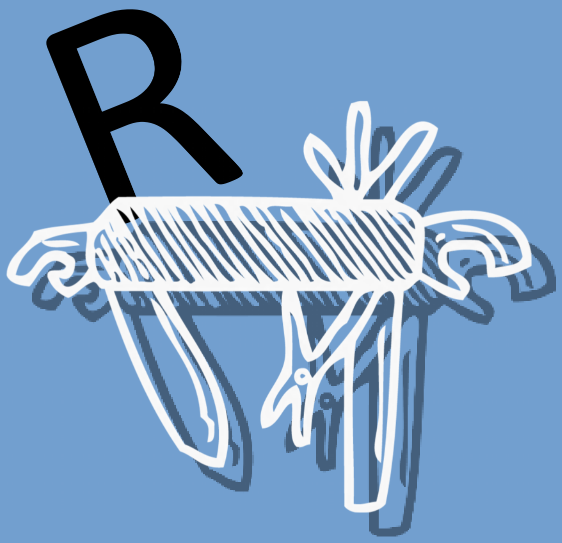
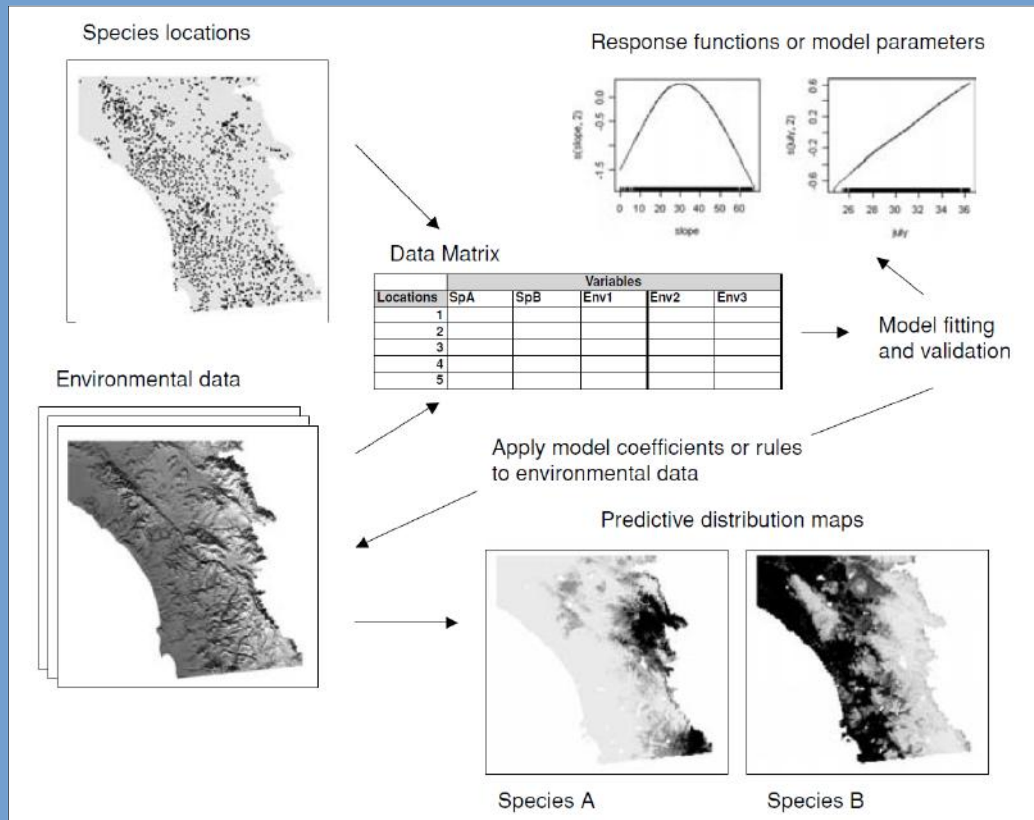
SEEC Stats Toolbox

Species distribution modelling II: using expert range maps and other spatial information to supplement biased occurrence data



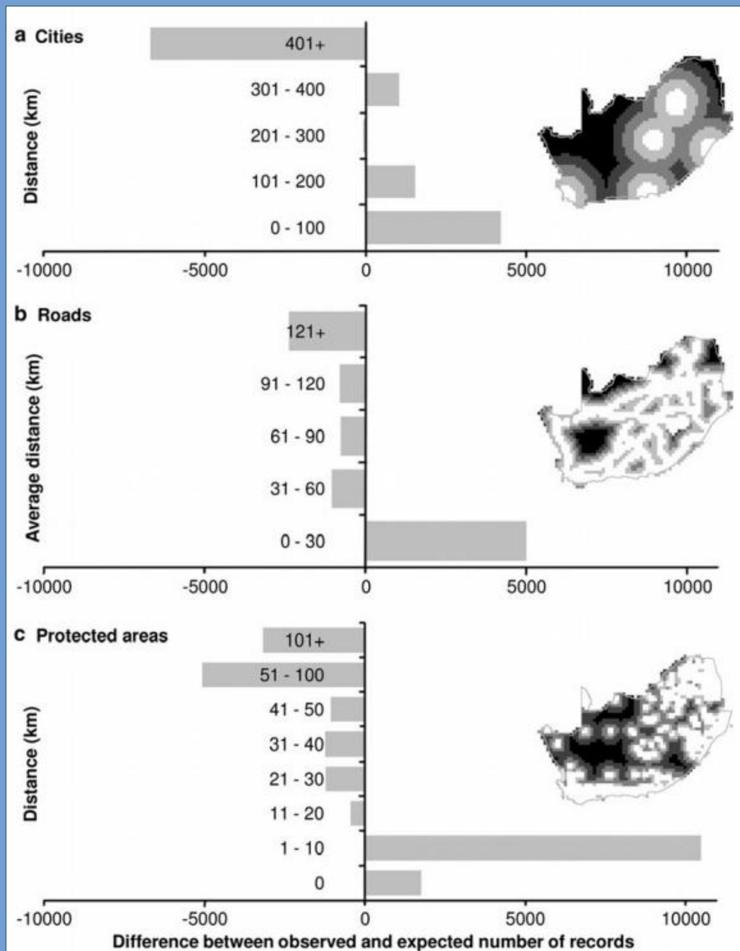
Setting the scene

What is a species distribution model?



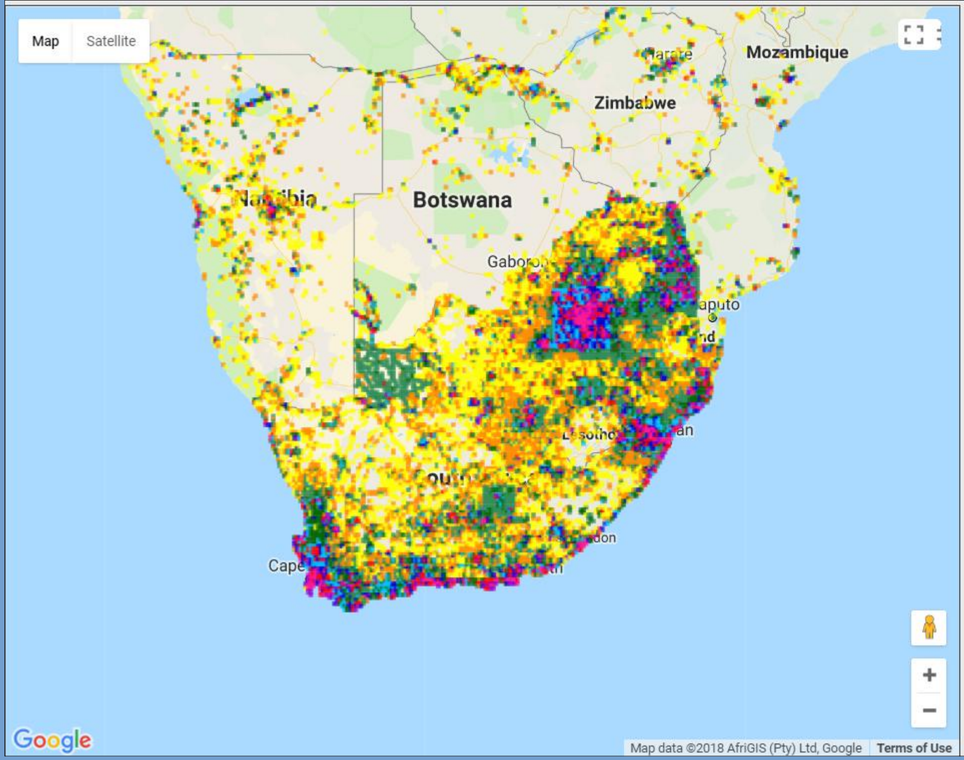
Franklin (2009). Mapping species distributions. Cambridge University Press

