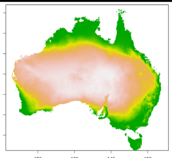
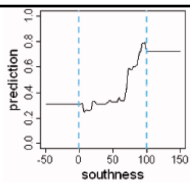
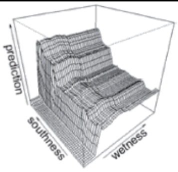
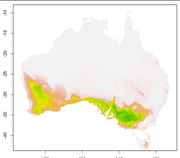














Application of GIS to conservation and ecology

Roozbeh Valavi

Quantitative & Applied Ecology Group (QAECO)

School of BioSciences

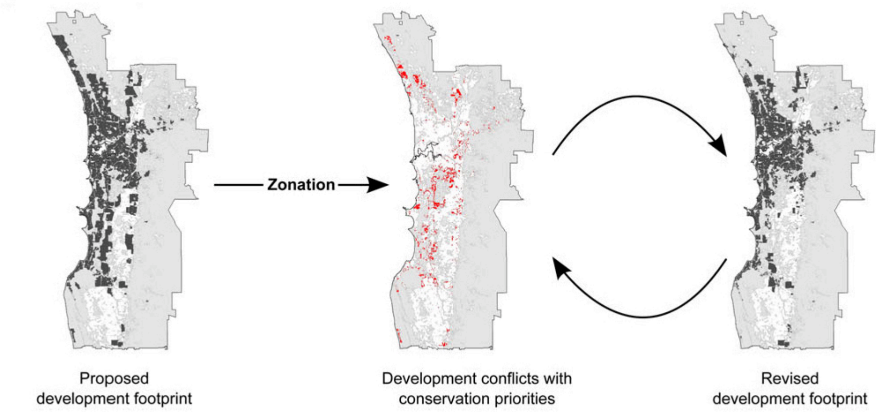
1

The sort of works we are doing in QAECO!

Using the science of **ecology** to answer real-world conservation (and management) questions.

2

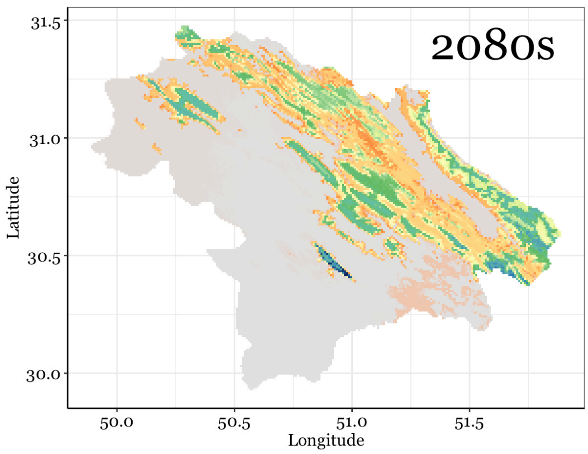
Mapping species distribution and spatial prioritization



Whitehead, A.L., Kujala, H. & Wintle, B.A. (2017) Dealing with Cumulative Biodiversity Impacts in Strategic Environmental Assessment: A New Frontier for Conservation Planning. Conservation Letters

3

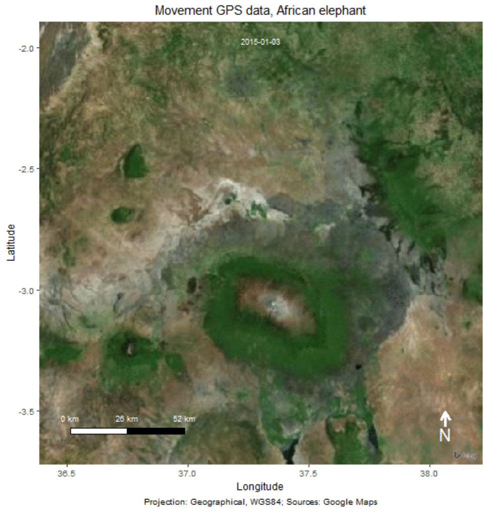
Predicting the impacts of climate change

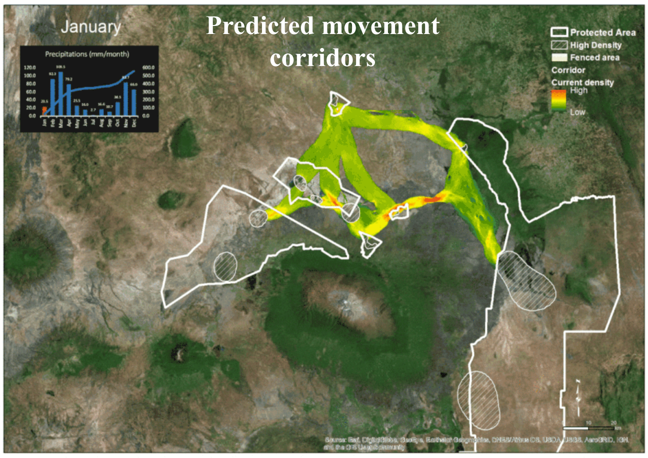


Valavi, et al., (2019) Modelling climate change effects on Zagros forests in Iran using individual and ensemble forecasting approaches. Theoretical and Applied Climatology.

