Habitat assessment following ungulate exclusion in upper Kahikinui Forest & Nakula Natural Area Reserves

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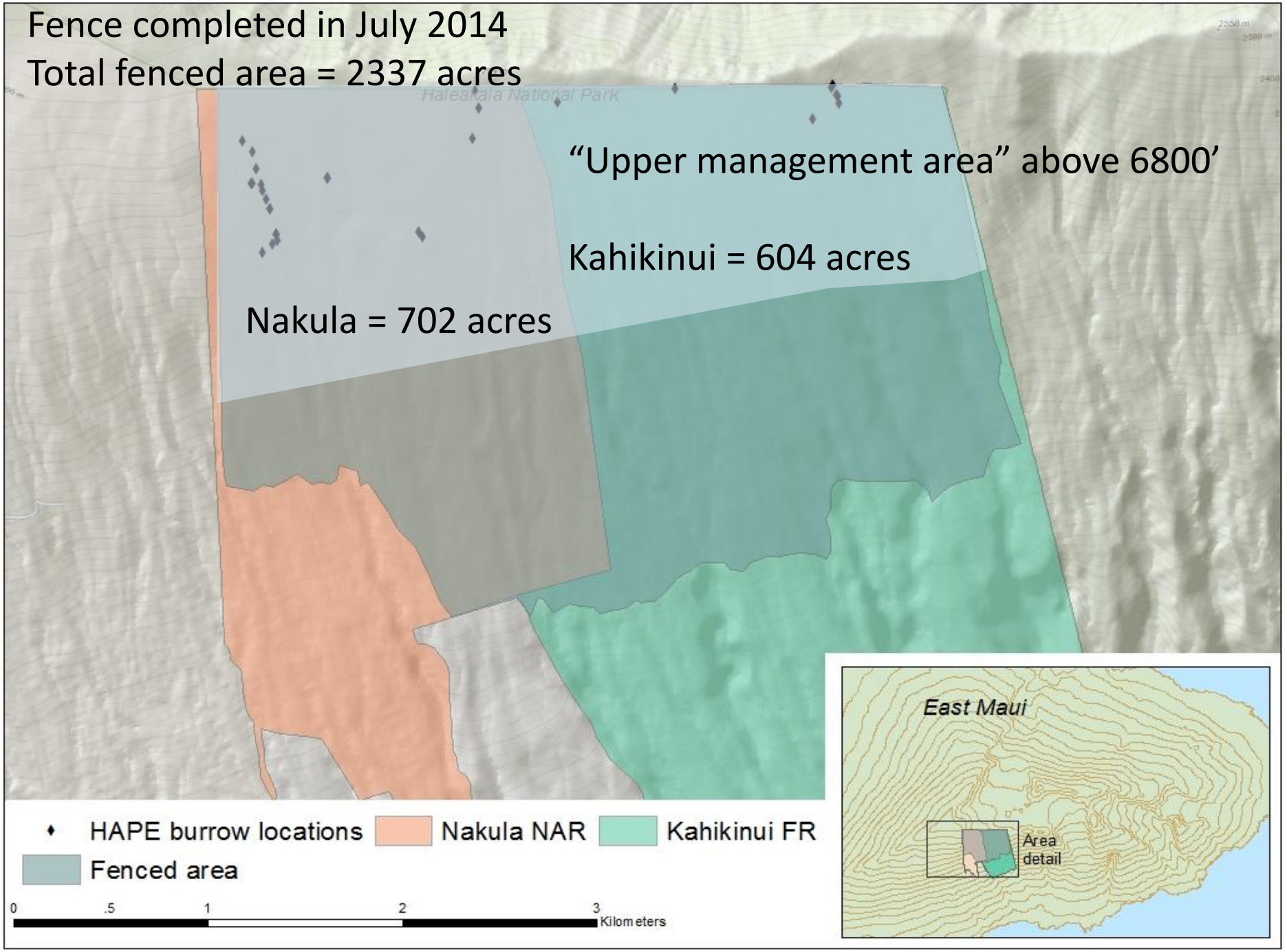
Hawaiian petrel; *Pterodroma sandwichensis* (HAPE)

