

# Hawaii-wide surveys for Newell's Shearwater, Hawaiian Petrel & Band-rumped Storm Petrels



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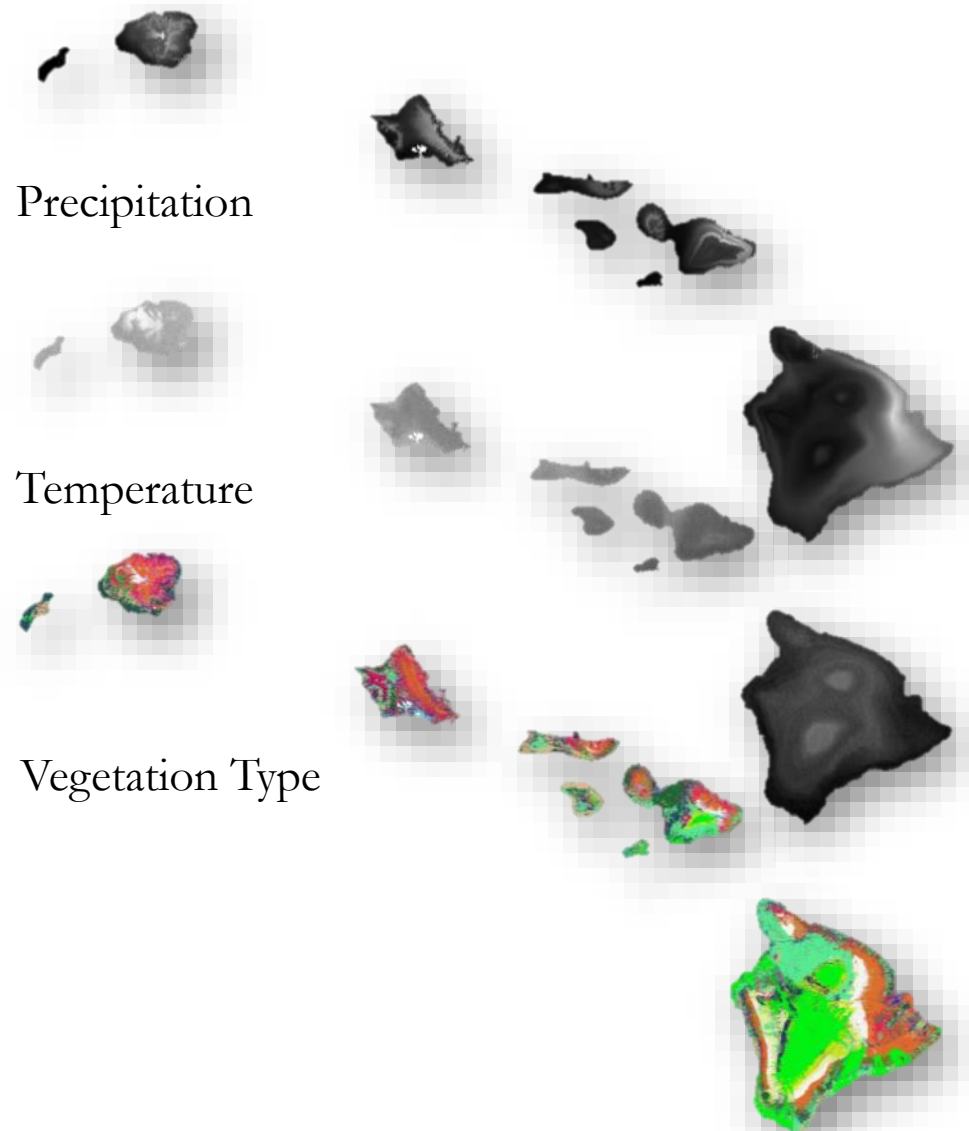
American Bird Conservancy <sup>5</sup> State of Hawaii Natural Area Reserves System <sup>6</sup> National Park Service,  
Hawaii Volcanoes National Park <sup>7</sup>Conservation Metrics, Santa Cruz, CA



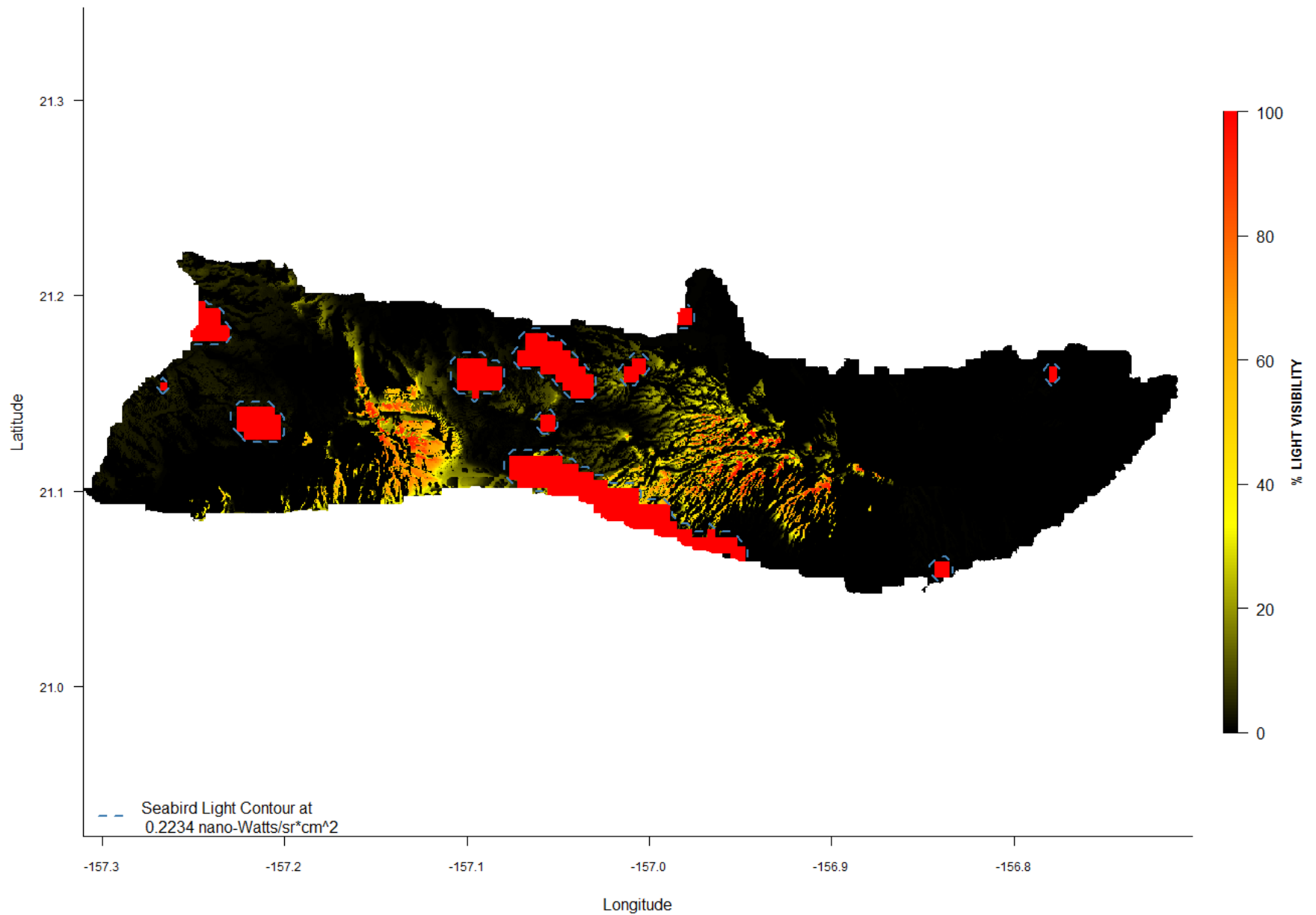


# Methods- modeling

- Used a Best Subset (BIC, AICc, VIF and Adj-R<sup>2</sup>) Selection Criteria to Select from 29 Climatic, Topographic, Env. Covariates
- Isothermality, Precip. Seasonality, Slope, Wind, TRI
- Developed Ensemble Modeling Approach in R
- Statistically Validated All Analyses (AUC, TSS, Kappa)
- Projected All Analyses into 2100 using A1b emission scenario

