Studying land snail ecology to inform conservation planning on Norfolk Island

Junn Kitt Foon, Isabel Hyman, Frank Köhler, Alexandra Nance, John Hunt, Kate Umbers

School of Science

Western Sydney University

WESTERN SYDNEY UNIVERSITY

AUSTRALIAN MUSEUM


O‘ahu, Hawai‘i
282 species
Cowie (1995)
DOI: 10.1111/j.1558-5646.1995.tb04446.x
Brian CC BY-NC-SA 2.0

Norfolk Island

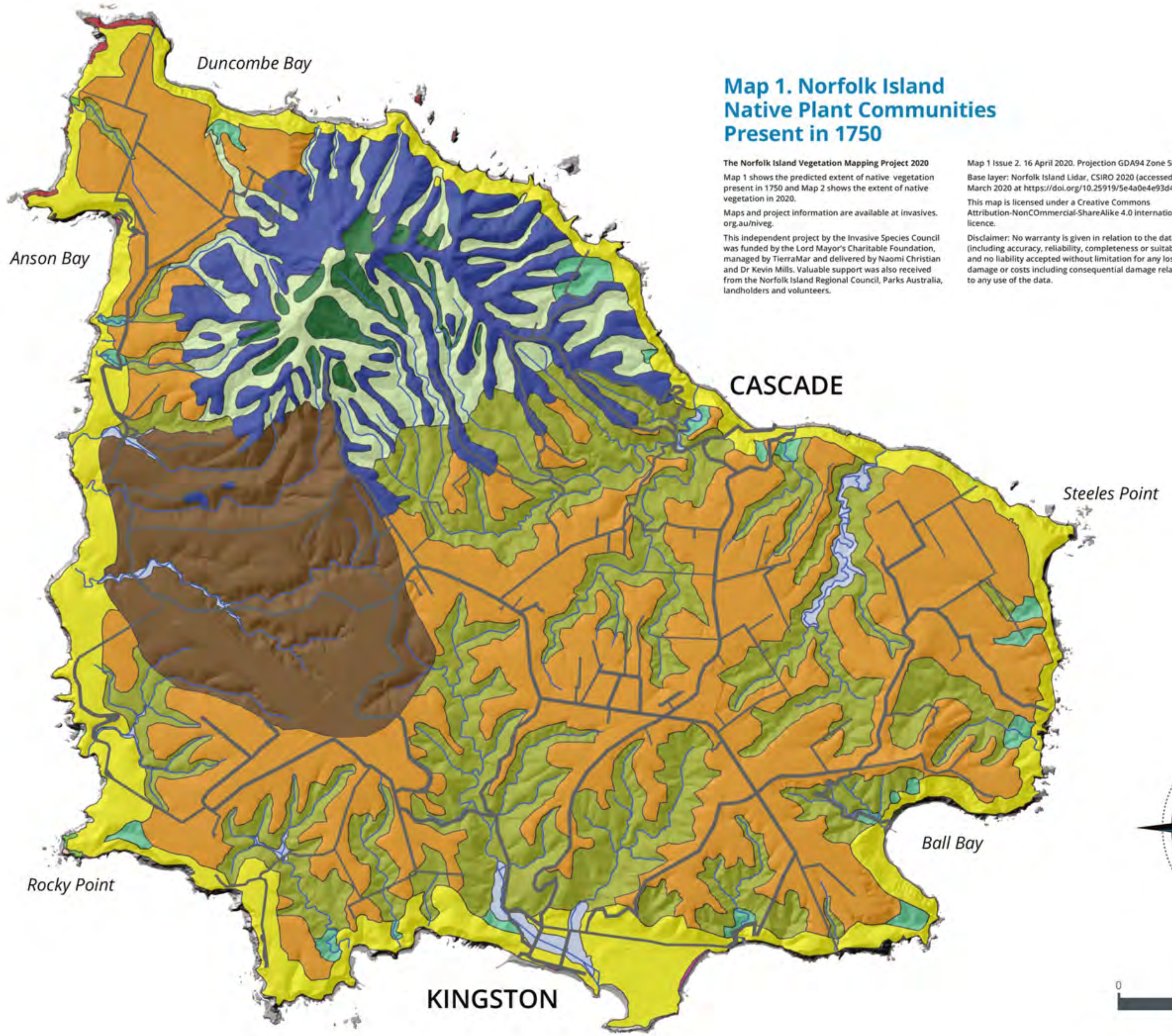
60 species

Australian Museum | J.K. Foon

Norfolk Island


Palm
Hardwood
Pine
Guava & olive
Australian Museum | J. K. Foon

Map 1. Norfolk Island Native Plant Communities Present in 1750



The Norfolk Island Vegetation Mapping Project 2020

Map 1 shows the predicted extent of native vegetation present in 1750 and Map 2 shows the extent of native vegetation in 2020.

Maps and project information are available at invasives.org.au/niveg.

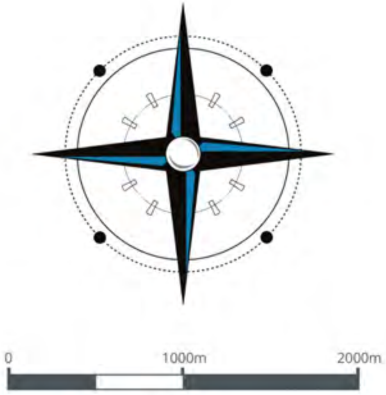
This independent project by the Invasive Species Council was funded by the Lord Mayor's Charitable Foundation, managed by TierraMar and delivered by Naomi Christian and Dr Kevin Mills. Valuable support was also received from the Norfolk Island Regional Council, Parks Australia, landholders and volunteers.

Map 1 Issue 2. 16 April 2020. Projection GDA94 Zone 58.

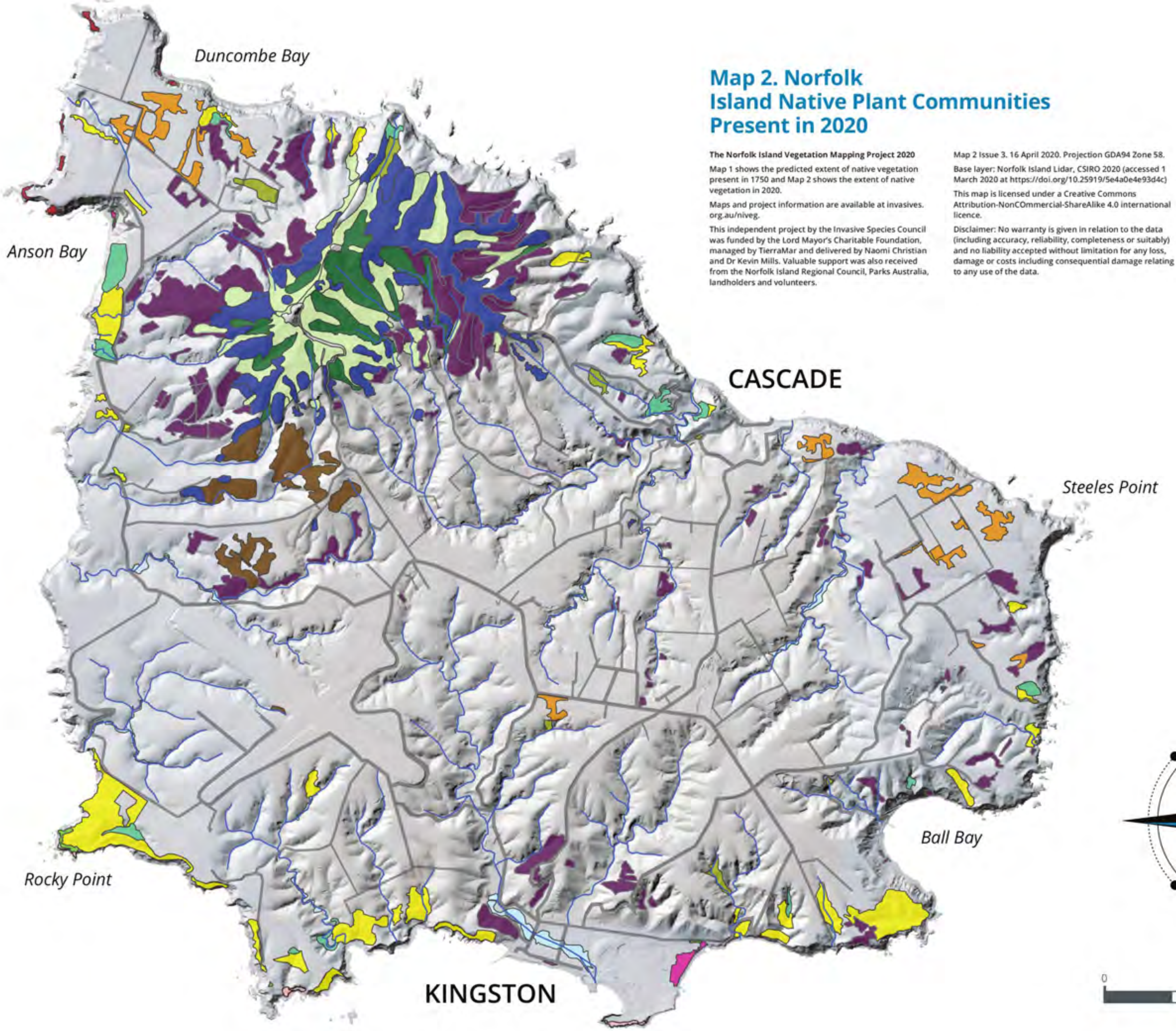
Base layer: Norfolk Island Lidar, CSIRO 2020 (accessed 1 March 2020 at https://doi.org/10.25919/5e4a0e4e93d4c)

LEGEND

1 Moist Palm Valley Forest
2 Moist Upland Hardwood Forest
3 Pine-Hardwood Ridge Forest
4 Viny Hardwood Forest
5 Plateau Hardwood Forest
6 Lowland Valley Hardwood Forest
7 Sheltered Coastal Forest
8 Coastal Pine and White Oak Forest
9 Coastal White Oak Shrubland
10 Sandy Beach Herbland
11 Coastal Grassland
12 Moo-oo Sedgeland
13 Coastal Flax Community
14 Freshwater Swamp
Waterway
Road



Map 2. Norfolk Island Native Plant Communities Present in 2020



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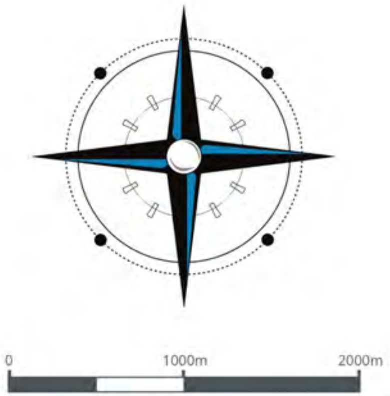
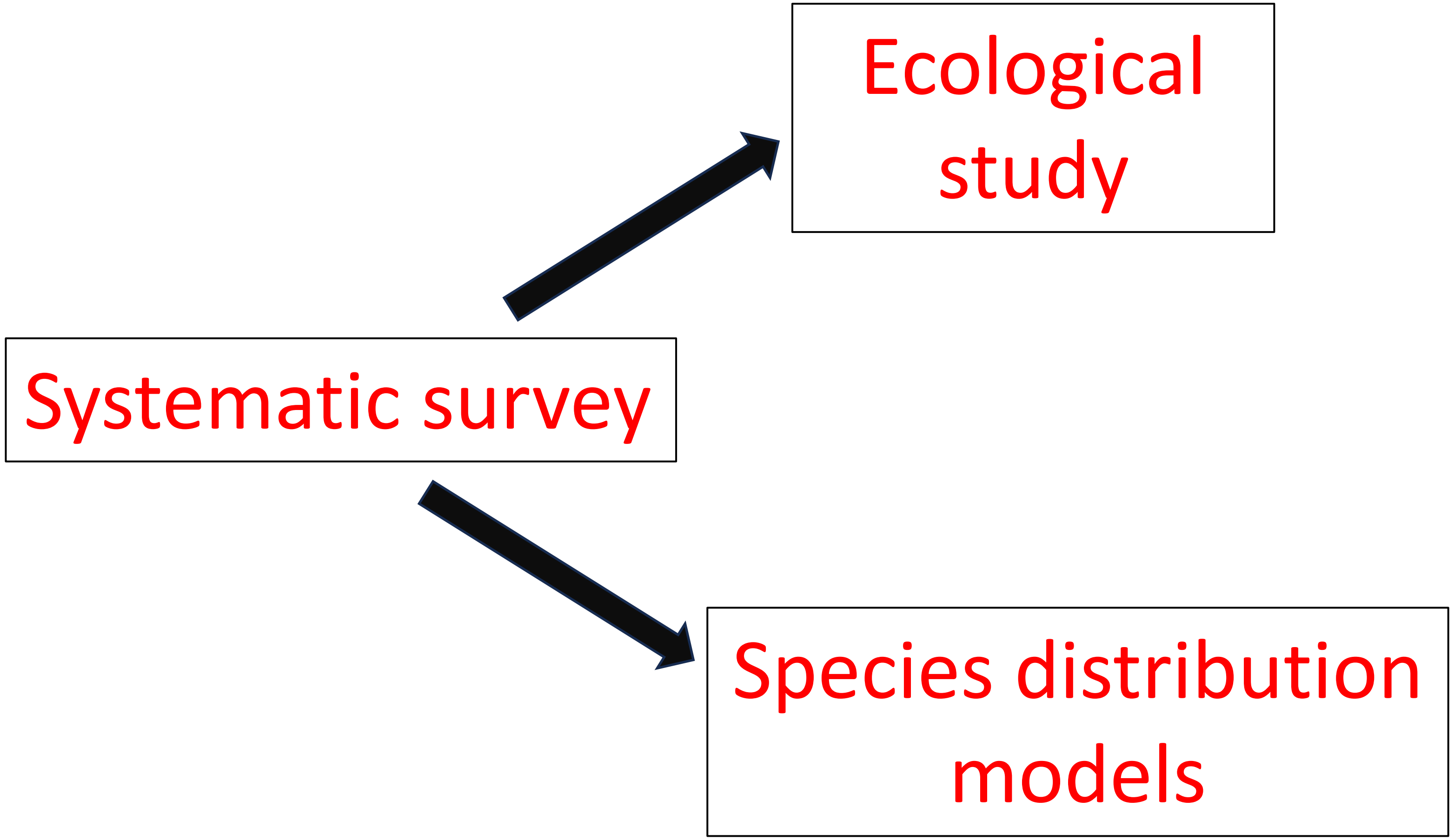
- Waterway
- Road