4

Using GPS track data to monitor wildlife

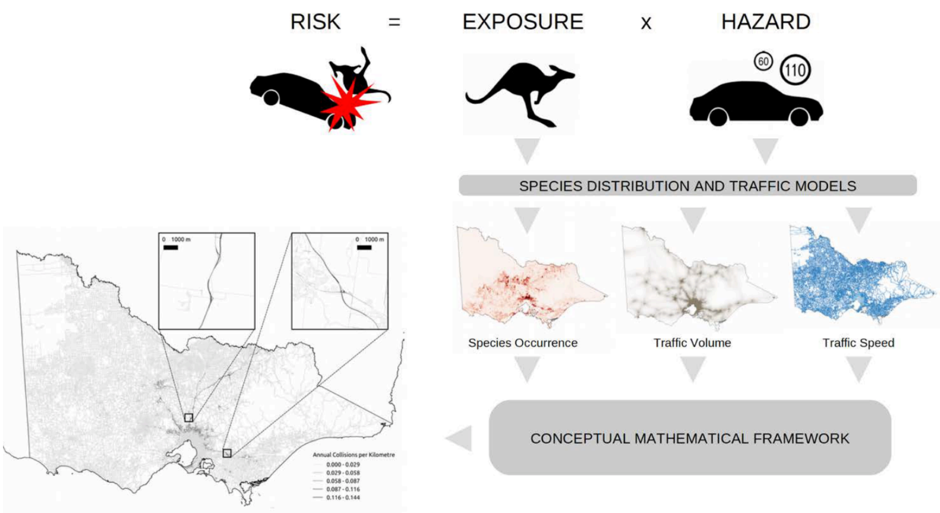




Osipova, et al., (2018) Using step-selection functions to model landscape connectivity for African elephants: accounting for variability across individuals and seasons. Animal Conservation.

5

Predicting wildlife-vehicle collisions



Casey Visintin
casey.visintin@unimelb.edu.au

Visintin, C., van der Ree, R. & McCarthy, M.A. (2016) A simple framework for a complex problem? Predicting wildlife-vehicle collisions. Ecology and Evolution

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Case studies and examples:

- **Mapping species distribution**: what is it? and why GIS is important here?
- **The impact of spatial autocorrelation** on evaluating spatial prediction of species
- **Spatial conservation prioritisation**: biodiversity offsetting for two Australian species

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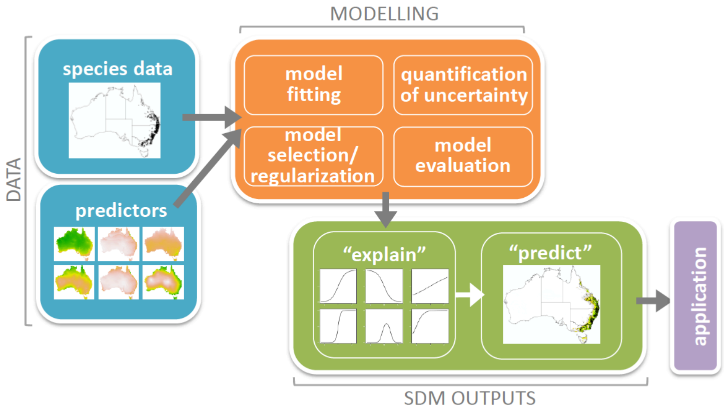
Species Distribution Modelling (SDM)

Species distribution models are quantitative tools that relate the species occurrence data to the environmental variables to explain species-environment relationship and predict their geographic distribution.



Modelling Species Distributions & Niches (Melbourne university online course)

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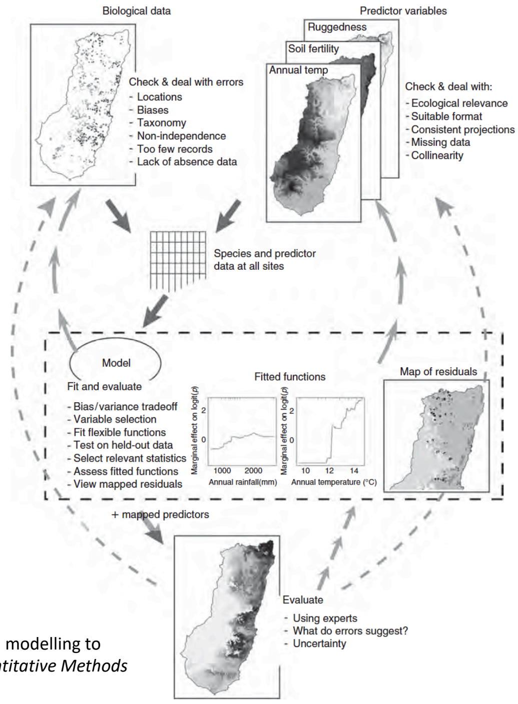
Aspects of SDMs to be considered:

- Species records (geographic locations)
- Environmental predictor maps
- Spatial scale
- Sampling bias
- Map projection
- Spatial autocorrelation



Elith, J., & Leathwick, J. (2009). The contribution of species distribution modelling to conservation prioritization. In *Spatial Conservation Prioritization: Quantitative Methods & Computational tools*

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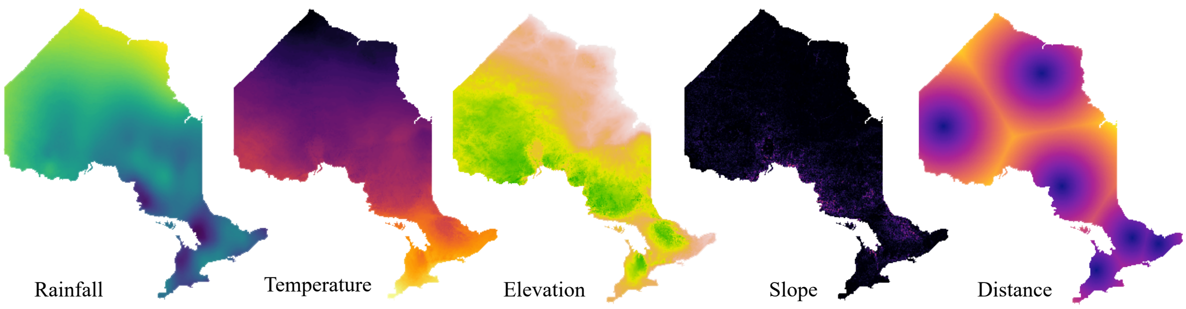
Environmental factors

