Kahuku Wind Power
Habitat Conservation Plan
Annual Report FY 2016

Kahuku Wind Power, LLC

56-1050 Kamehameha Hwy

Kahuku, Hawaii 96731

August, 2016

ITL-10 BO# 2010-F-0190

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.

Hawaii HCP Manager
SunEdison Energy, LLC

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Executive Summary

Kahuku Wind Power, LLC (KAH) has been implementing a Habitat Conservation Plan (HCP) since May 27, 2010. A federal Biological Opinion (BO 2010-F-0190) and a Hawaii Incidental Take License (ITL-10) were approved in May and June 2010, respectively. The project began commercial operations on March 23, 2011. This report summarizes work performed by KAH at the conclusion of the State of Hawaii 2016 fiscal year (FY 2016: July 1, 2015 - June 30, 2016). Species covered under the HCP include seven threatened and endangered birds and one endangered bat.

SunEdison, LLC acquired First Wind Energy, LLC officially on January 29, 2015 and sold KAH to the current owner, Terraform Power, LLC. SunEdison, LLC continues to maintain a contract with Terraform Power, LLC to operate KAH. As a result of this transaction the Federal loan guarantee with U. S. Department of Energy (DOE) is paid and DOE no longer regulates activities under the BO; however USFWS has determined that the Incidental Take Statement associated with the BO remains in effect with a letter dated November 19, 2014. The HCP, ITL and ITP remain unchanged and in the project owner's name, Kahuku Wind Power, LLC.

Fatality monitoring plots have been reduced to 35 m radius plots searched once weekly beginning in April 2015. Mean and standard deviation of search interval in days is 7.14 and 1.23, respectively.

Thirty-eight searcher efficiency (SEEF) trials with three medium size birds and 35 rats and four 28-day long carcass persistence (CARE) trials with four medium size birds and 20 rats were conducted in FY 2016. Considering only the first 14 days as the trial length in order to compare current trials to past trials that lasted only 14 days, the mean rat carcass persistence in days for FY 2015 is 8.7 (SD = 4.9) and for medium birds is 14.0 (SD = 0.0). The mean searcher efficiency for rats in FY 2016 is 85.7 % (N = 35) and for medium birds is 100 % (N = 3).

No HCP covered species were found in FY 2016. One Bulwer's petrel (*Bulweria bulwerii*), one great frigatebird (*Fregata minor*), and one Pacific golden plover (*Pluvialis fulva*) were the MBTA covered species found dead in FY 2016. No non-native introduced species were found dead in FY 2016.

The fatality estimate for four observed bats at 80% credibility level is 13 and the indirect take (IDT) is three adults (converted from juveniles).

Twelve Wildlife Acoustics SM2BAT+^{TM} ultrasonic detectors (SM2s) with one SM3BAT^{TM} microphone (mic) each located 50m from the project's 12 WTG's at 6.5m above the ground detected Hawaiian hoary bats on 28 of 3219 detector nights (0.9 % of detector nights) in FY 2016.

SunEdison continued periodic progress calls with the U.S. Fish and Wildlife Service (FWS) and the Division of Forestry and Wildlife (DOFAW) in FY 2016. The Endangered Species Recovery Committee (ESRC) reviewed the FY 2015 annual HCP report on October 21st. Barn owl eradication as mitigation for Newell's shearwater and Hawaiian petrel on Kauai began in FY 2015 Q4 and will continue through FY 2017 Q2. Baseline mitigation for waterbirds at Hamakua Marsh is complete. Baseline pueo and bat mitigation are complete.

Introduction

This report summarizes work performed by Kahuku Wind Power (KAH) under the terms of the approved Habitat Conservation Plan (HCP) dated May 27, 2010 and pursuant to the project's Incidental Take License (ITL-10) and Biological Opinion (BO# 2010-F-0190) at the conclusion of the State of Hawaii FY 2016 (July 1, 2015 – June 30, 2016). The BO and ITL were issued for the project in May and June, 2010, respectively. The ITL and BO cover seven federally-listed threatened and endangered species and one state-listed endangered species: the Hawaiian stilt or ae'o (*Himantopus mexicanus knudseni*), Hawaiian coot or 'alae ke'oke'o (*Fulica alai*), Hawaiian duck or koloa maoli (*Anas wyvilliana*), Hawaiian moorhen or 'alae 'ula (*Gallinula chloropus sandvicensis*), Newell's shearwater or 'a'o (*Puffinus newelli*), Hawaiian petrel or 'ua'u (*Pterodroma sandwichensis*), Hawaiian hoary bat or 'ope'ape'a (*Lasiurus cinereus semotus*) and the Hawaiian short-eared owl or pueo (*Asio flammeus sandwichensis*), respectively.

SunEdison, LLC acquired First Wind Energy, LLC officially on January 29, 2015. As a result of this transaction the U. S. Department of Energy no longer regulates activities under the BO, however FWS has determined in a letter dated November 19, 2014 that the Incidental Take Statement remains in effect. The HCP and ITL remain unchanged and in the project owner's name, Kahuku Wind Power, LLC.

Fatality Monitoring

With the agreement of DOFAW and FWS beginning in April 2015 searches have been conducted weekly within 35m radius circular plots centered on each WTG (Appendix 1, Figure 1). Search interval mean and standard deviation in days for KAH in FY 2016 is 7.14 and 1.23, respectively.

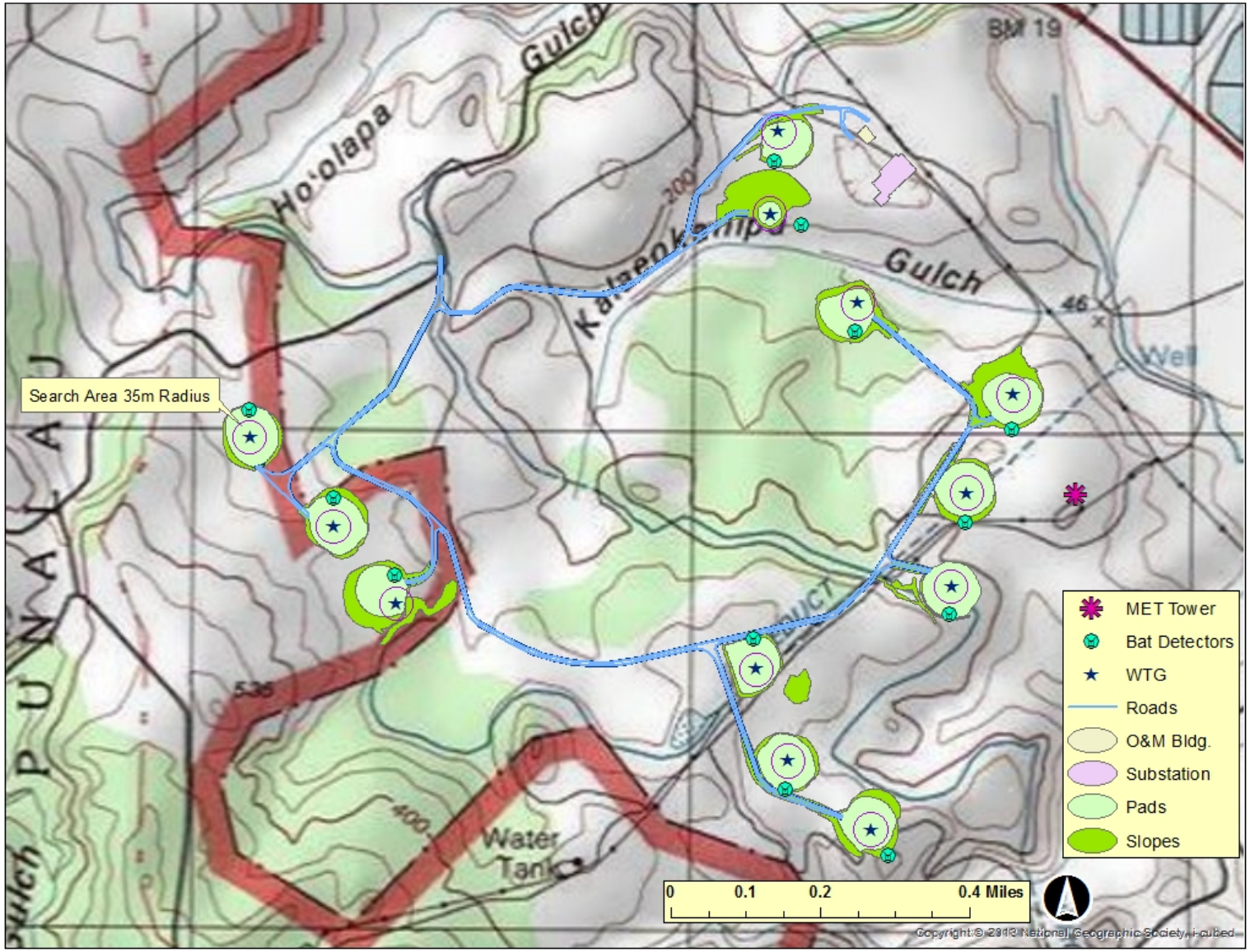


Figure 1. KAH roads, WTG's, MET tower, fatality monitoring plots and bat detector locations.

Vegetation Management

Fatality monitoring plots around the WTG's are mowed monthly only within the 35m reduced search radius. The vegetation within 35m is primarily bare ground and short grass that reaches 4-6 inches before management.

Carcass Persistence Trials

Four 28-day CARE trials with four medium size birds and 20 rats were conducted in FY 2016, one in each quarter (Appendix 2). Considering only the first 14 days as the trial length in order to compare current trials to past trials that lasted only 14 days, the mean and standard deviation for rat carcass persistence in days for FY 2016 is 8.7 (SD = 4.9) and for medium birds is 14.0 (SD = 0.0). For the 28-day length trials the mean and SD rat carcass persistence in days for FY 2016 is 11.8 (SD = 9.6) and for medium birds is 26.0 (SD = 4.0).

Searcher Efficiency Trials

Thirty-eight SEEF trials using a combination of human and dog searchers, proctored by the KAH HCP manager, with three medium size birds and 35 rats were conducted in FY 2016 (Appendix 3). The mean searcher efficiency for rats in FY 2016 is 85.7 %. The mean searcher efficiency for the medium birds in FY 2016 is 100 %.

Downed Wildlife

No downed wildlife listed in the ITL and federal BO were found in FY 2016. The total observed bat take at KAH is four. One Bulwer's petrel, one great frigatebird, and one Pacific golden plover were found dead in FY 2016. No non-native introduced species were found dead in FY 2016.

As prescribed in the HCP, KAH had initiated adaptive management (see Adaptive Management below) measures to reduce bat fatalities at the site on April 27, 2012.

Hawaiian Hoary Bat Take Estimation

The fatality estimate using the Huso *et al*. (2015) estimator for four observed bats found between January 2011 and June 2016 at the more conservative 80% credibility level is 13 (Appendix 4). The estimators used in this report were developed by USGS and have been recommended by DOFAW and FWS. The 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), 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 FWS the more conservative 80% credibility level is reported.

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, statistical methods have been developed for estimating 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, or were removed by scavengers or environmental factors such as high winds.

In addition to ODT and UDT, indirect take (IDT) is estimated separately to account for the loss of dependent young that may occur indirectly as the result of the loss of an adult female during the breeding season. The FWS and DOFAW have recently designated a more conservative breeding season from April 1 – September 15. Two observed take at KAH occurred in April and were not previously included in indirect take calculations but are now included (increasing the total take estimate more than expected compared to all previous estimates). Any adult female or sex unknown bat fatalities 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 observed take (2 pups X 0.9 survival rate to weaning per pup). All four observed take (1 female and 3 unknowns) were found during the breeding season. Thus, the IDT from the four observed take found during the breeding season would 7.2 juveniles (4 x 1.8 = 7.2) (Appendix 5).

Indirect take estimated from unobserved LACI take is calculated assuming half of the unobserved take 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 based on the information 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 in total (Hayssen *et al* 1993, Hayes and Wiles 2013, and NatureServe 2015 for *Lasiuris cinereus*). There is not enough information for hoary bats from Hawaii to determine the gestation and pre-weaning dependent period. Consequently, indirect take is assessed to bats lost through "unobserved direct take" at the rate of 0.225 juveniles/bat (0.5 x 0.25 x 1.8 = 0.225). The IDT for the unobserved direct take considering the 80% credibility level is 2.0 juveniles (13 estimated – 4 observed = 9 unobserved x 0.225 = 2.0).

The estimated rate of survival of young (indirect take) to reproductive age assumed from available data is 0.30 (little and big brown bats (*Myotis lucifugus* and *Eptesicus fuscus*); Humphrey 1982).

Juvenile indirect take of 9.2 (7.2 + 2.0 = 9.2) converts to 2.8 or three adults rounded up (9.2 x 0.3 = 2.8). The total take at 80% credibility are not more than 16 adults. Five and half years of the 20-year permit have been completed at the end of FY 2016 (although all WTGs were not operational from August 1, 2013 to September 1, 2014). The Tier 1 20-year take limit of 15 adults (12 adults and nine juveniles converted to three adults) has been exceeded. Mitigation planning, implementation, and funding for Tier 2 level take will occur in FY 2017. The total permitted take is 23 adults. Tier 2 mitigation will be for eight adult bats.

Hawaiian Hoary Bat Monitoring

Twelve Wildlife Acoustics SM2BAT+™ ultrasonic detectors (SM2) with one SM3BAT™ microphone (mic) each located 50m from the project's 12 WTG's at 6.5m above the ground detected Hawaiian hoary bats on 28 of 3219 detector nights (0.9 % of detector nights) in FY 2016 (Appendix 6).

Wildlife Education and Observation Program

No new personnel or longer term contractors required WEOP training orientation to be administered in FY 2016.

Mitigation

Newell's Shearwater and Hawaiian Petrel

As part of KAH's seabird mitigation obligation SunEdison funded the Kaua`i Endangered Seabird Recovery Project (KESRP) to deploy and then analyze data from Wildlife Acoustics SM2^{TM} Songmeters at multiple locations in Kauai's remote mountains to survey for Newell's shearwater and Hawaiian petrel nesting colonies. These were deployed in August 2013, April 2014, and April 2015 via helicopter and were retrieved in October 2013, August 2014, and August 2015, respectively. Songs were analyzed and results summarized by Conservation Metrics, Inc. (Appendix 7).

Additional mitigation for Newell's shearwater and Hawaiian petrel on Kaua`i began in FY 2015 Q4. SunEdison has funded DOFAW to conduct a barn owl predator control project on Kaua`i at the chosen seabird colonies through FY 2017 Q2 (Appendix 8). Total funding for these projects has been $350,000.

Waterbirds

SunEdison has completed its obligation for Hawaiian stilts, moorhens, and coot with funding already provided to DOFAW for four years of waterbird mitigation at Hamakua Marsh. Quarterly reports of progress and results were submitted by DOFAW in July and October 2014 and January, April and July 2015. Waterbird mitigation included four years of predator and vegetation control and productivity assessment. Total Coot, Moorhen and Stilt fledgling production from FY2012 through FY2015 was 13, 141 and 24, respectively. The total funding for this project was $457,000.

Pueo

Total funding for Pueo mitigation was $75,000. $25,000 funded the Hawaii Wildlife Center and $50,000 has been provided to DOFAW for population research. No report has been made available to summarize the population research.

Hawaiian Hoary Bat

KAH has paid the full obligation of $150,000 for ongoing Tier 1 bat mitigation being conducted by DOFAW at Kahikinui Forest Reserve on Maui. The annual report for this effort for FY2016 is Appendix 9.

Adaptive Management

The third of the four total Hawaiian hoary bat fatalities occurred April 23, 2012. According to fatality estimate calculations the Baseline annual take of four was exceeded then, triggering Adaptive Management. In

accordance with the HCP, curtailment of all turbines up to a wind speed of five m/s began April 27, 2012 and continues to be implemented between sunset and sunrise from April through November. Curtailment includes blades feathered to minimize rotation.

Agency Site Visits and Reporting

KAH continued progress calls with the FWS and DOFAW throughout FY 2016. KAH biologists met with the ESRC on October 21 to review the FY 2015 HCP annual report.

Expenditures

KAH total HCP related expenditures were $176,150 (Appendix 10).

Citations

Hayes, G. and G. J. Wiles. 2013. Draft Washington bat conservation plan. Washington Department of Fish and Wildlife, Olympia, Washington. 158+ vi pp.

Hayssen, V., A. van Tienhoven, and A. van Tienhoven. 1993. Asdell's Patterns of Mammalian Reproduction: A Compendium of Species-Specific Data. Cornell University Press, Ithaca, New York, viii+1023 pp.

Humphrey, S.R. 1982. Bats, Vespertilionidae and Molossidae. p 52 – 70 *in* Wild mammals of North America: biology, management, and economics (J.A. Chapman and G.A. Feldhamer, eds.). Johns Hopkins University Press, Baltimore, MD.

Huso, M. M. P., D. H. Dalthorp, D. A. Dail, and L. J. Madsen. 2015. Estimating wind-turbine caused bird and bat fatality when zero carcasses are observed. Ecological Applications. http://dx.doi.org/10.1890/14-0764.1

Appendix 1. Fatality monitoring plot search dates for all WTGs at KAH in FY 2016.

	Search Schedule				
July	7/2/2015	7/9/2015	7/16/2015	7/23/2015	7/30/2015
August	8/5/2015	8/12/2015	8/19/2015	8/26/2015	
September	9/2/2015	9/9/2015	9/16/2015	9/23/2015	
October	10/2/2015	10/8/2015	10/15/2015	10/20/2015	10/29/2015
November	11/10/2015	11/17/2015	11/24/2015	11/30/2015	
December	12/11/2015	12/17/2015	12/23/2015	12/28/2015	
January	1/5/2016	1/13/2016	1/19/2016	1/26/2016	
February	2/2/2016	2/9/2016	2/16/2016	2/23/2016	
March	3/1/2016	3/8/2016	3/15/2016	3/22/2016	3/29/2016
April	4/5/2016	4/12/2016	4/20/2016	4/26/2016	
May	5/3/2016	5/10/2016	5/17/2016	5/22/2016	5/29/2016
June	6/7/2016	6/15/2016	6/23/2016	6/30/2016	

Appendix 2. CARE trial X at KAH in FY 2016.

