iDigBio
Integrated Digitized Biocollections

Using museum data for species distribution modeling: The case of plants in Florida

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Niche Modeling: A widespread tool

- PRACTICAL
  - Invasive species
  - Disease
  - Data deficient species
  - Conservation/Land Management
- THEORETICAL
  - Diversity through time
  - Evolutionary and ecological patterns

Modeling the Distribution of Species

- Location information and environmental data
- Software to model the range of each species
- Project onto future climate conditions
- For Florida plants:
  - 1548 plant species (of 4100 species)
  - >511,000 georeferenced points (GPS)
  - Environmental features: temperature, precipitation, soil, etc.

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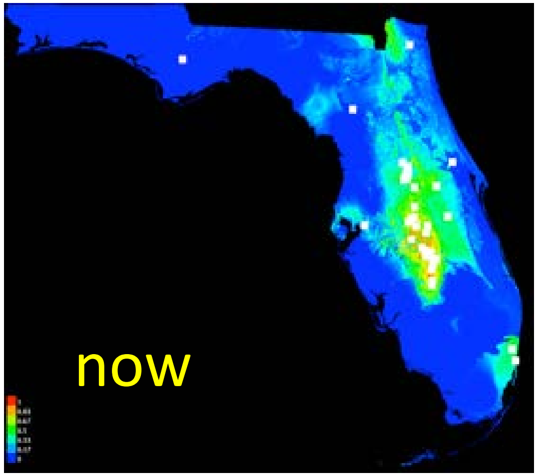
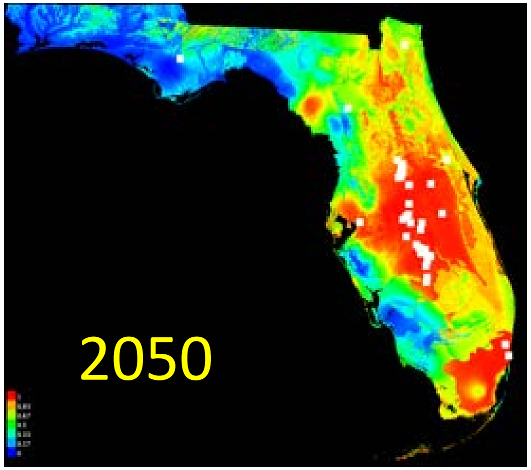
Response to Climate Change

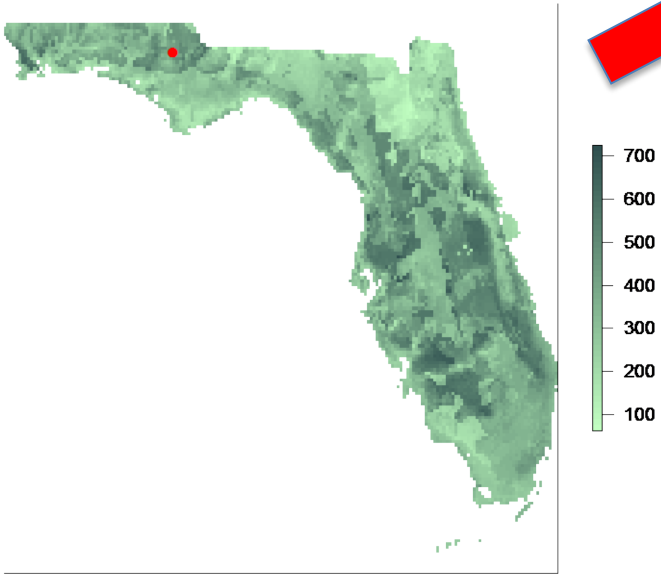
Prunus geniculata (scrub plum) – Lake Wales Ridge