Biased occurrence data



Botts et al. (2011) *Biodiv Cons* 20

Biased occurrence data



This map shows the number of cards (full protocol) submitted for each pentad

- 1 card
- 2 - 3 cards
- 4 - 6 cards
- 7 - 10 cards
- 11 - 15 cards
- 16 - 24 cards
- 25 - 49 cards
- 50 - 99 cards
- 100+ cards

Tools

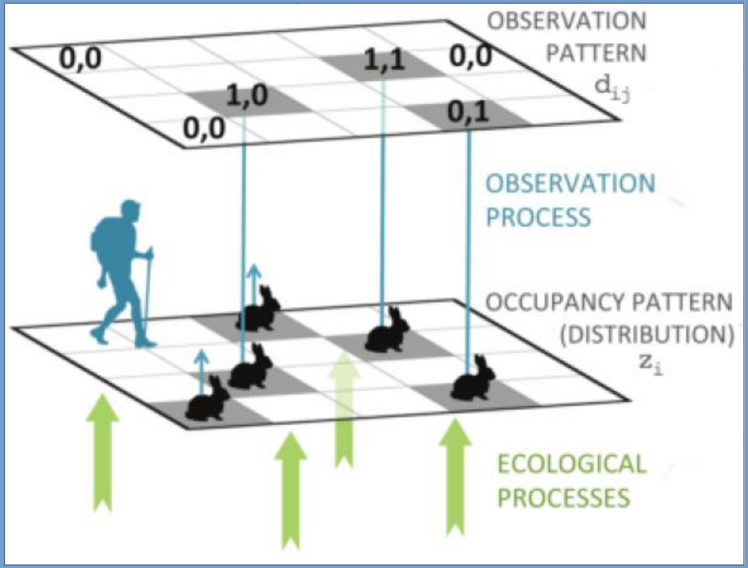
What is the Coverage map?

The Coverage map allows us to see the actual on the ground coverage of the project on a pentad scale. If the user clicks on one of the pentads, a small 'bubble' will open with the link to the pentads summary page, which will open in a separate browser tab.

Annual coverage for he project since its inception is accessed by selecting the year of interest along the top of the map.

Pentad:
A 5 minute x 5 minute coordinate grid super-imposed over the continent to for spatial reference. One QDGC comprises of 9 pentads.

Occupancy



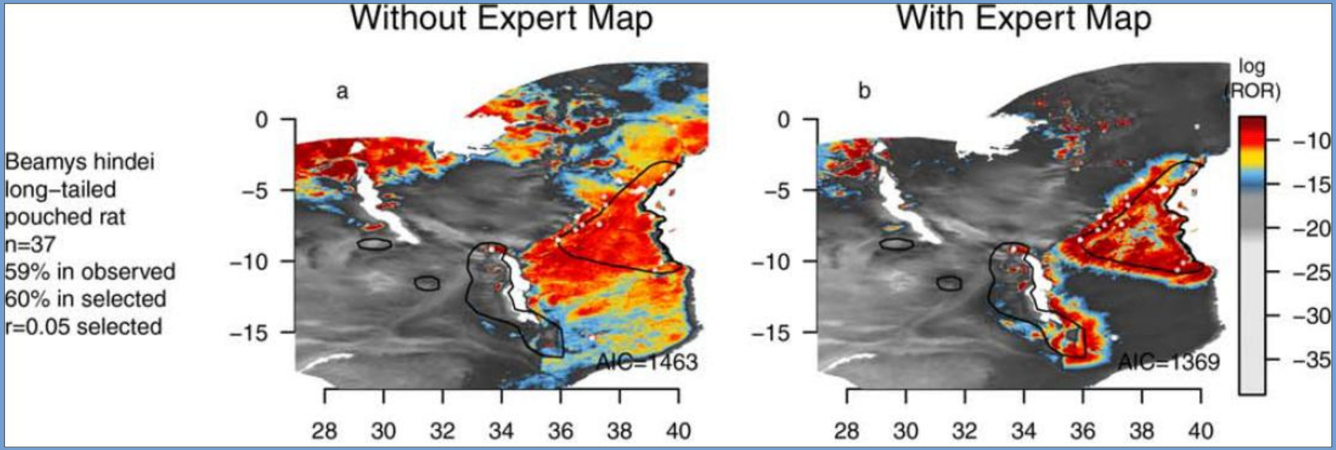
Occupancy = ψ x p

ψ is the probability a site is occupied

p is the probability of observing a species

SDMs usually model the probability a location contains a presence ($p \neq 1$)

SDMs tend to overpredict

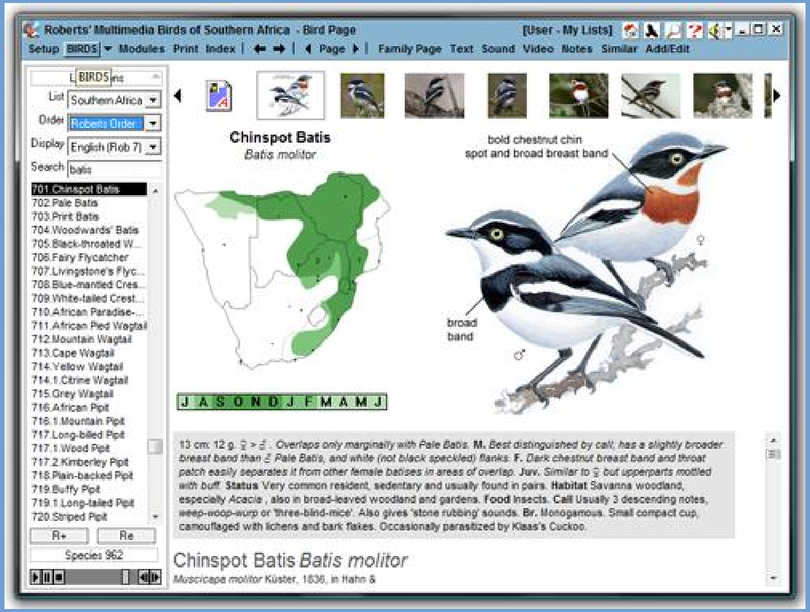


Dispersal limitations

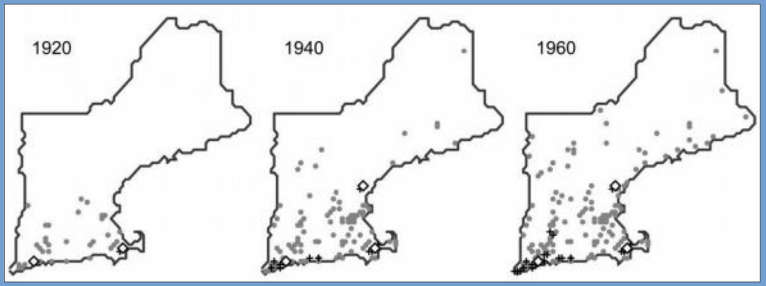
Invasions

Equilibrium with the environment

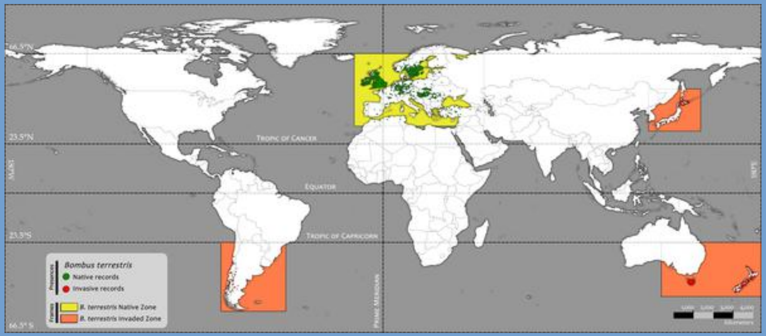
Incorporating other useful spatial information



