Kaheawa Wind Power
Habitat Conservation Plan
Annual Report: FY 2017

Kaheawa Wind Power, LLC
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Wailuku, Hawai`i 96768

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ITL 08 and ITP TE118901-0

I certify that to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate and complete.

Hawai'i HCP Manager
Terraform Power, LLC

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Executive Summary

Kaheawa Wind Power, LLC (KWPI) has been implementing a Habitat Conservation Plan (HCP) since approval in January 2006. The HCP supports the Federal Incidental Take Permit TE-118901-0 and State of Hawai'i Incidental Take License ITL-08. KWPI was commissioned to begin operating on June 22, 2006. Species covered under the HCP include the Hawaiian petrel (HAPE), Newell's shearwater (NESH), Hawaiian goose (nēnē), and Hawaiian hoary bat (bat). This report is for the State of Hawai'i fiscal year (FY) 2017, July 1, 2016 through June 30, 2017.

In FY 2017 the downed wildlife search area consisted of graded roads and wind turbine generator (WTG) graded pads found within a 70-meter radius circle centered on each turbine. Teresa Gajate has been contracted since October 2015 to conduct canine assisted searching. Staff HCP biologists visually searched when Ms. Gajate was not available. Visual searches were 12.4% of the all KWPI WTG searches in FY 2017. The search interval mean and standard deviation (SD) in days was 7.0 (SD = 0.49). The FY 2017 Quarter 1 (Q1) search area density weighted proportion (DWP) of the predicted total fall distribution for the nēnē, seabirds and bat is approximately 29.7%, 20.4% and 46.2%, respectively. The FY 2017 Q2-Q4 search area DWP is approximately 35.5%, 24.6% and 54.2% for the nēnē, seabirds and bat, respectively.

One bat fatality was observed within the search area during FY 2017. An adult nēnē and a second bat fatality were both found outside of or incidental to the search area. A nēnē gosling was also found dead within the search area but is not considered a take attributed to wind site operations. Twenty-two nēnē, seven HAPE, and nine bats have been observed within the search areas and included in the total take estimated since the permit period began in 2006. NESH have not been found at KWPI since operations began. The total estimated direct take at the 80% credibility level for KWPI HCP covered species is 34, 13 and 26 adults for the nēnē, HAPE and bat, respectively. Indirect take (IDT) converted to adult take is two, three, and five for the nēnē, HAPE and bat, respectively. Total estimated take therefore is 36, 16 and 31 for the nēnē, HAPE and bat, respectively. Lost future productivity as fledglings accrued for HAPE and nēnē is 8.8 and 1.78, respectively. Thirty-two nēnē fledglings have been produced at the Haleakala Ranch pen through FY 2016. These 32 fledglings have accounted for all nēnē lost productivity through FY 2016. Nēnē fledgling production in 2017 has not yet been determined.

Independent contractor Kristin Mack has conducted searcher efficiency (SEEF) trials at KWPI since October 2015. The SEEF results for large, medium, and small size carcasses was 100% (N = 11), 100% (N = 12), 88.1% (N = 42), respectively. Five 28-day carcass retention (CARE) trials used five large, five medium, and 25 small size carcasses. The CARE mean and standard deviation (SD) in days for large, medium, and small carcasses were 28.0 (SD = 0), 28.0 (SD = 0) and 20.4 (SD = 9.10), respectively.

Wildlife Acoustics SM2BAT+™ bat detectors with one SMX-U1™ microphone each recorded nightly bat detections at all nine WTG associated ground locations at KWPI during 5.1% of total detector nights (150 of 2917). Wildlife Acoustics SM3BAT™ bat detectors with one SMU-U1™ microphone each recorded detections 68 meters above ground at all seven WTG nacelle associated locations at KWPI during 7.3% of total detector nights (153 of 2091). Bats were detected in every month of the year with peaks in May, August and September near the ground and April, August and September at nacelle height.

A total of 17 site personnel received Wildlife Education and Observation Program trainings in FY 2017.

Vegetation management of the search plots at KWPI for FY 2017 treated 28.3 acres of total search plot area using hand-held weed whackers and herbicide.

Seabird mitigation for baseline estimated take continues at the Makamaka'ole seabird enclosures and includes trapping and monitoring for potential predators, maintenance of enclosure fences, erosion control and monitoring seabird activity within the Makamaka'ole Stream drainage area and near artificial burrows within the enclosures. HCP required alternative seabird mitigation site surveys in East Maui were completed in FY 2016. Additional HAPE nesting colony assessment and predator control on Lāna'i Island has been funded and arranged with the USFWS and Pūlama Lāna'i to mitigate for the loss of productivity accrued from HAPE

estimated take not yet mitigated for. Nēnē mitigation contracted to DOFAW for baseline estimated take continued at the Haleakala Ranch nēnē pen. Mitigation for baseline estimated bat take was completed in 2008. Mitigation for higher estimated bat take has begun to be funded in FY 2017 quarter 2 and is bat ecological research intended to better inform future bat habitat restoration and conservation.

KWPI provided abbreviated quarterly summary reports for FY 2017 quarters 1-3 and met periodically with USFWS and DOFAW. The Endangered Species Recovery Committee reviewed the FY 2016 annual HCP report on November 1-2, 2016.

Introduction

In June 2006 Kaheawa Wind Power, LLC (KWPI) began operating the island of Maui's first commercial wind energy generation facility in the Kaheawa Pastures area of West Maui. The State Board of Land and Natural Resources approved a Conservation District Use Permit (CDUP) for the facility, which is situated on state conservation lands, in January 2003.

In fulfillment of the Endangered Species Act and Chapter 195-D, Hawai`i Revised Statutes, KWPI developed a project-specific Habitat Conservation Plan (HCP) in cooperation with the U.S Fish and Wildlife Service (USFWS), the Department of Land and Natural Resources- Division of Forestry and Wildlife (DOFAW) ("the agencies") and the Hawai`i Endangered Species Recovery Committee (ESRC). Upon final approval of the HCP, the federal Incidental Take Permit (ITP #TE-118901-0) and state Incidental Take License (ITL# 08) were issued in January 2006, each with a duration of twenty years. The ITP and ITL cover four federally-listed and endangered species: the Hawaiian petrel or 'ua'u or HAPE (*Pterodroma sandwichensis*), Newell's shearwater or 'a'o or NESH (*Puffinus newelli*), Hawaiian goose or nēnē (*Branta sandvicensis*), and the Hawaiian hoary bat or 'ope'ape'a or bat (*Lasiurus cinereus semotus*).

KWPI has previously submitted annual HCP progress reports for FY 2007 through FY 2016 to the agencies (Kaheawa Wind Power 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015 and 2016). This report summarizes HCP related activities for KWPI during the State of Hawai`i fiscal year (FY) 2017 (July 1, 2016 through June 30, 2017).

Downed Wildlife Monitoring

KWPI biologists have implemented a year-round intensive monitoring program to document downed (i.e., injured or dead) wildlife incidents on the project site involving HCP-listed and non-listed species since operations began June 2006. Fatality monitoring plots were reduced in area on October 1, 2010, after receiving approval from the agencies, from the initial intensive weekly monitoring on 180 meter (m) by 200m plots centered on each wind turbine generator (WTG) to 73m circular plots centered on each WTG, except where steep slopes prohibited visual searching. At the March 31, 2015 ESRC meeting, after review of monitoring data for KWPI, 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".

Beginning in April 2015 with agreement from the agencies, the area searched weekly included only the graded roads and WTG pads found within a 70m radius circle centered on each WTG (Figure 1). Beginning October 1, 2016 (FY 2017 quarter (Q) 2) the search areas were expanded around specific WTGs where possible by increasing vegetation management of non-native grasses in the vegetation surrounding the WTGs. This expansion occurred only at WTGs 5, 6, 14, 15, 16, and 17 and increased total search area for all KWPI WTGs by 21% (from 16.9 acres to 20.5 acres).

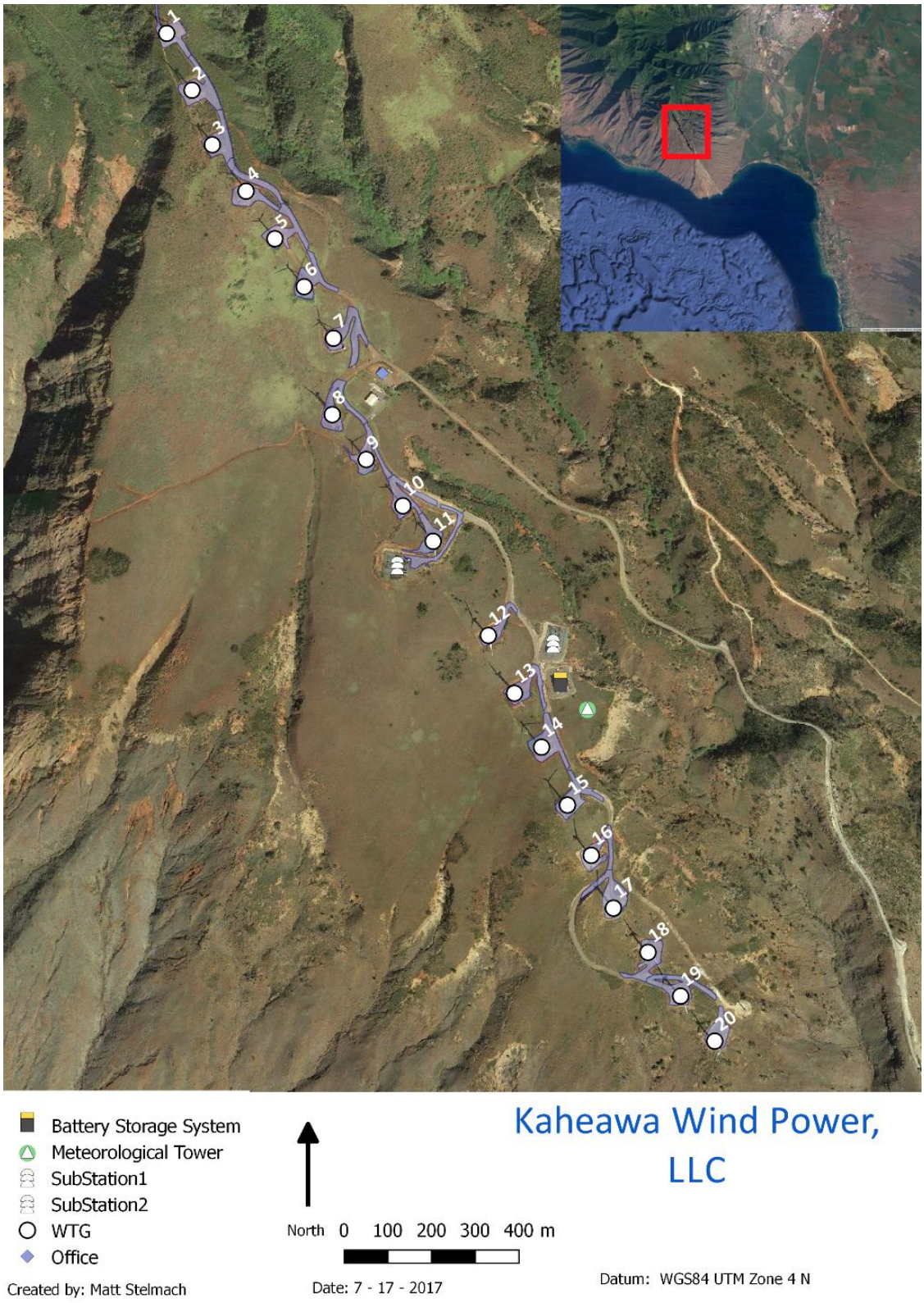

Figure 1. KWPI WTG, building and site utility locations.

Search Area Density Weighted Proportion of the Predicted Fall Distribution

The density weighted proportion (DWP) of the predicted total fall distribution is one of the measured variables used to estimate the total take for each HCP listed species (see Estimated Adjusted Take). The DWP has also been called the density weighted area (DWA). The FY 2017 Q1 search area DWP of the predicted total fall distribution for the nēnē, seabirds and bat is approximately 29.7%, 20.4% and 46.2%, respectively. The FY 2017 Q2-Q4 search area DWP is approximately 35.5%, 24.6% and 54.2% for the nēnē, seabirds and bat, respectively (Appendix 1).