- On Maui, nest Mar. - Oct. on high altitude slopes
- 3,000 – 4,000 breeding pairs in Haleakalā NP

HAPE habitat on leeward Haleakalā

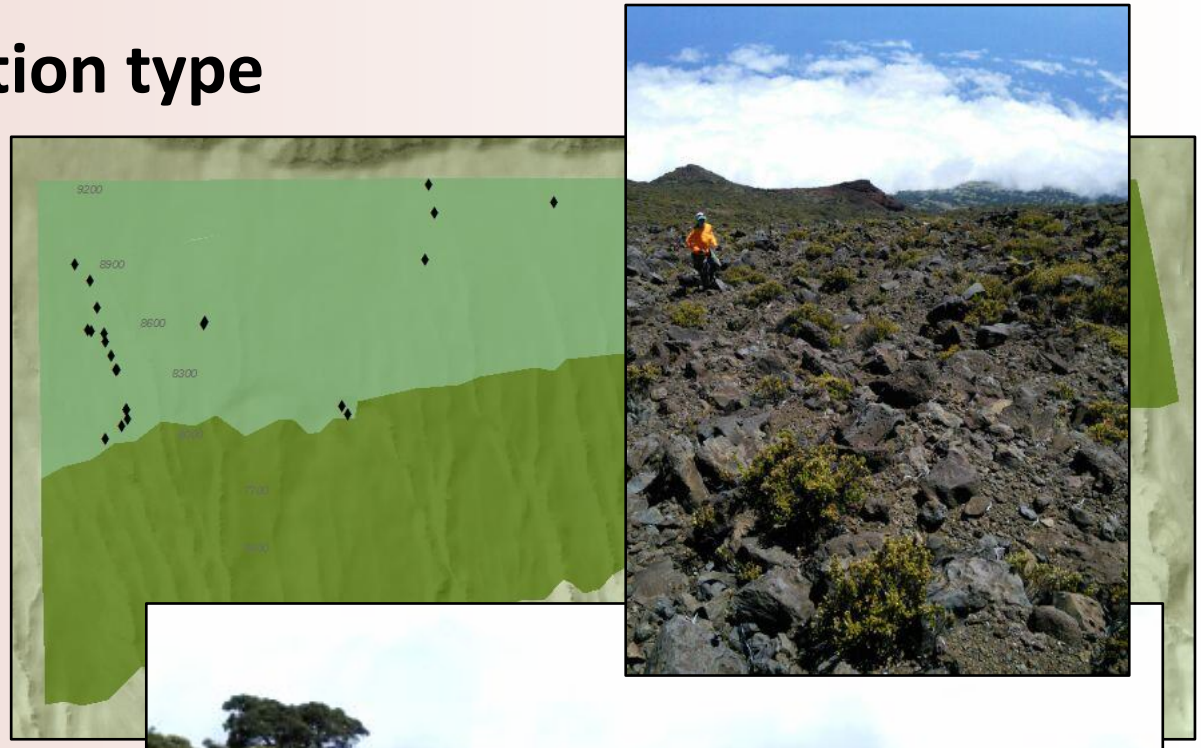
Burrow monitoring


Fence completed in July 2014
Total fenced area = 2337 acres
Haleakala National Park
"Upper management area" above 6800'
Kahikinui = 604 acres
Nakula = 702 acres
East Maui
Area detail
HAPE burrow locations
Nakula NAR
Kahikinui FR
Fenced area
0
.5
1
2
3
Kilometers

Habitat and vegetation type

<u>Alpine rockland</u>: Above 8000’

- High-altitude desert
  - *Dubautia menziesii and Argyroxiphium sandwicense*
  - pūkiawe/’ōhelo
  - *Agrostis sandwicensis*
- <30% cover, <40% humidity
- Minimal soil development