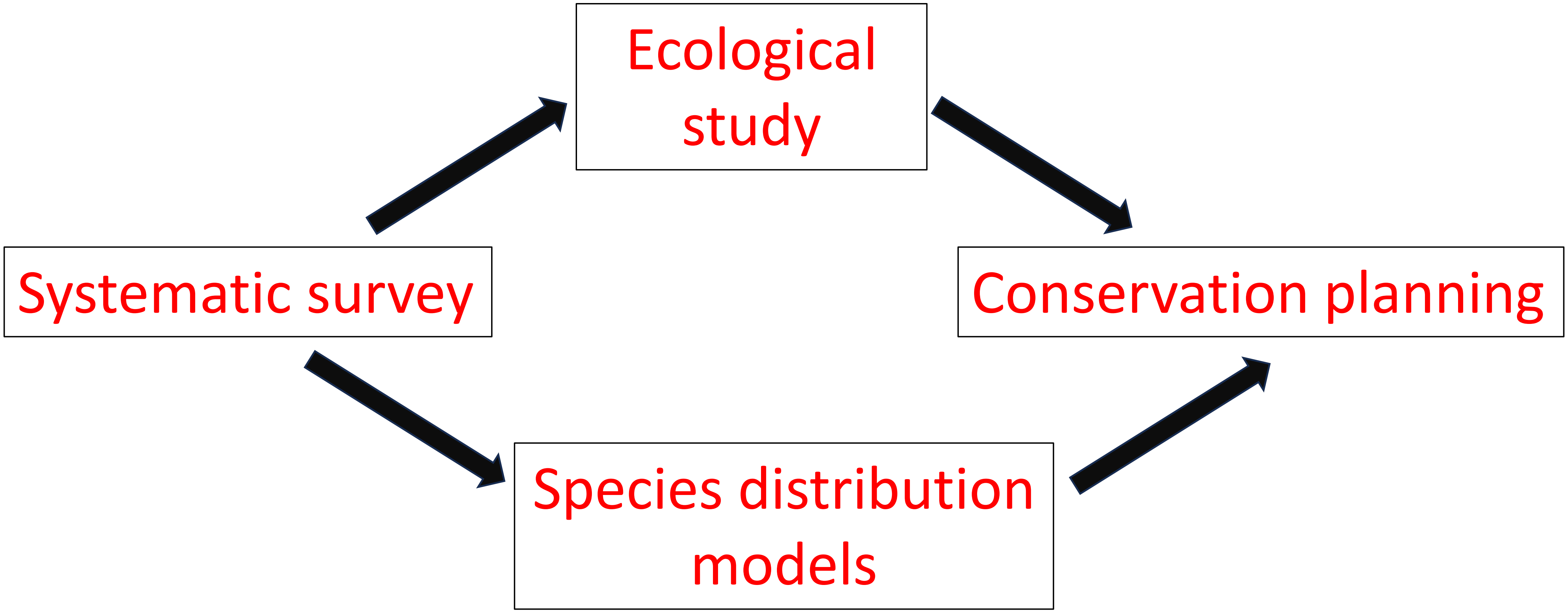
Land snails of Norfolk Island

Hyman et al. (2023) DOI: 10.1071/IS22049

Key steps

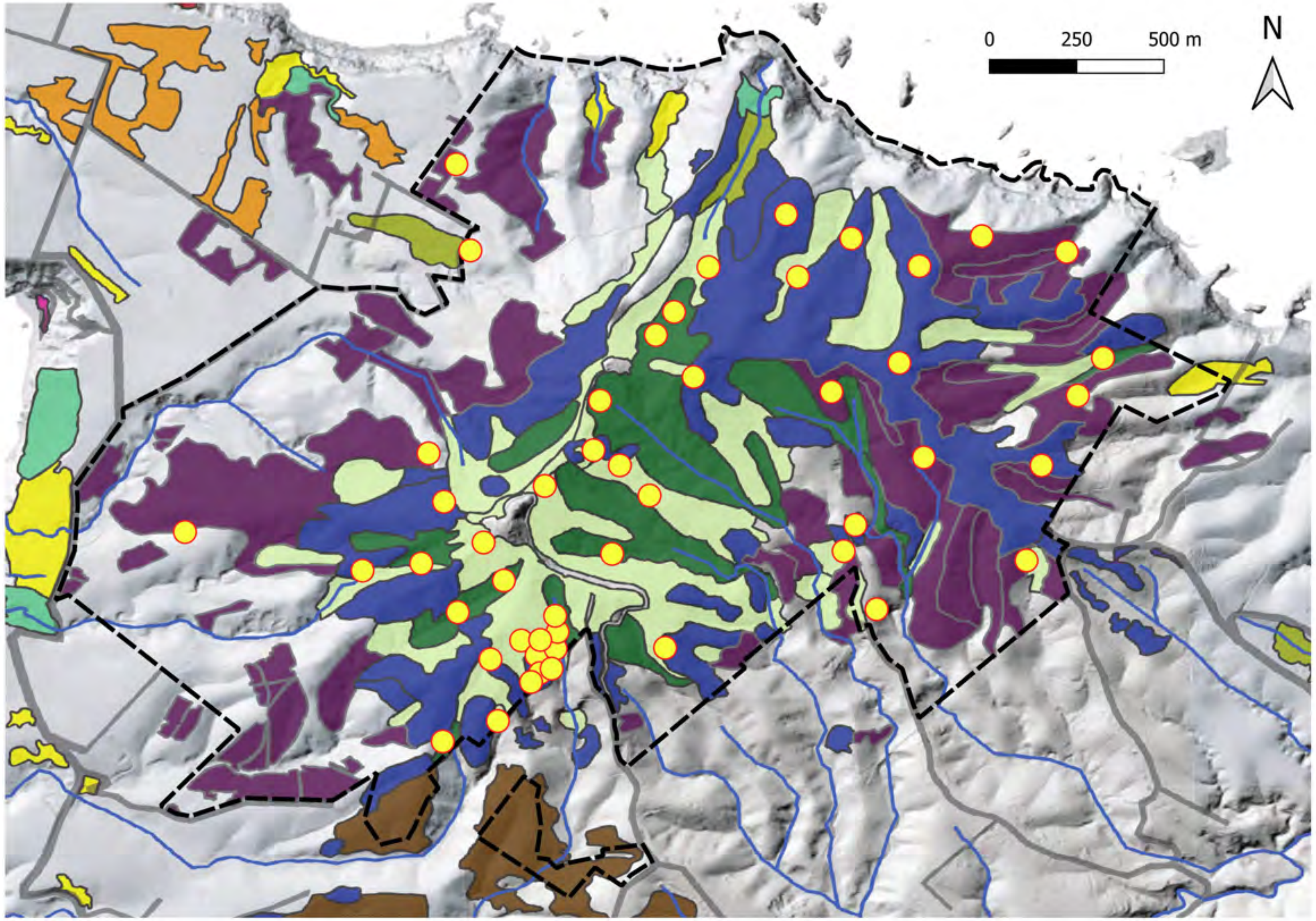

Ecological study
Systematic survey
Species distribution models

Key steps


Ecological study
Systematic survey
Conservation planning
Species distribution models

Question 1

What environmental factors are associated with abundance of a land snail species?



The Norfolk Island Vegetation Mapping Project 2020

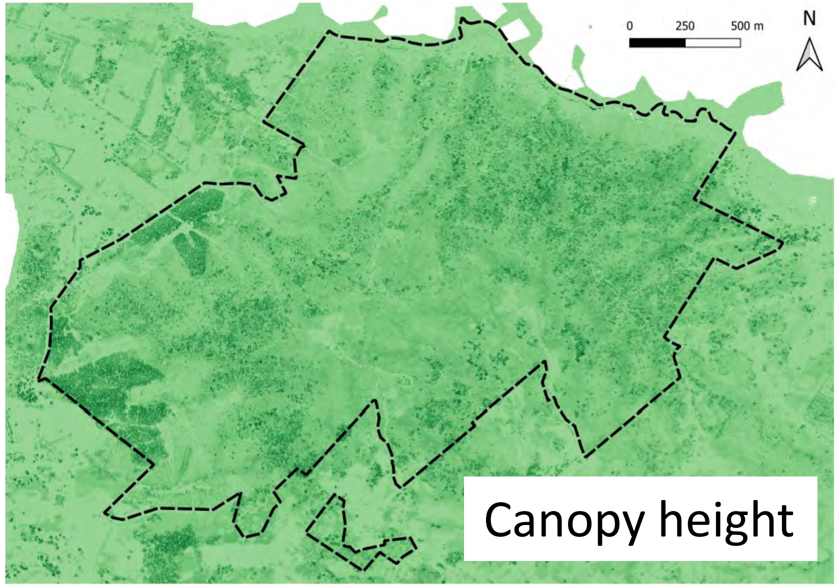
Systematic survey

Sep 2023 – Oct 2023
49 sites
4m x 4m quadrat per site

Data collected

- counts per snail species
- Soil pH
- Elevation
- Plant percentage cover
- Microhabitat percentage cover

Environmental variables



Analysis derived from LIDAR data by Gallant & Petheram (2020): https://doi.org/10.25919/5e4a0e4e93d4c

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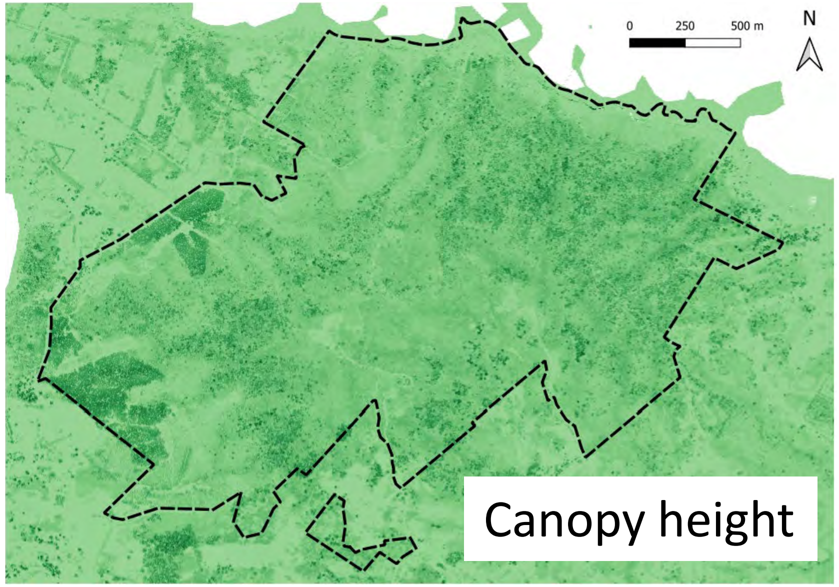

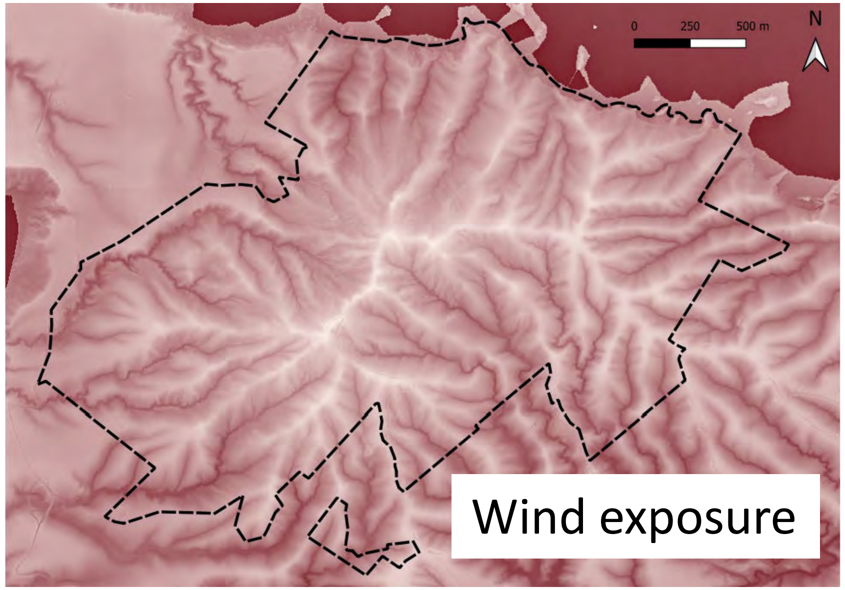

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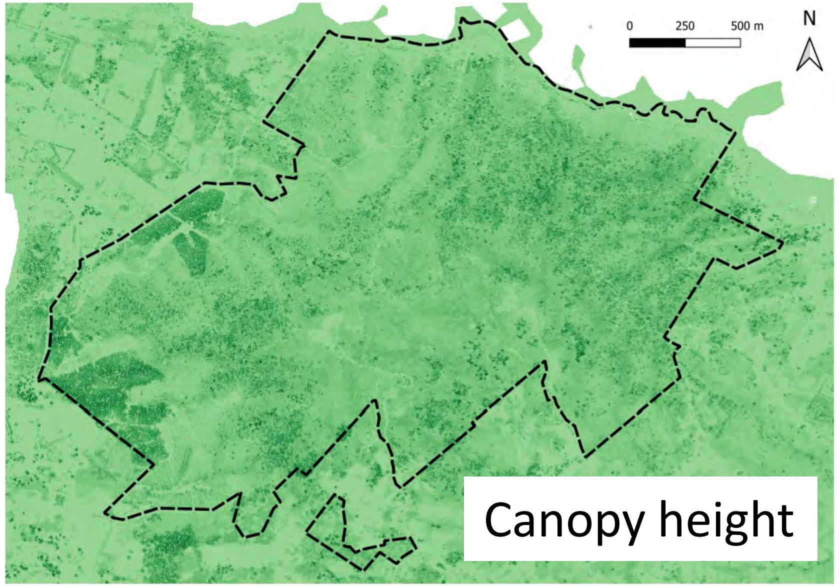