Expert range maps



Dispersal info



Native or “other” range info

The approach

The approach

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2016) **25,** 1022–1036

MACROECOLOGICAL METHODS

Improving niche and range estimates with Maxent and point process models by integrating spatially explicit information

Cory Merow[1*], Jenica M. Allen[2], Matthew Aiello-Lammens[3,4] and John A. Silander, Jr[5]

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2017) **26,** 243–258

MACROECOLOGICAL METHODS

Integrating occurrence data and expert maps for improved species range predictions

Cory Merow[1,2*], Adam M. Wilson[1,3] and Walter Jetz[1,4]

General approach - Minxent

Just a generalisation of Maxent

$$\ln[P^*(z(x_i))] = \ln(Q(x_i)) + z(x_i)\lambda - \ln(C)$$

Relative occurrence rate (ROR)

Offset

Vector of environmental predictors

Fitted coefficients

Constant

General approach - Minxent

Just a generalisation of Maxent

$$\ln[P^*(z(x_i))] = \ln(Q(x_i)) + z(x_i)\lambda - \ln(C)$$

- $P^*(z(x_i))$: Relative occurrence rate (ROR)
- $Q(x_i)$: **Offset**
- $z(x_i)$: Vector of environmental predictors
- λ: Fitted coefficients
- C: Constant

General approach - Minxent

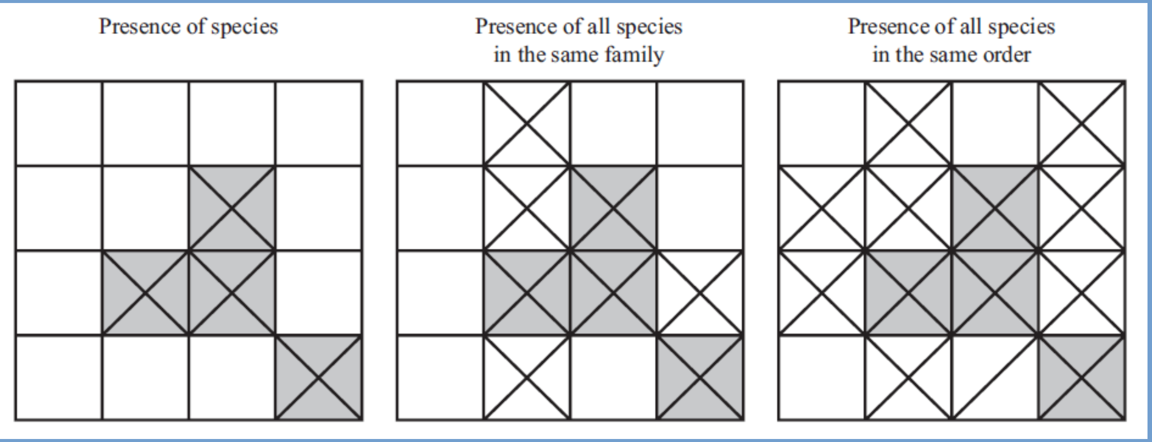
1) Build an offset (Maxent model using prior spatial information)
   a) Nuisance offset (factor out of the prediction)
   b) Informative offset (include in the prediction)
2) Build a normal Maxent SDM
3) Build Minxent SDM (by factoring offset in or out)
4) Compare 3) and 4) (optional)

Example 1: Accounting for sampling bias

App1_Sampling_Bias.r in Merow *et al*. (2016)

Accounting for sampling bias

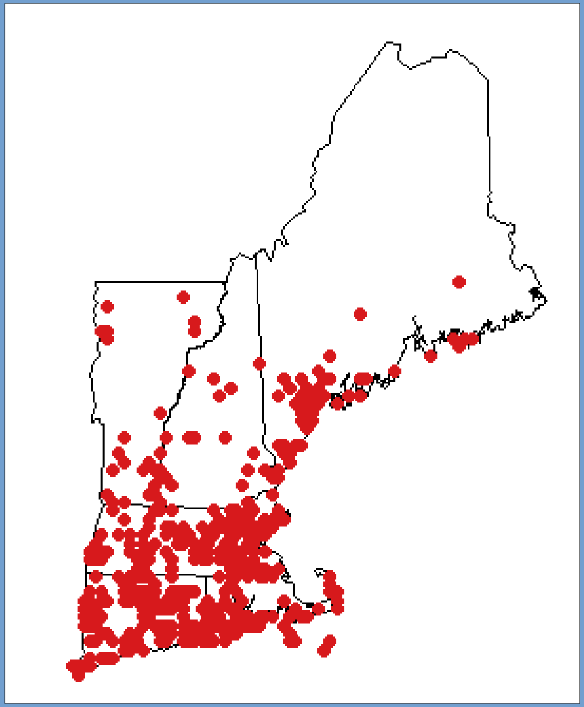
Approach used for a long time – Target Group Sampling (TGS)



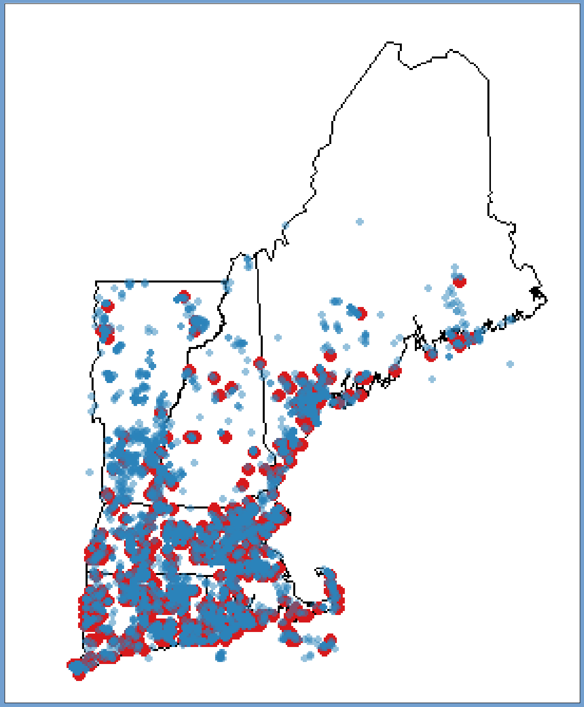
Niamir et al. (2016) *Glob Ecol Biogeog* 25

