Kaheawa Wind Power
Habitat Conservation Plan
FY 2021 Annual Report

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Incidental Take License ITL-08/ Incidental Take Permit TE118901-0

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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 Hawaiʻi fiscal year (FY) 2021 (July 1, 2020 – June 30, 2021) 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 (TE118901-0). 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 (fatality) monitoring in FY 2021 continued within search plots limited to cleared areas within 70-meters of each Wind Turbine Generator (WTG). Canine-handler teams searched within 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 2021, mean probabilities of a carcass persisting until the next search were 0.80 (bat surrogates), 0.97 (Hawaiian goose surrogates), and 0.92 (seabird surrogates); searcher efficiency was 0.91 for Hawaiian hoary bat surrogates and 1.00 for Hawaiian goose and seabird surrogates.

Of Covered Species, two Hawaiian geese fatalities were detected in FY 2021. Both fatalities were detected incidentally outside search plots. Since the commencement of operations, the Project's total observed direct take of Covered Species has been 12 Hawaiian hoary bats, 30 Hawaiian geese, and eight Hawaiian petrels. The fatality estimates using the Evidence of Absence estimator at the upper 80 percent credibility level are 26 (Hawaiian hoary bat), 45 (Hawaiian goose), and 16 (Hawaiian petrel). Rounded up indirect take estimates for the Covered Species are four (Hawaiian hoary bat), two (Hawaiian goose), and four (Hawaiian petrel). 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 2021 was less than or equal to 30 for the Hawaiian hoary bat, 47 for the Hawaiian goose, and 20 for the Hawaiian petrel.

The bat acoustic monitoring program captured bat activity across the Project at five detector locations throughout FY 2021. Between July 2020 and June 2021, Hawaiian hoary bats were detected on 225 nights out of 1680 (13.4 percent) detector-nights sampled. The seasonal pattern of detection rates was similar to previous years.

Mitigation commitments are ongoing. Baseline (Tier 1) mitigation obligations for the Hawaiian hoary bat were met prior to this fiscal year and current estimated take remains within Higher levels of take (Tier 2). Tier 2 mitigation will be complete in FY 2022 through funding of ecological research on Hawaiʻi Island. The Project's Hawaiian goose current estimate of take remains within Tier 1. Tier 1 mitigation has been funded and is ongoing as propagation efforts at the Haleakalā Ranch Hawaiian goose release pen. This release pen was funded in 2008 and constructed in 2011.

Proposed mitigation credit for fledgling production attributable to the Project has been described by Division of Forestry and Wildlife (DOFAW); however, KWP I considers that DOFAW's description undervalues the overall benefits of the mitigation funded by the Project to date, and is working with U.S. Fish and Wildlife Service (USFWS) and DOFAW to develop consensus on quantifying the Hawaiian goose mitigation benefits attributable to the Project. Current estimated take of Covered Species that are seabirds remains within Tier 1. Tier 1 mitigation is on-going as implementation of a comprehensive plan for seabird colony management at Makamakaʻole. The Maui Nui Seabird Recovery Project is contracted to continue work at Makamaka`ole through the 2021 breeding season. KWP I continues to work with wildlife agencies to assess overall benefits of Project's seabird mitigation project.

KWP I communicated actively with USFWS and DOFAW throughout FY 2021. The communication was conducted through conference calls, submittal of quarterly reports, and e-mail communications related to the Project's HCP. The purpose of these communications included required semi-annual HCP implementation meetings and focused discussions of mitigation funding and strategies.

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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 was issued a federal Incidental Take Permit (ITP; ITP- TE118901-0) from the U.S. Fish and Wildlife Service (USFWS) and a state Incidental Take License (ITL; ITL-08) from the Hawaii Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW) for the Project 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:

- Hawaiian hoary bat or ʻōpeʻapeʻa (*Lasiurus cinereus semotus*);
- Hawaiian goose or nēnē (*Branta sandvicensis*);
- Hawaiian petrel or ʻuaʻu (*Pterodroma sandwichensis*); and
- Newell's shearwater or ʻaʻo (*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 report to describe the work performed for the Project during the State of Hawaiʻi 2021 fiscal year (FY 2021; July 1, 2020 – June 30, 2021) 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 2020 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).

2.0 Fatality Monitoring

The Project has implemented a year-round intensive monitoring program to document downed (i.e., injured or dead) wildlife incidents (fatality monitoring) 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 searched 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 committees 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).
- In 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 2022.

In FY 2021, all 20 WTGs were searched for fatalities once per week. The FY 2021 mean search interval for all WTGs was 7.0 days (Standard Deviation = 0 days). The search plots were searched by a canine search team which included 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 2021, all searches were conducted by canine teams and no visual searches occurred.

Precautions have been taken to prevent potential canine interactions with wildlife, particularly the Hawaiian goose. If Hawaiian geese were present in the search area, the canine handler was directed to immediately retrieve and restrain the dog, avoid disturbing the birds, postpone searching in the vicinity of the birds, work on leash away from wildlife and/or temporarily skip canine searches in the proximity of the Hawaiian goose. Hawaiian geese were observed at the Project over 38 days in FY 2021 and in every month of the year with the exception of October. In each case, the canine handler moved the dog to a different WTG search area away from the Hawaiian geese and returned to finish the search later in the day. No canine searcher-wildlife interactions occurred in FY 2021.

3.0 Carcass Persistence Trials

Four 28-day carcass persistence trials were conducted in FY 2021, once per quarter, using bat surrogates (black rats; *Rattus rattus*), Hawaiian goose surrogates (chickens; *Gallus gallus*), and seabird surrogates (wedge-tailed shearwaters; *Ardenna pacifica*). For FY 2021, the probability that a carcass persisted until the next search was 0.80 for all bat surrogate carcasses (95 percent Confidence Interval [CI] = 0.63, 0.91; N=20), 0.97 for Hawaiian goose surrogates (95 percent CI = 0.87, 0.99; N=10), and 0.92 for seabird surrogates (95 percent CI = 0.37, 1.00; N=10).

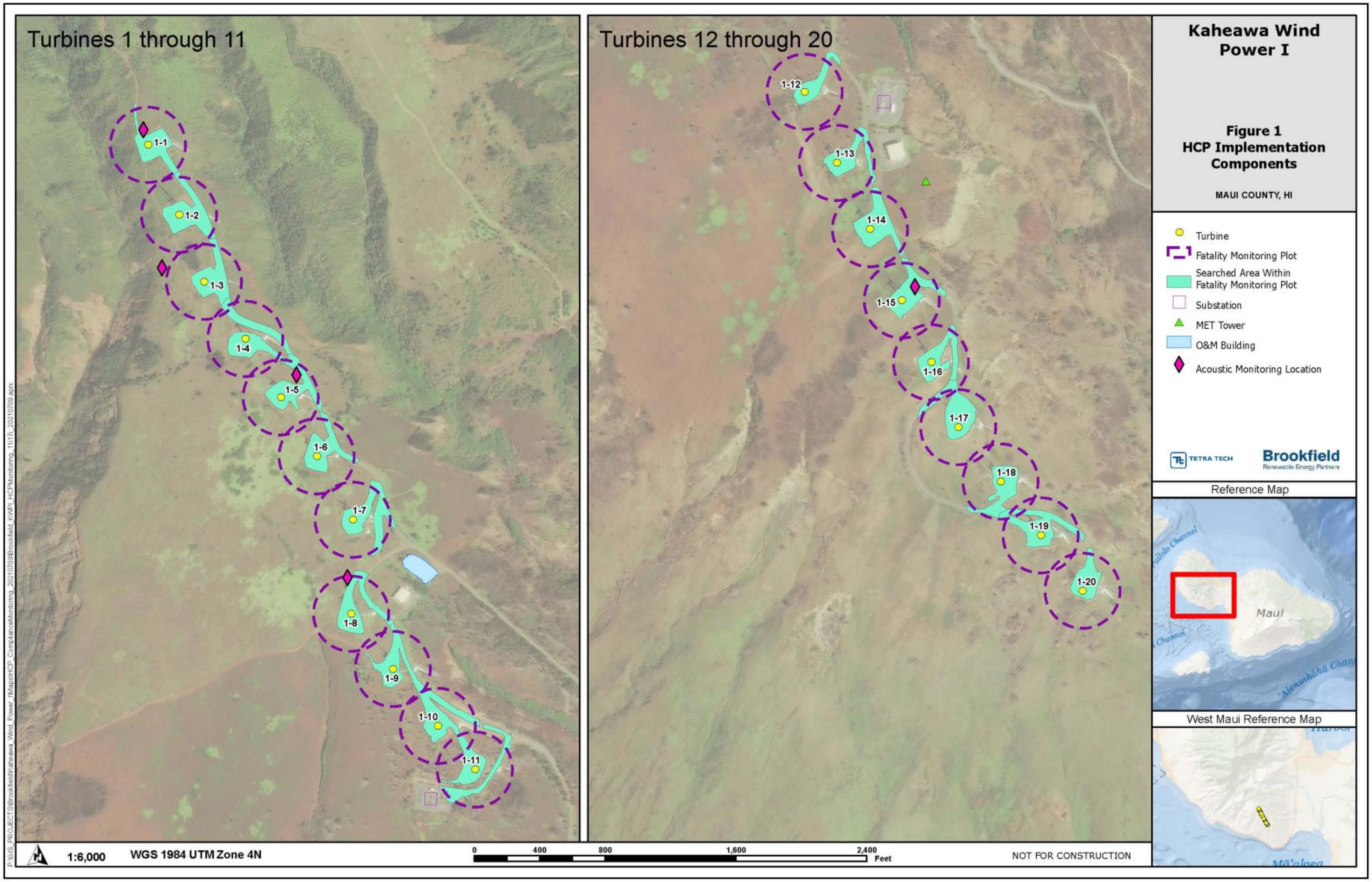

Figure 1. HCP Implementation Components

4.0 Searcher Efficiency Trials

A total of 64 searcher efficiency trials over 21 trial days were administered during FY 2021. Similar to the carcass persistence trials, black rats were used as surrogates for bats, large chickens were used as surrogates for Hawaiian goose, and wedge-tailed shearwaters and other medium-sized birds collected under the Project's Special Purpose Utility Permit (MB22096C-0) were used as surrogates for Covered Seabird Species. Searcher efficiency trials occurred throughout the year; 100 percent were conducted with canine search teams in FY 2021. Of the 64 trials placed, two bat surrogates, one chicken and two wedge-tailed shearwaters were lost to predation. All other carcasses were available for detection. For FY 2021, the probability that a canine search team would find a carcass was 0.91 for bat surrogates (95 percent CI = 0.77, 0.97; N=32), 1.00 for Hawaiian goose surrogates (95 percent CI = 0.85, 1.00; N=15), and 1.00 for Hawaiian petrel surrogates (95 percent CI = 0.82, 1.00; N=12).

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 incorporate Hawaiian goose nesting season restrictions:

- The vegetation management activities within the search plots were initially limited to between April 1 and October 31 to minimize risk to birds during the Hawaiian goose nesting season.
- In November 2016, Stephanie Franklin of DOFAW-Maui verbally approved using hand management tools (spray packs and weed whackers) during the Hawaiian goose 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 Hawaiian goose nesting habitat in the vicinity.

Vegetation management was implemented at the Project throughout FY 2021. Quarterly 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. Limited application of herbicide occurred in Q3 by spot treatment with a hand sprayer. On March 19, 2021, DOFAW was contacted for guidance on when herbicide application using a boom sprayer could resume. DOFAW requested that boom spraying be put on hold due to Hawaiian goose nesting season extending longer in 2021 than it has in the past. With the approval of DOFAW, the regular vegetation management program resumed on April 16, 2021.

6.0 Scavenger Trapping

KWP I has implemented 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. Additionally, this program benefits the resident wildlife by reducing the potential for predation. The scavenger trapping program at the Project was implemented in FY 2021. Trapping occurred bi-weekly. Active trapping occurred at 15 turbines throughout the period and included the use of nine DOC250 body grip traps and 12 live traps. The trapping program documented the removal of 28 mongooses (*Herpestes auropunctatus*), three feral cats (*Felis cattus*) and two rats (*Rattus sp.*) in FY 2021. No non-target animals were trapped.

7.0 Documented Fatalities and Take Estimates

Two fatalities of Covered Species were detected in FY 2021, both Hawaiian geese. One Hawaiian goose fatality was detected on March 2, 2021 outside the search area 114 meters from the nearest turbine and in proximity to the single meteorological tower onsite. The second fatality was detected on April 13, 2021 also outside the search plot at 80 meters to the nearest turbine. Based on the age and condition of the second carcass, KWP I intends to submit the carcass for necropsy to better understand if something other than Project infrastructure was the cause of death. 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 were observed at the Project in FY 2021.

To calculate take estimates, the number of observed fatalities is scaled to account for fatalities that are not detected, or 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; therefore, the proportion of the carcass distribution searched has varied over time. However, no changes to search plot dimensions have been made since FY 2016 (Section 2.0). Thus, the estimate of the density weighted proportion 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 Hawaiian hoary bats (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 permitted take exceedance, and may help operators in their mitigation planning, assuming future management and monitoring conditions can be reasonably estimated.

7.1 Hawaiian Hoary Bat

7.1.1 Estimated Take

A total of 12 Hawaiian hoary bat fatalities have been observed at the Project since monitoring began in June 2006, with no Hawaiian hoary bat fatalities detected in FY 2021. Of the 12 observed, nine were found inside of fatality search plots. Three bat detections were excluded from inputs to EoA and are accounted for in the estimated take generated. Bat carcasses were transferred to the U.S. Geological Survey for genetic sexing. Genetic sexing is used to estimate indirect take. The observed Hawaiian hoary bat fatalities by fiscal year are listed in Table 1.

Table 1. Observed Hawaiian Hoary Bat Fatalities at KWP I Through FY 2021

Fiscal Year	Hawaiian Hoary Bat Observed Direct Take	Hawaiian Hoary Bat 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
Total	**9**	**3**	**12**

The estimated direct take (ODT + UDT) for the 12 Hawaiian hoary bat fatalities found between the start of fatality monitoring in June 2006 and end of FY 2021 (June 30, 2021) is less than or equal to 26 bats (80 percent UCL; Appendix 1a). EoA therefore estimates 14 unobserved take in addition to the 12 observed take.

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 3.11 adults (Appendix 2a).

The UCL for cumulative Project take of the Hawaiian hoary bat at the 80 percent credibility level is 30 adult bats (26 [estimated direct take] + 4 [estimated indirect take, rounded up]). That is, there is an approximately 80 percent probability that cumulative take at the Project at the end of FY 2021 is less than or equal to 30 bats (Appendix 1a).

7.1.2 Projected Take

KWP I projected Hawaiian hoary bat take through the end of the permit term using the fatality monitoring data collected through FY 2021. 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 carcass detection probability for future years is assumed to match the estimated overall detection probability of FY 2021, 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, Tetra Tech 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 Hawaiian hoary bat 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 10.7 percent (3.11 adult bat equivalents estimated from indirect take / 29.11 bats estimated combining the direct and indirect take), making the assumption of indirect take of six adult bats to be upwardly 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 (take of 50 bats permitted by ITL and ITP minus take of six bats estimated as attributed to indirect take = 44 bats estimated direct take maximum).

Based on the analysis described above and presented in Appendix 3, there is greater than a 97 percent chance that the 80 percent UCL of cumulative take will not exceed Tier 2 during the permit term. Specifically, the estimated direct take threshold of 44 exceeds more than 97 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 44 bats. Therefore, based on these projections the Project is likely to remain below the permitted take limit of Hawaiian hoary bats for the permit term.

7.2 Hawaiian Goose

7.2.1 Estimated Take

A total of 30 Hawaiian goose fatalities attributable to the Project have been observed at the Project since monitoring began in June 2006. Twenty-five of the 30 geese were found inside of fatality search plots and are used to estimate direct take. The observed Hawaiian goose fatalities by fiscal year are listed in Table 2.

Table 2. Observed Hawaiian Goose Fatalities at KWP I Through FY2021

Fiscal Year	Hawaiian Goose Observed Direct Take	Hawaiian Goose 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
Total	**25**	**5**	**30**

1. KWP I plans to have the juvenile fatality found outside of search area necropsied to help determine if trauma contributed to cause of death. Based on carcass condition at discovery, it is unknown if carcass was attributed to Project operations or other circumstances.

On March 2, 2021, one Hawaiian goose carcass was observed during a scheduled search but outside of the designated search plot and 114 meters away from Turbine 14. Another Hawaiian goose fatality was detected on April 13, 2021, also during a scheduled search but outside of the search plot at 80 meters away from Turbine 17. The individual was a juvenile; based on the state of extensive immature flight feathers (juvenile molt), it is unclear if the bird could have sustained flight. Pre-fledging (flightless juvenile) geese would be unlikely to have suffered turbine collision.

The estimated direct take (ODT + UDT) for the 25 Hawaiian goose fatalities (within the search area) found between the start of operation (June 5, 2006) and end of FY 2021 (June 30, 2021) is less than or equal to 45 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 their parents. Both parents care for young well after 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 2.96 juveniles (1.52 adults assuming a 0.8 annual survival rate and 3 years from fledging to adult; Appendix 2b).[1]

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 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 0.1 to account for the probability that those unmitigated birds would have produced young (KWP I 2006). USFWS and DOFAW have agreed that the Project will not accrue lost productivity for Hawaiian goose take that occurred prior to calendar year 2011, the year the release pen was constructed. Six Hawaiian goose fatalities were documented at the Project prior to January 1, 2011.

