Joint Species Distribution Models and Drivers of Biodiversity Change

MLU Block Course
Introduction to Biodiversity Informatics Part II
June 17, 2022

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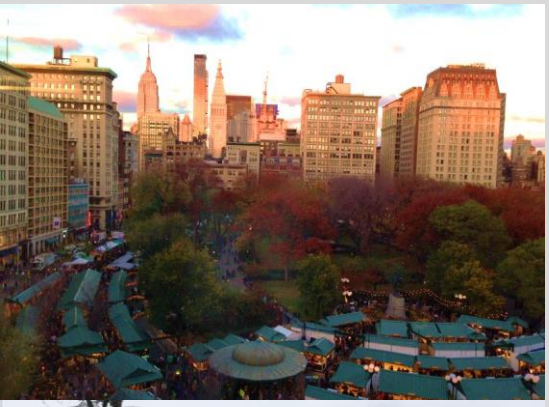
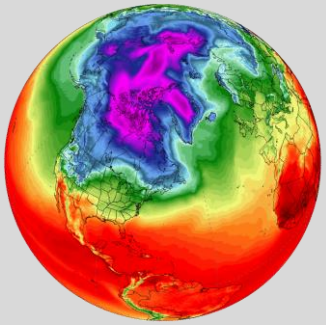
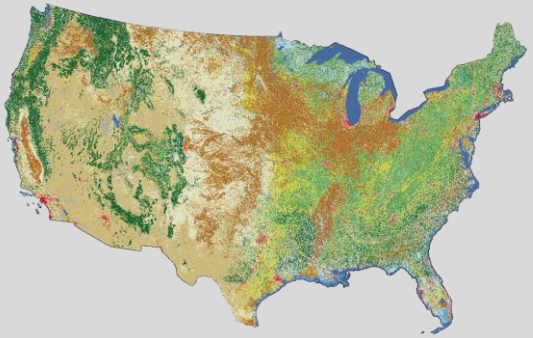
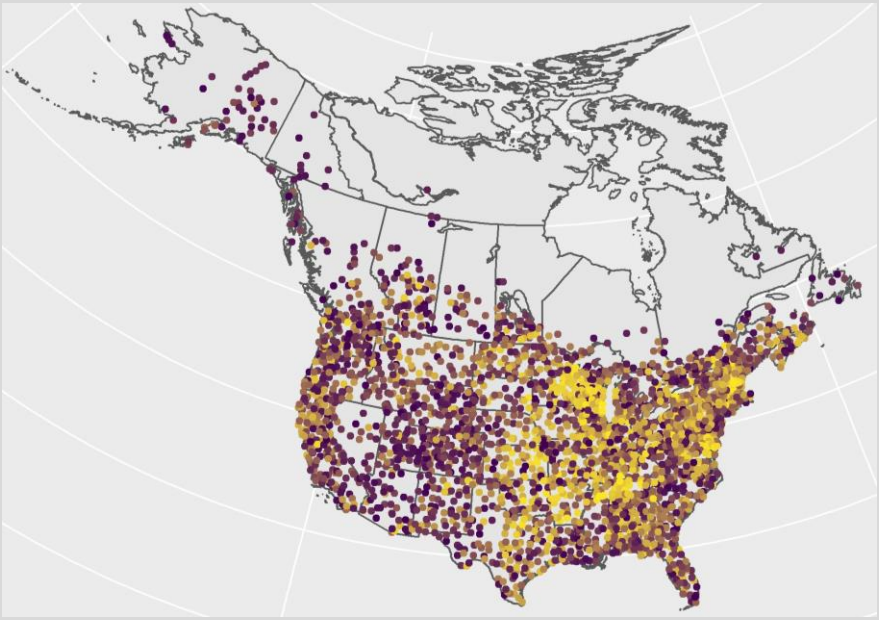
Who Am I?









Who Are You?