CARE X FY2015		**Trial 1**		**Trial 2**		**Trial 3**		**Trial 4**		**Trial 5**		**Trial 6**	
Carcass Type		Rat		Rat		bird		Rat		Rat		Rat	
WTG		12		10		8		6		4		2	
Vegetation		Short grass on pad											
Distance (m)		30m											
Day	**Date**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**
day 0	9-Jul	P		P		P		P		P		P	
day 1	10-Jul	P		P	A	P	A	P	A,M	P	A	P	A
day 2	11-Jul	P		P	S,D	P		P		P		P	
day 3	12-Jul	P		A	C	P		P		P		P	
day 4	13-Jul	P		A		P		**P**		**P**		P	
day 5	14-Jul	P	H	A		P		A		A		P	S,D
day 6	15-Jul	**P**		A		P						P	
day 7	16-Jul	A		A		P						P	
day 8	17-Jul			A		P						P	
day 9	18-Jul			A		P						P	
day 10	19-Jul			A		P						P	
day 11	20-Jul			A		P						P	
day 12	21-Jul			A		P						P	
day 13	22-Jul			A	C	P						P	
day 14	23-Jul			P	S	P						P	
day 21	30-Jul			P		P						P	
day 28	6-Aug			**P**		**P**						**P**	
Retention (days)		**6**		**28**		**28**		**4**		**4**		**28**	

A	ants	L	fly larvae
B	body feathers	M	moved
C	dirt covered	P	present
D	desiccated	A	absent
F	feathers	S	skeleton
H	hair loss	W	wing feathers
Scav	Scavenged		

Appendix 2 (cont.). CARE trial Y at KAH in FY 2016.

CARE Y FY2016		**Trial 1**		**Trial 2**		**Trial 3**		**Trial 4**		**Trial 5**		**Trial 6**	
Carcass Type		Bird		Rat		Rat		Rat		Rat		Rat	
WTG		1		3		5		7		9		11	
Vegetation		Short grass on pad											
Distance (m)		20m											
	Date	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**
day 0	5-Oct	P		P		P		P		P		P	
day 1	6-Oct	P		P	F	P		P	A,H	P		P	A
day 2	7-Oct	P	Scav,W	P		P		P	D,C	P	A	P	
day 3	8-Oct	P		P		**P**		P		P	D,H	P	
day 4	9-Oct	P		P		A		P		P		**P**	H
day 6	11-Oct	P		P	D			P	S	P		A	
day 7	12-Oct	P		P				P		P	S		
day 15	20-Oct	P		P				P		P			
day 20	25-Oct	**P**		**P**	S			**P**		**P**			
Retention (days)		**20**		**20**		**3**		**20**		**20**		**4**	

Appendix 2 (cont.). CARE trial Z at KAH in FY 2016.

CARE Z FY2016		Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
Carcass Type		Rat		Rat		Bird		Rat		Rat		Rat	
WTG		2		4		6		8		10		12	
Vegetation		Short grass on pad											
Distance (m)		30m											
	Date	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**
day 0	22-Jan	P		P		P		P		P		P	
day 1	23-Jan	P	A	P		P		P		P	M	P	
day 2	24-Jan	P		P		P		P		P		P	
day 3	25-Jan	P		P		P		P		P		P	
day 4	26-Jan	P	L	P		P	Scav,A	P	A,L	P	A,L,M	P	A,L
day 5	27-Jan	P		P		P	B,W	P		P		P	
day 6	28-Jan	**P**	D	P	A,L,D	P		P		P	S	P	
day 8	30-Jan	A		P	S	P	M	P	S	P		P	S
day 11	2-Feb			**P**		P		P		P		P	
day 13	4-Feb			A	H	P		P		P		P	
day 14	5-Feb					P		P		P		P	
day 22	13-Feb					P	W,B	P		P		P	
day 28	19-Feb					**P**		**P**		**P**		**P**	
Retention (days)		**6**		**11**		**28**		**28**		**28**		**28**	

Appendix 2 (cont.). CARE trial AA at KAH in FY 2016.

CARE AA FY2016		Trial 1		Trial 2		Trial 3		Trial 4		Trial 5		Trial 6	
Carcass Type		Rat		Rat		Rat		Bird		Rat		Rat	
WTG		1		3		5		7		9		11	
Vegetation		Gravel											
Distance (m)		1m											
	Date	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**	**P/A**	**Notes**
day 0	24-May	P		P		**P**		P		P		P	
day 1	25-May	P		P		A		P		P	D	P	
day 2	26-May	P		P				P		A		P	A
day 3	27-May	P		P				P	A	A		P	H, D
day 4	28-May	P	H, A	P	H, A			P		A		P	
day 5	29-May	P		P	D			P		**P**	D, Scav	P	
day 6	30-May	**P**		P				P	D	A		P	
day 10	3-Jun	A		**P**				P				P	
day 11	4-Jun			A				P				P	
day 13	6-Jun							P				P	D
day 14	7-Jun							P				**P**	
day 21	14-Jun							P				A	
day 28	21-Jun							**P**			-		
Retention (days)		**6**		**10**		**0**		**28**		**5**		**14**	

Appendix 3. SEEF trials at KAH in FY 2016.

Date	WTG	Vegetation Class	Carcass Type	Found	Human/K9
7/2/2015	3	Short	Rat	1	Human
7/2/2015	6	Short	Rat	1	Human
7/2/2015	6	Short	Bird	1	Human
7/9/2015	7	Short	Rat	0	Human
7/16/2015	1	Short	Rat	1	Human
7/16/2015	8	Short	Rat	1	Human
7/16/2015	9	Short	Rat	1	Human
7/16/2015	10	Short	Rat	1	Human
7/23/2015	4	Short	Rat	1	Human
7/23/2015	4	Short	Rat	0	Human
7/23/2015	4	Short	Rat	0	Human
8/13/2015	11	Short	Rat	0	Human
8/13/2015	11	Short	Rat	1	Human
8/13/2015	6	Short	Rat	1	Human
9/2/2015	6	Short	Rat	1	Human
9/2/2015	5	Short	Rat	1	Human
9/2/2015	5	Short	Rat	1	Human
9/2/2015	3	Short	Rat	1	Human
9/2/2015	3	Short	Rat	1	Human
12/14/2015	2	Short	Rat	1	K9
12/14/2015	3	Short	Rat	1	K9
12/14/2015	5	Short	Rat	1	K9
12/14/2015	5	Short	Rat	1	K9
12/14/2015	11	Short	Bird	1	K9
2/2/2016	11	Short	Rat	1	K9
2/2/2016	12	Short	Rat	1	K9
2/2/2016	12	Short	Rat	1	K9
2/2/2016	12	Short	Rat	1	K9
3/1/2016	3	Short	Rat	1	K9
3/1/2016	4	Short	Rat	1	K9
3/1/2016	6	Short	Rat	1	K9
3/1/2016	5	Short	Rat	0	K9
5/28/2016	1	Short	Rat	1	K9
5/28/2016	2	Short	Rat	1	K9
5/28/2016	3	Short	Rat	1	K9
5/28/2016	6	Short	Rat	1	K9
5/28/2016	12	Short	Rat	1	K9
5/28/2016	5	Short	Bird	1	K9

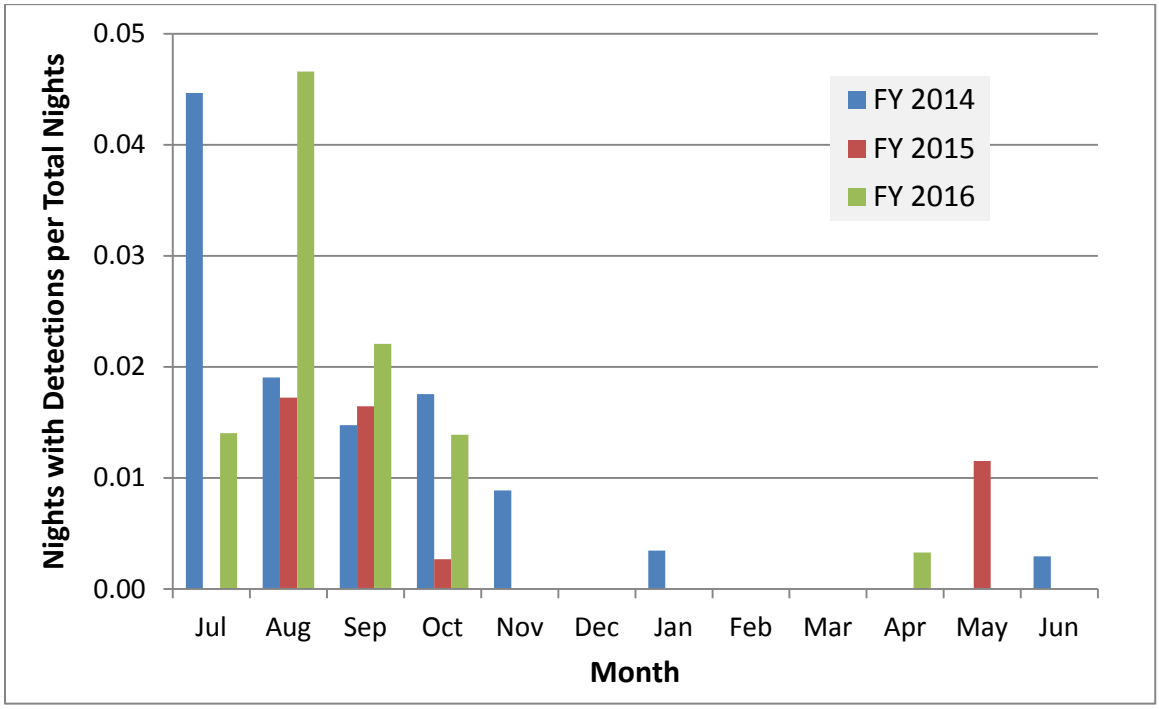
Appendix 4. Hawaiian hoary bat fatality estimation at KAH in FY 2016.

				ghat 95% CI	
Year Portion	rho	Observed Fatality	*ghat*	lower	upper
0.75	0.75	1	0.46	0.291	0.634
0.5	0.5	0	0.571	0.439	0.697
0.33	0.33	2	0.51	0.382	0.637
0.9	0.41	0	0.57	0.455	0.681
0.25	0.12	1	0.465	0.32	0.613
0.42	0.19	0	0.238	0.139	0.353
1.25	0.58	0	0.219	0.163	0.281
Overall		**4**	**0.438**	**0.326**	**0.553**
M* (estimated mortality, 80% Credibility)	**13**				

Appendix 5. Hawaiian hoary bat Indirect take calculation.

Component	Input/Description	Result/Value
A	Total Estimated Direct take	13
B	Observed direct take (ODT)	4
C	Unobserved direct take (UDT) (**A - B**)	9
D	ODT female or unknown during Apr 1-Sep 15 (1 female, 3 unknown)	4
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**)	7.2
H	UDT IDT (**C x E x F**)	2.0
I	IDT total (**G + H**)	9.2
J	Survival of juvenile to adult	0.3
	IDT as adults (I x J)	2.8
	Total IDT rounded up	**3**

Appendix 6. Proportion of nights with bat detections at KAH in FY 2014-2016.



Appendix 7.

Monitoring of endangered seabird colonies on Kaua‘i

Implementation of Kahuku Wind Power and Kawailoa Wind Power Habitat Conservation Plan Seabird Mitigation Actions

Annual Report 2015

André F. Raine[1], Megan Vynne[1], Mike McFarlin[1], Matthew McKown[2] & David Savage[2]

March 2016

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[2]Conservation Metrics, Inc. (CMI), Center for Ocean Health, 100 Shaffer Rd., Santa Cruz, CA 95060

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1.0 INTRODUCTION

Predation by non-native predators is a constant threat to endangered seabird populations in the Hawaiian islands. Feral cats (*Felis cattus*), rats (particularly Black (*Rattus rattus)*), Barn Owls (*Tyto alba*) and feral pigs (*Sus scrofa*) are all non-native predators that are potentially limiting the breeding success of birds within these colonies. Predation by all of the above predators has been documented to occur within Newell's Shearwater (*Puffinus newelli*) and Hawaiian Petrel (*Pterodroma sandwichensis*) colonies on Kaua'i. In some areas on Kaua'i, endangered seabird populations are for the most part protected from terrestrial mammalian predators by topography. This is particularly true on the steep cliffs of the Na Pali coast, as well as off-shore islets such as Lehua. In these areas, the primary threat from introduced predators are therefore aerial predators.

The removal of Barn Owl populations was identified as an important management action within key seabird colonies on Kauai. Management for Barn Owls (ie lethal control) at these sites is expected to increase the survival rates of both adult birds and fledglings.

This project was initiated via funding from Sun Edison (then First Wind) in 2013 as part of the implementation of Kahuku Wind Power and Kawailoa Wind Power Habitat Conservation Plan Seabird Mitigation Actions. In that year a total of five sites were assessed by the Kaua'i Endangered Seabird Recovery Project (KESRP) for the presence of two endangered seabirds, the Newell's Shearwater and the Hawaiian Petrel, to help guide site selection for a Barn Owl control project planned for the following year. These sites were: (1) North Fork Wailua; (2) Sleeping Giant; (3) Kalaheo; (4) Makaleha; and (5) Haupu. Auditory surveys conducted by the KESRP in previous years had confirmed that these sites all contained Newell's Shearwater colonies, with some sites also containing Hawaiian Petrels. In 2013, no seabird conservation or management was being conducted in these areas and so they made potential candidates for predator control. Song meters were deployed at all of these sites by helicopter to record call rates during the peak of the breeding season. The only exception to this was Lehua, where song meters were deployed by hand.

The majority of the sites identified as potential control sites in 2013 were found to contain very low levels of seabird activity and were thus removed from further consideration the following year. Based on the song meter work conducted in 2013 and further updated survey information on known seabird colonies provided by KESRP, six sites were subsequently identified to benefit from Barn Owl control in 2014: (1) Nualolo Aina; (2) Nualolo Kai; (3) Honopu; (4) Kalaheo/Kahili; (5) Lehua Islet; and (6) the back of Hanalei Valley. Song meters were again used to assess seabird activity rates at these sites.

The same sites surveyed in 2014 were surveyed again in 2015 to allow for inter-annual comparisons at each site. 2015 also saw the initiation of the Barn Owl control project through a two person control team hired through DOFAW. Results of the Barn Owl control work are presented in a separate report.

The main aims of the seabird monitoring project in 2015 were as follows:

- Monitoring of seabird colony (Newell's Shearwater & Hawaiian Petrel) activity through the use of song meters deployed at each site through the peak of the breeding season.
- Monitoring of overall annual change of colony size through the use of static song meters at each area.
- Monitoring of Barn Owl presence and change in Barn Owl population following Barn Owl control activities.

2.0 METHODOLOGY

2.1 Song meter deployment

Eleven sites were monitored by the Kauai Endangered Seabird Recovery Project in 2015 using Song Meter 2+ sensors (http://www.wildlifeacoustics.com). Three song meters were deployed on Lehua Islet, six in North-West Kaua'i, and two in central Kaua'i (Figures 1 & 2). Each of these locations had been included in the 2014 survey effort, and two (ROVFW2 and ROVFW3) had also been surveyed in 2013. Sensors on the Na Pali coast were deployed from 7 April to 18 November; sensors in interior Kaua'i were deployed from 7 April to 27 August; and sensors on Lehua were deployed from 19 May to 1 September. Contracted analysis was for the period from April to September, but Conservation Metrics has included analysis of the period from September to November to better understand the activity trends of Barn Owls.

Song Meters were powered by 4 D-cell alkaline batteries and stored recordings on a 32 GB SD memory card. All sensors were fitted with one or two omni-directional microphones (depending on method of deployment) and recorded on one or two channels at a sampling rate of 22 kHz. Song meters were deployed either by helicopter or on foot. For helicopter deployments (all sites on Kauai), song meters were placed in specially designed deployment boxes (Figure 3) and lowered out of the helicopter using a rope and grappling hook. For deployments on foot (all sites on Lehua Islet), permanent static locations were selected such that sensor microphones were sheltered from prevailing winds, and were well away from moving branches and leaves. Rocks or stakes were used to stabilize the sensor vertically, with microphones pointing horizontally.

Sensors were programmed to record 1 minute every 5 minutes for 5 hours after sunset, and 1 minute every 10 minutes for 5 hours before sunrise. Programming was undertaken using the SMCONFIG software package.

After deployment, song meters were checked after two months (just short of the expected duration of battery life). SD cards and batteries were swapped out during this check. If a microphone was obviously malfunctioning (i.e., the weather screen was extensively damaged by rats, for example) then it was immediately replaced by a new microphone in the field. Even if both microphones were functioning properly, one was switched with a new microphone to decrease the likelihood of microphone failure. For song meters deployed by helicopter, song meters were collected using the grappling hook method and taken to a central location (Nualolo Kai LZ) to switch out batteries, SD cards and microphones. For Lehua song meters, switch outs occurred *in situ*.

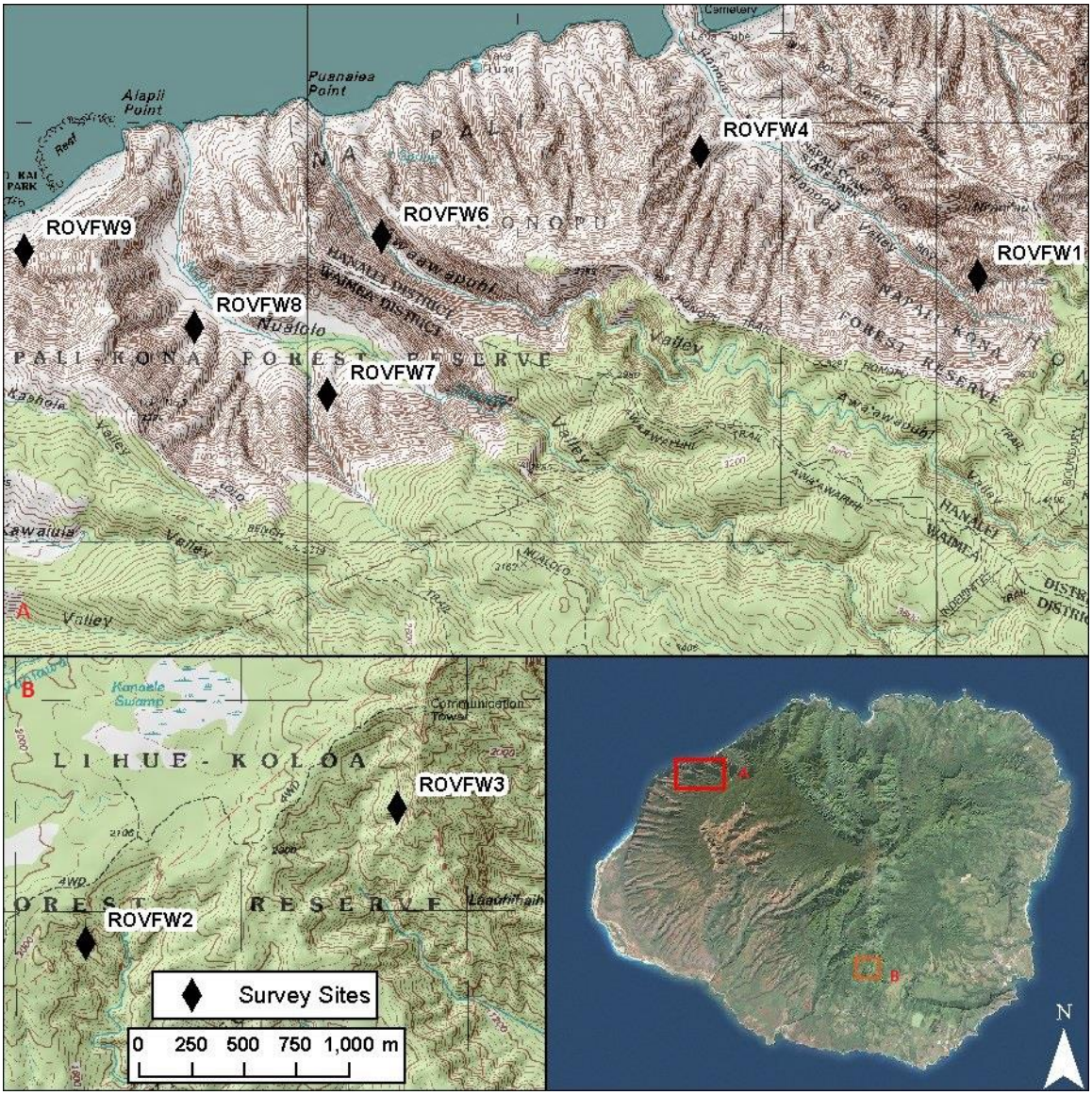


Figure 1. 2015 survey locations on Kaua'i.