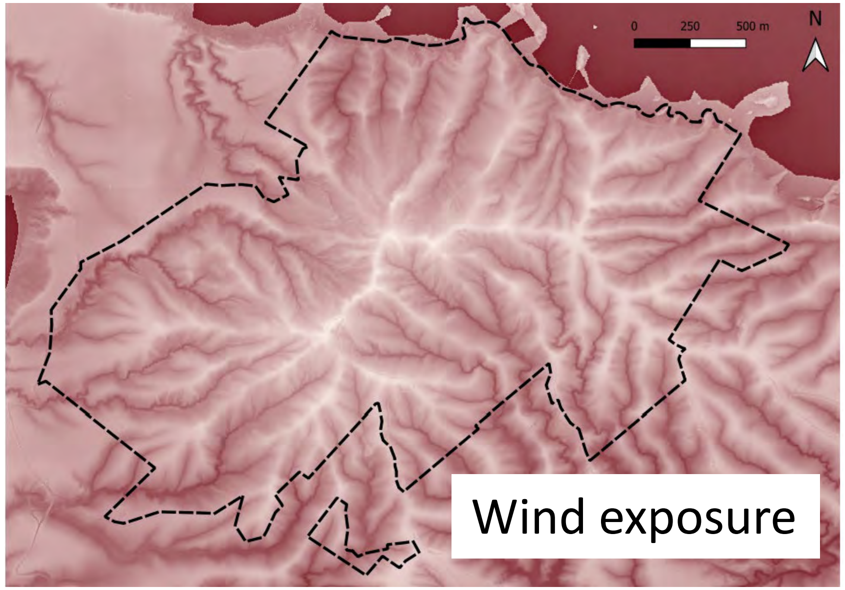

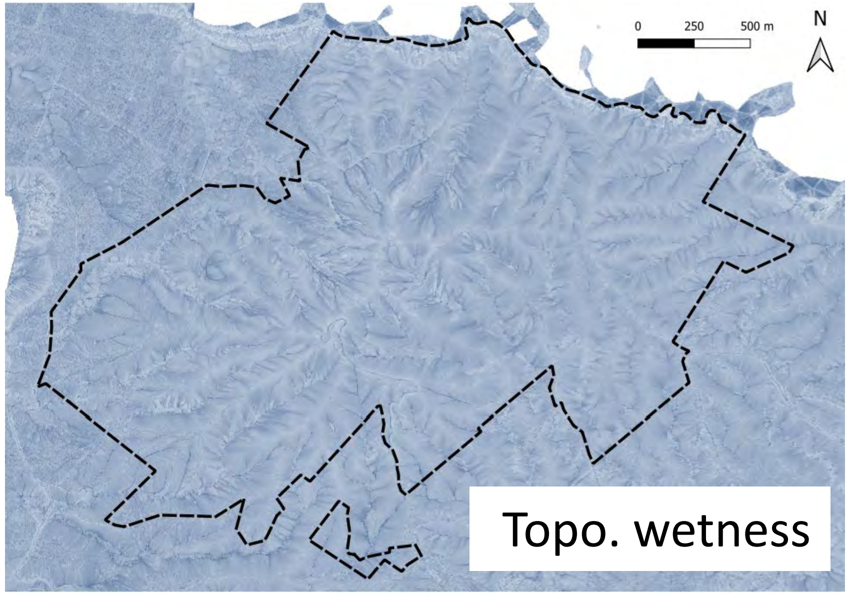

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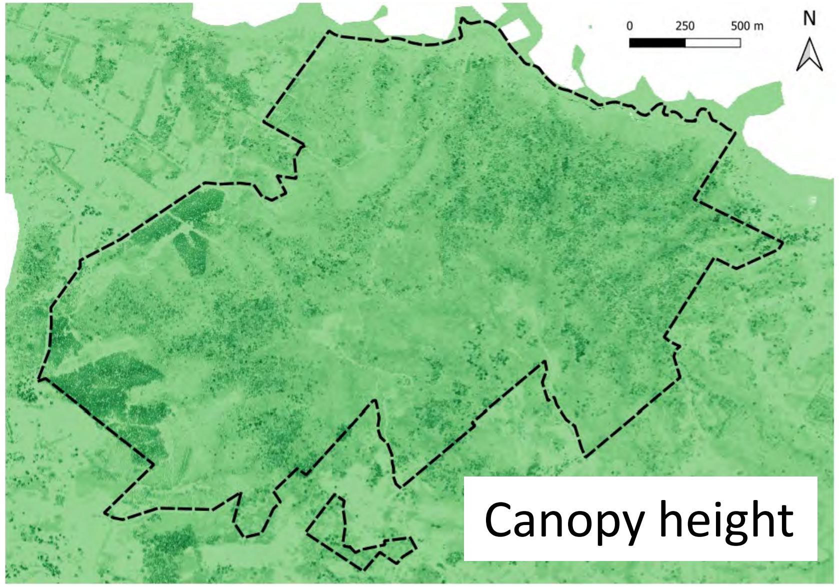

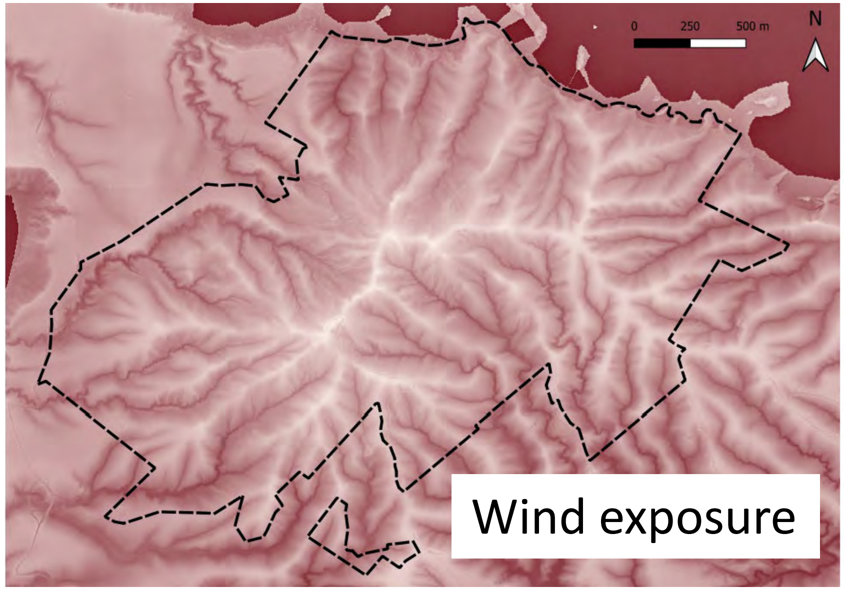

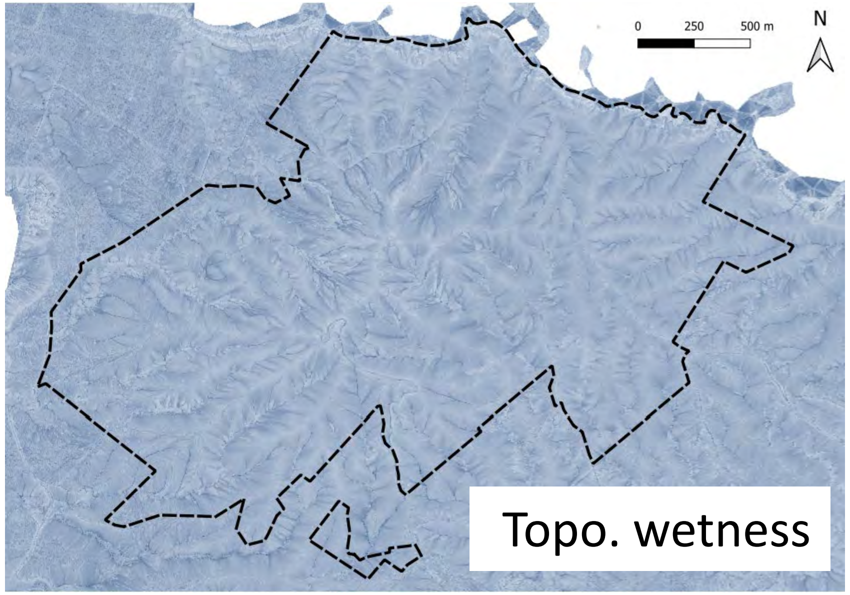

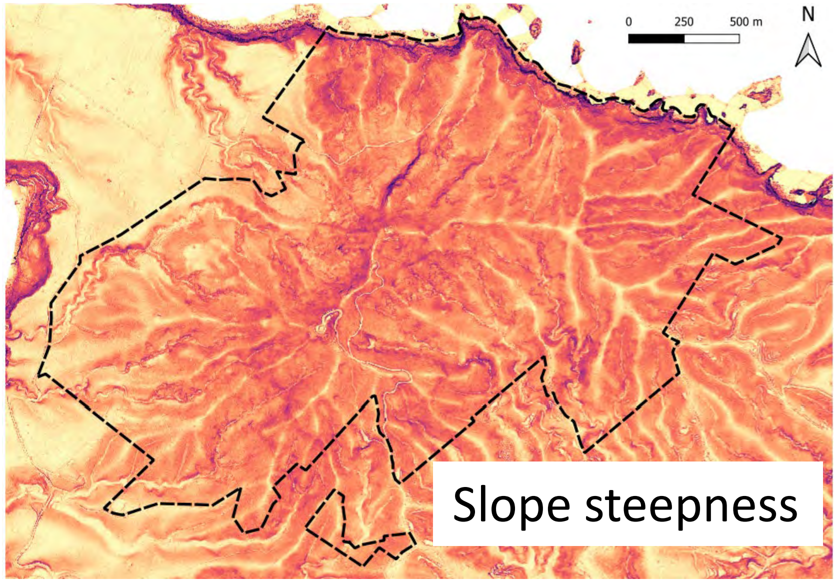

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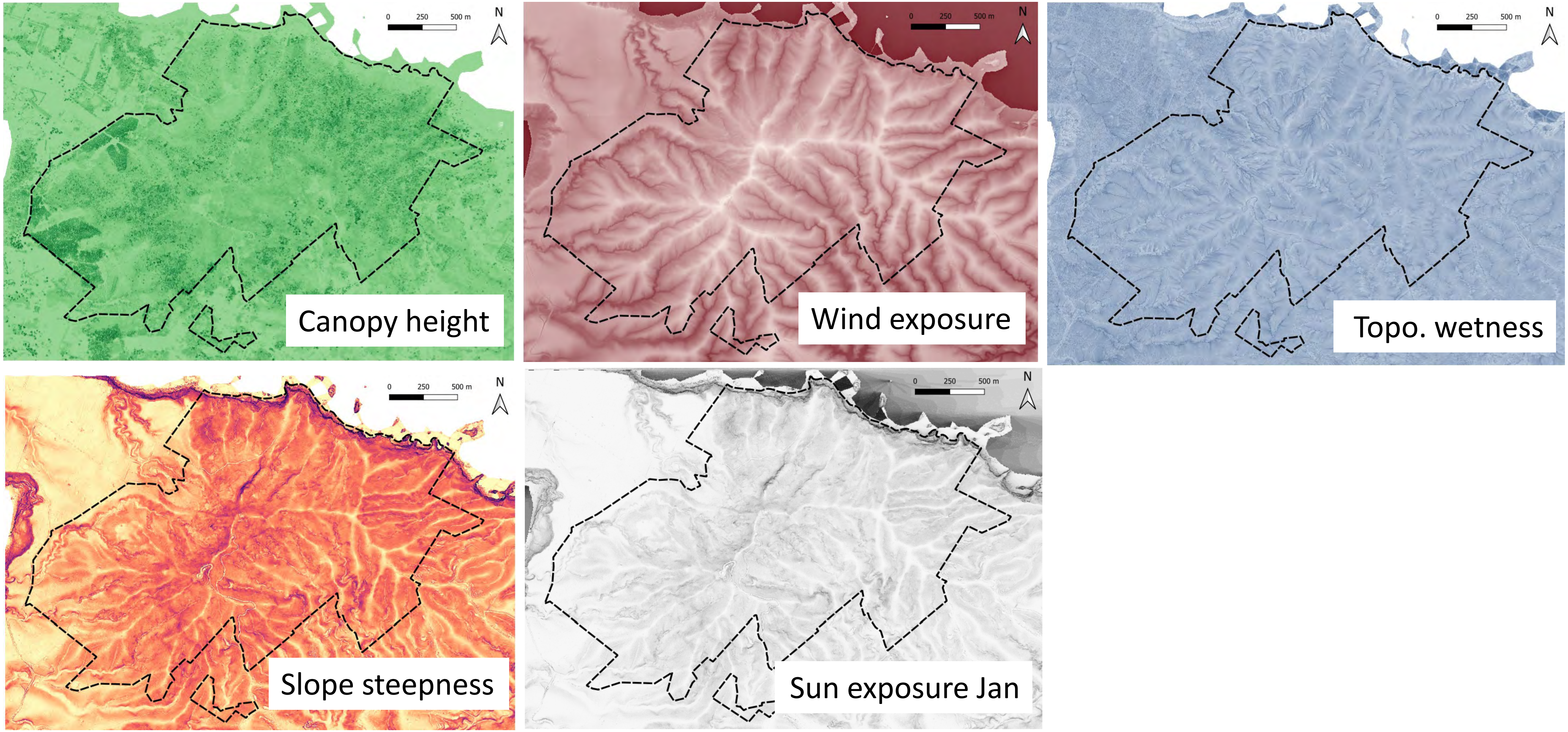

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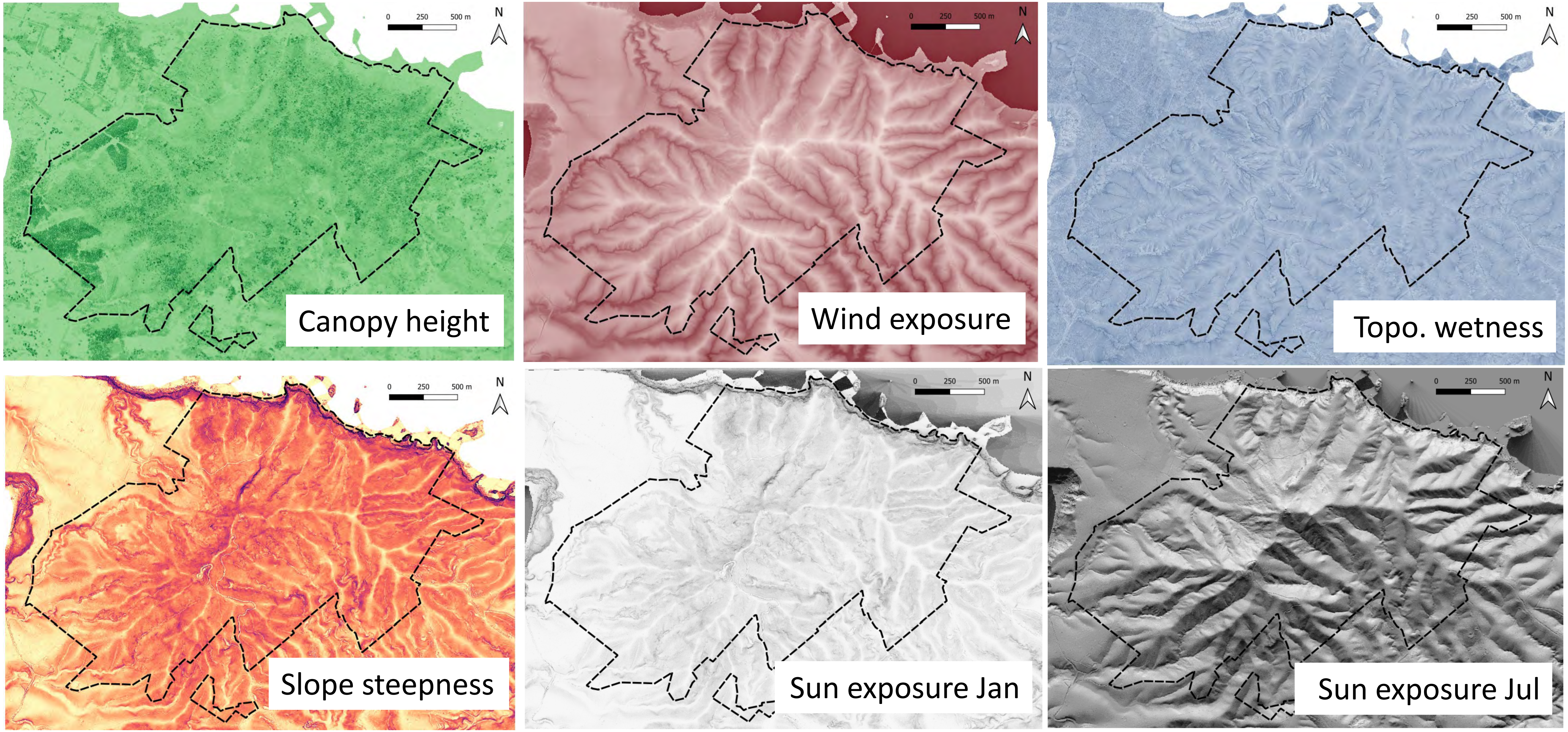