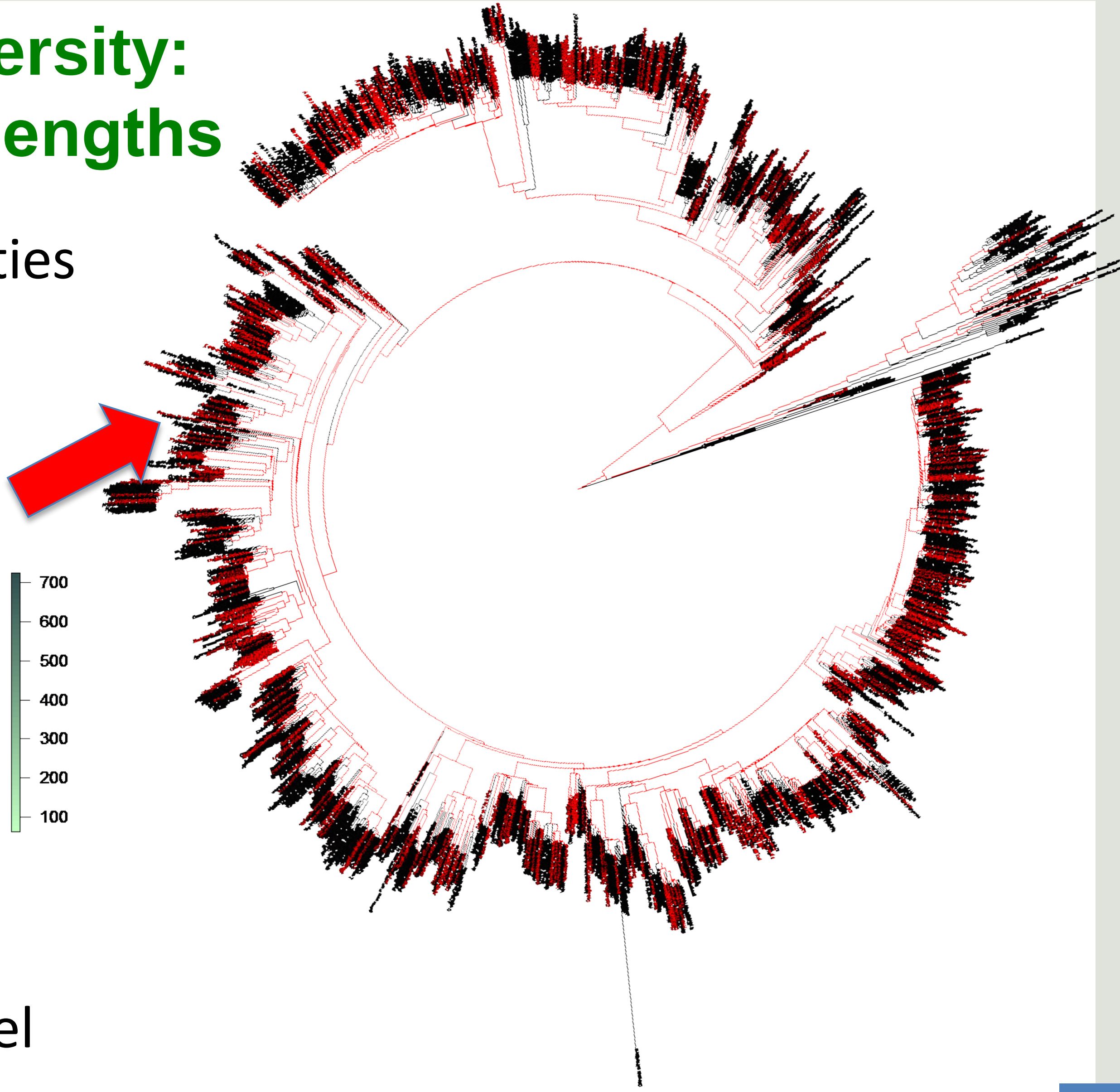




Phylogenetic Diversity: ≈ sum of branch lengths

8,045 pixels/communities
16 km^2 per pixel





Species list at each pixel generated from ENMs

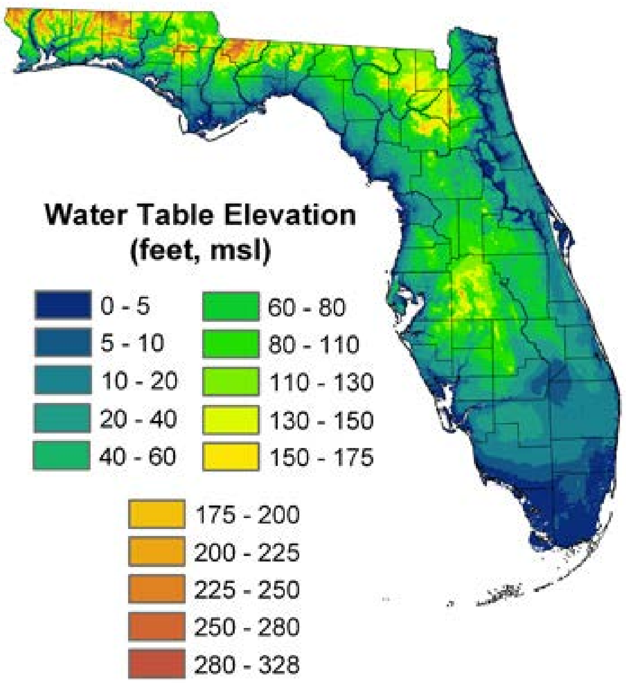
How does MaxEnt work?

- Uses presence only
- Using Maps:
  - Extract values from environmental layers
  - Creates background points as pseudo-absences
- Using Values:
  - You can feed MaxEnt the environmental values for each point
  - Allows one to extract values from different maps/inputs

Parameters to explore:

1. Using **yearly climate data** from time of collection to improve niche models using museum specimens
2. Using **reduced area** to train the models
3. **Smoothing response curve** to mimic more realistic response of organism
4. Using **fewer background points** to increase computing efficiency

Florida


Water Table Elevation
(feet, msl)
0 - 5
5 - 10
10 - 20
20 - 40
40 - 60
60 - 80
80 - 110
110 - 130
130 - 150
150 - 175
175 - 200
200 - 225
225 - 250
250 - 280
280 - 328

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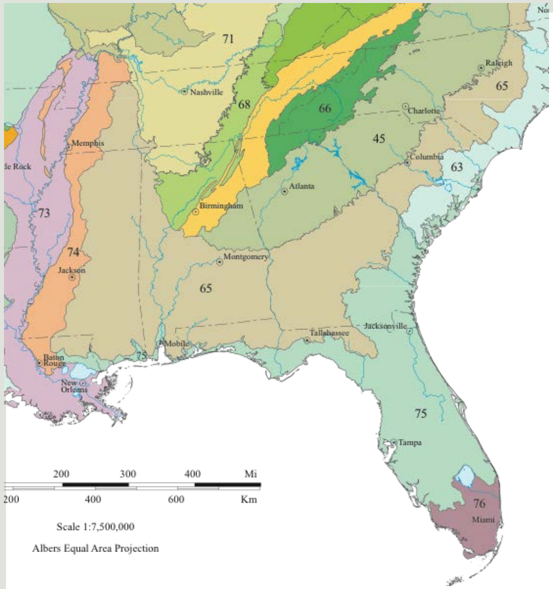
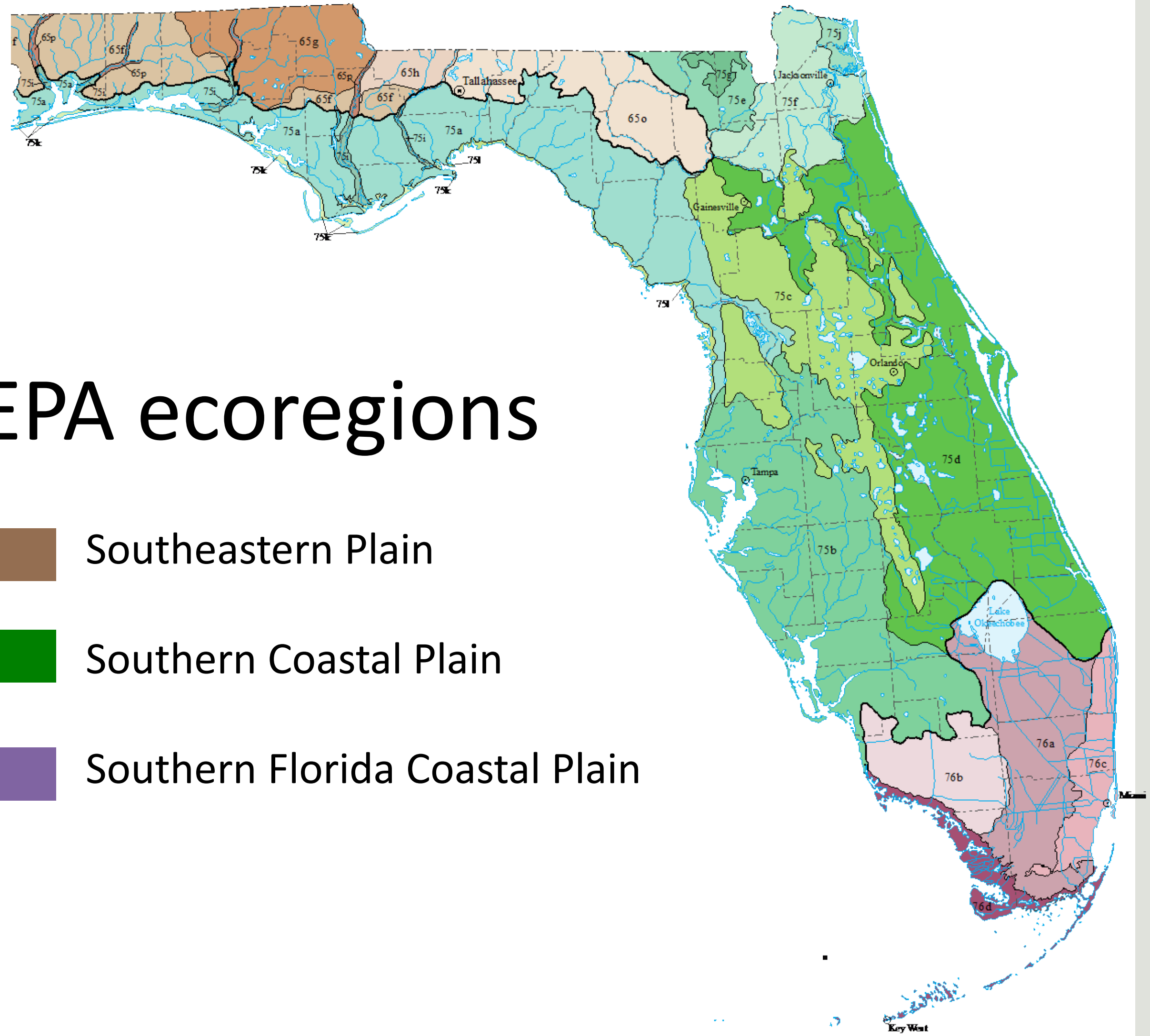
Florida