- GIS variables:
  - interpolation of climatic variables, e.g. rainfall and temperature
  - topographic derived variables, e.g. slope, solar radiation and landforms
  - distance to feature, e.g. surface water, roads, rivers…
- Using GIS to combine layers and produce maps e.g. human footprint



Rainfall Temperature Elevation Slope Distance

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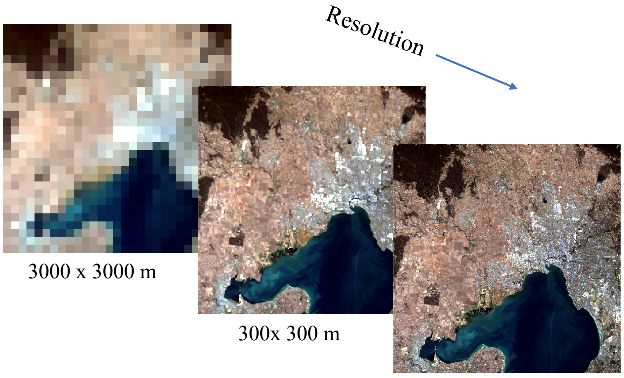
Spatial scale

- **Extent**: Is data available across occurrence locations & landscape we want to predict to?
- **Grain/resolution**: cell size, smallest unit. Does this match what we want to model (species) & our application?



3000 x 3000 m

300x 300 m

30 x 30 m

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Different environmental factors tend to operate at different spatial & temporal scales

SCALE DOMAIN

ENVIRONMENTAL VARIABLE	Global > 10 000 km	Continental 2000–10 000 km	Regional 200–2000 km	Landscape 10–200 km	Local 1–10 km	Site 10–1000 m	Micro < 10 m
Climate	↔	↔	↔				
Topography			↔	↔	↔		
Land-use				↔	↔	↔	
Soil type					↔	↔	
Biotic interaction					↔	↔	↔

Pearson & Dawson (2003) *Global Ecology and Biogeography*

Dr Natalie Briscoe
nbriscoe@unimelb.edu.au

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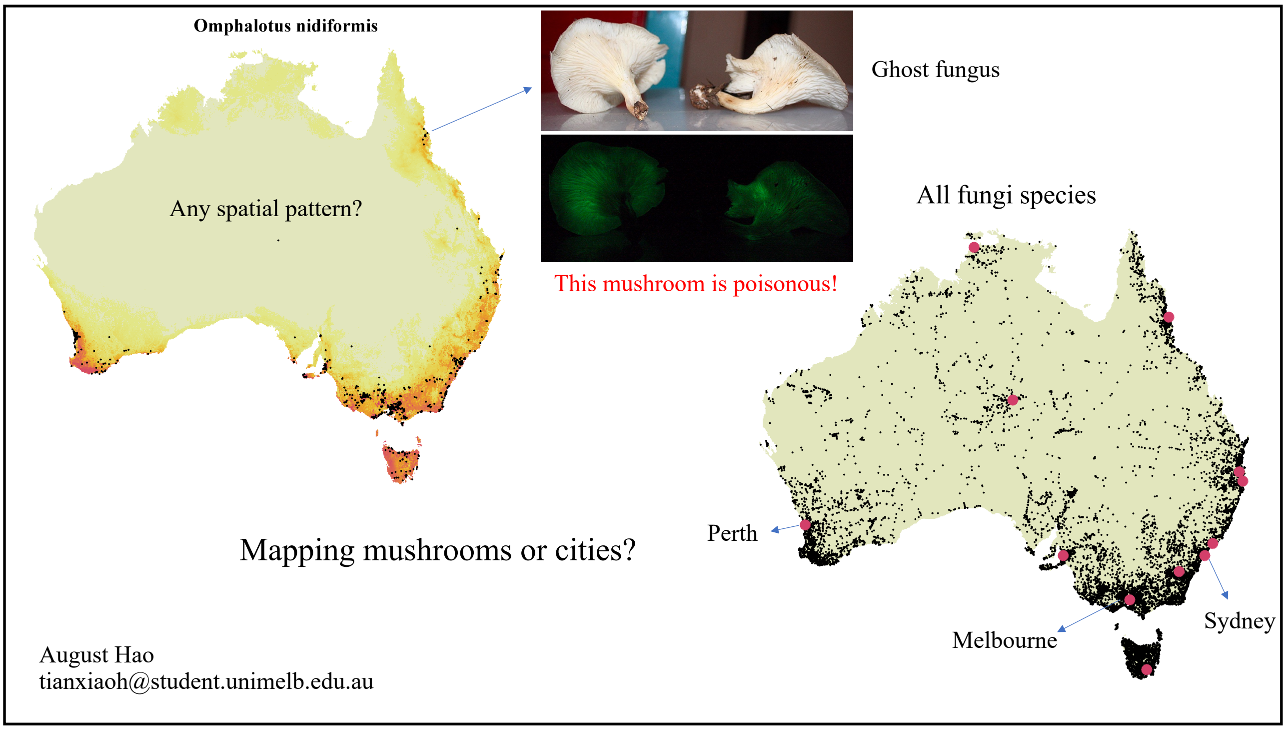
Omphalotus nidiformis
Any spatial pattern?
Ghost fungus
This mushroom is poisonous!
All fungi species
Perth
Mapping mushrooms or cities?
Sydney
Melbourne
August Hao
tianxiaoh@student.unimelb.edu.au