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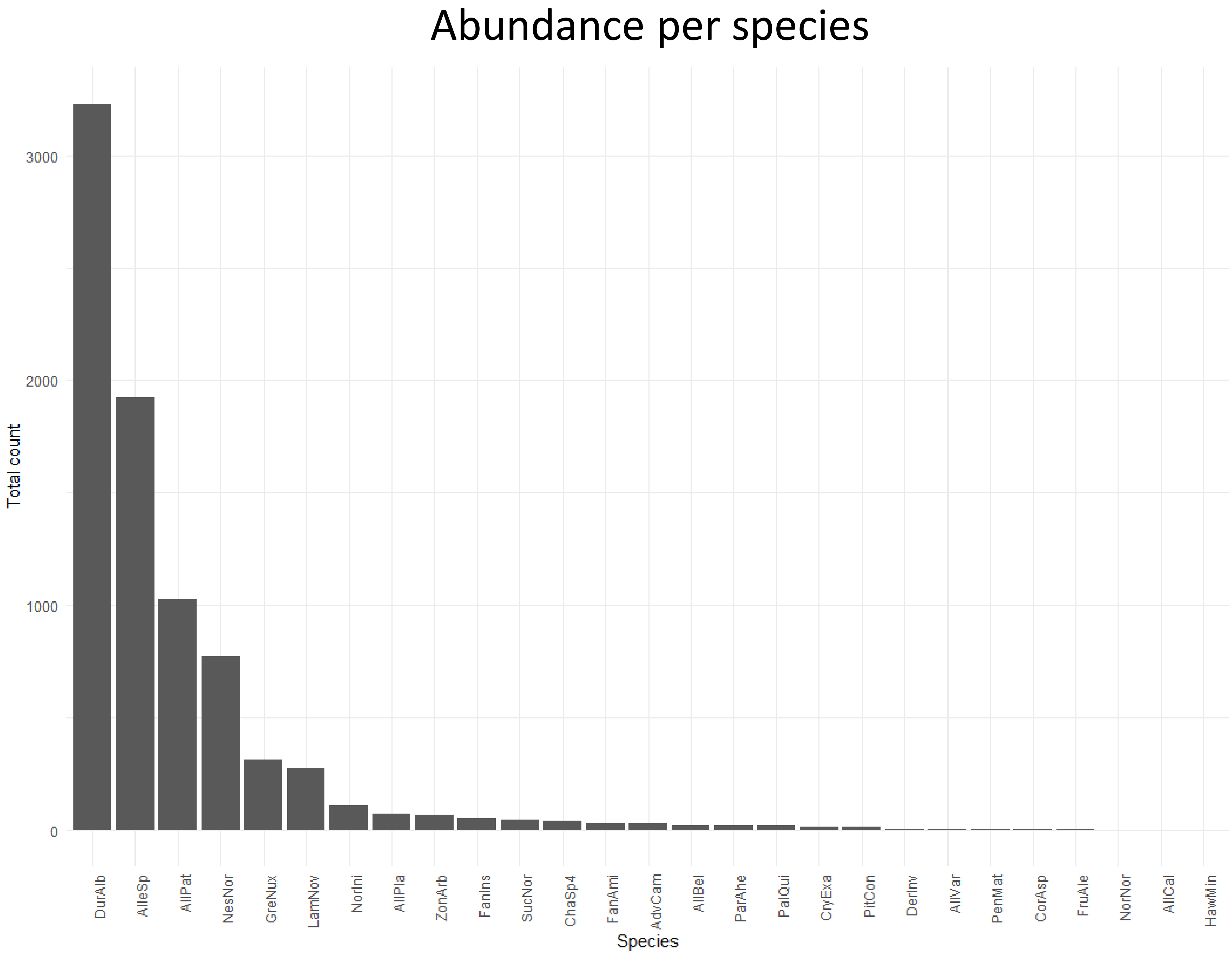
Exploratory statistics



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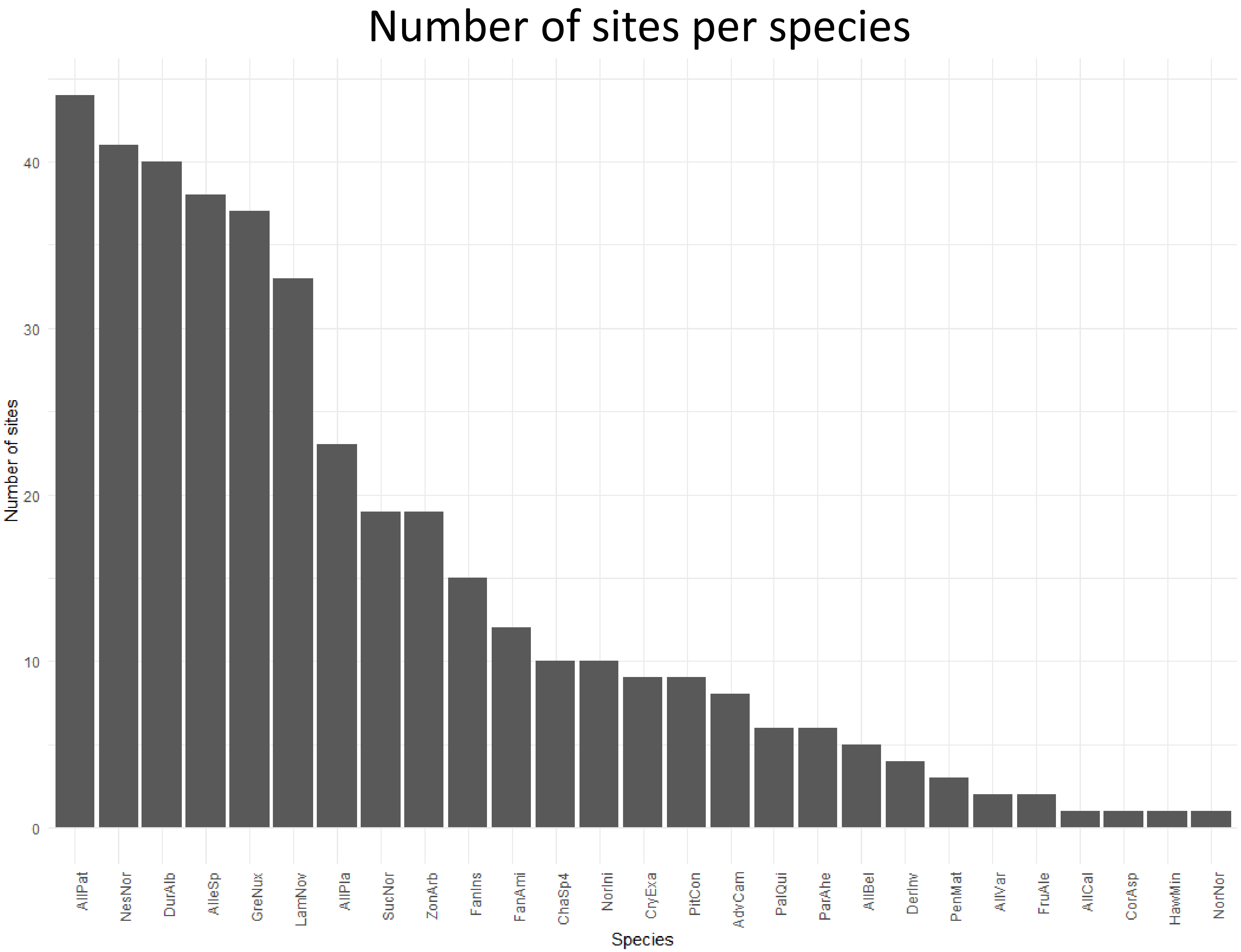
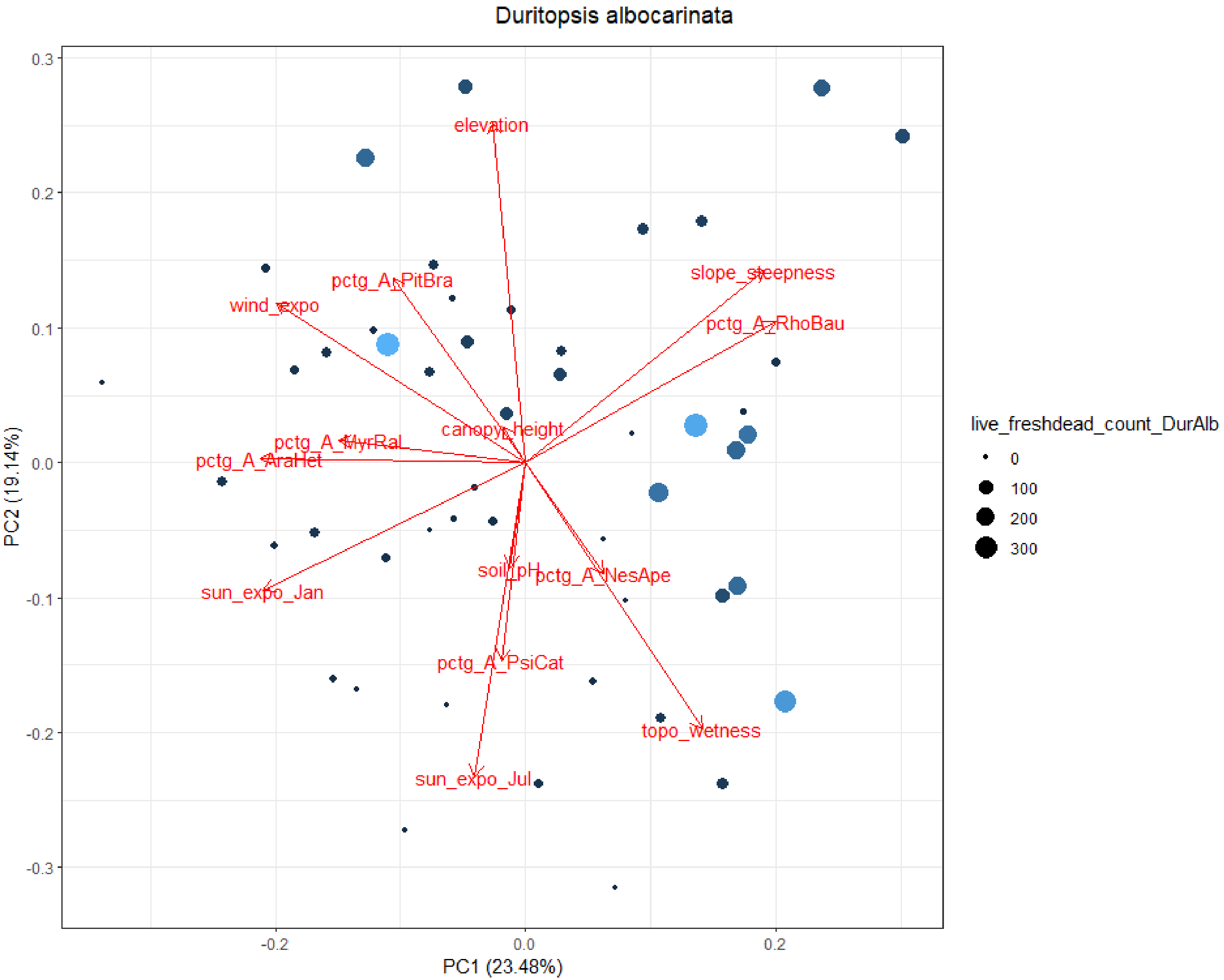


Statistical analyses

Principal Component Analysis (PCA) – to identify variables that explain the most differences between sites

Duritopsis albocarinata



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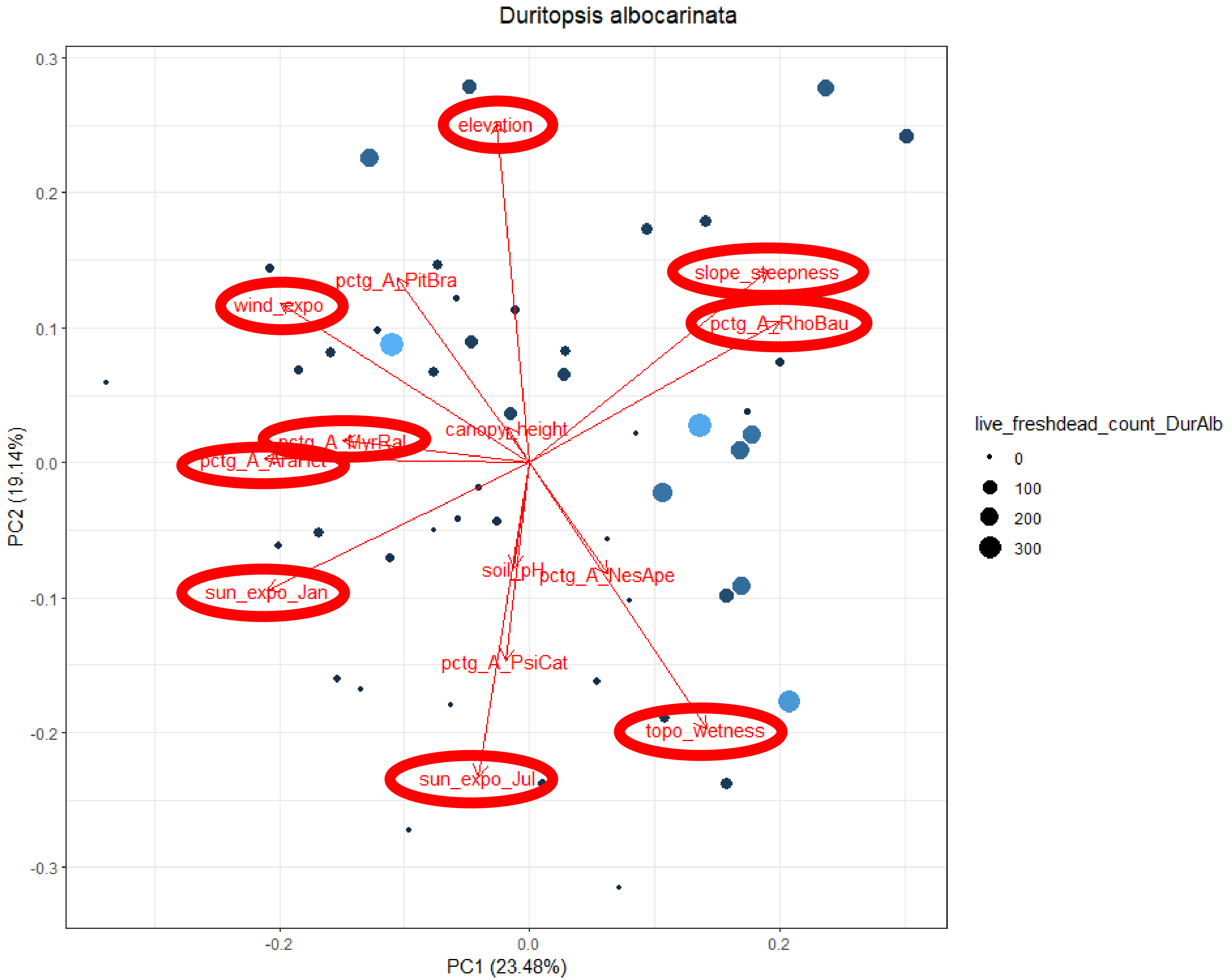

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Generalised Additive Model (GAM) – to model species abundance against the key variables