- Your name
- What attracted you to this field of study?
- Your favorite part of this class so far
- Your least favorite part of this class so far

Ecological Niches

- What is a niche?
  - Grinnell (1917): 'the sum of habitat requirements and behaviors that allow a species to persist and produce offspring'

  - Elton (1927): 'the place of an animal in the abiotic environment, its relation to food and enemies'

  - Hutchinson (1959): Formalized the niche concept by defining it as an n-dimensional hypervolume

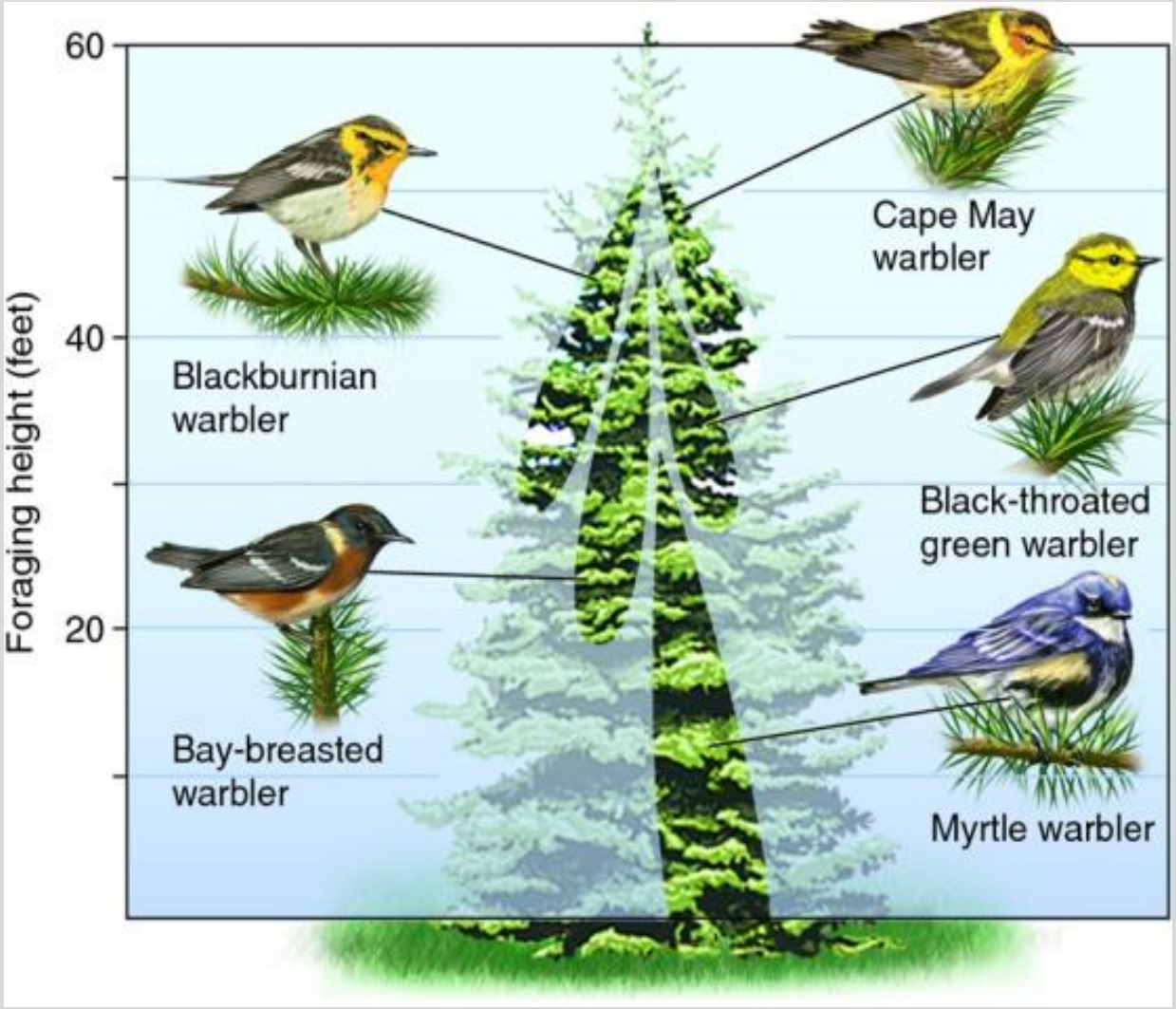
    - Fundamental vs. Realized Niches according to Hutchinson
      - Fundamental niche = hypervolume that the species requires to persist