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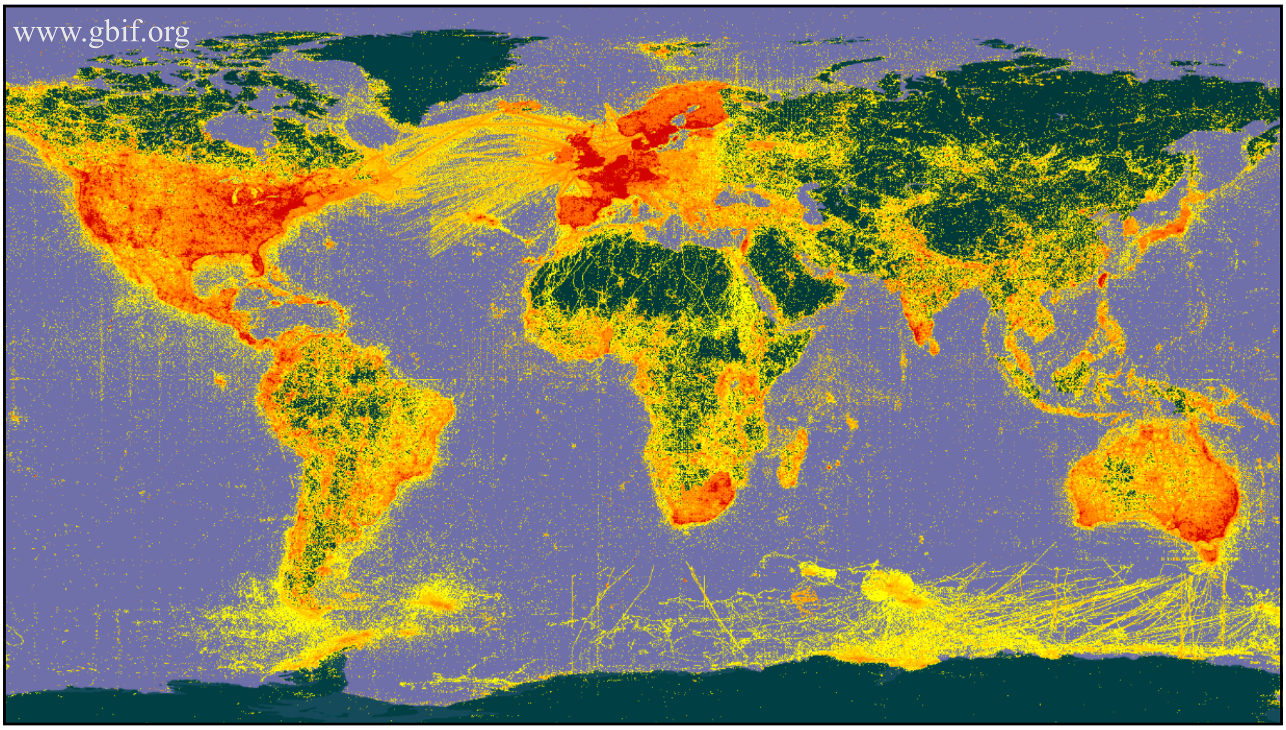
www.gbif.org

14

Sampling bias towards accessible area

- Most available data are form citizen science data available in digital databases
  - Atlas of Living Australis (**ALA**) or Global Biodiversity Information Facility (**GBIF**)
- People tend to search for species around cities, roads and more populated areas
- This can introduce bias into the produced map
- We need to be careful what the data represent
  - What does the map show? Probability of species **occurrence** or **observation**?
- The bias in the model can be costly for conservation management!
- How can we solve this issue?

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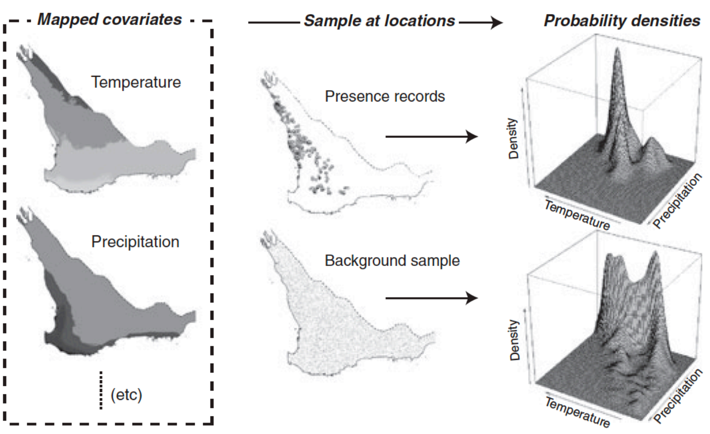
Background vs “real” absence

- Models need both presence & absence locations
- Most available data have only the locations of species presence
- Sampling random background



Elith, J., Phillips, S.J., Hastie, T., Dudík, M., Chee, Y.E. & Yates, C.J. (2011) A statistical explanation of MaxEnt for ecologists. Diversity and distributions, 17, 43–57.

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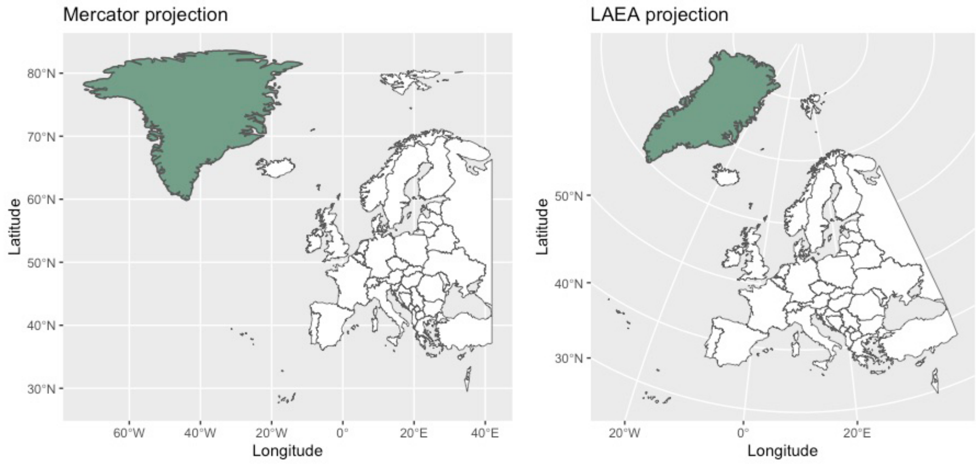
Projection

Mercator projection distorts the size of objects (area) as the latitude increases from the Equator to the poles.