Step-by-step sampling bias

Step 1: Get species occs and ID target group samples



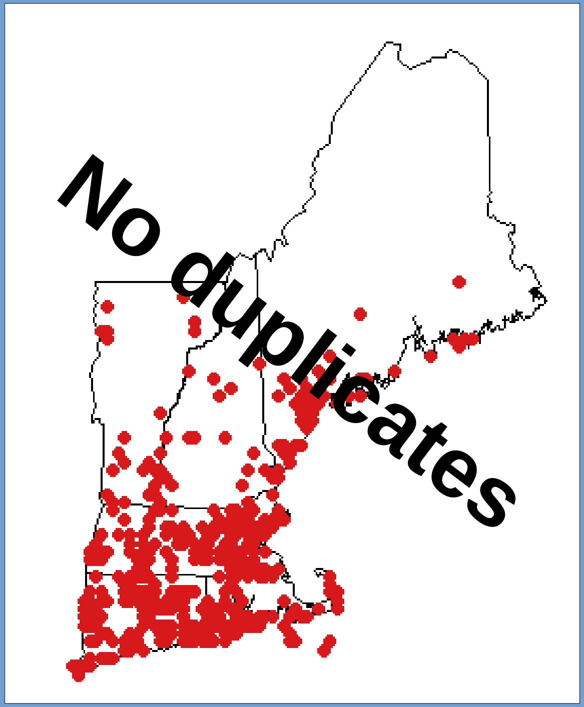
Celastrus orbiculatus



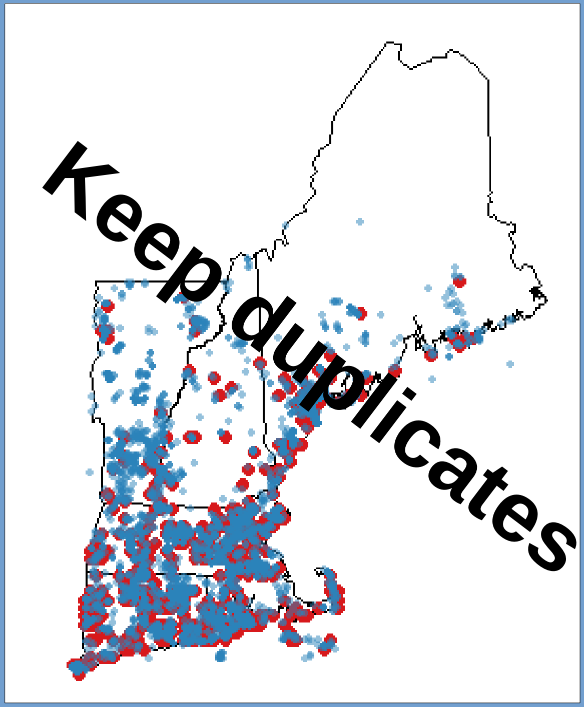
Other invasive species' occurrences

Step-by-step sampling bias

Step 1: Get species occs and ID target group samples

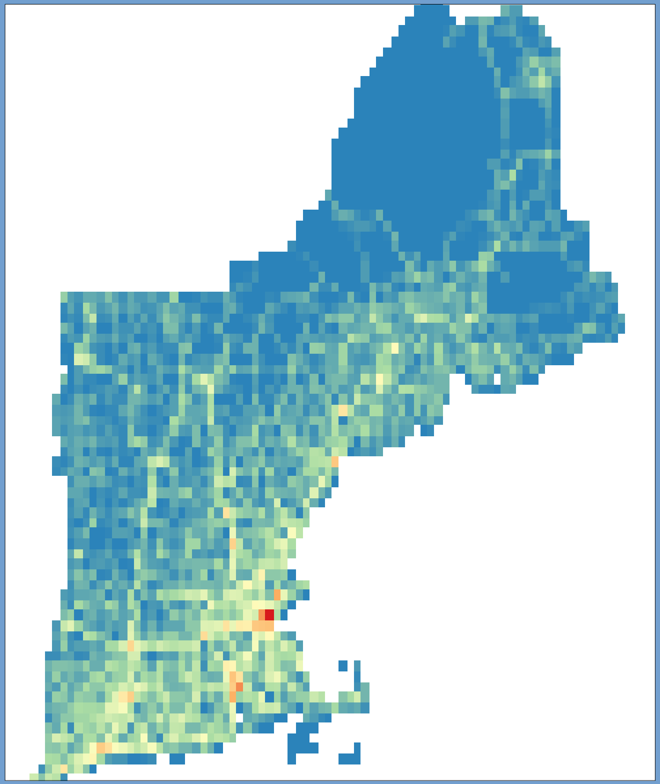


Celastrus orbiculatus

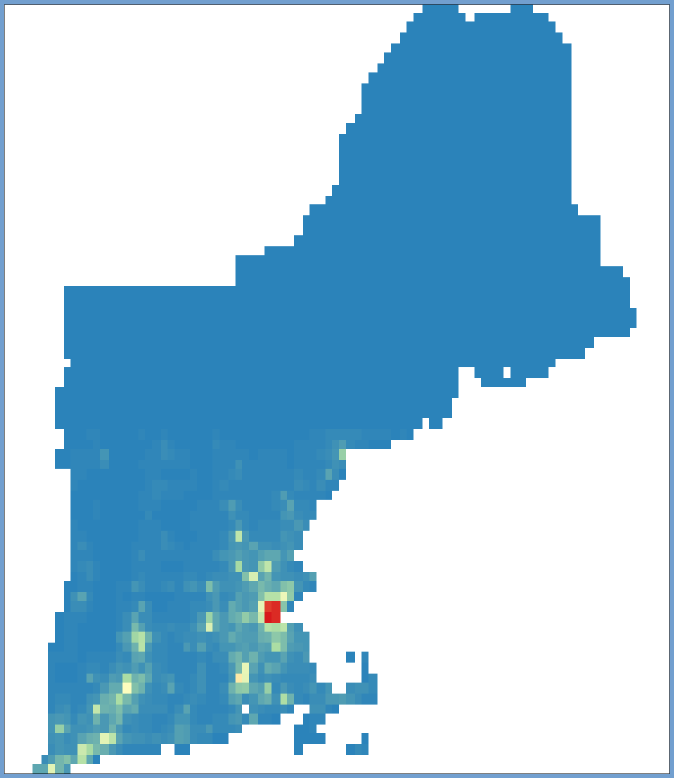


Other invasive species' occurrences

Step 2: Get predictors of sampling bias

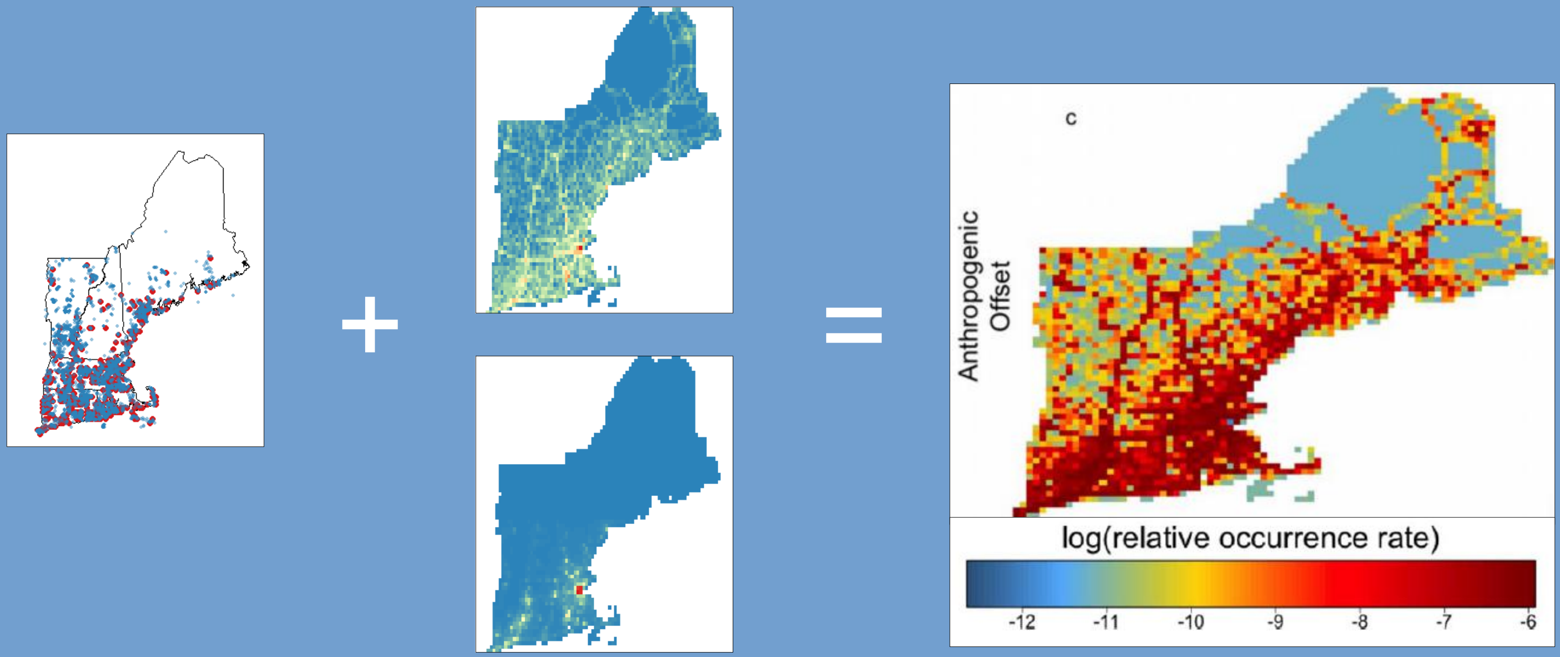


Road density

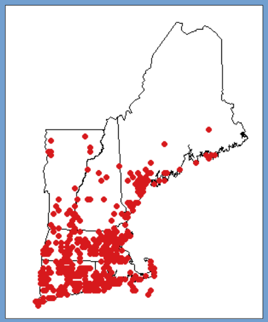


Population density

Step 3: Build a sampling bias model



Step 4: Build a normal Maxent model for your species