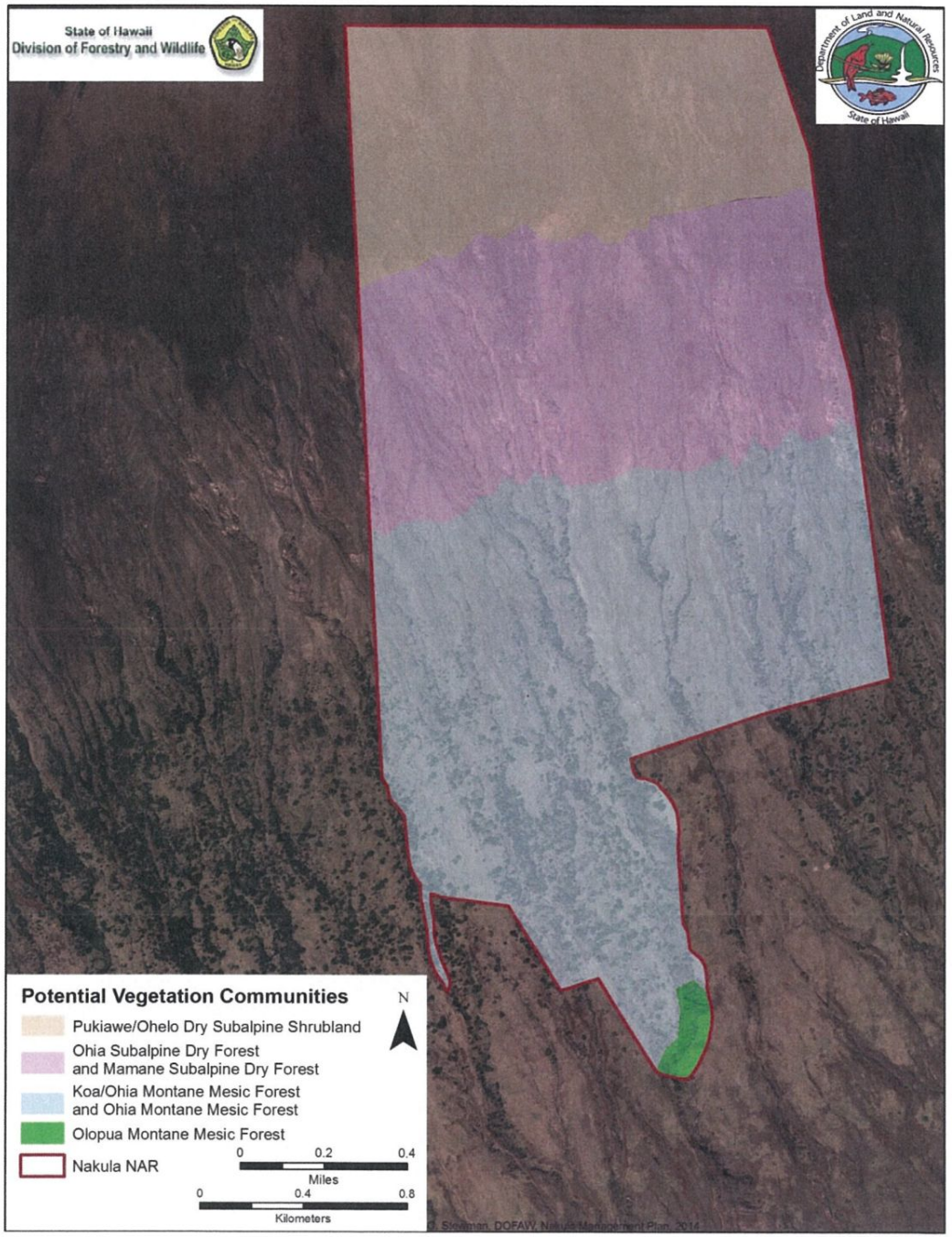
<u>Sub-alpine shrubland</u>: 6000’-8000’

- Ericaceous shrub community
  - pūkiawe/’ōhelo
  - *Deschampsia/Pteridium*
- Spans inversion layer
- Moderate soil formation

Impacts of feral goats

- Low impact on pūkiawe/’ōhelo
- HIGH impact on *Dubautia and Argyroxiphium*
- HIGH impact on māmane
- Introduced grasses move in and outcompete

Figure 7. Potential native vegetation of Nakula NAR.