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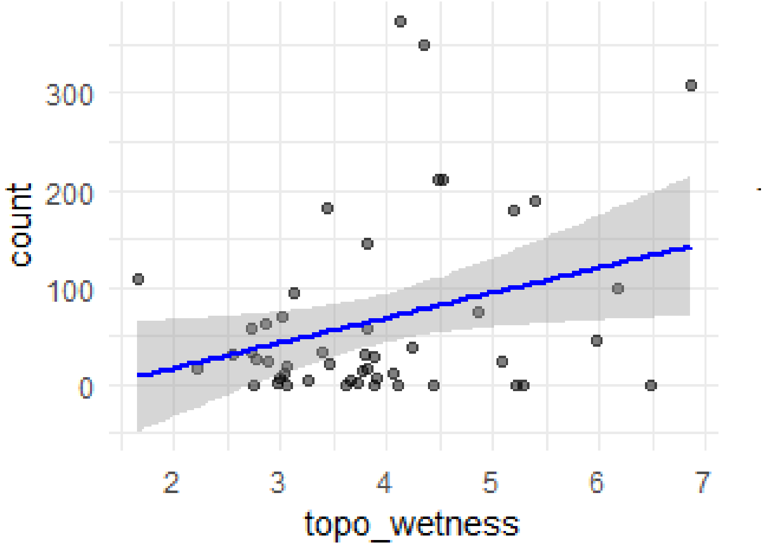
Topo. wetness vs. snail abundance



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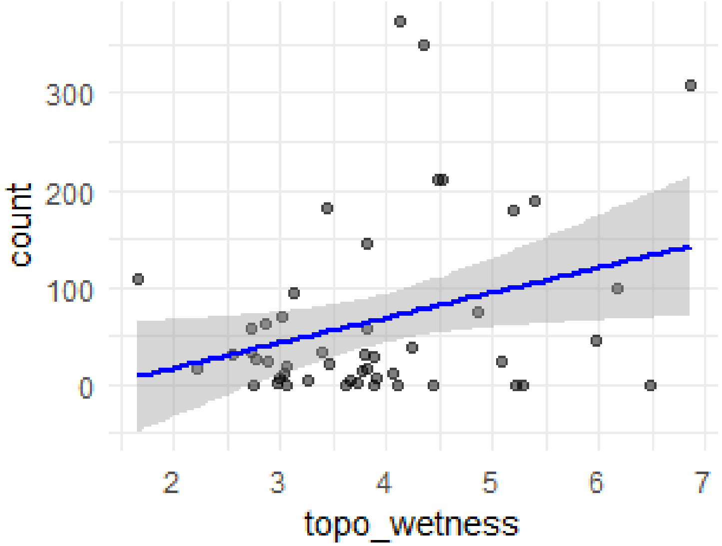
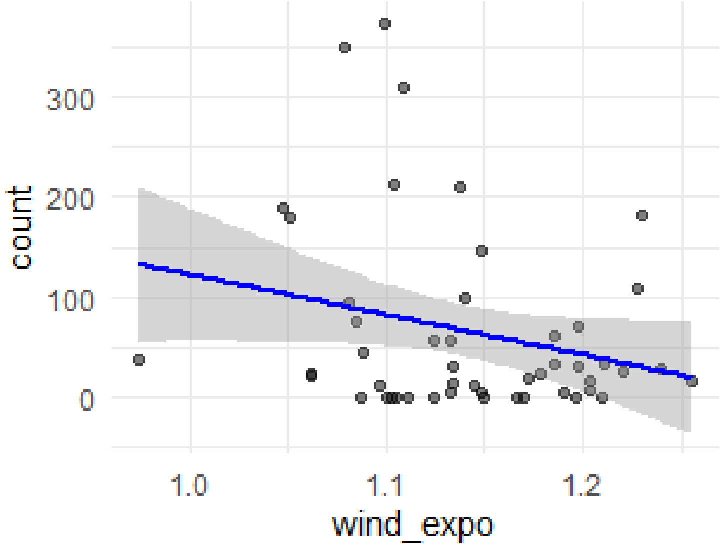


Wind exposure vs. snail abundance



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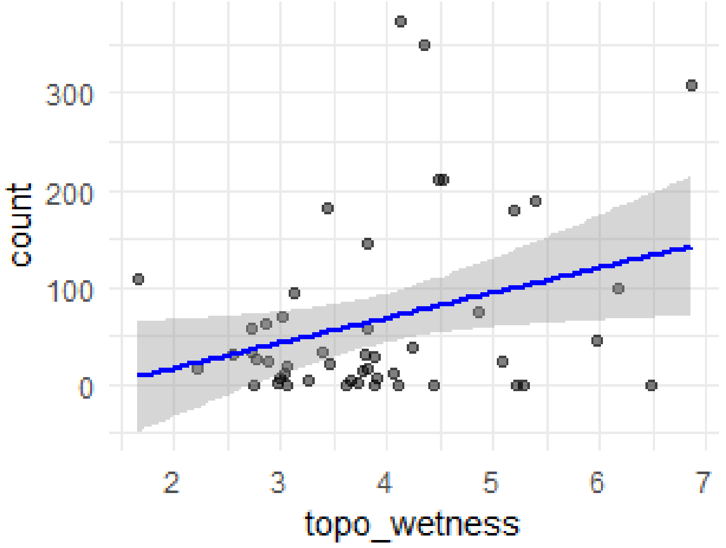

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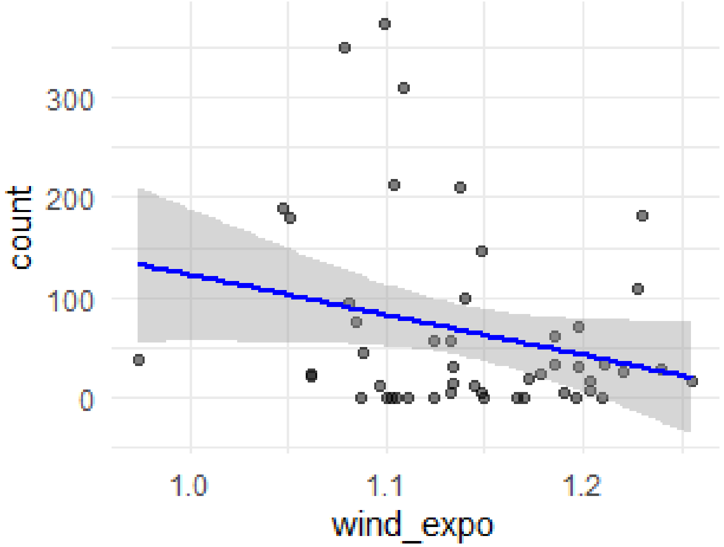
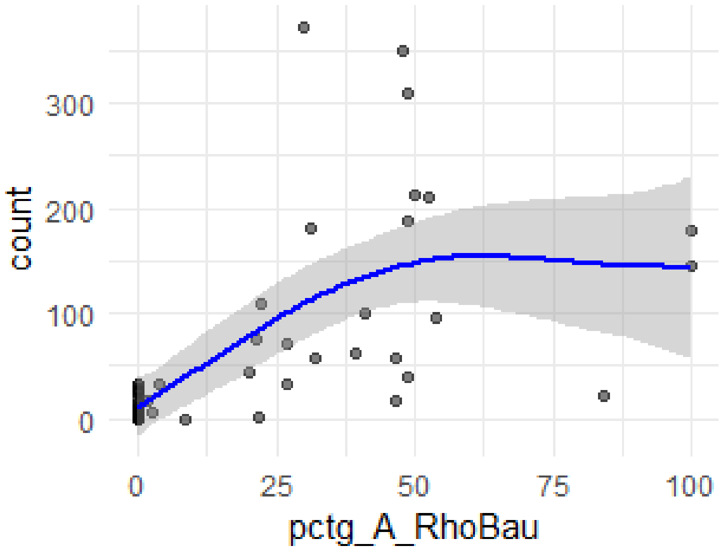


Palm % cover vs. snail abundance



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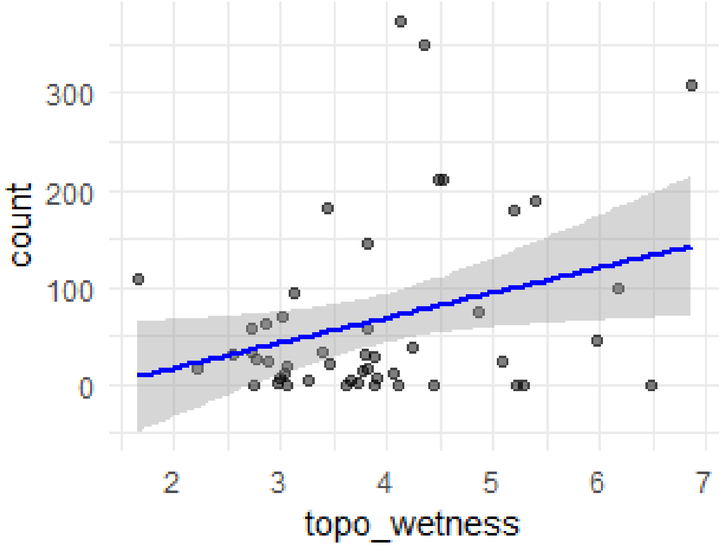

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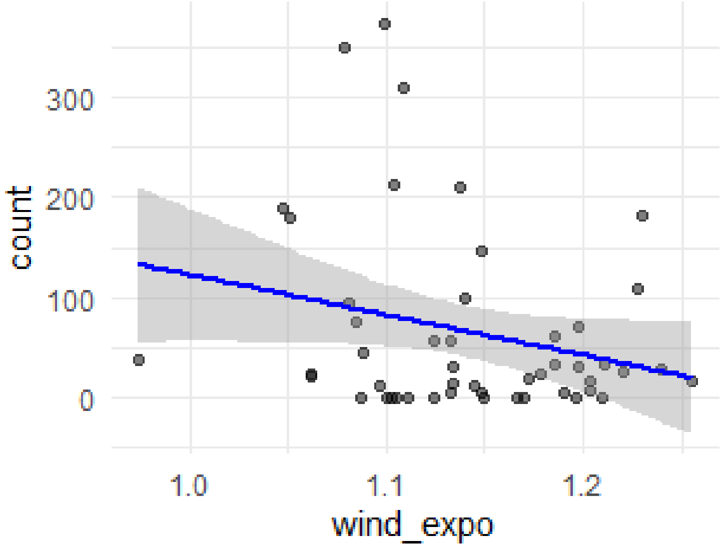

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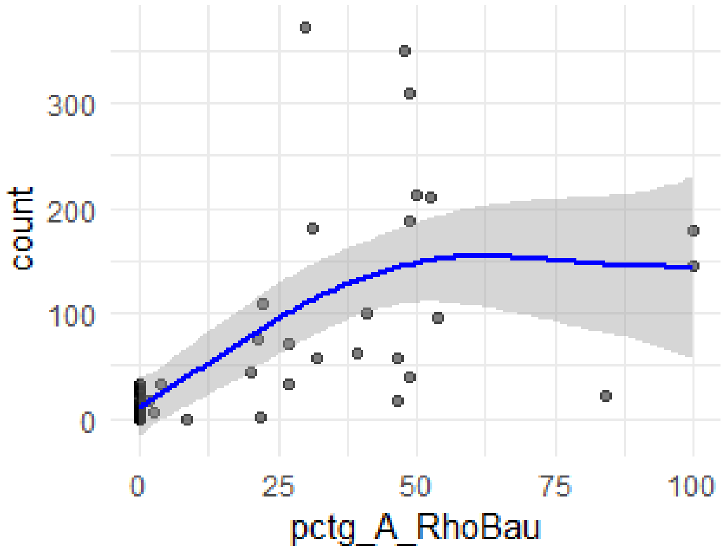
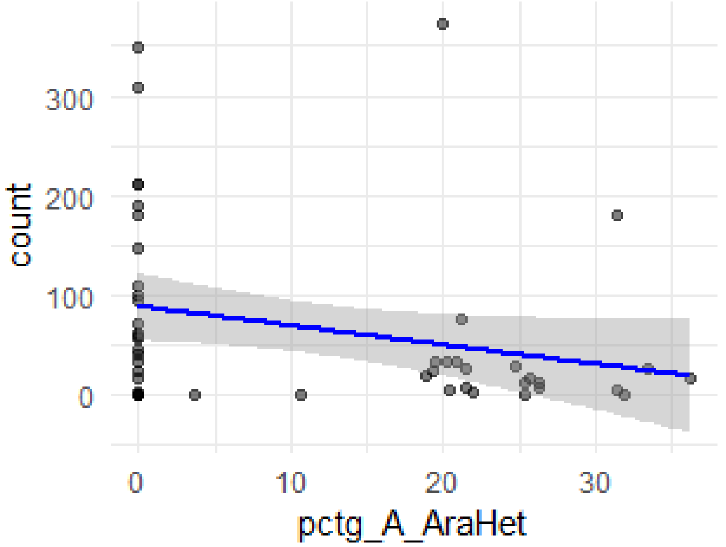


Pine % cover vs. snail abundance



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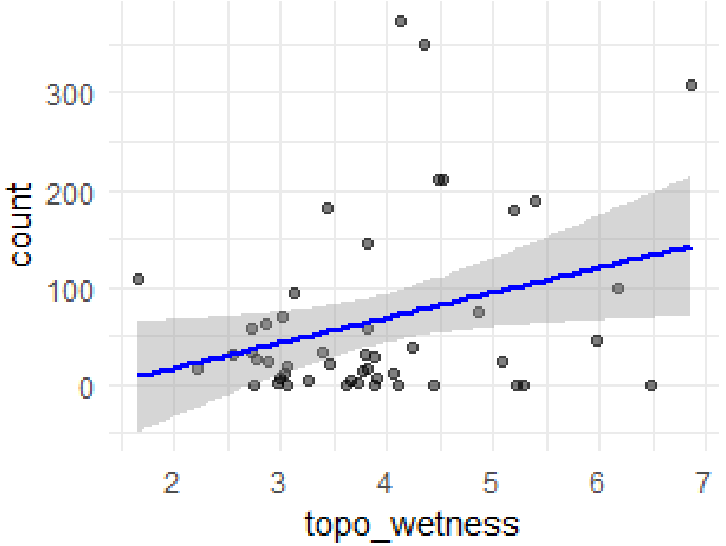

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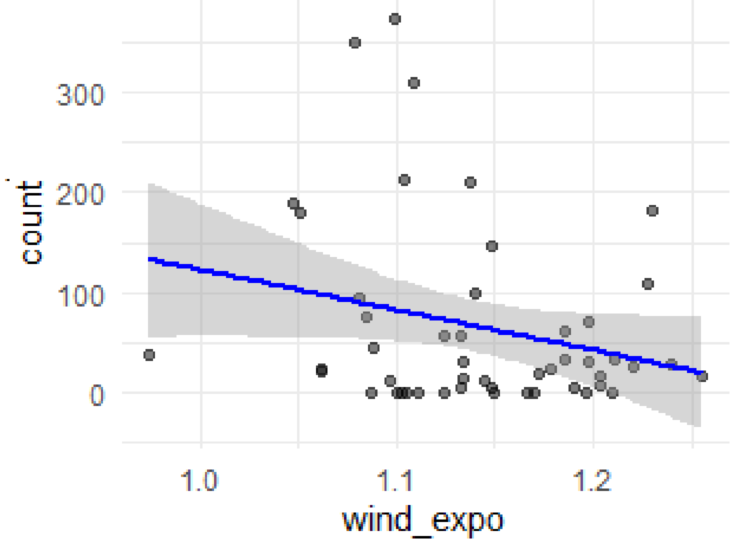