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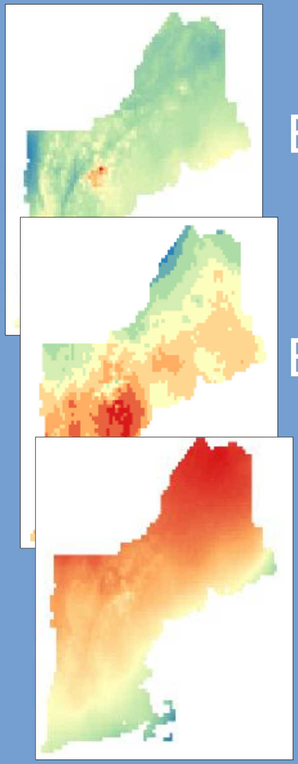

Bio12

Bio3

Bio4

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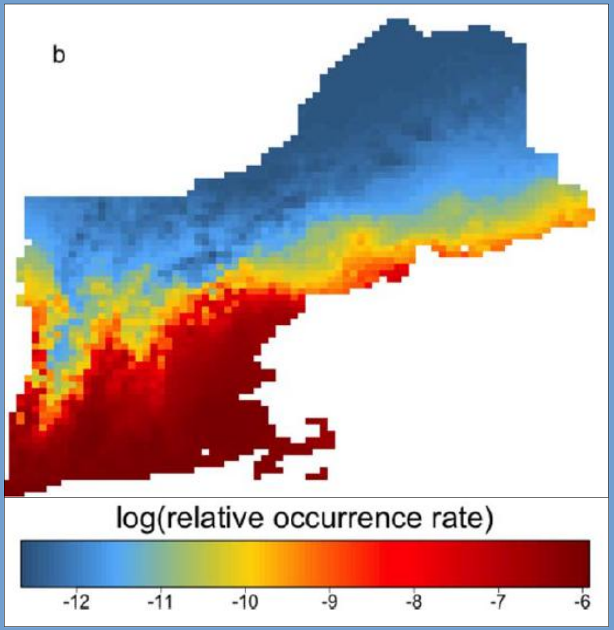
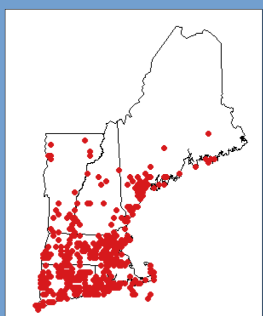


Step 5: Build Maxent model with an offset (your sampling bias model as a bias grid)



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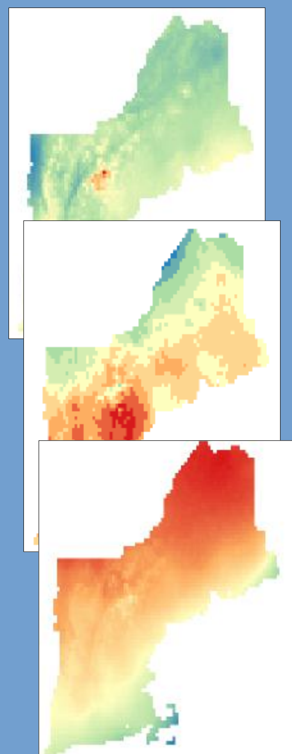
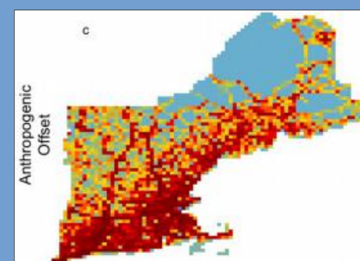


Bio12

Bio3

Bio4

+



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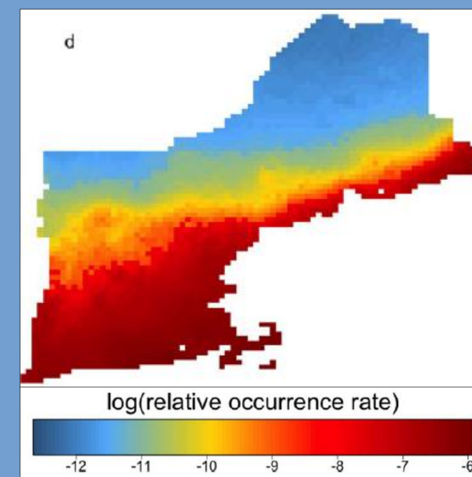
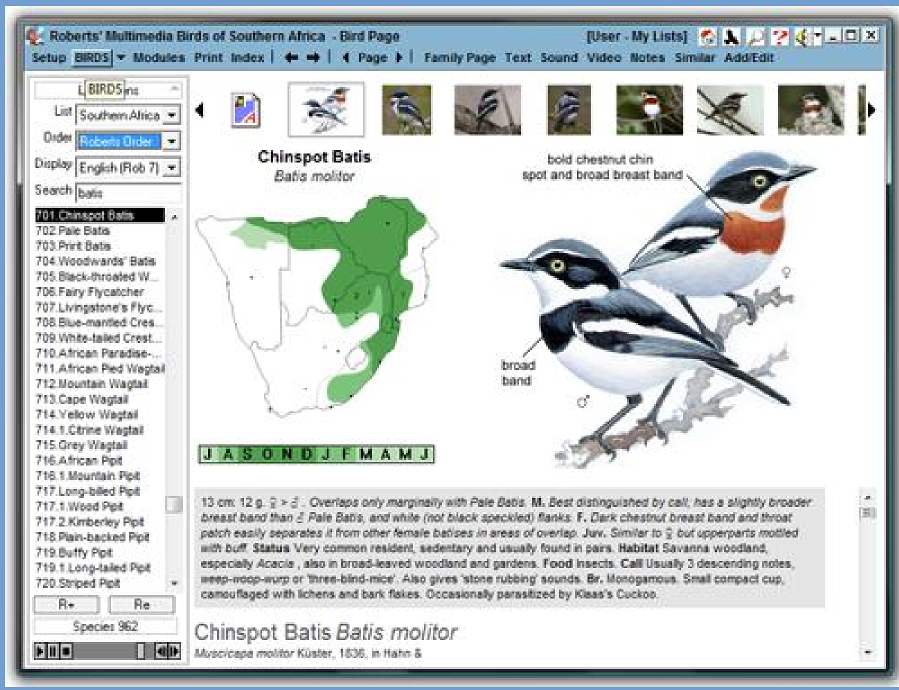


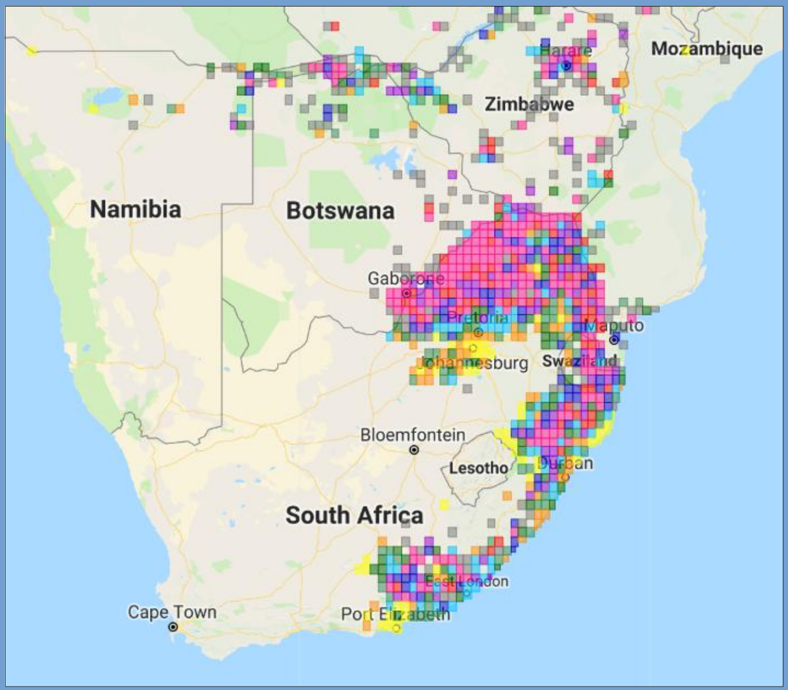
Example 2: Using expert range maps

App5_Expert_Maps.r in Merow *et al*. (2016)
Merow et al. (2017)
bossMaps R package