      - Realized niche = what remains from the hypervolume after interactions with other species are taken into account

Ecological Niches

- Fundamental: entire set of conditions under which an individual can survive and reproduce

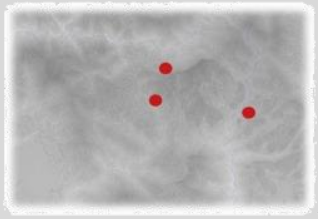
- Realized: actual set of conditions used by the individual



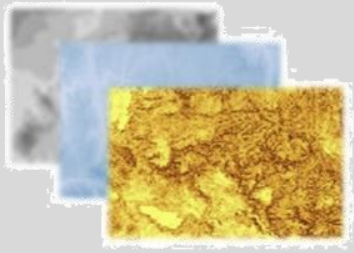
Species Distribution Models

Searching for a rare species…

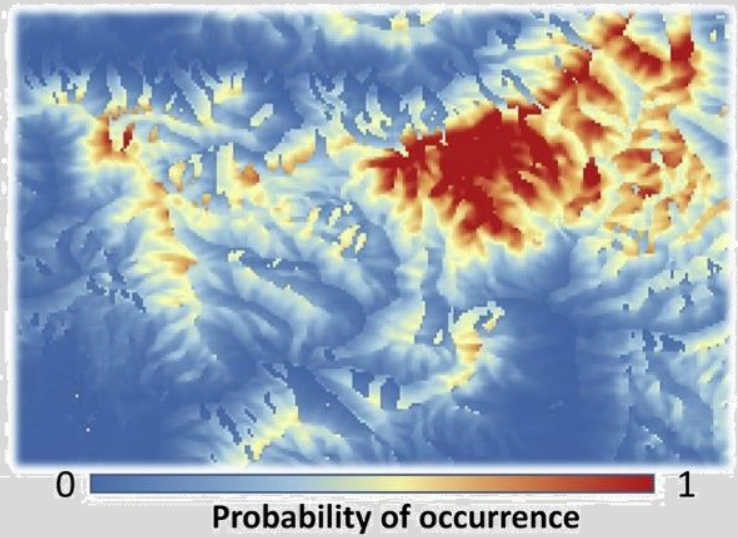
…correlating…



Limited information on species occurrence

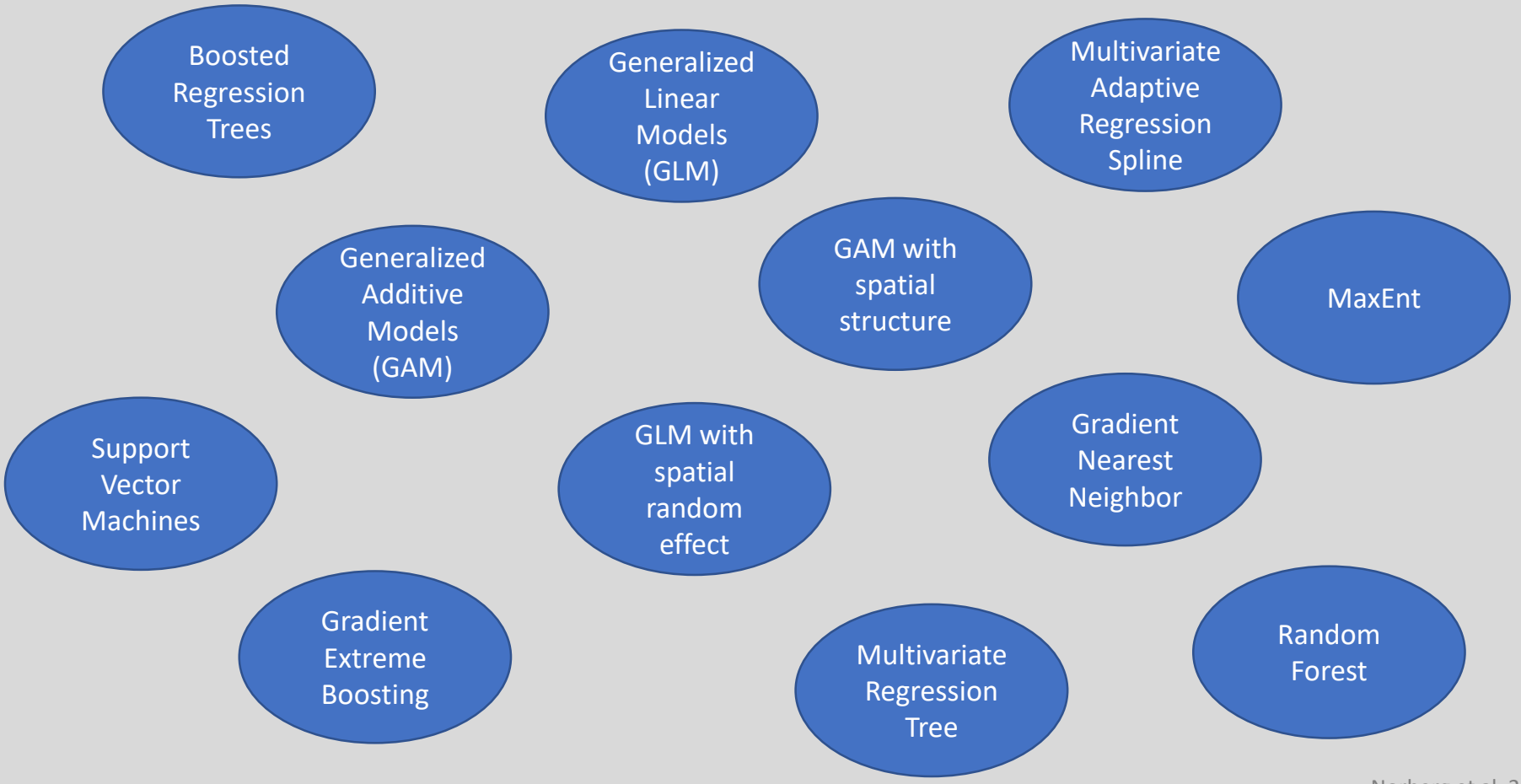


Environmental factors



Fois et al. 2018

Many different types of SDMs

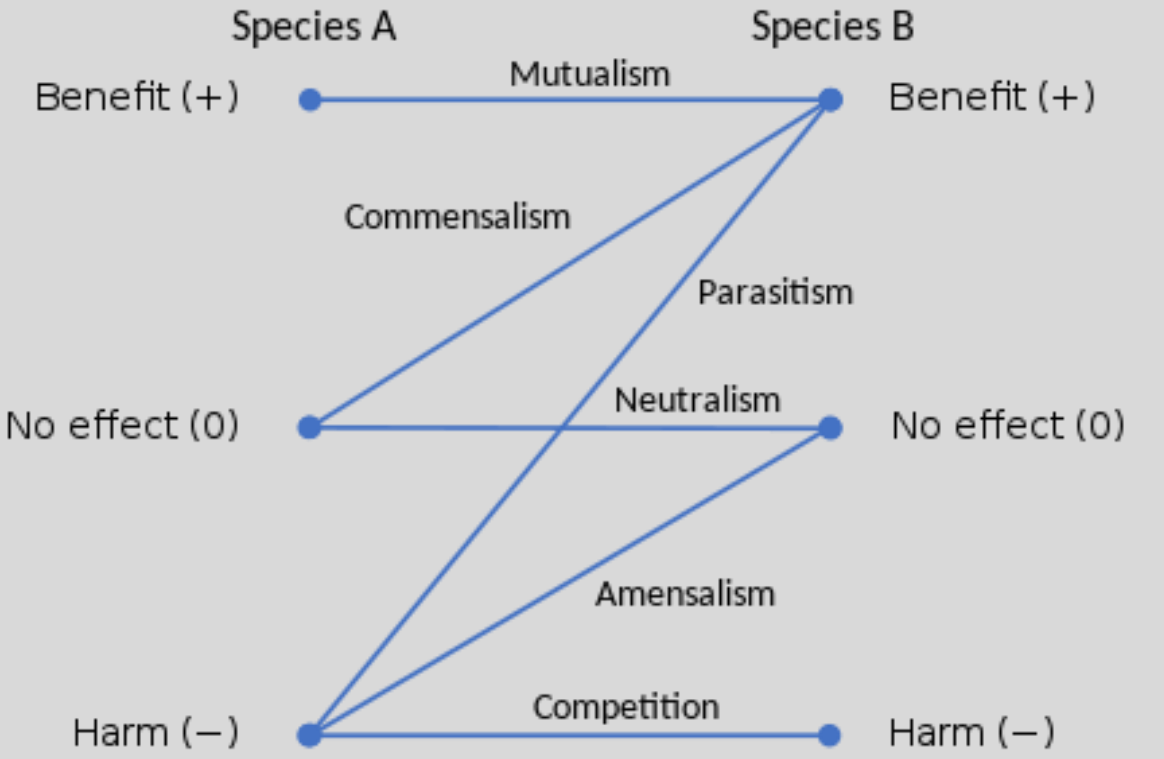


Norberg et al. 2019

Limitations of traditional SDMs