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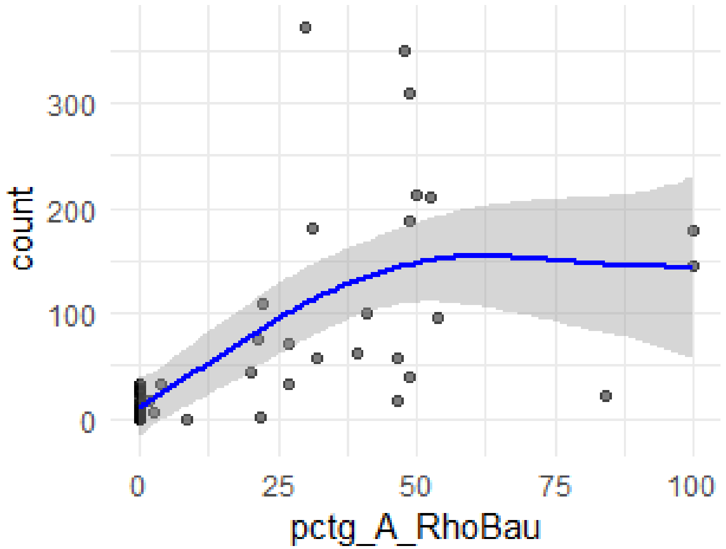

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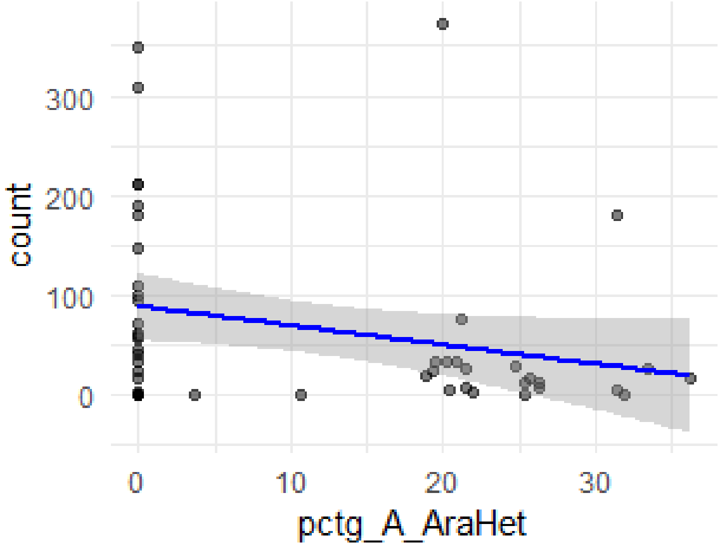
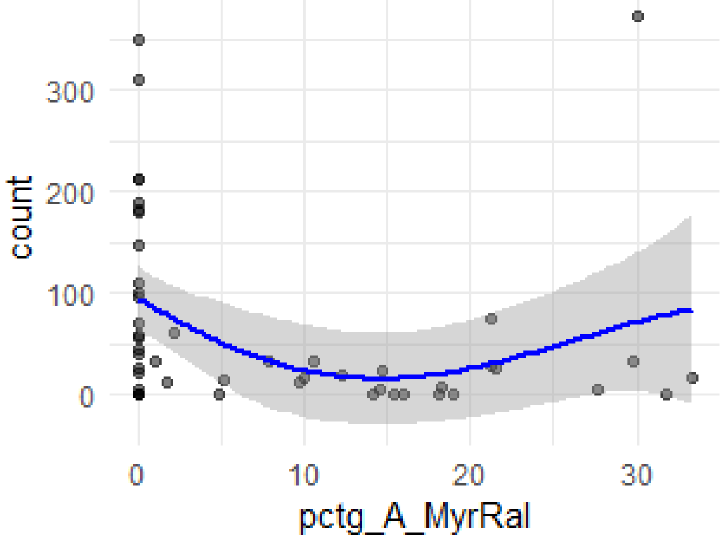
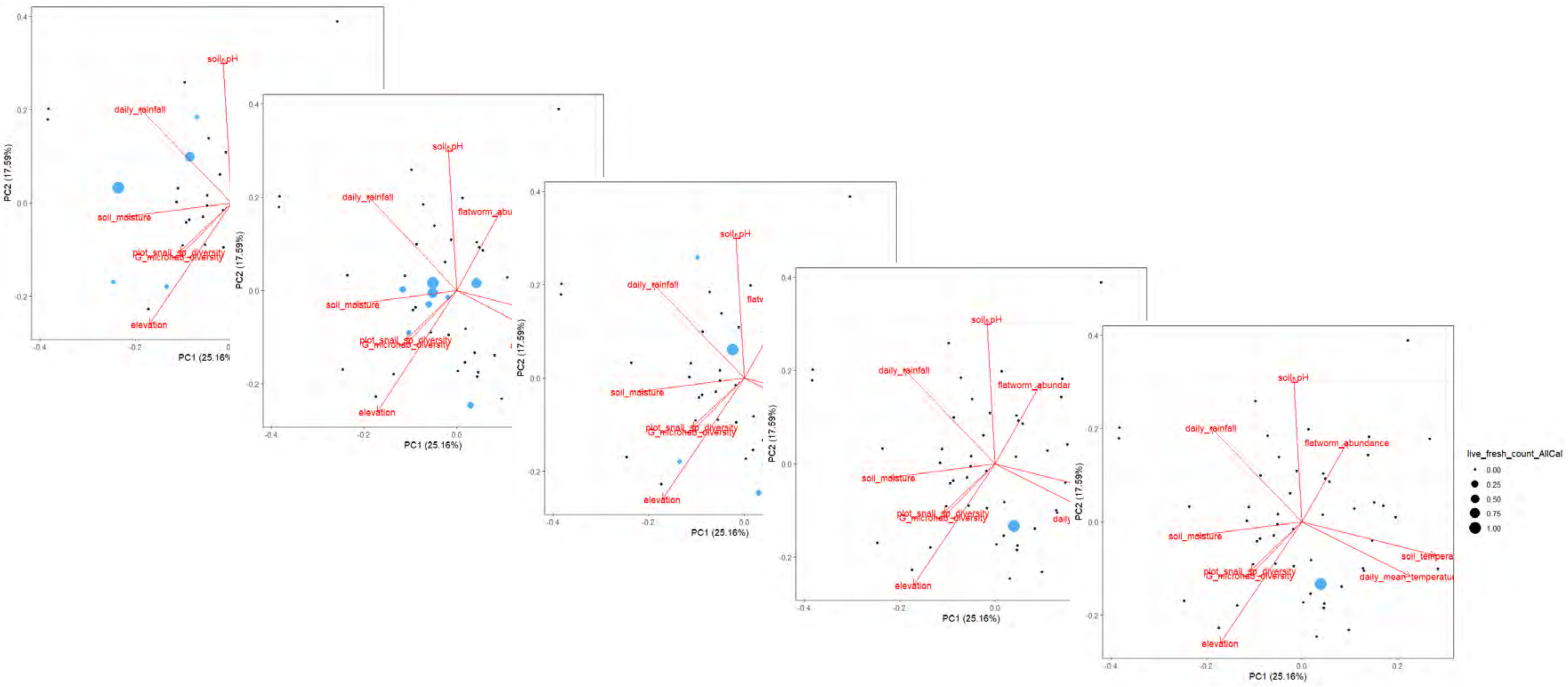


Beech % cover vs. snail abundance



Repeat the analyses for all other land snail species



Question 2

Where are the species distributed?

Data quality check

Field survey data
Museum data

Verify records
- Species identities
- Time of collection
- Specimen condition
- Geographical coordinates

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Museum data

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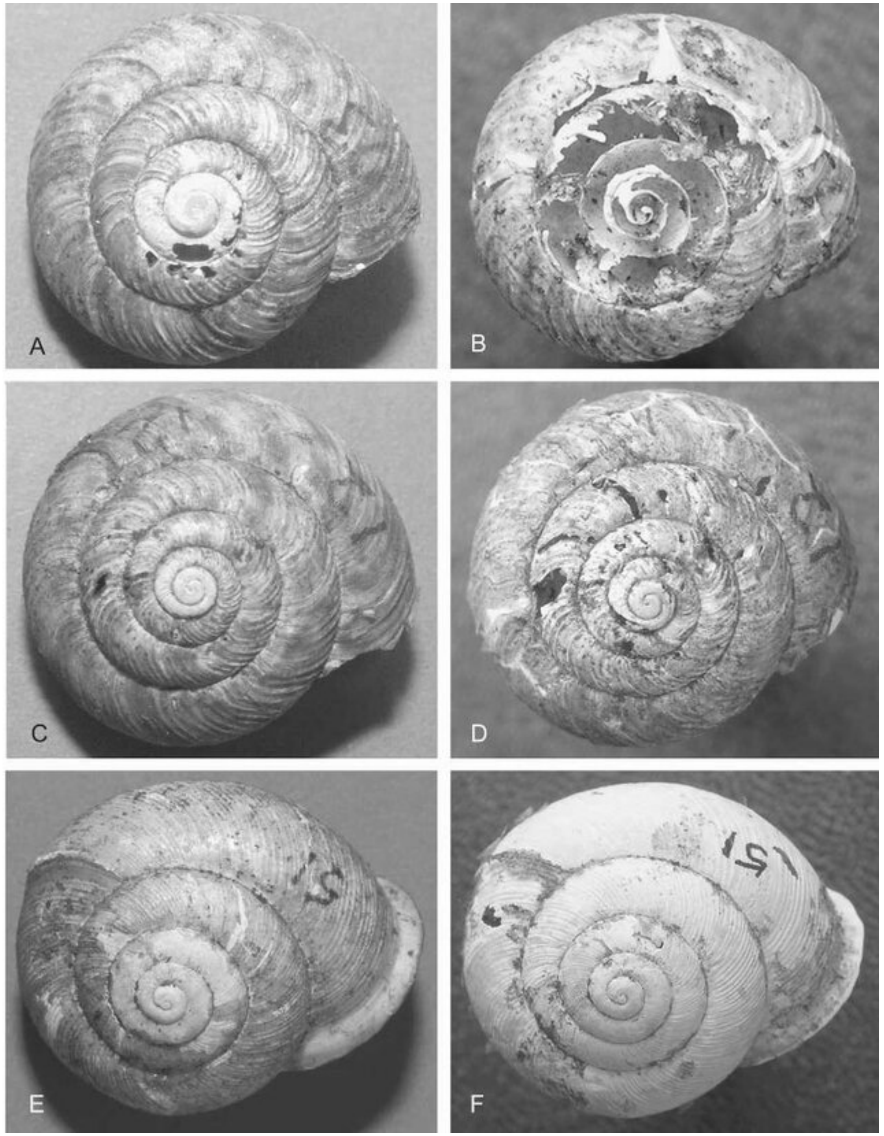
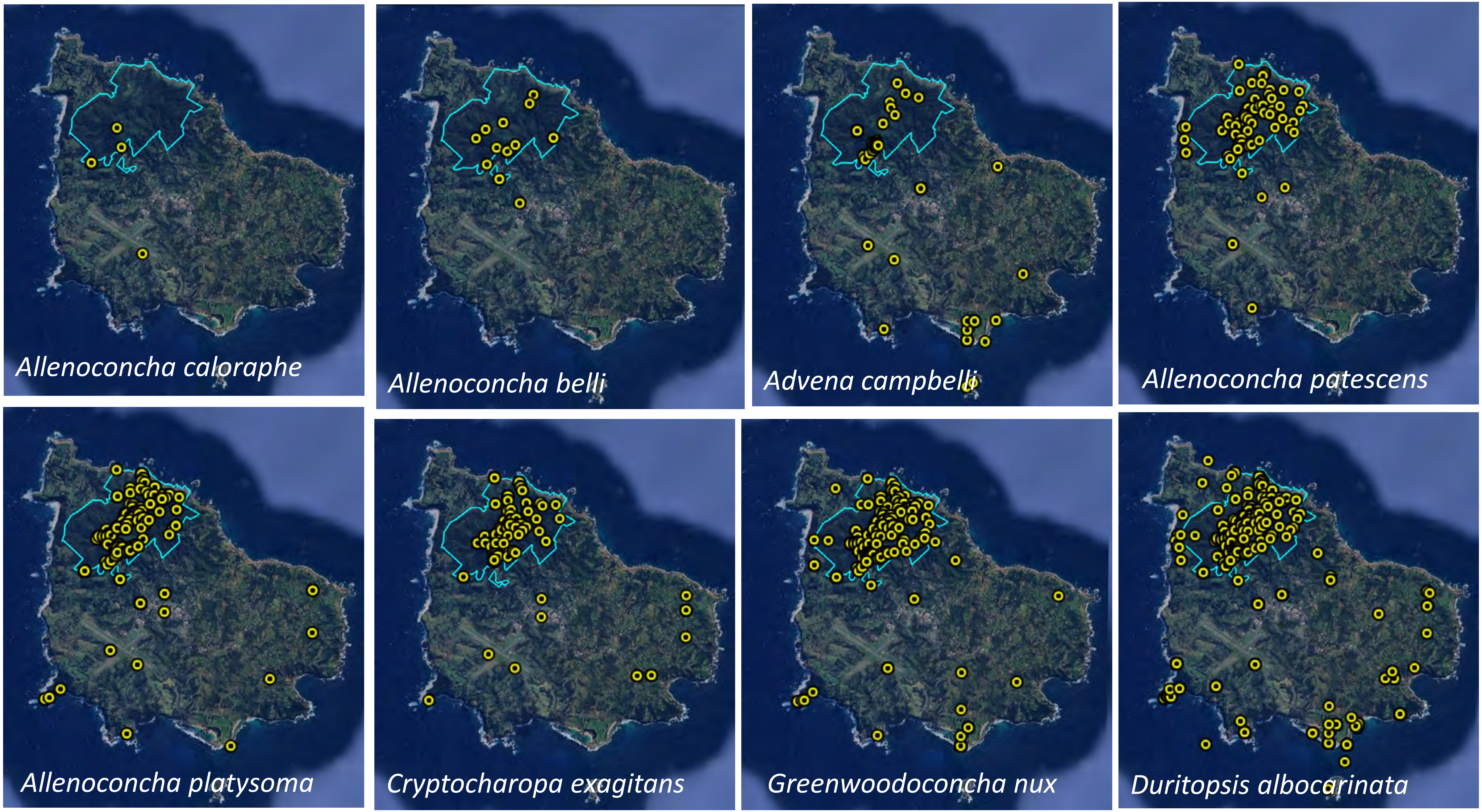


Pearce (2008)
http://dx.doi.org/10.4003/006.026.0211


Allenoconcha caloraphe
Allenoconcha belli
Advena campbelli
Allenoconcha patescens
Allenoconcha platysoma
Cryptocharopa exagitans
Greenwoodoconcha nux
Duritopsis albocarinata