DOFAW provided KWP I with Hawaiian goose fledgling data and subsequent credit issuance for Project-funded release efforts at the Haleakalā Ranch pen in July 2020. KWP I believes the current approach to account for mitigation credit undervalues the full extent of benefits the Project's mitigation efforts have provided to the species and is working with USFWS and DOFAW to develop consensus on a modified approach. Accrued lost productivity will be calculated once agreement on the allocation of mitigation credit has been achieved. KWP I hopes to incorporate this analysis in a subsequent draft of the FY 2021 annual report.

The UCL for cumulative Project take of the Hawaiian goose at the 80 percent credibility level is 45 geese (45 [estimated direct take] + 2 [estimated indirect take, rounded up]). That is, there is an approximately 80 percent probability that cumulative take at the Project at the end of FY 2021 is less than or equal to 47 adult geese (Appendix 1b).

7.2.2 Projected Take

KWP I projected Hawaiian goose take through the end of the permit term using the fatality monitoring data collected through FY 2021. 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, 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, Tetra Tech assumed total indirect take for the Project over the permit term would be a maximum of two adult equivalents (approximately four juveniles based on an assumed Hawaiian goose survival rates 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 (1.52 adult goose equivalents estimated from indirect take/ 46.52 adult geese estimated, combining the direct and indirect take), making the assumption of two indirect take on par with the data. Assuming two

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

adult Hawaiian geese 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 Hawaiian geese (take of 60 geese permitted by ITL and ITP for Tier 1 minus take of two geese estimated attributed to indirect take = 58 geese estimated direct take maximum).

Based on the analysis described above and presented in Appendix 3, there is a 33 percent chance that the 80 percent UCL of cumulative take will not exceed the Tier 1 take limit during the permit term. Specifically, the estimated direct take threshold of 58 exceeds 33 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 58 geese. Although the Project may exceed the Tier 1 permitted take limit within the permit term, the Tier 2 take (described as Higher Take in the Project's HCP) limit is 100. As with Tier 1 take, assuming 3.3 percent of the Tier 2 take limit is attributable to indirect take, authorized direct take under Tier 2 would be 96 Hawaiian geese (take of 100 geese permitted by ITL and ITP for Tier 1 minus take of 4 geese estimated to be attributed to indirect take = 96 geese estimated direct take maximum). A permitted direct take value of 96 exceeds 100 percent of the EoA projected mortality estimates (Appendix 3). KWP I has taken actions to minimize the threats to the Hawaiian goose and anticipates working with USFWS, DOFAW, and technical experts to further reduce risks of take (Section 10.0).

7.3 Hawaiian Petrel

7.3.1 Estimated Take

A total of eight Hawaiian petrel fatalities have been observed at the Project since monitoring began in June 2006; no Hawaiian petrel fatalities were detected in FY 2021. Seven of the eight petrels were found inside of fatality search plots. The FY 2013 fatality was found outside of the designated search areas and is treated as an incidental observation. The observed Hawaiian petrel fatalities by fiscal year are listed in Table 3.

Table 3. Observed Hawaiian Petrel Fatalities at KWP I Through FY2021

Fiscal Year	Hawaiian Petrel Observed Direct Take	Hawaiian Petrel 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
2015	2	0	2

Fiscal Year	Hawaiian Petrel Observed Direct Take	Hawaiian Petrel Incidental Fatality Observations	Total
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	1	0	1
2020	0	0	0
2021	0	0	0
Total	**7**	**1**	**8**

The estimated direct take (ODT + UDT) for the seven Hawaiian petrel fatalities found between the start of operation (June 5, 2006) and end of FY 2021 (June 30, 2021) is less than or equal to 16 petrels (80 percent UCL; Appendix 1c). Appendix 1c presents the cumulative Hawaiian petrel direct take estimate based on results from the FY 2021 multi-year analysis from EoA.

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 Hawaiian petrel 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 12.08 juveniles (3.62 adults assuming a 0.3 survival rate from fledging to adult; Appendix 3).

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 Hawaiian petrels 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.

KWP I is working with DOFAW and USFWS to quantify the benefits accrued through mitigation efforts at the Makamakaʻole Seabird Mitigation Site (Makamakaʻole) and on Lānaʻi. Reporting from the 2018 Hawaiian petrel breeding season on Lānaʻi (see FY 2019 annual report [Tetra Tech 2019]) and expected additional benefits historical petrel mitigation benefits from Makamaka'ole and from the 2021 breeding season on Lānaʻi should allow for an understanding of any remaining petrel mitigation needs prior to the 2022 breeding season.

The UCL for cumulative Project take of the Hawaiian petrel at the 80 percent credibility level is 20 petrels (16 [estimated direct take] + 4 [estimated indirect take, rounded up]). That is, there is an approximately 80 percent probability that cumulative take at the Project at the end of FY 2021 is less than or equal to 20 petrels.

7.3.2 Projected Take

KWP I projected Hawaiian petrel take through the end of the permit term using the fatality monitoring data collected through FY 2021. 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 2). For this analysis, the detection probability for future years is assumed to match the estimated overall detection probability of FY 2021, 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, Tetra Tech 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 Hawaiian petrel 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 (3.62 adult petrel equivalents estimated from indirect take/ 19.62 adult petrel estimated combining the direct and indirect take), making the assumption of eight indirect take conservative. Assuming eight adult Hawaiian petrel equivalents are attributed to the Project as indirect take, the permitted direct take under the Project's ITP and ITL would be 30 petrels (take of 38 petrels permitted by ITL and ITP minus the take of eight petrels estimated to be attributed to indirect take = 30 Hawaiian petrel estimated direct take maximum).

Based on the analysis described above and presented in Appendix 2, there is more than a 99 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 2). 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 Hawaiian petrels for the permit term.

7.4 Non-listed Species

In addition to the two Hawaiian goose fatalities, 16 of non-listed bird species fatalities representing 10 species were documented at WTGs at the Project in FY 2021. Three of the 10 species observed in FY 2021 are protected by the Migratory Bird Treaty Act (MBTA): white-tailed tropicbird (*Phaethon lepturus;* one individual), Hawaiian short-eared owl (*Asio flammeus sandwichensis;* one individual), and house finch (*Haemorhous mexicanus;* one individual). Fatalities of seven non-native (introduced) species without MBTA protection were also detected: black francolin (*Francolinus francolinus*; five individuals), gray francolin (*Francolinus pondicerianus;* two individuals), warbling white-eye (*Zosterops japonicus;* one individual), ring-necked pheasant (*Phasianus colchicus;* two individuals), common myna (*Acridotheres tristis;* two individuals), and house sparrow (*Passer domesticus;* one bird). For a complete list of fatalities for FY 2021, 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, 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 a 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 in 2020 on September 21, 26, 29 and October 13. In 2021, WEOPs trainings were provided on January 27 and March 16/19 at the Project, training total of 22 people in FY 2021. 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 Hawaiian Hoary Bats

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 Hawaiian hoary bats under Tier 2. A mitigation project that accounts for 15 of the authorized additional take of 30 bats began May 2017 and was completed in FY 2020 (KWP I 2017, Tetra Tech 2020). This mitigation project consists of Hawaiian hoary bat ecological research in East Maui, contracted to H.T. Harvey Ecological Consultants. The contract total cost was $750,000.

KWP I is also partially funding another Hawaiian hoary bat ecological research project on Hawaiʻi Island contracted to the U.S. Geological Survey Hawaiian Hoary Bat Research Group (Appendix 5). Bat ecological research on Hawaiʻi Island began in FY 2018 and is intended to better inform future bat habitat restoration and conservation. The Project contribution to this contract totaled $378,553 in FY 2021; the research project is expected to be completed in FY 2022. This research project provides mitigation benefits to account for the remaining 15 bats of Tier 2. Because the total funding amount of $1.7M required to mitigate for identified portions of the Project's and Brookfield's Kaheawa II Wind Project's (KWP II) mitigation obligations was exceeded, Brookfield has engaged with DOFAW and USFWS requesting authorization to fund USGS research costs above $1.7M from Brookfield's Kahuku Wind Project for mitigation credit of 2.63 bats. This engagement yielded differing agency conclusions. DOFAW agreed with Brookfield's interpretation that Brookfield's funding of costs beyond that required for the Project's and KWP II's mitigation obligations could represent a partial fulfillment of Kahuku's Tier 2 bat obligation; USFWS did not.

9.1.2 Acoustic Monitoring at the Project

As a voluntary measure (not required in the HCP), acoustic monitoring for bat activity at the Project has been conducted continuously beginning in August 2008. In October 2013 (FY 2014) nine Song Meter SM2BAT+ ultrasonic recorders (SM2) were deployed, replacing the 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). SM2 units have been continuously used since October 2013. Because of differences in the equipment used, data collected in FY 2021 is only comparable to data collected between FY 2014 and FY 2020.

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) 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 excluded from the analysis because it did not represent a full sampling year, excluding months with the highest detection rates (July, August, and September). All data were normalized using an Ordered Quantile normalization transformation. 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 the R version 4.05 (R Core Team 2017). The characterization of Hawaiian hoary bat seasons corresponds approximately to Starcevich et al. (2019).

In FY 2021, detection rates fluctuated seasonally and were similar to the seasonal trends observed in previous monitoring years. In FY 2021, Hawaiian hoary bats were detected on 225 nights out of 1,680 (13.4 percent) detector-nights sampled. Detection rates were highest between the months of September and October during the post-lactation reproductive period, with the peak in activity occurring during the month of October (Figure 2). Lower detection rates were observed during the second half of the post-lactation and first half of the pre-pregnancy reproductive periods[2] (Figure 2). A second increase in detection rates was observed beginning in March at the end of the pre-pregnancy reproductive period and continued through April with a smaller peak in May during the

[2] Corresponding reproductive periods defined by Gorresen et al. 2003.

pregnancy reproductive period (Figure 2). The temporal pattern in detection rates during FY 2021 were similar to the detection rates observed in previous years (Figure 3).

Throughout the FY 2015 – FY 2021 dataset of the Project's monitoring program, there were only marginal fluctuations in the interannual detection rates. However, across analyzed monitoring years, there is an increasing trend in the annual detection rates. The annual detection rates in FY 2021 were lower (by 1.7 percent), but not significantly different (Tukey's HSD: $P = 1.000$), than the annual detection rate for FY 2020 (15.1 percent, Table 4). Between FY 2015 through FY 2021, interannual detection rates varied between all monitoring years (Table 4). Although initial results from an ANOVA suggested a significant difference in interannual detection rates between FY 2015 through FY 2021 (ANOVA: $F_{6,72} = 2.19$, $P < 0.019$), a 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 between the annual detection rates for any of the sampling years (Table 5). There is a considerable amount of variance in the monthly detection rates between years (Figure 3) which may be contributing to the lack of significance in the interannual detection rates. Overall, across analyzed monitoring years (FY 2015 – FY 2021), there is a significant increasing trend in the annual detection rates (LM: $R^2 = 12.1\%$; $F_{1,82} = 11.26$, $P < 0.002$; Figure 4).

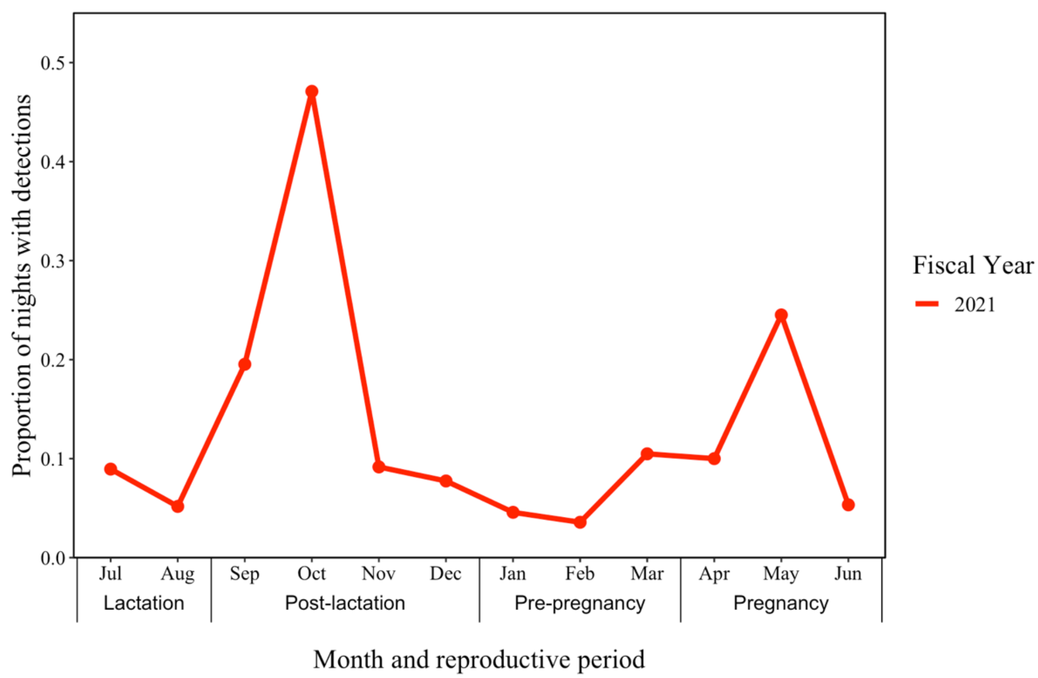

Figure 2. Monthly Detection Rates at the Project in FY 2021 with Corresponding Reproductive Periods

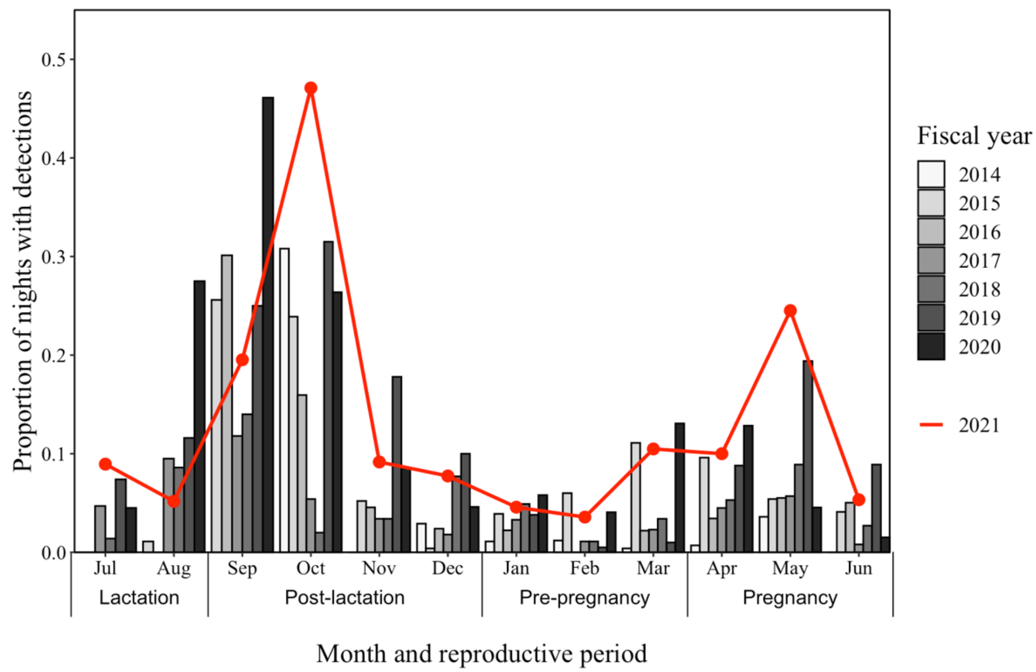

Figure 3. Monthly Bat Detection Rates at the Project for FY 2014 to FY 2021 with Corresponding Reproductive Periods

Table 4. Number of Nights Sampled, Number of Nights with Detections and Proportion of Nights with Bat Detections Between FY 2014 and FY 2021

Dates	No. of Nights Sampled	No. of Nights with Detections	Proportion of Nights with Detection(s)
FY 2014 (October 2013 – June 2014)[1]	2,700	101	0.037
FY 2015 (July 2014 – June 2015)[1]	3,203	249	0.078
FY 2016 (July 2015 – June 2016)[1]	2,426	175	0.072
FY 2017 (July 2016 – June 2017)[1]	2,827	129	0.045
FY 2018 (July 2017 – June 2018)[1]	2,989	162	0.054
FY 2019 (July 2018 – June 2019)[1]	2,906	372	0.128
FY 2020 (July 2019 – June 2020)[2]	1,853	280	0.151
FY 2021 (July 2020 – June 2021)[2]	1,680	225	0.134

1. Number of detectors = 9.
2. Detectors reduced from 9 to 5 in November 2019 due to fire.

Table 5. Results of a Tukey's HSD Test on the Annual Detection Rates for Each of the Sampling Years at the Project Between FY 2015 – FY 2021

Sampling Years	Difference in Means	Lower 95% CI	Upper 95% CI	*P*-value
2015 - 2016	-0.42	-1.57	0.73	0.923
2015 - 2017	-0.27	-1.42	0.88	0.992
2015 - 2018	-0.16	-1.31	0.99	1.000
2015 - 2019	0.50	-0.66	1.65	0.848
2015 - 2020	0.56	-0.60	1.71	0.766
2015 - 2021	0.69	-0.47	1.84	0.551
2016 - 2017	0.15	-1.00	1.30	1.000
2016 - 2018	0.26	-0.89	1.41	0.993
2016 - 2019	0.92	-0.23	2.07	0.206
2016 - 2020	0.98	-0.17	2.13	0.149
2016 - 2021	1.11	-0.04	2.26	0.067
2017 - 2018	0.11	-1.04	1.26	1.000
2017 - 2019	0.77	-0.39	1.92	0.415
2017 - 2020	0.83	-0.33	1.98	0.323
2017 - 2021	0.96	-0.20	2.11	0.170
2018 - 2019	0.66	-0.50	1.81	0.603
2018 - 2020	0.72	-0.44	1.87	0.499
2018 - 2021	0.85	-0.31	2.00	0.296
2019 - 2020	0.06	-1.09	1.21	1.000
2019 - 2021	0.19	-0.96	1.34	0.999
2020 - 2021	0.13	-1.02	1.28	1.000