More birds or bats are expected to and do fall closer to the WTG and the distribution of fatalities is not uniform, becoming less dense per acre as distance increases from the WTG. To determine the DWP as distance increases the 70m circle around the WTG is divided into six circular adjacent bands and the 71-100m area into three 10m bands. The first, closest band encompasses the area from the WTG out to 20m radius and each band farther from the WTG has a 10m radius. The total area in square meters is calculated for each band. The portion of the total area in each band that was searched (roads and pads) was determined using ARCGIS (Appendix 1). The product of the portion of area searched per band and the predicted fatality distribution per band are determined for each band for each carcass size class (large, medium and small) and the results summed for all bands to derive the DWP of the entire fall distribution of each carcass size class searched (Appendix 1). The fall distribution is assumed to be uniform around the turbine.

Nēnē

The DWP of the predicted total fall distribution was calculated for all observed nēnē fatalities from turbine strikes at KWP I and KWP II that fell within the search area between each WTG and out to a 70m radius. The DWP between 0 and 70m radius was based on 27 observed nēnē. To account for hypothetical takes that would have been expected, based on the ballistics modelling of Hull and Muir (2012) for large birds around “small” turbines, but not observed, six individuals (22% of the observed nēnē) were added to create the fall distribution between 70m and 100m. The KWP I and KWP II nacelle heights are 68m and 72m, respectively, and the maximum height of the rotor swept zones are 90m and 100m, respectively. These are considered small turbines per Hull and Muir (2012). Since the heights at KWPI and KWPII are similar, all the observed nēnē take from both sites has been used in creating the observed fall distribution.

A 70m circle centered on each WTG therefore is modeled to include approximately 81.8% of all nēnē carcasses expected to fall from turbine strikes (Figure 2). The reduced search area of graded roads and pads within 70m is estimated to encompass 29.7% and 35.5% of all nēnē fatalities that could occur during FY 2017 Q1 and FY 2017 Q2-Q4, respectively (Appendix 1).

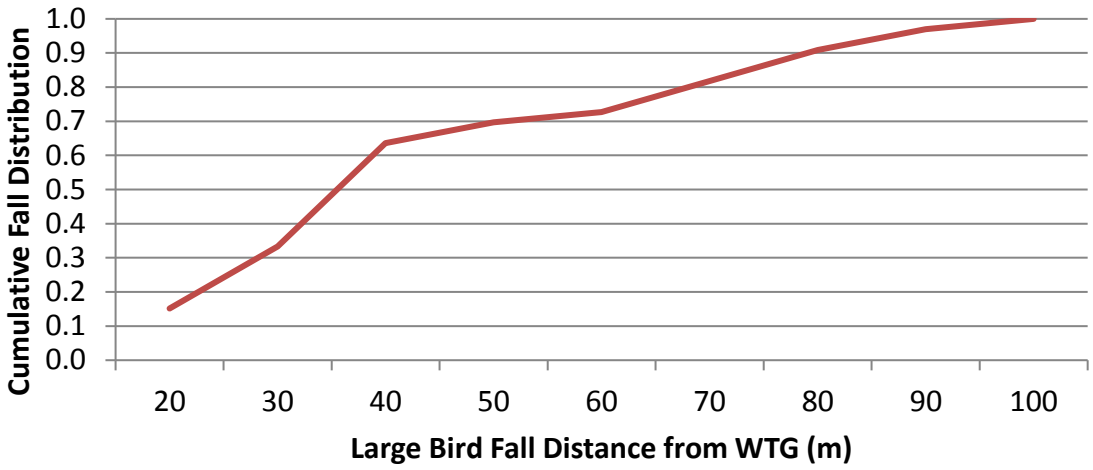

Figure 2. The cumulative fall distribution of nēnē struck by distance from WTG.

Hawaiian Petrel and Newell's Shearwater

The DWP of the predicted total fall distribution was calculated for all observed seabird fatalities from turbine strikes at KWP I and KWP II that fell within the search area between each WTG and out to a 70m radius. The DWP between 0 and 70m radius was based on 27 observed seabirds (HAPE, white-tailed tropicbirds and WTSH). To account for hypothetical takes that would have been expected, based on the ballistics modelling of Hull and Muir (2012) for medium birds around "small" turbines, but not observed, six individuals (22% of the observed seabirds) were added to create the fall distribution between 70m and 100m.

A 70m circle centered on each WTG therefore is therefore modeled to include approximately 81.8% of all seabird carcasses expected to fall from turbine strikes (Figure 3). The reduced search area of graded roads and pads within 70m is estimated to encompass 20.4% and 24.6% of all seabird fatalities that could occur during FY 2017 Q1 and FY 2017 Q2-Q4, respectively (Appendix 1).

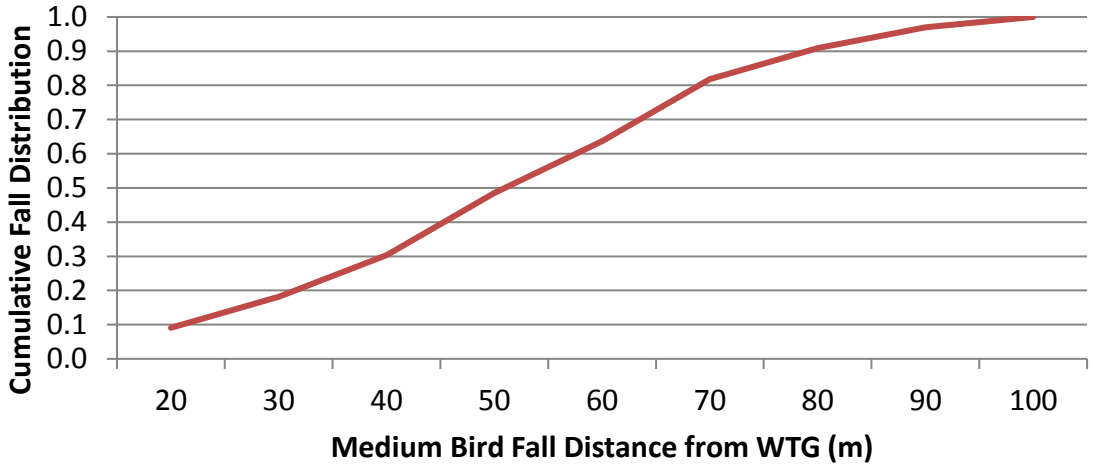

Figure 3. The cumulative fall distribution of HAPE struck by distance from WTG.

Hawaiian Hoary Bat

The DWP of the predicted total fall distribution was calculated using all bat fatalities (13 observed) from turbine strikes at KWP I and KWP II that fell within the search area out to a 70m radius circle. Hull and Muir (2012) modelled that no (or very few) bats fell beyond 50m.

A 70m radius circle centered on each WTG therefore is modeled to include 100% of all bat carcasses expected to fall from turbine strikes (Figure 4). The reduced search area of graded roads and WTG graded pads found within the 70m radius circle is estimated to encompass 46.2% and 54.2% of the predicted total fall distribution for all bat fatalities during FY 2017 Q1 and FY 2017 Q2-Q4, respectively (Appendix 1).

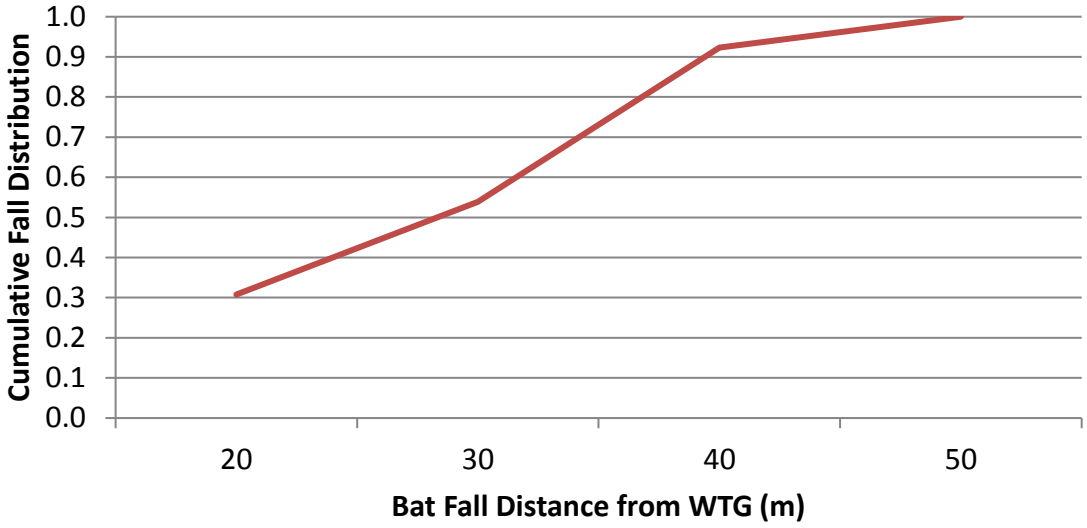

Figure 4. The cumulative fall distribution of bats struck by distance from WTG.

Search Interval

The search interval mean and standard deviation (SD) in days for KWPI downed wildlife monitoring was 7.0 (SD = 0.49) (Table 1 and Appendix 2). For the safety of the HCP staff, monitoring is halted during periods when wind speeds are reported higher than 15 meters per second (m/s). During FY 2017 no monitoring schedule interruptions occurred.

Teresa Gajate and her canine Makalani provided canine-assisted searching in FY 2017. Canine-assisted searching was the primary search method, with visual searching by HCP staff when canine- assisted searching was not available. In FY 2017 87.6% (N = 916) of WTG searches were canine-assisted and 12.4% (N = 130) were visual (Appendix 3).

Table 1. Search interval mean and standard deviation (SD) in days per WTG plot at KWPI during FY 2017.

WTG	1	2	3	4	5	6	7	8	9	10
Mean	7.00	7.00	7.00	7.00	7.00	7.02	7.00	7.00	7.00	7.00
SD	0.49	0.44	0.52	0.52	0.56	0.58	0.49	0.44	0.56	0.44
WTG	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Mean	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
SD	0.44	0.52	0.44	0.52	0.49	0.49	0.52	0.49	0.40	0.44

Mean TOTAL	**7.00**
SD TOTAL	**0.49**

Canine Interactions with Wildlife

Special precautions have been taken to eliminate any potential canine interaction with wildlife. The handler has been directed to immediately retrieve Makalani if nēnē were observed and to temporarily skip searching WTGs if nēnē were present within the WTG search area or vicinity. Skipped WTGs were preferentially searched later the same day or the next day with either canine assistance or visual search. Canine searches were postponed or skipped in favor of visual searches if nēnē were present at the turbine or if WTG repairs were necessary. Nēnē presence halted 0.5% (five) of WTG searches. No canine wildlife interactions were observed.

Downed Wildlife Incidents

Four incidents involved HCP-covered species: two Hawaiian hoary bats and two Hawaiian geese. Four incidents involved Migratory Species Treaty Act (MBTA) protected species: one house finch and three Hawaiian short-eared owls (also a Hawai`i state "species of concern"). One bat fatality was observed during FY 2017 inside the search area, with an adult nēnē and a second bat fatality both found outside of or incidental to the search area. A nēnē gosling was also found dead within the search area but is not considered a take attributed to wind site operations. Table 2 summarizes all downed wildlife incidents documented at KWPI during FY 2017 including non-listed species incidents. Figure 5 displays locations of fatalities in relation to nearest WTGs and site facilities. All incidents were reported to the agencies within 24 hours and downed wildlife incident reports submitted within three days of each discovery. The total take observed within search areas through FY 2017 for each HCP covered species is 22 nēnē, seven HAPE, nine bats and no NESH. In addition to fatalities observed within the search area, two nēnē and one bat were observed outside of the search area through FY 2017.

Table 2. Downed wildlife incidents at KWPI during FY 2017.