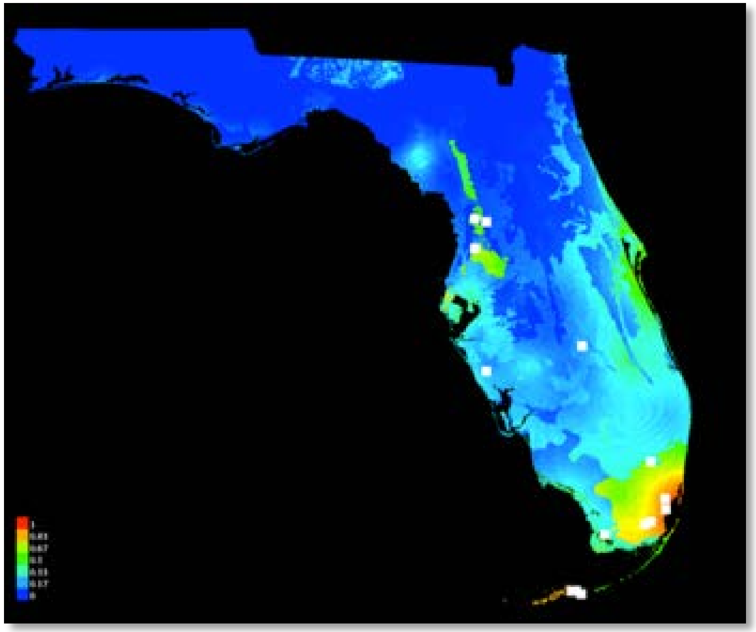
EPA ecoregions

- Southeastern Plain
- Southern Coastal Plain
- Southern Florida Coastal Plain

~ 4,100 plant species

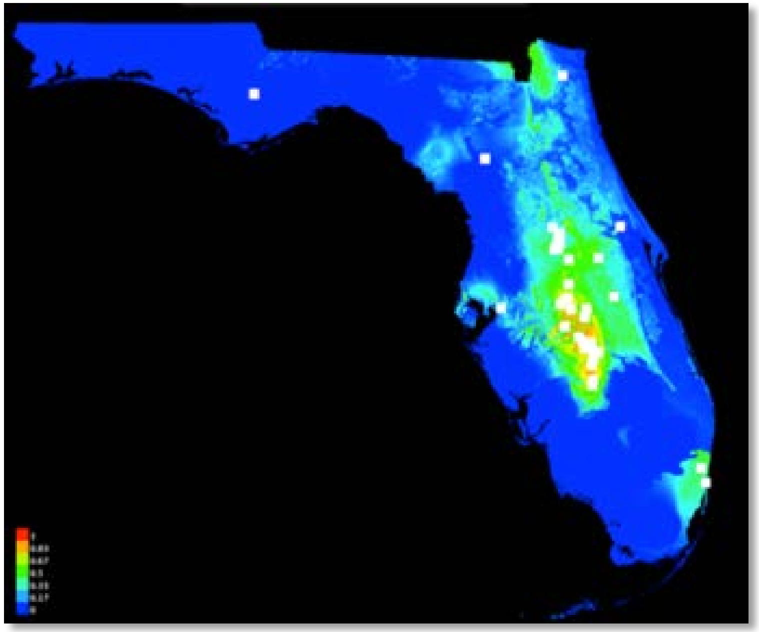
Flatspike Sedge

Abildgaardia obovata

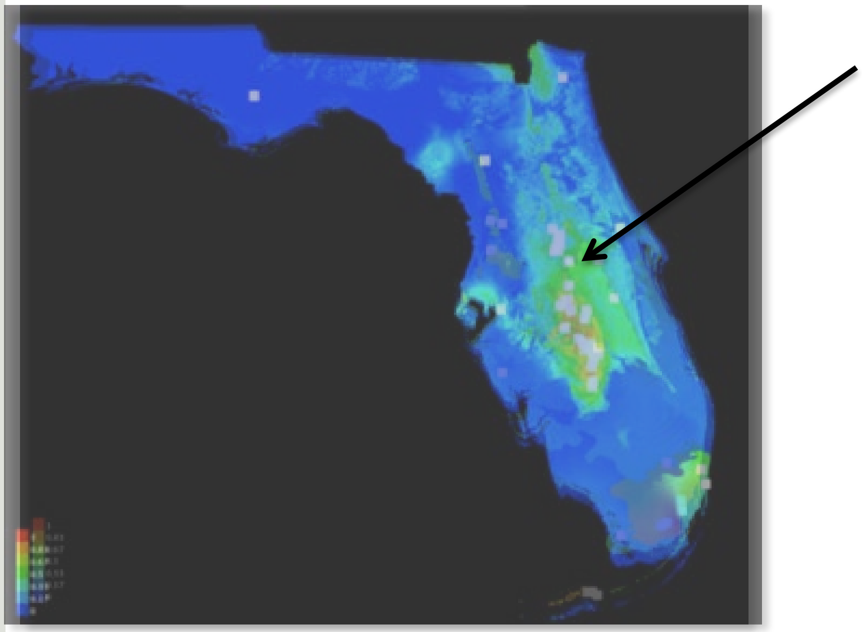


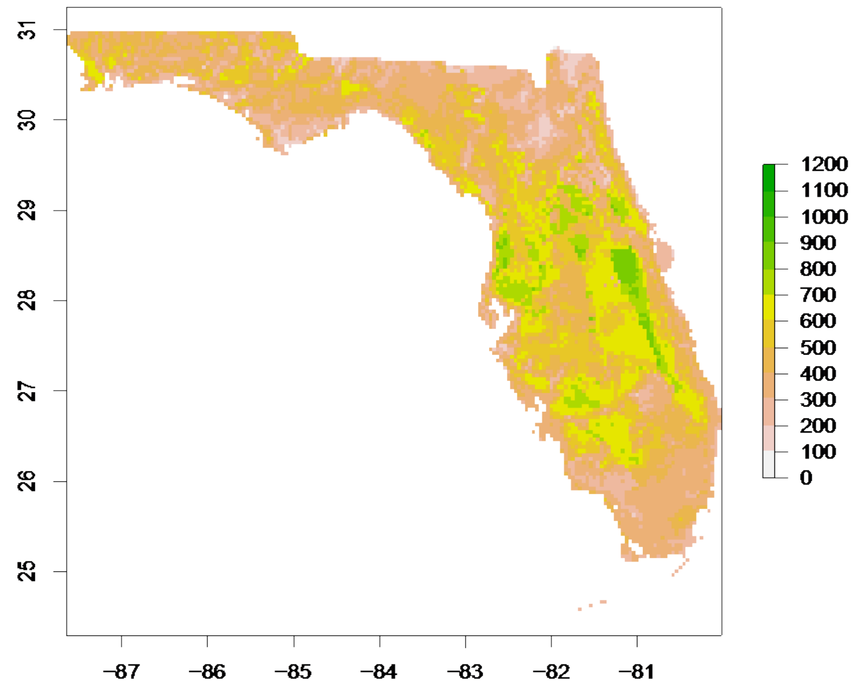
Scrub Plum

Prunus geniculata



What species are predicted to reside in this point?





