Spatially continuous identification of beta diversity hotspots using species distribution models

Gabriel Dansereau[1,2,3]

[1]Université de Montréal

[2]BIOS[2]

[3]Quebec Center for Biodiversity Science

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bios[2]

CENTRE DE LA SCIENCE DE LA BIODIVERSITÉ DU QUÉBEC

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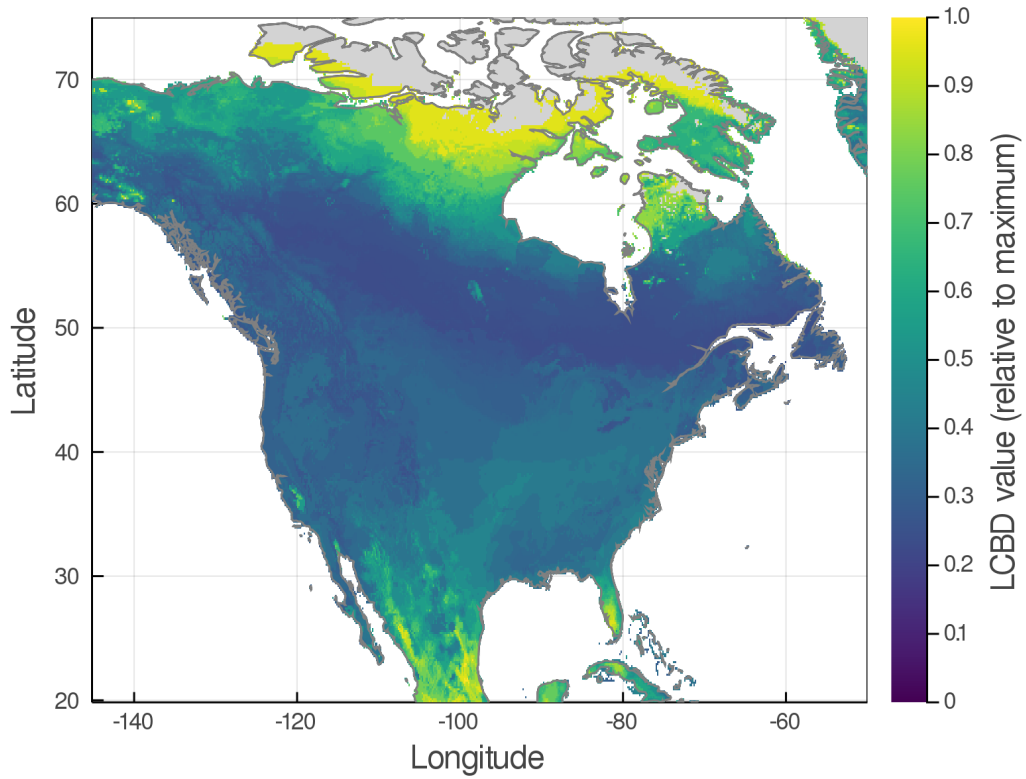
Fonds de recherche Nature et technologies Québec

Objective

Bring together 2 elements:

1. Identification of beta diversity hotspots → LCBD calculation
2. Species distribution modelling on continuous scales → SDMs



Why continuous scales?