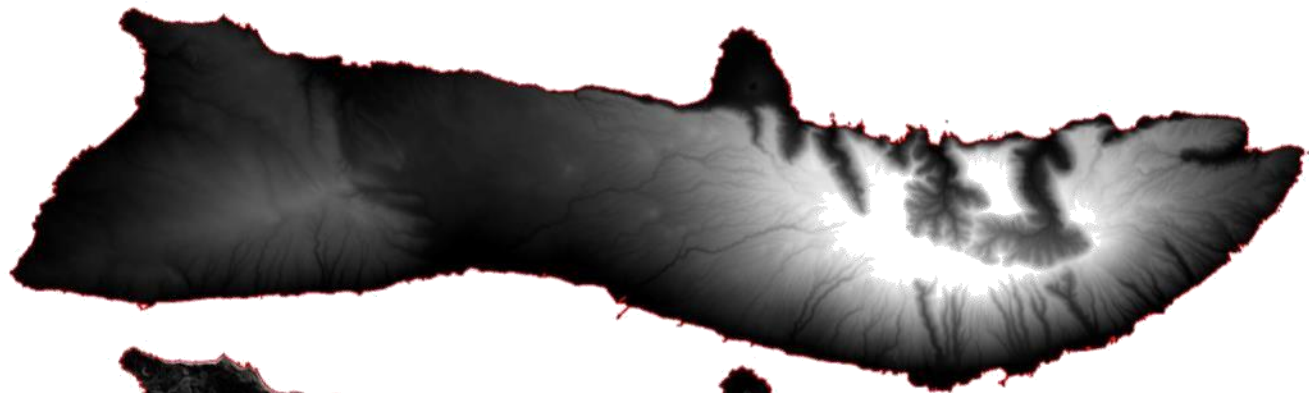


Light Visibility on Molokai;  
Compiled from 10 Viewshed Iterations

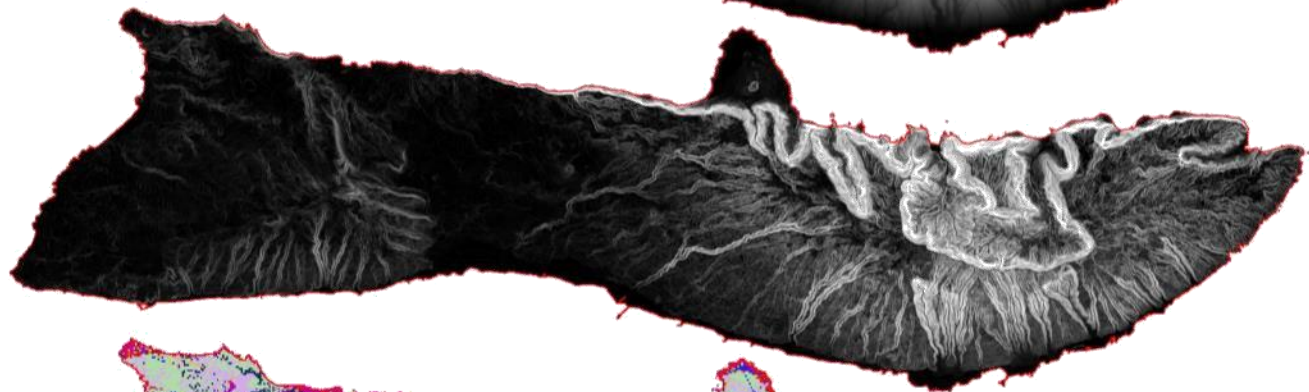




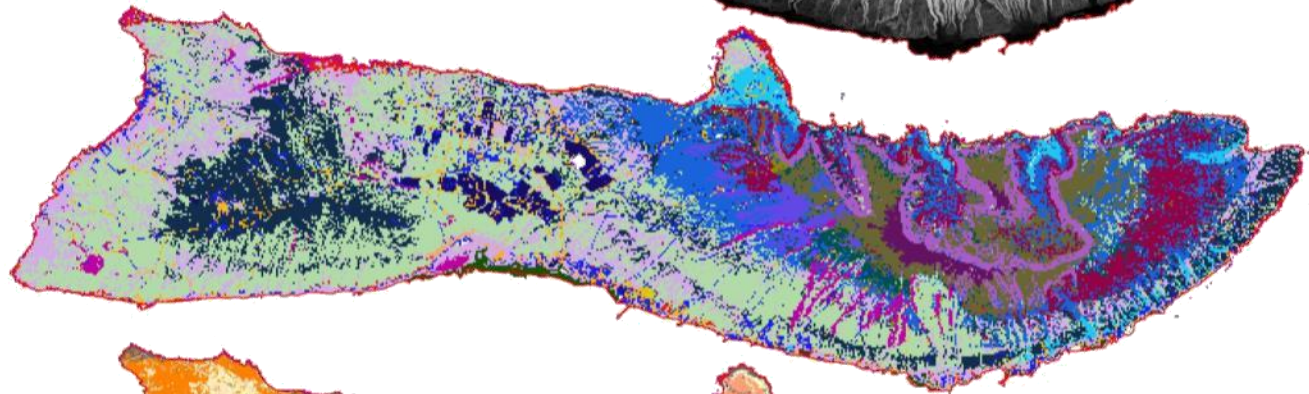
Elevation



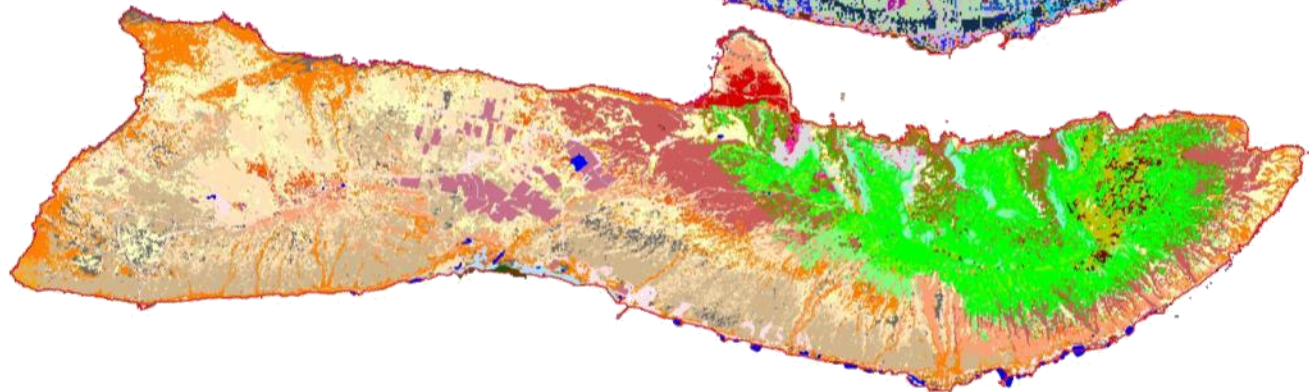
Slope



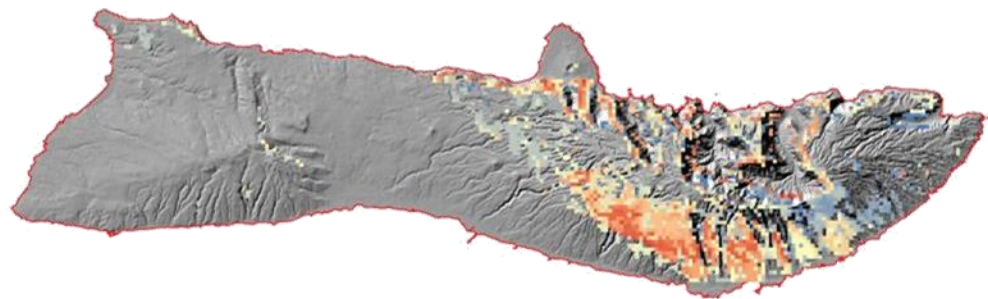
GAP Vegetation



Landfire  
Vegetation



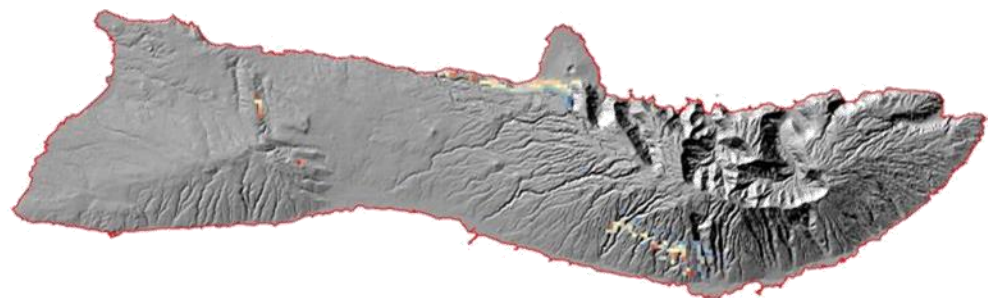
Vegetation  
Light Visibility  
Elevation  
Slope