Species Distribution Modeling

- Reconstructing species distributions
  - museum specimens
  - long-term monitoring data
  - *to generate ranges for use in biodiversity and PD analyses*

- Sampling in 3 EPA regions present in FL

- Taxonomic Name Resolution

- >30 points per species (10-20 for rare endemics)

  372,241 unique points

1,145 species models (30%)

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Using Yearly Climate Data to reconstruct a species niche

- Dated (year)
- Reflect distribution of plants through recent history
- Can use the climate conditions at the time of collection
- Use PRISM monthly data
  - Reconstruct Bioclim layers for each year of collection
    - ➢ Run MaxEnt model

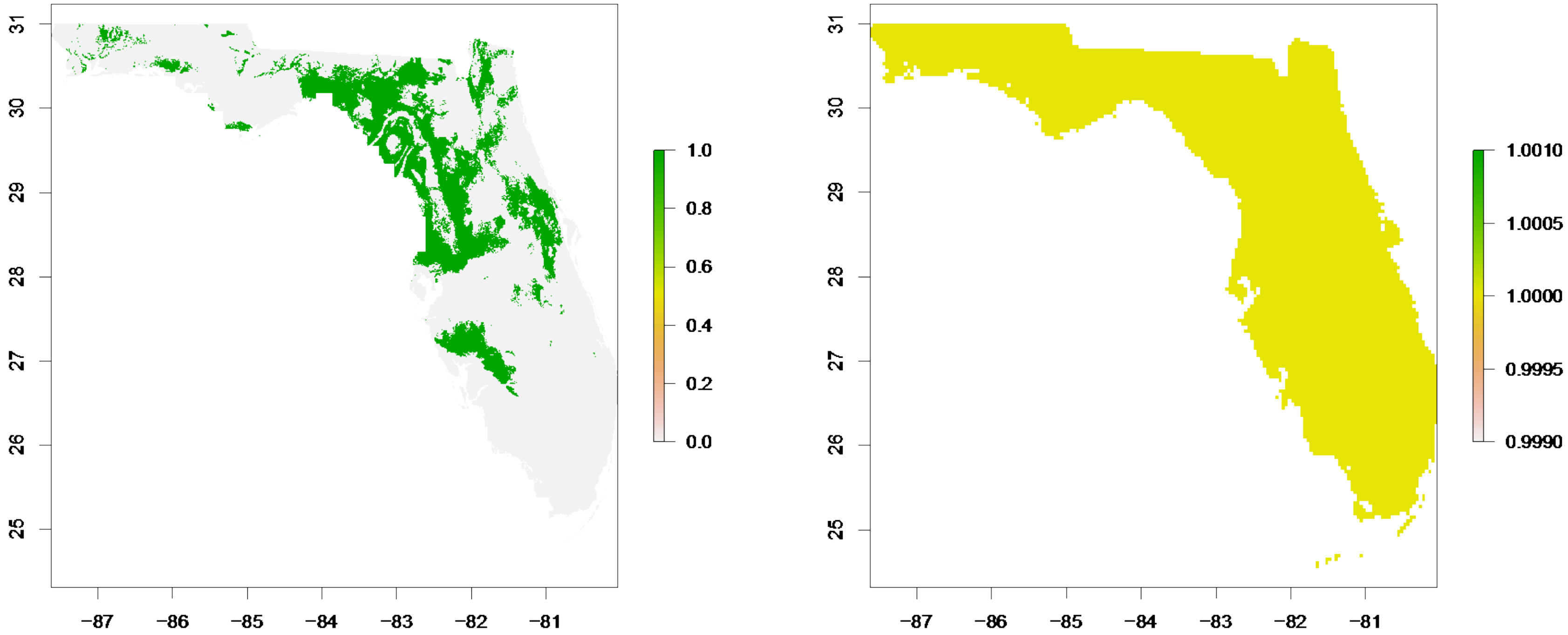
Collections: The Library of Life

>1600 natural history collections
in the US alone
1-2 billion specimens in the US
3-4 billion specimens worldwide