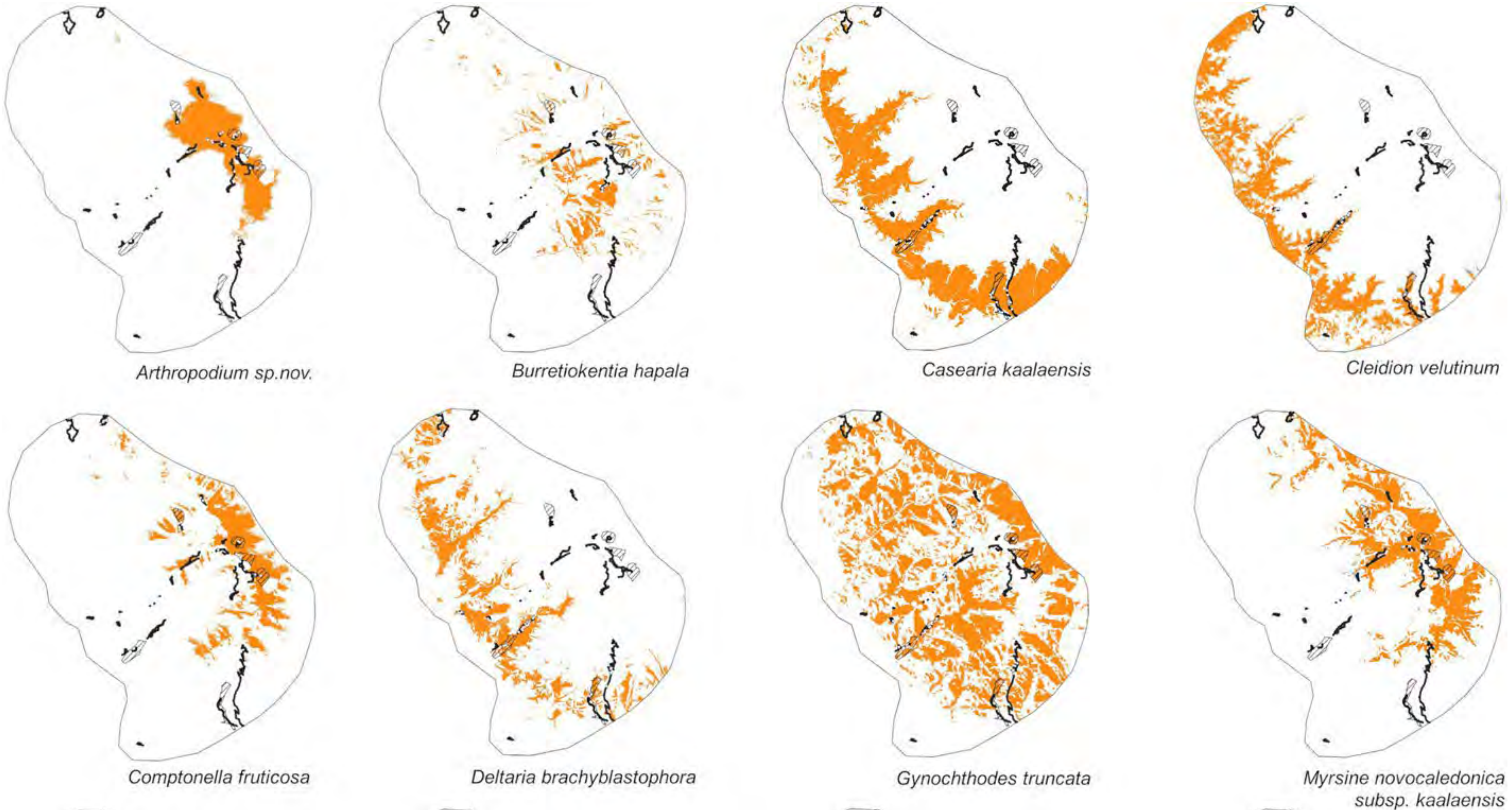
Spatial analysis

Species Distribution Modelling

Spatial analysis

Species Distribution Modelling

Example – Mt Kaala, New Caledonia



Lannuzel et al. (2021) DOI: 10.1007/s10531-021-02126-6

Spatial analysis

Identify Important Land Snail Conservation Areas

- Density of endemic species
- Conservation priority index score
- % overlap with protected areas and land uses

Spatial analysis

Example – Mt Kaala, New Caledonia

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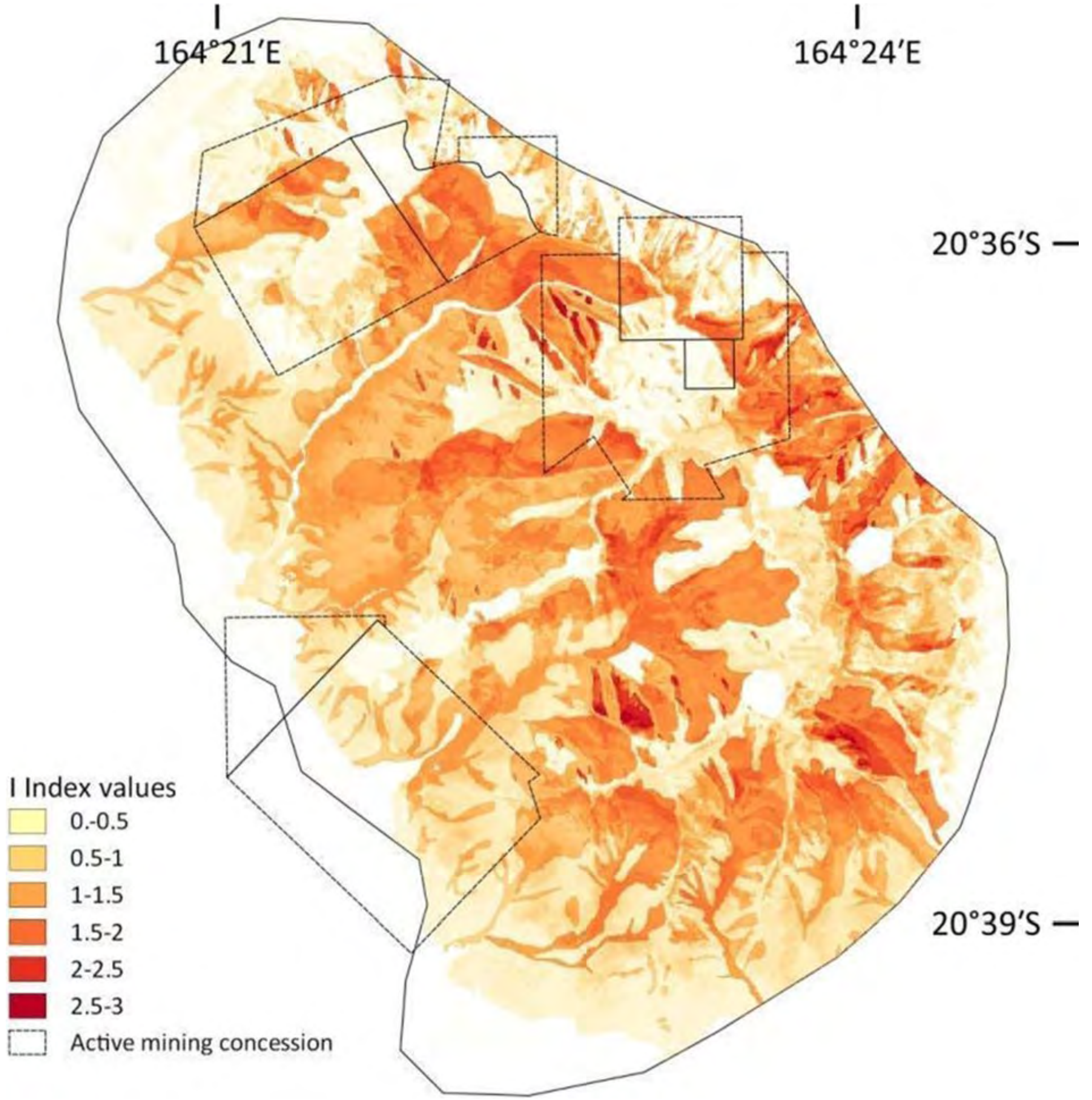


Lannuzel et al. (2021) DOI: 10.1007/s10531-021-02126-6

Implications

- Prioritise conservation management in areas of important land snail habitats
- Restore degraded habitats for native snail reintroduction

Acknowledgements

Hoong Fatt Foon | Melinda Wilson | Nigel Greenup | Sara Freeland | Lilli King | Tara Patel
Mark Scott | Mark Hallam | Rob Varman | The Norfolk Island Community
Norfolk Island Flora & Fauna Society

We acknowledge and pay our respects to the Norfolk Islanders, particularly to the Norf'k Ailen Kaunsl' Eldas and all Pitkern descendants who call Norf'k home, as the traditional owners of Norfolk Island where we conducted this research.

We acknowledge the Dharug, Dharawal, Gandangarra, Eora and Wiradjuri Peoples as the First Peoples and Traditional Custodians of the land and waterways on which Western Sydney University and Australian Museum stands, and pay our respects to their elders past, present, and future.

NORFOLK ISLAND Regional Council

NORFOLK ISLAND NATIONAL PARK

Australian Government
Parks Australia

Australian Government
Department of Climate Change, Energy, the Environment and Water