Common Name	Discovery Date	WTG	Distance to Nearest Structure (m)
Endangered and MBTA Species			
Hawaiian Hoary Bat	8/30/2016	9	23
Hawaiian Hoary Bat*	11/21/2016	18	19
Hawaiian Goose**	4/18/2017	5	20
Hawaiian Goose*	5/30/2017	9	65
House Finch	8/23/2016	4	13
Hawaiian Short-eared Owl*	11/21/2016	14	34
Hawaiian Short-eared Owl*	5/2/2017	16	40
Hawaiian Short-eared Owl	6/20/2017	15	25
Non-Listed Species			
Rock Pigeon	7/27/2016	19	4
Gray Francolin	11/21/2016	10	25
Black Francolin	12/19/2016	20	25
Common Myna	2/9/2017	8	36
Gray Francolin	3/13/2017	20	1
Ring-Necked Pheasant	3/27/2017	16	1
Spotted Dove	3/30/2017	6	2
Common Myna*	4/24/2017	13	90
Ring-Necked Pheasant	4/25/2017	16	1
Nutmeg Mannikin	4/27/2017	Other	0
Gray Francolin	5/16/2017	10	45
Gray Francolin	5/16/2017	11	30
Gray Francolin*	5/30/2017	10	25

*Downed wildlife found outside of the search area
**Gosling take not attributed to wind site operations

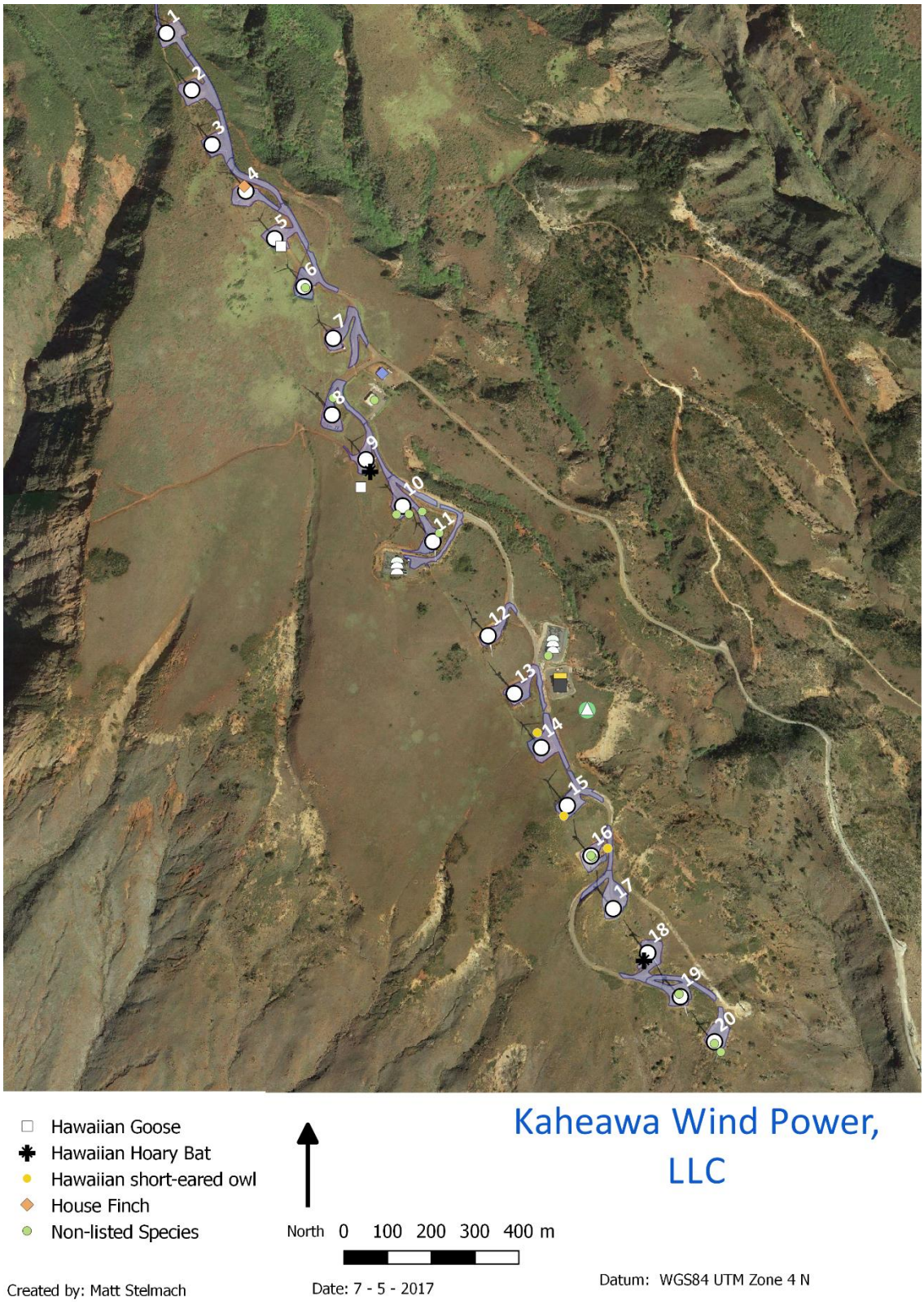

Figure 5. All downed wildlife observed during FY 2017 at KWPI in relation to WTGs.

Searcher Efficiency Trials

In FY 2017, independent contractor Kristin Mack (the SEEF proctor) conducted searcher efficiency (SEEF) trials. The SEEF proctor used randomly selected points within the reduced search area for SEEF locations. The schedule for placing carcasses was pre-determined for each week and unavailable to HCP staff and the canine handler. HCP staff would inform the SEEF proctor of the planned weekly search schedule to ensure SEEFs were put out for scheduled search days. At the end of each search day HCP staff would communicate to the SEEF proctor what was found. If any SEEF carcasses were missed a different HCP staff member (typically the HCP manager) would attempt to recover the carcass and report to the SEEF proctor if the carcass was still present. If the carcass was not found that carcass trial would be considered lost and not included in SEEF results.

For KWPI SEEF trials 65 total carcasses were placed and recovered; 42 small size (rats), 12 medium size (wedge-tailed shearwaters (WTSHs)), and 11 large size (chickens) (Appendix 4). Large, medium and small SEEF results were 100%, 100% and 88.1%, respectively (Table 3). Ten of 65 SEEF trials (15.4%) occurred during visual searches (Table 4).

Table 3. SEEF results for KWPI during FY 2017.

Carcass Size	Result	Trials
Large	100.0%	11
Medium	100.0%	12
Small	88.1%	42

Table 4. SEEF by carcass size and search type for KWPI during FY 2017.

Search Type	Carcass Size	Trials	Result
Visual	Large	3	100.0%
	Medium	1	100.0%
	Small	6	50.0%
Canine-assisted	Large	8	100.0%
	Medium	11	100.0%
	Small	36	94.4%

Carcass Retention Trials

Carcass retention (CARE) trials are used to estimate how long a carcass remains detectable to searchers before complete removal or obscuring by scavengers or weather conditions (wind blowing a carcass out of a search area). Trials proctored were conducted using Rhode Island Red crossed chickens as surrogates for nēnē, WTSHs for HAPE and NESH, and commercially produced rats for bats. The chickens were from Maui farmers. WTSH carcasses were fledglings and adults found dead by the public and delivered to Sea Life Park on Oahu or

collected by DOFAW on Maui. Rat carcasses were purchased from Layne Laboratories, Inc. in California, a pet food company. These rats are brown and/or black and are the Layne Laboratory "Small Colored" size category (approximately 11.4 cm in body length not including the tail) and have been chosen to mimic the body size of Hawaiian hoary bats. The HCP listed species are not available to use in CARE trials. Our state and federal wildlife collection permits for WTSH use for KWPI are numbers WL 15-05 and MB24151B-0, respectively, through 2016, and WL18-09 and MB22098C-0, respectively, during 2017. Any take of MBTA species is also reported annually through these permits.

During FY 2017, CARE trials used five large size (chickens), five medium size (WTSHs), and 25 small size (rats) carcasses (Appendix 5). All trials were for 28 days. The CARE mean and SD for each surrogate in days were 28.0 for large (SD = 0), 28.0 for medium (SD = 0) and 20.4 for small (SD = 9.1) (Table 5).

Table 5. Carcass retention trial results at KWPI during FY 2017.

Carcass Size	Count	Mean Retention (days)	SD (days)
Large	5	28	0
Medium	5	28	0
Small	25	20.4	9.1

Scavenger Trapping

We initiated scavenger trapping near the WTGs in August 2015. Trapping in FY 2017 included 12 DOC200™ or DOC250™ body grip kill traps and eight cage live traps (Figure 6). During FY 2017, 50 mongooses, and six rats were caught using the approved trapping protocol and monitoring frequency (Table 6).

Trapping is intended to decrease scavenging and therefore maximize the opportunity to find any downed wildlife and prolong CARE trial persistence and may improve nēnē fledgling survival and nesting success. All traps were designed to minimize inadvertent interaction with nēnē. One black francolin was trapped inside a cage trap and apparently died of exposure. One common myna was killed in a DOC200™.

Table 6. KWPI trapping and monitoring protocol.

Trap Type	Species Targeted	Monitoring Frequency	Frequency of Baiting/Re-setting	Frequency of Cleaning and Re-locating
DOC	Mongoose, Rat	Weekly	Weekly	Minimum 1x per 3 months
Cage	Cat, Mongoose	24 Hours	2-7 Days	Minimum 1x per 3 months

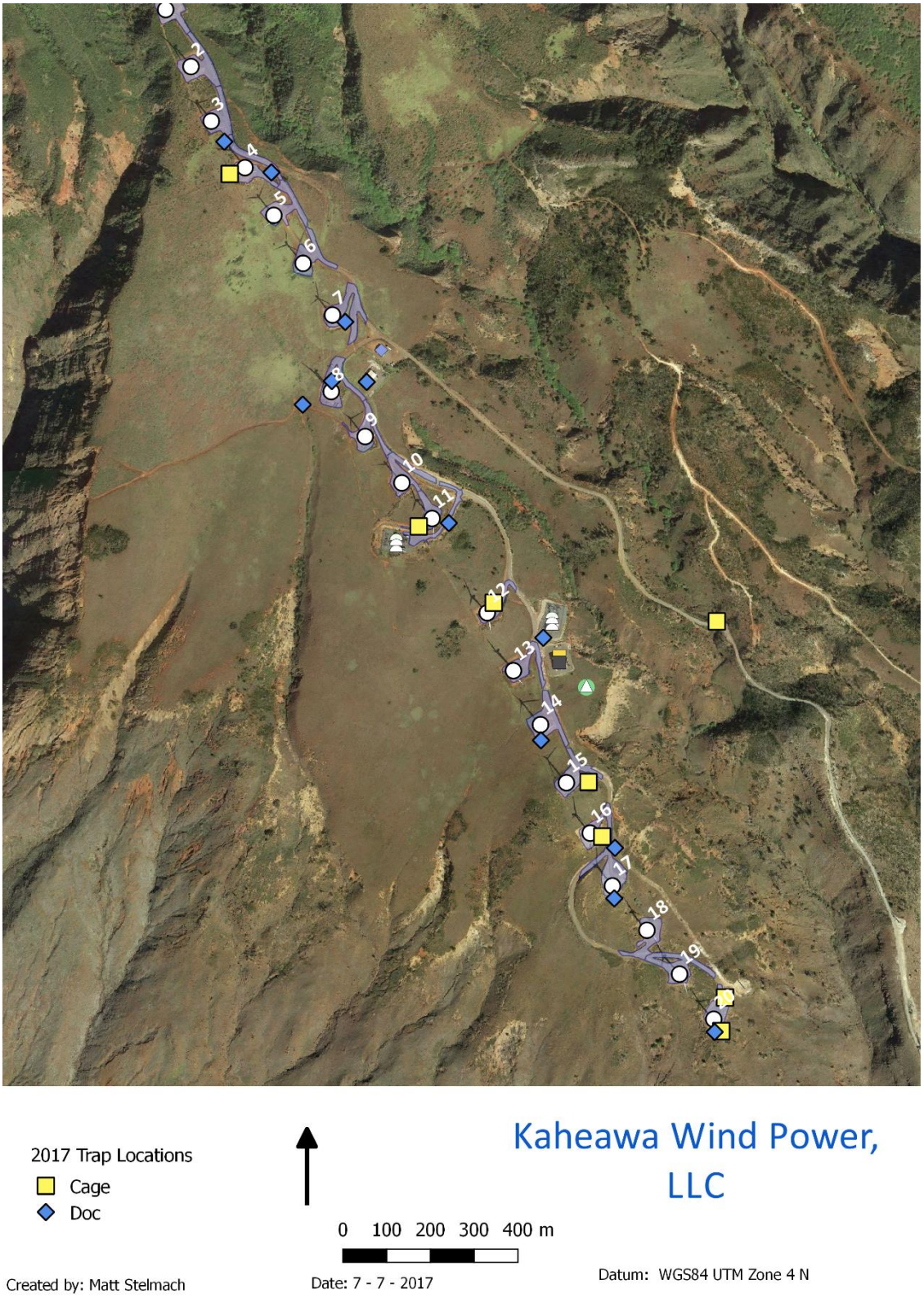

Figure 6. Location of KWPI predator traps.

Estimating Adjusted Take

The estimators used in this report were developed by the USGS (Huso *et al.* 2015 and Dalthorp *et al.* 2017) and have been recommended by the agencies. The USGS Evidence of Absence estimator's output is a value that represents the number of fatalities that has not likely been exceeded during the survey period. Values can be generated for varying levels of "credibility" (confidence) and expressed as a percentage (e.g., 50%, 80%, etc.). The higher the desired level of credibility the more conservative (higher) the estimated value. At the request of the agencies, the more conservative 80% credibility level is reported.