Long-lived species

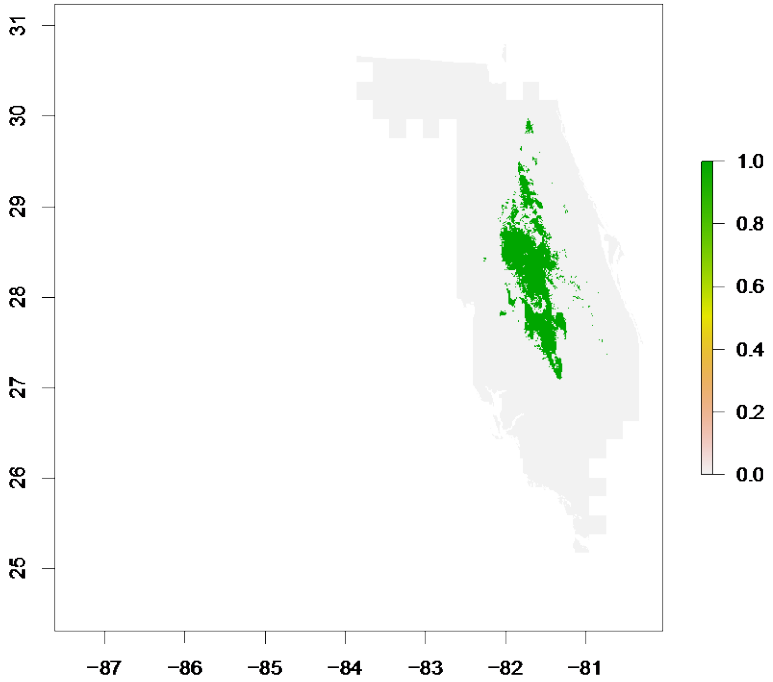
Average Climate

Yearly Climate

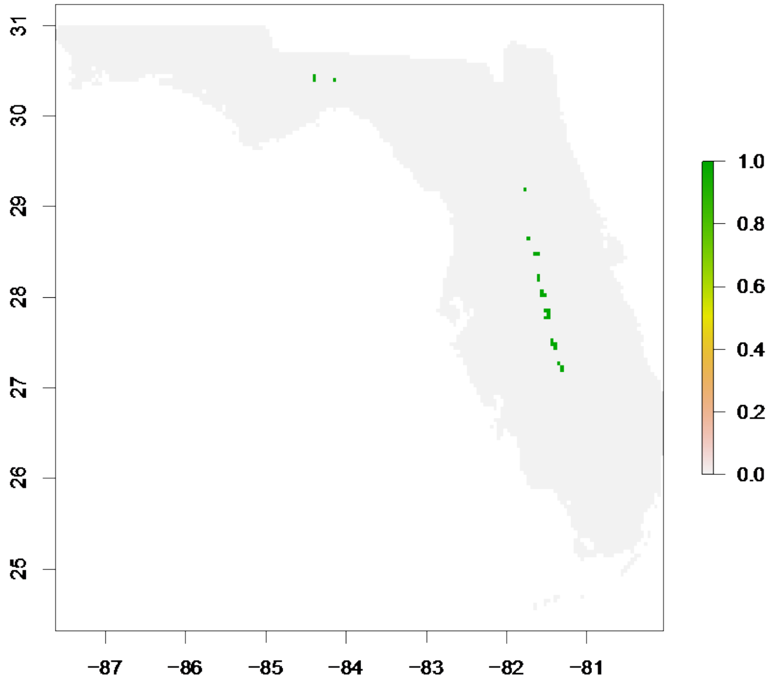


Short-lived narrow species

Average Climate



Yearly Climate



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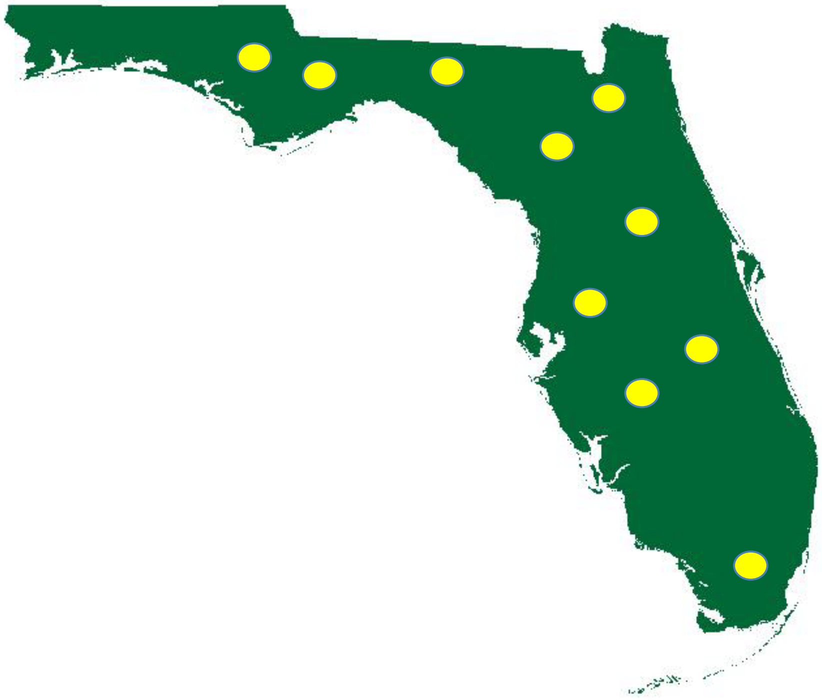
Selecting an area to train the model

- Limiting the area in which the model trains
- If you want to recover suitable niche
  - – Include an area where biotic interactions might be excluding the species
    - Large mask
- If you want to recover species distribution
  - – Consider abiotic factors as part of the limiting factor
  - – Delimit mask from presence points
    - Tighter mask