**NESH**



**HAPE**

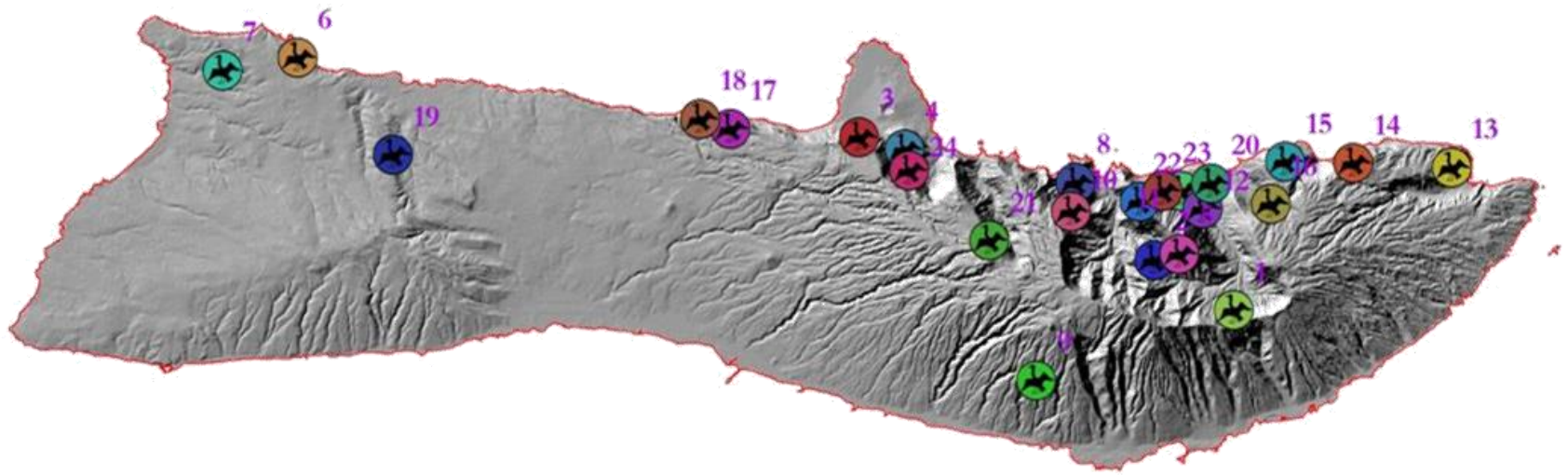


**BANP**

**Moderate Suitability**



**High Suitability**



FID	NESH_Suit	HAPE_Suit	BANP_Suit	Light_Vis	Elevation	% Slope	GAP Vegetation Type	Landfire Vegetation Type
1	858	0	0	0	524.921	28.8959	Open Ohia Forest (native shrubs)	Hawai'i Lowland Rainforest
2	855	0	0	0	908.876	55.6345	Open Ohia Forest (native shrubs)	Hawai'i Wet Cliff and Ridge Crest Shrubland
3	779	0	330	0.565702	367.505	44.3141	Native Shrubland / Sparse Ohia (native shrubs)	Hawai'i Lowland Dry Forest
4	777	0	0	0.550412	659.547	40.4417	Alien Forest	Hawai'i Lowland Mesic Forest
5	822	0	0	0	1,322.26	32.8574	Open Ohia Forest (native shrubs)	Hawai'i Lowland Mesic Shrubland
6	680	0	0	17.55855	180.507	6.50847	Alien Grassland	Open Water
7	455	0	0	0.450097	124.665	15.2138	Alien Grassland	Introduced Coastal Wetland Vegetation - Herbaceous
8	636	0	0	0	426.517	54.7038	Uncharacterized Shrubland	Hawai'i Lowland Dry Forest
9	774	0	382	0	524.921	36.4377	Alien Grassland	Hawai'i Dry Coastal Strand
10	737	0	0	0	885.936	45.7735	Uncharacterized Shrubland	Hawai'i Wet Cliff and Ridge Crest Shrubland
11	775	0	0	0	922.007	29.302	Native Shrubland / Sparse Ohia (native shrubs)	Hawai'i Lowland Rainforest
12	703	0	0	0	410.066	41.7553	Open Ohia Forest (native shrubs)	Hawai'i Lowland Dry Forest
13	540	0	0	0	242.84	34.8621	Native Shrubland / Sparse Ohia (native shrubs)	Hawai'i Lowland Mesic Forest
14	643	0	0	0.022934	587.253	6.59511	Open Ohia Forest (uluhe)	Hawai'i Lowland Mesic Forest
15	719	0	0	0	718.559	17.832	Mixed Native-Alien Shrubs and Grasses	Hawai'i Lowland Mesic Forest
16	692	0	0	0	751.31	29.9691	Open Ohia Forest (native shrubs)	Hawai'i Lowland Rainforest
17	430	0	0	0	321.472	15.3327	Alien Forest	Hawai'i Lowland Mesic Forest
18	698	0	505	3.667569	308.342	3.3799	Alien Grassland	Open Water
19	0	0	554	18.17396	216.579	21.7305	Kiawe Forest and Shrubland	Open Water
20	784	0	0	0	246.009	32.714	Mixed Native-Alien Forest	Hawai'i Lowland Mesic Forest
21	682	0	0	0	1,066.29	39.7758	Native Shrubland / Sparse Ohia (native shrubs)	Hawai'i Lowland Mesic Shrubland
22	540	0	0	0.236983	981.019	41.5913	Open Ohia Forest (native shrubs)	Hawai'i Lowland Rainforest
23	645	0	0	0	925.176	22.5726	Open Ohia Forest (native shrubs)	Hawai'i Lowland Rainforest
24	673	0	0	3.174564	757.95	6.95895	Alien Forest	Hawai'i Lowland Mesic Forest



Molokai songmeters



Google earth

Data USGS

Image © 2016 DigitalGlobe

Data SOEST/UHM







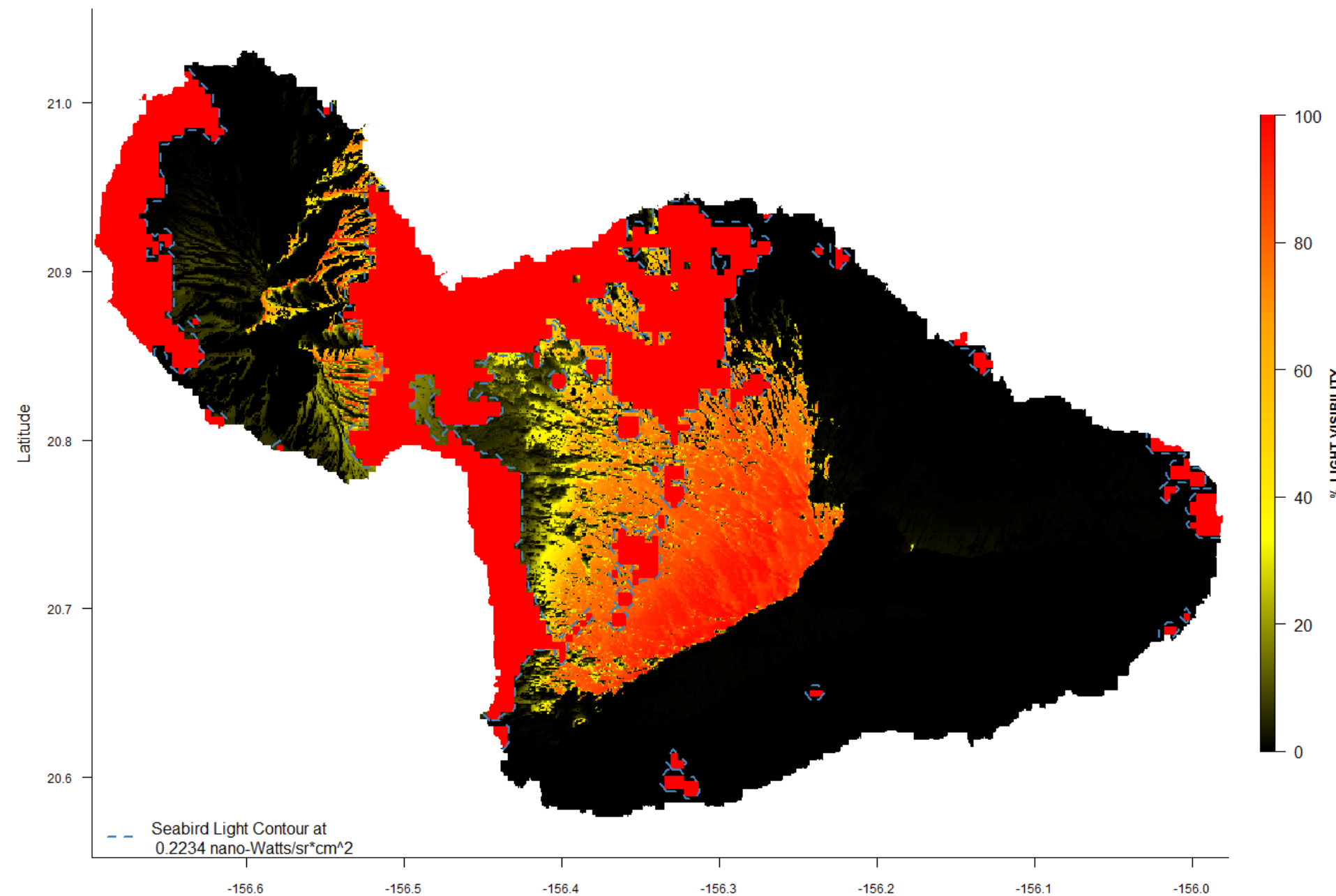




Molokai songmeters



Light Visibility on Maui;  
Compiled from 10 Viewshed Iterations







© 2015 Google  
Data USGS  
Data SOEST/UHM

Google Earth

Imagery Date: 1/12/2013 20°47'15.64" N 156°21'14.72" W elev 1557 ft eye alt 43.13 n





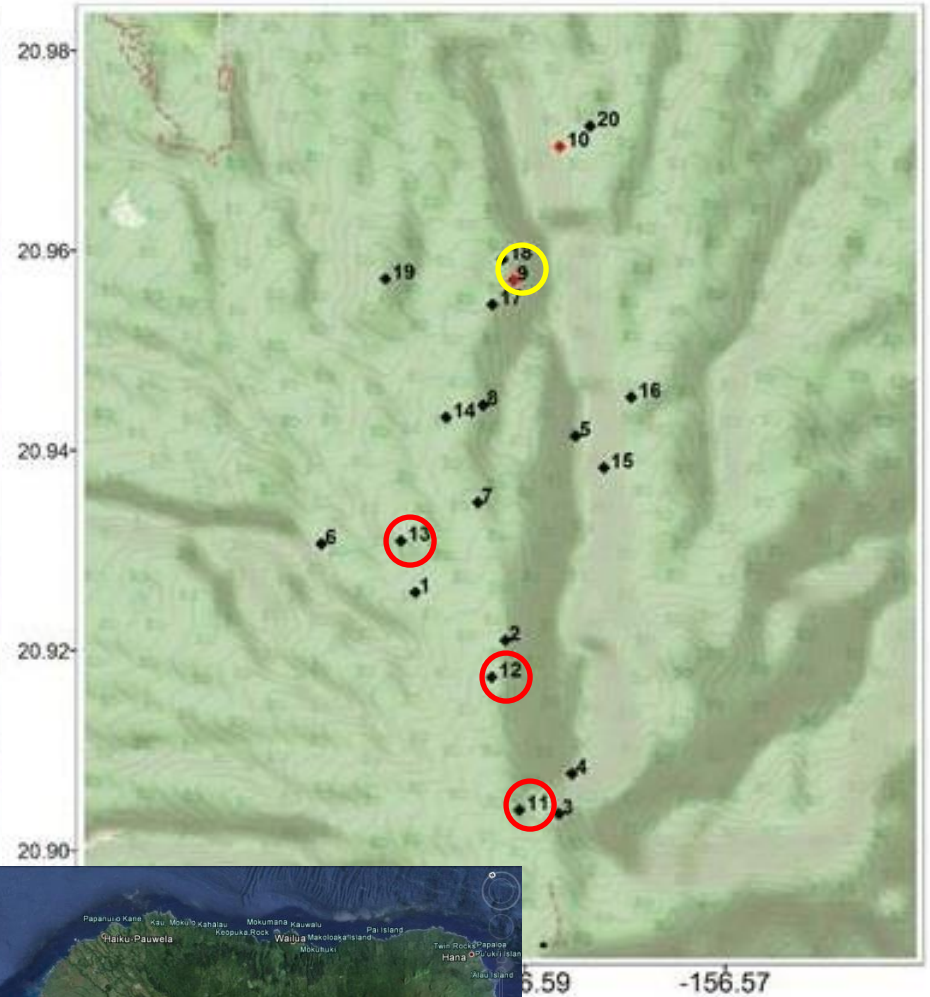
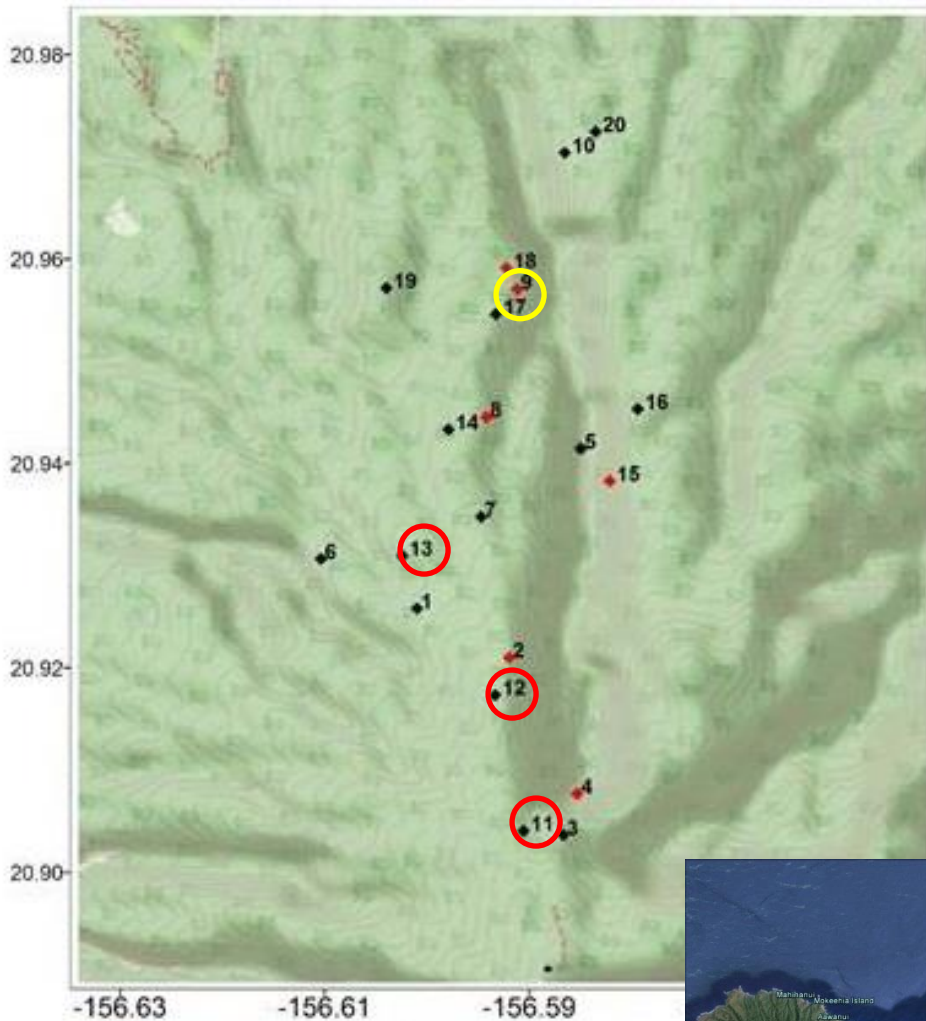