A stipulation of the estimator model is that only fatalities observed within the designated search area are included in the take estimation. Fatalities observed outside of the designated search area or incidental to searches are considered in the estimation calculation to have already been represented in the un-searched portion of the total expected fatality distribution.

Of the HCP covered species two nēnē and two bat fatalities were observed during FY 2017. One bat fatality was observed inside the search area and an adult nēnē and a second bat fatality were both found outside of or incidental to the search area. A nēnē gosling was also found within the search area but is not considered a take attributed to wind site operations.

The total estimated direct take at the 80% credibility level for KWPI HCP species is 35, 13 and 26 adults for nēnē, HAPE and bat, respectively (Appendix 6, 7 and 8). Observed direct take (ODT) is the only take that has been documented and confirmed at the site. However, for the purposes of estimating potential take for permitting and mitigation, the Evidence of Absence estimator calculates additional take that may have occurred but that was not observed. This unobserved direct take (UDT) attempts to account for fatalities that may have fallen outside of search plots, were missed by searchers within search plots, or were removed by scavengers or environmental factors such as high winds.

In addition to ODT and UDT, indirect take (IDT) is estimated separately for ODT and UDT and is the possible or known take of offspring that have been negatively affected by the direct take of their parents. Both parents of nēnē and the seabird species exhibit equal responsibility for care of young until fledging while only the female bat cares for their offspring. All four HCP covered species have seasonal breeding periods as described in the KWPI HCP and the point during the breeding season when an adult is taken determines to what extent the offspring is affected (i.e. the chance of survival of an offspring without one or both parents may vary).

IDT for nēnē and HAPE are detailed in Appendix 9 and 10 and depends on what time of year the adult take was observed. Total IDT (for ODT and UDT) for nēnē and for HAPE is 2.15 and 9.56 fledglings, respectively (Appendix 9 and 10). IDT converted to adult take for nēnē is two (rounded up, 2.15 x 0.512 = 1.10), and assumes three years from fledging to adulthood at an annual survival rate of 0.8 (0.512 after three years). IDT converted to adult take for HAPE is three, rounded up (9.56 x 0.3 = 2.87), and assumes five years from fledging to adulthood and a 0.3 survival rate from fledgling to adult.

The total estimated nēnē take (direct plus indirect take) at the 80% credibility level is not more than 37 adults. Baseline take level according to the KWPI HCP is 60 nēnē. Thirty-seven nēnē is 62% of the baseline take level. The total estimated HAPE take at the 80% credibility level is not more than 16 adults. Baseline take level is 25 individuals. Sixteen HAPE is 64% of the baseline take level.

Accrued lost productivity as fledglings for nēnē is 0 assuming at least one fledgling was produced in 2017 (Appendix 9) and for HAPE is 8.8 (Appendix 10). Accrued lost productivity for a given year is determined by adding adult estimated take accumulated from all previous years (not yet mitigated for) and multiplying that adult total by 0.1 for nēnē and 0.15 for HAPE as proscribed in the KWPI HCP. Each year's lost productivity is accumulated until estimated adult take is mitigated for.

Thirty-two nēnē fledglings have been produced from KWPI funded mitigation at the Haleakala Ranch pen through FY 2016. Nēnē lost productivity and total indirect take through FY 2016 is completely accounted for

with these 32 fledglings. If all lost productivity and indirect take are accounted for by the number fledglings produced in each year, then the remaining fledgling "surplus" will be considered to survive to adult age three years later at a rate of 0.8 per year (0.512 for three years). The adults survived from the surplus fledglings then reduces each current year's adult estimated take and reduces the subsequent lost productivity that will accrue from that adult estimated take. The six nēnē fatalities that were observed at KWPI before calendar year 2011 are not included in the lost productivity assessment (May 20, 2014 agency meeting notes) since the pen intended for mitigation was not available to introduce nēnē goslings prior to 2011. DOFAW has not yet determined nēnē fledgling production for FY 2017. Once determined accrued lost productivity will be reassessed.

IDT estimated from bat ODT is calculated for adult female bats or bats of unknown sex (conservatively assumed to be female), found between April 1 and September 15, the bat breeding season designated by the agencies. Any ODT of adult female or sex unknown bats found during the breeding season are assumed to have dependent young and a loss of 1.8 juveniles is calculated per female or unknown sex ODT (2 pups per female X 0.9 survival rate to weaning per pup = 1.8 juveniles). For KWPI two female bats and four bats whose sex has not yet been determined were observed during the breeding period through FY 2017. Thus, the IDT from the six ODT found during the breeding season would 10.8 juveniles (6 x 1.8 = 10.8). The sex of all bats found during the breeding period will be determined in FY 2018 and IDT from ODT recalculated.

IDT estimated from bat UDT assumes 50% of the UDT would be female and that for each female there is an average probability that she would be pregnant or lactating for three months in a year. Bats fly through the project area throughout the year and the probability of an individual female bat having dependent young during a 12-month period is assumed to be 25% (three out of 12 months). The average period of dependence is determined considering that Hawaiian hoary bats have one brood a year, and that hoary bats in North America have an average 56-day gestation period followed by parental care to weaning averaging 34 days or approximately three months for gestation and parental care (Hayssen *et al* 1993, Hayes and Wiles 2013, and NatureServe 2015 for *Lasiuris cinereus*). There is not enough information for hoary bats from Hawai`i to determine the gestation and pre-weaning dependent period. Consequently, IDT is assessed to bats lost from female UDT at the rate of 0.225 juveniles/adult female bat (0.5 x 0.25 x 1.8 = 0.225). The IDT for the UDT considering the 80% credibility level is 3.8 juveniles (26 estimated – 9 observed = 17 unobserved x 0.225 = 3.8) (Appendix 11).

The estimated rate of survival of young to reproductive age (the next year after birth) assumed from available data is 0.30 (extrapolated from little and big brown bats (*Myotis lucifugus* and *Eptesicus fuscus*; Humphrey 1982, Humphrey and Cope 1976). Bat total IDT of 14.6 (10.8 + 3.8 = 14.6) converts to 4.4 or five adults, rounded up (14.6 x 0.3 = 4.4) (Appendix 11). The total estimated bat take at the 80% credibility level is not more than 31 adults. The baseline take limit of 20 bats has been mitigated for. The higher take limit (and total permitted take) is 50 bats or 30 more than the baseline take limit. Eleven bats more than the baseline level of 20 bats (31-20 = 11) is 37% of the higher take limit of 30 bats (11/30 = 0.37).

Hawaiian Hoary Bat Monitoring

To better understand variations in bat activity specifically near the ground close to the WTGs, we have operated nine Wildlife Acoustics SM2BAT+™ ultrasonic bat detectors with one SMX-U1™ microphone (mic) since October 2013 throughout KWPI. Prior to October 2013 Titley Anabat™ detectors had been deployed around the site near WTGs beginning in 2008 (KWP 2013). The detector mics are mounted at 6.5 meters' height. Eight are placed near the WTGs and one is placed near a gulch edge; each mic is positioned horizontally, pointing SW (away from the prevailing NE trade winds).

In addition to the ground units, seven Wildlife Acoustics SM3BAT™ ultrasonic bat detectors were deployed in January 2015 on nacelles equipped with one SMM-U1™ mic pointing backwards from the blades

and parallel to the top of the nacelle. The SMX-U1 and the SMM-U1 mics are the same except that each is physically configured differently to fit the two different bat detector types. These seven nacelle detectors were deployed as an adaptive management measure to better understand bat activity patterns.

In FY 2017 bats were detected in every month of the year with peaks in May, August and September near the ground and April, August and September at nacelle height (Figures 7). Detectors recorded bat activity at all nine ground locations during 5.1% of detector nights (150 of 2917) (Figure 8) and at all seven detectors at nacelle height during 7.3% of detector nights (153 of 2091) (Table 7, Figure 8).

Table 7. Hawaiian hoary bat nights with detections and total detection nights at KWPI in FY 2017.

Detector Location (WTG)	Total Detector Nights	Total Detector Nights with Activity	% Total Detector Nights with Activity
Ground Detectors			
1	280	9	3.2%
3 (Gulch)	357	1	0.3%
5	328	12	3.7%
8	348	33	9.5%
10	359	32	8.9%
13	358	15	4.2%
15	276	25	9.1%
16	358	6	1.7%
20	253	17	6.7%
Totals	**2917**	**150**	**5.1%**
Nacelle Detectors			
1	307	14	4.6%
4	292	25	8.6%
6	282	22	7.8%
9	307	3	1.0%
13	300	24	8.0%
16	347	44	12.7%
20	256	21	8.2%
Totals	**2091**	**153**	**7.3%**

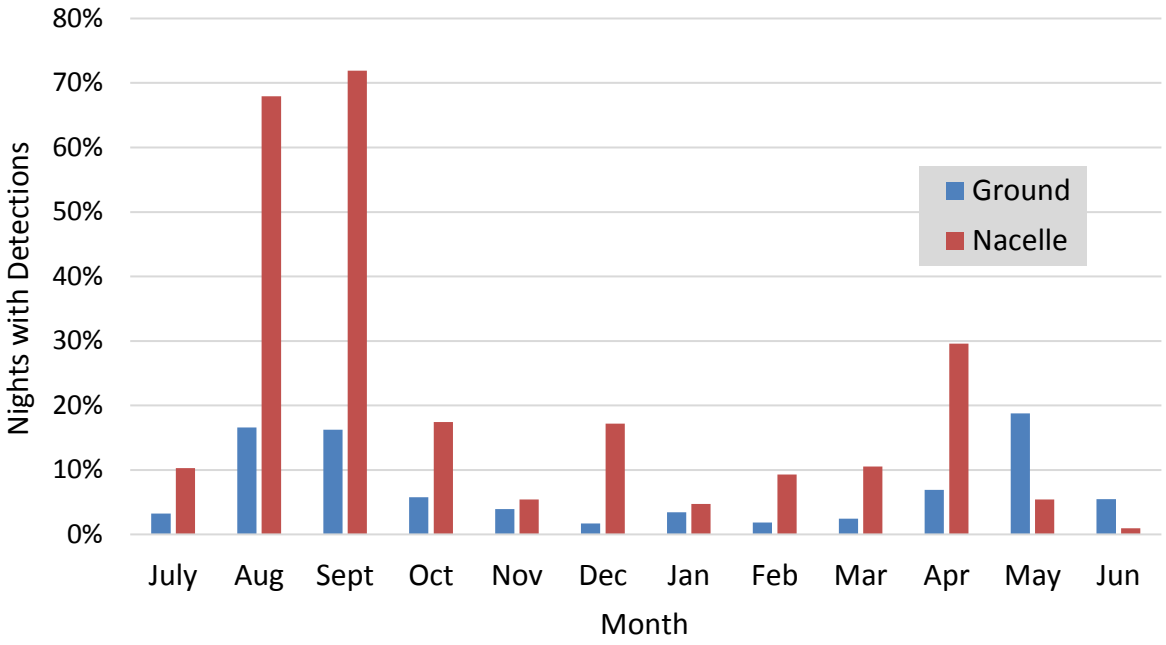

Figure 7. Bat nightly presence at KWPI by month in FY 2017.

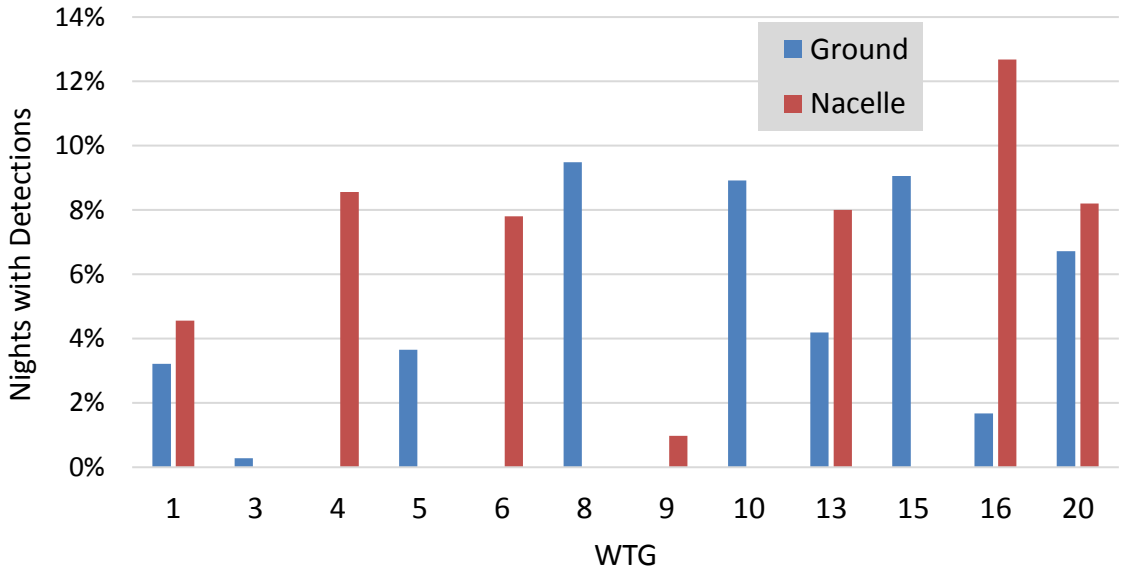

Figure 8. Bat nightly presence at KWPI by WTG during FY 2017 (these locations range from the highest elevation on the left (WTG 1) to the lowest on the right (WTG 20)). WTG 1, 13, 16 and 20 have both ground and nacelle detectors.