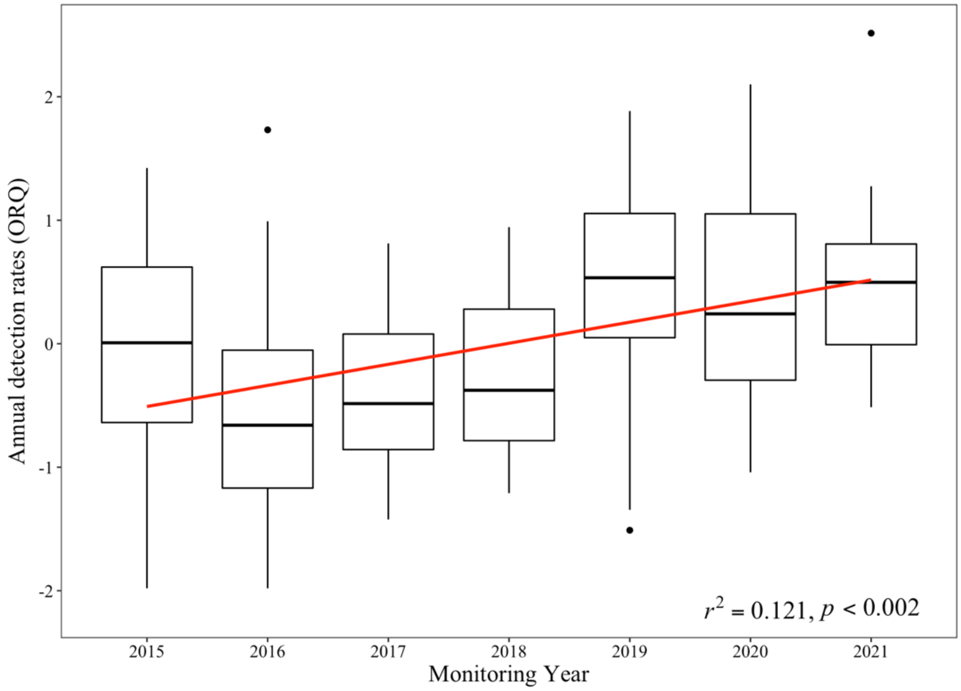

Figure 4. Box-plot with Linear Regression Showing the Increasing Trend in the Annual Detection Rates at the Project Between FY 2015 and FY 2021

9.2 Hawaiian Goose – Haleakalā Ranch Release Pen

As part of Project Hawaiian goose mitigation, the Project provided $140,852 to DOFAW to fund construction and management of the Haleakalā Ranch Hawaiian goose release pen in 2008. DOFAW completed construction of the release pen three years later. The remaining funds were used by DOFAW to perform fence maintenance, predator control, vegetation management, and monitoring at the Haleakalā Ranch pen over the nine years since construction. Hawaiian geese 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. Through FY 2021, 66 fledglings have been produced in the pen from these translocated birds.

In FYs 2019, 2020, and 2021, KWP I met with USFWS and DOFAW to better understand the past management of the Hawaiian goose release pen, improve accountability, and identify an approach to allow KWP I to meet its mitigation obligations for the Hawaiian goose. In FY 2020, an updated Memorandum of Understanding was signed for managing the release pen program; KWP I provided standardized annual reporting forms to capture the annual activities occurring the pen. The 2020 breeding season report was provided by DOFAW in September 2020 (Appendix 6); DOFAW provided the 2021 breeding season report on December 8, 2021 (Appendix 7).

Several potential benefits can be accrued based on the effects of these actions including production of fledglings and increases in adult survival rates. In July 2020, DOFAW provided a letter describing proposed mitigation credit for fledgling production attributable to the Project however, KWP I believes that the proposed accounting approach for mitigation credit undervalues the benefits the Project's mitigation efforts have produced and is working with USFWS and DOFAW to develop consensus. Once consensus is reached, KWP I will assess accrued lost productivity and incorporate that information into an overall assessment of the Hawaiian goose mitigation status for the Project.

9.3 Seabirds

KWP I is committed to seabird protection and recovery on Maui and within Maui Nui. Although results at the Makamakaʻole Seabird Mitigation Site (Makamakaʻole) have suggested the potential for the site to support successful reproduction of Newell's shearwaters, the Project is not on track for fulfilling the Project's Hawaiian petrel mitigation needs. KWP I is actively working with USFWS and DOFAW to adaptively manage Hawaiian petrel mitigation to achieve the goals laid out in the HCP by funding Hawaiian petrel mitigation on Lānaʻi.

9.3.1 Hawaiian Petrel and Newell's Shearwater – Makamakaʻole

Mitigation efforts at Makamaka'ole have been ongoing since construction of the two breeding site enclosures (predator fence exclosures) was completed on September 5, 2013. Mitigation efforts at Makamakaʻole involve predator monitoring and trapping, artificial burrow checks and monitoring using game cameras, seabird social attraction using decoys and sound systems, and ongoing maintenance of both enclosures. In July 2021, KWP I provided to agencies an accounting of differences between the initial agency assessment and what Tetra Tech believes are appropriate measures of burrow occupancy and breeding activity to be used in the calculation of increased Newell's shearwater adult survival based on available evidence. Hawaiian petrel occupancy of the site has not been confirmed since 2017; however, monitoring results indicate annual increases in burrow attendance, pair-bonding activity, and breeding attempts by Newell's shearwaters since the first evidence of site occupation in 2016. Results from the 2020 breeding season, which concluded in FY 2021 added to the multi-year trove of (photographic) evidence that burrow attendance by species other than Newell's shearwaters at this site is rare (Appendix 8).

Seabird breeding activity is 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 2020 breeding season, 26 burrows in Enclosure A showed evidence of activity over the monitoring period, with 18 burrows showing consistent occupancy (exceeding 2 months) and Newell's shearwater activity. In Enclosure B, 17 burrows had primarily Newell's shearwater and limited Bulwer's petrel (*Bulweria bulwerii*) activity, with four burrows demonstrating consistent Newell's shearwater breeding activity. A total of seven (nonviable) eggs were recovered from six nest boxes, and there was no evidence of chicks (Appendix 8).

In FY 2021, continued mitigation efforts at Makamakaʻole were contracted to Maui Nui Seabird Recovery Project (MNSRP) through the 2021 breeding season. USFWS and DOFAW reviewed an updated protocol prior to the 2021 breeding season, which included adjustments incorporated based on seabird experts who reviewed the status of the mitigation site after the 2020 breeding season. This protocol is currently being implemented at the site. Updates from previous years include replacement of nesting substrate in consultation with seabird experts, Maui Natural Area Reserve System and Maui Forest Reserve, data collection consistent with Raine et al. (2020), an adjusted social attraction regime, and barn owl control as needed (Appendix 9). Project staff are regularly visiting the enclosures with MNSRP to ensure consistent oversight.

MNSRP staff continue to update and maintain perimeter fencing. Approximately bi-weekly visits to Enclosures A and B are ongoing, checking burrows and game cameras for seabird breeding activity, managing vegetation including clearing the outside perimeter and inside pathways, and conducting predator control. Site visits through June 2021 suggest Newell's shearwater breeding activity is consistent with or greater than observed in the 2020 breeding season, and at least one pair of Newell's shearwaters is confirmed incubating an egg.

9.3.2 Lānaʻi Hawaiian Petrel Protection Project

Hawaiian petrels have not been observed occupying the burrows of the Makamaka'ole mitigation site since 2017. Therefore, KWP I has worked with USFWS and DOFAW to adaptively manage mitigation efforts for this species to ensure that its mitigation obligations are met.

For the 2018 Hawaiian petrel breeding season, KWP I worked with USFWS and DOFAW to adaptively manage Hawaiian petrel mitigation efforts in an interim fashion. As a result of this adaptive management, KWP I provided funding to Pūlama Lānaʻi to supplement Hawaiian petrel breeding colony protection efforts on Lānaʻi. KWP I funded one year of mitigation efforts, aiding in the expansion of predator control for cats and rats into extremely dense petrel nesting areas on the island of Lānaʻi and improved monitoring in those areas to better understand the effects of predator control. In 2018, activities resulted in a net increase of 36 Hawaiian petrel fledglings over the calculated baseline. Activities and results are reported in the 2018 annual report (Appendix 5 in Tetra Tech 2019).

In FY 2021, the two KWP projects with concurrence from USFWS and DOFAW, adaptively managed their seabird mitigation programs by providing funding to Pūlama Lānaʻi in the amount of $104,657 for the 2021 breeding season. This effort includes predator control as well as burrow monitoring and evaluation in the densely occupied Hawaiian petrel nesting area (Greater Hiʻi). Results from the 2021 breeding season will be reported in the FY 2022 annual report.

9.3.3 Newell's Shearwater Survey - East Maui

Surveys of East Maui for potential additional mitigation sites was funded and completed in September 2015 (KWP I 2016). These surveys evaluated potential colony locations, estimated the numbers of birds present, assessed predator activity, and provided for management feasibility assessment.

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 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 the Kaheawa Wind Power II Project on March 13, 2013 and February 26, 2014. Curtailment at 5.5 m/s was 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 monitoring period (Section 9.1.1).

The Project has previously implemented a variety of actions to minimize risk to the Hawaiian goose which continued in FY 2021. Safety measures to avoid interactions between Hawaiian goose and canine search teams have been identified and are implemented as needed. Scavenger trapping efforts implemented at the Project to improve persistence of carcasses during fatality monitoring also have likely reduced the risk of predation of the Hawaiian goose and their nests. Additionally, KWP I is updating the meteorological tower's guy wires with new, higher visibility bird diverters which incorporate updated technology. KWP I has identified additional practicable actions to minimize the threats to the Hawaiian goose based on current projections of take. KWP I presented Hawaiian goose take minimization opportunities currently being explored to the agencies during the FY 2021 semi-annual meeting in May 2021 and is planning for coordination with technical experts on vegetation management opportunities. KWP I will continue to work with USFWS, DOFAW, and technical experts in FY 2022 to further reduce risk to the species.

11.0 Agency Meetings, Consultations, and Visits

KWP I communicated actively with USFWS and DOFAW throughout FY 2021 through in-person meetings, conference calls, submittal of quarterly reports, and e-mail communications related to the Project's HCP. The purpose of these communications included required semi-annual HCP implementation meetings and focused discussions regarding mitigation funding, and adjustments to all current mitigation programs, and mitigation credits for the Hawaiian goose and seabird mitigation programs. All meetings in FY 2021 were via teleconference. A summary of agency coordination follows in Table 6.

Table 6. Summary of Agency Coordination and Communication in FY 2021

Date	Communication	Participants
September 29, 2020	Submittal of the final KWP I HCP FY 2020 annual report	Submitted to DOFAW, USFWS by Tetra Tech
October 20, 2020	Annual HCP Implementation Review meeting	KWP I, Tetra Tech, USFWS, DOFAW
November 2, 2020	Submittal of FY2021 Q1 report	Submitted to DOFAW, USFWS by Tetra Tech
December 2, 2020	Makamakaʻole informational meeting with seabird experts	KWP I, Tetra Tech, DOFAW, USFWS, Dr. Andre Raine, Dr. Lindsay Young, Jay Penniman, Dr. Eric VanderWerf
January 6, 2021	Follow up to the Makamakaʻole informational meeting for contextualizing data for seabird mitigation credit.	KWP I, Tetra Tech, USFWS, DOFAW
January 19, 2021	USGS research as bat Mitigation update	KWP I, Tetra Tech, USGS, USFWS, DOFAW
January 28, 2021	Annual HCP Implementation review by ESRC	KWP I, Tetra Tech, ESRC
January 29, 2021	Submittal of FY 2021 Q2 report	Submitted to DOFAW, USFWS by Tetra Tech
February 11, 2021	Makamakaʻole data collection planning for 2021 breeding season	KWP I, Tetra Tech, USFWS, DOFAW
February 19, 2021	Lānaʻi Hawaiian Petrel Mitigation planning for KWP projects	KWP I, Tetra Tech, Rachel Sprague (Pūlama Lānaʻi), DOFAW, USFWS
February 25, 2021	Submittal of Makamaka'ole report and supplemental data for agency review	Submitted to DOFAW, USFWS by Tetra Tech
March 15, 2021	Submittal of USGS Research Summary adaptive management plan	Submitted to DOFAW, USFWS by Tetra Tech
March 23, 2021	Submittal of adaptive management proposal for Hawaiian petrel mitigation work on Lānaʻi	Submitted to DOFAW, USFWS by Tetra Tech.
April 27, 2021	Submittal of FY 2021 Q3 report	Submitted to DOFAW, USFWS by Tetra Tech
May 5, 2021	Semi-annual HCP Implementation review meeting	KWP I, Tetra Tech, USFWS, DOFAW
June 16, 2021	Hawaiian goose release pen update	KWP I, Tetra Tech, DOFAW
June 28, 2021	Submittal of Brookfield's Hawaiian goose mitigation counter proposal memo requesting a more comprehensive approach to Hawaiian goose mitigation credit.	Submitted to DOFAW, USFWS by Tetra Tech
June 30, 2021	Submittal of Makamakaʻole game camera footage and summary data.	Submitted to DOFAW, USFWS by Tetra Tech

12.0 Expenditures

Total HCP-related expenditures for the Project in FY 2021 were $900,278 (Table 7).

Table 7. HCP-related Expenditures at the Project in FY 2021

Category	Amount
Permit Compliance	$55,000
Fatality Monitoring	$65,000
Acoustic Monitoring for Bats	$18,500
Vegetation Management and Scavenger Trapping	$23,000
Equipment and Supplies	$1,700
Staff Labor[1]	-
Makamakaʻole Mitigation Project[2]	$113,016
Lānaʻi Hawaiian Petrel Protection Project[2]	$104,657
Haleakala Release Pen	$140,852
Tier 2 Bat Research Projects	$378,553
Total Cost for FY 2021	**$900,278**

1. Staff labor costs are included in the overall costs for each category except for Equipment and Supplies.
2. This total is co-funded with KWP II. Mitigation benefits attributable to the Project will not be available until after the submittal of this report.

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Appendix 1. Dalthorp et al. (2017) Fatality Estimation for Hawaiian Hoary Bats, Hawaiian Geese, and Hawaiian Petrels at the Project through FY 2021

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Appendix 1a. Dalthorp et al. (2017) Fatality Estimation for Hawaiian Hoary Bats at Project Through FY 2021

Modelling Parameter		Modelling Period														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15 (current)**
FY		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dates	**Begin**	2006-06-22	2007-07-01	2008-07-01	2009-07-01	2010-07-01	2011-07-01	2012-07-01	2013-07-01	2014-07-01	2015-07-01	2016-07-01	2017-07-01	2018-07-01	2019-07-01	2020-07-01
	End	2007-06-30	2008-06-30	2009-06-30	2010-06-30	2011-06-30	2012-06-30	2013-06-30	2014-06-30	2015-06-30	2016-06-30	2017-06-30	2018-06-30	2019-06-30	2020-06-30	2021-06-30
Period Length (days)		545	365	364	364	364	365	364	364	364	365	364	364	364	365	364
% Year		1.02	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LWSC		no	no	no	no	no	no	no	no	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s	5.5 m/s
Search Interval (days)		9	9	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Searches in Modelling Period		61	41	52	52	52	52	52	52	52	52	52	52	52	53	52
Observed Fatalities (X)		0	0	0	0	0	0	2	4	0	0	1	1	1	0	0
K		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1
Canine Searches		No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
DWP[1]		1	1	1	1	1	1	1	1	1	0.4922	0.4922 or 0.573	0.573	0.573	0.573	0.573
g	**g**	0.445	0.442	0.501	0.45	0.505	0.345	0.414	0.484	0.217	0.44	0.524	0.459	0.368	0.466	0.4365
	95% LCI	0.260	0.258	0.312	0.272	0.257	0.149	0.183	0.332	0.128	0.408	0.499	0.386	0.289	0.405	0.354
	95% UCI	0.638	0.636	0.69	0.634	0.752	0.574	0.669	0.638	0.321	0.472	0.549	0.533	0.45	0.529	0.521
B	**Ba**	11.21	11.06	12.70	12.37	7.145	6.089	5.894	19.23	14.76	407.9	816.1	80.67	50.35	115.3	58.18
	Bb	13.96	13.94	12.64	15.14	7.007	11.56	8.335	20.47	53.30	520.1	741.03	95.13	86.64	132.0	75.11
M*[2]		1	1	1	1	1	1	7	18	19	19	21	23	26	26	26

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 1b. Dalthorp et al. (2017) Fatality Estimation for the Hawaiian Goose at Project Through FY 2021