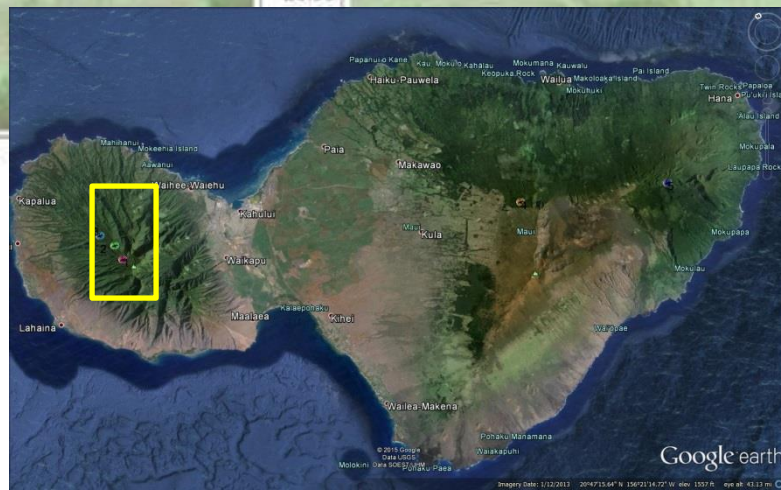


# HAPE detections

# NESH detections

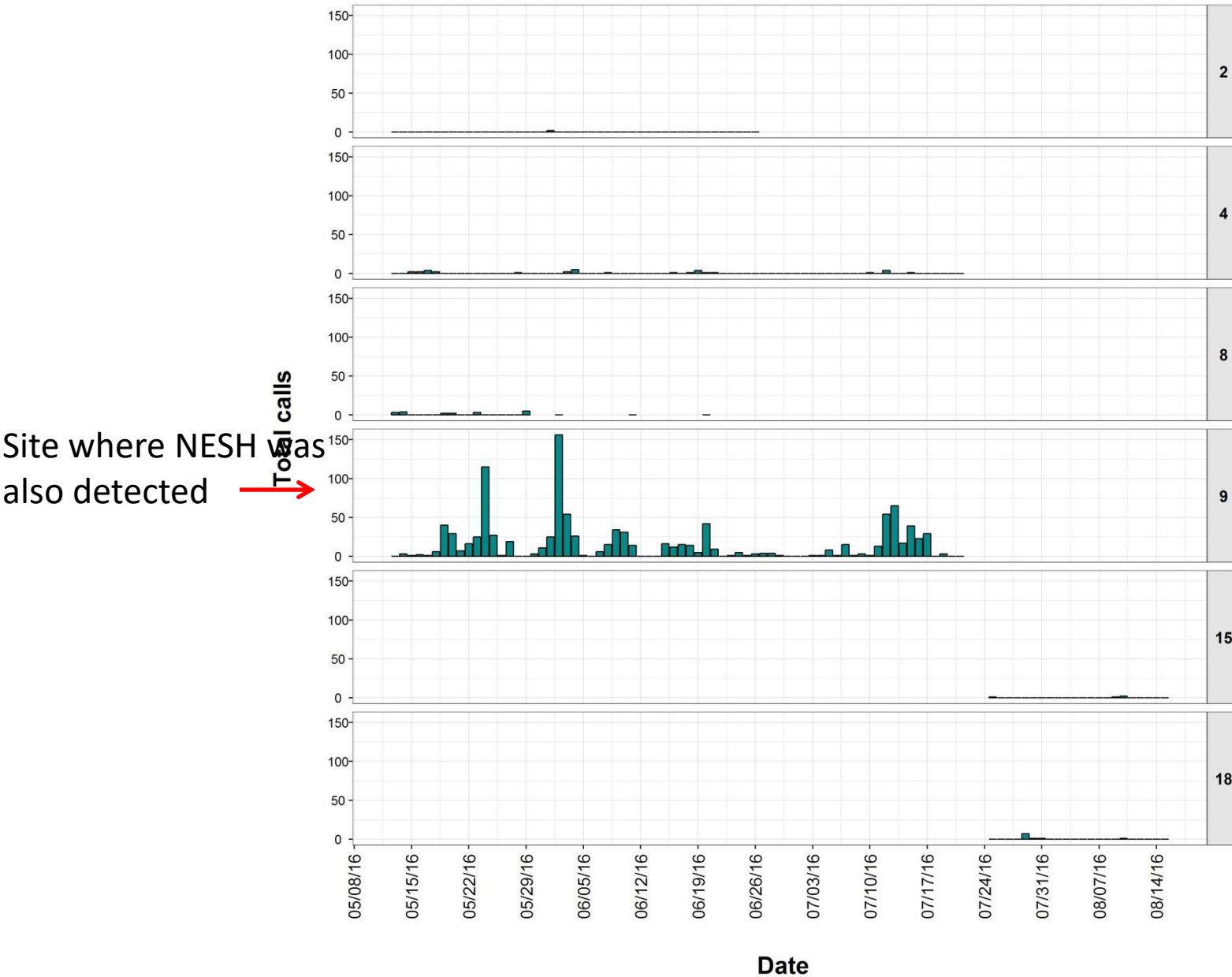


- Fenceable
- NESH & HAPE detected
- Seabirds detected

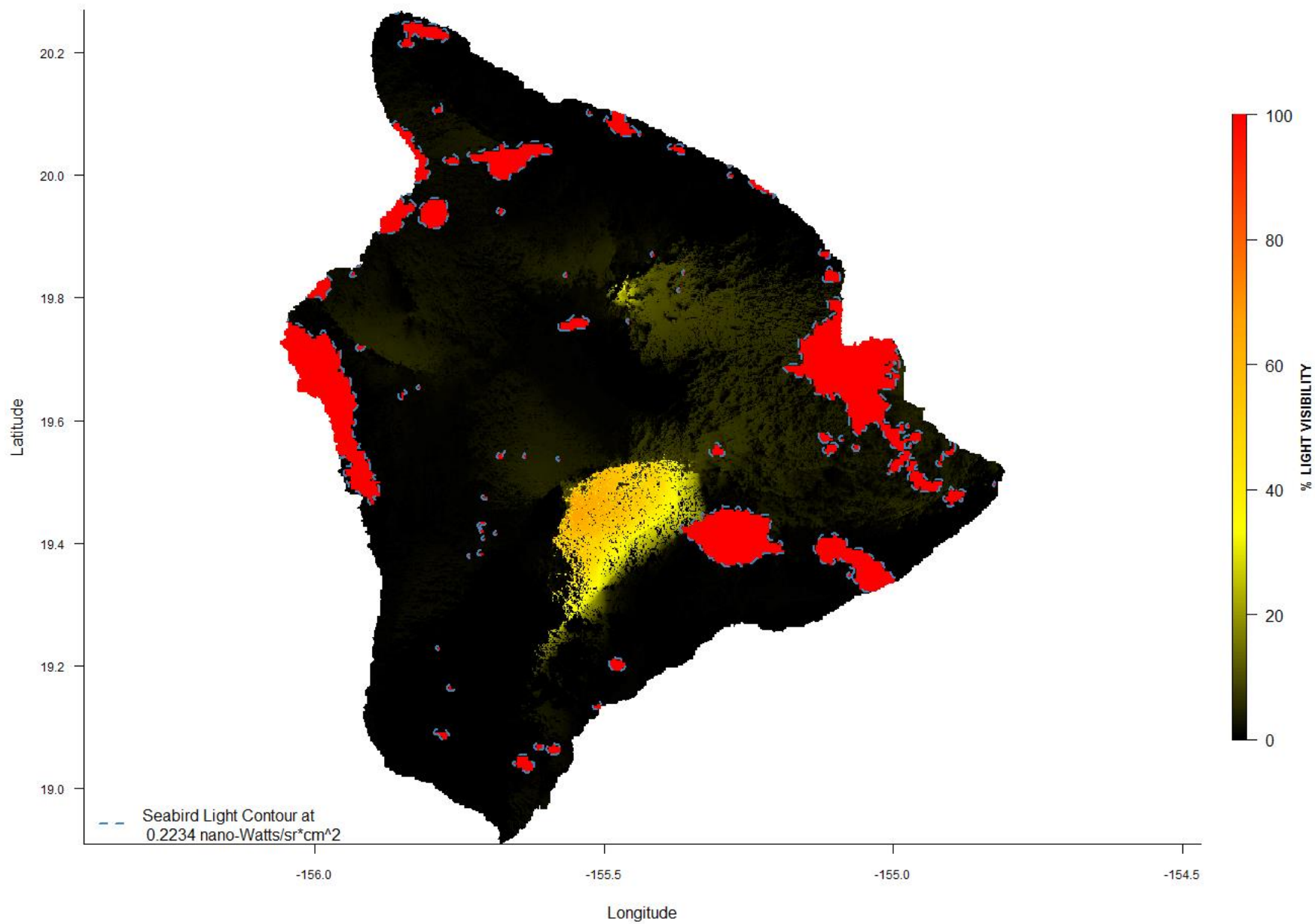




# Maui HAPE call rates



Light Visibility on Hawaii;  
Compiled from 10 Viewshed Iterations



Legend

1N

Mauna Loa S

1N

Mauna Loa S flank

30 mi











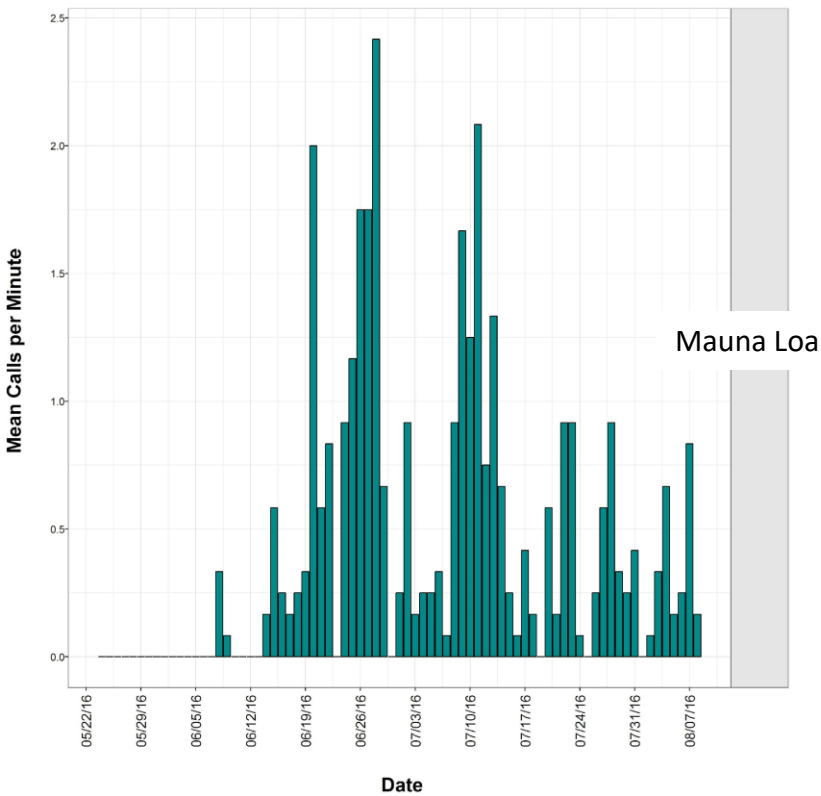




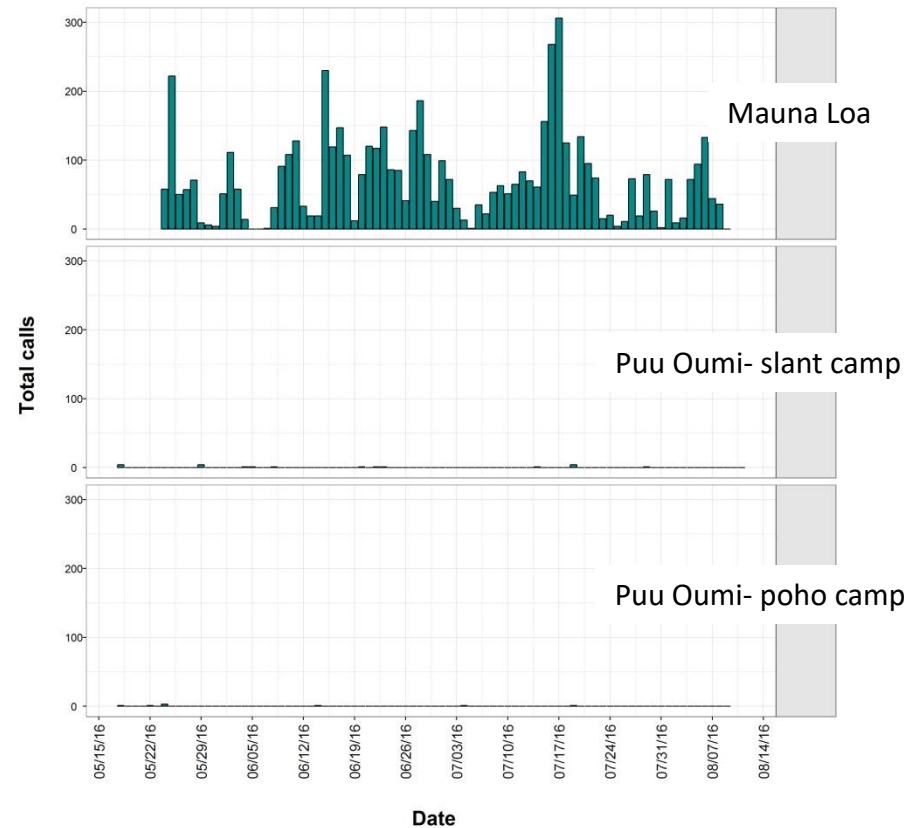
# Hawaii Island call rates

- NESH detected at Puu Oumi on auditory surveys, but not song meters

## BANP



## HAPE





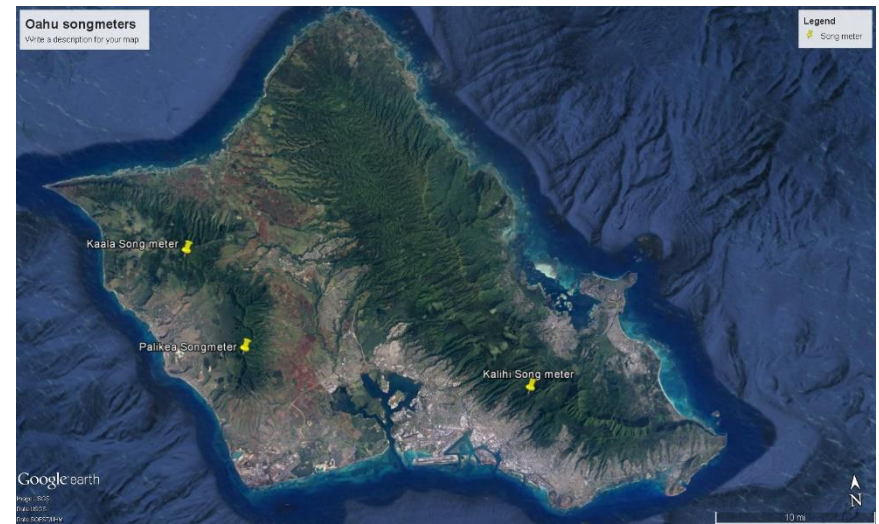