Expert knowledge vs messy data



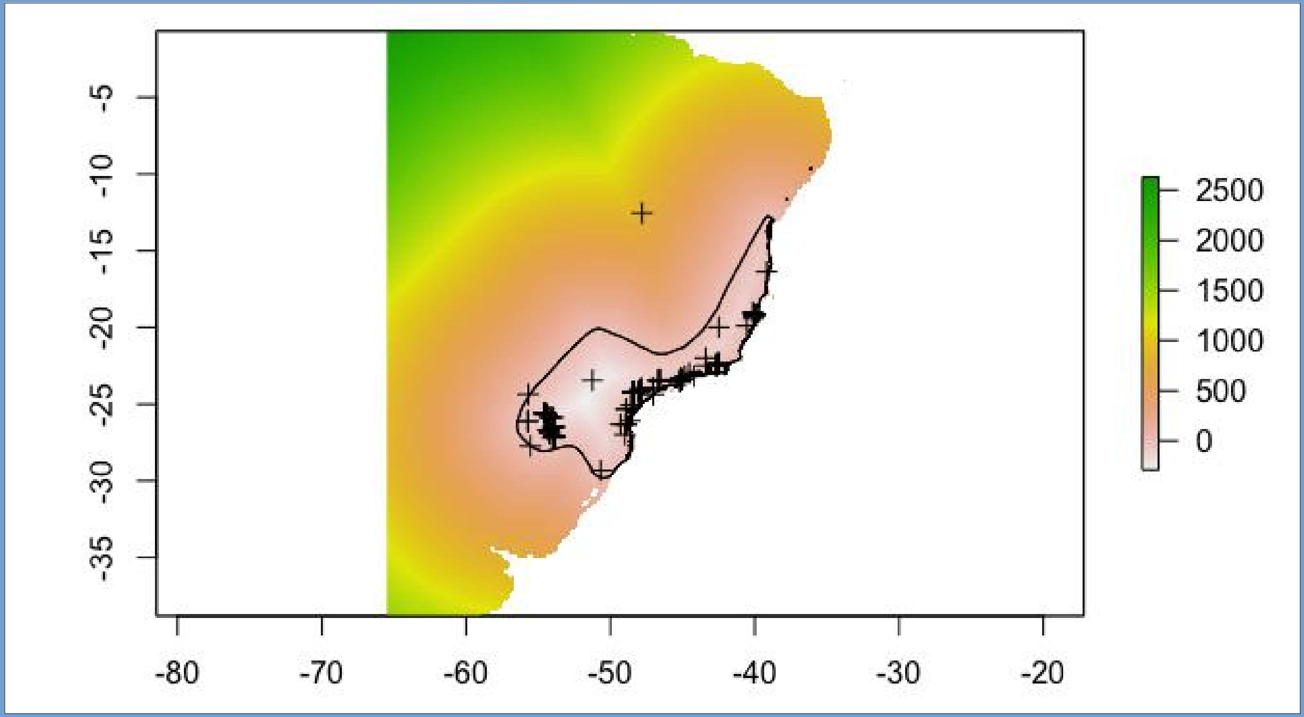
Roberts' Birds



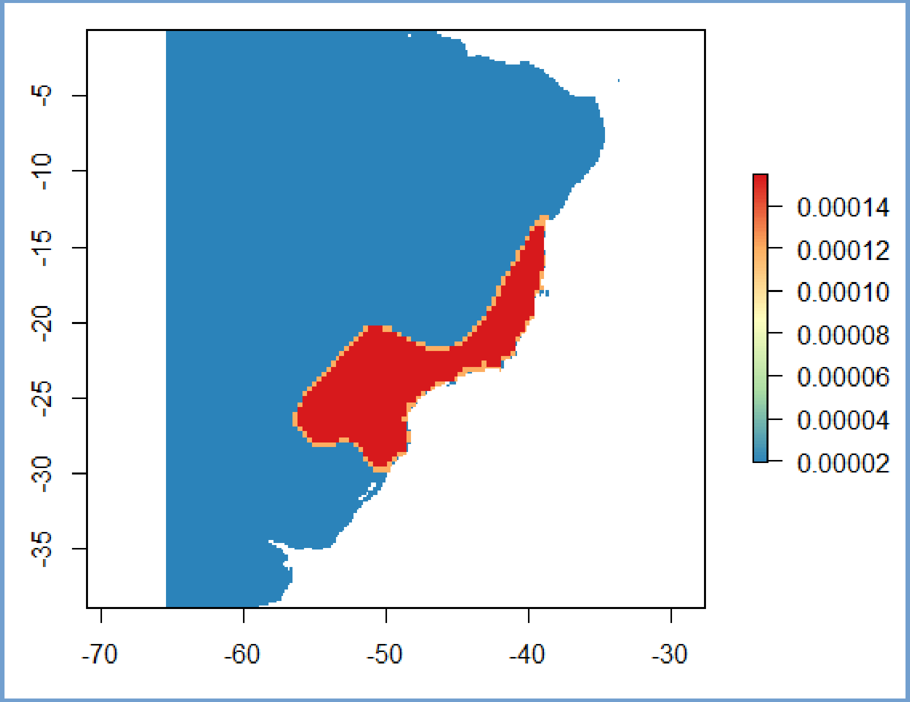
SABAP2

Step-by-step expert maps

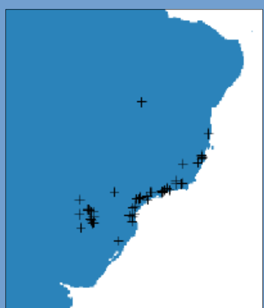
Step 1: Get species occurrences and an expert map



Step 2: Assign probabilities to areas inside and outside of expert range map (expert prior)



Step 3: Build a normal Maxent model for your species



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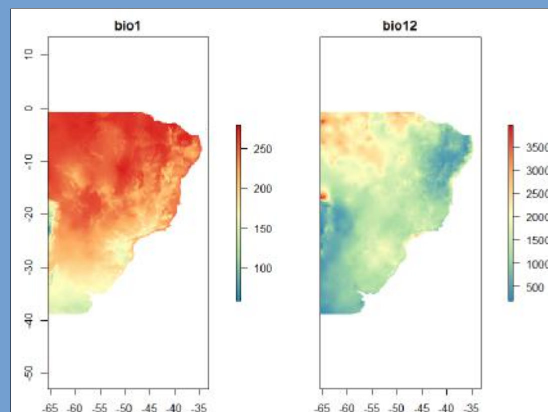