Modelling Parameter		Modelling Period														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 (current)
FY		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dates	Begin	2006-01-01	2007-07-01	2008-07-01	2009-07-01	2010-07-01	2011-07-01	2012-07-01	2013-07-01	2014-07-01	2015-07-01	2016-07-01	2017-07-01	2018-07-01	2019-07-01	2020-07-01
	End	2007-06-30	2008-06-30	2009-06-30	2010-06-30	2011-06-30	2012-06-30	2013-06-30	2014-06-30	2015-06-30	2016-06-30	2017-06-30	2018-06-30	2019-06-30	2020-06-30	2021-06-30
Period Length (days)		545	365	364	364	364	365	364	364	364	365	364	364	364	365	365
% Year		1.02	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Search Interval (days)		9	9	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Searches in Modelling Period		61	41	52	52	52	52	52	52	52	52	52	52	52	53	52
Observed Fatalities (X)		0	2	1	1	5	1	4	3	4	1	0	1	2	0	0
K		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Canine Searches		No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
DWP[1]		0.95	0.95	0.95	0.95	0.95 or 0.7	0.7	0.7	0.7	0.7	0.29	0.29 or 0.35	0.35	0.35	0.35	0.35
g	g	0.923	0.923	0.928	0.928	0.773	0.678	0.666	0.683	0.691	0.284	0.327	0.344	0.339	0.33	0.336
	95% LCI	0.871	0.871	0.886	0.886	0.748	0.633	0.58	0.626	0.658	0.265	0.314	0.336	0.282	0.301	0.315
	95% UCI	0.962	0.962	0.961	0.961	0.797	0.72	0.748	0.737	0.722	0.302	0.341	0.352	0.399	0.359	0.357
B	Ba	120.8	120.8	162.5	162.5	889.3	299.4	79.75	183.9	548.7	661.2	1474.3	4420	84.70	337.8	674.4
	Bb	10.14	10.14	12.60	12.60	261.5	142.5	39.93	85.39	245.9	1671	3031	8438	165.3	686.5	1280
M*[2]		0	2	4	5	11	13	18	23	28	32	34	37	42	43	45

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 Hawaiian Petrel at Project Through FY 2021

Modelling Parameter		Modelling Period														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 (current)
FY		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Dates	Begin	2006-06-22	2007-07-01	2008-07-01	2009-07-01	2010-07-01	2011-07-01	2012-07-01	2013-07-01	2014-07-01	2015-07-01	2016-07-01	2017-07-01	2018-07-01	2019-07-01	2020-07-01
	End	2007-06-30	2008-06-30	2009-06-30	2010-06-30	2011-06-30	2012-06-30	2013-06-30	2014-06-30	2015-06-30	2016-06-30	2017-06-30	2018-06-30	2019-06-30	2020-06-30	2021-06-30
Period Length (days)		545	365	364	364	364	365	364	364	364	365	364	364	364	365	365
% Year		1.02	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Search Interval (days)		9	9	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Searches in Modelling Period		61	41	52	52	52	52	52	52	52	52	52	52	52	53	52
Observed Fatalities (X)[1]		0	1	0	0	0	2	0	1	2	0	0	0	1	0	0
K		0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1	1	1	1	1	1
Canine Searches		No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
DWP[2]		1	1	1	1	1 or 0.75	0.75	0.75	0.75	0.75	0.204	0.204 or 0.246	0.246	0.246	0.246	0.246
g	g	0.807	0.786	0.847	0.861	0.798	0.581	0.646	0.714	0.65	0.197	0.232	0.24	0.239	0.218	0.2096
	95% LCI	0.602	0.593	0.717	0.706	0.752	0.431	0.511	0.668	0.555	0.18	0.221	0.203	0.196	0.192	0.12
	95% UCI	0.948	0.928	0.942	0.963	0.841	0.724	0.77	0.758	0.74	0.214	0.243	0.28	0.284	0.244	0.316
B	Ba	14.64	16.78	31.55	22.06	244.5	24.57	32.73	281.2	65.57	414.2	1272	114.8	85.20	210.7	13.62
	Bb	3.512	4.580	5.682	3.566	61.78	17.70	17.93	112.6	35.30	1690	4216	362.8	272.0	757.7	51.37
M*[3]		0	2	2	2	2	5	5	6	10	10	11	12	14	15	16

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 Hawaiian Hoary Bat, Hawaiian Goose, and Hawaiian Petrel at the Project in FY 2021

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Appendix 2a. Indirect Take for the Hawaiian Hoary Bat at the Project in FY 2021

Parameter	Description	Fiscal Year															
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
A	Observed Breeding Female Take	0	0	0	0	1	0	0	2	0	0	0	1	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	**7.2**
C	Observed Breeding Unknown Sex Take	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**
E	All Observed Take (Search and Incidental)	0	0	1	0	1	0	2	4	0	0	2	1	1	0	0	**12**
F	Estimated Take Multiplier (26/12=2.17)	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17	2.17
G	Estimated Direct Take (E x F)	0.00	0.00	2.17	0.00	2.17	0.00	4.33	8.67	0.00	0.00	4.33	2.17	2.17	0.00	0.00	**26**
H	Unobserved Direct Take (G - E)	0.00	0.00	1.17	0.00	1.17	0.00	2.33	4.67	0.00	0.00	2.33	1.17	1.17	0.00	0.00	**14**
I	Indirect Take Calculated from Unobserved Take (H * 0.5 * 0.25 * 1.8)	0.00	0.00	0.26	0.00	0.26	0.00	0.53	1.05	0.00	0.00	0.53	0.26	0.26	0.00	0.00	**3.15**
Total Indirect Take (B + D + I; juveniles)																	**10.35**
Total Indirect Take (B + D + I)*0.3 (adults)																	**3.11**

Appendix 2b. Indirect Take for the Hawaiian Goose at the Project in FY 2021

Parameter	Description	Fiscal Year																		
		2007	2008	2009	2010	2011		2012	2013	2014		2015		2016	2017	2018	2019	2020	2021	Total
A	Observed Take	0	3	1	1	3	2	1	4	2	1	3	1	1	1	2	2	0	2	**30**
B	Estimated Take Multiplier (45/30=1.5)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	--
C	Estimated Direct Take (A x B)	0.00	4.50	1.50	1.50	4.50	3.00	1.50	6.00	3.00	1.50	4.50	1.50	1.50	1.50	3.00	3.00	0.00	3.00	**45.00**
D	Observed Indirect Take Multiplier (Season Defined)	0.00	0.09	0.00	0.00	0.09	0.00	0.09	0.09	0.09	0.00	0.09	0.04	0.09	0.04	0.09	0.09	0.00	0.09	**--**
E	Observed Indirect Take (C x D)	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	**2.06**
F	Unobserved Direct Take (C - A)	0.00	1.50	0.50	0.50	1.50	1.00	0.50	2.00	1.00	0.50	1.50	0.50	0.50	0.50	1.00	1.00	0.00	1.00	**--**
G	Unobserved Indirect Take (F x 0.06)	0.00	0.09	0.03	0.03	0.09	0.06	0.03	0.12	0.06	0.03	0.09	0.03	0.03	0.03	0.06	0.06	0.00	0.06	**0.90**
Total Indirect Take (E + G; fledglings)																				**2.96**
Total Indirect Take (E + G)*0.512 (adults)																				**1.52**

Appendix 2c. Indirect Take for the Hawaiian Petrel at the Project in FY 2021

Parameter	Description		Fiscal Year																
		2007	2008	2009	2010	2011	2012		2013	2014	2015		2016	2017	2018	2019	2020	2021	Total
A	Observed Take	0.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	**8.00**
B	Estimated Take Multiplier (16/8=2)	0.00	2.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	
C	Estimated Direct Take (A x B)	0.00	2.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00	0.00	0.00	0.00	2.00	0.00	0.00	**16.00**
D	Observed Indirect Take Multiplier (Season defined)	0.00	0.66	0.00	0.00	0.00	0.66	0.50	0.89	0.89	0.89	0.66	0.00	0.00	0.00	0.89	0.00	0.00	
E	Observed Indirect Take (A x D)	0.00	0.66	0.00	0.00	0.00	0.66	0.50	0.89	0.89	0.89	0.66	0.00	0.00	0.00	0.89	0.00	0.00	**6.04**
F	Unobserved Direct Take (C - A)	0.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	**8.00**
G	Unobserved Indirect Take (D x F)	0.00	0.66	0.00	0.00	0.00	0.66	0.50	0.89	0.89	0.89	0.66	0.00	0.00	0.00	0.89	0.00	0.00	**6.04**
Total Indirect Take (E + G) chicks/eggs																			**12.08**
Total Indirect Take (E + G) x 0.3 adults																			**3.62**
1. Productivity information for FY 2019 and FY 2020 is not yet available; values will be updated when data becomes available.																			

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Appendix 3. Hawaiian Hoary Bat, Hawaiian Goose, and Hawaiian Petrel 20-Year Projected Take at the Project in FY 2021

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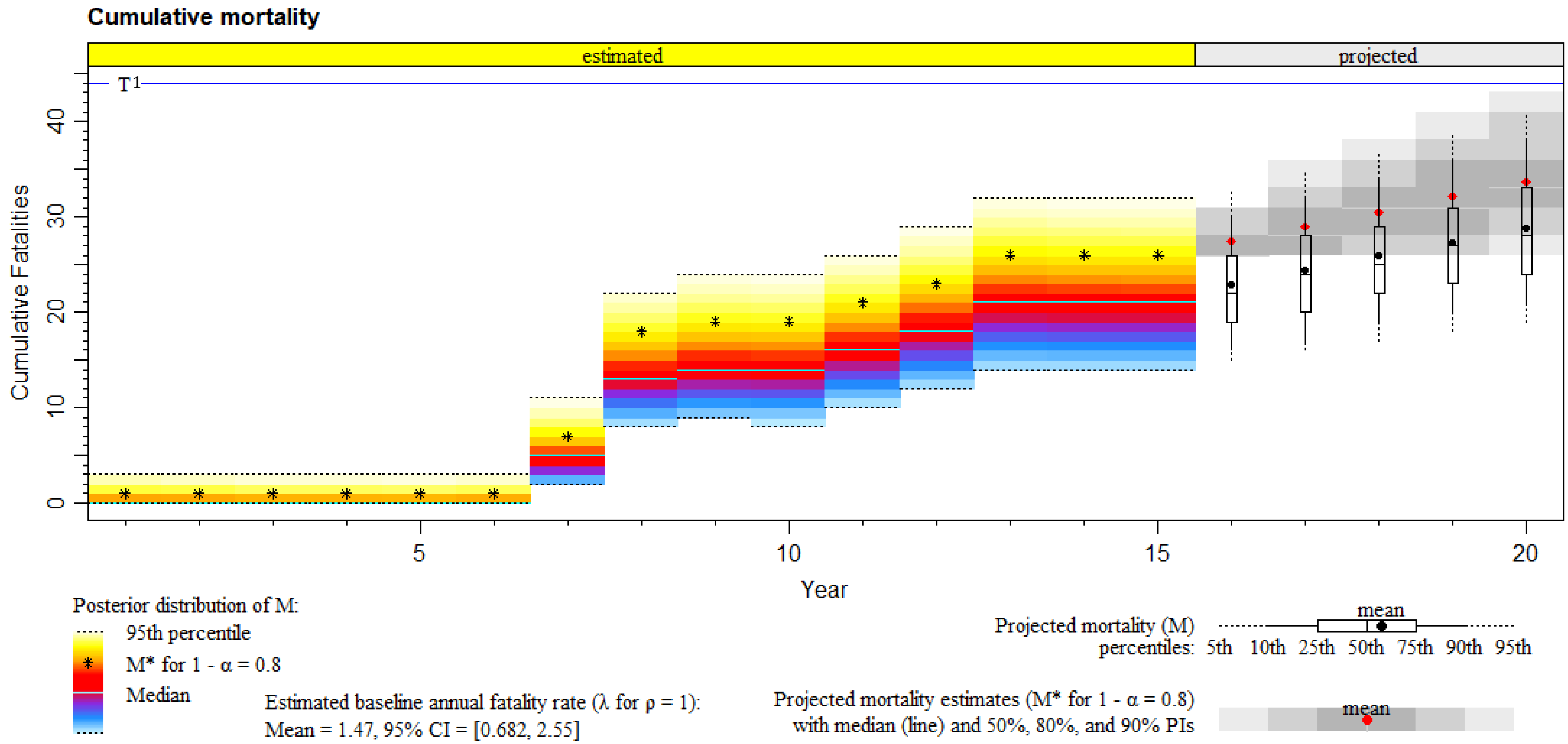
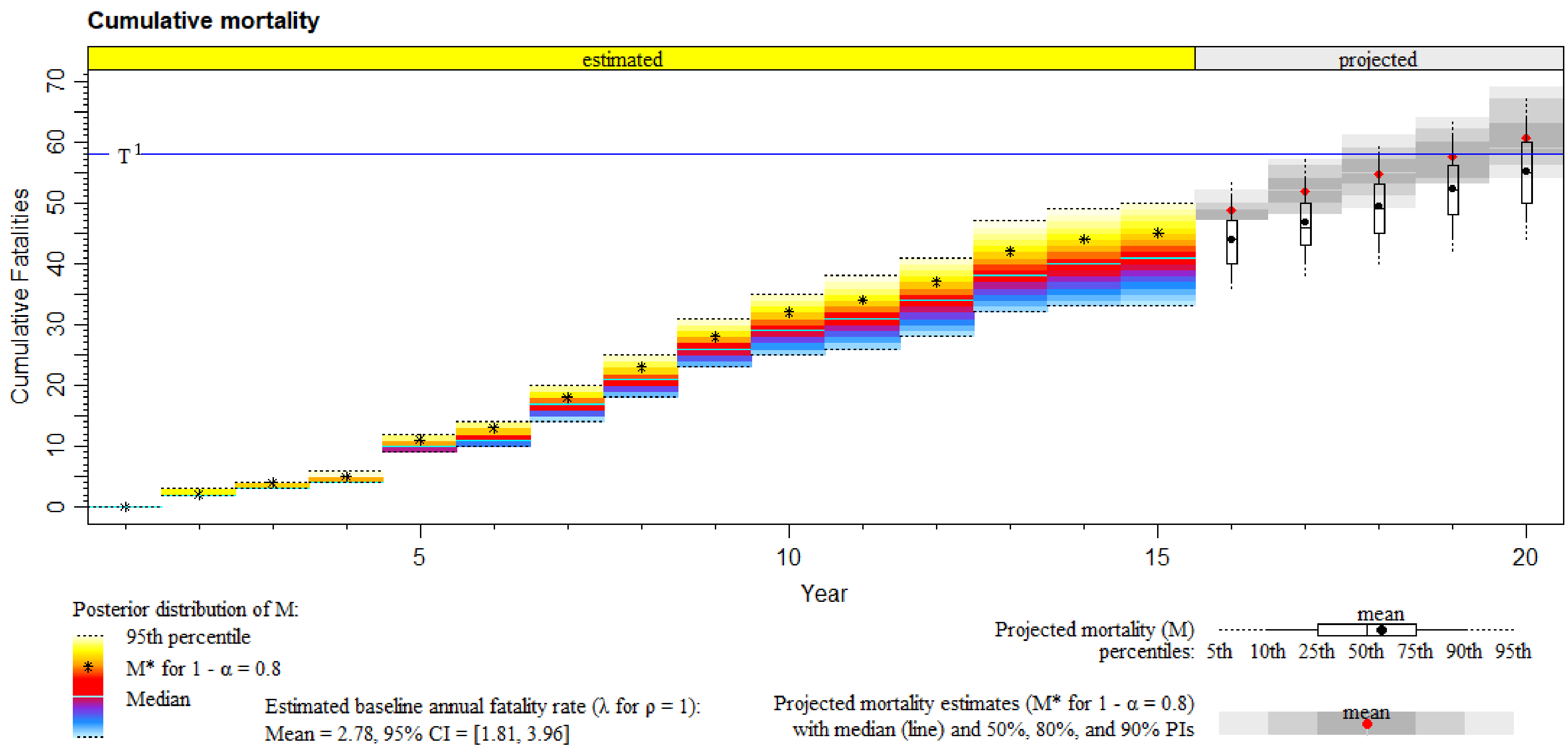
Figure 1. Projected Cumulative Mortality for the Hawaiian Hoary Bat at the Project



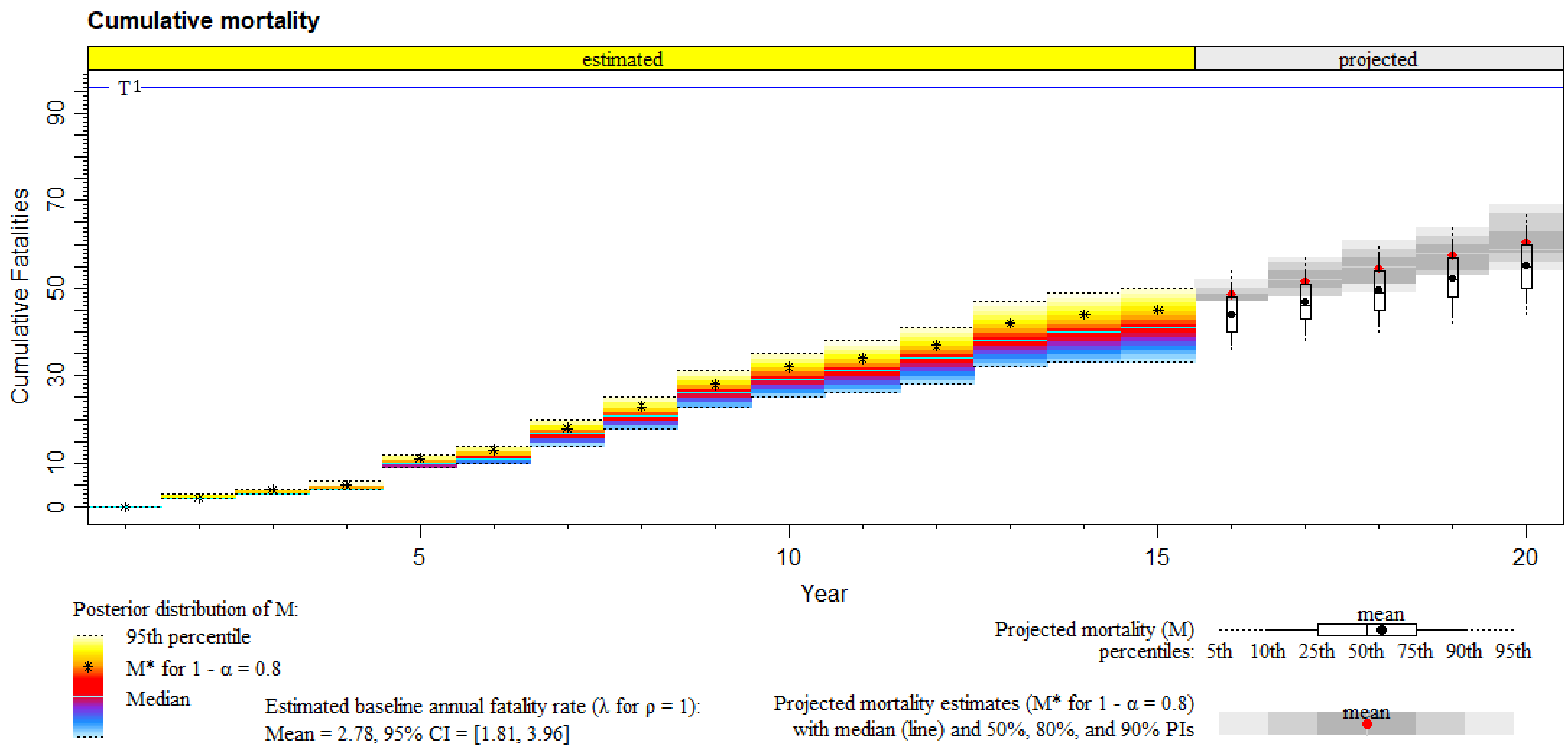
1. Permitted take for the Hawaiian hoary bat at the Project is 50; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 44 is shown, representing authorized bat take (50) minus 6 adult equivalents of indirect take (12.0 percent of the authorized limit). Currently, the proportion of total take that is attributable to indirect take is 10.7 percent.