# Oahu listed seabird surveys





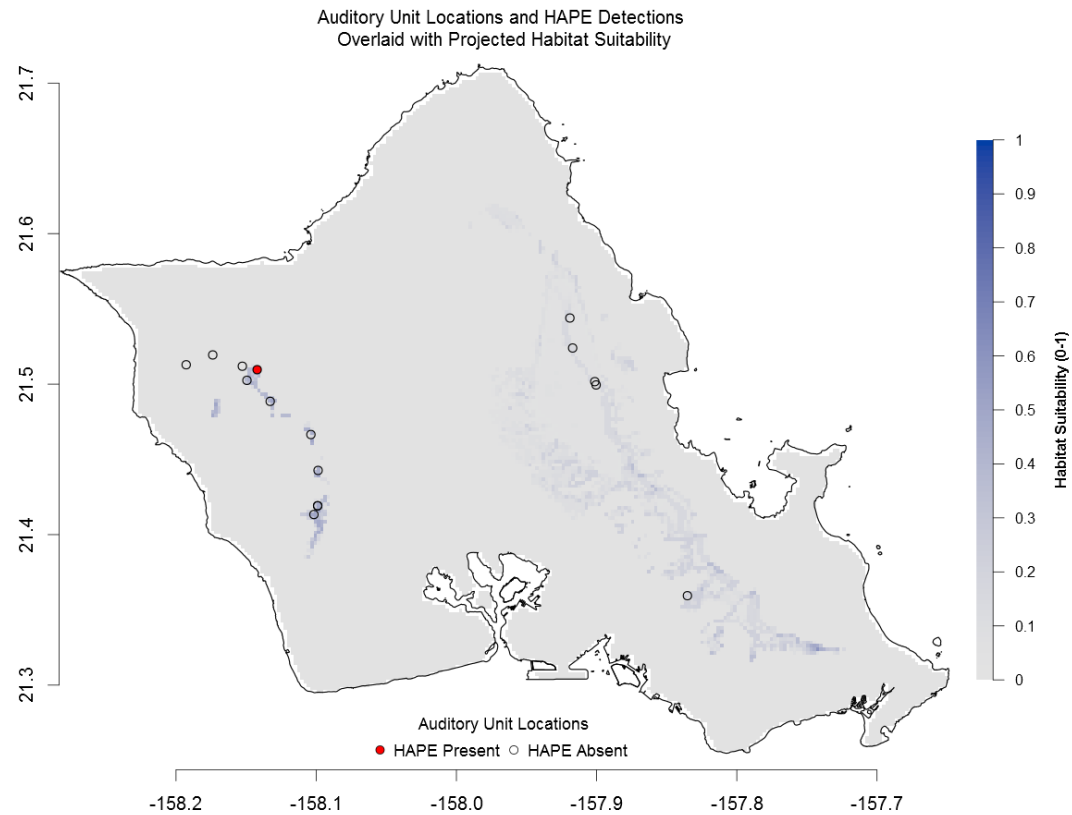
# 2016 Song meter locations

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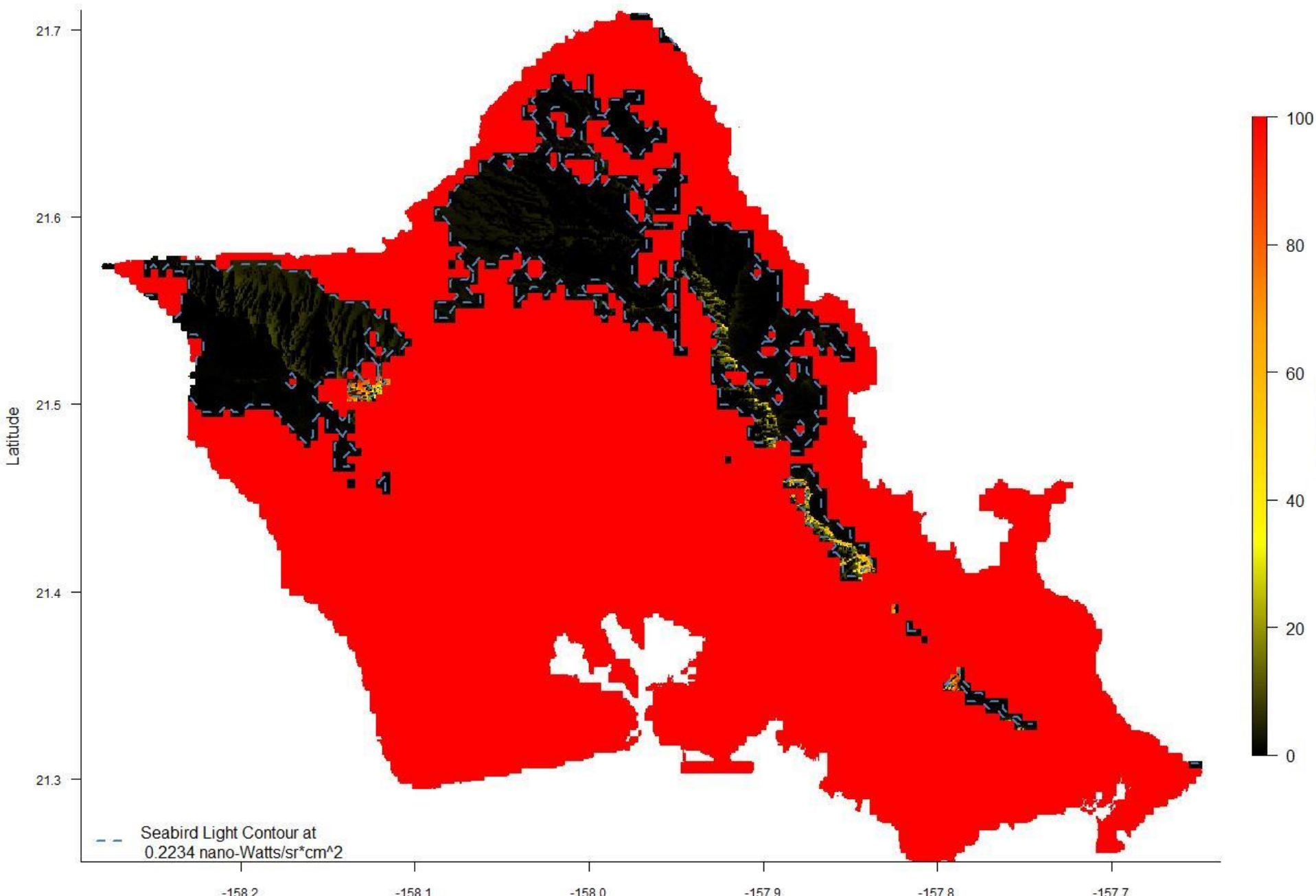


# 2017-2021 deployment locations

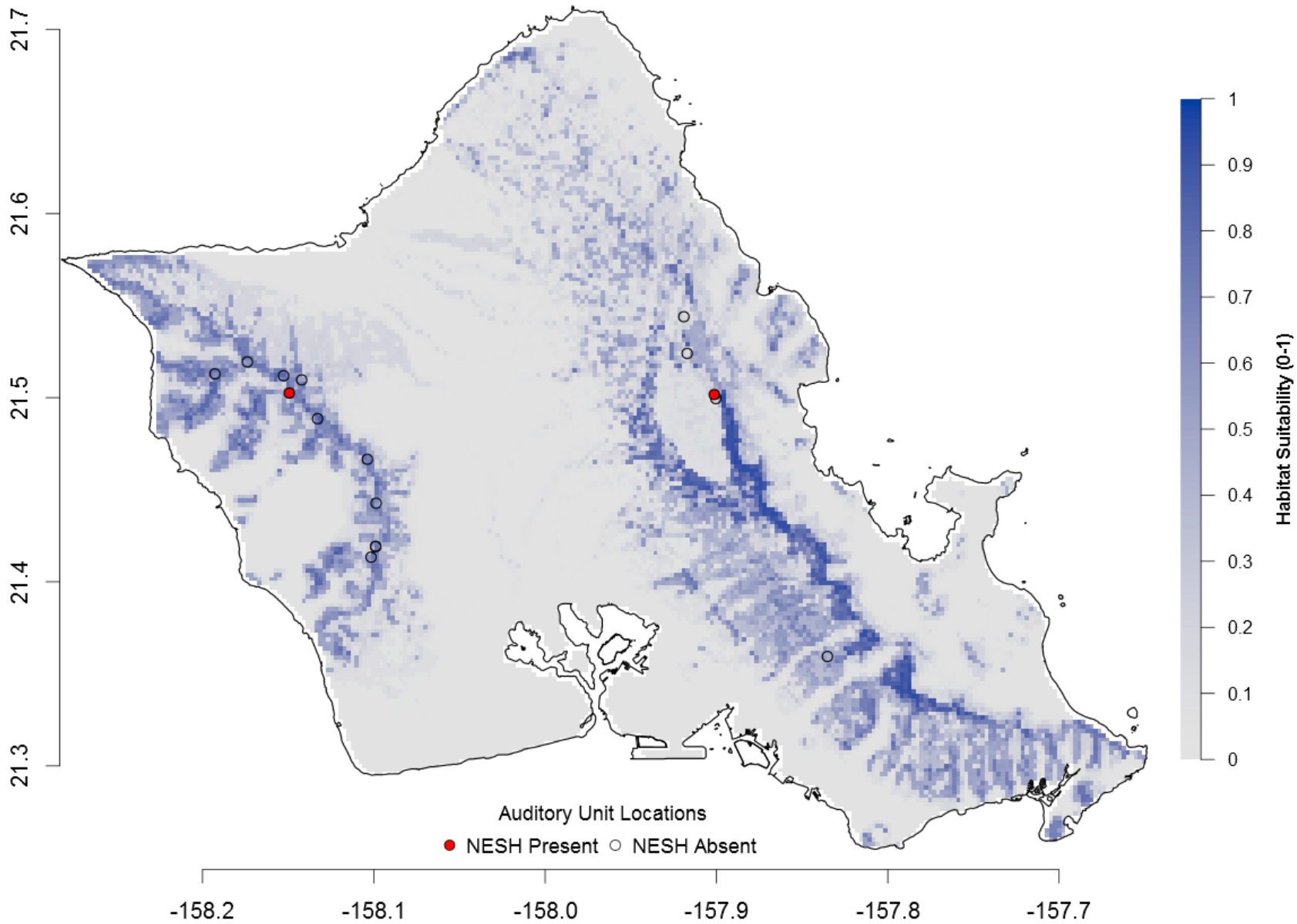




Light Visibility on Oahu;  
Compiled from 10 Viewshed Iterations



Auditory Unit Locations and NESH Detections  
Overlaid with Projected Habitat Suitability





**Table 4: Newell's Shearwater-like Targets Flight Characteristics from Oahu Wind Energy Facilities<sup>1</sup>**

<b>Project</b>	<b>Season</b>	<b>Passage Rate (shearwater-like targets per hour)<sup>2</sup></b>	<b>Flight Height (mean <math>\pm</math> SE above ground level)</b>	<b>Percent Below Maximum Blade Tip Height<sup>3</sup></b>
Kahuku	Summer (2008)	0.2 $\pm$ 0.1	None measured	NA
	Fall (2007)	0.3 $\pm$ 0.2	None measured	NA
Kawailoa	Summer (2009)	0.60 $\pm$ 0.07	Not reported	NA
	Fall (2009)	1.41 $\pm$ 0.15	Not reported	NA
Na Pua Makani	Spring (2013)	0.52 $\pm$ 0.09	482 $\pm$ 108 ft (147 $\pm$ 33 m)	71%
	Summer (2013)	0.34 $\pm$ 0.09	430 $\pm$ 66 ft (131 $\pm$ 20 m)	86%
	Fall (2012)	0.43 $\pm$ 0.09	600 $\pm$ 98 ft (183 $\pm$ 30 m)	80%
	Mean	Not calculated	499 $\pm$ 56 ft (152 $\pm$ 17 m)	79%