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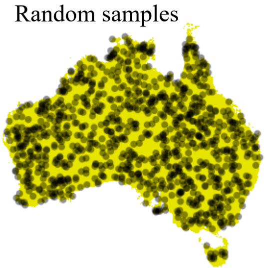
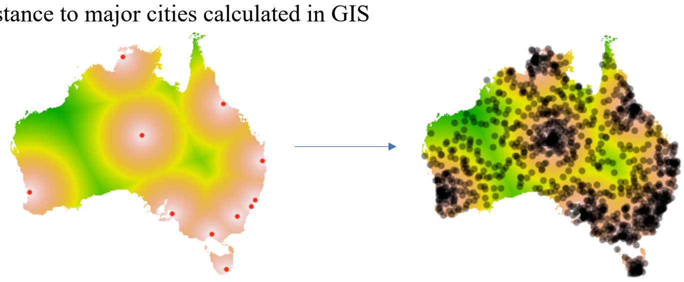
Random sampling and distance map

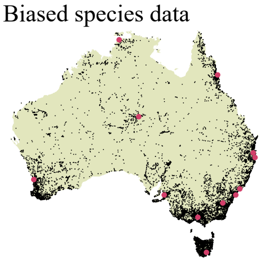
Random samples



Distance to major cities calculated in GIS

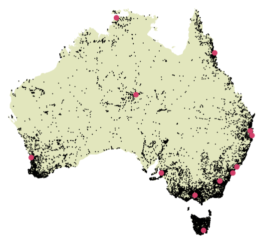


Biased species data



Other ways?

similar bias



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Summary

- GIS is used for producing environmental maps
- Spatial scale is important – extent, resolution
- Projection can bias the sampling
- Sampling towards accessible areas can bias species distribution models

Questions?

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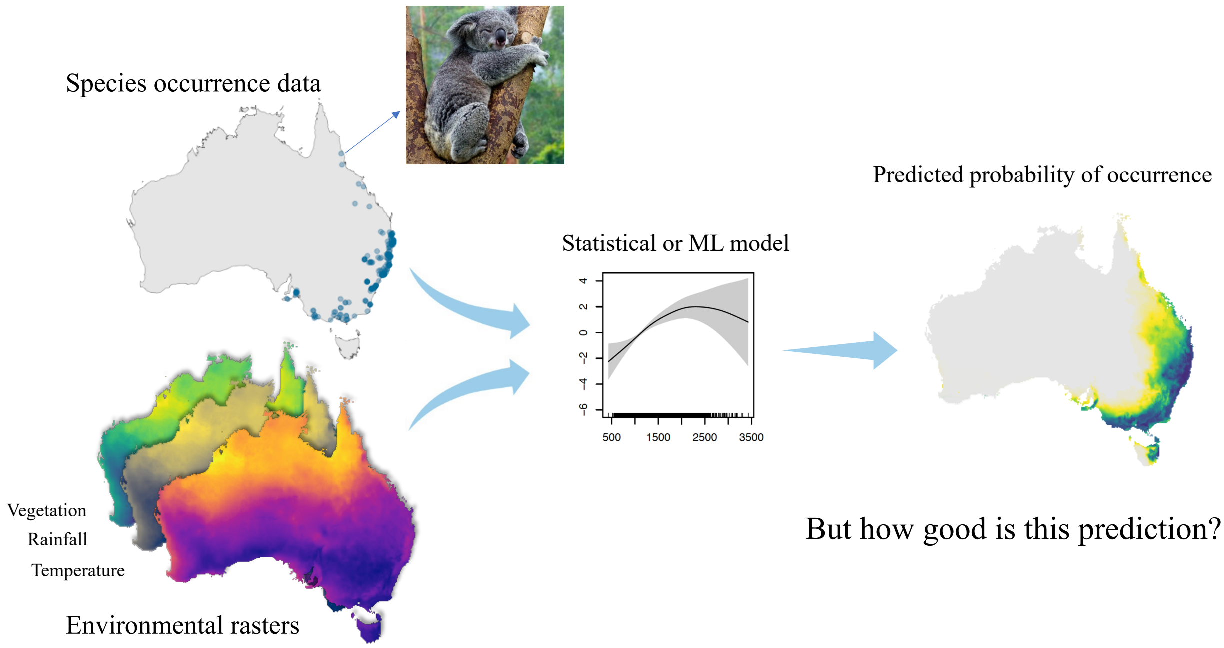

But how good is this prediction?

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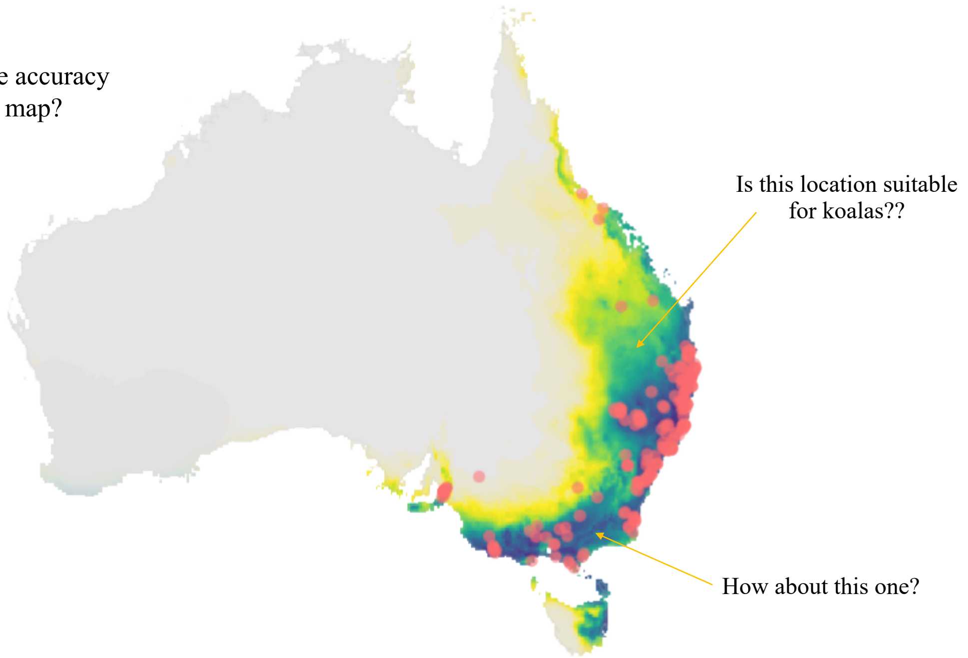
How we quantify the accuracy of the produced map?