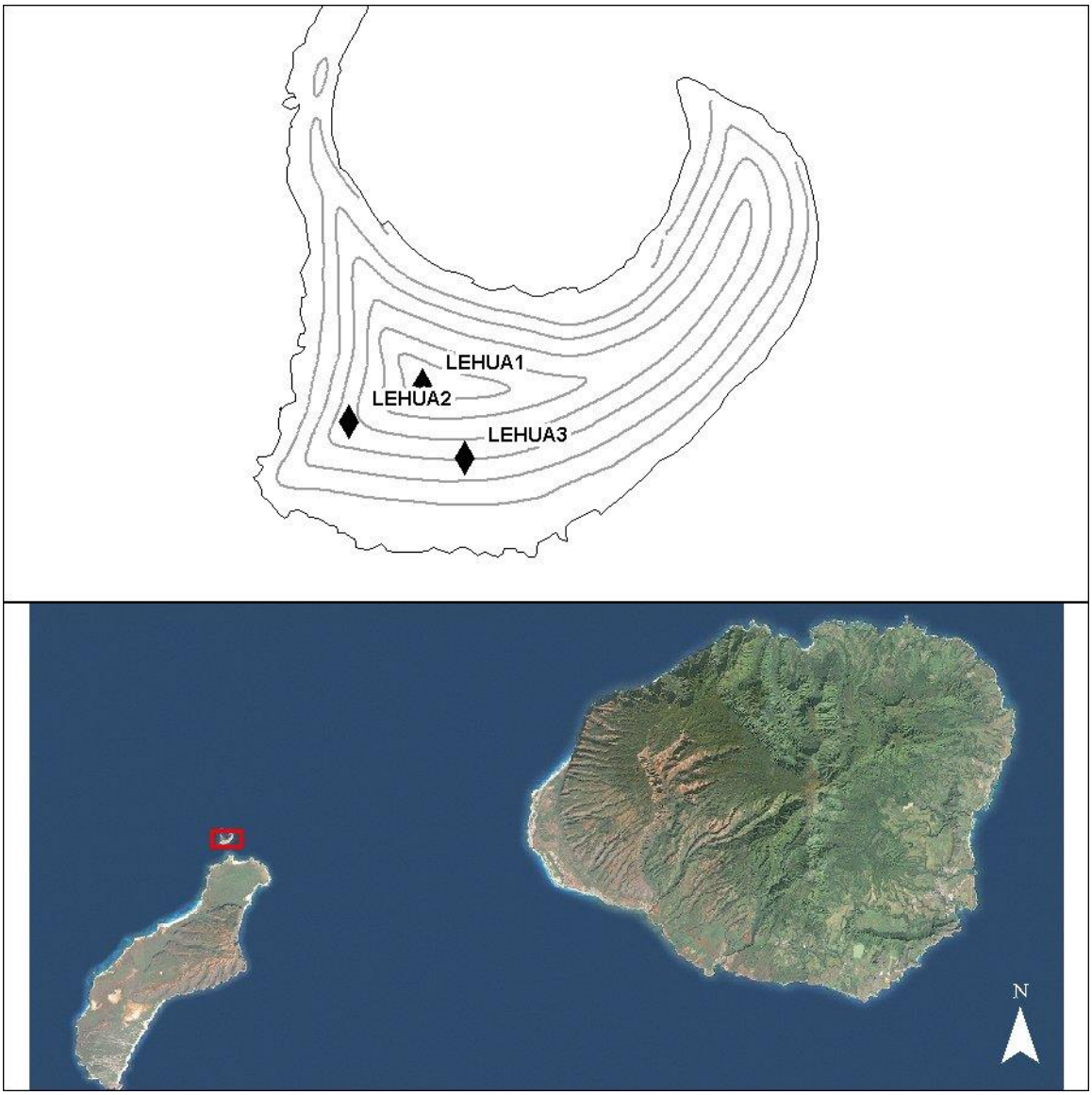


Figure 2. 2015 survey locations on Lehua.

2.2 Song meter analysis

Automated analysis of all field recordings from Upper Mānoa was carried out by Conservation Metrics (CMI). In 2014, CMI developed more powerful automated detection and classification software for use in colony monitoring efforts by KESRP and this was used at all monitored colonies again in 2015. The new method relied on Deep Neural Network (DNN) models, a machine learning technique that categorizes sounds by searching field recordings for sounds matching the spectro-temporal features of target sounds (i.e. calls from the species of interest). Deep Neural Networks are the current state of the art for detection and classification problems in many fields including speech recognition (Deng, Hinton, & Kingsbury, 2013), computer vision, image recognition (Cires & Meier, 2012), as well as other classification problems.

The process used by CMI splits field-recordings into 2-second clips and takes measurements of 10 spectro-temporal features that are typically found in biological sounds. A DNN detection model is then constructed for each species from a training dataset that contains many examples of target sounds (vocalizations from target species) as well as a representative example of other background sounds from the soundscape at all survey sites. The DNN learns which spectral features best differentiate target sounds from other sounds in the environment through a series of rounds of training and cross-validation. The trained model can then be used to flag sounds of interest on field recordings, returning a probability that a given 2-second window contains a sound from a target species. This method has proven to find more target sounds, and generate less errors than the previous detection algorithm employed in 2012 and 2013 (the Spectrogram Cross Correlation (SCC) detector in the XBAT bioacoustics analysis package).

As in previous years for other monitored sites, all events flagged by the automated classification model were reviewed manually during the 2015 analysis process to confirm true calls and/or remove all sounds misidentified as Newell's Shearwater or Hawaiian Petrel vocalizations.

2.2.1 Call Rate Comparisons

The 2015 monitoring season was the second year of large-scale acoustic surveys conducted for Sun Edison (previously First Wind) on Kaua'i and Lehua. Where appropriate, CMI has included comparisons between 2014 survey data and the results from 2015 surveys. Because seabird activity can be influenced by lunar state, we used subsets of each year's data corresponding to 4 complete moon cycles during the same stage of the breeding season. The start date for each comparison period was chosen as the first full or new moon closest to May 1 of each year. **Error! Reference source not found.** displays the dates and duration of these comparison periods.

Year	Start of Comparison Period	End of Comparison Period	Number of Days in Comparison Period
2014	4/30/2014	8/25/2014	117
2015	5/4/2015	8/29/2015	117

Table 1. Comparison periods for each year of survey effort on Kaua'i and Lehua.

Figure 3. Song meter being deployed in specially designed deployment box in Nualolo Aina.

3.0 MONITORING EFFORT

In 2015, a total of 5 trips were undertaken by KESRP as part of this project. Table 2 provides details for each trip.

Date	Location	# staff	Notes
7 Apr	Na Pali Coast & Kalaheo/Kahili	2	Helicopter deployment of Song Meters
18-20 May	Lehua Islet	3	Deployment of song meters
15 Jun	Na Pali Coast & Kalaheo/Kahili	2	Helicopter switch out of SD cards, batteries and microphones
27 Aug	Na Pali Coast & Kalaheo/Kahili	2	Helicopter recovery of Song Meters
31 Aug – 2 Sept	Lehua Islet	3	Recovery of song meters

Table 2. Monitoring trips carried out by KESRP in 2015 as part of this project.

4.0 RESULTS

4.1 Survey Effort

A total of 2,706.23 hours of recordings were collected over the course of 1,810 survey nights. After correcting for recordings made with defective microphones, survey effort was reduced to 1,607.95 hours of recording over 1,707 survey nights (i.e. 40.58% of data was lost) (Table 1). There were seven sites (Lehua2, ROVFW1, ROVW2, ROVFW3, ROVFW6, ROVFW8, and ROVFW9) that experienced a failure rate greater than 20% (Table 2, Figure 4). It is likely that this is an overestimate of the data lost, as the current tool for detecting poor quality recordings is a blunt tool. Conservation Metrics (CMI) is developing a more precise tool for removing poor quality recordings, and a more sophisticated statistical approach to dealing with these data gaps. In practice, year on year comparisons will be improved and the 2015 data could be re-analyzed with the new approach to recover some of the data removed for this analysis.

SPID	Total Nights	Total Hours	Corrected Nights	Corrected Hours	Nights Lost	% Nights Lost	Hours Lost	% Hours Lost
LEHUA01	64	94.95	63	91.93	1	2.00%	3.02	3.00%
LEHUA02	63	94.8	63	33.31	0	0.00%	61.49	65.00%
LEHUA03	59	88.8	59	80.41	0	0.00%	8.39	9.00%
ROVFW1	226	339.02	222	205.46	4	2.00%	133.56	39.00%
ROVFW2	143	211.72	134	162.6	9	6.00%	49.12	23.00%
ROVFW3	143	211.41	139	154.88	4	3.00%	56.53	27.00%
ROVFW4	226	338.99	226	275.78	0	0.00%	63.21	19.00%
ROVFW6	226	338.44	149	155.5	77	34.00%	182.94	54.00%
ROVFW7	208	310.6	208	248.13	0	0.00%	62.47	20.00%
ROVFW8	226	338.59	220	106.89	6	3.00%	231.7	68.00%
ROVFW9	226	338.91	224	93.06	2	1.00%	245.85	73.00%
Total	**1810**	**2706.23**	**1707**	**1607.95**	**103**	**6.03%**	**1098.28**	**40.58%**

Table 2. Acoustic monitoring effort at each site over the full monitoring period (*7 April* to *18 November 2015*).

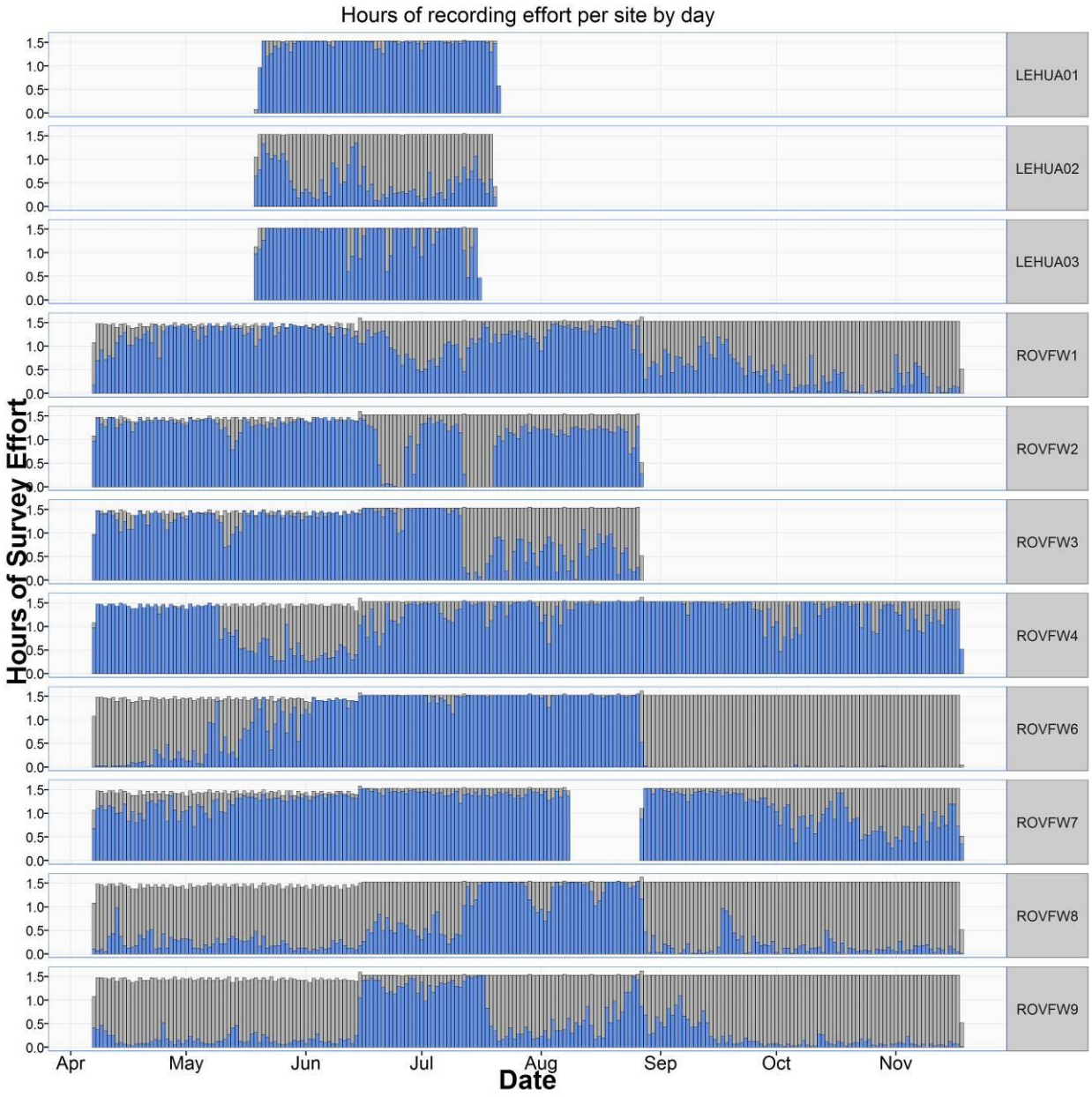


Figure 4. Acoustic monitoring effort over the full survey period (7 April to 18 November 2015). Grey bars show total amount of recordings received, and blue bars represent recordings determined to be of acceptable quality for use in analysis.

4.2 Acoustic Monitoring of Seabirds

4.2.1 Newell's Shearwater

Newell's Shearwater activity was first detected at 19:54 on 7 April, the first day of survey effort, at sites ROVFW1 and ROVFW4 on Kaua'i, with regular vocal activity at ROVFW1 having already begun (Figure 5), and at ROVFW4, ROVFW 7, and ROVFW 8 around 15 April (Figure 5). Regular activity continued throughout the entire survey period at all sites on Kaua'i. Sites ROVFW2, 3, and 6 exhibited low to intermittent levels of activity following no obvious pattern (Figure 5, Table 3). No Newell's Shearwater calls were detected on Lehua in 2015.

Activity was highest at ROVFW1, followed by ROVFW7, with strong activity also detected at ROVFW4 and ROVFW8, (Figure 6 & 7, Table 3). At sites where Newell's Shearwater was detected, call rates peaked 30-90 minutes before sunrise, with a secondary lower peak of acoustic activity 40-100 minutes after sunset (Figure 8). Call rates were also linked to moon phase, with lower levels of calling during the full moon (Figure 9).

In comparing this year's call rates on Kaua'i to those from 2014, there were no significant differences (Paired T-test, DF=7, $p>0.05$) (Figure 10, Figure 11).

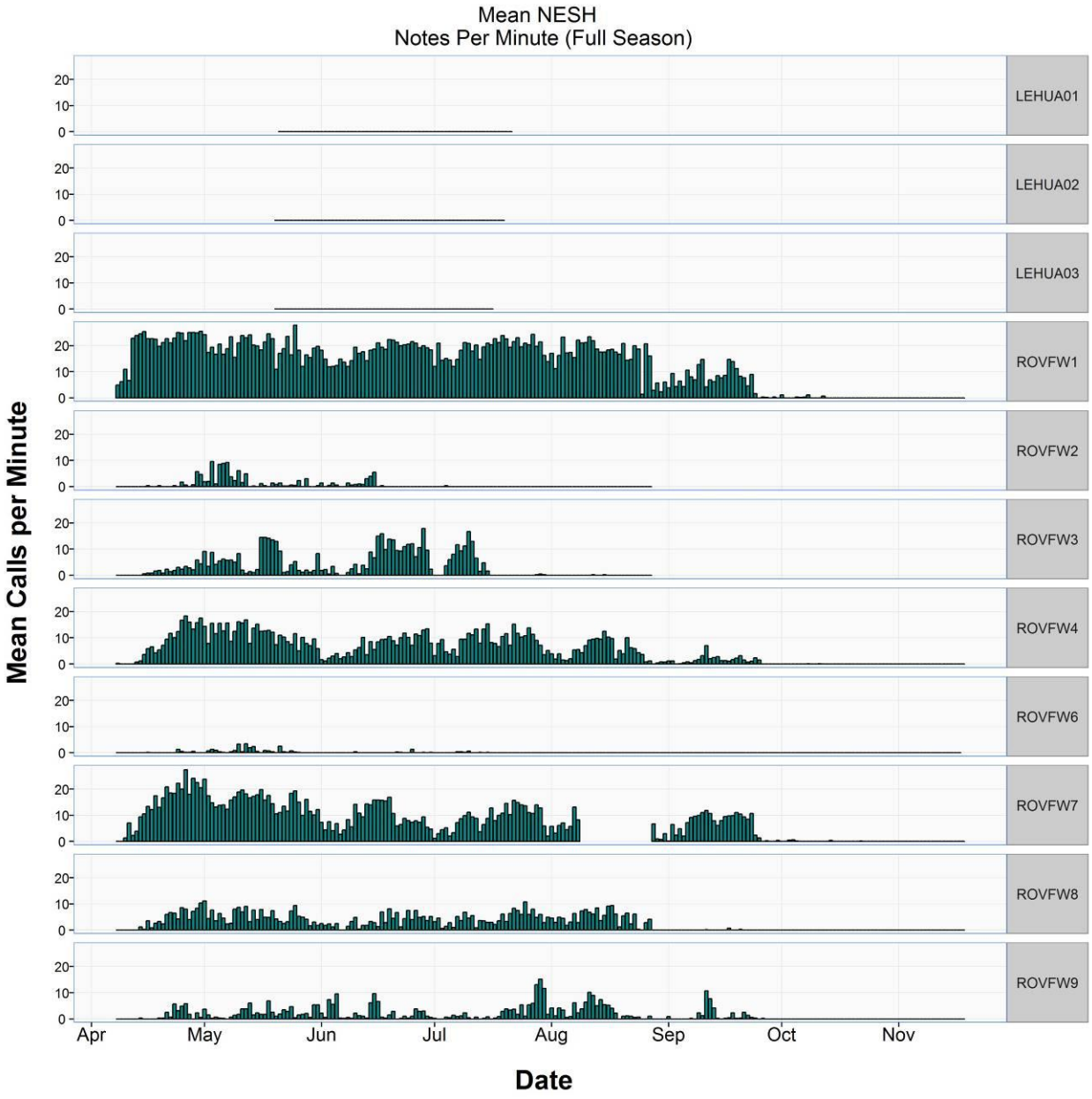


Figure 5. Newell's Shearwater activity by date during peak calling hour (90 to 30 minutes before sunrise).