Figure 2a. Projected Cumulative Mortality for the Hawaiian Goose at the Project with Tier 1 Threshold



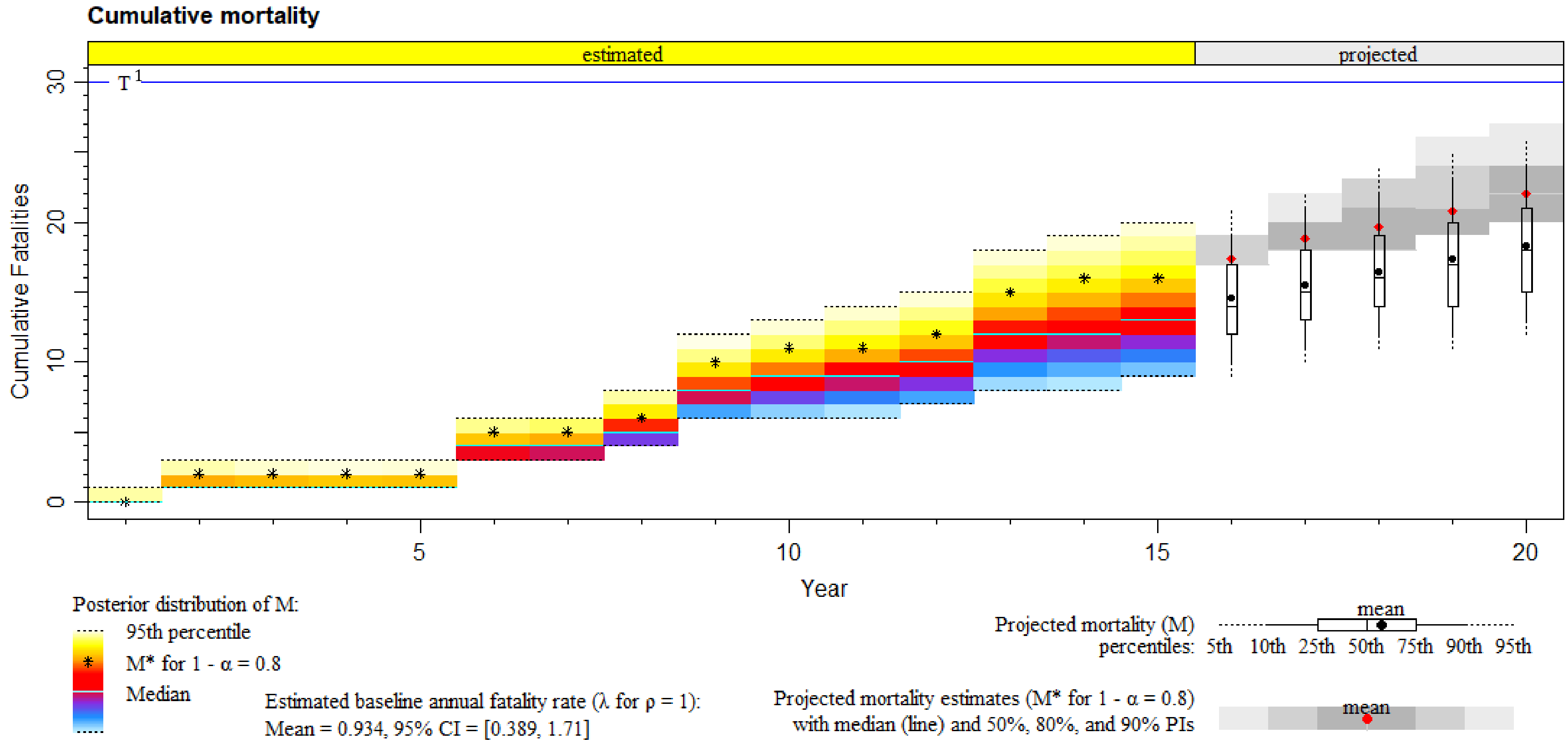
1. Permitted take for Tier 1 of the Hawaiian goose at the Project is 60; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 58 is shown, representing permitted Hawaiian goose take (60) minus 2 adult equivalents 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.

Figure 2b. Projected Cumulative Mortality for the Hawaiian Goose at the Project with Tier 2 Threshold



1 Permitted take for Tier 2 of the Hawaiian goose at the Project is 100; however, take as calculated from EoA only includes direct take. To account for indirect take in this figure, an approximate take threshold (T) of 96 is shown, representing permitted Hawaiian goose take (100) minus 4 adult equivalents of indirect take (4.0 percent of the requested authorized limit). Currently, the proportion of total take that is attributable to indirect take is 3.3 percent.

Figure 3. Projected Cumulative Mortality for the Hawaiian Petrel at the Project



1. Permitted take for the Hawaiian petrel 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.

Appendix 4. Documented Fatalities at the Project during FY 2021

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Species	Date Documented	WTG	Distance to WTG (meters)	Bearing from WTG (degrees)
Phaethon lepturus (White-tailed tropicbird)[1]	07/10/20	2	22	205
Francolinus francolinus (Black francolin)	07/28/20	6	25	357
Phasianus colchicus (Ring-necked pheasant)	07/28/20	7	65	45
Asio flammeus sandwichensis (Hawaiian short eared owl)[1]	08/18/20	11	45	115
Francolinus pondicerianus (Gray francolin)	09/29/20	19	22	48
Haemorhous mexicanus (House finch)[1]	10/03/20	16	25	83
Zosterops japonicus (Warbling white-eye)	11/17/20	12	40	54
Francolinus pondicerianus (Gray francolin)	12/15/20	20	1	30
Acridotheres tristis (Common myna)	01/19/21	13	40	165
Branta sandvicensis (Hawaiian goose)[2]	03/02/21	14	114	40
Francolinus francolinus (Black francolin)	03/09/21	8	1	348
Acridotheres tristis (Common myna)	04/06/21	15	54	34
Francolinus francolinus (Black francolin)	04/13/21	13	5	20
Branta sandvicensis (Hawaiian goose)[2]	04/13/21	17	80	84
Phasianus colchicus (Ring-necked pheasant)	04/20/21	17	2	272
Francolinus francolinus (Black francolin)	05/25/21	18	2	62
Passer domesticus (House sparrow)	06/07/21	Ops office parking lot	-	-
Francolinus francolinus (Black francolin)	06/22/21	5	1	316

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

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Appendix 5. USGS Hawai‘i Island Hawaiian Hoary Bat Ecological Research Project Annual Report

Hawaiian Hoary Bat Conservation Biology: Movements, Roosting Behavior, and Diet

Agreement # 17WSTAAZB005541

Annual Report

Summary of Research Activities through July 2021

29 July 2021

Prepared by:

USGS-Pacific Island Ecosystems Research Center, Kilauea Field Station, P.O. Box 44, Hawaiʻi National Park, HI 96718

Hawaiʻi Cooperative Studies Unit, University of Hawaiʻi at Hilo, P.O. Box 44, Hawaiʻi National Park, HI 96718

The Hawaiian Hoary Bat Conservation Biology project is designed to advance understanding of key aspects of endangered Hawaiian hoary bat (*Lasiurus semotus*) ecology and population biology. Key components of the study include:

- Roost fidelity and characterization
- Maternal roost ecology and mother-pup behavior
- Habitat use
- Diet analysis using molecular techniques
- Insect prey selection and availability
- Insect prey-host plant associations
- Movements throughout the annual cycle
- Banking of tissue and fur collection for genetic and pesticide studies (outside scope of this study)

Study preparation and design

This USGS-led study is being conducted in collaboration with several researchers with the University of Hawaiʻi at Hilo – Hawaiʻi Cooperative Studies Unit.

Land and special use access permits were granted by: Hawaiʻi DLNR Division of Forestry and Wildlife - Forest Reserve System, Natural Area Reserve System, and Land Division; USDA Forest Service – Hawaiʻi Experimental Tropical Forest; The Nature Conservancy; USFWS – Hakalau Forest National Wildlife Refuge; Department of Hawaiian Home Lands. Additionally, numerous private landowners have provided access to properties. Sampling permits were granted for bat handling and sampling and for insect collections: USFWS Recovery Permit (TE003483-33); Hawaiʻi Protected Wildlife Permit (WL19-52); Hawaiʻi Native Invertebrate Research Permit (I2444); University of Hawaiʻi System IACUC (04-039-17). The USDA Forest Service - Institute for Pacific Islands Forestry and the University of Hawaiʻi College of Tropical Agriculture and Human Services granted permission to station automated telemetry receiver stations on their properties.

Field data collection commenced in May 2018 and will be completed in August 2021. During the first 2.5 years of field work, the sampling area spanned much of the east side of Hawaiʻi Island (Figure 1). Eight fixed sampling sites were selected for regularly scheduled bat mist netting and insect collections; these sites were sampled three times per year (approximately 4-month interval between visits) for two years (Jan 2019 – Jan 2021). Four fixed sites were located at high elevation (above 1000 m asl) and four at low elevation (below 600 m asl). The fixed sample sites included native and exotic forests, orchards, pastures, and mixed habitats. Sampling cycles were divided by breeding cycle phase: non-reproductive (December-March), pregnancy/pupping (April-July), post-lactation/fledging (August-November). Additional bat mist netting efforts during this time were conducted at sites that spanned a range of habitat types in east Hawaiʻi. During the final 7-months of field work (February-August 2021) mist netting efforts were focused in (1) native-dominant forest habitats, (2) leeward dryland forest (a habitat type not previously sampled), and (3) sites where reproductive females had been captured in previous years.

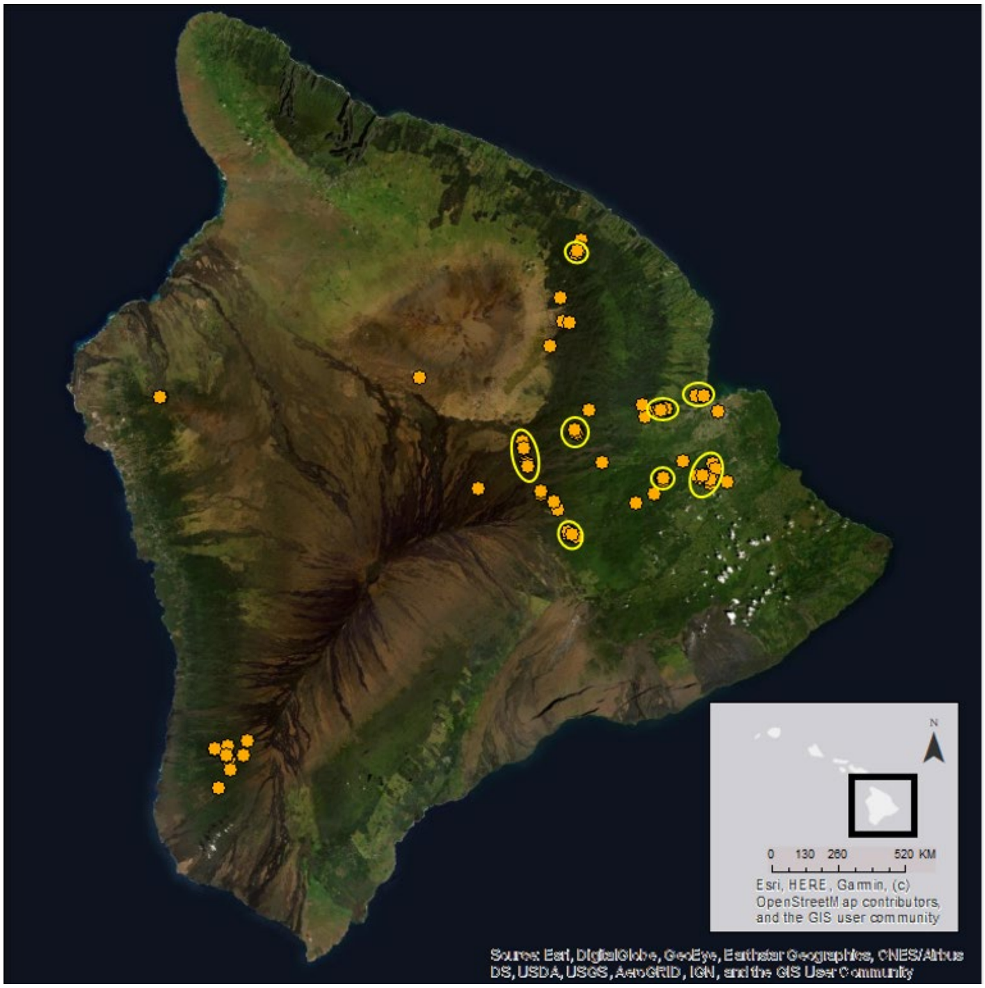

Figure 1. Mist net sites on the island of Hawaiʻi. Fixed sampling sites are circled in yellow.

Effect of Covid-19 pandemic on study

Bat capture efforts were paused mid-March through early June 2020 due to the Covid-19 pandemic. During this time a number of field and lab tasks, that could be conducted without the handling of bats and while maintaining social distancing, continued relatively uninterrupted and data processing continued. After careful evaluation of conditions on the island of Hawaiʻi, implementation of enhanced sanitation protocols, acquisition of personal protective equipment, and personnel training in the proper use of N95 respirators, bat captures resumed in early June 2020.

Capture effort

Bat mist netting was conducted during 221 nights from 14 May 2018 to 23 June 2021 (2018: 37, 2019: 87, 2020: 60, 2021: 37); bats were captured on 57 of these nights (Figure 2). One hundred thirty-five individuals were captured and from all individuals tissue and hair samples were collected and morphometric measurements and reproductive status recorded. All bats were marked with unique color-coded bands. Radio-telemetry tags were affixed to 122 individuals. Additionally, nine individuals were captured twice, one individual was caught three times, and seven of these recaptures were radio-tagged twice.

Figure 2. Mist nest being set up to capture Hawaiian hoary bats (top) and captured bat (bottom).

Roost ecology

Roost ecology studies were a primary focus during the three years of field data collection. Once individuals were captured and radio-tagged, efforts to track the individuals to a day roost tree(s) commenced within one day. Dense forest vegetation and a limited road network creates extremely difficult conditions for tracking individuals to their day roost resulting in significant effort devoted to this work. Radio telemetry (Figure 3) was used to track a total of 32 bats to a day roost tree occupied for at least one day; an additional 51 bats were tracked to at least one day roost located within a forest stand (Figure 4). Ten individuals were tracked to more than one day roost tree. Three maternity roost trees were confirmed in 2019, five in 2020, and three in 2021; from each of these roosts the number of pups was evaluated by repeat observations at each maternity roost (Figure 5). Active maternity roosts have been monitored on a nightly basis using acoustic and thermal video recordings to obtain information on roost fidelity, the time of roost emergence/return, the within-night frequency and duration of foraging flights, time to pup fledging, and presence of potential predators (Figure 5). All historical maternity roosts are visited weekly during the maternity season to monitor for activity. Regular monitoring of select non-maternity roosts is also being conducted to check for returning individuals to document fidelity and identify opportunities for video monitoring (Figure 6). Where possible, roost fidelity of bats with active radio tags was monitored using an automated receiver station near the roost (Figure 3). Data from these systems have been collected and downloaded at 37 tree or stand-level roosts since May 2019, when the system was first used. Roost monitoring and data collection at active roosts will continue through September 2021.

Roost trees are identified to species and characteristics are measured (e.g., height, dbh, percent canopy cover, etc.). Roost tree metrics have been collected at 50 trees. Stand-level characteristics (e.g., stand height, dominant tree, understory, etc.) for an additional 64 locations (114 total) were derived from a combination of satellite and airborne imagery and ground measurements. Trees used by roosting bats were comprised of non-native plantation species, invasive species, and native *Metrosideros polymorpha* and *Diospyros sandwicensis*. Preliminary tree and stand metric results collected through 2019 and associated metadata are publicly available through the USGS ScienceBase Catalog, https://doi.org/10.5066/P9R95UYT (Montoya-Aiona et al. 2019). A metadata viewer is available for download: https://github.com/usgs/fort-pymdwizard/releases.