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, CDUP, land use agreements and applicable laws. 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 given to 17 personnel who were on-site regularly for two days or more (Appendix 12). The personnel were trained to identify covered and non-covered species of wildlife that may be found on-site and what protocol to follow, as determined in the HCP, when a downed wildlife is found. The trainees were also made aware of driving conditions and received instruction on how to drive and act around wildlife.

A total of 65 wildlife observations have been reported during FY 2017 at KWPI, including 96 Hawaiian geese, 19 Hawaiian short-eared owls, seven white-tailed tropicbirds, and 23 cattle egrets (Figures 9 and 10). There was an influx of cattle egrets to the site in March 2017. Data collected was used to better protect and understand HCP species and their habitat use.

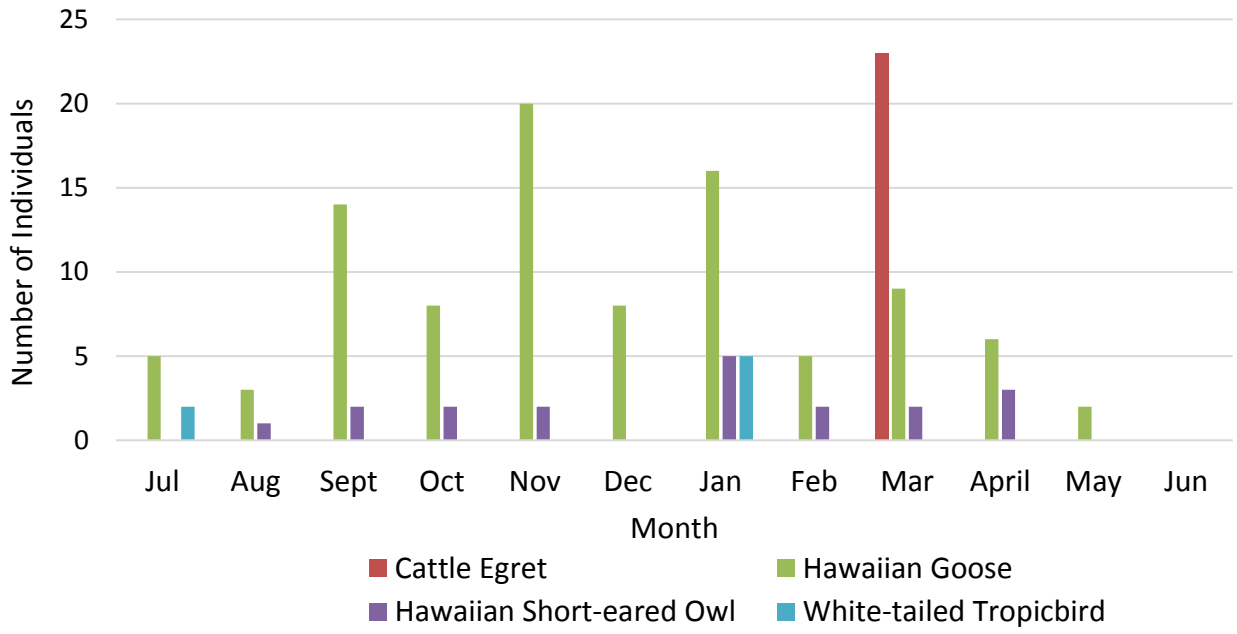

Figure 9. Wildlife observed as part of WEOP by month at KWPI during FY 2017.

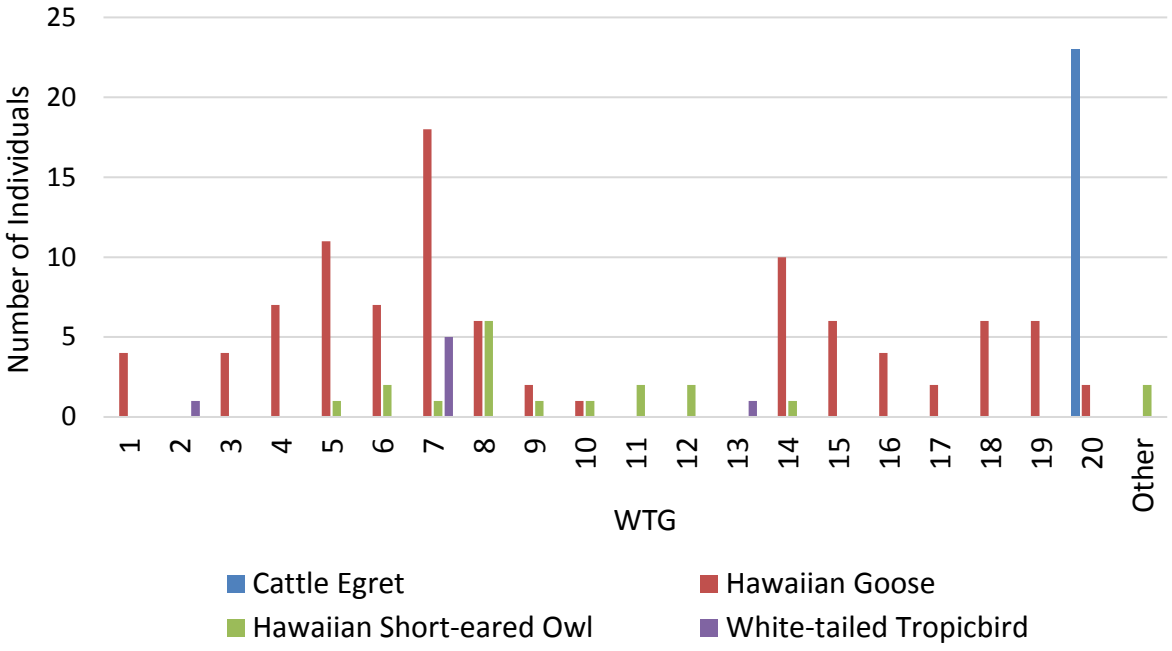

Figure 10. Wildlife observations by turbine at KWPI during FY 2017.

Vegetation Management

The HCP team manages ground cover at a low stature that will improve monitoring efficiency and minimize impacts to native plants without compromising soil stability. An overall site vegetation management plan was approved via letter from DOFAW dated November 15, 2010. Prior to 2010 no vegetation management was authorized. Nēnē nesting season restricts vegetation management activities within the search plots to only occur from April 1 through October 31. In November 2016, Stephanie Franklin of DOFAW-Maui verbally approved using hand management tools (spray packs and weed whackers) during nesting season if 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 Christmasberry (*Schinus terebinthifolius*) within 70m of the turbines to reduce potential nēnē nesting habitat near to the WTGs.

Treatment of the search plot areas for the FY 2017 was conducted in August through October and April through May. Primary vegetation management involve herbicide application, and weed whackers. A total of 28.3 acres were treated with glyphosate based herbicide in FY 2017; this area consisted of roads and pads primarily within the search area. Additional control of Ironwood (*Casuarina equisetifolia*) involved Garlon 3A and Garlon 4 Ultra cut stump application on approximately 200 trees. In total, we devoted 75 person-hours to vegetation management.

Mitigation

Hawaiian Hoary Bat-Research

Considering the more conservative estimate using the 80% credibility level the estimated total take is 31 adult bats. Mitigation for the baseline take of 20 bats was funded in 2006 and completed. Thirty additional take has been authorized through a minor amendment approved by USFWS in October 2015 and DOFAW in

January 2016. A mitigation project that will account for take of 15 of the higher take amount of 30 bats began May 2017 and is Hawaiian hoary bat ecological research. The contract total cost is $750,000 to be funded by mid-2019. KWPI will also partially fund another Hawaiian hoary bat ecological research project to begin in FY 2018 (KWPII 2017). KWPI contribution to this contract will be $131,565 by mid-2021 and account for take of 2.6 bats. Mitigation for the remaining 12.4 bats ($618,435) will be planned for in FY 2018.

East Maui Seabird Survey

In the unlikely event the initial five-year mitigation targets at Makamaka'ole for the NESH would not be met, surveys of East Maui for potential additional mitigation sites were funded and completed in September 2015 (KWP 2016). These surveys evaluated potential colony locations, estimated the numbers of birds present, assessed predator activity, and provided for management feasibility assessment.

Hawaiian Petrel and Newell's Shearwater- Makamaka'ole

Figure 11. Two completed enclosures on the Makamaka'ole Seabird Mitigation site in northern West Maui (Enclosure B is left and Enclosure A is right).

Weekly site visits to Makamaka'ole continue and focus on predator trapping and tracking, ongoing maintenance of both enclosures, artificial burrow checks, and game camera operation (Figure 11). Monitoring checklists have been created to ensure consistent oversight. These checklists include sound system battery checks, game camera operation and download, burrow checks for erosion damage, signs of bird activity (visual, scent, and game camera) and ongoing perimeter checks of fences and culverts. The Victor™ rat snap kill traps, DOC 200™ body grip kill traps (all encased in bird-safe boxes), and cage live traps are routinely maintained. Experimentation with bait and trap types have been ongoing.

The enclosures have shown to be an effective but not impermeable barrier to rats (Table 8). This year we saw an average of 6.5 rats per enclosure (N = 13). This translates to an average ingress rate of one rat every 56 days. Ingress tend to be clustered, and appear to have been related to breaches in the enclosure associated with heavy rain events and temporary fence or culvert degradation.

Table 8. Makamaka'ole trapping data by species and location for FY 2017.

Trap Location	Trap Type	Quantity Deployed	Number Caught
Outside A	Cage	1	0
	Victor Rat Snap	13	56 rats, 7 mice, 1 mongooses
	DOC 200 Body Grip	13	29 mongooses
Inside A	Victor Rat Snap	10	10 rats, 5 mice
	Cage	1	0
	DOC 200 Body Grip	4	1 rat
Outside B	Cage	1	0
	Victor Rat Snap	10	40 rats, 1 mongooses
	DOC 200 Body Grip	5	28 mongooses, 2 rats
Inside B	Victor Rat Snap	10	2 rats, 2 mice
	Cage	1	0
	DOC 200 Body Grip	5	0

Ten tracking tunnels inside each enclosure have been inked and baited every other month to assess small mammal activity (Table 9). Since January 24, 2014 no mongoose have been detected or trapped inside either enclosure. On January 7, 2015, we received our approved protocol to continue using Diphacinone bait blocks (KWP 2015). Twenty-five and 22 bait stations using Diphacinone bait blocks are currently deployed inside Enclosure A and Enclosure B, respectively. Bait stations within both enclosures continue to be checked biweekly, and re-baited as needed. Barn owl control contracted to DOFAW began at night in March 2017. No owls had been removed in FY 2017.

Erosion inside and outside of enclosures continues to be monitored closely. Specially fabricated hydrologic flumes are still attached to the outflow sections of two culverts at Enclosure A. These flumes direct water away from the enclosure, preventing erosion directly outside of the culvert tube and at the fence line. ʻUki (Machaerina augustifolia), ʻōhiʻa lehua (Metrosideros polymorpha), naupaka kuahiwi (Scaveola gaudichaudii), manono (Kadua affinis), propagated by Maui Native Nursery continue to be out-planted in and around both enclosures to stabilize soil in disturbed areas and to add to native flora within the mitigation area. We planted 110 ʻUki, 140 ʻōhiʻa, 40 naupaka, and 100 manono during FY 2017 with more variety of out-plantings scheduled for FY 2018. As specified by the NARs permit, regular herbiciding and weeding without motorized tools occurred each quarter. Target species for removal were *Clidemia hirta*, *Tibouchina spp*., *Melinus minutiflora* and *Psidium spp.*

Acoustic attraction systems broadcast social calls year-round at night. Sound files for the acoustic attraction system were updated in July 2016 with a mixture of both HAPE and NESH calls provided by Maui Nui Seabird Recovery Project in enclosure A and only HAPE calls in enclosure B. Additional HAPE calls were recorded from Waikamoi, Maui in 2015 and NESH calls were recorded on Kaua'i from Pohakea in Hono O Nā Pali as well as from Upper Limahuli. KWP Biologists have been conducting monthly night surveys, beginning on March 9th, to ensure the sound systems work correctly and to monitor bird activity in the area (Appendix 13).