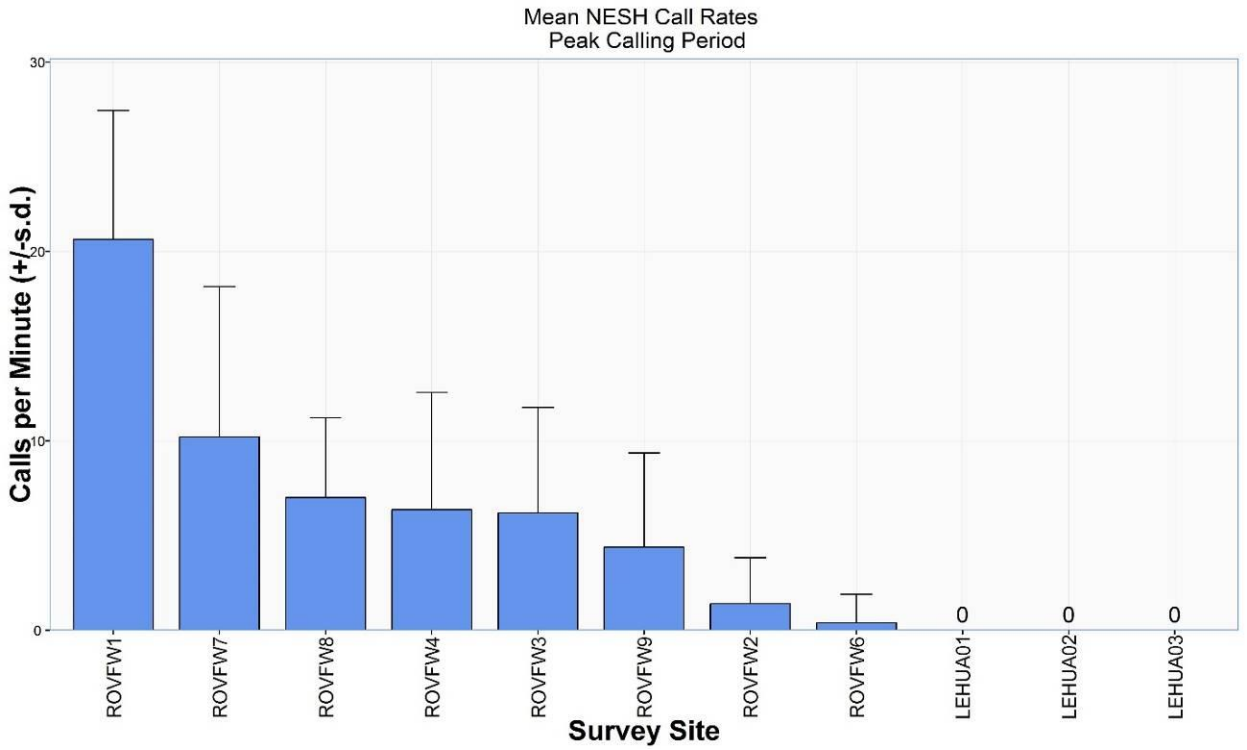


Figure 6. Newell's Shearwater call rates across entire survey duration (7 April 20 18 November 2015), during peak calling hour (90 to 30 minutes before sunrise).

SPID	N	Calls/min	sd	se
LEHUA01	62	0	0	0
LEHUA02	46	0	0	0
LEHUA03	56	0	0	0
ROVFW1	174	20.639	6.803	0.516
ROVFW2	74	1.402	2.417	0.281
ROVFW3	92	6.203	5.560	0.580
ROVFW4	224	6.372	6.185	0.413
ROVFW6	120	0.390	1.507	0.138
ROVFW7	184	10.208	7.942	0.586
ROVFW8	135	7.006	4.208	0.362
ROVFW9	153	4.388	4.962	0.401

Table 3. Newell's Shearwater call rates across entire survey duration (7 April 20 18 November 2015), during peak calling hour (90 to 30 minutes before sunrise).

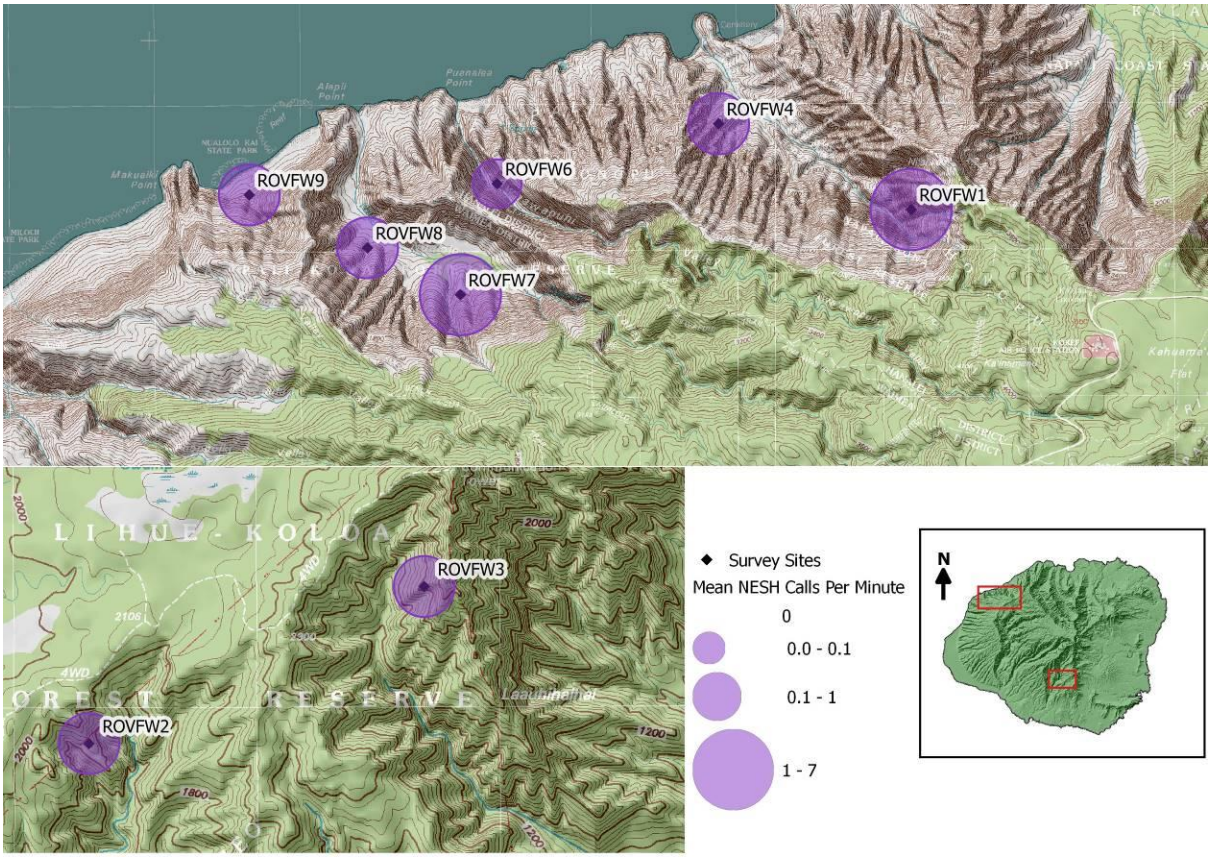


Figure 7. Map showing Newell's Shearwater call rates in comparison period (4 May to 29 August 2015), during peak calling hour (90 to 30 minutes before sunrise).

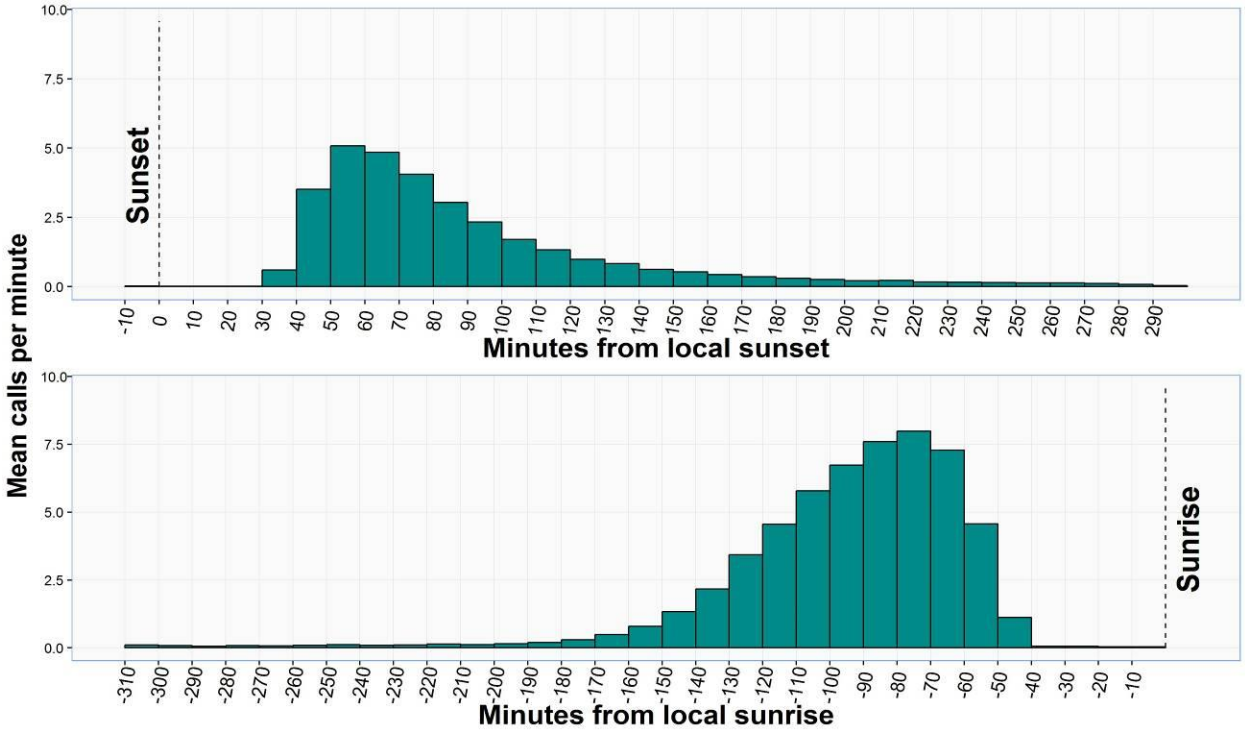


Figure 8. Newell's Shearwater call rates as a function of time from sunrise and sunset averaged across the complete 2015 survey duration in ten-minute bins, showing activity peak in the time before sunrise.

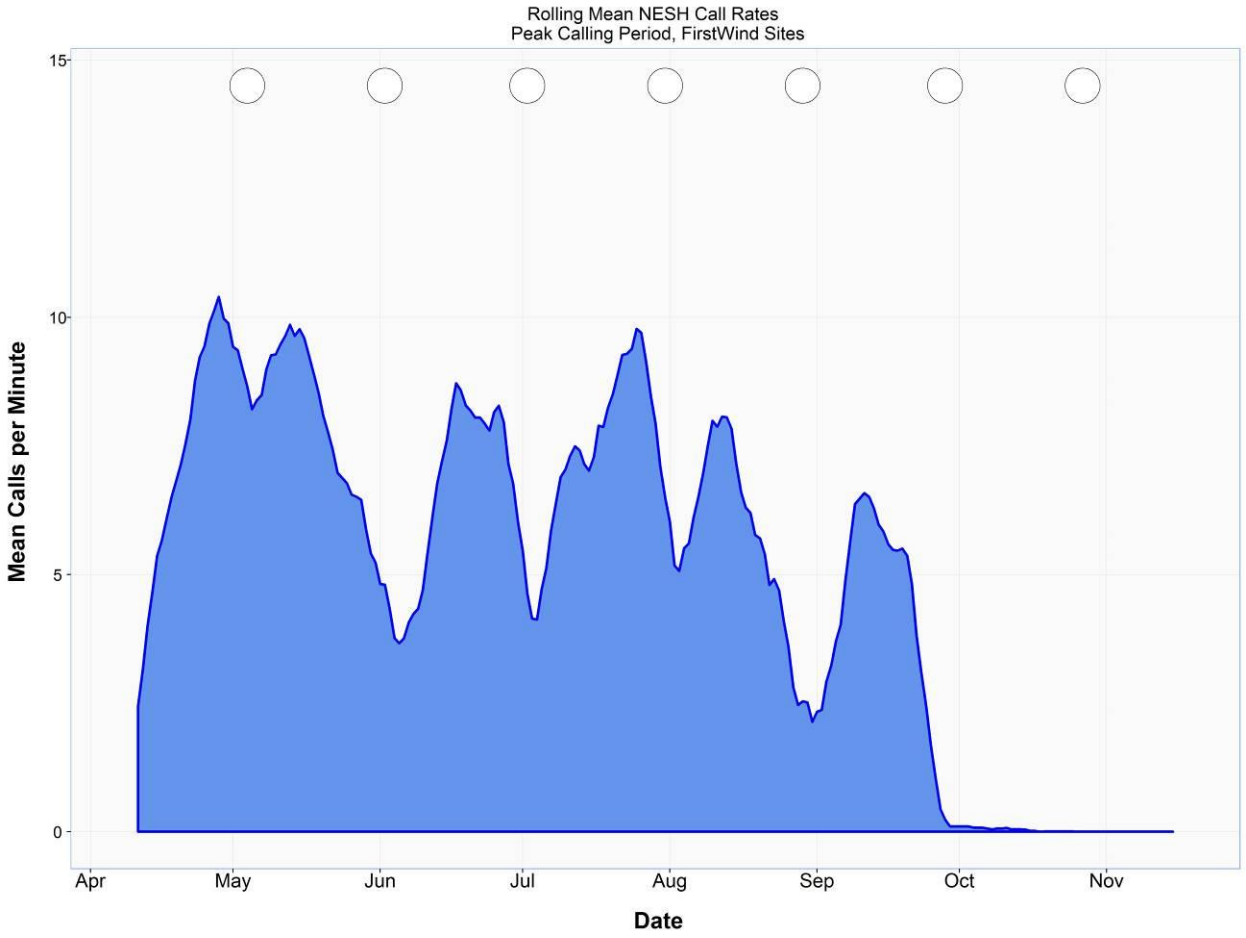


Figure 9. Seven-day rolling mean of Newell's Shearwater activity during peak calling hour (90 to 30 minutes before Sunrise) combining all Kaua'i sites (three sites on Lehua excluded). Data suggest a reduction in shearwater acoustic activity around the full moon, which is consistent with patterns observed during auditory surveys.

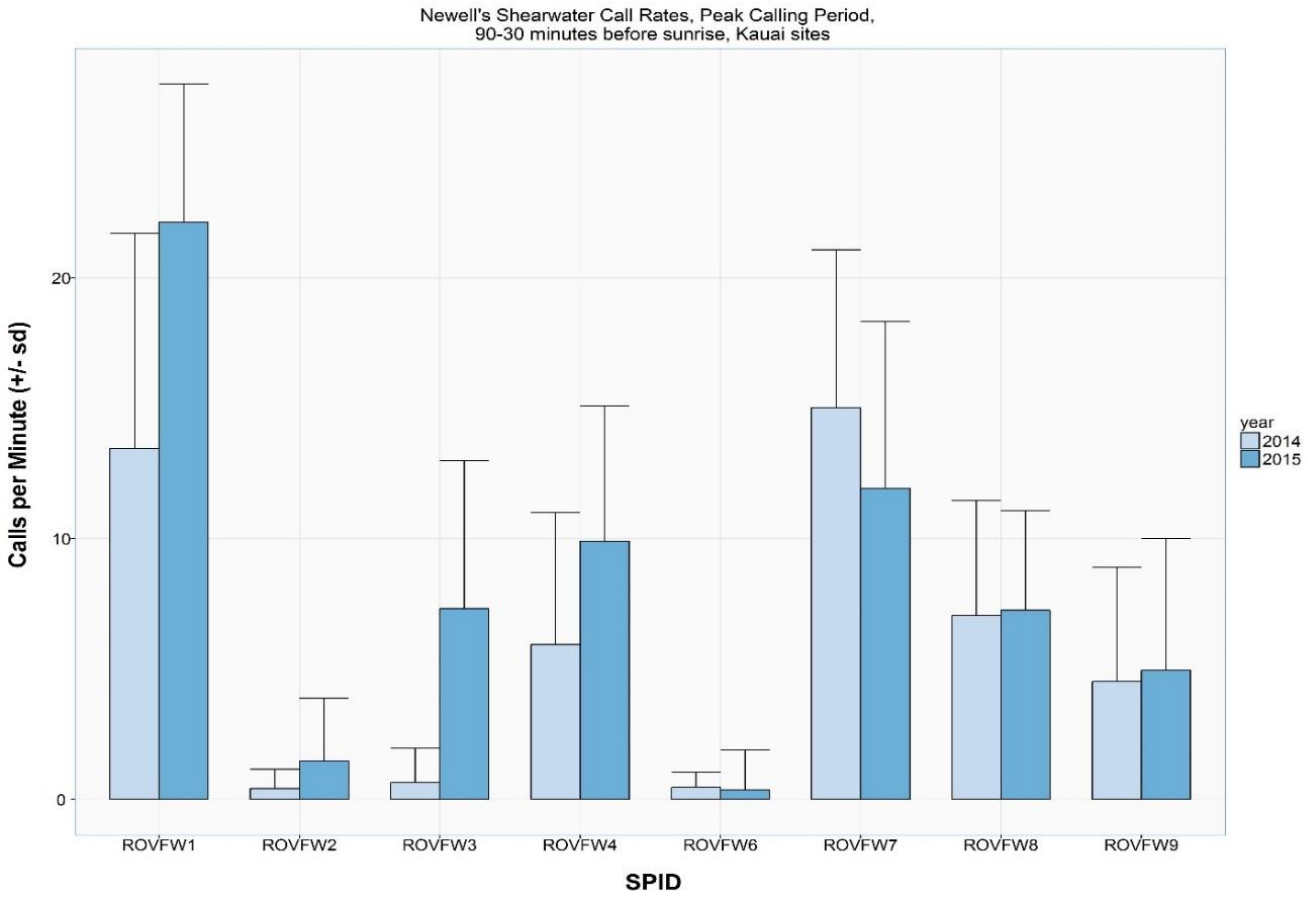


Figure 10. Comparison between years of survey effort, during comparison period (Table 2), at all sites on Kaua'i during peak calling hours (90-30 minutes before Sunrise).