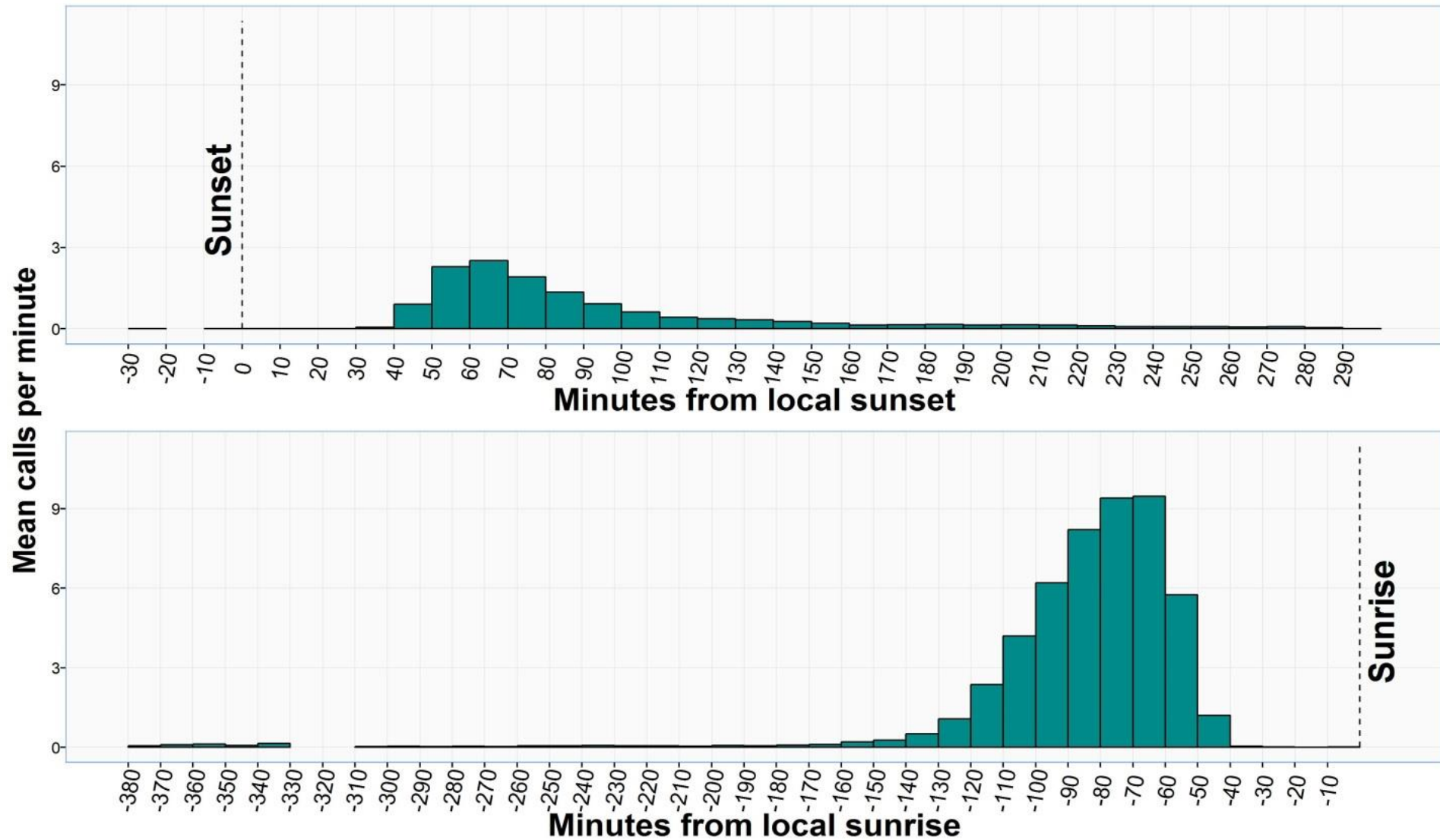
1/ Sources: Day and Cooper 2008, Cooper et al. 2009, Sanzenbacher and Cooper 2013 (Appendix B).

2/ Shearwater-like targets are birds that: fly >30 mph (48 kph), have directional flight toward potential breeding habitat, are not confirmed visually or aurally to be another species.

3/ Assumed: WTG maximum blade tip height of 656 ft (200 m); met tower height 262 ft (80 m).

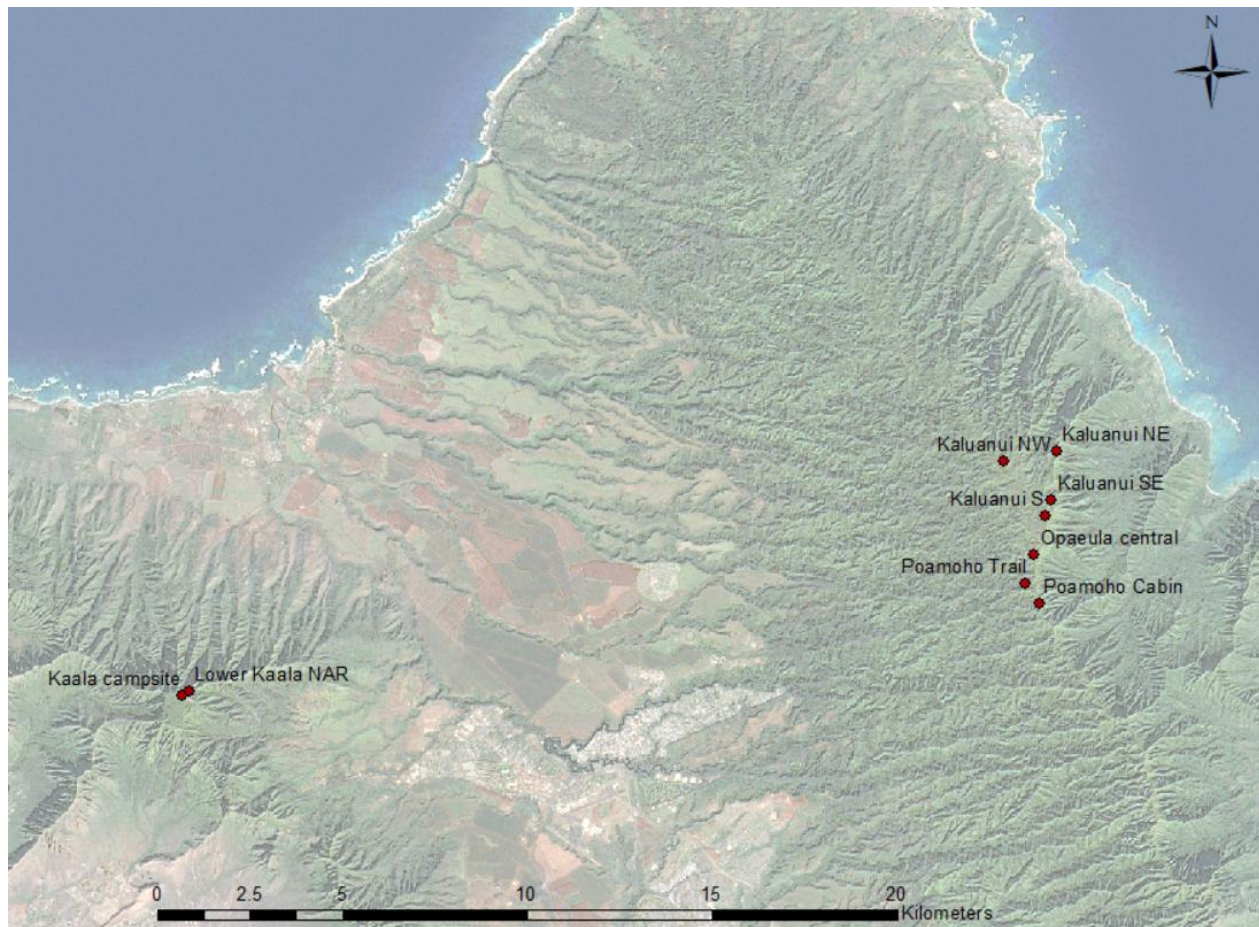


# NESH calling periods





# Locations of listed seabird detections on Oahu





# Summary of Oahu detections

- HAPE:
  - 66 detections since 2016
  - 56 at Kaala NAR (Waianae)
  - 9 at Kaluanui NAR (Koolau)
- NESH:
  - 78 detections since 2016
  - 16 at Kaala NAR
  - 62 at Koolau sites (Poamoho, Opaeha, Kaluanui)

**Young, L.C., VanderWerf, E.A., McKown, M., Roberts, P., Schlueter, J., Vorsino, A., and Sischo, D. 2019. Evidence of Newell's Shearwaters and Hawaiian Petrels on Oahu, Hawaii. The Condor: Ornithological Applications. 121: 1-7.**