Selecting a meaningful area to train the model

NO mask

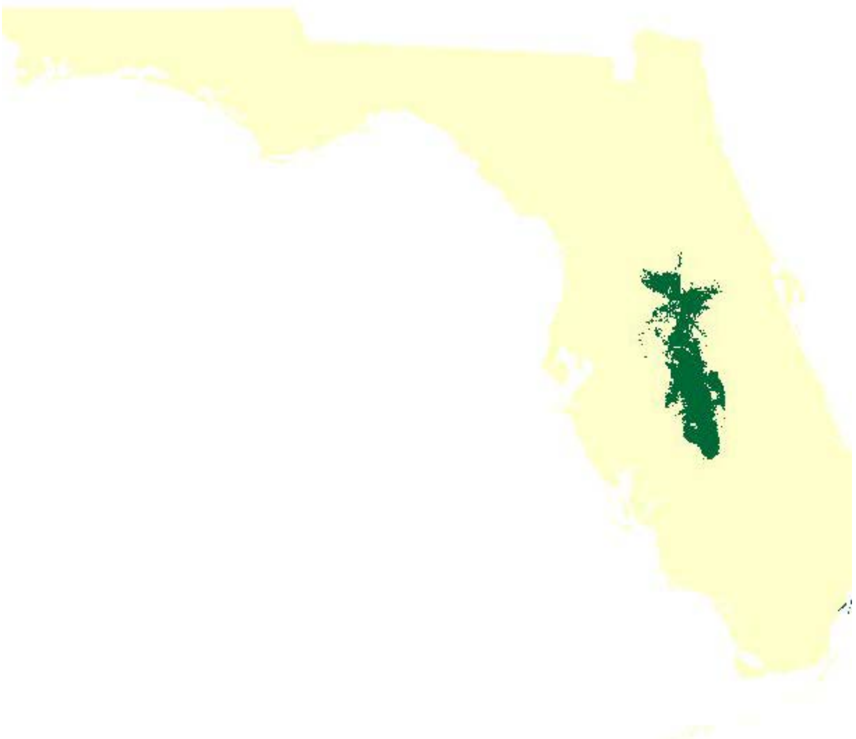


WITH mask

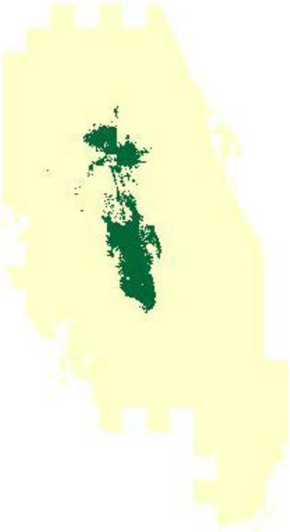
Prunus geniculata

Credit: fws

NO mask

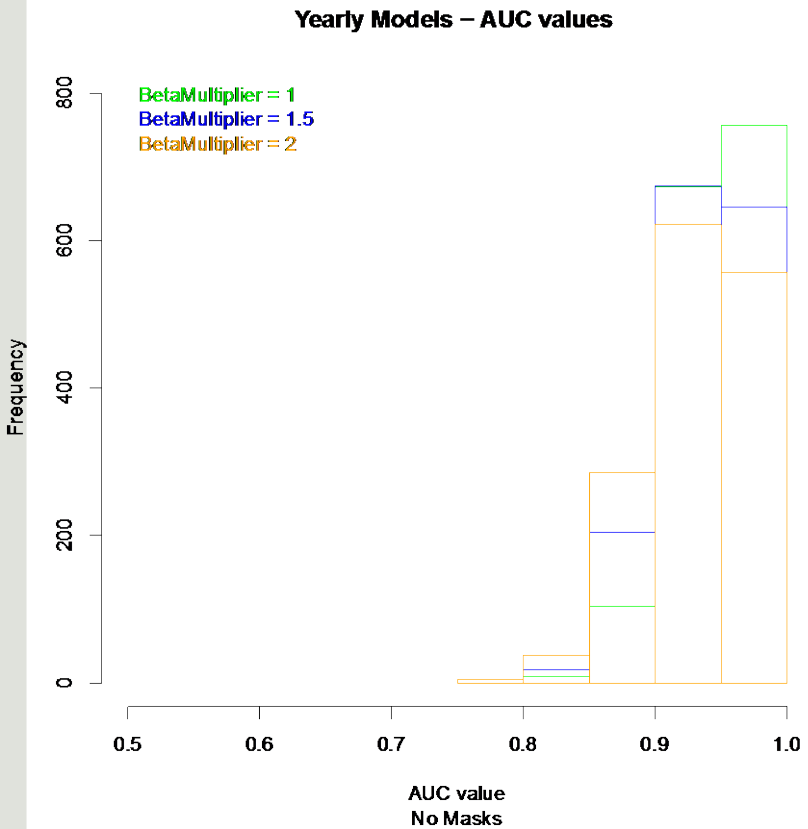


WITH mask

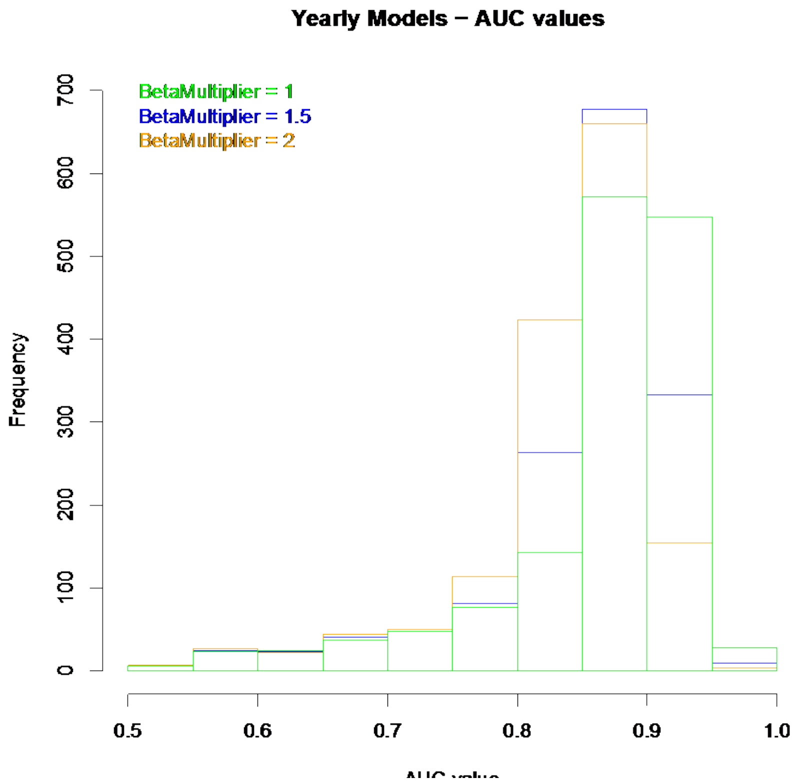


AUC scores

NO MASKS



MASKS



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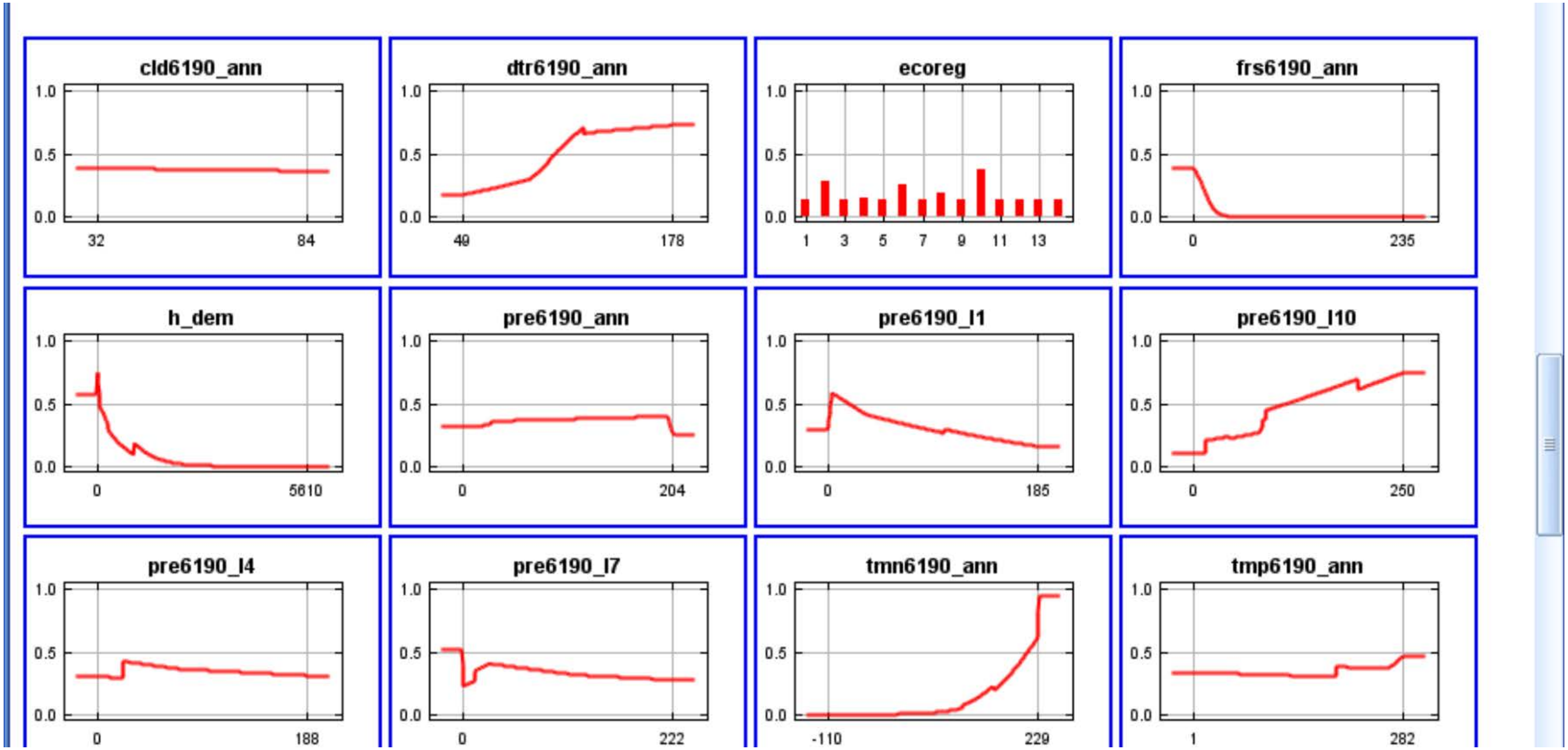
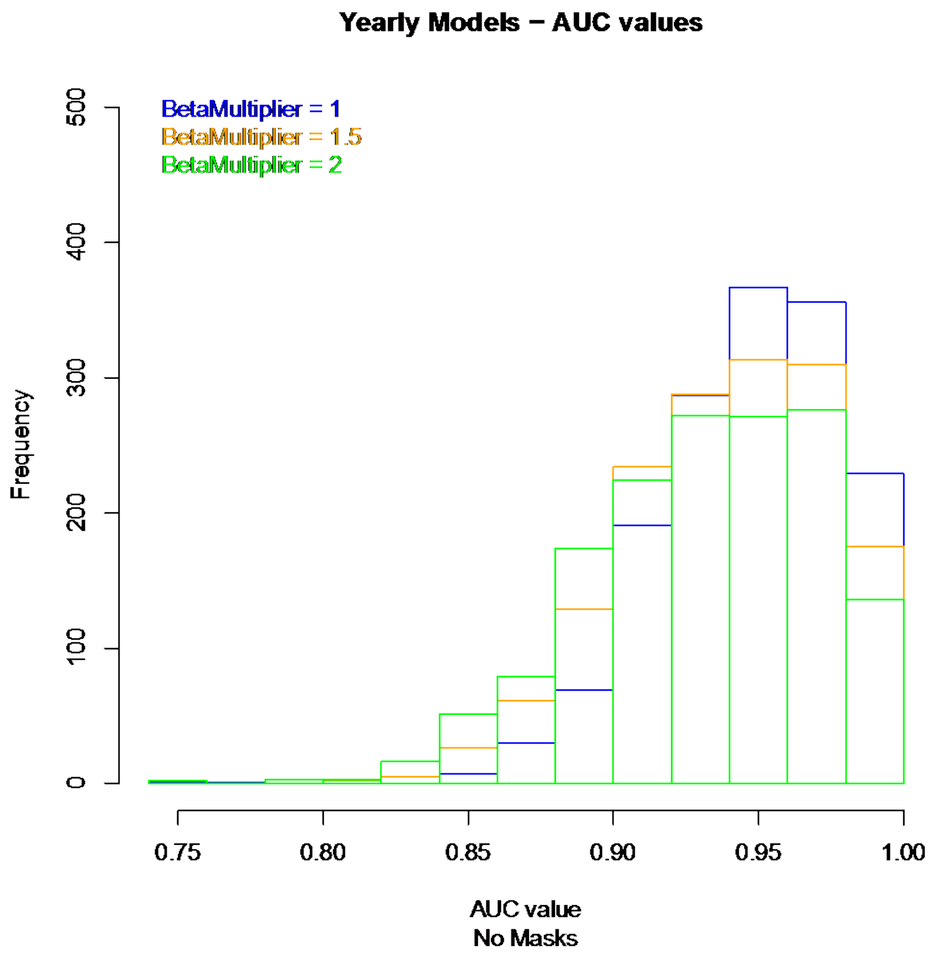
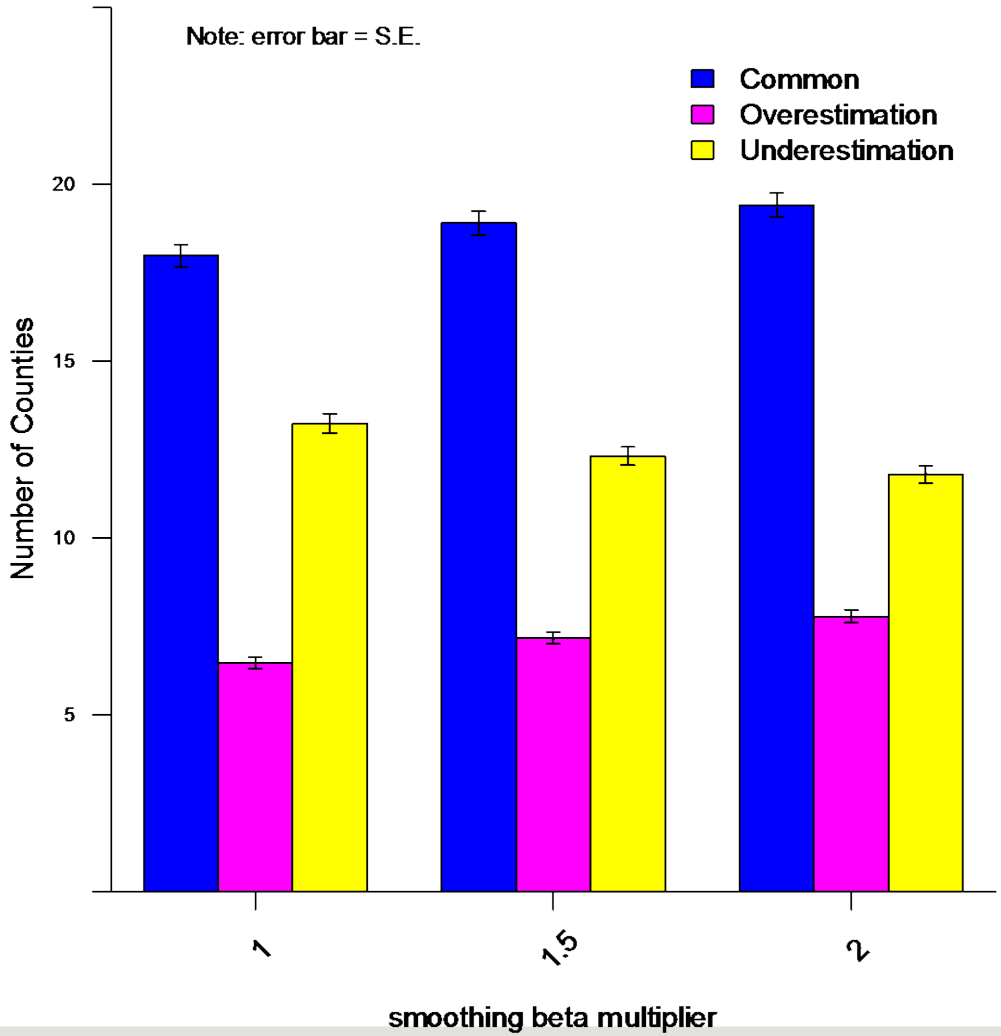
Beta parameter: smoothing environmental response