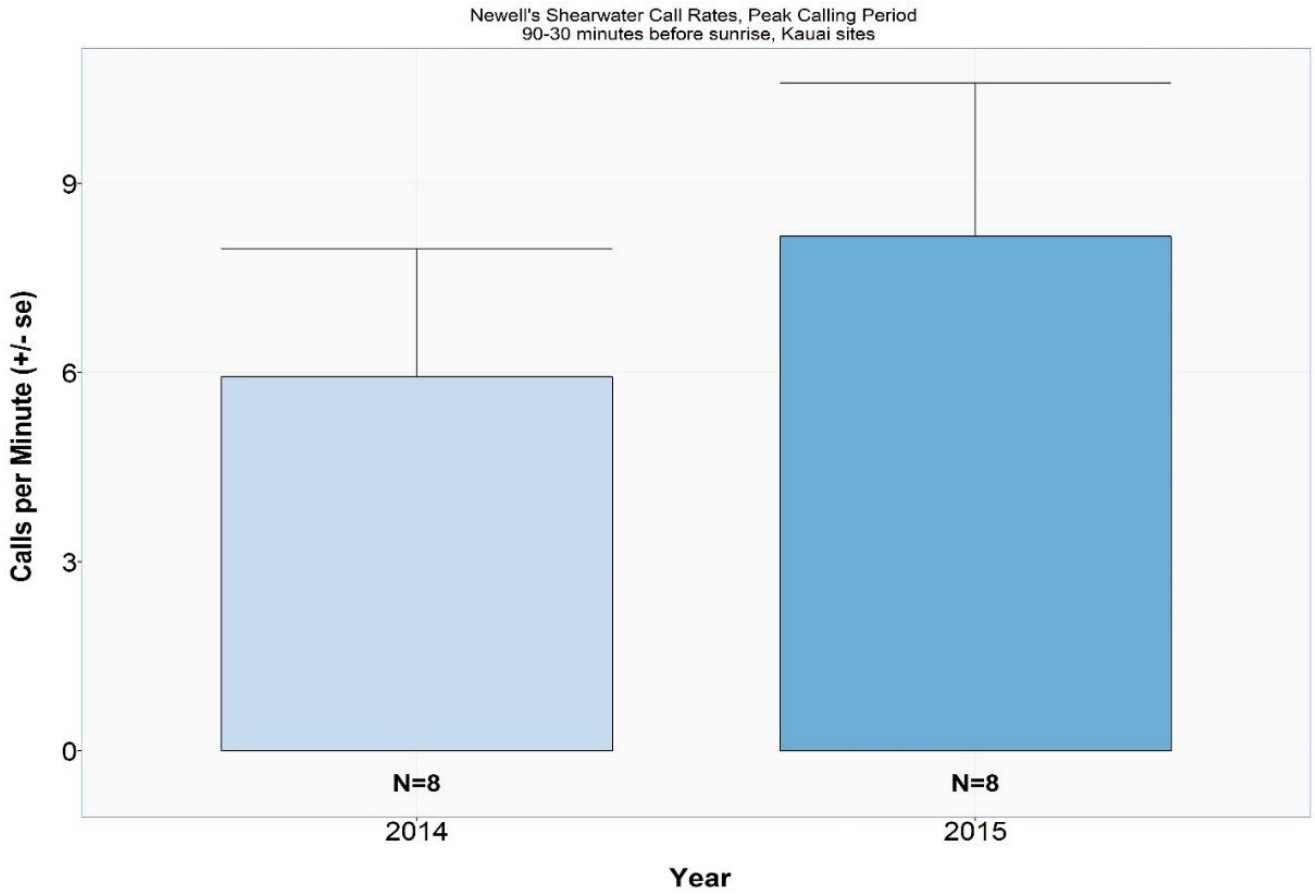


Figure 11. Summary comparison between years of survey effort, during comparison period (Table 2), at all sites on Kaua'i during peak calling hours (90-30 minutes before Sunrise). Differences between years at Kaua'i sites were not significantly (t.test, $p>0.05$)

4.2.2 Hawaiian Petrel

The first detection of Hawaiian Petrel activity during the 2015 surveys was on 8 April, the second day of survey effort, at the ROVFW3 location. Sporadic detection of this species continued throughout the 2015 surveys, but were limited to that single survey location (Table 4, Figure 12 & 13). Activity was extremely rare and sporadic, and because there was such limited data followed no apparent seasonal or diel patterns (Figure 14). No Hawaiian Petrel calls were detected on Lehua in 2015.

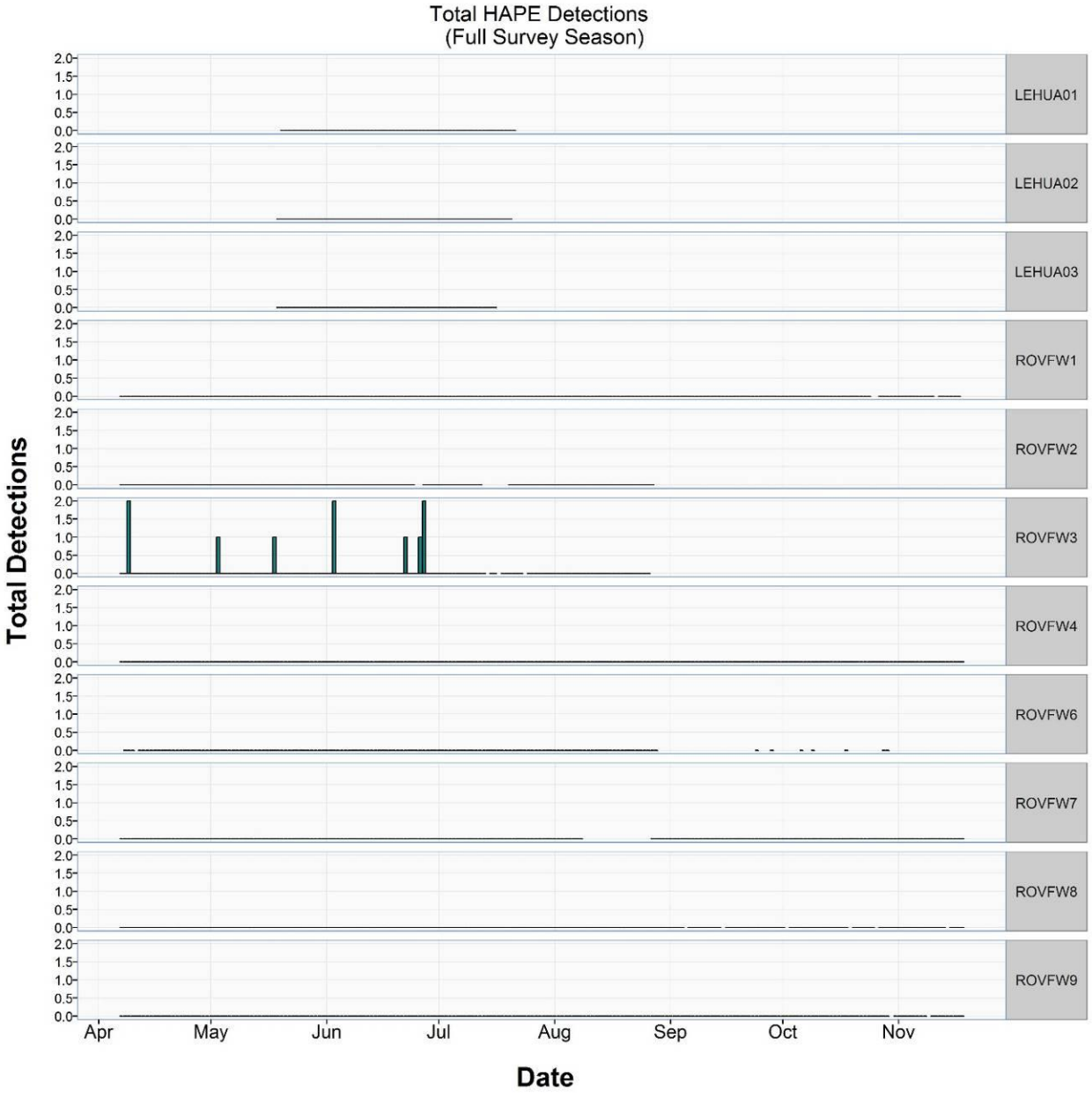


Figure 12. Total 2015 Hawaiian Petrel detections by date at all sites.

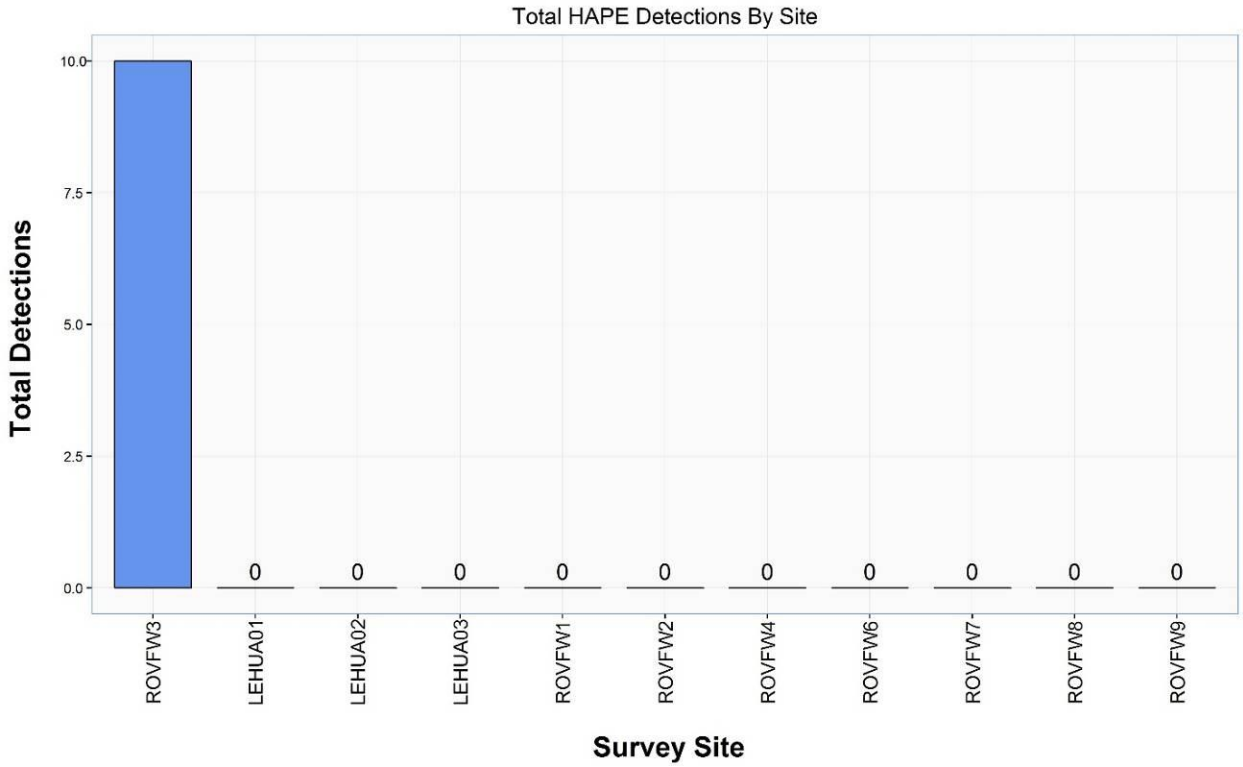


Figure 13. Total Hawaiian Petrel detections at all survey sites during complete 2015 survey effort.

SPID	N	Total Detections
LEHUA01	63	0
LEHUA02	63	0
LEHUA03	59	0
ROVFW1	222	0
ROVFW2	134	0
ROVFW3	139	10
ROVFW4	226	0
ROVFW6	149	0
ROVFW7	208	0
ROVFW8	220	0
ROVFW9	224	0

Table 4 Total Hawaiian Petrel detections at all 2015 survey sites during complete 2015 survey effort.

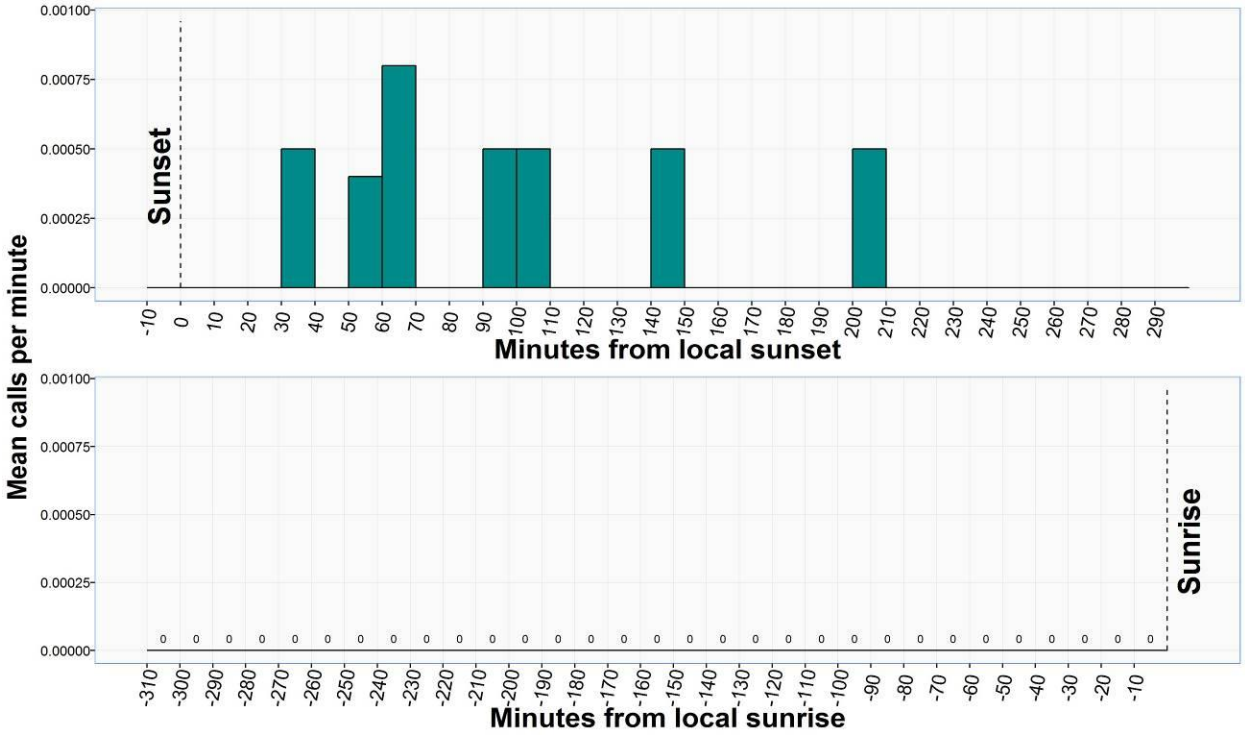


Figure 14. Hawaiian Petrel activity at all sites as a function of time from sunset and sunrise

4.3 Acoustic Monitoring of Predators

4.3.1 Barn Owl

We quantified Barn Owl "territorial screams" on field recordings. Owl acoustic activity was first detected on Kaua'i during the initial day (7 April) of the 2015 survey effort, and first detected on Lehua on 26 May. The eight Kaua'i survey sites exhibited a high degree of variability in call detection rates, with ROVFW7 (in lower Honopu valley) showing particularly high call frequency (**Error! Reference source not found.**15-18). Calls were detected during the majority of survey nights at this site, with detection totals more than ten times greater than the next most active site early in the season (Note, we removed nights when predator control teams were playing acoustic recordings of Barn Owl calls). Lehua sites had comparatively low call rates, and were similar to each other (Figure 17).

Barn Owl calls were generally rare and sporadic at most survey sites, with calling continuing throughout the night (Figure 19). This, coupled with the potentially large size of Barn Owl home ranges, ongoing control efforts, and relatively large spatial scale on Kaua'i made it difficult to discern spatial and temporal patterns.

Statistical comparisons across seasons show a drop in nights with owl acoustic activity between 2014 and 2015 on Kaua'i and Lehua, although these differences were not statistically significant (Figure 20 & 21). An increase in survey effort, and or exploration of other owl call types might improve the power of acoustic surveys for monitoring Barn Owl activity in the face of management actions.

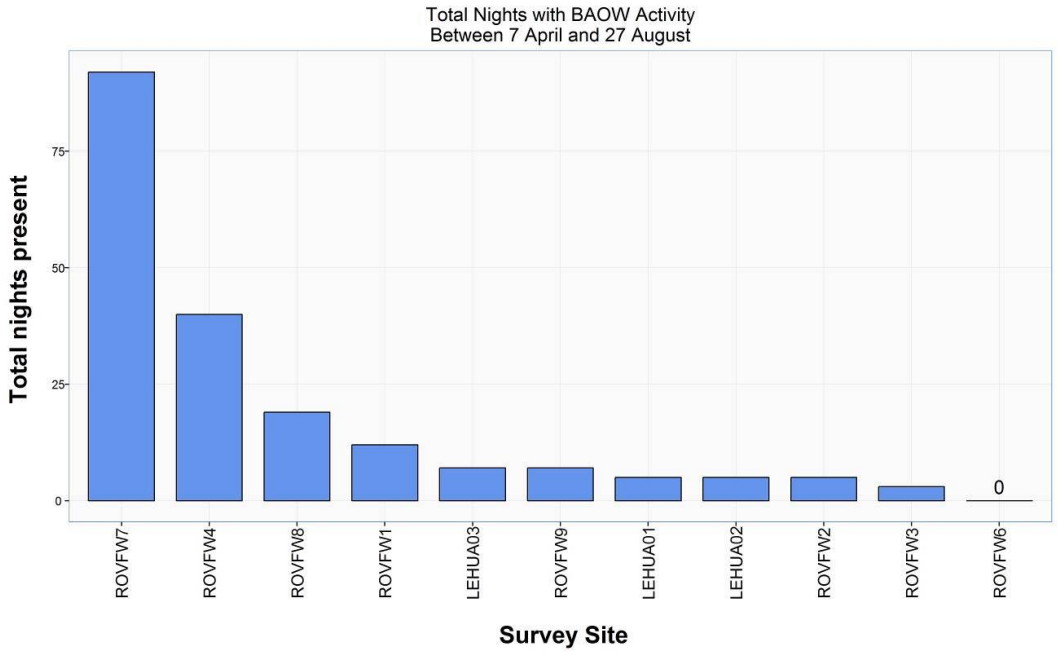


Figure 15. Total nights with one or more Barn Owl call detected at each survey site in comparison period used for comparing activity between 2014 and 2015.