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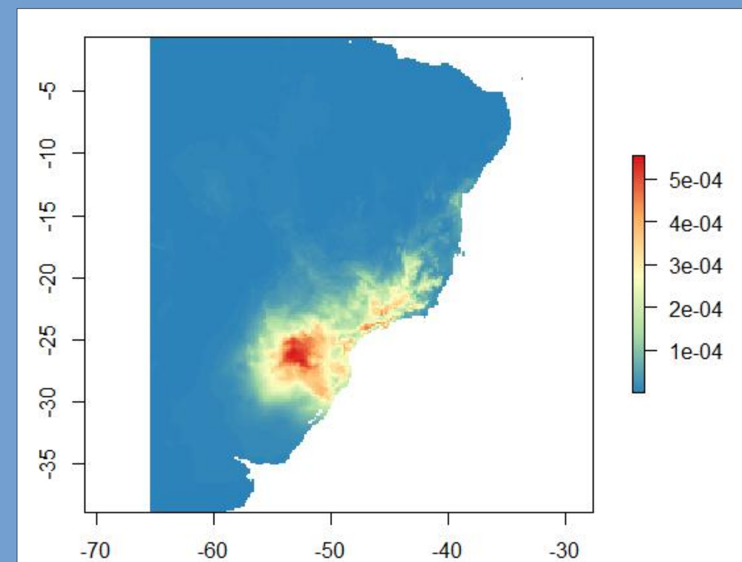
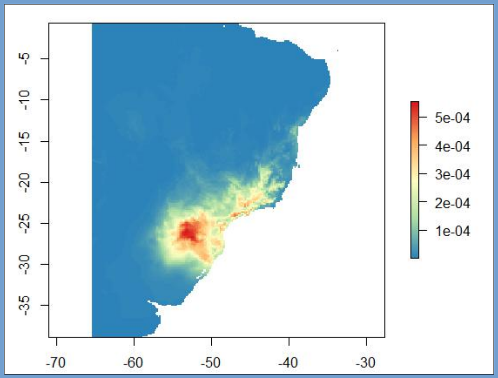
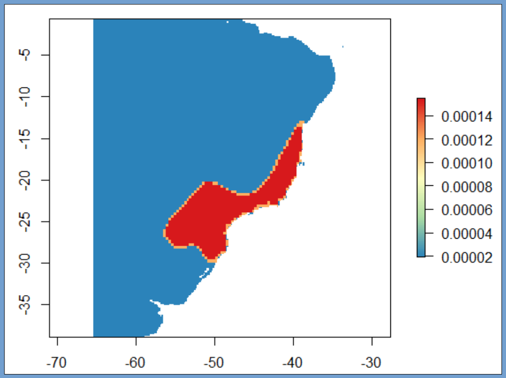


Step 4: Multiply normal Maxent model by expert prior



x



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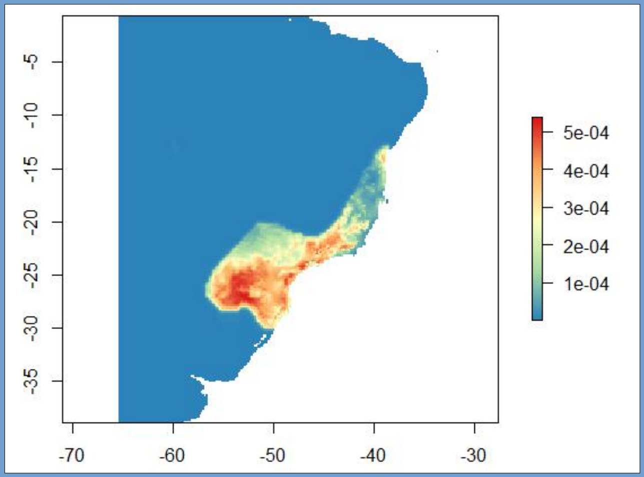
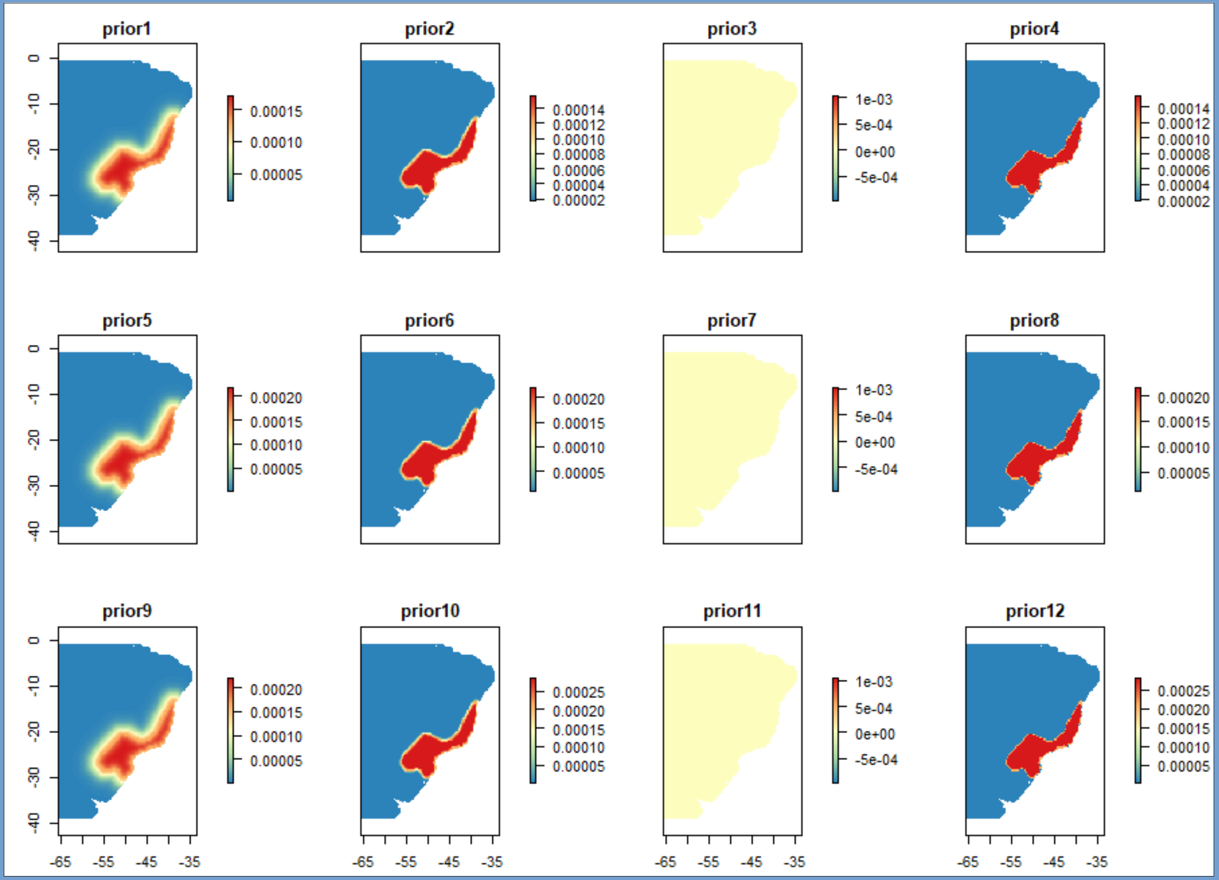


Extra steps!