The realized niche of an individual (and more broadly a species) can be influenced by far more than just its associations with the environment.

Species Interactions



Limitations of traditional SDMs

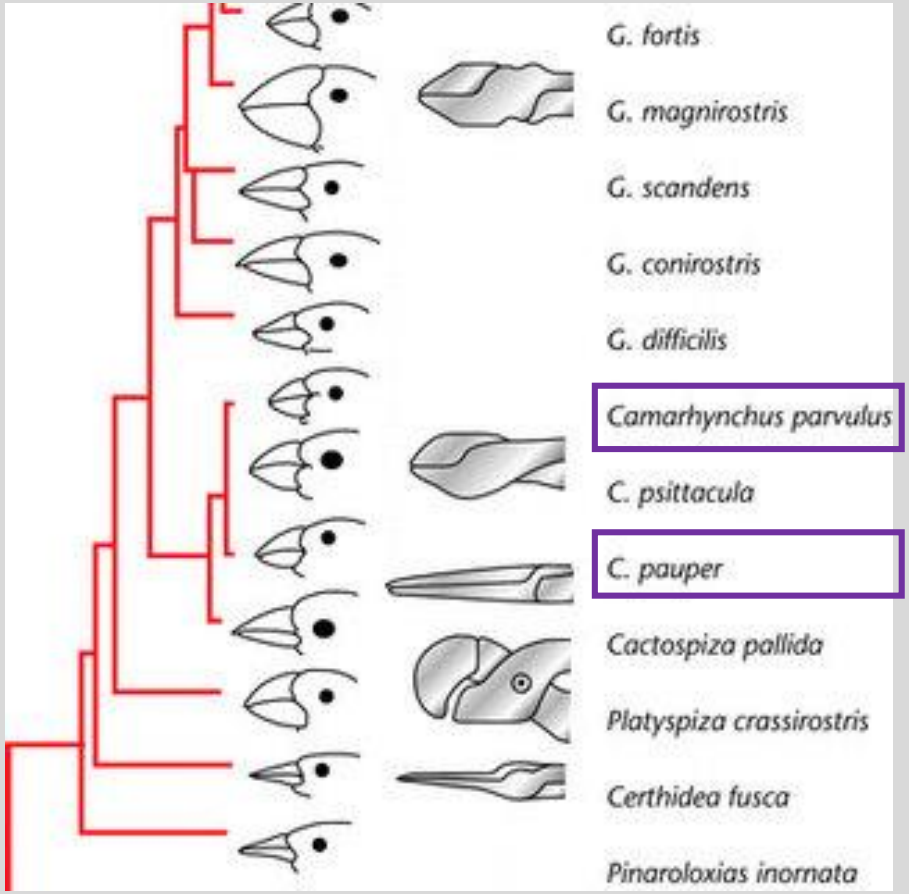
The realized niche of an individual (and more broadly a species) can be influenced by far more than just its associations with the environment.