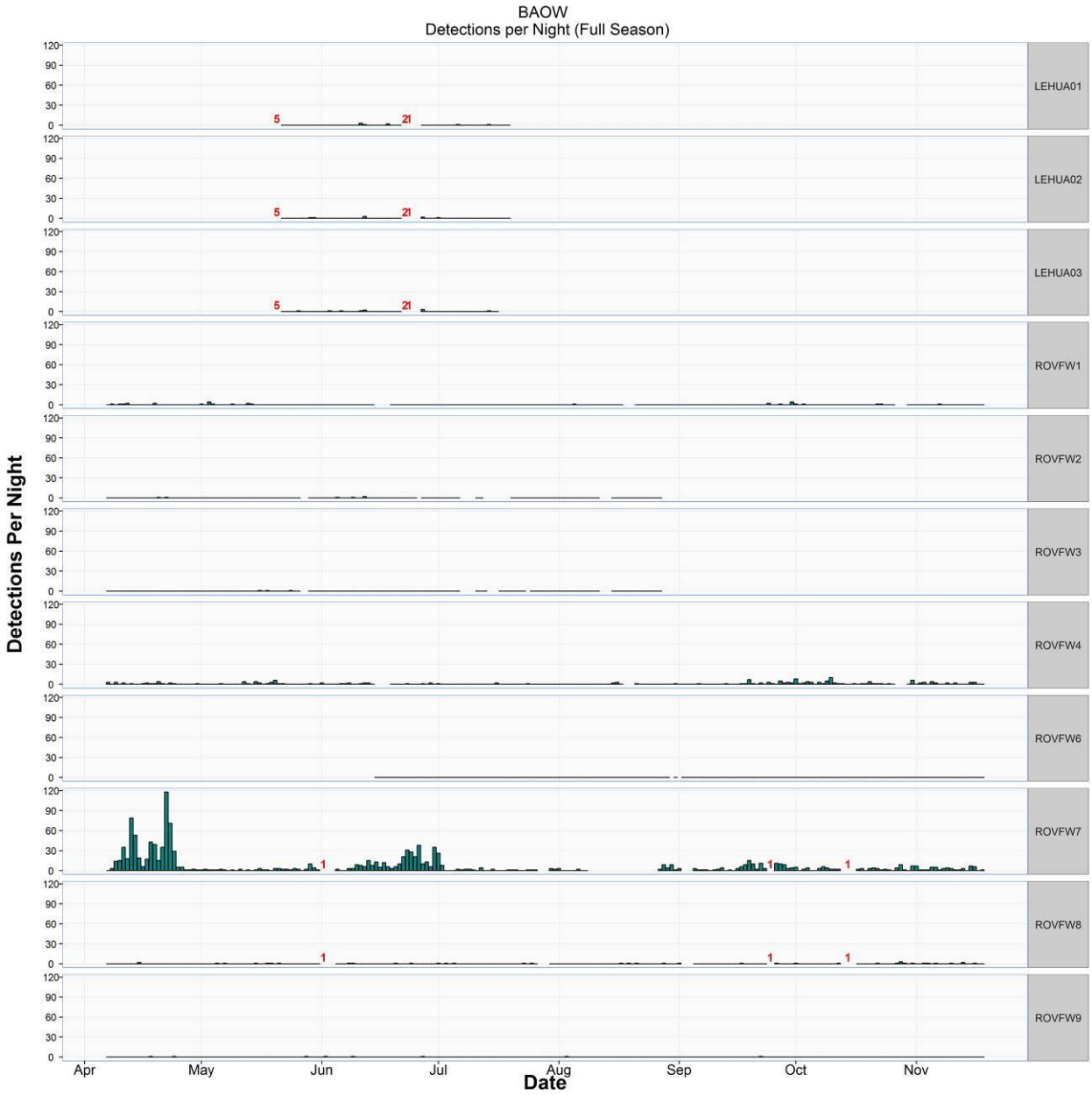


Figure 16. Total Barn Owl detections by day at all sites surveyed on Kaua'i and Lehua in 2015. Red numbers show number of owls removed on a given day, as per data provided by the DOFAW Barn Owl control team. Note the '21' for Lehua denotes 2 BAOW removed on one day and 1 BAOW removed the following day.

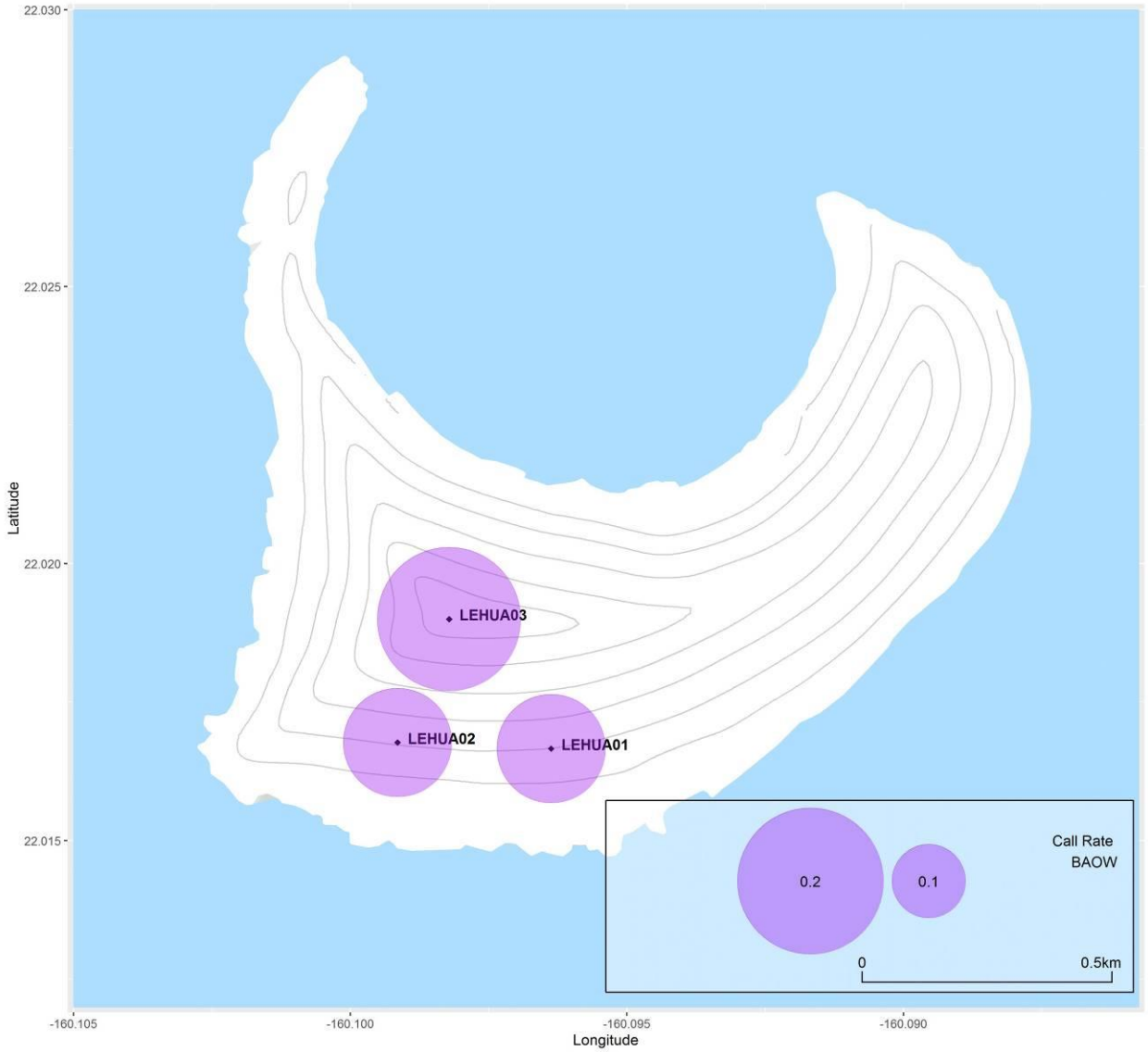


Figure 17. Map showing mean Barn Owl calls per Night detected on Lehua during 2015 survey effort.

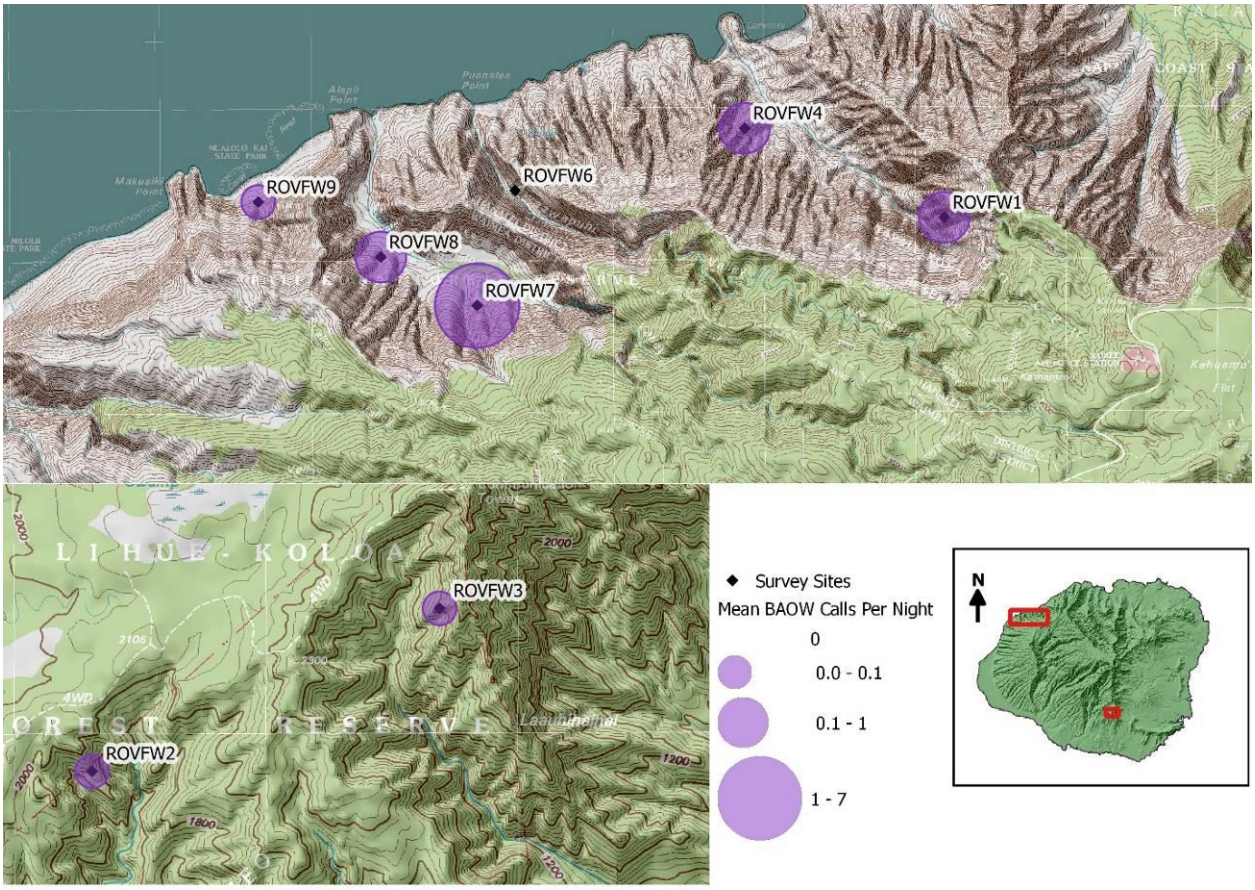


Figure 18. Map showing mean Barn Owl calls per night detected on Kaua'i during survey effort in 2015.

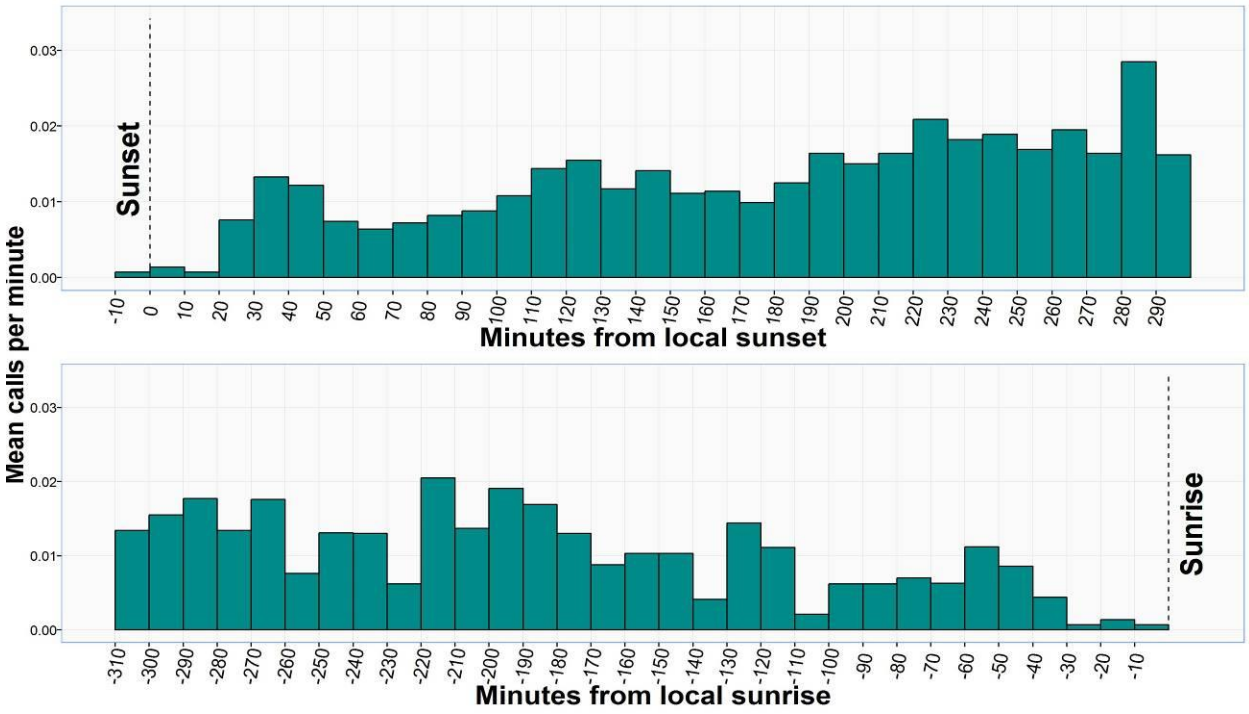


Figure 19. Barn Owl call rates across all sites, as a function of time from sunset and sunrise.

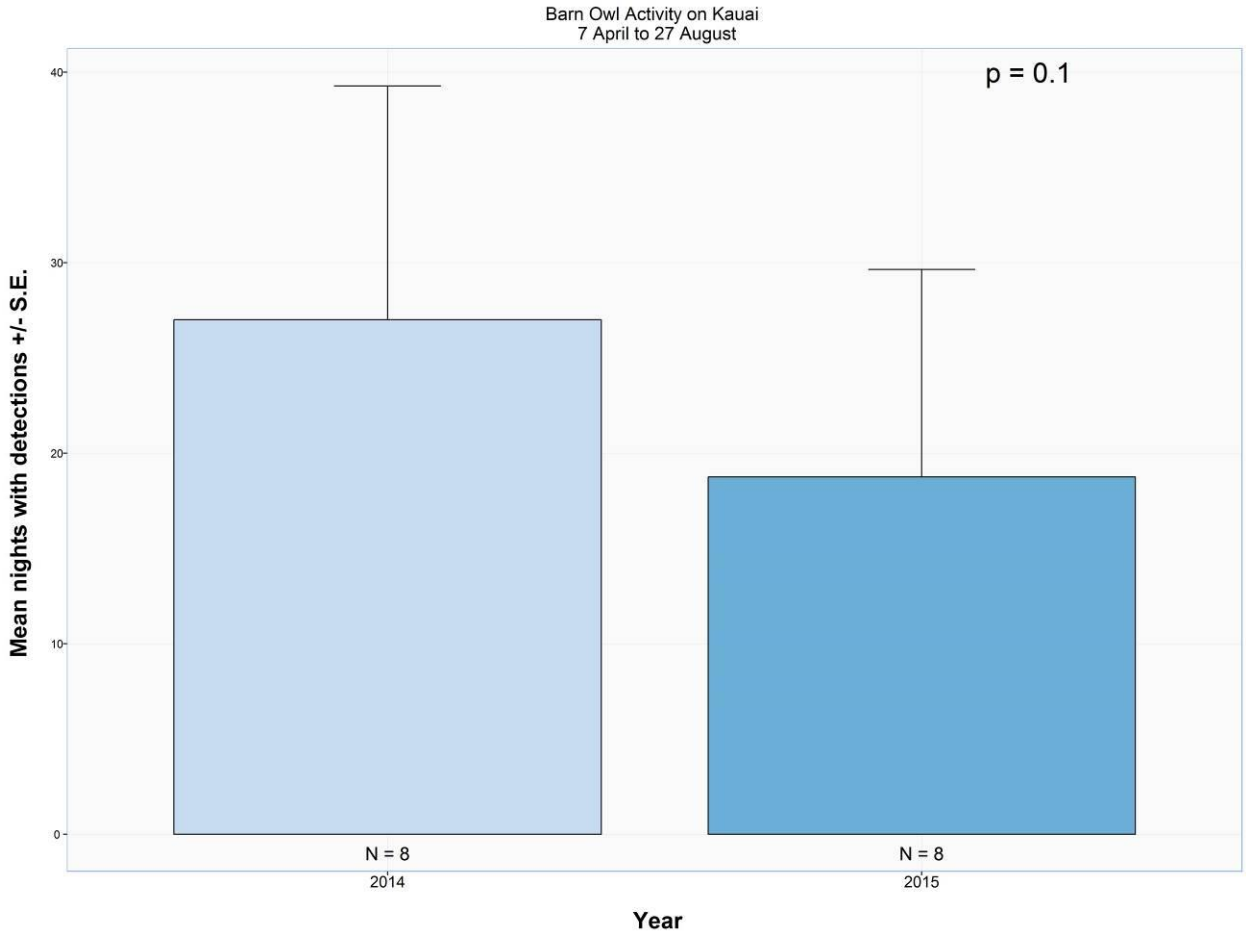


Figure 20. Mean nights with activity at all sites on Kaua'i in comparable period between years (7 April to 27 August). Differences between years were not significant (Paired t-test, one-tailed, p=0.1)