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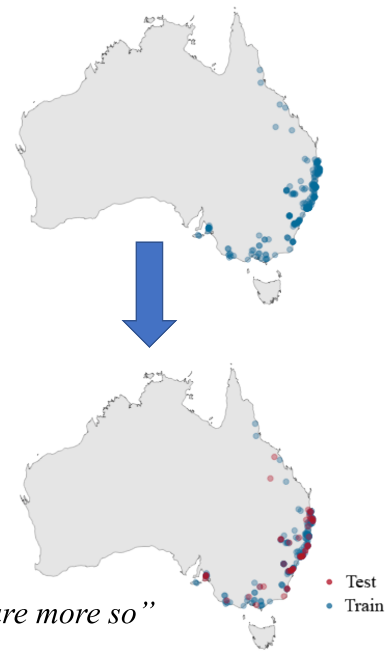
Evaluating the model performance

- Data for testing the model's performance
- Independent data
- Splitting to train and test samples
- Is *random* splitting good enough?
- What might be wrong?



"Everything is related to everything else, but near things are more so"

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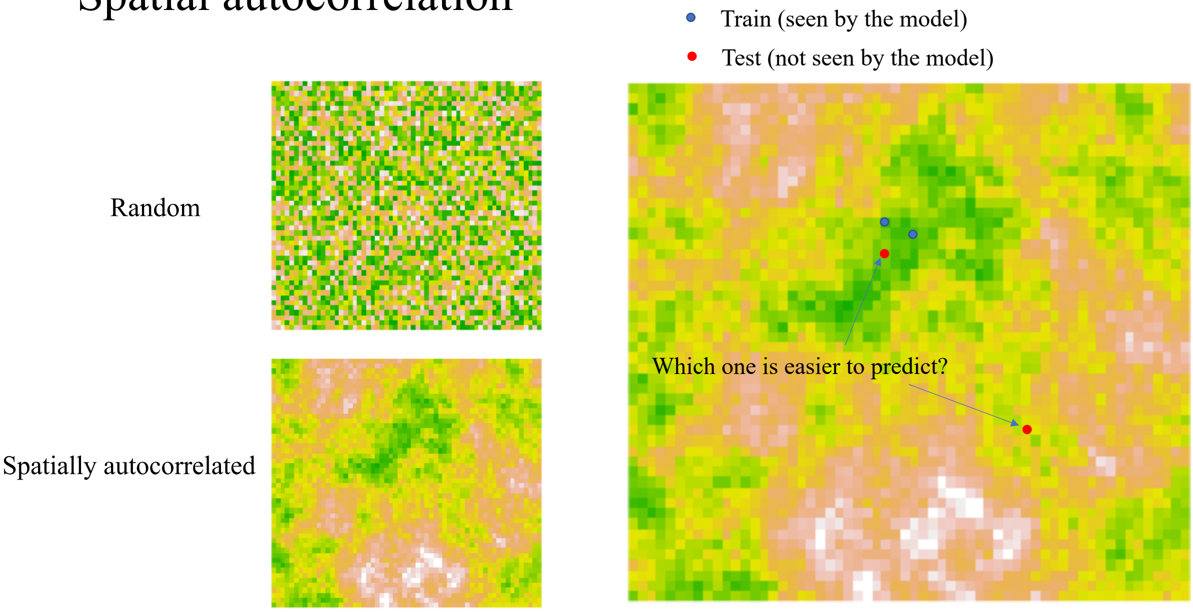
Spatial autocorrelation



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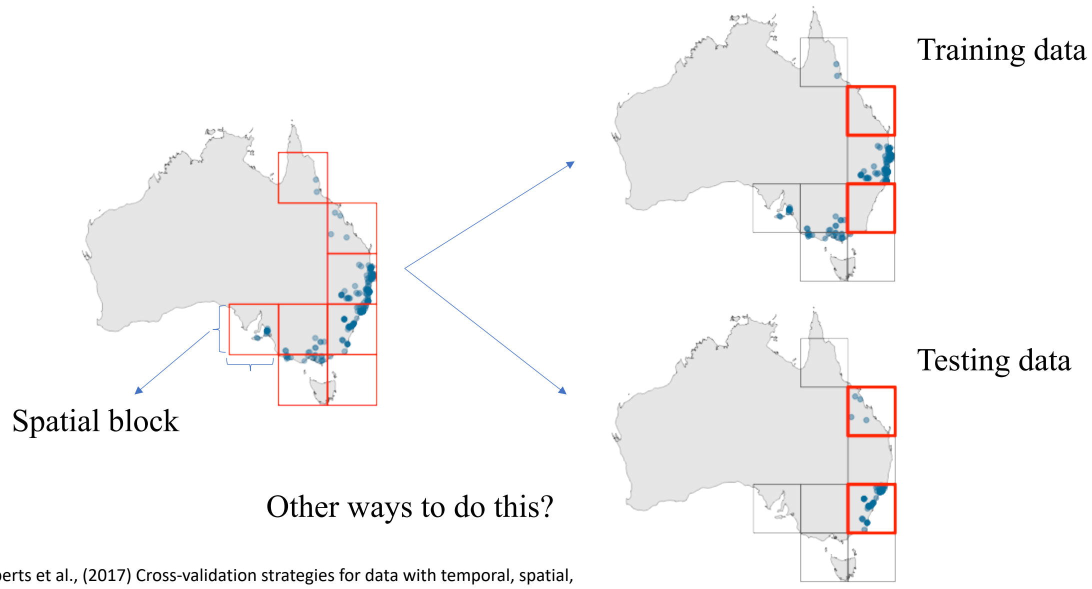
Spatially separated train and test



Other ways to do this?