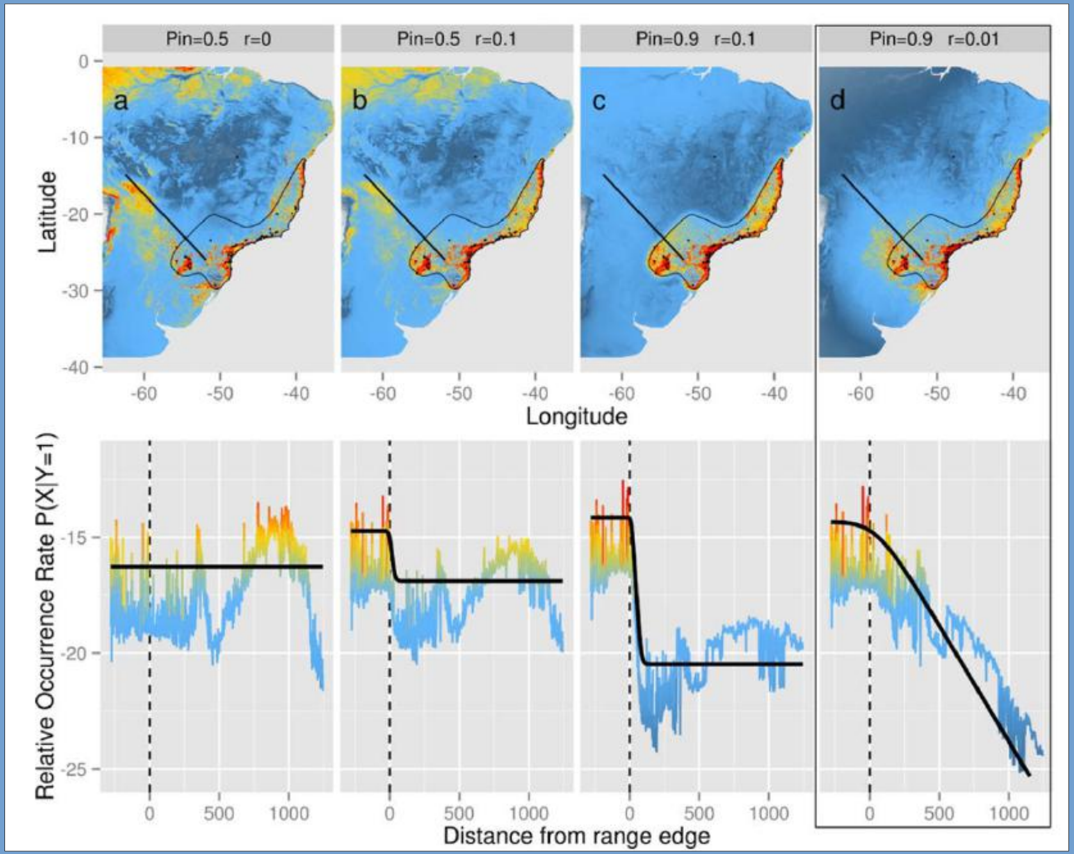


1) Assigning the probability values inside and outside the expert map
2) Sharpen or relax the expert map boundary

1) Assigning expert map probabilities

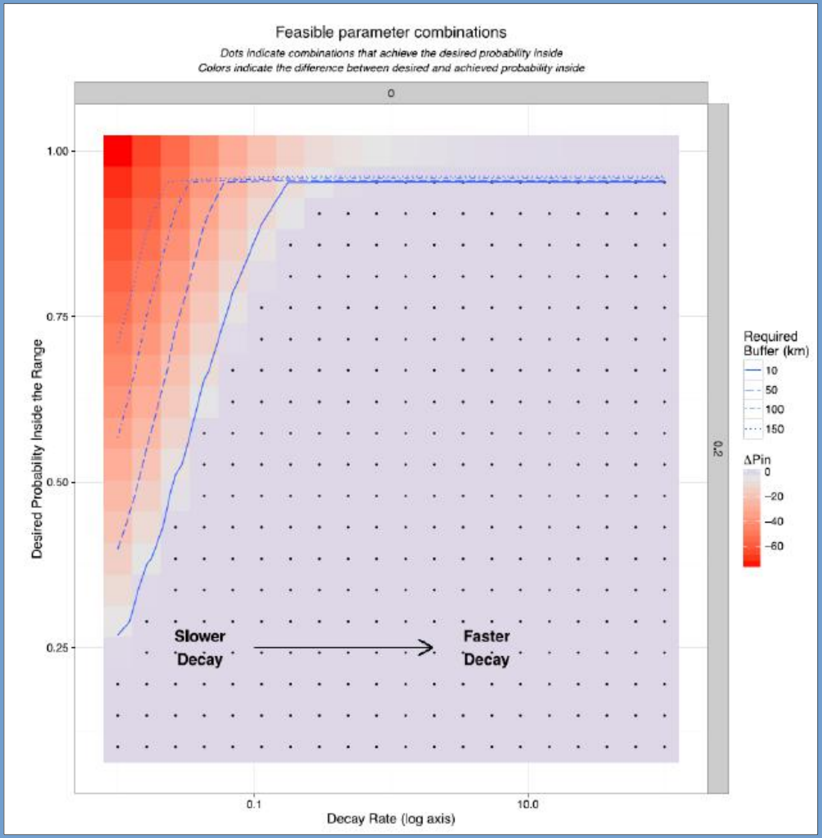
- Higher values inside expert map (P_{in}) = higher certainty
- Can use omission rate (prop. of observed presences outside the expert map)
- Should ideally use independent data for this

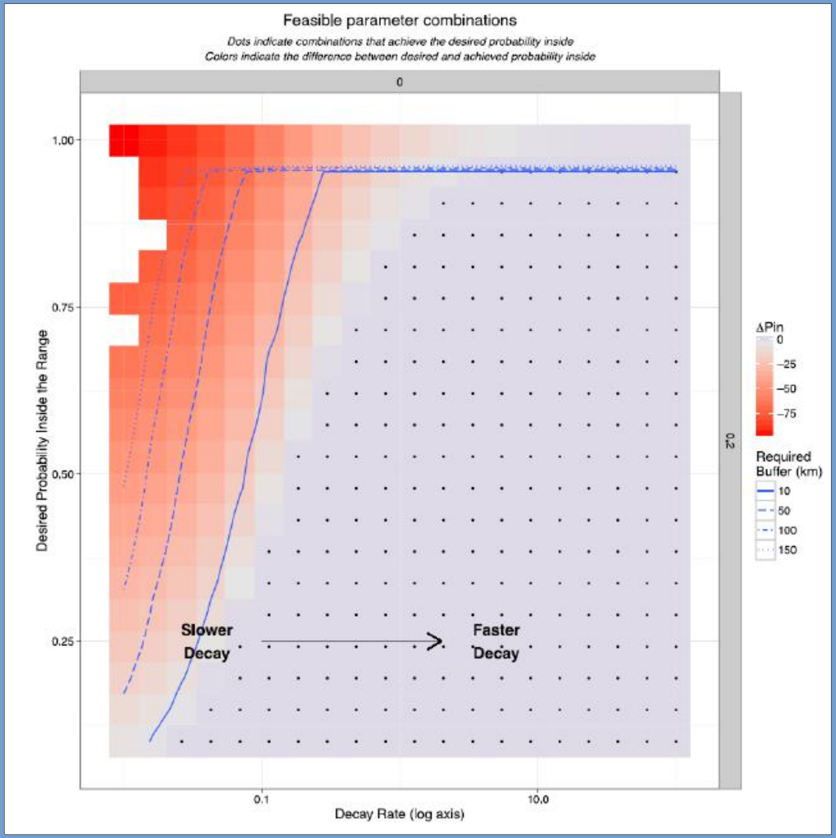
2) Expert map boundary transition "shape"



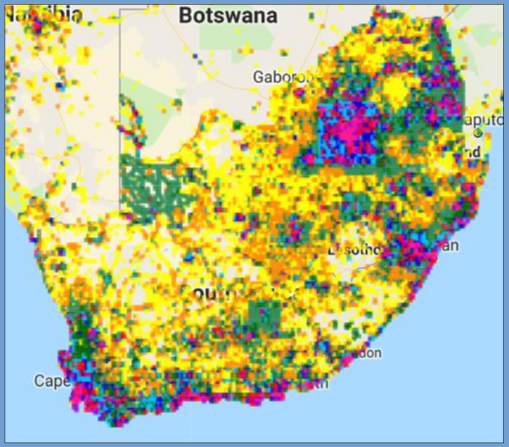
- Simplest = step function
- Logistic curve that can be parameterized
  - Decay parameter (r): determines steepness

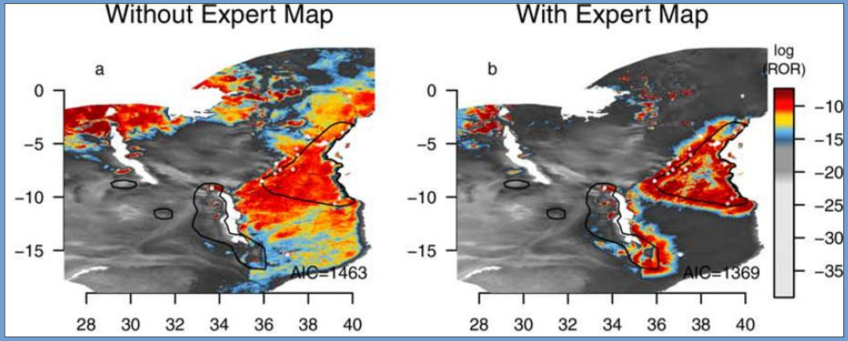
Not all combinations of P_{in} and r are possible





Summary





- Occurrence data usually biased
- SDMs overpredict
- Using offsets can help to address these problems by incorporating other sources of spatial info
- Other applications