Figure 3. Radio telemetry effort to located day roost tree (left). Automated receiver station used to measure roost fidelity (middle). Thermal imager used for searches for roosting bats (right).

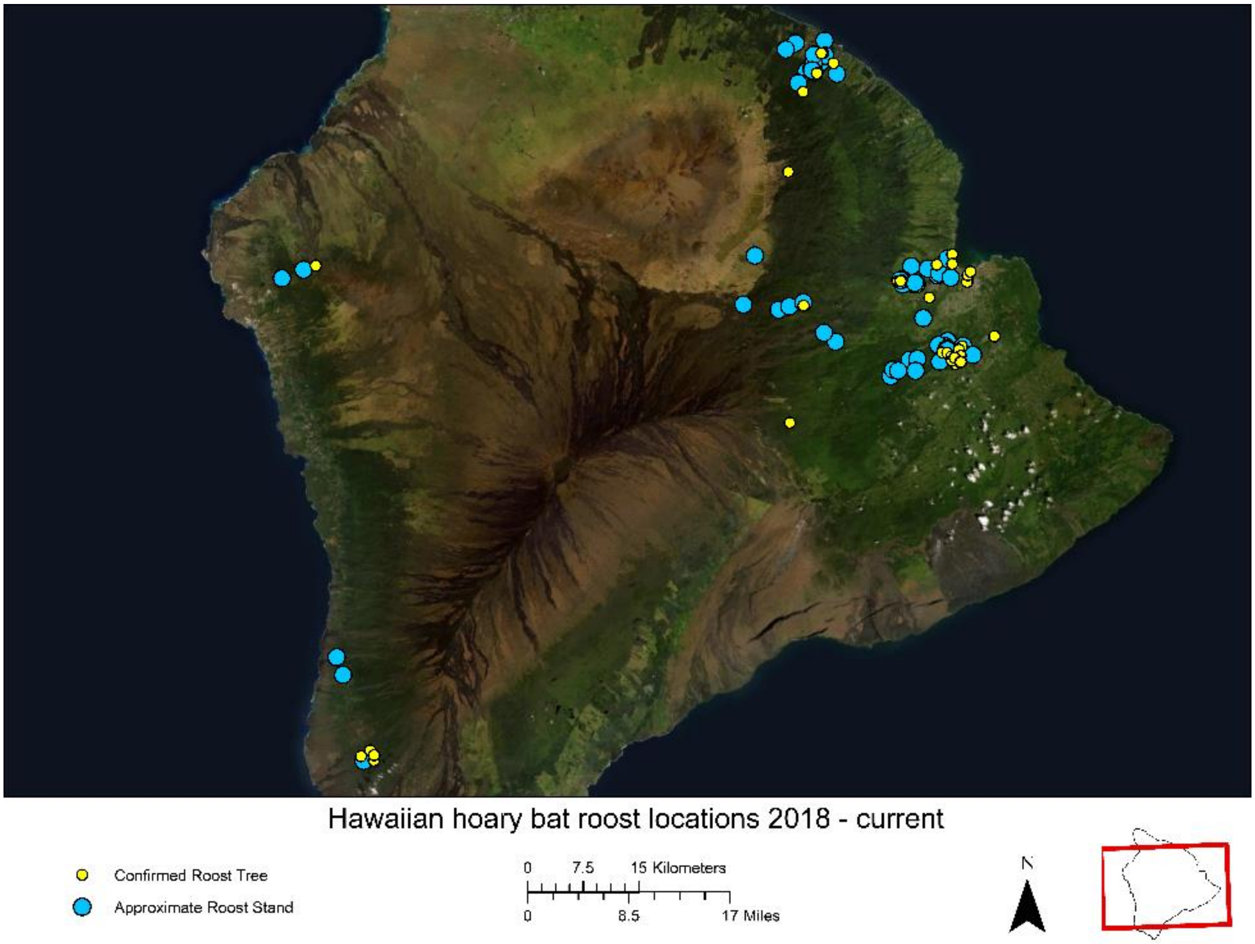

Figure 4. Confirmed and approximate Hawaiian hoary bat roost locations, 2018 – July 2021.

Figure 5. Thermal video camera deployment at maternity roost (top left). A mother Hawaiian hoary bat with two pups observed during maternity roost monitoring (top right). Thermal video monitoring of bat roost behavior (bottom).

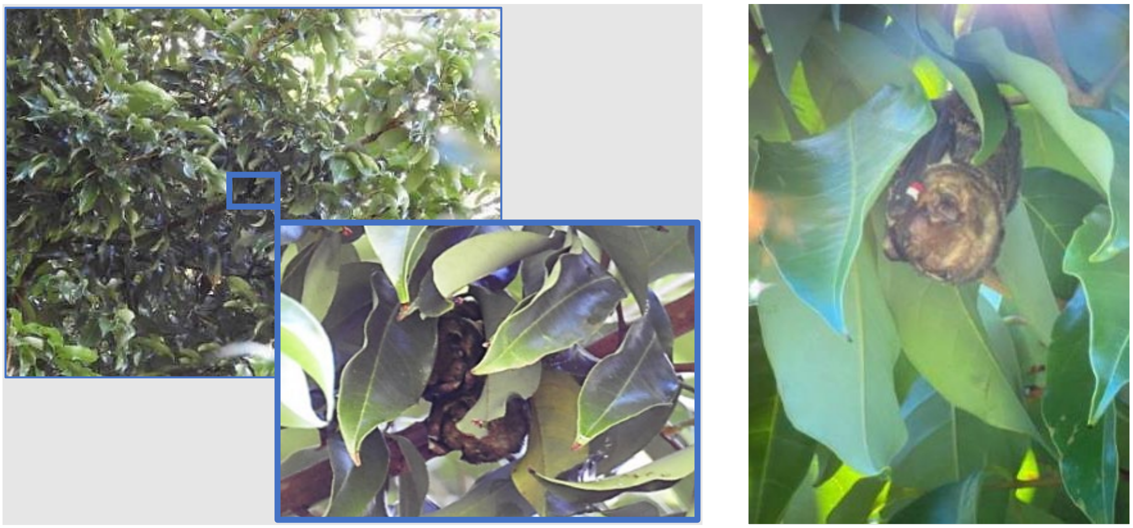

Figure 6. Example of a mother-pup Hawaiian hoary bats at roost (left). Adult male Hawaiian hoary bat observed during roost fidelity monitoring (right).

Diet studies

Studies of diet are focused on three primary lines of research: prey selection (comparison of availability with what is in fecal samples and comparison between sexes), seasonal and elevational comparisons, and host-plant associations with diet species.

Insect collection commenced in February 2019 and continued for two years ending in January 2021. Nocturnal flying insects were collected using light traps (Figure 7) run at each fixed collection site concurrently with mist netting. Insect collection was conducted during two nights in each sampling cycle (i.e., 16 nights total per cycle). Collected insects are being categorized by size class and identified to the highest possible taxonomic classification; this lab work is underway and nearly complete (Figure 7). Additionally, DNA extracted from potential prey items were submitted for genetic barcoding to establish a reference library of potential bat prey items. Additional prey items will be submitted for barcoding during September-October 2021.

To identify bat prey, genetic meta-barcoding of guano samples is being conducted, and a bioinformatics approach used to match bat prey items with the reference library (above) and public databases (see Pinzari et al. 2019). A total of 85 guano samples have been collected from captured bats to date. Samples were processed and submitted for sequencing in November 2019 and February 2021. 74 samples were submitted, 69 of which yielded usable data. Remaining samples will be processed and submitted for meta-barcoding in September 2021.

Collection of caterpillars from vegetation at the fixed sampling sites was conducted March–May 2020 (Figure 8). A combination of rearing caterpillars to adult form and genetic barcoding of the caterpillars will be used to link the collections with bat diet. Host plants of bat prey are being identified using these collections and are examined further with in-depth literature searches and the cataloging of insect host plants in Hawaiʻi.

Figure 7. Insect collection using UV light trap (left). Potential bat prey collected and identified (middle). Hawaiian hoary bat guano sample being prepared for genetic meta-barcoding (right).

Figure 8. Caterpillar collection from vegetation to identify host plants of potential Hawaiian hoary bat prey (left). Caterpillars collected with host plant material (middle and right).

Movements

The automated telemetry system did not serve to provide data on bat movements on the landscape (see Technical issues section below). However, additional movement information has been documented when possible, including site fidelity and seasonality of re-captured bats (n = 10), the distance between multiple roosts used by individual bats (n = 10), and the distance between capture and roost locations (n = 114; Figure 9). Additionally, the activity budget (i.e., flight bout duration and frequency) of individual bats at roosts monitored by thermal video as part of the current study and bat telemetry location data obtained between 2004 and 2010 is being examined for its use in inferring the spatial extent of nightly movements.

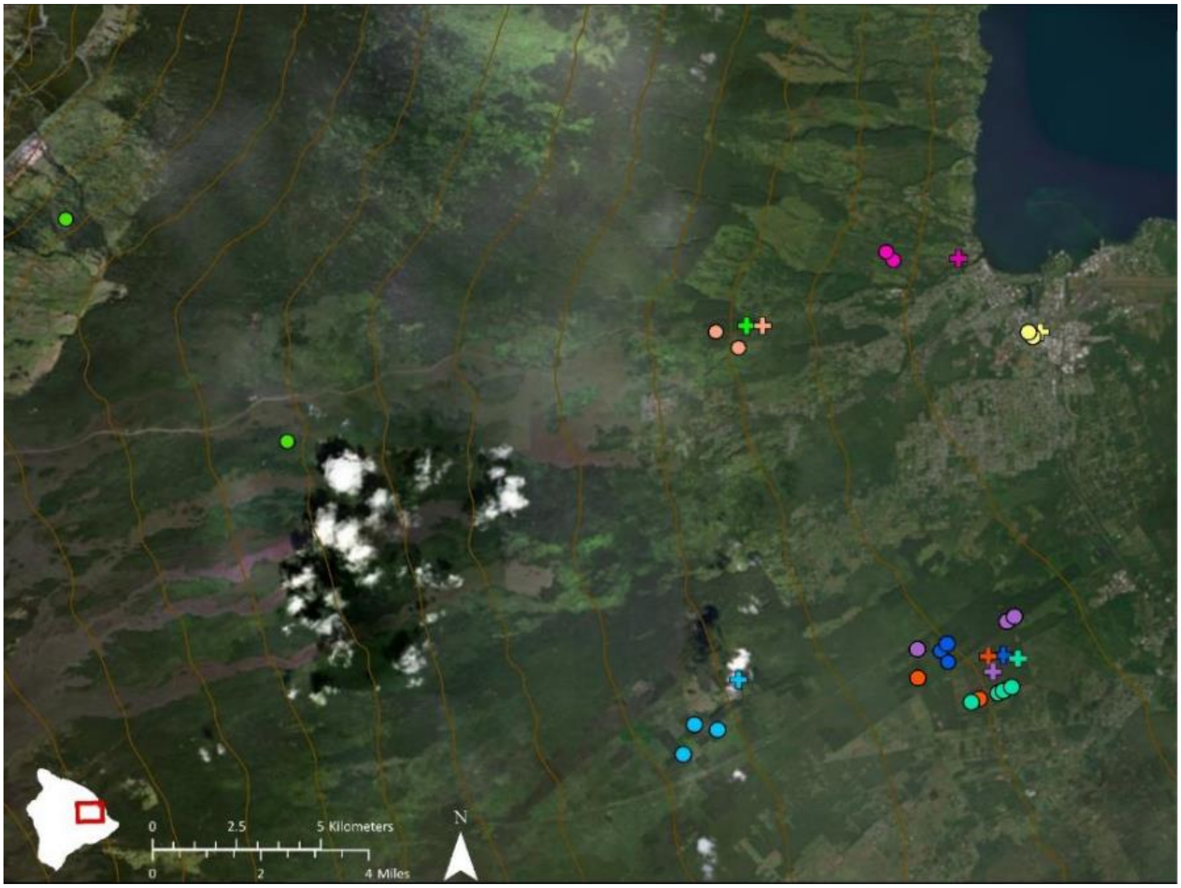

Figure 9. Example of net sites (cross symbols) relative to roost locations (circles) for captured bats (grouped by color) (data as of March 2020).

Technical issues

An automated telemetry system comprised of a network of six stations was established across a broad section of the Wailuku watershed. Each station consisted of a 20 to 30 ft mast with six radially arranged antennas and a radio receiver with cellular connectivity allowing for real-time coverage with live data feeds. However, technical issues with the system precluded its use in recording telemetered bat movement. The issues primarily entailed the high levels of ambient electromagnetic noise present in the region from which transmitter (i.e., radio-tag) signals could not be reliably discerned, persistent software bugs and power failure problems related to overheating of the receiver components. Bat flight behavior, specifically low altitude and within-forest movement, may also have contributed to limiting the reception range of transmitters in many parts of the landscape.

Given the technical difficulties collecting movement data with the automated system, there was a need to adaptively manage the research project to maximize the benefits of this project to the management of Hawaiian hoary bats. The following adjustments were proposed and implemented during 2021:

1) Expanded sampling area for roost and diet studies into additional habitat/forest types that represent a broader range of the landscape in Hawaiʻi to improve inference for planning

restoration and mitigation areas on other islands. The study area described in the Statement of Work was limited to the east side of Hawaiʻi Island dominated by rain forests and wet shrublands; we expanded sampling areas into mesic and dry forests with a broader range of dominant tree and shrub species.

2) Focused efforts to collect roost and diet (guano collection) sampling at higher elevation and native dominated forest sites where samples were underrepresented due to the difficulty of obtaining samples in these areas.

3) Continued sustained high intensity monitoring at roosts, including maternity roosts. In lieu of shifting efforts to facilitate tracking work, we maintained and expanded roost research efforts that yielded quality datasets (e.g., video monitoring, visual checks).

4) Analysis of hand-held and automated telemetry data collected to find and monitor roosts to better understand Hawaiian hoary bat movements on the landscape. From continued high intensity roost searching efforts and expansion of these efforts into additional habitats, we expanded datasets to calculate distances and elevational differences between capture locations and roost sites and analyze time spent away from the roost.

Future research efforts

We will conclude field work and data collection in August–September 2021. Analysis of data collected over the 3-year period of field work and report writing is on-going and planned through remainder of 2021 and early 2022.

References

Montoya-Aiona, K. M., F. A. Calderon, S. P. Casler, K. N. Courtot, P. M. Gorresen, and J. P. S. Hoeh. 2020. Hawaii Island, Hawaiian hoary bat roosting ecology and detection 2018-2019. U.S. Geological Survey data release, https://doi.org/10.5066/P9R95UYT.

Pinzari, C., T. Zinn, R. W. Peck, D. Gross, K. Montoya-Aiona, K. Brinck, P. M. Gorresen, and F. Bonaccorso. 2019. Hawaiian hoary bat (*Lasiurus cinereus semotus*) activity, diet, and prey availability at the Waihou Mitigation Area, Maui. Hawai`i Cooperative Studies Unit Technical Report HCSU-TR090, University of Hawai'i at Hilo, Hilo, Hawaiʻi. Available: http://hdl.handle.net/10790/4638.

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Appendix 6. Nēnē Monitoring and Predator Control Management at Haleakalā Ranch, Maui FY 2020 Annual Report

NĒNĒ MONITORING AND PREDATOR CONTROL MANAGEMENT AT HALEAKALĀ RANCH, MAUI

ANNUAL REPORT

FY 2020 (JULY 1, 2019 through JUNE 30, 2020)

1.0 Introduction

Since May 2011, the Hawaiʻi 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 2020. 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

Due to erosion from storms, five hundred feet of road leading up to the open-top pen was repaired by backfilling with dirt and rocks.

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 FY2020, thirty-seven (37) banded birds were sighted at the Ranch. Twenty-seven (27) were wild Maui Nēnē, one (1) was an Olinda released bird, eight (8) were from the Kauai translocation, and one (1) was from a Big Island translocation. An island-wide annual Nēnē survey was conducted on August 28, 2019. 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.

Nine (9) nests were located on the Ranch this year, where eight (8) were located inside the pen. Six (6) 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 2019-2020 Breeding Season at Haleakalā Ranch, Maui

Total Number of Nests	
Located in open-top pen	**8**
Located outside open-top pen (on Ranch)	**1**
Successful	**6**
Abandoned	**2**
Depredated	**1**
Failed (other reason)	**0**
Renests	**0**
Total Number of Eggs	
Known	**23**
Destroyed naturally	**0**
Depredated	**1**
Mongoose	**1**
Abandoned (later scavenged)	**8**
Rats	**8**
Salvaged	**2**
Hatched	**12**
Total Number of Goslings/Fledglings	
Known goslings	**12**

Goslings depredated	**0**
Goslings died (drowned)	**1**
Goslings died (unknown reason, body scavenged by avian predators)	**1**
Fledglings fledged from pen (credited for mitigation)	**10**

2.3 Banding

No birds were banded this year.

2.4 Pen Maintenance

The open-top pen's fence line was continuously checked and maintained throughout the year with holes being patched continuously. A total of eight (8) feet of fence was repaired along the pen. A new electric fence unit was installed this year. The entire fence line was weedeated each month for a total of one thousand two hundred (1,200) feet for the year. Two (2) acres along the pen's boundary fence was treated with herbicide for weed control this year, and an additional two (2) acres along the inner fence line was also sprayed. The pond was cleaned and flushed twice a month, and the automatic waters were cleaned and maintained weekly. The water catchment rain gutter was repaired after damage from strong winds.