Dispersal

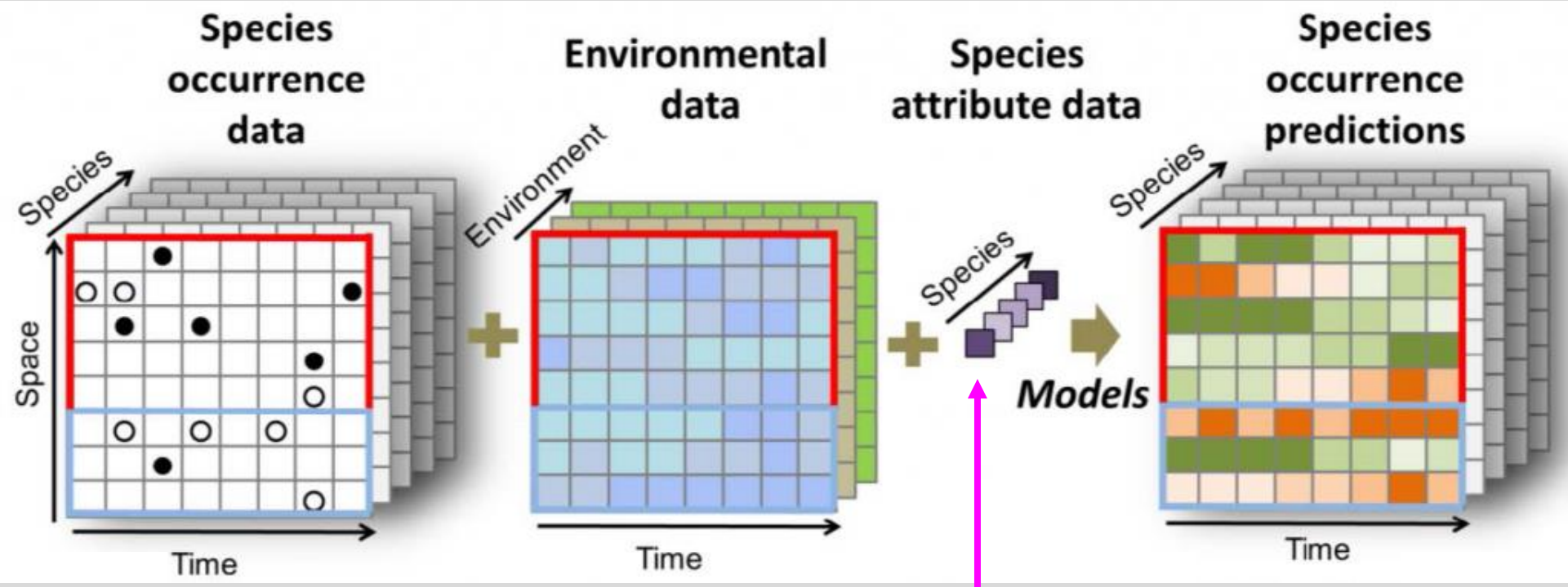
Limitations of traditional SDMs

The realized niche of an individual (and more broadly a species) can be influenced by far more than just its associations with the environment.