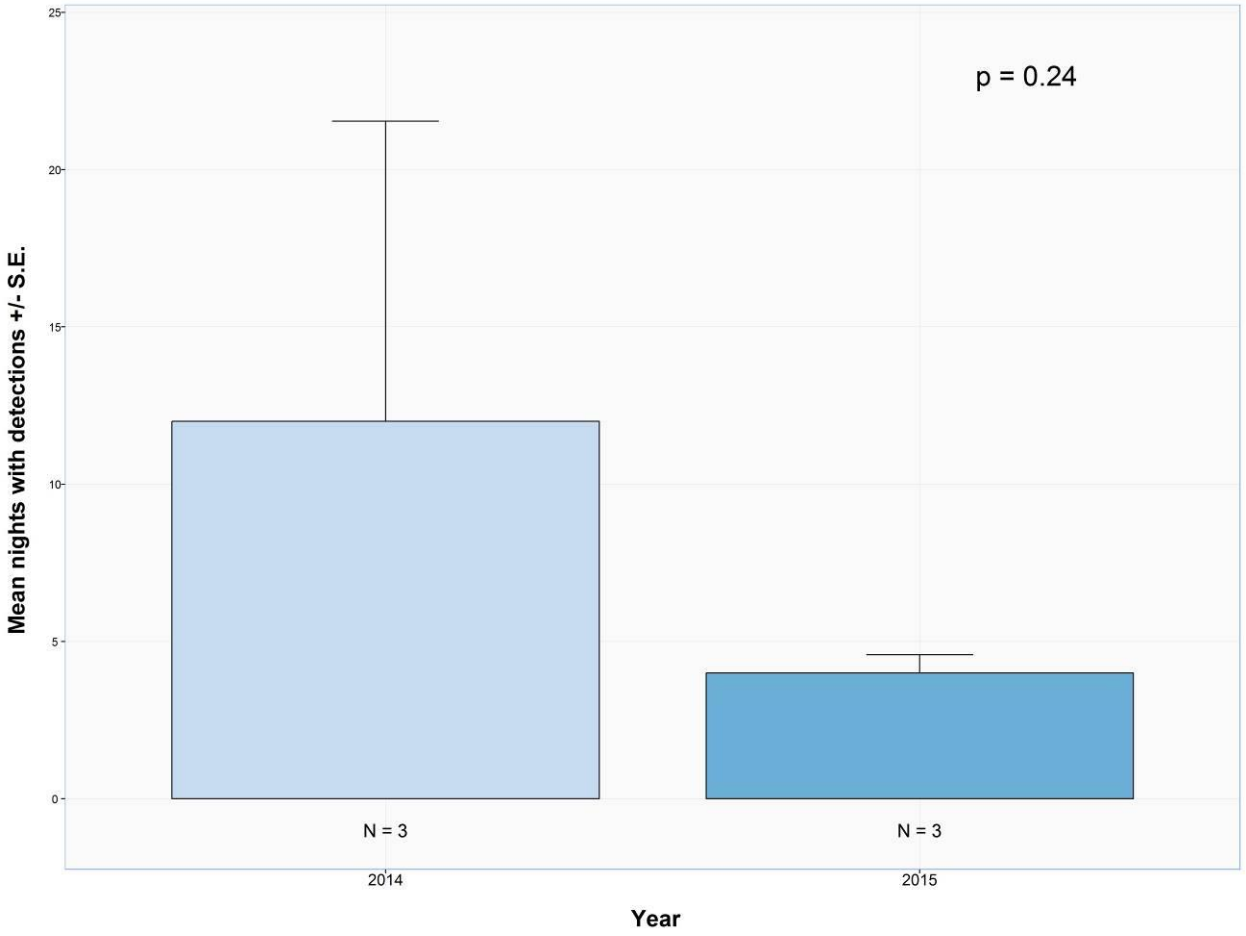


Figure 21. Mean number of nights with Barn Owl vocalizations at survey sites on Lehua. Differences between years were not significant (Paired t-test, one-tailed, p=0.24).

5.0 CONCLUSIONS

This report outlines the results of acoustic surveys conducted in 2015 for Newell's Shearwater, Hawaiian Petrel and Barn Owl (an introduced avian predator) on Kauai and Lehua Islet. It also presents a comparison of call rates for both seabird species and the Barn Owl between 2014 and 2015.

Regarding the endangered seabirds, Newell's Shearwater was recorded at all sites on Kauai. Locations such as the back of Honopu and Nualolo Aina valleys in particular had high call rates of this species. Hawaiian Petrel on the other hand was only recorded at the song meter deployed at Kahili. This is not surprising as this species is not known to breed on the dry cliffs of the Na Pali coast and is typically found in upper montane forests such as those at Kahili. Neither species was recorded on Lehua Islet. Sporadic calls of Newell's Shearwater have been recorded on Lehua in previous years, but it is not known whether these were transient birds or the remnants of a very small breeding colony. The species has also been confirmed breeding on Lehua in the past, with one record known to date (Vanderwerf 2007).

While call rates were too low to compare inter-annual differences for Hawaiian Petrel, it was possible to compare between years for Newell's Shearwater. There was no significant difference for call rates between the two years. This is not surprising, given the fact that Barn Owl control only started in 2015. If Barn Owl control continues into the future, then one would expect to see changes in breeding populations of endangered seabirds if the effects of reduced predator pressure translate into increased numbers of breeding birds and the populations slowly increase.

Barn Owls were recorded at all survey locations, demonstrating how widespread this introduced species is on Kauai and Lehua. The utility of using song meters to detect changes in Barn Owl populations after control measures is as yet unclear. While call rates did not decrease between the two years, there were markedly fewer nights with Barn Owl vocalisations in 2015 when compared with 2014 (although it was not statistically significant). This suggests there may have been an effect in removing Barn Owls from some of the sites. Either way there are two potential reasons for a lack of statistical difference between the year of control (2015) and the year pre-control (2014).

Firstly it could be that Barn Owls recolonize the sites rapidly after birds are removed, and therefore the lack of significant differences between years is a reflection of rapid recolonization. This in itself is an important piece of information for Barn Owl control as a management activity. It should be noted that rapid recolonization by itself may not necessarily reflect a failure of Barn Owl control as anecdotally it appears that Barn Owls have to learn to target seabirds and some individuals are far more proficient that others. So removing individuals may still be beneficial even if the territory is subsequently filled rapidly. Indeed on Lehua, there have been markedly fewer Black Noddy (*Anous minutus*) and Wedge-tailed Shearwater (*Puffinus pacificus*) kills attributed to Barn Owl since the commencement of control activities on the islet.

Alternatively it could be that Barn Owl vocalisations are too sporadic and infrequent to allow for an accurate assessment of the effect of Barn Owl control, or that individual Barn Owls have wildly varying call patterns. If this is the case, then it would be worth considering other Barn Owl vocalisations (such as contact calls) rather than the screech used in this analysis to see whether different vocalization types may be more reflective of changes in Barn Owl populations subsequent to control activities. A further year of acoustic monitoring of Barn Owl in these areas would help in our understanding of this issue.

6.0 ACKNOWLEDGEMENTS

We would like to thank the 2015 KESRP Field Crew for all their hard work this season. Staff members for 2015 were Megan Vynne, Mike McFarlin, Harrison Hyatt, Rochelle Streker, Alexander Shiarella, Constance Johnson, Nathaniel Young and Maggie Massie.

The Kaua'i Endangered Seabird Recovery Project is a Division of Forestry and Wildlife project, administered through the Pacific Studies Co-operative Unit of the University of Hawaii. We would like to thank both organizations for their continued support this year. In particular, from PCSU we appreciate the support of David Duffy, Linda Hara, Dana Fukata, Michelle Miyata, Chin Lee Nicolaides, Lynnette Kinoshita and Jeanne Hiroshige. From DOFAW we appreciate the support of Galen Kawakami, Thomas Ka'iakapu, Afsheen Siddiqi, Jason Omick, Angela Amlin, Dan Dennison, Debbie Ward and Jim Cogswell.

Funding for all of this work was via Sun Edison. We would therefore like to express our appreciation to the Sun Edison team for their support with this work, in particular Mitchell Craig.

Appendix 1. Selection of photographs from the 2015 field season.

Figure 1. Flying over the Na Pali coast

Figure 2. Deploying a song meter at the back of Nualolo Aina

Figure 3. Flying over the Na Pali coast while deploying song meters.

Figure 4. Flying out of Awa'awa'puhi after song meter deployment.

Figure 5. View from the top of Lehua Islet.

Figure 6. View from the top of Lehua Islet

Appendix 8.

Predator Control for Newell's Shearwaters on Kauai

Progress Report
September 16th, 2015

Overview

This report provides an update on work performed from March 1-September 15, 2015 by the RCUH Project "Predator Control for Newell's Shearwaters on Kauai" (hereafter Predator Control) under the Kahuku Wind Power Habitat Conservation Plan.

This project consists of a two-person field team which specializes in the removal of Barn Owl *(Tyto alba)* from select breeding colonies of threatened Newell's Shearwater *(Puffinis auricularis newelli)* on the island of Kauai. The nonnative Barn Owl (BANO) is a documented predator of Newell's Shearwater (NESH) and other colonial seabirds on the Hawaiian Islands [1,2].

Permits and Training

Staff	Start Date	All Training Complete*	All Permits Issued**
Galen Reid	March 9, 2015	May 16, 2015	May 13, 2015
Alex Nicely	March 23, 2015	May 16, 2015	May 13, 2015

*Training include Hawaiian Hunter Education, NRA Firearms Safety, International Aviation Training (IAT) Helicoptor Basics and Sling Load Certifications, Wilderness First Aid and CPR.

**Permits include Federal Fish and Wildlife Migratory Bird Depredation Permit 50 CFR 21.41 (issued 5/1/2014) and State of Hawaii Department of Land and Natural Resources Wildlife Control Permit WCP 15-25 (issued 5/13/2015).

Barn Owl (BANO) Removal Work Summary

Work Site (NESH Colony)	# Trips to Site	# Nights Hunting at Site	# BANO Individuals Detected	#BANO Removed
Honopu Valley	2	5	0	0
Kalaheo/Kahili	3	9	0	0
Lehua Islet	3	8	10	8
Nualolo Aina	3	7	3	1

Crew member at Nualolo Aina.

Project Status

The Predator Control project is actively developing new strategies and techniques to work efficiently at BANO removal at challenging work sites. Current field techniques include the use of firearms, night vision (IR) goggles, spotlights, and electronic calls for attraction, identification and removal of BANO at night. The team also uses custom-made bal-chatri noose traps for attraction and capture of BANO. These traps are new to the project, have seen limited field usage thus far, and are undergoing modifications for improvement after each deployment. Traps are set exclusively at night to avoid capture of the diurnal Hawaiian Short-eared Owl (Pueo – *Asio flammeus sandwichensis*).

Techniques for safe transportation and access to remote hunting sites have been developed for each work site. Safe Landing Zones (LZ's) have been identified and utilized at each site. Day work for the team includes surveys for potential daytime BANO activity, as well as BANO nest searches and documentation of other potential introduced seabird predator usage of the area. Records are kept of any feral cat *(Felis catus)*, feral pig *(Sus scrofa)*, or rat *(Rattus spp.)* sign or sightings. Night work includes four to six hours of BANO hunting per night, and navigation of steep terrain to reach prominent hunt locations within the colony. Traps are also set at night, although they have failed to make a capture thus far (three deployments). We believe these trapping efforts will have a greater potential for success at ridge sites where detectability and BANO activity are maximal. An upcoming trip to such a ridge site (Nualolo Aina colony) will allow further testing of these traps.

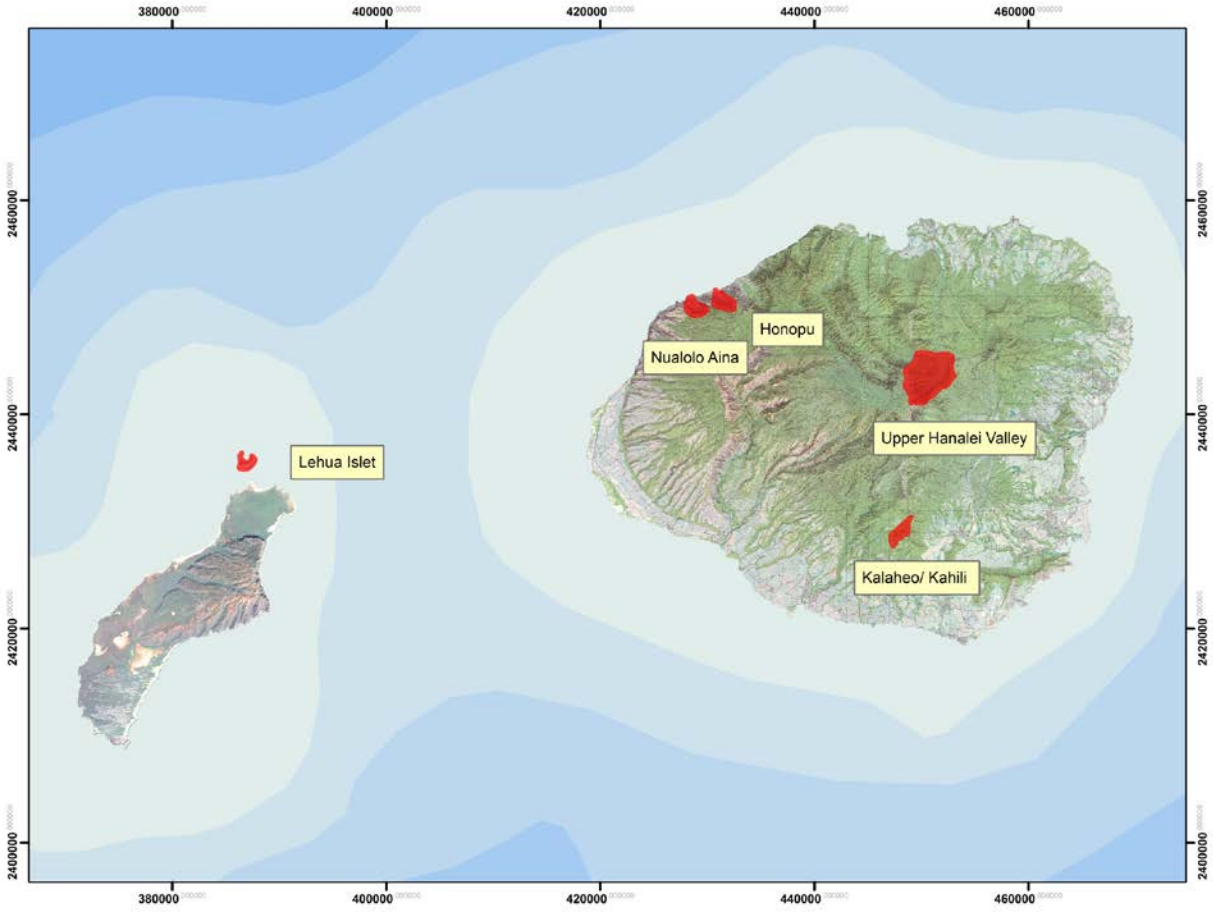
Trips into Honopu Valley and the Kalaheo/ Kahili colony area have not resulted in any BANO detections, possibly due to seasonal changes in distribution of these birds. Trips to these areas will continue, but on a less-intensive basis, throughout the year. The Predator Control team will therefore begin working in the Upper Hanalei Valley (one of six proposed work locations in the Scope of Work). The project's first visit to the Hanalai Valley Colony is planned for October 2015.

The Nualolo Kai colony has not been cleared for access by the Predator Control team.

References

1. Kowalsky, J. R., T. K. Pratt, and J. C. Simon. 2002. Prey taken by feral cats (*Felis catus*) and barn owls (*Tyto alba*) in Hanawi Natural Area Reserve, Maui, Hawai'i. *'Elepaio* 62:127–130.

2. VanderWerf, E. A., K. R. Wood, C. Swenson, M. LeGrande, H. Eijzenga, and R.L. Walker. 2007. Avifauna of Lehua Islet, Hawai'i: Conservation Value and Management Needs. *Pacific Science* 61:39-52.



Current and planned Predator Control sites

Appendix 9.

FY 2016 – HAWAIIAN HOARY BAT MITIGATION FOR KAHEAWA WIND POWER II, ISLAND OF MAUI

Prepared by: Lance De Silva, Forest Management Supervisor
Division of Forestry and Wildlife, Maui Branch

INTRODUCTION

Since June 4, 2014, the Division of Forestry and Wildlife (DOFAW), funded as per the requirements described in the Kaheawa Wind Power II Habitat Conservation Plan (HCP) continues to actively manage 340 acres within the Kahikinui State Forest Reserve (SFR), as well as sections of the larger surrounding units of the Nakula Natural Area Reserve (NAR) and Kahikinui SFR. Activities including controlling ungulates, and restoring and creating native habitat have been identified as key needs for maintaining and increasing hoary bat productivity.

Management of the 340 acres project area, as well as the larger surrounding units of the Nakula Natural Area Reserve (NAR) and Kahikinui SFR has increased since last calendar year, largely in part due to the continued funding support of Kaheawa Wind Power II. Controlling ungulates, restoring and creating native habitat, and increasing native bird and bat populations are some of the multiple management efforts geared for this area. These management efforts continue to be conducted and managed primarily by Maui DOFAW staff.

OVERVIEW

All helicopter services have continued to be procured with Windward Aviation, a Maui based company. The pilots' familiarities with the area, weather and flying conditions, and type of contract operations required for this type of work continue to be beneficial to the efficiency of the project and overall continued success. The construction and maintenance of temporary landing zones and campsites near the project area has also provided work crews with better accessibility. During the past year, the area has seen more average seasonal weather patterns as compared to last year's above normal precipitation accumulations.

Since the initial efforts to remove the feral ungulates in October 2014, staff members have continued to notice significant changes within the project area, as well as the surrounding Nakula NAR and Kahikinui SFR. There continues to be an increase in grass and native shrub growth and, more noticeably, a steady increase of bracken fern *(Pteridium aquilinum)* recruitment in the hardpan and gulch areas. Large sections of rock surface areas are being populated with these bracken ferns. The most impressive change has been the increase in natural generation of native flora, specifically koa *(Acacia koa)* and pukiawe *(Styphelia tameiameiae)*; largely in part due to a viable seed bank and ungulate free environment. We continue to see an increase in game bird species presence and activity, as well as an increase in sightings of nene, all of which are positive improvements. However, with the absence of feral ungulates, there are new issues that have risen and continue to threaten the restoration and reforestation efforts; most significantly, the threats of increased fuel loading and weed infestation. These issues are being addressed through various control and mitigation efforts, and continuous collaborations and discussions between agencies are on-going. In

May 2016, DOFAW was awarded a USDA Forest Service State & Private Forestry (S&PF) grant that will help address some of the challenges identified in last fiscal year's end of year report.

ACTIVITIES & RESULTS

Fencing

Approximately 2.8 miles of fence apron was installed in July 2014 by DOFAW Forestry Program field crews. This fence section is part of the 7.3 miles of ungulate proof fence that has been installed to protect the entire Nakula NAR and sections of the Kahikinui SFR from encroaching ungulates. This protected larger unit encompasses approximately 2,700 acres. Eight inspections, including one inspection immediately following the onset of Tropical Storm Darby (July 2016) have been conducted by DOFAW staff while conducting aerial control missions for feral ungulates within the reserves.

DOFAW personnel continue to maintain approximately 2.8 miles of white poly tape along the fenceline to prevent bird strikes.