2.5 Habitat Management

Short grass habitat was maintained at the open-top release pen. A total of 34.75 acres was mowed this year to maintain Nēnē short grass habitat. In addition, 8.25 acres of weeds, including lantana, guava, tomato, fireweed, and glycine, were removed from the pen.

2.6 Predator Control

Predator traps are used to control rats, mongoose, feral cats, and dogs that may pose a threat to Nēnē and their nesting sites. Traplines were baited and checked at the Ranch throughout the year using 33 Tomahawk live traps and 8 A24s.

This year at the Ranch, six (6) mongoose and one (1) mouse were removed through predator trapping. No avian predators were controlled this season on the Ranch.

Table 2. Traps Deployed and Predators Removed during 2019-2020 at Haleakalā Ranch, Maui

Predator Type Removed	Trap Type		
	Tomahawk Live Trap (33)	Sherman Trap (0)	A24 Traps (8)

Cats	**0**	**0**	**0**
Dogs	**0**	**0**	**0**
Mongoose	**6**	**0**	**0**
Rats	**0**	**0**	**0**
Mice	**0**	**0**	**1**

Table 3. Avian Predator Control during 2019-2020 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 birds were relocated to the pen.

2.8 Injury, Fatalities, Disease

Two (2) gosling fatalities occurred in the open-top pen this year. One (1) gosling drowned in the water trough, and one (1) gosling was found dead and scavenged by an avian predator.

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 7. Nēnē Monitoring and Predator Control Management at Haleakalā Ranch, Maui FY 2021 Annual Report

NĒNĒ MONITORING AND PREDATOR CONTROL MANAGEMENT AT HALEAKALĀ RANCH, MAUI

ANNUAL REPORT

FY 2021 (JULY 1, 2020 through JUNE 30, 2021)

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 2021. 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, five hundred twenty-five (525) 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 FY2021, thirty-eight (38) banded birds were sighted at the Ranch. Twenty-eight (28) were wild Maui Nēnē, two (2) were Olinda released birds, and eight (8) were from the Kauai translocation. An island-wide annual Nēnē survey was conducted on August 2, 2010. During this survey, seven (7) 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.

Six (6) nests were located inside the Ranch's open-top release pen this year. Three (3) of these nests were successful in producing five (5) goslings. One (1) Nēnē fledged from the Ranch open-top release pen this season.

Table 1. Nēnē Nesting Summary for 2010-2021 Breeding Season at Haleakalā Ranch, Maui

Total Number of Nests	
Located in open-top pen	**6**
Successful	**3**
Abandoned	**3**
Depredated	**0**
Failed (other reason)	**0**
Renests	**1**
Total Number of Eggs	
Known	**13**
Destroyed naturally	**0**
Depredated	**0**
Abandoned (later scavenged)	**0**
Salvaged	**0**
Outcome unknown	**8**
Hatched	**5**
Total Number of Goslings/Fledglings	
Known goslings	**5**
Goslings died (unknown cause)	**4**
Fledglings fledged from pen (credited for mitigation)	**1**

2.3 Banding

No birds were banded this year.

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 ten (10) feet of fence was repaired along the pen. The entire fence line was weedeated each month for a total of six (6) acres for the year. A half (0.5) acre along the pen's boundary fence was treated with herbicide for weed control this year. The water unit was checked monthly, and the pond and automatic waterers were cleaned and maintained monthly.

2.5 Habitat Management

Short grass habitat was maintained at the open-top release pen. A total of twenty-six and a quarter (26.25) acres was mowed this year to maintain Nēnē short grass habitat. Ten (10) acres of alien vegetation was mechanically removed, including lantana, guava, tomato, Bocconia, fireweed, and bur. An additional one (1) acre of non-native vegetation was treated with herbicide.

2.6 Predator Control

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

This year at the Ranch, three (3) mongoose were removed through predator trapping. No avian predators were controlled this season on the Ranch. No cats or cat sign have been 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 2020-2021 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	**3**	**0**	**0**
Rats	**0**	**0**	**0**
Mice	**0**	**0**	**0**

Table 3. Avian Predator Control during 2020-2021 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

Three (3) adult nene were relocated to the Ranch's open-top release pen after being captured at other areas on Maui due to injuries. These birds included an Upcountry bird with an eye injury and two (2) South Maui birds with leg and pelvic girdle injuries.

2.8 Injury, Fatalities, Disease

Two (2) adult nene carcasses with no known cause of death were salvaged this year at the pen. One (1) of the fatalities was of the relocated Upcountry bird.

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 8. Makamakaʻole Seabird Mitigation Area 2020 Annual Report

Makamaka'ole Threatened and Endangered Seabird Mitigation Project: Exclosures and Artificial Burrows Annual Summary Report

Reporting Period: May 2020 – December 2020
Monitored and Reported by Maui Nui Seabird Recovery Project for Brookfield Renewables and Tetra Tech

Overall Summary: The Makamaka'ole seabird mitigation site consists of 2 predator-proof exclosures, each housing 50 artificial seabird burrows with nest boxes. Social attraction mechanisms including seabird models and nighttime auditory playback are in place to attract Newell's shearwaters (*Puffinus newelli,* NESH) in exclosure A, and Hawaiian petrels (*Pterodroma sandwichensis*, HAPE) in exclosure B. MNSRP performed assessment of the exclosures at Makamaka'ole and began monitoring in May 2020. The brackets holding the metal cap of the exclosures had rusted to the point of failure, resulting in severe compromise of the structures as wind ripped off sections of the cap in multiple locations. This created post flex, hogging out holes and necessitating brace construction throughout the impacted sections of fence. Maintenance and repairs progressed for all structural components of both exclosures throughout the year and are ongoing.
The playback system for auditory attraction was activated on May 22, 2020. By that time, NESH were already attending the nest boxes in both exclosures, and one Bulwer's petrel (*Bulweria bulwerii,* BUPE) was noted in exclosure B. NESH activity continued through the end of October. A total of 7 eggs (nonviable) were recovered from 6 nest boxes, and there was no evidence of chicks. Based on weekly burrow monitoring and a final check inside each nest box on Nov. 23, the annual burrow visitation rate is 43%.
Traps were deployed inside and outside the exclosures in June and July 2020. A total of 7 rats and 7 mice were captured inside. Outside; 12 rats, 1 mouse, and 22 mongooses were removed. Tracking tunnels show a low level of rodent activity inside the exclosures, mainly mice.

Vegetation Control: Prior to any exclosure repair could begin, extensive vegetation removal was needed along the inside and outside of the fence. Vegetation was overgrown as a result of infrequent site visits and monitoring activities in the months prior to MNSRP's assessment. Weed-whacking of the overgrowth continued over several visits. Controlling the vegetation requires regular upkeep to maintain open access to predator traps, artificial burrows, decoys and other enclosure infrastructure. It is not possible to keep aware of all the needs for fence repair and possible compromise if the vegetation is uncontrolled.

Exclosure Fence – Status and Activities:
All damaged hood sections were removed from both exclosures. Degraded posts, braces, and mesh panels were removed and replaced, and installation of new hood sections began. Replacing the rusted mesh and brackets and repairing sections of skirt continues. Repair at exclosure A is dependent on the stabilization of the slope with a retaining wall and steps, which is ongoing work by MNSRP. Work on the exclosure structure slowed at the end of the year due to inclement weather and reduced staff availability.

Sound Playback System – Status and Activities: The sound playback system was active from May 22 through September 17. Established burrows were already active and clustered around speaker locations before the system was active this season, suggesting that the birds were returning from previous years. The continuous calling that was broadcast each night throughout the season may have caused stress to the already established NESH, especially in exclosure A. Aggressive behaviors among birds were noted from game camera footage. See figure 1 for active burrows and speaker locations.

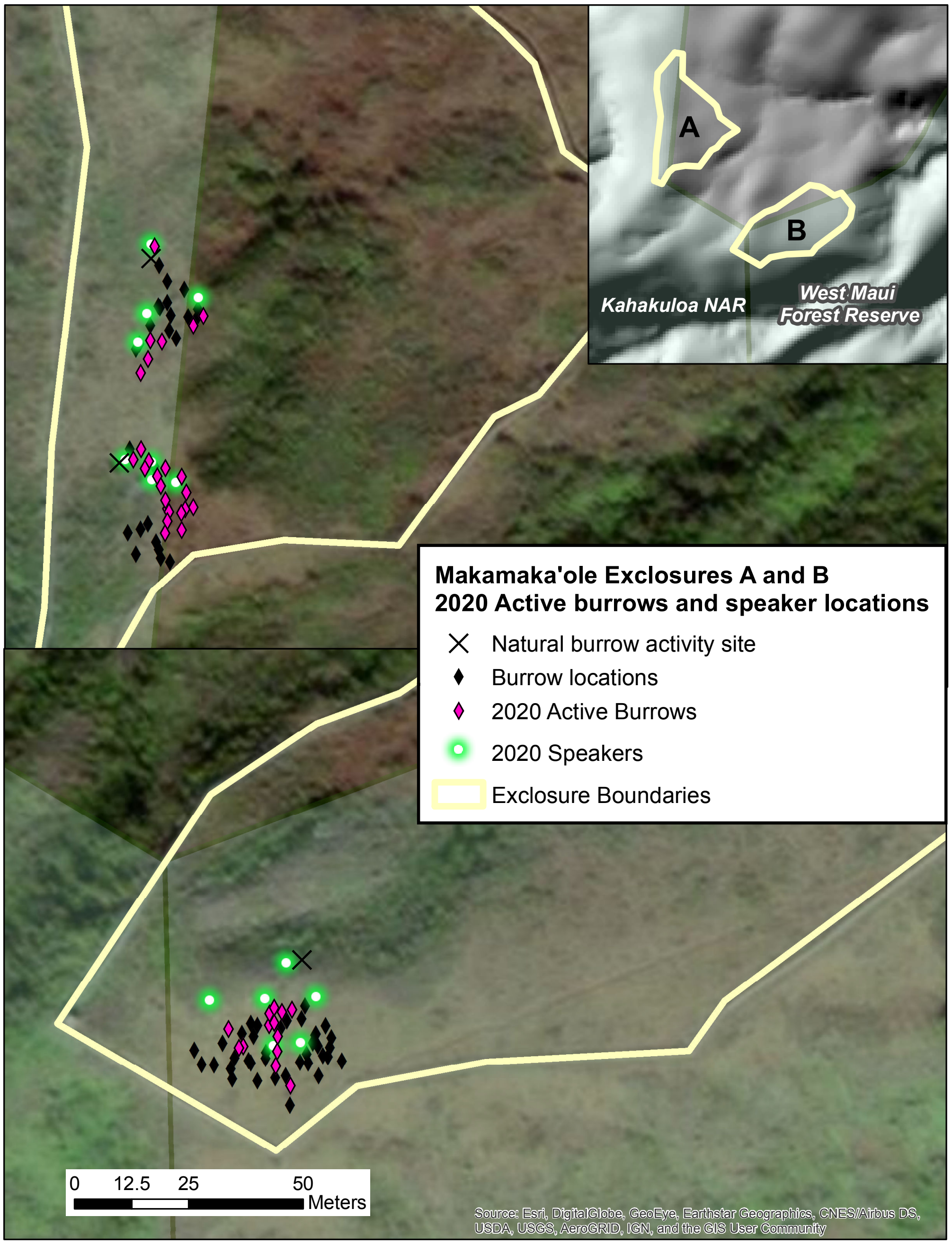


Figure 1. Natural and artificial burrow and speaker locations in exclosures A and B.

Artificial Burrow Checks:
Seabird activity was assessed weekly at each burrow by checking for removal or displacement of toothpicks erected at the entrance, searching for guano and feathers, and by noting bird scent. Data collection for burrow activity began on 5/22. During regular checks, 2 eggs were discovered rolled out at burrow 22A on June 18, and 1 egg was recovered from burrow 50B on August 8. Burrow scoping was attempted but inconclusive for egg/chick identification in several of the active burrows. On August 31, active nest boxes were open to assess breeding activity. Four broken eggs were recovered from inside burrows 14A, 25A, 43A, and 22B. In addition, a desiccated carcass of a Band-rumped storm petrel (*Oceanodroma castro*, BANP) was recovered from inside 22A. Six adult NESH were banded and returned to the nest boxes; 2 pairs (14A and 26A) and 1 each from 20A and 48A.

On September 17, Spencer Engler and search dog "Mochi" from Aloha Environmental Services performed a search for any bird activity outside the nest boxes. Bird sign was noted at 2 natural nest scrapes in exclosure A and 1 in B near the speakers and colony area (see Figure 1). Burrow scoping at the natural sites revealed no eggs or birds present.

All nest boxes were opened on November 23 to check for bird activity, and to assess the condition of the boxes. In total, 26 artificial burrows in A and 17 artificial burrows in B showed some sign of activity over the monitoring period. Of those, 18 in A and 4 in B were consistently active, with bird sign (displaced toothpicks, guano, feathers) on at least 4 consecutive visits (i.e., for at least one month). A summary of burrow activity by exclosure is presented in Table 1, and details for active burrows are shown in Table 2.

Game cameras were deployed and moved among active burrows in both exclosures to capture bird activity. Only NESH and one BUPE (burrow 50B) were documented as visiting the burrows. A NESH was active at the scrape site in B. Much of the game camera footage is overexposed, but NESH were positively identified at 15 burrows in A (11, 12, 14, 17, 18, 20, 21, 22, 24, 25, 26, 28, 29, 43, and 48) and 2 in B (22 and 50). Bird activity outside the burrow entrances was highest in June. During that time footage from several of the burrows reveals 2 – 3 birds outside at the same time.

Table 1. 2020 activity summary for all nest boxes.

Burrow	Bird Sign at opening (11/23/20)	Activity over the season	Burrow	Bird Sign at opening (11/23/20)	Activity over the season
A1	No sign	No activity	B1	No sign	No activity
A2	No sign	No activity	B2	No sign	No activity
A3	No sign	No activity	B3	No sign	No activity
A4	Minimal vegetation, one moldy feather	No activity	B4	No sign	No activity
A5	Some sticks - maybe rodent?	No activity	B5	No sign	No activity
A6	Minimal vegetation but no other sign	No activity	B6	No sign	No activity
A7	Some sticks, minor duff	No activity	B7	No sign	No activity

A8	A few feathers and some vegetation	Entered, feathers, guano	B8	No sign	No activity
A9	Feathers, toothpicks, sticks, duff, and guano	Entered, guano	B9	No sign	Entered
A10	No sign	No activity	B10	Feathers	No activity
A11	Feathers, toothpicks, duff in nest cup	Entered, feathers, guano	B11	No sign	No activity
A12	Feathers and vegetation in nest bowl; toothpicks inside	Entered, guano, odor	B12	No sign	No activity
A13	Feathers, toothpicks, duff in nest	Entered, feathers, guano	B13	No sign	Entered, guano
A14	Copious toothpicks, feathers, and vegetation; egg membrane	Entered, feathers, guano, odor	B14	No sign	No activity
A15	One feather, much grass in nest cup	Entered, guano	B15	One feather and minimal vegetation	Entered
A16	Feathers, no nest	Entered, guano	B16	No sign	No activity
A17	Four feathers, no nest	Entered, feathers, guano	B17	No sign	Entered
A18	No sign	Entered, guano	B18	Nest material, 1 toothpick	No activity
A19	No sign	Entered, guano	B19	Minimal vegetation	No activity
A20	Feathers, toothpicks, nest material	Entered, feathers, guano	B20	Feathers	No activity
A21	Feathers, some nest material	Entered, feathers, guano	B21	Lots of sign - vegetation and feathers	Entered, feathers
A22	Feathers, nest material, toothpicks, nest bowl	Entered, feathers, guano	B22	Nest material, feathers, toothpicks	Entered, feathers, guano
A23	No sign	No activity	B23	A couple feathers but no other sign	Entered
A24	Feathers, toothpicks, nest material	Entered, feathers, guano	B24	Feathers	Entered, feathers, guano
A25	Nest material, toothpicks, feathers	Entered, feathers, guano	B25	Feathers and vegetation	Entered
A26	Nest bowl with grass and toothpicks	Entered, feathers, guano	B26	Feather	Entered
A27	No sign	No activity	B27	Some feathers, no other sign	Entered, guano
A28	Feathers, toothpick, nest bowl	Entered, guano	B28	No sign	Entered, feathers, guano
A29	Feathers, nest material and bowl, toothpicks	Entered, feathers, guano	B29	Toothpicks, feathers (collected)	Entered, guano
A30	No sign	No activity	B30	Two feathers, some vegetation	No activity

A31	No sign	No activity	B31	No sign	No activity
A32	Feathers, nest material (grass)	Entered, feathers, guano	B32	No sign	No activity
A33	Nest material (grass), feathers, toothpicks	Entered, guano	B33	No sign	No activity
A34	Some plant material; no other sign	No activity	B34	Minor grass inside	No activity
A35	No sign	No activity	B35	1 feather, couple pieces of grass	No activity
A36	No sign	No activity	B36	1 small feather	No activity
A37	Some plant material; no other sign	No activity	B37	3 small white body feathers	Entered
A38	No sign	No activity	B38	Few small feathers	Entered, feathers, guano
A39	One body feather, old guano	No activity	B39	No sign	No activity
A40	A few feathers, no other sign	No activity	B40	Some leaves	No activity
A41	A few feathers and grass pieces	Entered, guano	B41	1 feather, no other sign	No activity
A42	Feathers, toothpicks, grass/nest material, cobwebs	No activity	B42	Duff, toothpicks, nest cup (no feathers)	No activity
A43	Feathers, nest material, toothpicks, eggshell (1/2 intact with rocks) - collected	Entered, feathers, guano	B43	2 feathers, small amount of nest material	Entered
A44	One body feather, no other sign	No activity	B44	Minor grass	Entered, feathers
A45	No sign	No activity	B45	3 feathers - collected	No activity
A46	No sign	Entered	B46	No sign	No activity
A47	No sign	No activity	B47	No sign	No activity
A48	Body feathers, toothpicks, small duff	Entered, feathers, guano	B48	No sign	No activity
A49	Some grass, no other sign	No activity	B49	No sign	No activity
A50	Nest bowl with grass and toothpicks	Entered	B50	Feathers, toothpicks, duff, nest cup	Entered, feathers, guano

Table 2. 2020 summary of burrow boxes with seabird activity.