Traits
Phylogeny



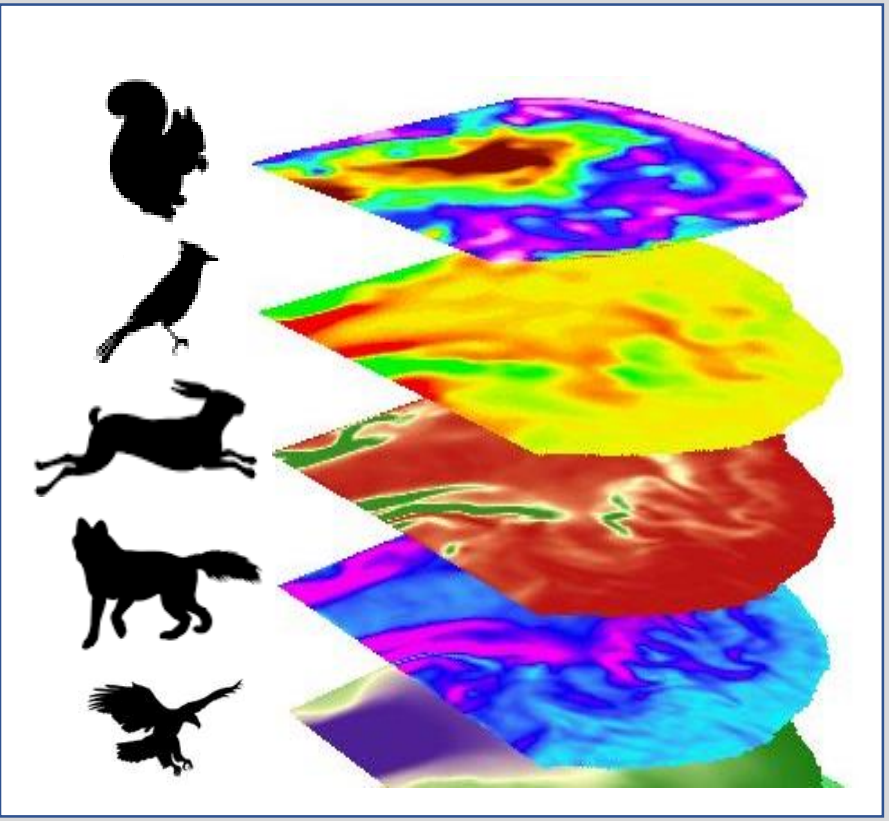
Joint Species Distribution Models (JSDMs)

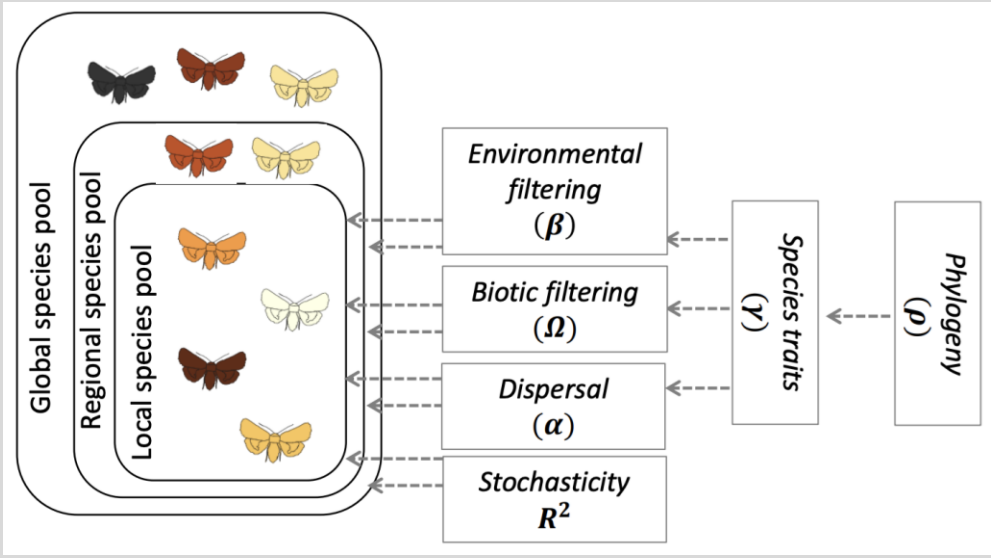


Dispersal
Traits
Phylogeny

Stacked SDMs vs. JSDMs

Stacked SDMs vs. Joint SDMs





Hierarchical Modelling of Species Communities

Corvus monedula, Western Jackdaw

Hmsc package in R

Simulated Data

- Linear model
- Presence absence model
- Abundance model

Real World Example
with Finnish birds

Joint Species Distribution Models (JSDMs)

Full functionality of JSDMs:

- Multiple species
- Environmental, trait, and phylogenetic predictors
- Handle hierarchical and spatially structured data
- Explicitly account for stochasticity through variance partitioning

Our introduction:

- Single species
- Environmental predictors only
- Examples with hierarchical and spatially structured data