Our questions:

- How are the vegetation communities responding to ungulate removal?
  - *Veg survey completed March 2017, to be repeated annually*

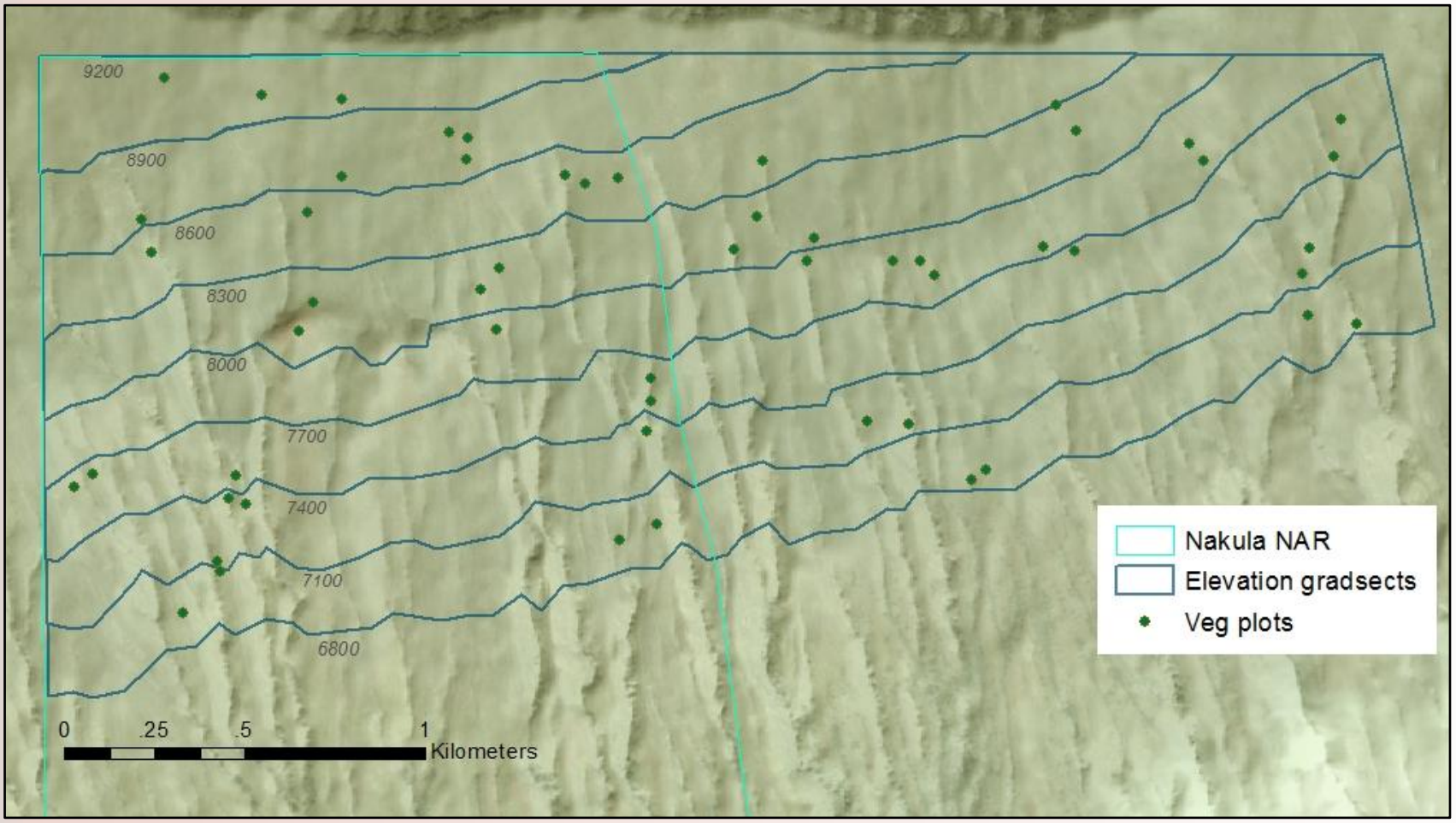
- Does ungulate exclusion benefit the Hawaiian petrel colony on Haleakalā?
  - *Burrow searching/monitoring annually*

Permanent plot selection:

- Upper management area = 8 gradsects of 300’ elev.
- 10m x 10m plots randomly generated to represent 0.1% total area
- Plot n = 55

Survey methodology:

- Standard Relevé method; % cover class (1-6) for each species
- Other variables; slope, aspect, surficial geology, evidence of bioturbation



Survey results: Diversity

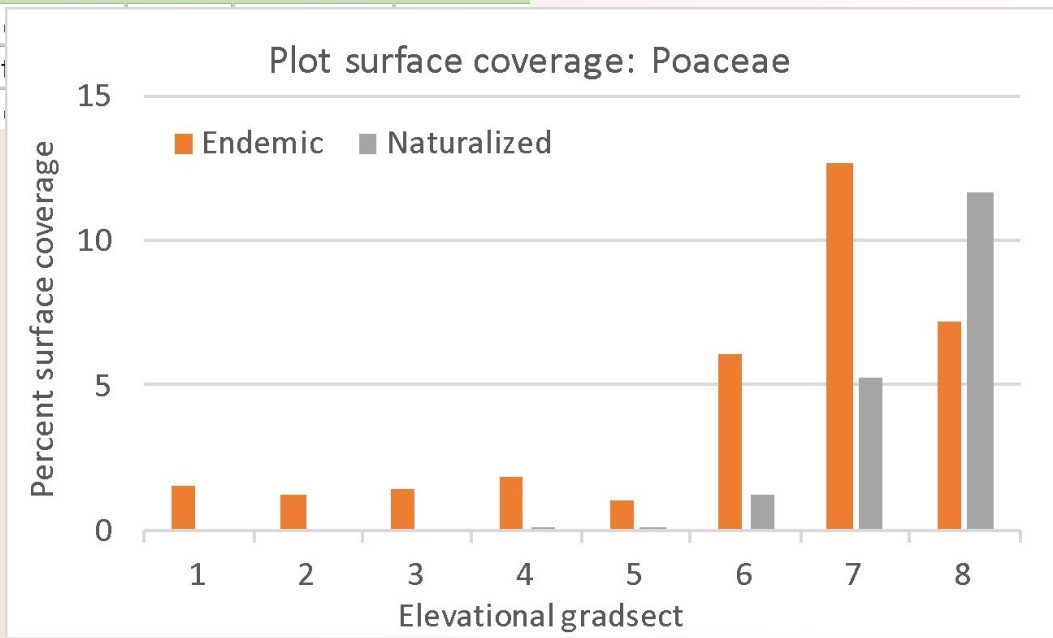
	Endemic		Indigenous		Naturalized	
	Species	Plot count	Species	Plot count	Species	Plot count
TOTAL	**15**	**246**	**9**	**140**	**23**	**241**
Family						
Aspleniaceae	1	19				
Asteraceae	4	27			8	145
Campanulaceae					1	4
Caryophyllaceae					1	18
Cyperaceae	1	14				
Dennstaedtiaceae			1	4		
Ericaceae	1	39	1	53		
māmane Fabaceae	1	1				
→ Gentianaceae					1	9
Geraniaceae					1	6
Hypolepidaceae	1	49				
Juncaceae	1	13				
Lythraceae			1	9		
Myrtaceae	1	1				
ʻōhiʻa → Oxalidaceae			1	9		
Plantaginaceae					1	8
Poaceae	2	70			6	30
Polygonaceae					1	3
Primulaceae					1	4
Psilotaceae			1	2		
Pteridaceae			2	55	2	14
Rosaceae			1	7		
Rubiaceae	2	13				
Santalaceae			1	1		

- **24** native vs. **23** non-native species
- Family richness higher for native species (**17** vs. **10** families)
- Native species are more even in distribution (*E* = **0.66** vs. **0.41**)