Funding Source: Partially funded by DOFAW Forestry operating and watershed grant funds and Kaheawa WindPower II HCP funds.

Ungulate Control

During the reporting period for fiscal year 2016, a total of eight aerial control missions (approximately 11 hours total flight time) were conducted by DOFAW staff resulting in 39 feral goats dispatched from within the entire Nakula NAR and Kahikinui SFR unit. Total number of ungulates dispatched since the initial mission conducted in October 2014 is 688 feral goats and 18 feral pigs. Currently, ungulate presence within the 2,700 acres unit is 'zero'. To ensure 'zero' tolerance, a collared goat also referred to as a 'Judas' goat was placed within the unit to 'round up' any remaining goats, taking advantage of its natural instinct to socialize and congregate.

Quarterly scheduled aerial control missions to monitor ungulate presence within the unit will continue in fiscal year 2017. Ungulates detected during subsequent monitoring flights will be dispatched accordingly in a timely manner through scheduled aerial control missions. New detections or ungulate ingress into this protected unit may, at any time, occur because of a fence break that may be caused by inclement weather, vandalism, normal wear and tear, etc. Per our DOFAW Forestry Program's fence maintenance protocol, personnel will continue to conduct regular scheduled fence checks throughout the year, as well as immediately following the onset of any strong weather disturbances that may pose a threat to the integrity of the fence.

Funding Source: Partially funded by DOFAW Forestry operating and watershed grant funds and Kaheawa WindPower II HCP funds.

Plant Quality and Procurement

The out-planting work for this reporting period covered approximately 74 acres of the 340 total

acres of the project area. During this period, 31,990 native plant seedlings were out-planted, making the total number of native plant seedlings out-planted within the unit at approximately 42,000 since the initial reforestation efforts began. An additional 15,000 seedlings are projected to be out-planted by spring 2017. Another 20,000 seedlings will be procured and planted in fiscal years 2017-19 to supplement and account for anticipated plant mortality due to various causes.

A new experimental product utilizing a self-condensing 'planter's' box will be installed on an experimental basis in several hard pan areas where success and survivorship of recently out-planted seedlings have been mildly low.

Funding Source: Funded by Kaheawa Wind Power II HCP funds.

Site Preparation – Soil Testing/Conditioning

Several soil collections from various areas within the unit were conducted in July 2015 and samples were sent for analysis in August 2015. In general, majority of the sites contain sufficient to high levels of pH and calcium, while showing deficiencies in potassium, phosphate, and magnesium. Recommendations on how to improve soil conditions have been noted for future field application use. Collecting and analyzing soil samples to determine deficiencies remain a priority and will aid in future reforestation and restoration efforts.

In fiscal year 2016, no additional grass control treatments were scheduled due to unforeseen inclement weather and lack of helicopter availability. Grass control treatments for site prep work is scheduled for approximately 50 acres in fiscal year 2017.

Funding Source: Partially funded by DOFAW Forestry operating funds and Kaheawa Wind Power II HCP funds.

Weed Monitoring and Suppression

Two aerial weed surveys were conducted in fiscal year 2016 covering the entire Nakula NAR and Kahikinui SFR unit. Of the two surveys, one focused primarily on Rapid Ohia Death (R.O.D). Fortunately, there were no visual signs or symptoms of the disease. Forestry personnel who are conducting aerial control missions within the unit continue to survey for weed species during their missions. Fireweed *(Senecio madagascariensis),* bull thistle *(Cirsium vulgare)* and balloon plant *(Asclepias physocarpa)* were sighted and documented across the lower elevations of the Nakula NAR and Kahikinui SFR.

One ground survey was also conducted in fiscal year 2016 covering the areas around a number of temporary landing zones and camp sites. As a result, forestry program personnel detected and removed one bocconia plant *(Bocconia frutescens)* near the Pahihi Gulch area located within the forest reserve. To date, this is the furthest east along the slopes of Leeward Haleakala that this plant has been detected.

Efforts by partnering agencies continue to work on controlling populations of bocconia that are sighted outside of the project area to prevent further spread into this unit. The four pine trees

(Pinus radiata) that were detected last fiscal year have since been cut down and treated. Subsequent weed surveys are scheduled for this area to ensure early detection and rapid response.

Funding Source: Partially funded by DOFAW Forestry operating funds and Kaheawa Wind Power II HCP funds.

Table 1. Schedule of Mitigation Activities

Implementation Activities	Fiscal Year 2016				Entity Responsible	Total Cost
	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr		
Fence Inspection		XX	XX	XX	DOFAW Maui Nui Branch	*included into aerial control missions
Aerial Control Eradication and Tagging of Animals (ACETA) Activities		XX	XX	XX	DOFAW Maui Nui Branch	**$13,200** *$8,755 paid by DOFAW; $4,445 paid w/ KWP II funds
Soil Sampling and Conditioning	XX				*DOFAW Maui Nui Branch collected and submitted to CTAHR for analysis	**$1500*** flight time paid with KWP II funds
Plant Procurement		XX	XX	XX	Obtained from Native Nursery, LLC by DOFAW	**$133,315** *procured approximately 48k seedlings
Planting of Overstory/Understory Species	XX	XX	XX	XX	DOFAW Maui Nui Branch	*costs included overstory/under story cost paid by KWP II
Weed Surveys					DOFAW Maui Nui	*included into aerial control missions paid by KWP II
Total						**$148,015.00**

MEASURES OF SUCCESS

According to the HCP, prior to the start of management measures, the following must be achieved:

a. **Survivorship monitoring of out-planted seedlings.** Survivorship plots are randomly established throughout the planting area. Plot size is 1/10 acre with a radius of 37.2 feet from plot center. The vigor of the plot is noted on a scale from 1-3, where 1 is poor health and 3 is excellent health. A general survey of the top 3 dominant flora besides

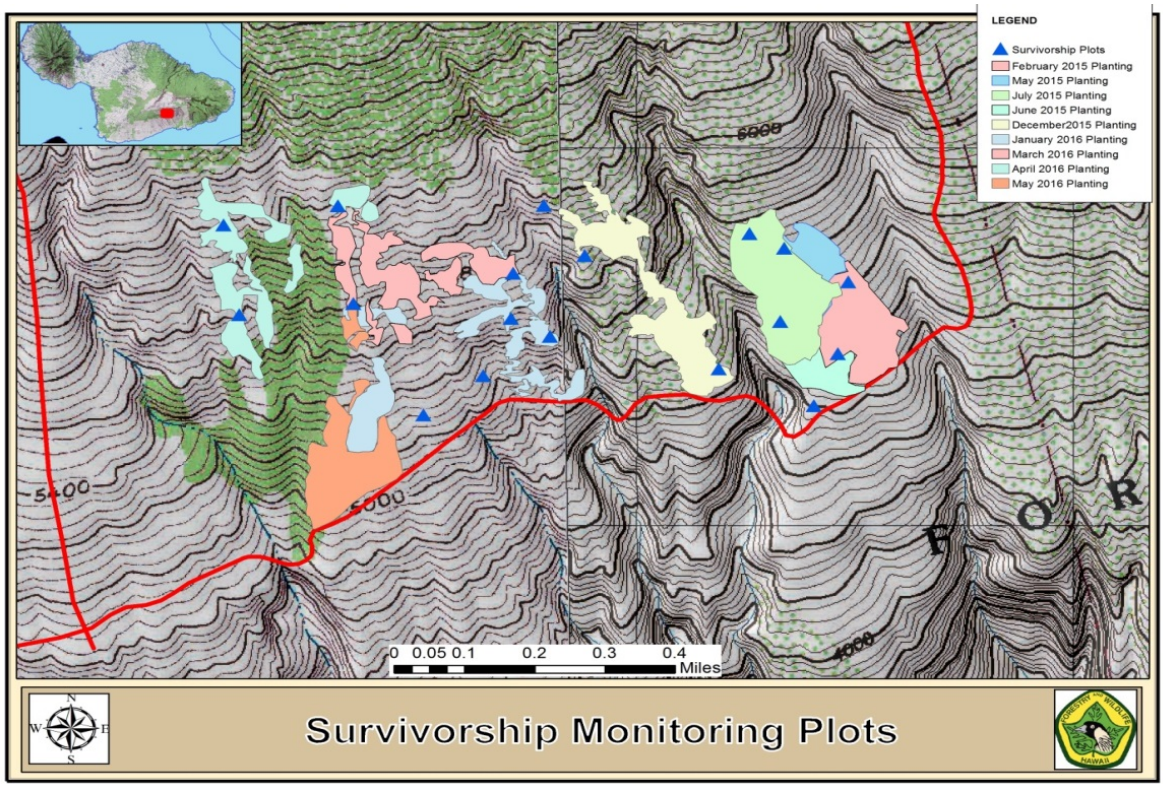
the planted trees within the plot is also recorded. Plots are scheduled to be revisited every six months. Forestry personnel have installed 20 plots (9 grass, 3 rock/grass, 2 rock, 4 hardpan, and 2 herbicide treated) to date, covering all substrate and ground cover types (Figure 1). The results of these monitoring plots represent the average % of plants surviving per plot per ground type since initial out-planting. The monitoring trips were completed on January 12, 2016, February 26, 2016, April 22, 2016, and August 4, 2016 and the results are as follows:

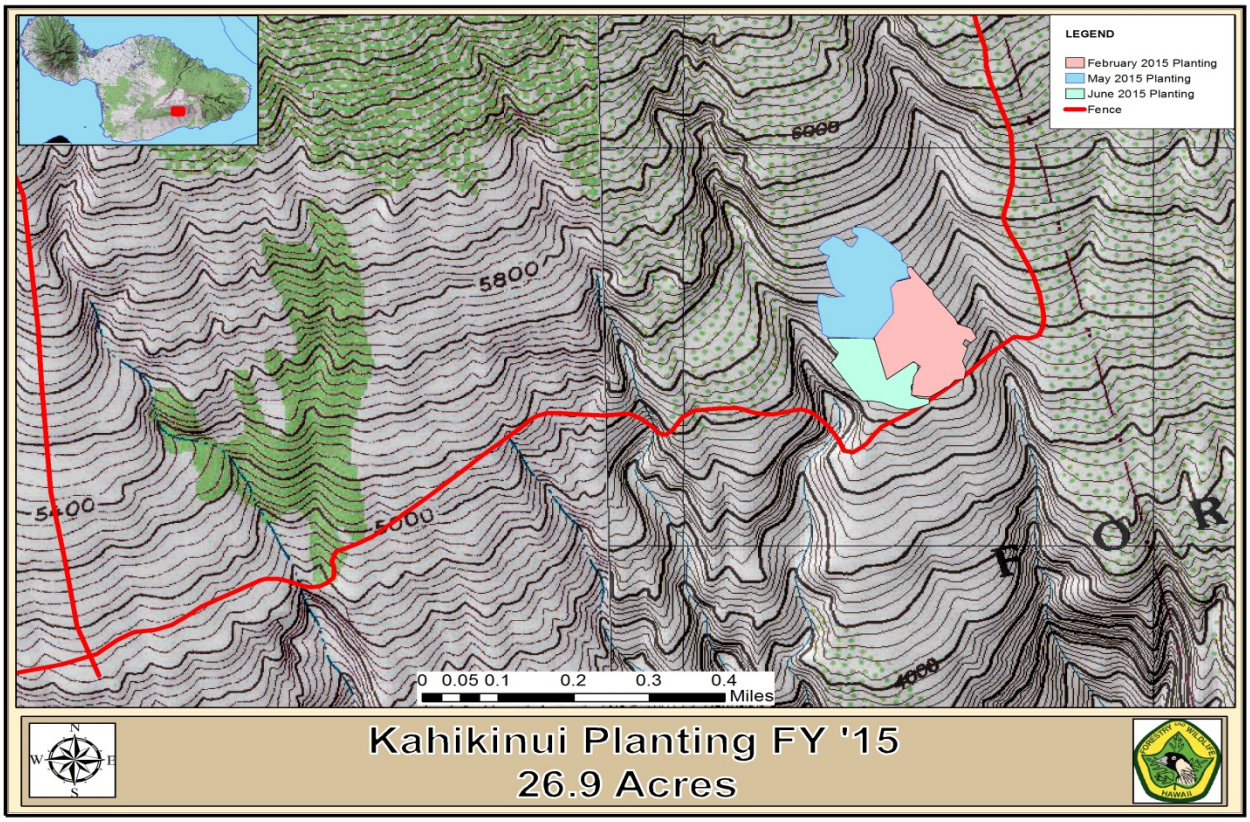
Grass average = 94.4%
Grass/Rock average = 79.9%
Rock average = 43.2%
Dirt/Hardpan average = 53.1325%
Herbicide pretreated average = 77.45%

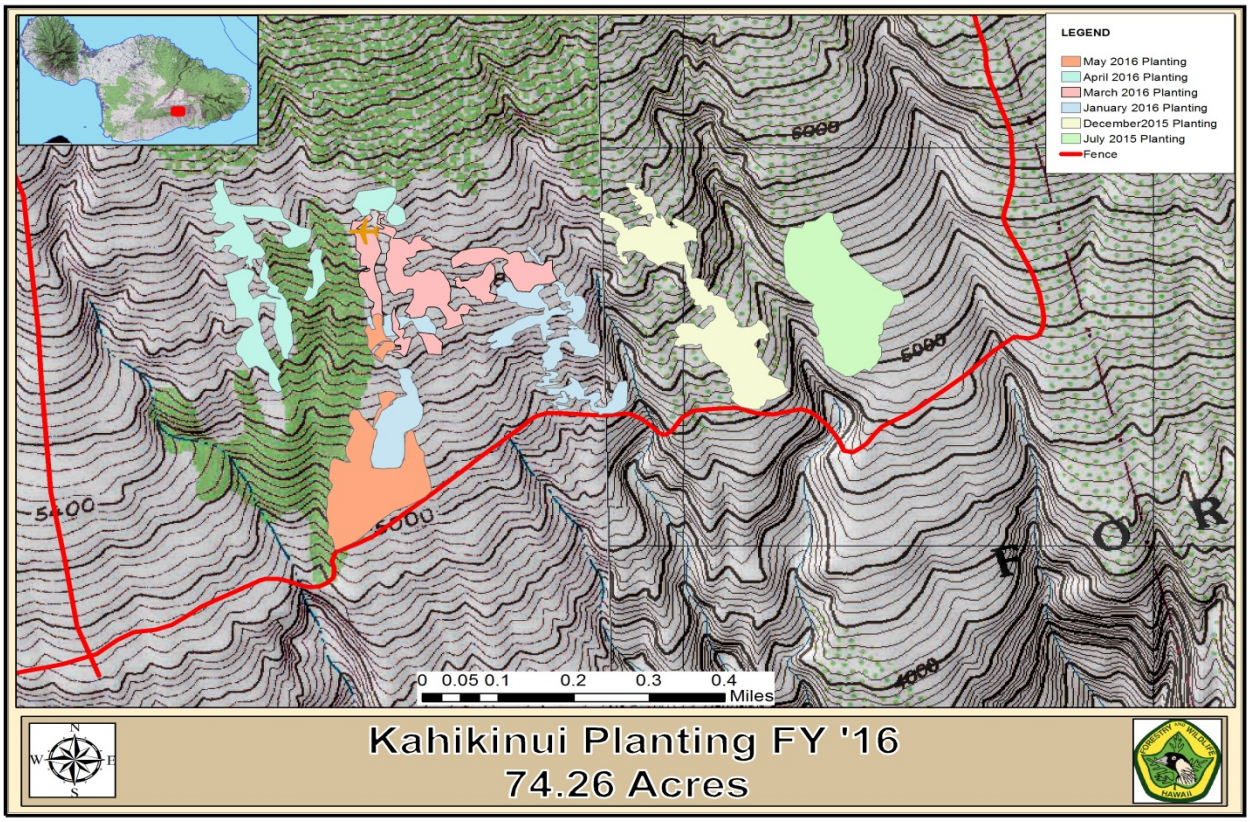
By Species*:
Koa *(Acacia koa)* - 348/454, overall yielding a 76.6% survival rate
Aalii *(Dodonaea viscosa)* - 182/214, overall yielding a 85.0% survival rate
Pilo *(Cosprosma spp.)* **-** 40/42, overall yielding a 95% survival rate
Ohia *(Metrosideros polymorpha)* – 58/58, overall yielding a 100% survival rate
Mamane *(Sophora chrysophylla)* – 125/125, overall yielding a 100% survival rate

**other plant species such as Osteomeles anthyllidifolia, Santalum freycinetianum, and Cheirodendron trigynum were not present in the random sample plots taken so far.*

Figure 1 – Survivorship Monitoring Plot Locations




LEGEND
February 2015 Planting
May 2015 Planting
June 2015 Planting
Fence
5800
5400
5000
6000
0 0.05 0.1 0.2 0.3 0.4
Miles
Kahikinui Planting FY '15
26.9 Acres


LEGEND
May 2016 Planting
April 2016 Planting
March 2016 Planting
January 2016 Planting
December2015 Planting
July 2015 Planting
Fence
5400
5000
6000
0 0.05 0.1 0.2 0.3 0.4
Miles
Kahikinui Planting FY '16
74.26 Acres

Outplanting Taxon By Subunit

Subunits = <All>

From 7/1/2015 to 6/30/2016

Kahikinui-Nakula Units-Ka

Action = Plant

Taxon:	*Quantity:*
Acacia koa	17473
Cheirodendron trigynum sub	91
Coprosma ochracea	32
Dodonaea viscosa	6609
Metrosideros polymorpha	3048
Osteomeles anthyllidifolia	161
Sophora chrysophylla	4576
Action Total Plants	31990
Polygon Total Plants	31990
Total all subunits	31990

Species List for FY'16 out-planting

Outplanting Taxon By Subunit

Subunits = <All>

From 7/1/2014 to 6/30/2016

Kahikinui-Nakula Units-Ka

Action = Plant

Taxon:	*Quantity:*
Acacia koa	25412
Cheirodendron trigynum sub	91
Coprosma ochracea	32
Coprosma waimeae	270
Dodonaea viscosa	7092
Metrosideros polymorpha	3783
Osteomeles anthyllidifolia	161
Santalum freycinetianum	15
Sophora chrysophylla	4576
Action Total Plants	41432
Polygon Total Plants	41432
Total all subunits	41432

Species List for FY'15 and FY'16 out-planting

Temporary campsite located in the Kahikinui State Forest Reserve. View from project area looking makai with (Nu'u) shoreline in the background.

Forestry staff member planting koa (Acacia koa) seedlings in 340 unit.

Healthy koa (Acacia koa) seedling 6 months after planting.

Natural regeneration of pukiawe seedlings (Styphelia tameiameiae).

Appendix 10. KAH expenditures for FY 2016.

KWPI	Cost
Permit Compliance	$37,585
Seabird Management	$92,773
Fatality Monitoring	$3,553
Equipment and Supplies	$1,679
Staff Labor	$40,560
Total Cost for FY 2015	**$176,150**