UNITAS MALACOLOGICA

WESTERN SYDNEY UNIVERSITY

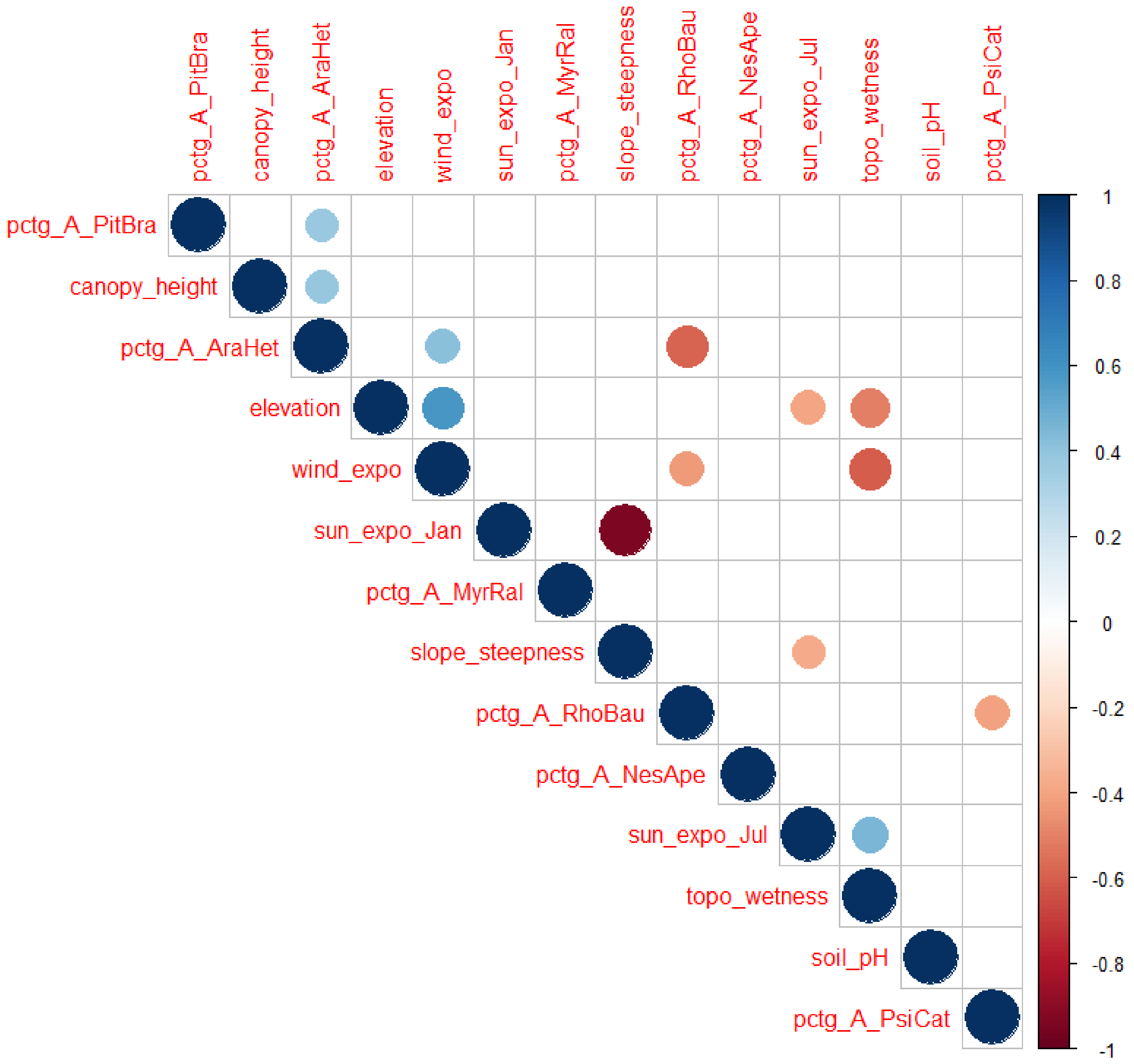
AUSTRALIAN MUSEUM


Thank you!
Australian Museum | J.K. Foon

Appendix slides

Statistical analyses

Exploratory – correlation plots



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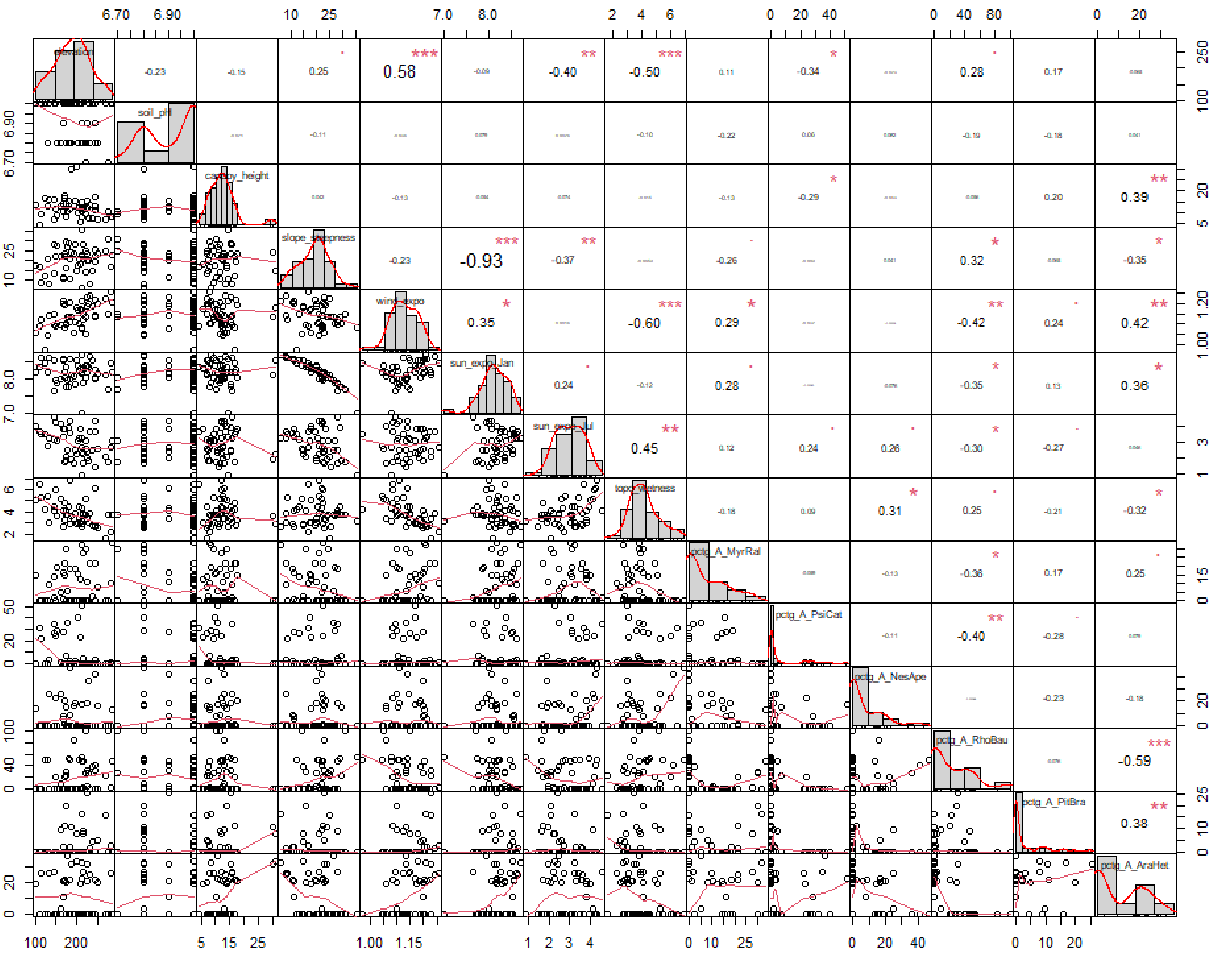
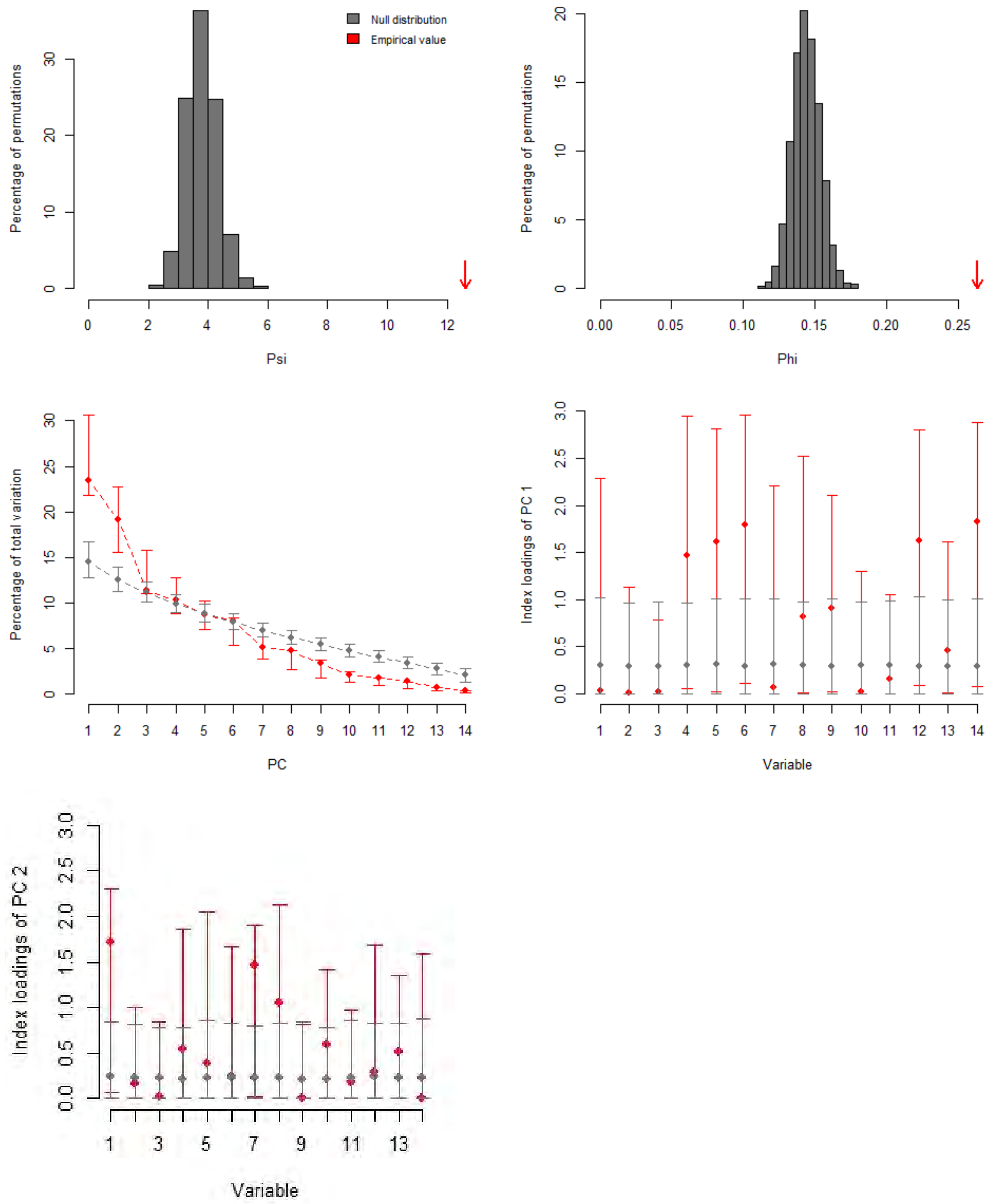


Statistical analyses

PCA – to determine variables that explain the main differences between sites

	PC1	PC2
Eigenvalues	3.28650697	2.67975565
Percentage variance	23.4750498	19.1411118
Cumulative variation	23.4750498	42.6161616
Macrohabitat variables	Correlation (rS)	Correlation (rS)
elevation	0.09136752	-0.80157926*
soil pH	0.04578524	0.24703297
canopy height (m)	0.06443903	-0.08498624
slope steepness	-0.66935947*	-0.4520428
wind exposure	0.70172922*	-0.37691269
sun exposure in January (kWh m2)	0.73847128*	0.30237588
sun exposure in July (kWh m2)	0.14417835	0.74013354*
topographic wetness index	-0.49660362	0.62776845*
percentage cover Myrsine ralstoniae	0.52592833*	-0.052473
percentage cover Psidium cattleianum	0.06863041	0.4682351
percentage cover Nestegis apetalum	-0.21702941	0.26126694
percentage cover Rhopalostylis baueri	-0.7027268*	-0.33169891
percentage cover Pittosporum bracteolatum	0.37320006	-0.43458307
percentage cover Araucaria heterophylla	0.74644903*	-0.01029147



Statistical analyses

GAM – to model species abundance against the key variables

Family: poisson
Link function: log

Formula:
live_freshdead_count_DurAlb ~ s(elevation, k = 10) + s(slope_steepness, k = 10) + s(wind_expo, k = 10) + s(topo_wetness, k = 10) + s(sun_expo_Jan, k = 10) + s(sun_expo_Jul, k = 10) + s(pctg_A_MyrRal, k = 10) + s(pctg_A_RhoBau, k = 10) + s(pctg_A_AraHet, k = 10)

Parametric coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	2.7372	0.1169	23.41	<2e-16	***

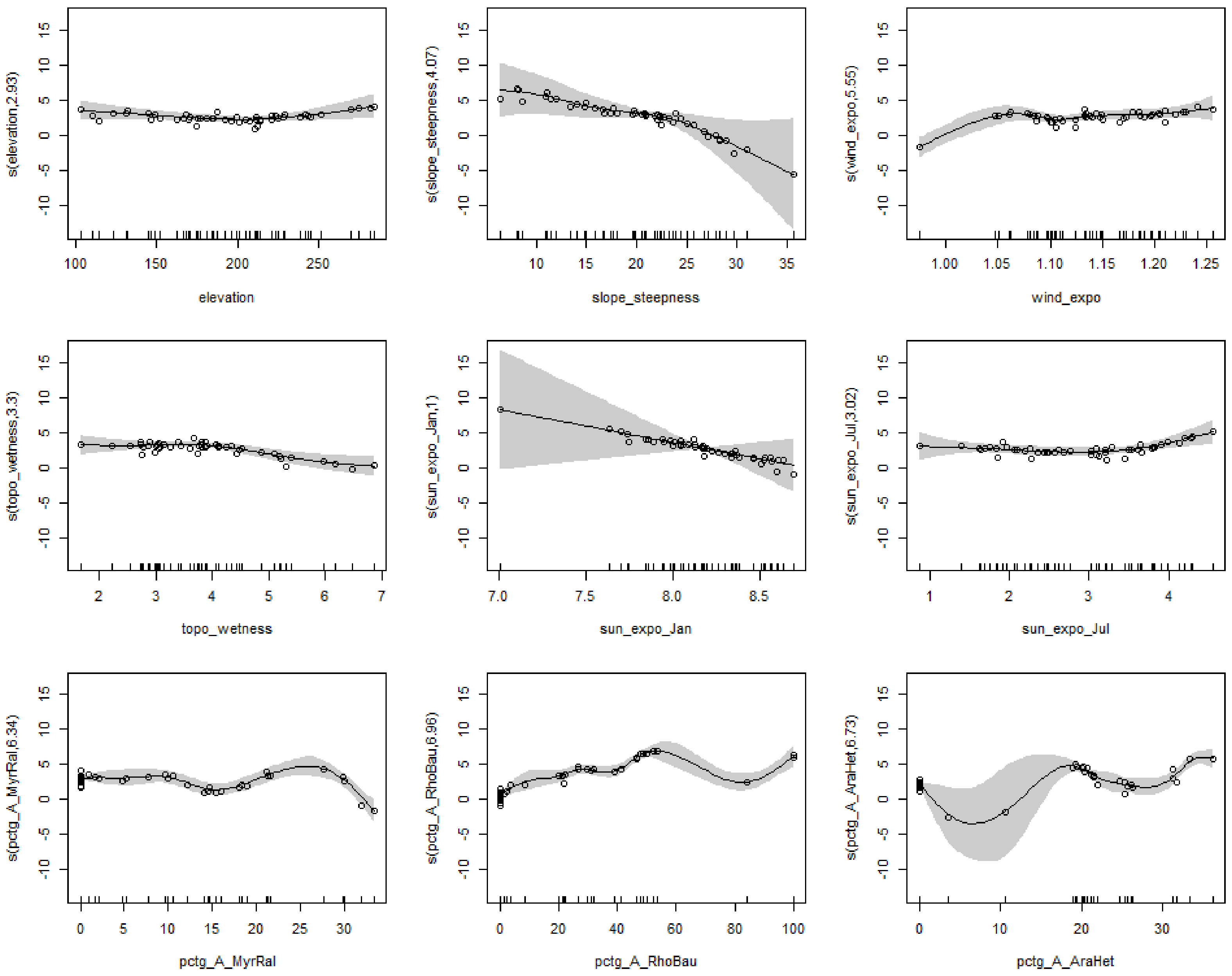
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:

	edf	Ref.df	Chi.sq	p-value	
s(elevation)	2.933	3.147	1.344	0.7251	
s(slope_steepness)	4.069	4.352	6.707	0.2205	
s(wind_expo)	5.553	5.976	30.952	3.21e-05	***
s(topo_wetness)	3.298	3.524	10.877	0.0101	*
s(sun_expo_Jan)	1.000	1.000	1.652	0.1987	
s(sun_expo_Jul)	3.017	3.261	6.940	0.1216	
s(pctg_A_MyrRal)	6.344	6.744	48.180	< 2e-16	***
s(pctg_A_RhoBau)	6.959	7.219	196.059	< 2e-16	***
s(pctg_A_AraHet)	6.733	7.307	71.051	< 2e-16	***

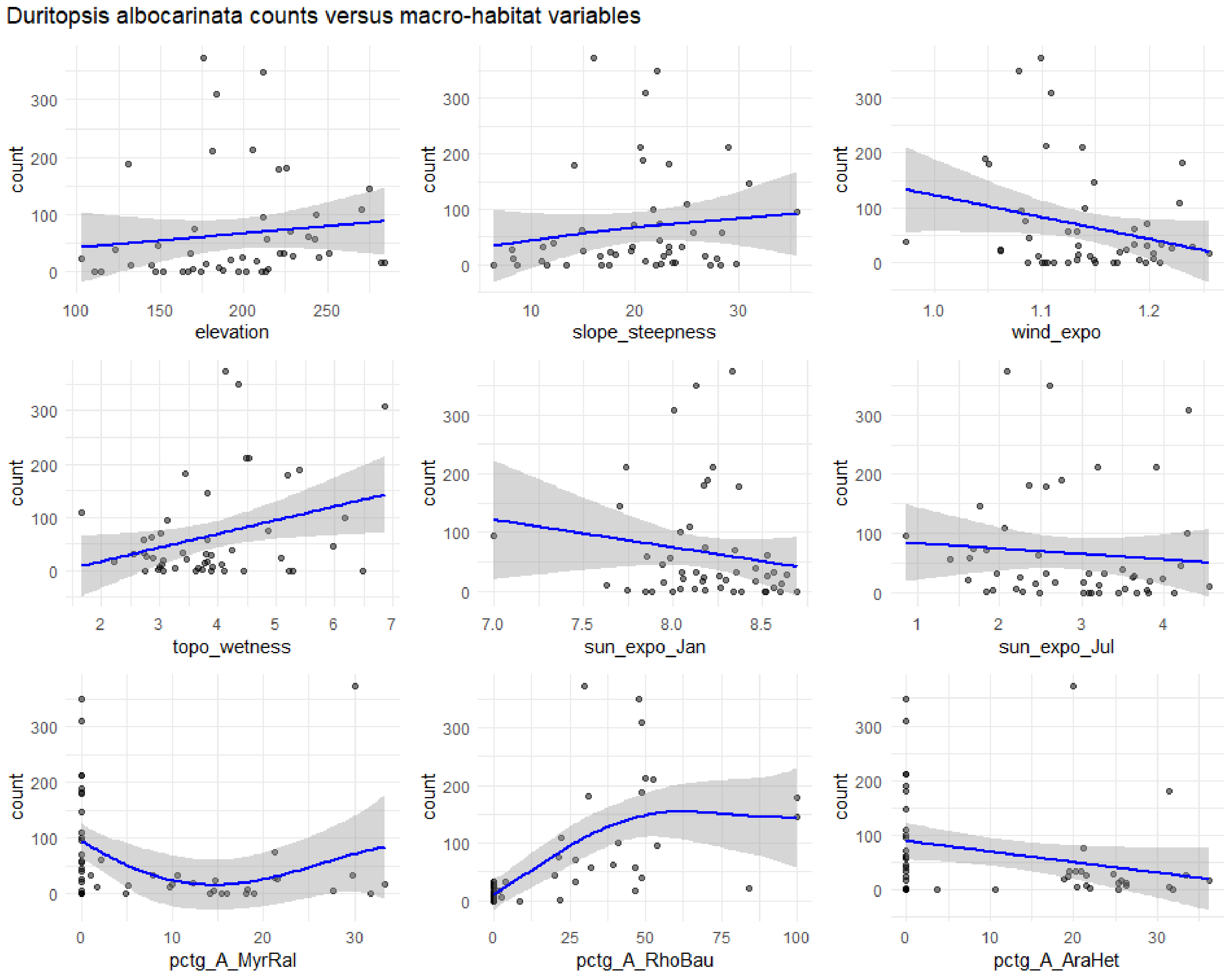
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) = 0.999 Deviance explained = 99.7%
-REML = 233.19 Scale est. = 1 n = 49



Statistical analyses

GAM – to model species abundance against the key variables




3.94 km
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2024 Airbus
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