Table 9. Makamaka'ole rodent presence/absence summary, as the number of tracking tunnels with paw prints out of 10 total tunnels deployed.

	July 2016 Totals		September 2016 Totals		November 2016 Totals	
	% Enclosure A	% Enclosure B	% Enclosure A	% Enclosure B	% Enclosure A	% Enclosure B
Mouse	20	0	40	100	90	60
Rat	0	0	20	0	0	0
Mongoose	0	0	0	0	0	0
	January 2017 Totals		**March 2017 Totals**		**May 2017 Totals**	
	% Enclosure A	% Enclosure B	% Enclosure A	% Enclosure B	% Enclosure A	% Enclosure B
Mouse	30	40	0	20	10	0
Rat	0	0	0	0	0	0
Mongoose	0	0	0	0	0	0

Seabird activity inside enclosure B has been increasing since our first sighting during the 2015 calendar year breeding season on June 22, 2015. Since then there have been three species of seabird, HAPE, NESH, and Bulwer's petrel (*Bulweria bulwerii*), frequenting burrows within both enclosures between the months of April and October. The first bird activity for the 2017 calendar year breeding season recorded on May 11th was a NESH entering burrow A43 inside enclosure A. Last year the first bird sighting had been a NESH on August 27, 2016 inside of enclosure A. Since the first sighting of 2017, there are now two burrows inside of enclosure A (A26, and A43) that are being frequented nightly by NESH (Figure 12 and 13). Burrow A26 had two NESH visiting on June 23rd. The first activity inside enclosure B this season on May 21st was a Bulwer's petrel entering burrow 22B (Figure 14). Since May 21st there have been frequent visits from both Bulwer's petrel and NESH at this burrow. On June 25th, two NESH was captured at the same time in enclosure B at 22B (Figure 15).

Figure 12. A Newell's shearwater near burrow A43 entrance (with NESH decoy in background) inside enclosure A on June 19, 2017.

Figure 13. Two Newell's shearwaters in front of burrow A26 (with NESH decoy to the right). The bird in front of the burrow entrance has nesting material in its mouth.

Figure 14. A Bulwer's petrel in front of burrow entrance 22B inside enclosure B on May 23, 2017 (with HAPE decoy).

Figure 15. Two Newell's shearwaters near the burrow entrance for 22B inside enclosure B on June 25, 2017 (HAPE decoy in the background).

Nēnē – Haleakala Ranch Pen

As part of KWPI nēnē mitigation, the Haleakala Ranch pen was paid for in 2008 by KWPI and constructed three years later by DOFAW. Nēnē have been trans-located from Kaua`i to the Haleakala Ranch pen since 2011. Through FY 2016, 32 fledglings produced in the pen from these trans-located birds have been credited to KWPI.

The agencies have agreed that KWPI will not accrue lost productivity for nēnē take that occurred prior to calendar year 2011, when the pen was constructed. Six nēnē fatalities were documented at KWPI prior to January 1, 2011. Nēnē fledgling production in 2017 has not yet been determined.

Adaptive Management

KWPI began implementing low wind speed curtailment (LWSC) at all WTGs up to wind speeds of 5.0 m/s on July 29, 2014. LWSC is expected to reduce bat take as explained in the KWPII HCP. Curtailment was increased to 5.5 m/s on August 4, 2014 in response to take occurring at KWPI and KWPII. Curtailment will continue to be in effect from sunset to sunrise, annually, from February 15 through December 15. KWPI currently operates nine ground bat detectors, and seven bat detectors at nacelle height to provide additional information about bat activity patterns that may lead to reduced take.

Agency Visits and Reporting

During FY 2017, KWPI attended several meetings with agencies to discuss a variety of topics related to HCP implementation. DOFAW conducted a site visit in December 2016 and observed HCP operations at both KWP sites and the Makamaka'ole mitigation site. Abbreviated summary reports for FY 2017 quarters 1-3 were provided to USFWS and DOFAW. The Endangered Species Recovery Committee reviewed the FY 2016 annual HCP report on November 1-2, 2016.

Expenditures

The total KWPI HCP related expenditures in FY 2017 is $242,161 (Table 10).

Table 10. Expenses by category for KWPI during FY 2017.

Category	Cost ($)
Permit Compliance	850
Bat Mitigation	68,450
Seabird Mitigation	21,986
Vegetation Management	2,641
Fatality Monitoring	38,240
Equipment and Supplies	6,995
Staff Labor	102,999
Total Cost	**242,161**

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Appendices

Appendix 1. Density weighted proportion searched for Hawaiian goose, Hawaiian petrel and Hawaiian hoary bat at KWP I in FY 2017 Q1 and FY 2017 Q2-Q4.

FY 2017 Q1

Radius Band (m)	Total Area ($m^{2)}$	Search Area (m^2)	Portion searched	Small Size Distribution	Small DWP	Medium Size Distribution	Medium DWP	Large Size Distribution	Large DWP
0-20	25120.0	22039.6	0.877	0.308	0.270	0.091	0.080	0.152	0.133
30	31400.0	14354.4	0.457	0.231	0.105	0.091	0.042	0.182	0.083
40	43960.0	8699.4	0.198	0.385	0.076	0.121	0.024	0.303	0.060
50	56520.0	7790.3	0.138	0.077	0.011	0.182	0.025	0.061	0.008
60	69080.0	7300.2	0.106	0.000	0.000	0.152	0.016	0.030	0.003
70	81640.0	8115.7	0.099	0.000	0.000	0.182	0.018	0.091	0.009
			Total	**1.000**	**0.462**	**0.818**	**0.204**	**0.818**	**0.297**

FY 2017 Q2-Q4

Radius Band (m)	Total Area ($m^{2)}$	Search Area (m^2)	Portion searched	Small Size Distribution	Small DWP	Medium Size Distribution	Medium DWP	Large Size Distribution	Large DWP
0-20	25120.0	24249.3	0.965	0.308	0.297	0.091	0.088	0.152	0.146
30	31400.0	18447.7	0.588	0.231	0.136	0.091	0.053	0.182	0.107
40	43960.0	11092.9	0.252	0.385	0.097	0.121	0.031	0.303	0.076
50	56520.0	9387.9	0.166	0.077	0.013	0.182	0.030	0.061	0.010
60	69080.0	9184.3	0.133	0.000	0.000	0.152	0.020	0.030	0.004
70	81640.0	10582.3	0.130	0.000	0.000	0.182	0.024	0.091	0.012
			Total	**1.000**	**0.542**	**0.818**	**0.246**	**0.818**	**0.355**

Appendix 2. Downed wildlife monitoring dates at KWPI during FY 2017.

WTG																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28	6/28
7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5	7/5
7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12	7/12
7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19	7/19
7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26	7/26
8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4	8/4
8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9	8/9
8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16	8/16
8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/23	8/24	8/23	8/23	8/23
8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30	8/30
9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6	9/6
9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13	9/13
9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20	9/20
9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27	9/27
10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4	10/4
10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11	10/11
10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18	10/18
10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25	10/25
11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1	11/1
11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8	11/8
11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15	11/15
11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/21	11/22	11/21
11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29	11/29
12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/6	12/7	12/6	12/6	12/6	12/6	12/6
12/13	12/13	12/13	12/14	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13	12/13
12/20	12/20	12/20	12/20	12/20	12/20	12/20	12/20	12/21	12/20	12/20	12/20	12/20	12/20	12/20	12/20	12/20	12/20	12/20	12/20
12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27	12/27
1/3	1/3	1/3	1/4	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3	1/3
1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/11	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10
1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17	1/17
1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24	1/24
1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31	1/31
2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7	2/7
2/14	2/14	2/14	2/14	2/14	2/15	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14	2/14
2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21	2/21
2/28	2/28	3/1	2/28	3/1	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28
3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/7	3/8	3/7	3/7	3/7	3/7	3/7	3/7
3/14	3/14	3/14	3/14	3/15	3/15	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14	3/14
3/21	3/21	3/22	3/21	3/21	3/22	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21	3/21
3/28	3/28	3/29	3/28	3/28	3/29	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28	3/28
4/4	4/4	4/4	4/4	4/4	4/4	4/5	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4	4/4
4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11	4/11
4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/18	4/19	4/18	4/18
4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/25	4/26	4/25	4/25
5/3	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/2	5/3	5/2	5/2	5/2
5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/9	5/10	5/9	5/9	5/9	5/9	5/9	5/9	5/10	5/9	5/9	5/9	5/9
5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/16	5/17	5/16	5/16	5/16	5/16	5/16	5/16
5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23	5/23
5/30	5/30	5/30	5/30	5/30	5/31	5/30	5/30	5/30	5/30	5/30	5/31	5/30	5/30	5/30	5/30	5/30	5/30	5/30	5/30
6/6	6/6	6/6	6/6	6/7	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13	6/13
6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20	6/20
6/27	6/27	6/27	6/27	6/27	6/28	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27	6/27

Appendix 3. Canine-assisted to visual search ratio at KWPI during FY 2017.

	WTG									
Search Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Canine	46	46	46	46	46	43	46	46	45	46
Visual	7	7	7	7	7	9	6	6	7	6
Total	**53**	**53**	**53**	**53**	**53**	**52**	**52**	**52**	**52**	**52**
Canine Portion	*0.87*	*0.87*	*0.87*	*0.87*	*0.87*	*0.83*	*0.88*	*0.88*	*0.87*	*0.89*
Visual Portion	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.17*	*0.12*	*0.12*	*0.13*	*0.11*

	WTG										
Search Type	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**Total**
Canine	46	46	46	46	47	46	46	45	46	46	916
Visual	6	6	6	6	6	6	6	7	6	6	130
Total	**52**	**52**	**52**	**52**	**53**	**52**	**52**	**52**	**52**	**52**	**1046**
Canine Portion	*0.88*	*0.88*	*0.88*	*0.88*	*0.89*	*0.88*	*0.88*	*0.87*	*0.88*	*0.89*	*0.88*
Visual Portion	*0.12*	*0.12*	*0.12*	*0.12*	*0.11*	*0.12*	*0.12*	*0.13*	*0.12*	*0.11*	*0.12*

Appendix 4. SEEF trials at KWPI during FY 2017.

Trial Date	Carcass Size	WTG	Found	Recovered	Human/ Canine Searcher
7/12/2016	Large	9	Yes	Yes	Human
7/12/2016	Small	8	No	Yes	Human
8/4/2016	Small	7	Yes	Yes	Canine
8/4/2016	Small	7	Yes	Yes	Canine
8/4/2016	Medium	5	Yes	Yes	Canine
9/20/2016	Small	20	Yes	Yes	Canine
9/20/2016	Large	16	Yes	Yes	Canine
9/20/2016	Small	16	Yes	Yes	Canine
9/20/2016	Small	15	Yes	Yes	Canine
9/20/2016	Small	11	Yes	Yes	Canine
9/20/2016	Small	8	Yes	Yes	Canine
9/20/2016	Small	6	Yes	Yes	Canine
9/20/2016	Medium	4	Yes	Yes	Canine
10/11/2016	Small	13	Yes	Yes	Canine
10/11/2016	Small	12	Yes	Yes	Canine
10/11/2016	Medium	11	Yes	Yes	Canine
10/11/2016	Large	7	Yes	Yes	Canine
10/11/2016	Small	7	Yes	Yes	Canine
10/11/2016	Small	4	Yes	Yes	Canine
11/21/2016	Small	6	Yes	Yes	Canine
11/21/2016	Medium	6	Yes	Yes	Canine
11/21/2016	Small	5	Yes	Yes	Canine
11/21/2016	Medium	4	Yes	Yes	Canine
12/13/2016	Large	3	Yes	Yes	Canine
12/13/2016	Small	4	Yes	Yes	Canine
12/13/2016	Small	5	Yes	Yes	Canine
12/13/2016	Large	7	Yes	Yes	Canine
12/13/2016	Small	16	No	Yes	Canine
1/17/2017	Small	14	Yes	Yes	Canine
1/17/2017	Medium	12	Yes	Yes	Canine
1/17/2017	Large	6	Yes	Yes	Canine
1/17/2017	Small	6	Yes	Yes	Canine
1/17/2017	Small	5	Yes	Yes	Canine
1/17/2017	Small	3	Yes	Yes	Canine
2/14/2017	Small	9	Yes	Yes	Canine
2/14/2017	Large	5	Yes	Yes	Canine
3/7/2017	Medium	20	Yes	Yes	Canine
3/7/2017	Small	20	Yes	Yes	Canine
3/7/2017	Small	18	Yes	Yes	Canine
3/7/2017	Small	15	Yes	Yes	Canine
3/7/2017	Small	15	Yes	Yes	Canine
3/7/2017	Small	13	Yes	Yes	Canine
5/9/2017	Medium	19	Yes	Yes	Canine
5/9/2017	Small	14	Yes	Yes	Canine

5/9/2017	Large	11	Yes	Yes	Canine
5/9/2017	Small	11	Yes	Yes	Canine
5/9/2017	Small	10	Yes	Yes	Canine
5/9/2017	Medium	5	Yes	Yes	Canine
5/23/2017	Small	2	Yes	Yes	Human
5/23/2017	Small	2	Yes	Yes	Human
5/23/2017	Large	3	Yes	Yes	Human
5/23/2017	Large	7	Yes	Yes	Human
5/23/2017	Medium	9	Yes	Yes	Human
5/23/2017	Small	14	Yes	Yes	Human
5/23/2017	Small	18	No	Yes	Human
5/23/2017	Small	1	No	Yes	Human
6/28/2017	Small	14	Yes	Yes	Canine
6/28/2017	Small	2	Yes	Yes	Canine
6/28/2017	Medium	3	Yes	Yes	Canine
6/28/2017	Small	7	Yes	Yes	Canine
6/28/2017	Medium	9	Yes	Yes	Canine
6/28/2017	Small	10	Yes	Yes	Canine
6/28/2017	Large	17	Yes	Yes	Canine
6/28/2017	Small	1	Yes	Yes	Canine
6/28/2017	Small	15	No	Yes	Canine

Appendix 5. CARE AD-AH trial results at KWPI during FY 2017.