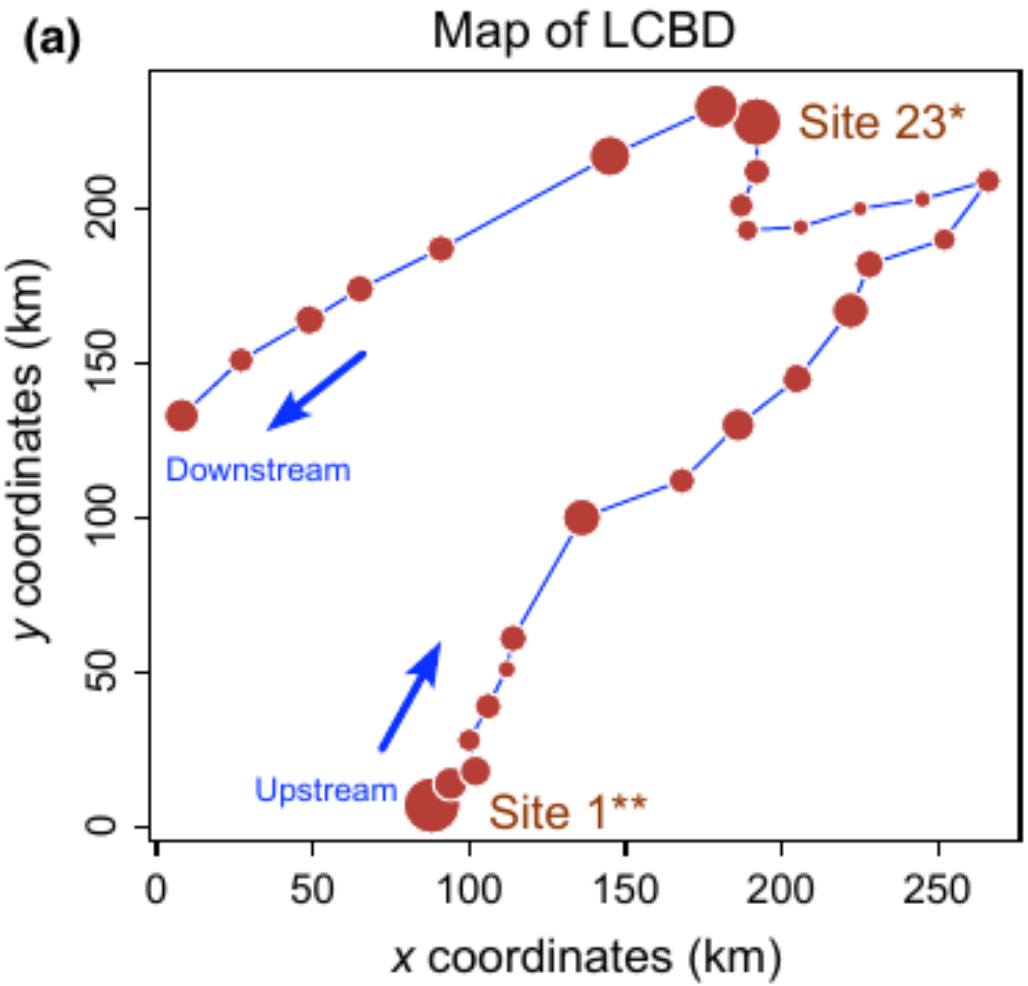


Figure 1: Example of discontinuous LCBD calculation along a river stream (Legendre & De Caceres, 2013)

Why continuous scales?