Roberts et al., (2017) Cross-validation strategies for data with temporal, spatial, hierarchical, or phylogenetic structure. Ecography.

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Summary

- Training and testing sample to evaluate model’s prediction map
- Independent samples is needed
- Spatial autocorrelation can inflate the accuracy measure
- Spatially separated testing samples can reduce the impact of spatial autocorrelation
- Block cross-validation

Questions?

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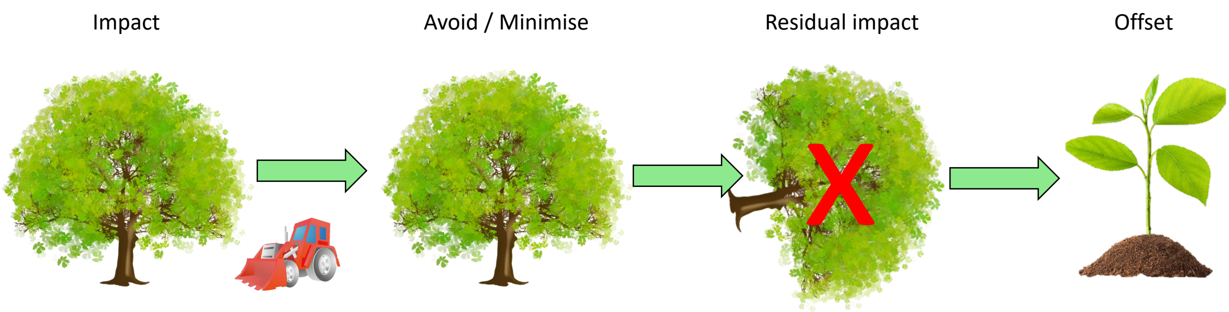
Biodiversity Offsets

“Conservation actions designed to compensate for the adverse residual impacts of development”



Erica Marshall
marshalle@student.unimelb.edu.au

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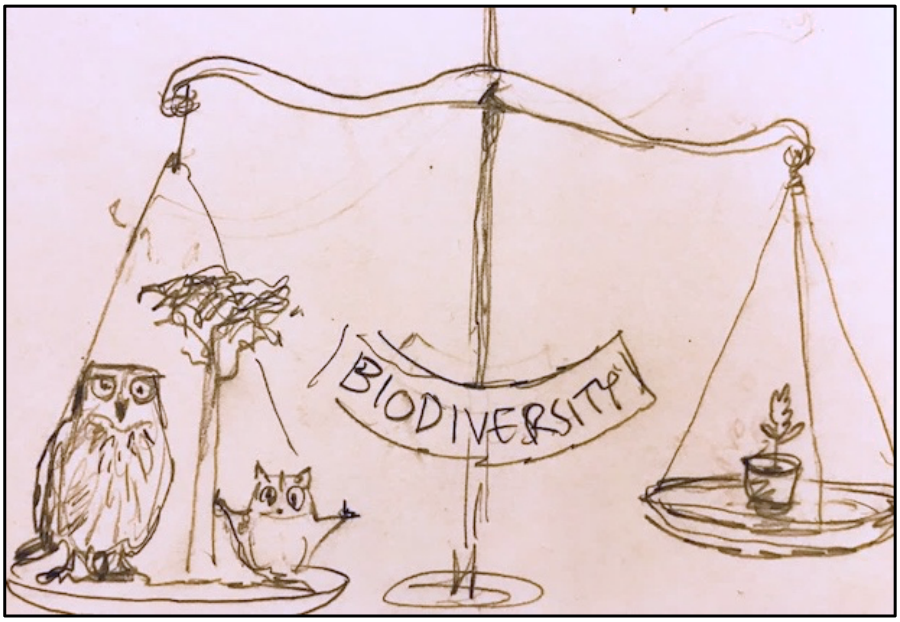

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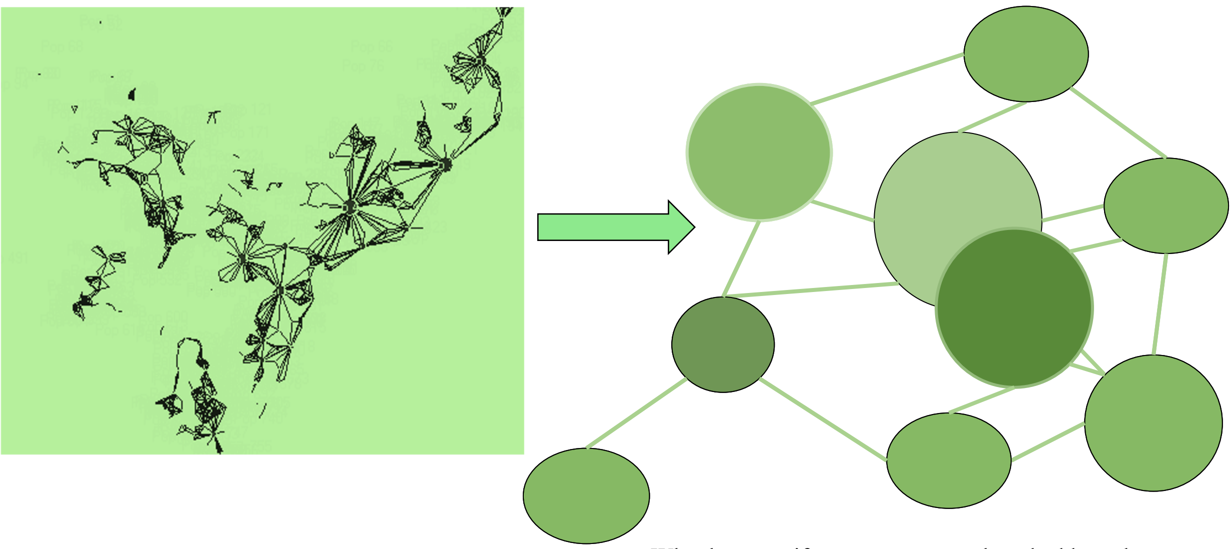
Population Viability Analysis (PVAs)