Burrow	Consistent activity?	Dates of noted activity at burrow checks	Species on game cam	Visitation summary
A8	yes	9/11/20-10/14/20		Entered with feathers, guano throughout active period. Feathers and duff in box.
A9	no	9/11/20-9/17/20		Entered twice, guano present once. Feathers and duff in box.

A11	yes	5/28/20-10/23/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box.
A12	yes	6/18/20-10/23/20	NESH	Entered with guano throughout active period. Feathers and duff in box.
A13	yes	6/18/20-10/14/20		Entered with feathers, guano throughout active period. Feathers and duff in box.
A14	yes	6/4/20-11/19/20	NESH	Entered with feathers and guano throughout active period. Feathers, duff, and egg membrane in box. Two adults banded 8/31/20.
A15	no	6/18/20		Entered once with guano. One feather and grass in box.
A16	no	9/11/20-9/17/20		Entered twice, guano present once. Feathers in box.
A17	yes	6/18/20-10/1/20	NESH	Entered with feathers, guano throughout active period. Feathers in box.
A18	yes	5/28/20-10/1/20	NESH	Entered with guano throughout active period.
A19	no	6/4/20, 6/18/20		Entered with guano twice.
A20	yes	5/28/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box. One adult banded 8/31/20.
A21	yes	5/28/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box.
A22	yes	5/28/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box. Two eggs roll out 6/18/20.
A24	yes	5/28/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box.
A25	yes	5/28/20-10/1/20	NESH	Entered with feathers, guano throughout active period. Feathers, duff, egg shell and membrane in box.
A26	yes	5/28/20-10/23/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box. Two adults banded 8/31/20.
A28	yes	7/21/20-10/14/20	NESH	Entered with guano throughout active period. Feathers and duff in box.
A29	yes	7/15/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box.
A32	no	7/21/20-7/29/20, 8/19/20, 9/17/20		Entered four times, twice with guano.
A33	yes	7/15/20-10/14/20		Entered with guano throughout active period. Feathers and duff in box.
A41	no	6/9/20, 6/30/20		Entered once, guano present once. Few feathers and grass in box.
A42	no	none		Considered active by the amount of nesting material in box. Visitation prior to 5/22/20?
A43	yes	5/28/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers,duff, egg shell and membrane in box.

A48	yes	5/28/20-10/14/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box. One adult banded 8/31/20.
A50	no	6/30/20-7/7/20		Entered twice. Duff in box.
B13	no	6/4/20-6/18/20		Entered once, guano three times.
B15	no	8/31/20		Entered once. One feather and duff in box.
B21	no	8/19/20-8/31/20		Entered with feathers twice. Feathers and duff in box.
B22	yes	5/28/20-11/19/20	NESH	Entered with feathers, guano throughout active period. Feathers and duff in box.
B23	no	8/19/20-8/31/20		Entered twice. Few feathers in box.
B24	yes	6/4/20, 8/5/20-10/1/20		Entered with feathers, guano throughout active period. Feathers in box.
B25	no	8/31/20, 9/17/20		Entered twice. Feathers and duff in box.
B26	no	8/5/20		Entered once. Feather in box.
B27	no	9/17/20		Entered with guano once. Few feathers in box.
B28	no	8/31/20-9/11/20		Entered with feathers and guano twice.
B29	no	8/5/20, 8/19/20-8/31/20, 9/17/20		Entered with guano on four separate occasions. Few feathers in box.
B37	no	8/31/20		Entered once. Few feathers in box.
B38	yes	7/29/20-9/17/20		Entered with feathers, guano throughout active period. Feathers in box.
B42	no	none		Considered active by the amount of nesting material in box. Visitation prior to 5/22/20?
B43	no	8/19/20, 9/11/20		Entered twice, two feathers and some duff in box.
B44	no	8/12/20		Entered with feathers once. Some grass in box.
B50	yes	5/28/20-11/19/20	NESH, BUPE	Entered with feathers, guano throughout active period. Feathers and duff in box. Egg roll out on 8/5/20.

Seabird Monitoring: No acoustic or visual night surveys were conducted this season.

Predator Removal: DOC200 traps (10 inside and 22 outside) and snap traps (18 inside and 20 outside) are deployed at the exclosures. Baits typically used are eggs for DOC200s and peanut butter for snap traps, although cat food kibble and dehydrated banana were also used. Mongooses were only captured outside the exclosures (n=22). A total of 7 rats and 7 mice were captured inside. An additional 12 rats and 1 mouse were removed outside. Overall catch rate was 49 total catches for 12,205 trap nights (0.004). The average catch rate was greater outside (0.004 vs 0.002 inside) and at exclosure A (0.004 vs 0.003 at B). See Table 3 for trapping summary.

Bait stations within the exclosures were all located and baited with ramik bars in July 2020. They are checked every 3 – 4 weeks for depletion, and moldy bait is replaced. The rate of depletion was much greater in exclosure B compared to exclosure A after initial deployment (100% vs 7% in August), but has since leveled off. The estimated overall bait consumption is 27% in A and 61% in B.

Table 3. Summary of trap nights and catches, inside and outside exclosures.

Exclosure	Placement	Trap Type	Trap Nights	Mongoose catch	Rat catch	Mouse catch	Total catch	**Catch rate**
A	Outside	DOC200	2003	13	2		15	**0.007**
	Outside	Snap trap	2173		6		6	**0.003**
	Inside	DOC200	847				0	**0.000**
	Inside	Snap trap	1782		4	7	11	**0.006**
B	Outside	DOC200	1993	8	4		12	**0.006**
	Outside	Snap trap	1338	1			1	**0.001**
	Inside	DOC200	795		2	1	3	**0.004**
	Inside	Snap trap	1274		1		1	**0.001**
Total			**12205**	**22**	**19**	**8**	**49**	**0.004**

Predator Tracking: Tracking cards baited with peanut butter were used to assess rodent and mongoose activity within the exclosures. They were deployed in 10 tracking tunnels within each exclosure on August 11 and again on October 10. The cards were pulled and checked for rodent activity after 24 hours, and re-deployed and checked for mongoose activity after 72 hours. There were no mongoose detections. Two cards in exclosure B showed rat activity in August. After 24 hours, 50% of the tracking cards in each exclosure had mouse tracks in August. In October, 50% in exclosure A and 30% in exclosure B had mouse activity.

Recommendations:

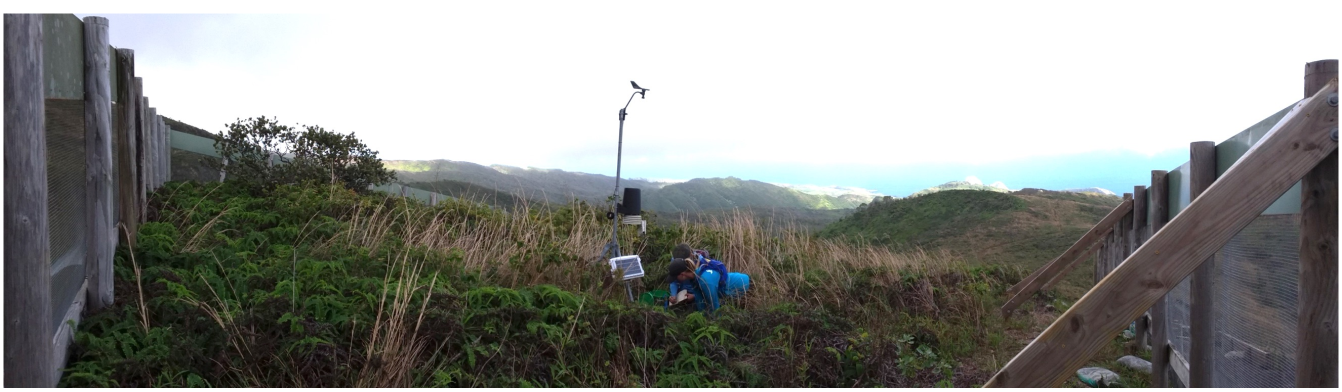
1. The most reliable game cameras for the close proximity and nature of the environment are the Reconyx HP2X. More cameras are needed to get as complete and accurate coverage of all active burrows as possible.
2. For the 2021 seabird breeding season, the call playback system in enclosure A, for NESH, should not be used. Evidence of established NESH site fidelity was provided inadvertently by no management of the enclosures until May of 2020 when the broadcast system was turned on. Documented NESH intra-species aggression may have been caused by the conflicting soundscape created by non-stop broadcast, at high volume, of aerial flight calls in the vicinity of breeding burrows. This aggressive behavior may also account for the eggs ejected from burrows and broken eggs.
3. For the 2021 seabird breeding season, the call playback system in enclosure B, for HAPE, should be modified by moving a speaker to the observation deck to provide elevation above the colony area. The aerial calls being broadcast should be played on the type of schedule that calls are made in a natural colony; shortly after sunset for 3 – 4 hours. After that speakers in the colony area should be programmed with HAPE ground calls. Additional speakers, already in inventory, should be deployed within the colony area.
4. Night surveys to more clearly document species attendance and behavior should be performed, especially in the early months of the breeding season. These surveys further the mitigation benefit by providing information about the flight behaviors of the HAPE

and targeting them for recruitment to the exclosure. Maui Nui Seabird Recovery Project has acquired an infrared illuminator and power supply (not Brookfield Renewables inventory) that will illuminate the entirety of the exclosure areas and the surrounding terrain visible from the observation deck in enclosure B. The project is willing to use this tool, with night vision goggles, to document where birds are coming to ground and the species composition of aerial display assemblages.

5. Nest box substrate should be modified to eliminate the sharp-edged rocks and large round river rocks (These may be responsible for egg breakage in previous years) from the nest bowl surface. This will require collection of the duff, vegetation, and other material present that may hold the odor of birds that have been in attendance in past years. This material will be bagged while the existing substrate is removed, drainage rocks placed, deeply enough to allow water to drain but not protrude to the nesting surface, and sand added to create a suitable nesting substrate. Odor holding material will then be returned to the nest box.
6. Predator control continue year-round, inside and outside of enclosures.
7. Vegetation control continue year-round.
8. Fence repair, stabilization, and maintenance continue year-round.

Makamakaʻole exclosure photo point panoramas; January 12, 2021


Exclosure A, entrance, photo point makai west


Exclosure A, photo point mauka west


Exclosure A, photo point makai east


Exclosure B, entrance, photo point makai east


Exclosure B, photo point mauka east


Exclosure B, platform, photo point mauka west

Supplemental data files available for agency review:

1. *iForm data files*
   - Makamakaole trapping
   - Makamakaole burrow checks
2. Burrow status and observations notes summary
3. *GIS shapefiles*
   - Updated exclosure boundaries
   - Updated speaker locations
   - Updated bait station locations
   - Updated trap locations
4. *Images*
   - Reconyx vs Moultrie burrow entrances and bird images
   - Burrow substrate images
5. *Game camera addendum report*

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Appendix 9. Planned Methods to Address Makamakaʻole Management Recommendations in 2021 Seabird Breeding Season

TETRA TECH

MEMO

To:	Lasha-Lynn Salbosa, USFWS Paul Radley, DOFAW
From:	Tetra Tech, Inc.
Date:	March 15, 2021
Correspondence #	TTCES-PTLD-2021-025
Subject:	Planned Methods to Address Makamakaʻole Management Recommendations in 2021 Seabird Breeding Season

Plan Overview

The Maui Nui Seabird Recovery Project (MNSRP) will continue managing Brookfield's mitigation efforts at Makamakaʻole in 2021, incorporating recommendations from the agency and independent expert informational meeting and Makamakaʻole project review (Informational Meeting) held via teleconference on December 2, 2020. The primary goals for the 2021 breeding season are to:

- Support continued increased visitation and breeding attempts by Newell's shearwaters at the colony
- Improve artificial burrow conditions to increase the potential for successful Newell's shearwater reproduction
- Modify the social attraction techniques to increase the probability of visitation by Hawaiian petrels and decrease the risk of inter- and intra-species antagonistic behaviors

Recommendations follow in italics with planned approach provided in bold.

Recommendations and Planned Activity

1. *Field Cameras*
    a. *Make sure these are set preferably at the hybrid option to capture both stills and video. Contact Pacific Rim for further ideas.*
    b. *Reconxy cameras are expensive. Bushnells are cheaper and Pacific Rim has found success in using them, since they are cheaper it is possible to get better coverage across the colony.*
    c. *Camera placing and settings are crucial. These are the best tools for confirming the presence of fledgling chicks.*

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Plan: Brookfield understands the value of cameras in documenting activity at the colony and will purchase additional cameras to improve documentation. The MNSRP will consult with outside experts as necessary to troubleshoot issues and ensure game camera documentation meets needs.

2. *Burrow Monitoring Frequency*
    a. *Need to conduct multiple burrow checks as the breeding season progresses. Makamakaʻole field site manager/workers should contact Kauaʻi Endangered Seabird Recovery Project (KESRP) and Pacific Rim to help develop a more refined monitoring schedule.*

Plan: MNSRP will monitor burrows for activity at approximately 2-week intervals, using burrow inspections or game cameras to identify newly occupied burrows. Game cameras will be deployed at active burrows to document the frequency of visits.

3. *Monitoring Data*
    a. *Monitoring Parameters*
        i. *Number of active burrows visited*
        ii. *Number of active nests*
        iii. *Number of fledglings*
    b. *Monitoring methods should clearly define what determines an active nest versus an active burrow that's being visited; and what indicates the presence of a fledgling and what does not. Monitoring frequency for any particular burrow may change depending on burrow status.*

Plan: MNSRP will provide supporting data consistent with reporting from the 2020 breeding season (MNSRP 2021) and will report summary statistics of key monitoring parameters consistent with those described in Raine et al. (2020).

4. *Substrate in Artificial Burrows*
    a. *Existing gravel and river rocks are much too hard of a surface and will only cause eggs to break.*
    b. *Collect any nest material present to preserve scent and replace substrate with gravel for drainage covered with sand. Makamakaole site managers should contact Pacific Rim for further details on what has worked in the past.*

Plan: MNSRP has coordinated with the Maui Natural Area Reserve System manager (Dr. Fern Duvall) and the Department of Land and Natural Resources Maui Forest Reserve manager (Lance DeSilva) to get approval for replacement of substrate in artificial burrows. MNSRP has replaced the top 2 inches of the 3/4 minus gravel with about 2 inches of sand within 94 artificial burrows as of March 3, 2021 and anticipates completing replacement in the final 6 burrows prior to the return of seabirds to Makamakaʻole. MNSRP used sand that was fresh,

washed, and free of weed seed. Nest material was collected using nitrile gloves, bagged, and then replaced in the burrow after the substrate replacement was completed.

5. *Social Attraction Playback Calls*
    a. *Discontinue playback calls for Newell's shearwater, since a colony has been established and their natural calls can be used.*
    b. *Makamaka`ole site managers to contact KESRP to obtain copies of Hawaiian petrel playback recordings of various behaviors to increase likelihood of Hawaiian petrel visitation.*
    c. *Move speakers to non-occupied burrows.*
    d. *Keep in mind, it is extremely rare to get aggressive behavior between species (HAPE and NESH), given the close proximity of colonies at other locations.*

Plan: MNSRP plans to adjust the social attraction element of the Makamaka'ole colony management in 2021 consistent with recommendations from the Informational Meeting. In 2021, it is expected that Newell's shearwater playbacks will not be used and new Hawaiian petrel recordings that incorporate petrel ground calls and flight calls will be incorporated into the playbacks at exclosure B. Although not expected, should burrow monitoring suggest a reduced level of visitation by Newell's shearwater in 2021 to exclosure A, Brookfield may reinstate Newell's shearwater playbacks in exclosure A to support the continued expansion of the Newell's shearwater colony. MNSRP has already acquired Hawaiian petrel playback recordings from KESRP which include ground calling petrels as well as petrel flight calls. A new speaker will be deployed at the observation platform in exclosure B to broadcast the aerial flight calls, while ground calls will be played in proximity to burrows.

6. *Barn Owl Control*
    a. *Recommend being very vigilant on barn owl control now.*
    b. *Inspect site for likelihood of pueo as that might determine what control tools can be used if and when barn owls are observed.*
    c. *Recommend the use of pole traps. These do not injure the owl; it holds the target animal until it can be dispatched the next day.*

Plan: MNSRP has a barn owl depredation permit through its affiliation with the University of Hawaii, and will implement control measures if evidence of barn owl predation is observed at Makamaka'ole. Regular site visits throughout the breeding season, should allow for prompt detection of barn owl predation. MNSRP staff have extensive experience identifying and responding to barn owl depredation at seabird colonies. Based on habitat and observations, it can be assumed that both pueo and barn owls are present in the vicinity. So, pole traps or

another suitable method that minimizes risk to non-target animals would be employed to manage barn owls.

References

MNSRP (Maui Nui Seabird Recovery Project). 2021. Makamakaʻole threatened and endangered seabird mitigation project: exclosures and artificial burrows annual summary report and supplemental data.

Raine, A. F., J. Rothe, S. Rossiter, and S. Driskill. 2020. Kauaʻi Endangered Seabird Recovery Project: monitoring of endangered seabirds. September 2020.

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