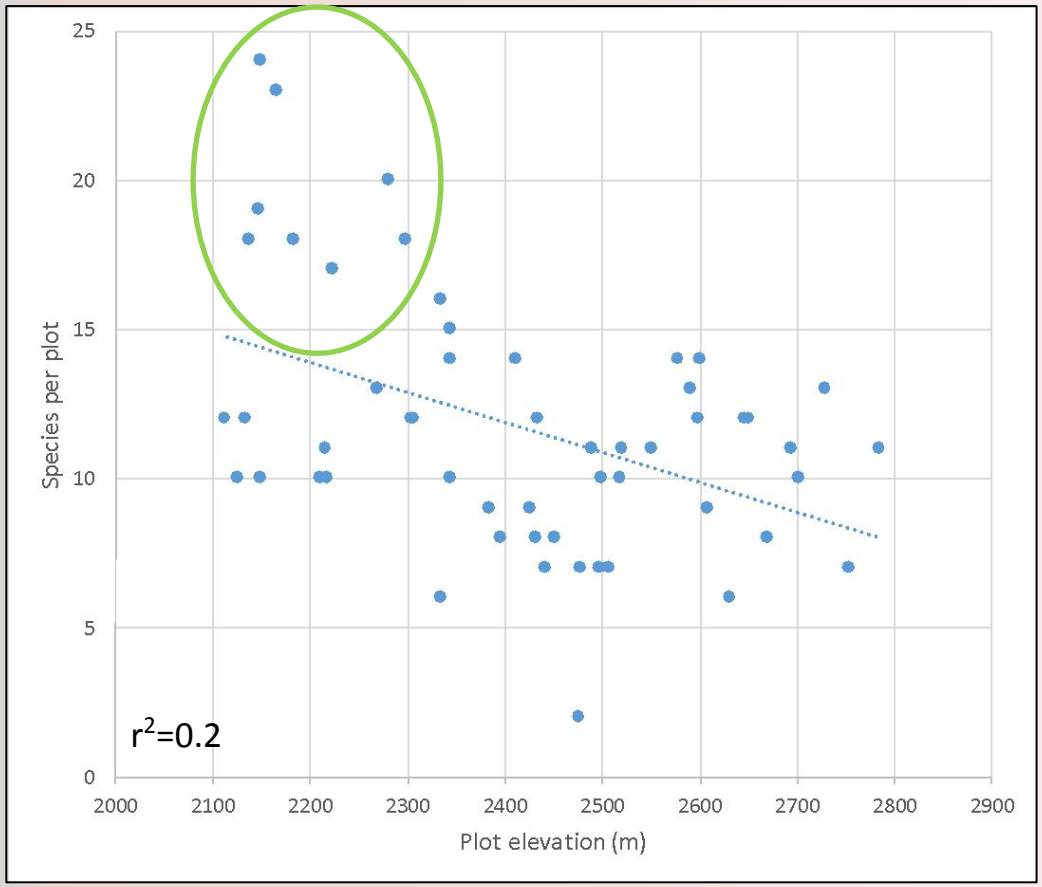
Survey results: Abundance

Abundance Rank	Family	Species	Nativity	Plot count	cover (m2)	e % cover
1	Ericaceae	*Styphelia tameiameiae*	indigenous	53	1359	25.6
2	Asteraceae	*Hypochoeris radicata*	naturalized	51	45.5	0.9
3	Pteridaceae	*Pellaea ternifolia*	indigenous	51	45.3	0.9
4	Hypolepidaceae	*Pteridium aquilinum*	endemic	49	291.5	5.9
5	Poaceae	*Deschampsia nubigena*	endemic	46	211	4.6
6	Ericaceae	*Vaccinium reticulatum*	endemic	39	108	2.8
7	Asteraceae	*Conyza bonariensis*	naturalized	34	27	0.8
8	Asteraceae	*Ageratina riparia*	naturalized	24	27	1.1
9	Poaceae	*Agrostis sandwicensis*	endemic	24	27	1.1
10	Aspleniaceae	*Asplenium trichomares*	endemic	19	9.5	0.5
11	Caryophyllaceae	*Arenaria serpyllifolia*	naturalized	18	9	0.5
12	Poaceae	*Holcus lanatus*	naturalized	15	115.5	7.7
13	Cyperaceae	*Carex wahuensis*	en			
14	Asteraceae	*Ageratina adenophera*	nat			
15	Juncaceae	*Luzula hawaiiensis*	en			

- **38%** coverage for native, **4%** coverage for non-native species
- **Elevation** determines coverage of grasses