CARE AD FY2017		**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**	**Trial 5**	**Trial 6**	**Trial 7**
Carcass Type		**Rat**	**Rat**	**Rat**	**WTSH**	**Chicken**	**Rat**	**Rat**
WTG		19	18	16	16	7	3	2
Vegetation		Bare						
Distance (m)		23	17	15	6	52	19	30
Day	Date	P/A	P/A	P/A	P/A	P/A	P/A	P/A
0	7/26	P	P	P	P	P	P	P
1	7/27	P	P	P	P	P	P	P
2	7/28	P	P	P	P	P	P	P
3	7/29	P	P	P	P	P	P	P
4	7/30	P	P	**P**	P	P	P	**P**
5	7/31	P	P	A	P	P	P	A
6	8/1	P	P		P	P	P	
7	8/2	P	P		P	P	P	
8	8/3	P	P		P	P	P	
9	8/4	P	P		P	P	P	
10	8/5	P	P		P	P	P	
11	8/6	P	P		P	P	P	
12	8/7	P	P		P	P	P	
13	8/8	P	P		P	P	P	
14	8/9	P	P		P	P	P	
21	8/16	P	P		P	P	P	
28	8/23	**P**	**P**		**P**	**P**	**P**	
Retention (days)		**28**	**28**	**4**	**28**	**28**	**28**	**4**

CARE AE FY2017		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7
Carcass Type		**Chicken**	**Rat**	**Rat**	**Rat**	**Rat**	**WTSH**	**Rat**
WTG		19	18	17	16	14	5	4
Vegetation		Bare						
Distance (m)		40	61	59	37	18	32	5
Day	Date	P/A	P/A	P/A	P/A	P/A	P/A	P/A
0	9/7	P	P	P	P	P	P	P
1	9/8	P	P	P	P	P	P	P
2	9/9	P	P	P	P	P	P	P
3	9/10	P	P	P	P	P	P	P
4	9/11	P	P	P	P	P	P	P
5	9/12	P	P	P	P	P	P	P
6	9/13	P	P	P	P	P	P	P
7	9/14	P	P	P	P	P	P	P
8	9/15	P	P	P	P	P	P	P
9	9/16	P	P	P	P	P	P	P
10	9/17	P	P	P	P	P	P	P
11	9/18	P	P	P	P	P	P	P
12	9/19	P	P	P	P	P	P	P
13	9/20	P	P	P	P	P	P	P
14	9/21	P	P	P	P	P	P	P
21	9/28	P	P	P	P	**P**	P	P
28	10/5	**P**	**P**	**P**	**P**	A	**P**	**P**
Retention (days)		**28**	**28**	**28**	**28**	**21**	**28**	**28**

CARE AF FY2017		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7
Carcass Type		**Rat**	**Rat**	**WTSH**	**Rat**	**Chicken**	**Rat**	**Rat**
WTG		20	14	9	5	2	2	1
Vegetation		Bare						
Distance (m)		19	32	28	23	10	20	30
Day	Date	P/A	P/A	P/A	P/A	P/A	P/A	P/A
0	10/19	P	P	P	P	P	P	P
1	10/20	P	P	P	P	P	P	P
2	10/21	P	P	P	P	P	P	P
3	10/22	P	P	P	P	P	P	P
4	10/23	P	P	P	P	P	P	P
5	10/24	P	P	P	P	P	P	P
6	10/25	P	P	P	**P**	P	P	P
7	10/26	P	P	P	A	P	P	P
8	10/27	P	P	P		P	P	P
9	10/28	**P**	P	P		P	P	P
10	10/29	A	**P**	P		P	P	P
11	10/30		A	P		P	P	P
12	10/31			P		P	P	P
13	11/1			P		P	P	P
14	11/2			P		P	P	P
21	11/9			P		P	P	P
28	11/16			**P**		**P**	**P**	**P**
Retention (days)		**9**	**10**	**28**	**6**	**28**	**28**	**28**

CARE AG FY2017		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7
Carcass Type		**Rat**	**Chicken**	**Rat**	**Rat**	**Rat**	**WTSH**	**Rat**
WTG		19	18	13	8	7	4	2
Vegetation		Bare						
Distance (m)		43	29	16	22	42	36	21
Day	Date	P/A	P/A	P/A	P/A	P/A	P/A	P/A
0	1/4	P	P	P	P	P	P	P
1	1/5	P	P	P	P	P	P	P
2	1/6	P	P	P	P	P	P	P
3	1/7	P	P	P	P	P	P	P
4	1/8	P	P	P	P	P	P	P
5	1/9	P	P	P	P	P	P	P
6	1/10	P	P	P	P	P	P	P
7	1/11	P	P	P	P	P	P	P
8	1/12	P	P	P	P	P	P	P
9	1/13	P	P	P	P	P	P	P
10	1/14	P	P	P	P	P	P	P
11	1/15	P	P	P	P	P	P	P
12	1/16	P	P	P	P	P	P	P
13	1/17	P	P	P	P	P	P	P
14	1/18	**P**	P	**P**	**P**	P	P	P
21	1/25	A	P	A	A	P	P	P
28	2/1		**P**			**P**	**P**	**P**
Retention (days)		**14**	**28**	**14**	**14**	**28**	**28**	**4**

CARE AH FY2017		Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7
Carcass Type		**Chicken**	**Rat**	**Rat**	**Rat**	**WTSH**	**Rat**	**Rat**
WTG		6	6	11	13	19	19	20
Vegetation		Bare						
Distance (m)		17	19	26	21	16	12	15
Day	Date	P/A	P/A	P/A	P/A	P/A	P/A	P/A
0	4/17	P	P	P	P	P	P	P
1	4/18	P	P	P	P	P	P	P
2	4/19	P	P	P	P	P	P	P
3	4/20	P	P	P	P	P	P	P
4	4/21	P	P	P	P	P	P	P
5	4/22	P	P	P	P	P	P	P
6	4/23	P	P	P	P	P	P	P
7	4/24	P	P	P	P	P	P	P
8	4/25	P	P	P	P	P	P	P
9	4/26	P	P	P	P	P	P	P
10	4/27	P	P	P	P	P	P	P
11	4/28	P	P	**P**	P	P	P	P
12	4/29	P	P	A	P	P	P	P
13	4/30	P	P		P	P	P	P
14	5/1	P	P		P	P	**P**	P
21	5/8	P	P		P	P	A	**P**
28	5/15	**P**	**P**		**P**	**P**		A
Retention (days)		**28**	**28**	**11**	**28**	**28**	**14**	**21**

Appendix 6. Fatality estimation input parameters and results for Hawaiian goose at KWPI through FY 2017.

													Estimation Results			
Period #	**Year Portion**	**Portion Dates**	**Observed Mortality**	**Search Interval (Days)**	**SEEF Results**	**SEEF Trial Total Placed**	**CARE Mean[1]**	**CARE SD**	**CARE Trials Placed**	***k*[2]**	***dwp*[3]**	***rho*[4]**	***g*[5]**	***g lower***	***g upper***	**M* (Estimated Mortality, 80% Credibility**
1	2.00	7/1/06-6/30/08	2	9	0.73	22	19.0	7.1	19	1	0.95	2.00	0.922	0.874	0.96	2
2	2.38	7/1/08-11/15/10	2	7								2.38	0.928	0.885	0.961	5
3	0.62	11/16/10-6/30/11	5								0.7	0.62	0.678	0.646	0.708	11
4	1.00	7/1/11-6/30/12	1			11						1.00	0.678	0.633	0.72	13
5		7/1/12-6/30/13	4		0.60	10	26.8	1.9	10				0.664	0.592	0.733	18
6		7/1/13-6/30/14	3		0.80	15							0.683	0.65	0.715	23
7		7/1/14-6/30/15	4		0.78	45	28.0	0.0	15		0.297		0.69	0.654	0.725	29
8		7/1/15-6/30/16	1		1.00	8							0.293	0.277	0.309	32
9	0.25	7/1/16-9/30/16	0			11						0.25	0.293	0.272	0.313	33
10	0.75	10/1/16-6/30/17	0								0.355	0.75	0.351	0.336	0.366	34

[1] CARE Trials in Periods 1-4 were for 14 or 28 days, in Periods 5-10 were for 28 days

[2] *k* represents the factor by which searcher efficiency decreases with each successive search (value of 1 indicates a carcass can be found on the second search as easily as for the first search)

[3] *dwp* is density weighted proportion: fraction of the total modeled or known carcasses that arrive in a searched area (value of 1 indicates the search area includes the area where all possible carcasses could fall)

[4] *rho* is the relative mortality rate

[5] *g* is overall detection probability, *g lower* and *upper* are the 95% confidence intervals around *g*

Appendix 7. Fatality estimation input parameters and results for Hawaiian petrel at KWPI through FY 2017.

													Estimation Results			
Period #	**Year Portion**	**Portion Dates**	**Observed Mortality**	**Search Interval (Days)**	**SEEF Results**	**SEEF Trial Total Placed**	**CARE Mean[1]**	**CARE SD**	**CARE Trials Placed**	***k*[2]**	***dwp*[3]**	***rho*[4]**	***g*[5]**	***g lower***	***g upper***	**M* (Estimated Mortality, 80% Credibility**
1	1.00	7/1/06 - 6/30/07	0	9	0.75	8	12.6	9.4	13	0.9	1	1.00	0.805	0.599	0.947	0
2		7/1/07-6/30/08	1	9	0.67	18							0.786	0.593	0.928	2
3		7/1/08-6/30/09	0	7	0.78	255	10.5	4.0	17				0.847	0.717	0.942	2
4		7/1/09-6/30/10	0		0.70	20	11.9	4.4	14				0.861	0.706	0.963	2
5	0.38	7/1/10-11/15/10	0		0.71	21	18.7	7.4	11			0.38	0.939	0.848	0.990	2
6	0.62	11/16/10-6/30/11	0								0.75	0.62	0.712	0.654	0.767	2
7	1.00	7/1/11-6/30/12	2		0.38	37	22.0	7.9	10			1.00	0.581	0.431	0.724	5
8		7/1/12-6/30/13	1		0.60	10							0.646	0.511	0.770	6
9		7/1/13-6/30/14	1		0.77	44	24.6	7.6	14				0.714	0.668	0.758	8
10		7/1/14-6/30/15	2		0.69	71	20.5	11.2	8	1			0.650	0.555	0.740	11
11		7/1/15-6/30/16	0		1.00	7	25.8	7.0	10		0.204		0.194	0.179	0.21	12
12	0.25	7/1/16-9/30/16	0			12						0.25	0.195	0.182	0.209	12
13	0.75	10/1/16-6/30/17	0								0.246	0.75	0.213	0.199	0.226	13

[1] CARE Trials in Periods 1-7 were for 14 or 28 days, in Periods 8-13 were for 28 days

[2] *k* represents the factor by which searcher efficiency decreases with each successive search (value of 1 indicates a carcass can be found on the second search as easily as for the first search)
[3] *dwp* is density weighted proportion: fraction of the total modeled or known carcasses that arrive in a searched area (value of 1 indicates the search area includes the area where all possible carcasses could fall)
[4] *rho* is the relative mortality rate
[5] *g* is overall detection probability, *g lower* and *upper* are the 95% confidence intervals around *g*

Appendix 8. Fatality estimation input parameters and results for Hawaiian hoary bat at KWPI through FY 2017.