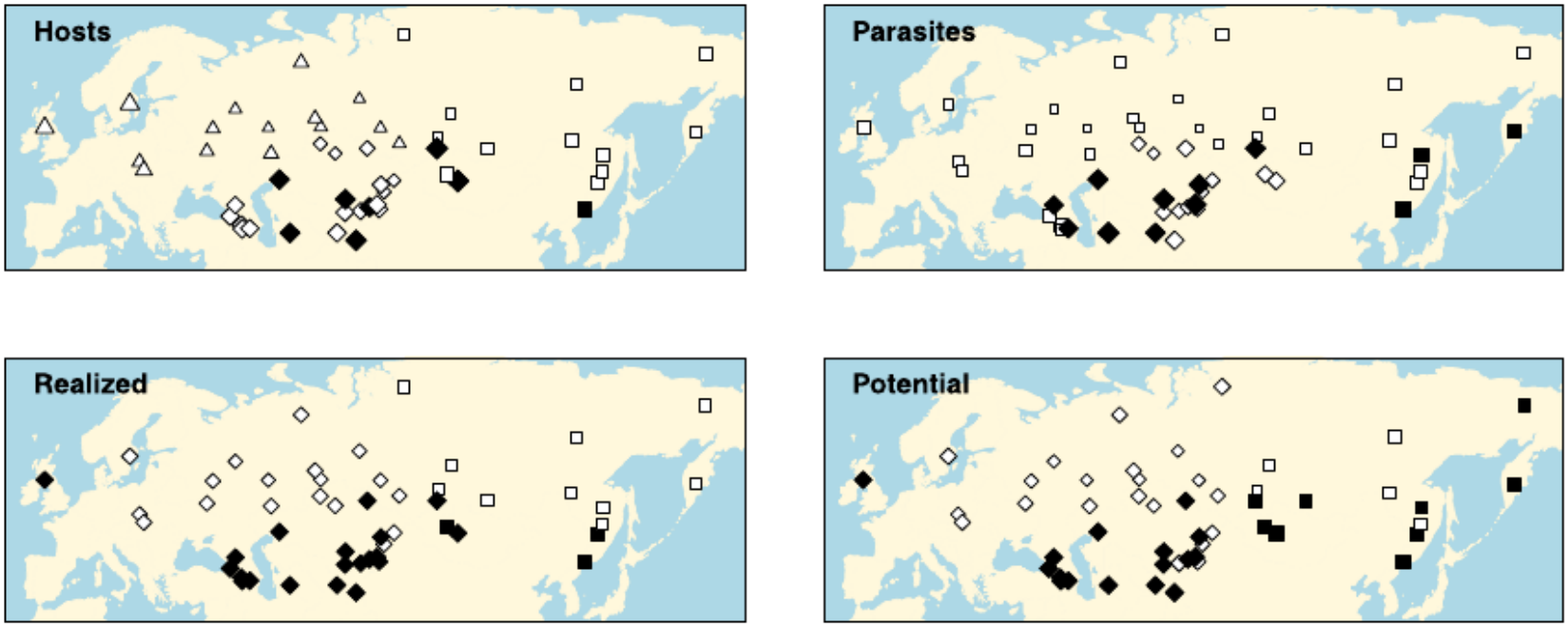


Figure 2: Example of discontinuous LCBD calculation on an extended scale (Poisot et al., 2017)

Why continuous scales?