AUC values for different beta



Model performance



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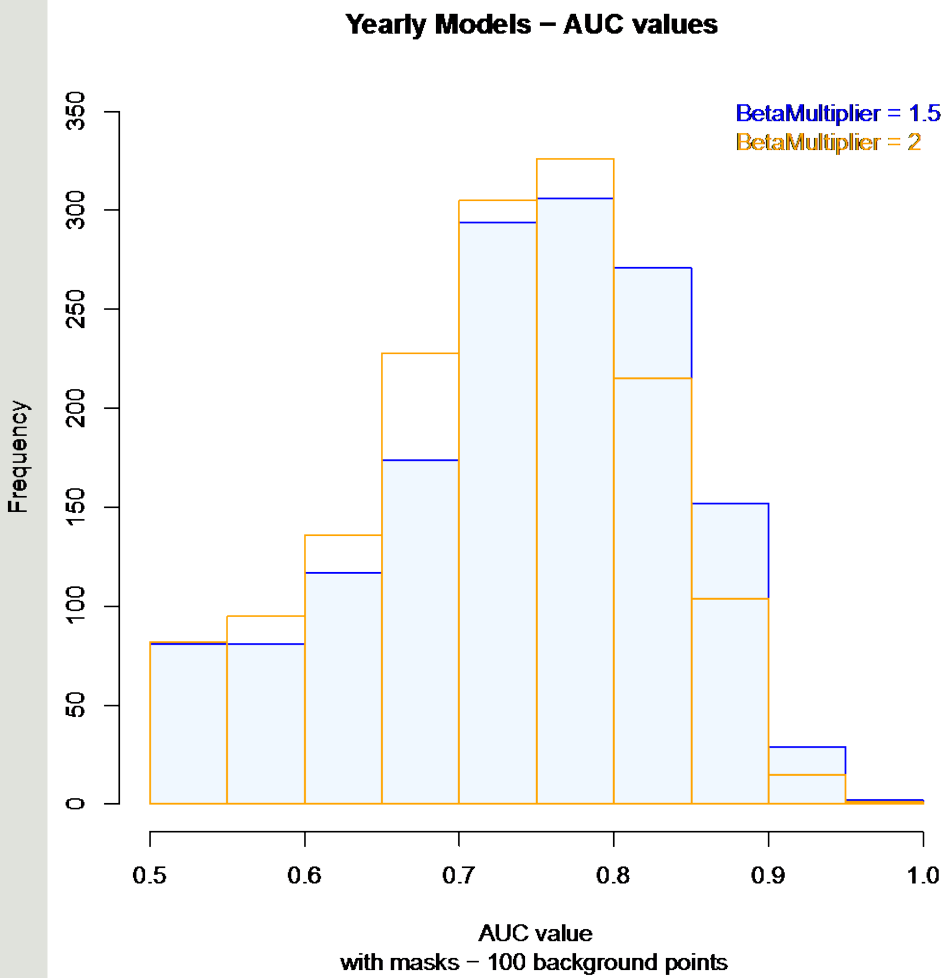
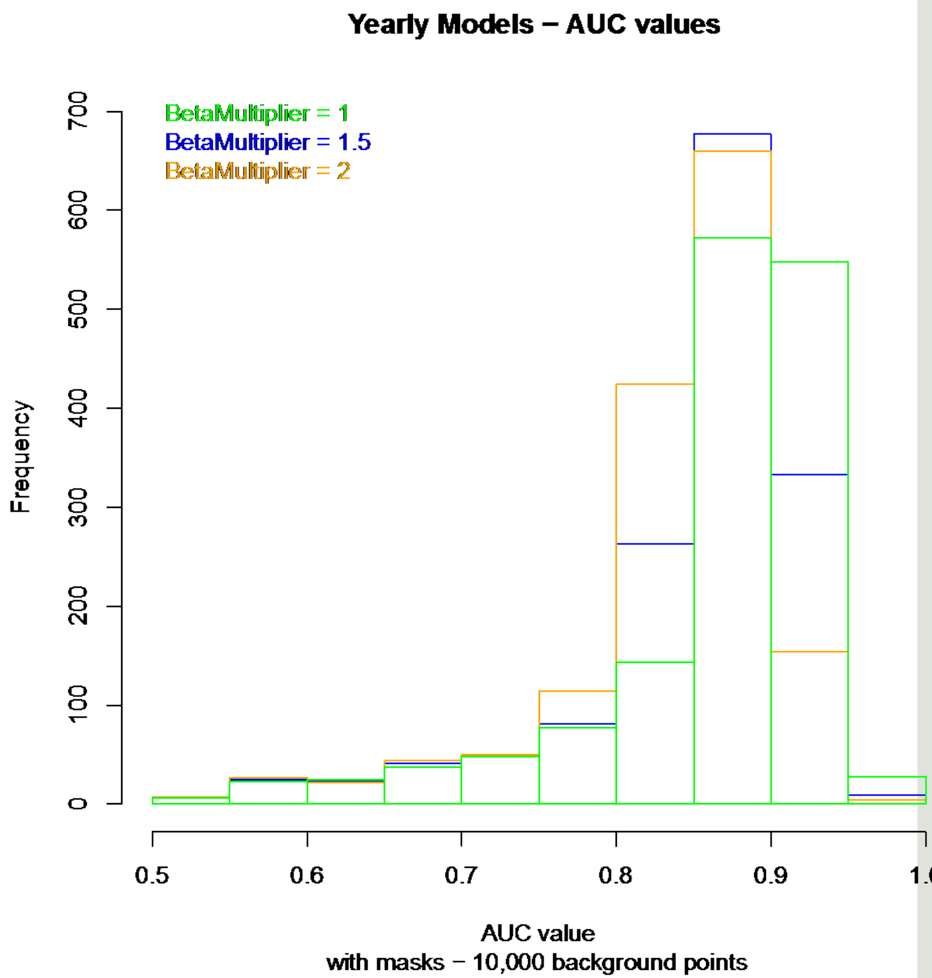
Importance of the number of background points

