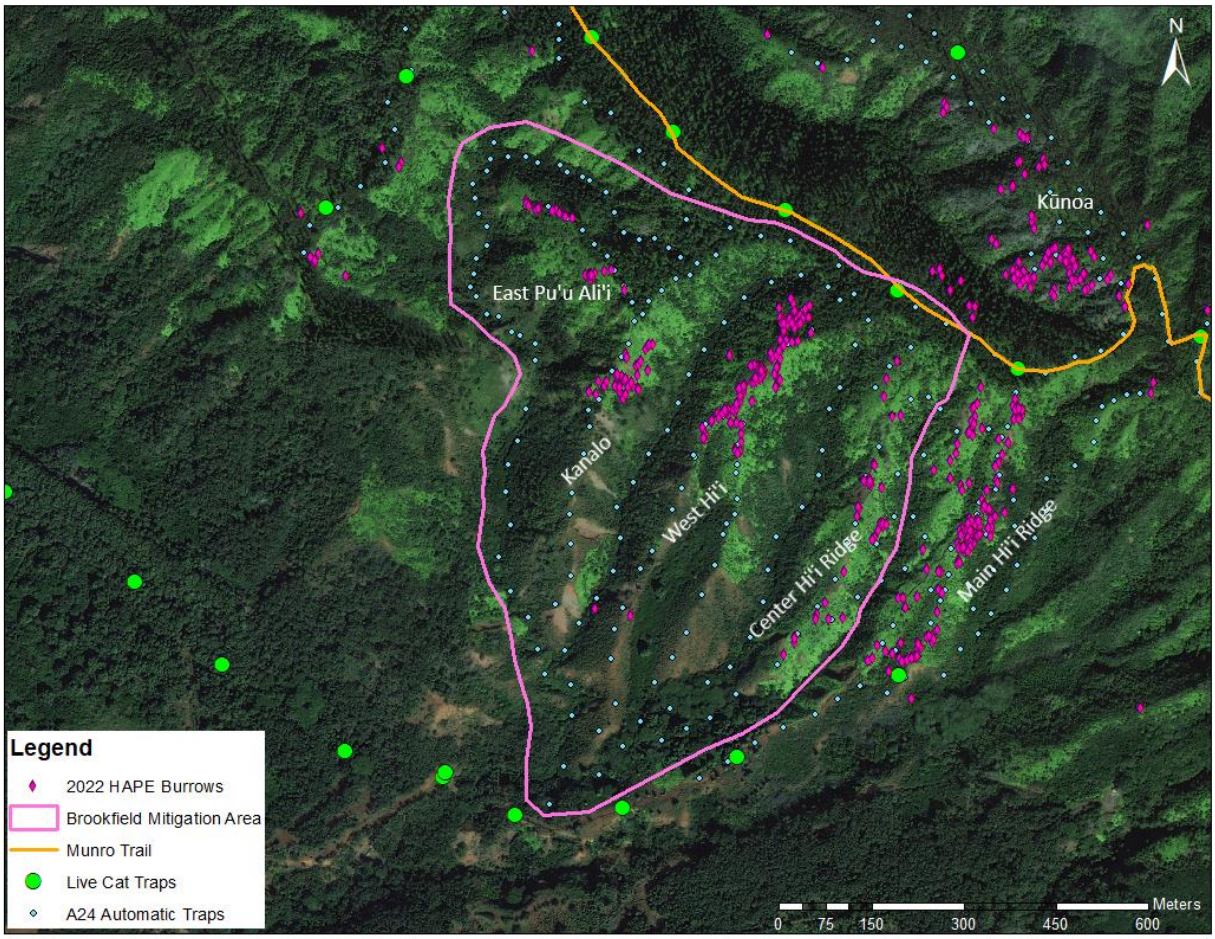

Figure 3. Locations of A24 self-resetting rat traps in the area supported by Brookfield Renewable Partners mitigation funding.

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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