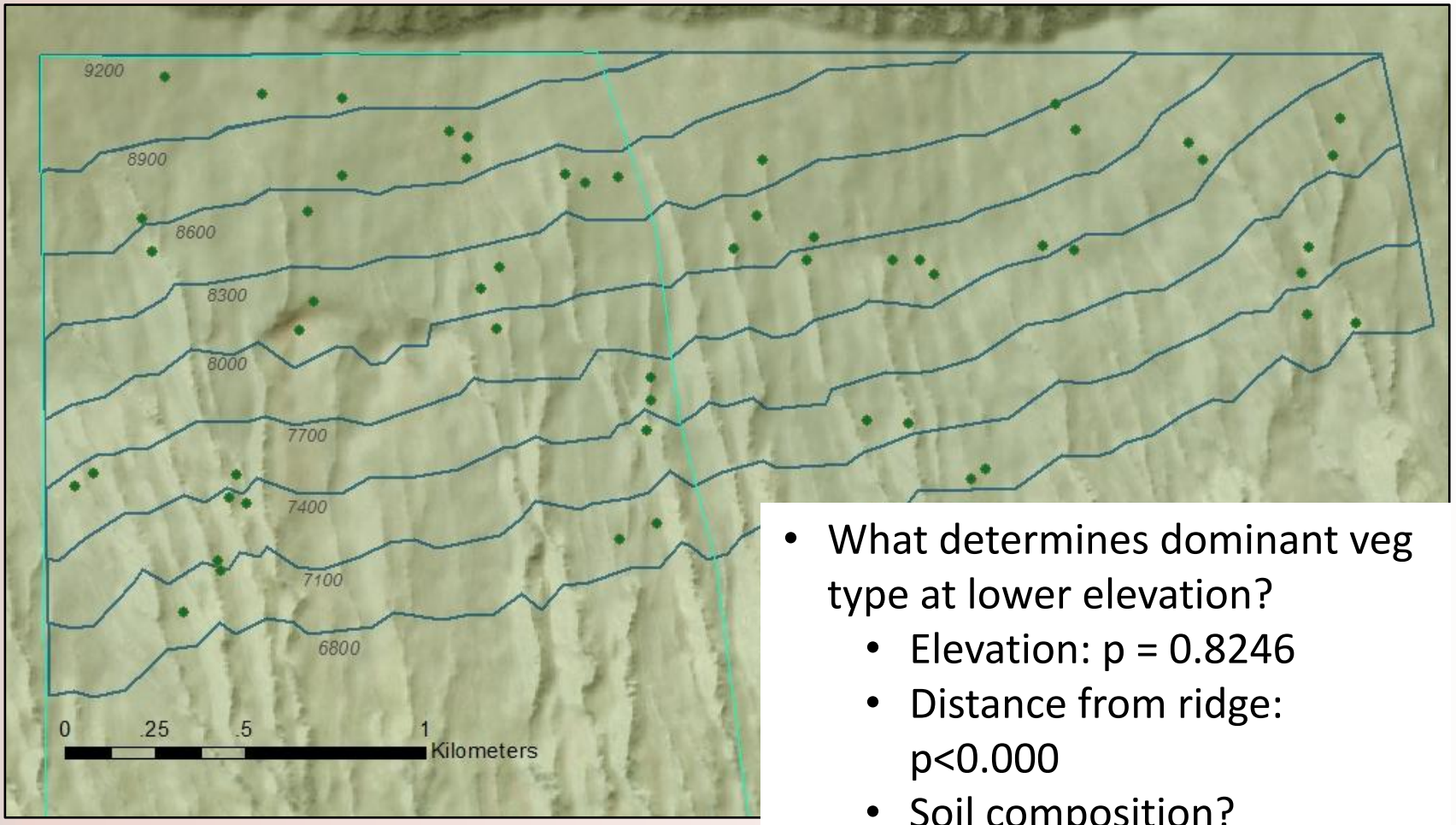


Survey results: Elevation effects



- Weak negative relationship between species diversity and elevation
- **In sub-alpine habitat, plots with high species counts are Poaceae-dominant vs. *Styphella*-dominant**
- Poa = 18 sp/plot
  Sty = 11 sp/plot

Survey results: Elevation effects



- What determines dominant veg type at lower elevation?
  - Elevation: p = 0.8246
  - Distance from ridge: p<0.000
  - Soil composition?