- Pseudo absences are ‘soft’ absences:
  - for the evaluation of the model
  - not the fitting
- Fewer background points
  - assign a higher probability to each cell
  - Hard to distinguish regions of high probability
- Large number of background points is computationally more demanding

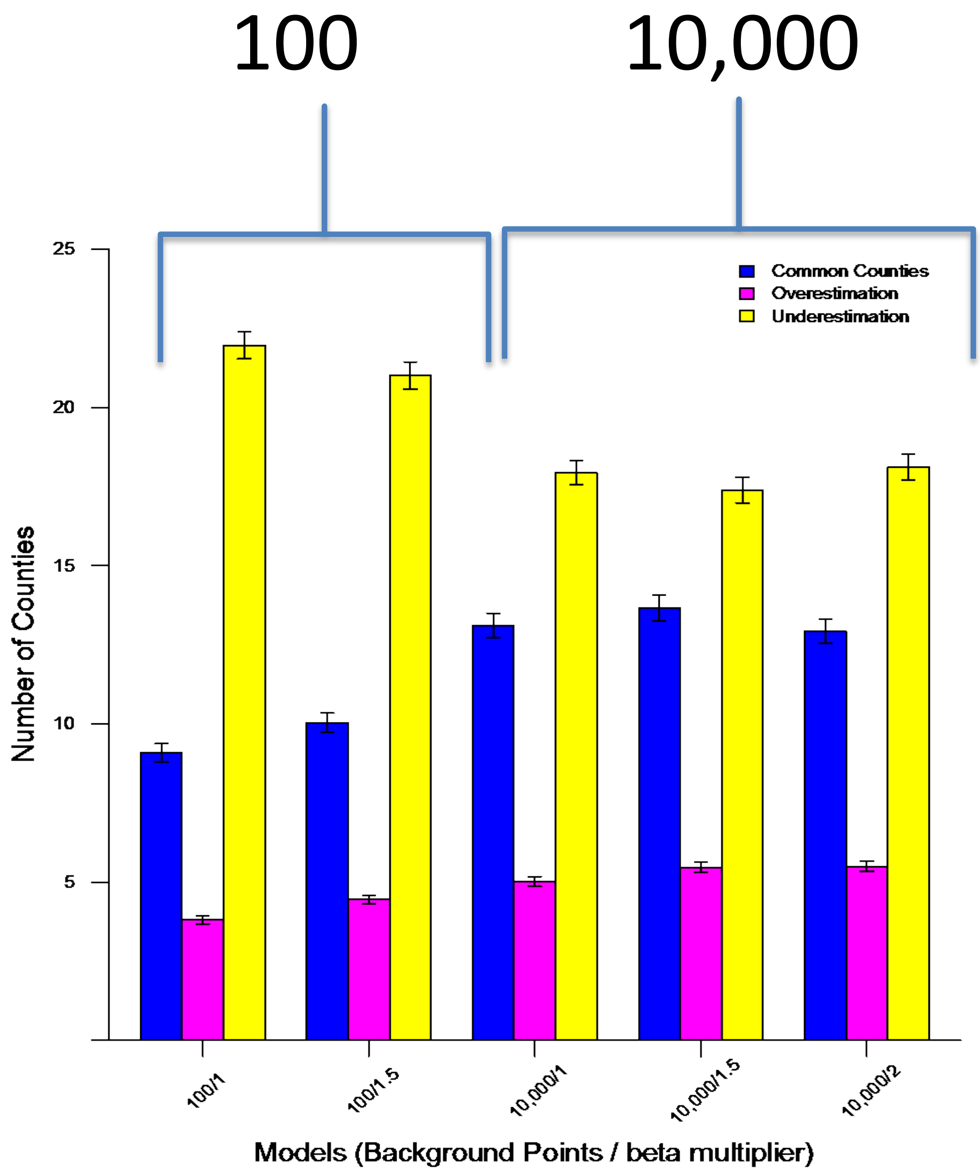
AUC



Yearly Models – AUC values
BetaMultiplier = 1.5
BetaMultiplier = 2
Frequency
0
50
100
150
200
250
300
350
0.5
0.6
0.7
0.8
0.9
1.0
AUC value
with masks – 100 background points



Yearly Models – AUC values
BetaMultiplier = 1
BetaMultiplier = 1.5
BetaMultiplier = 2
Frequency
0
100
200
300
400
500
600
700
0.5
0.6
0.7
0.8
0.9
1.0
AUC value
with masks – 10,000 background points



100
10,000
Common Counties
Overestimation
Underestimation
Number of Counties
25
20
15
10
5
100/1
100/1.5
10,000/1
10,000/1.5
10,000/2
Models (Background Points / beta multiplier)

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CONCLUSIONS

- Yearly Climate Data:
  - Annual, small distribution performs better
  - Perennials and/or widespread doesn't
- Use of Masks:
  - Improves models, refines the local delimitation
    - Mask has to be carefully chosen
- Smoothing parameter
  - Test with a subset of species to determine
- Number of background points:
  - Worth the extra time !!!

✧ Think about why you are modeling the species niche (fundamental or realized?)

✧ Beware of statistical performance vs. biological accuracy

THANK YOU !!!!

Atlas of Florida Vascular Plants

Alabama Plant Atlas
Alabama Herbarium Consortium
& The University of West Alabama

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