													Estimation Results			
Period #	**Year Portion**	**Portion Dates**	**Observed Mortality**	**Search Interval (Days)**	**SEEF Results**	**SEEF Trial Total Placed**	**CARE Mean[1]**	**CARE SD**	**CARE Trials Placed**	***k*[2]**	***dwp*[3]**	***rho*[4]**	***g*[5]**	***g lower***	***g upper***	**M* (Estimated Mortality, 80% Credibility**
1	1.00	7/1/06-6/30/07	0	9	0.63	30	6.0	5.8	10	0.7	1	1.00	0.442	0.256	0.636	1
2		7/1/07-6/30/08	0										0.443	0.258	0.636	1
3		7/1/08-6/30/09	1	7									0.501	0.312	0.69	4
4		7/1/09-6/30/10	0		0.55	40							0.45	0.272	0.634	4
5		7/1/10-6/30/11	1		0.42	12	9.9	7.1	17				0.505	0.257	0.752	7
6		7/1/11-6/30/12	0				6.1	4.3	11				0.345	0.149	0.574	7
7		7/1/12-6/30/13	2		0.33	15	11.1	7.5	10				0.414	0.183	0.669	13
8		7/1/13-6/30/14	4		0.59	79	6.5	7.7	11				0.484	0.332	0.638	23
9		7/1/14-6/30/15	0		0.42	65	3.3	3.0	10			0.500	0.217	0.128	0.321	23
10		7/1/15-6/30/16	0		0.95	37	18.1	10.1	16	1	0.462		0.411	0.379	0.442	24
11	0.25	7/1/16-9/30/16	1		0.89	9	22.5	10.0	10			0.125	0.422	0.378	0.467	26
12	0.75	10/1/16-6/30/17	0		0.88	33	18.7	8.5	15		0.542	0.375	0.517	0.489	0.545	26

[1]CARE Trials in Periods 1-6 were for 14 or 28 days, in Periods 7-12 were for 28 days

[2] *k* represents the factor by which searcher efficiency decreases with each successive search (value of 1 indicates a carcass can be found on the second search as easily as for the first search)
[3] *dwp* is density weighted proportion: fraction of the total modeled or known carcasses that arrive in a searched area (value of 1 indicates the search area includes the area where all possible carcasses could fall)
[4] *rho* is the relative mortality rate (the product of Year Portion and Low Wind Speed Curtailment predicted mortality rate reduction (0.5 for periods 9-12))
[5] *g* is overall detection probability, *g lower* and *upper* are the 95% confidence intervals around *g*

Appendix 9. Nēnē lost productivity and indirect take at KWPI through FY 2017.

		Fiscal year					Fiscal years when loss of productivity is calculated									
Component	**Description**	**2007**	**2008**	**2009**	**2010**	**2011**	**2011**	**2012**	**2013**	**2014**		**2015**		**2016**	**2017**	**Total**
A	**Observed Take**	0	2	1	1	2	3	1	4	2	1	3	1	1	0	**22**
B	Estimated Take Multiplier (**34/22=1.545**)	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	
C	**Estimated Direct Take** (**A** x **B**)	0	3.09	1.55	1.55	3.09	4.64	1.55	6.18	3.09	1.55	4.64	1.55	1.55	0	**34**
D	Observed Indirect Take Multiplier (Season Defined)	0	0.09	0	0	0.09	0	0.09	0.09	0.09	0	0.09	0.04	0.09	0.04	
E	**Observed Indirect Take** (**C** x **D**)	0	0.18	0	0	0.18	0	0.09	0.36	0.18	0	0.27	0.04	0.09	0	**1.39**
F	**Unobserved Direct Take** (**C** - **A**)		1.09	0.55	0.55	1.09	1.64	0.55	2.18	1.09	0.55	1.64	0.55	0.55	0.00	**12**
G	**Unobserved Indirect Take** (**F x 0.06**)		0.07	0.03	0.03	0.07	0.10	0.03	0.13	0.07	0.03	0.10	0.03	0.03	0.00	**0.72**
H	Accrued Adult Take (**Previous Years Accrued C - M)** (beginning 1/1/2011**)**							4.78	6.34	12.70		16.95		19.61	17.85	
I	Lost Productivity from accrued adult take **(Current year's H x 0.1)**							0.48	0.63	1.27		1.69		1.96	1.78	
J	Indirect Take + Lost Productivity (as fledglings) (**E + G + I**)							1.25	1.12	1.55		2.14		2.08	1.78	**1.78**[1]
K	**Mitigation fledglings produced**							**2**	**8**	**8**		**6**		**8**	**N/A**	
L[2]	Net fledglings remain (**Current Year K - I - G - E)**)		-0.25	-0.03	-0.03	-0.34		**0.75**	**6.88**	**6.45**		**3.86**		**5.92**		
M	Net adults 3 yrs later (**Three year's previous L x 0.8**[3])						-0.13	-0.02	-0.02	-0.18		**0.38**		**3.52**	**3.30**	

[1] Lost productivity accrued through FY 2017 will be reduced to zero if fledgling production for 2017 is greater than two.

[2] Prior to 1/1/2011 Indirect Take (E+G) is converted to adult take 3 years later (M) and added to current Accrued Adult Take (H)

Appendix 10. HAPE lost productivity and indirect take at KWPI through FY 2017.

		Fiscal Year												
Component	**Description**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**		**2013**	**2014**	**2015**		**2016**	**2017**	**Total**
A	**Observed Take**	0	1	0	0	0	1	1	1	1	1	1	0	0	**7.00**
B	Estimated Take Multiplier (**13/7 = 1.86**)		1.86				1.86	1.86	1.86	1.86	1.86	1.86			
C	**Estimated Take (A x B)**		1.86				1.86	1.86	1.86	1.86	1.86	1.86			**13.00**
D	Observed Indirect Take Multiplier (**Season defined**)		0.66				0.66	0.50	0.89	0.89	0.89	0.66			
E	**Observed Indirect Take (A x D)**		0.66				0.66	0.50	0.89	0.89	0.89	0.66			**5.15**
F	Unobserved Direct Take (**C** - **A**)		0.86				0.86	0.86	0.86	0.86	0.86	0.86			**6.00**
G	**Unobserved Indirect Take (D x F)**		0.57				0.57	0.43	0.76	0.76	0.76	0.57			**4.41**
H	Accrued Adult Take (**Sum all previous years C**)			1.86	1.86	1.86	1.86		5.57	7.43	9.29		13.00	13.00	
I	Adult Lost Productivity Accrued (**H x 0.15**)			0.28	0.28	0.28	0.28		0.84	1.11	1.39		1.95	1.95	**8.36**
J	Indirect Take to Adult accumulated/ unmitigated (sum five year's previous **(E + G) *0.3**)								0.37	0.37	0.37		0.37	1.01	
K	Fledgling to Adult Lost Productivity (accumulated **J x 0.15**)								0.06	0.06	0.06		0.06	0.21	**0.43**
											Total Lost Productivity				**8.79**
											Total Indirect Take				**9.56**

Appendix 11. Indirect take calculations for Hawaiian hoary bat at KWPI through FY 2017.

Component	Input	Value
A	Total Estimated Direct take	26
B	Observed direct take (ODT)	9
C	Unobserved direct take (UDT) (**A - B**)	17
D	ODT female or unknown during Apr 1- Sep 15 (2 female, 4 unknown)	6
E	Proportion of UDT that could be female and probability a female is pregnant or lactating (0.5 x 3/12)	0.125
F	Survival of twin pups to weaning (0.9 x 2 pups)	1.8
G	ODT IDT (**D x F**)	10.8
H	UDT IDT (**C x E x F**)	3.8
I	IDT total (**G + H**)	14.6
J	Survival of juvenile to adult	0.3
	IDT as adults (I x J)	4.4
	Total IDT rounded up	**5**

Appendix 12. WEOP training log at KWPI during FY 2017.

Name	Date	Employer	Trainer
Patrick Hannon	2/7/2017	Rope Partner	MS
Terry Miller	2/20/2017	Run Energy	MS
Willie Gonzales Jr	2/20/2017	Run Energy	MS
Eric Segura	2/20/2017	Run Energy	MS
Matthew Devers	2/20/2017	Run Energy	MS
Ryan O'Connell	2/20/2017	Run Energy	MS
Clyde Garcia	2/20/2017	Run Energy	MS
Darrel Grice	2/20/2017	Run Energy	MS
Ben Rhoan	2/21/2017	GE	SE
Jeremy Jones	3/3/2017	GE	MS
Nick Roussean	3/3/2017	Rope Partners	MS
Chris Banner	3/3/2017	Run Energy	SE
Jimmy Finen	3/3/2017	Rope Partner	SE
Micah Vokers	3/3/2017	GE	MS
John Calderera	4/5/2017	Rope Partner	MS
Jacob Macdonnell	5/30/2017	Run Energy	SE
Dave Bergstrom	5/30/2017	Run Energy	SE

Appendix 13. Makamaka'ole night survey summary through FY 2017.

Survey Date	Location	Time	Type	Count	Distance (m)	Elevation	Behavior	Notes
7/20/16	B Makai	19:00	Unknown	4	0-50	Above	Transit	4 Unknown birds fly overhead
7/20/16	B Makai	19:38	NESH	1	51-200	Same	Transit	
7/20/16	B Makai	19:46	NESH	1	51-200	Same	Circling	
7/20/16	B Makai	19:50	NESH	1	0-50	Above	Circling	
7/20/16	B Makai	19:56	NESH	2	0-50	Above	Circling	
7/20/16	B Makai	20:06	NESH	2	0-50	Above	Circling	
7/20/16	B Makai	20:10	NESH	2	0-50	Above	Courtship	circling together
7/20/16	B Makai	20:20	NESH	1	0-50	Above	Courtship	
7/20/16	B Makai	20:26	NESH	1	0-50	Above	Ground Call	sounded like inside burrow entrance 22B
7/20/16	B Makai	20:33	NESH	1	0-50	Above	Other (notes)	landing in thick uluhe west of speaker and burrow 22B
8/10/16	B Mauka	19:20	NESH	1	0-50	Same	Circling	
8/10/16	B Mauka	19:20	HAPE	2	51-200	Below	Transit	
8/10/16	B Mauka	19:25	HAPE	2	51-200	Below	Circling	
8/10/16	B Mauka	19:33	HAPE	2	51-200	Below	Circling	
8/10/16	B Mauka	19:38	HAPE	2	51-200	Below	Circling	
8/10/16	B Mauka	19:42	NESH	2	0-50	Below	Transit	
8/10/16	B Mauka	19:47	NESH	2	51-200	Same	Transit	
8/10/16	B Mauka	19:50	NESH	2	0-50	Same	Circling	
8/10/16	B Mauka	19:55	HAPE		51-200	Same	Circling	
8/10/16	B Mauka	20:00	BAOW	2	0-50	Below	Transit	loud screech from below
8/10/16	B Mauka	20:07	NESH	1	0-50	Same	Circling	
8/10/16	B Mauka	20:14	NESH	1	0-50	Same	Ground Call	Landed
9/19/16	B Mauka	19:00	NESH	1	0-50	Above	Circling	
9/19/16	B Mauka	19:07	NESH	1	0-50	Above	Circling	Observed
3/30/17	Top of B	19:27	HAPE	1	201-500	Same	Transit	Call only (50% confidence)
5/4/17	Top of B	19:53	HAPE	2				
5/4/17	Top of B	19:45	HAPE	2				
5/4/17	Top of B	19:39	HAPE	2				
5/4/17	Top of B	19:29	HAPE	2				
5/4/17	Top of B	19:25	HAPE	1				
5/25/17	Top of B	20:09	HAPE	1	101-500	Above	Circling	Calls
5/25/17	Top of B	19:56	NESH	2	0-50	Above	Circling	Circling and calling over A
5/25/17	Top of B	19:43	NESH	2	0-50	Same	Transit	Continued calls
5/25/17	Top of B	19:35	HAPE	1	501-1000	Below	Transit	Heard in gulch
5/25/17	Top of B	19:34	NESH	2	0-50	Same	Circling	Flew past platform
5/25/17	Top of B	19:29	HAPE	2	101-500	Same	Circling	
5/25/17	Top of B	19:21	NESH	2	51-100	Above	Circling	
6/15/17	Road	18:31	NESH	1	201-500m	Above	Transit	Heard before sound systems turned on above B.