What is the status of habitat regeneration in Nakula/Kahikinui?

- Non-native grasses outcompete native seedlings, slowing re-colonization in Poaceae dominated plots
- Native species preferred by goats (*Dubautia*, *Sophora*) occurring in plots, especially at high elevation
- Resilient native species maintain habitat structure

Continuing work

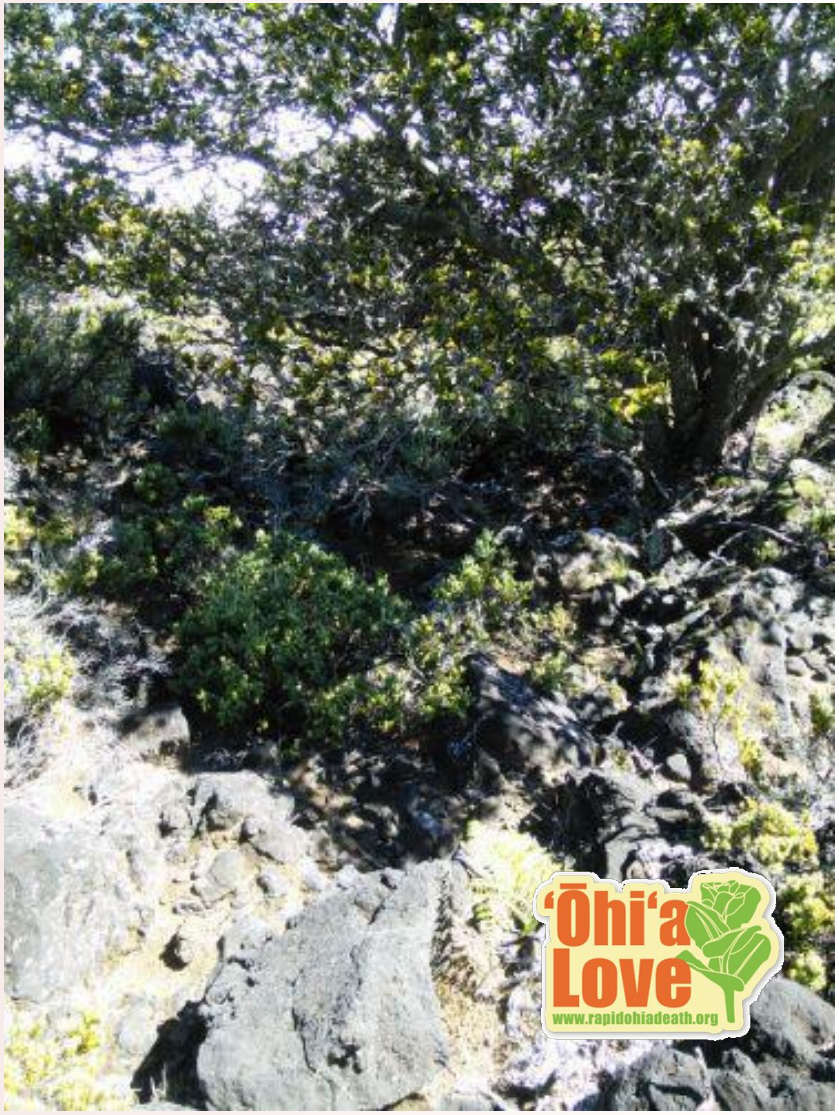
- Characterize habitat near active burrow sites
  - Fenced area in HALE showed 8% increase in recruitment 3 years after ungulate exclusion
  - Our site went from 8 – 32 burrows between 2016/2017

For discussion:

- Will changing climate influence vegetation communities on the leeward slope? Wouldn't it be great to have a long-term data logging weather sensor up there?

- *Argyroxiphium sandwicense* were not found in our plots but are being out-planted in the site. How can our work support those efforts?

- What harmful invasive species should our team be watching for?



Mahalo to Lynx Gallagher, Becca Pederson, and Amy Frate for veg survey work and burrow searching!