What happens if we remove a patch and add another one

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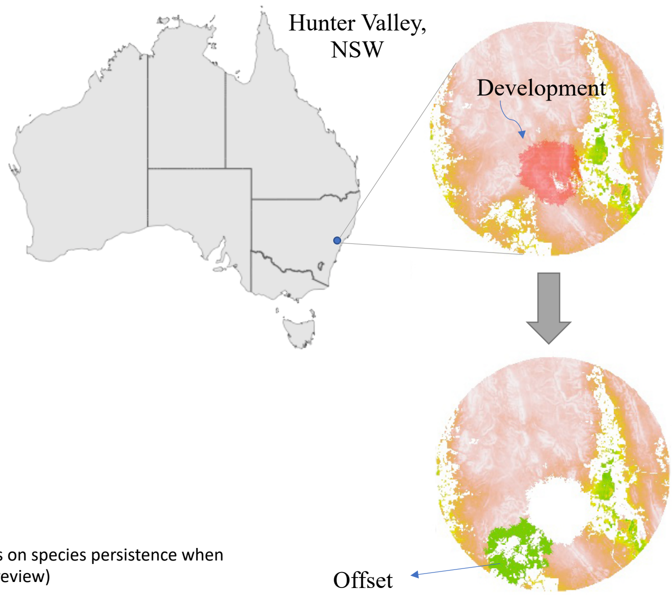
Spatial simulation

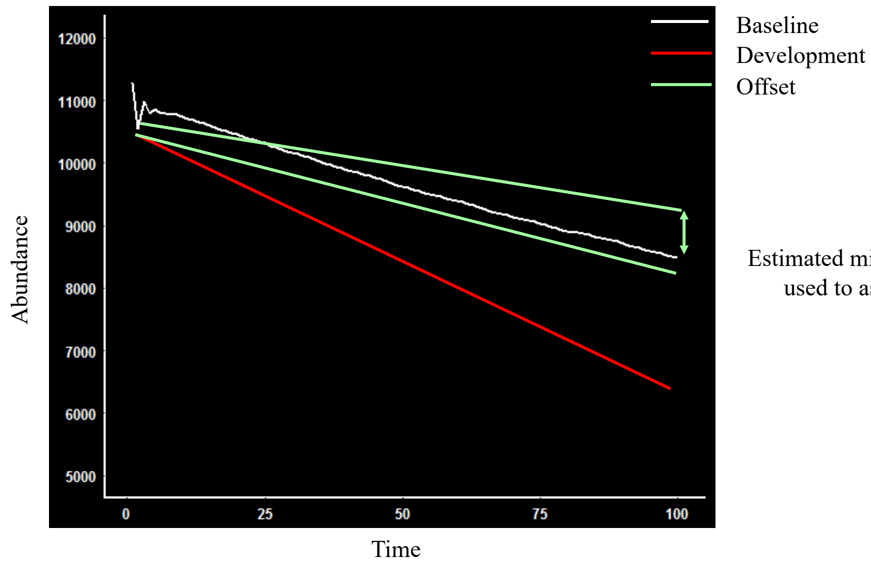
- Quantify the impact of **current biodiversity offsetting** metrics
- Identify options for improvement
- Testing different scenarios



Marshall, E., et al., Quantifying the impact of vegetation-based metrics on species persistence when choosing offsets for habitat destruction. *Conservation Biology* (under review)

29

Estimated population trajectory



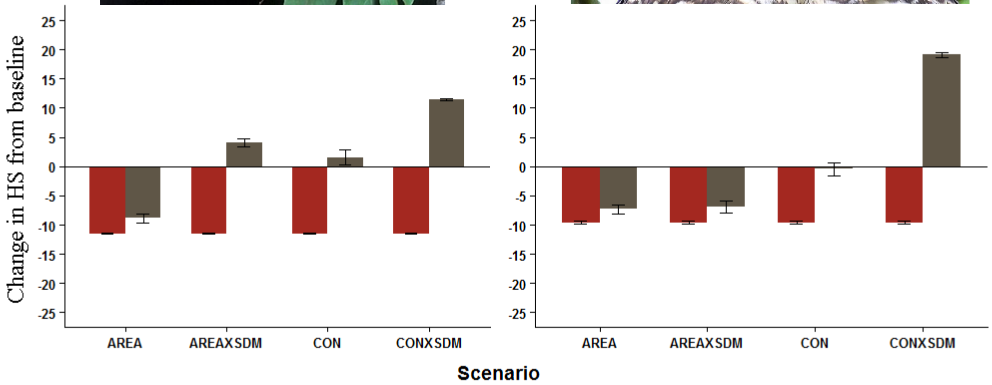
EMA
Estimated minimum abundance used to assess outcomes

30

Simulation results for two species

Squirrel Glider

Powerful Owl



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Summary

- Map of species distribution to estimate the population of species
- Using GIS to simulate urban development and biodiversity offsetting
- If you aren't explicitly accounting for species' habitats you are likely to be impacting long term persistence

Questions?

Thanks for listening!

rvalavi@student.unimelb.edu.au

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