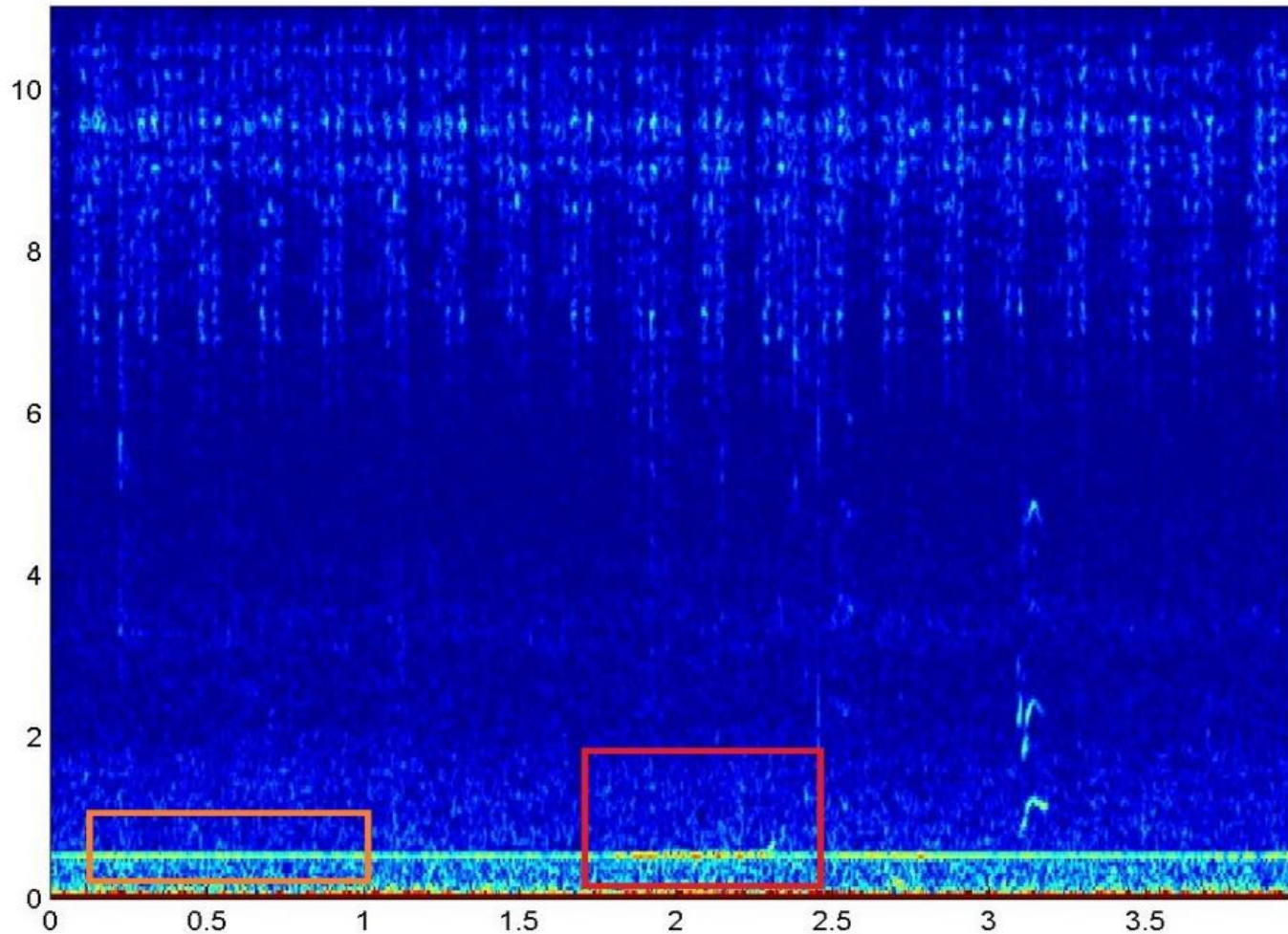


# In-person detections in 2020

Species	Site Name	Date	Time	Calling Bouts
NESH	Poamoho	05/31	04:46	1
NESH	Poamoho	05/31	04:47	1
NESH	Poamoho	06/10	20:19	3
NESH	Poamoho	06/10	20:21	3
NESH	Mount Ka'ala	06/16	19:30	1
NESH	Mount Ka'ala	06/16	19:38	0
NESH	Mount Ka'ala	06/16	19:52	1
UNKN	Mount Ka'ala	06/16	20:13	0
UNKN	Mount Ka'ala	06/16	21:07	0
UNKN	Mount Ka'ala	06/16	21:08	0
UNKN	Mount Ka'ala	06/17	04:11	0
UNKN	Mount Ka'ala	06/17	04:38	0
UNKN	Mount Ka'ala	07/01	04:04	0
HAPE	Poamoho	07/09	19:48	1

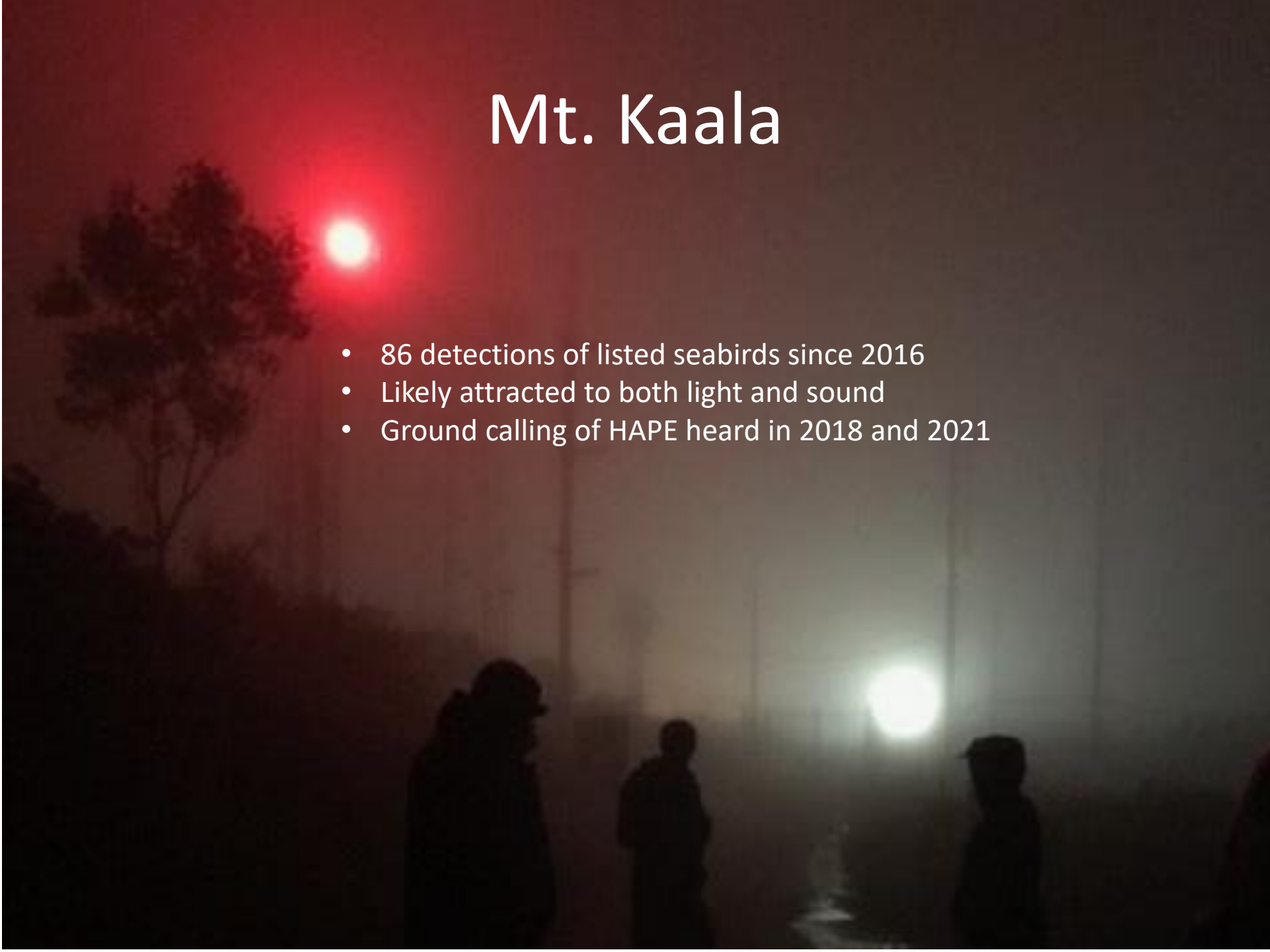


Spectrogram showing tonal energy between 478 and 550 Hz generated by a satellite facility near the Lower Kaala NAR survey site (orange box on left), and a Hawaiian Petrel call detected at the site (red box at center indicates the center of a petrel call mostly masked by the man-made noise source).



# Mt. Kaala

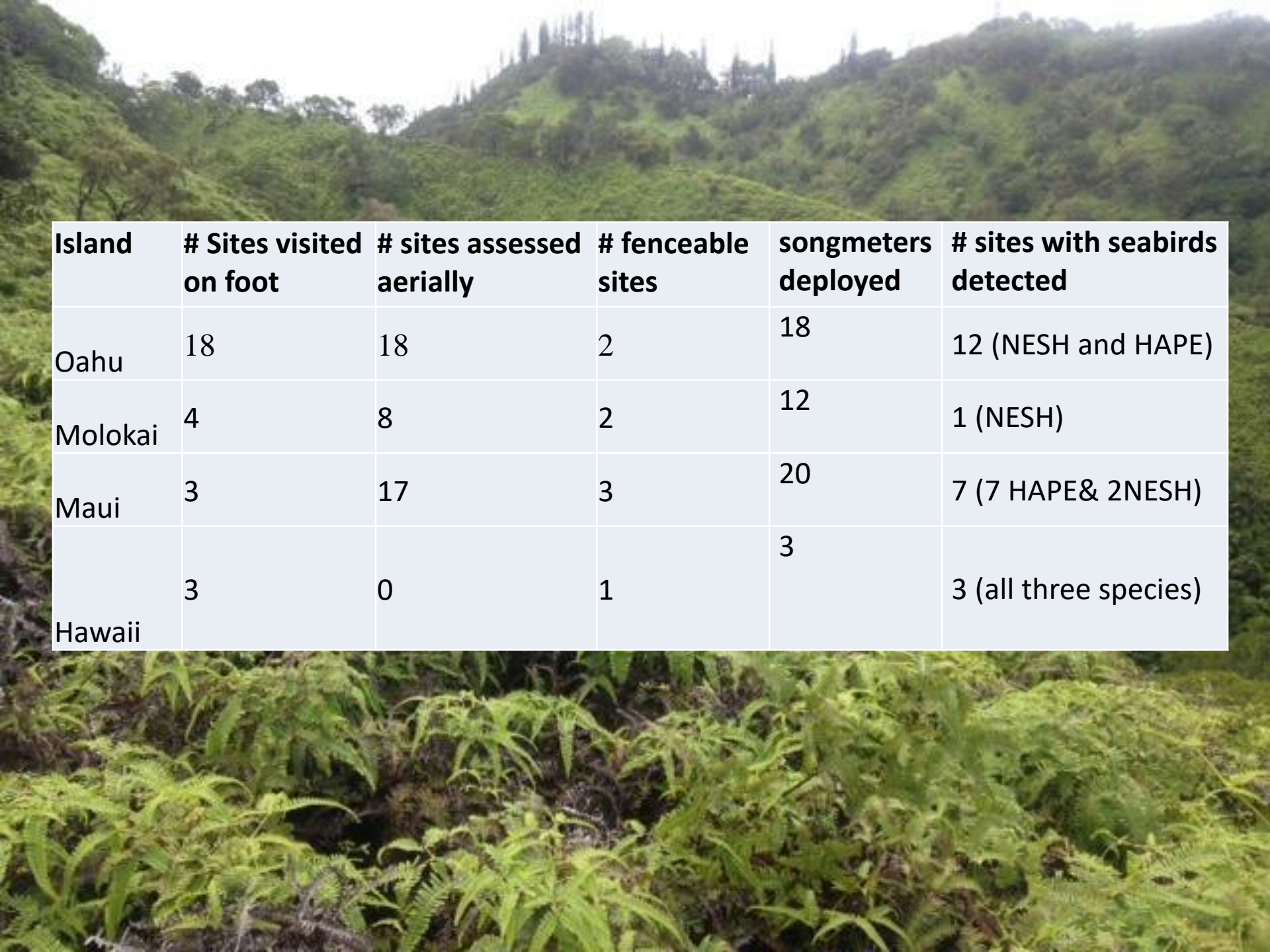
- 86 detections of listed seabirds since 2016
- Likely attracted to both light and sound
- Ground calling of HAPE heard in 2018 and 2021







Potential for attraction to windfarms



Island	# Sites visited on foot	# sites assessed aerially	# fenceable sites	songmeters deployed	# sites with seabirds detected
Oahu	18	18	2	18	12 (NESH and HAPE)
Molokai	4	8	2	12	1 (NESH)
Maui	3	17	3	20	7 (7 HAPE& 2NESH)
Hawaii	3	0	1	3	3 (all three species)



# Conclusions

- Plenty of suitable seabird habitat left on all islands
- Model doesn't account for predator density-likely the most important factor
- Follow up needed, particularly for NESH
- Noise pollution could be contributing to distribution patterns

# Thank you!

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Questions?