- Online data increasingly accessible
- Potential for novel ecological insights

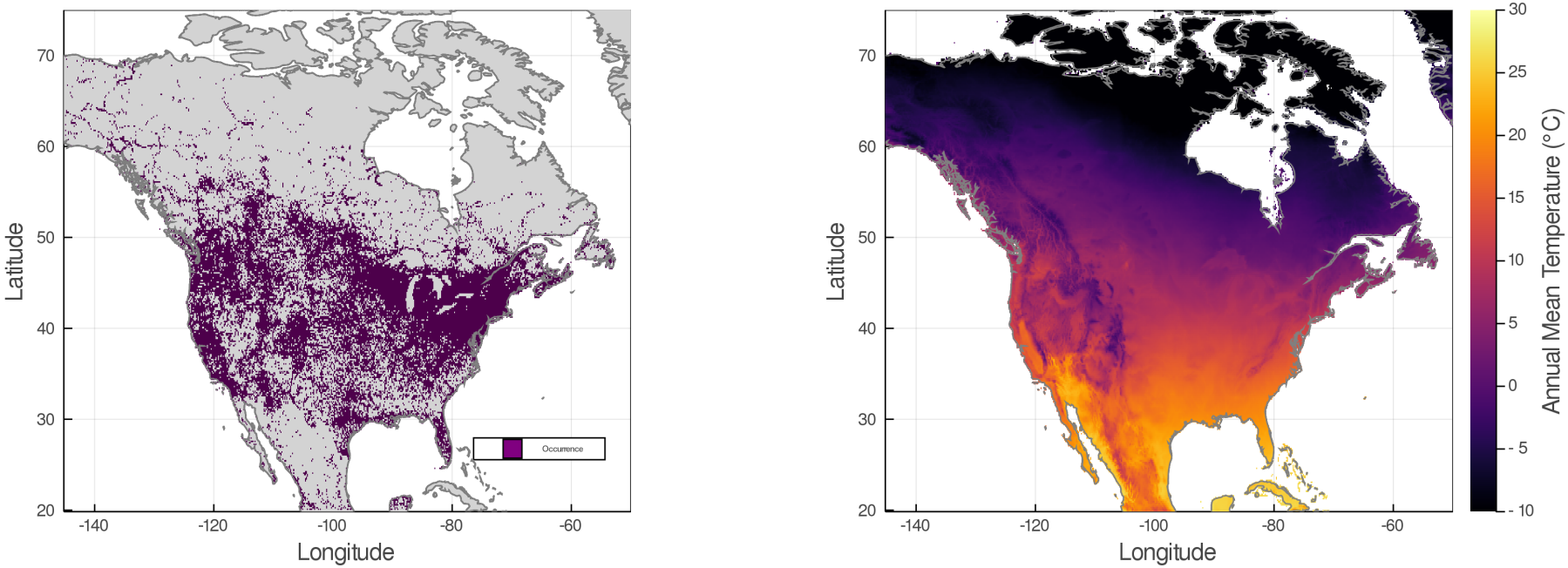
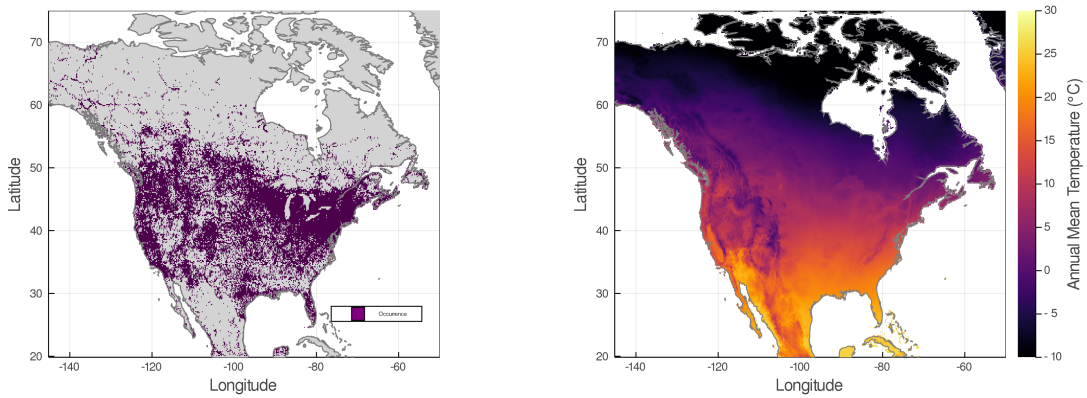
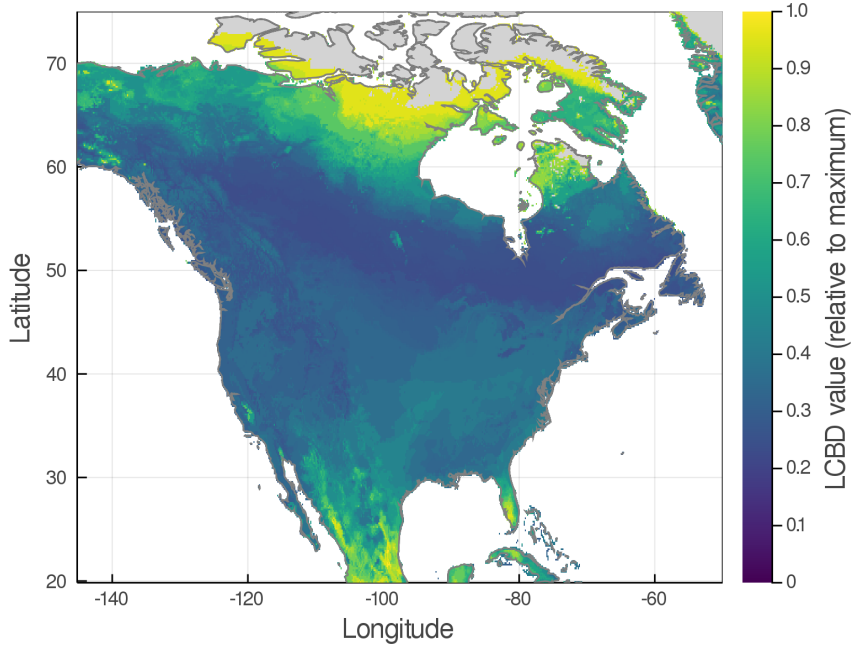


Figure 3: Example of Yellow Warbler occurrence data from eBird (left) and annual mean temperature data from WorldClim 2 (right)

Objective


Latitude
Longitude
Occurrence
Annual Mean Temperature (°C)


Latitude
Longitude
LCBD value (relative to maximum)

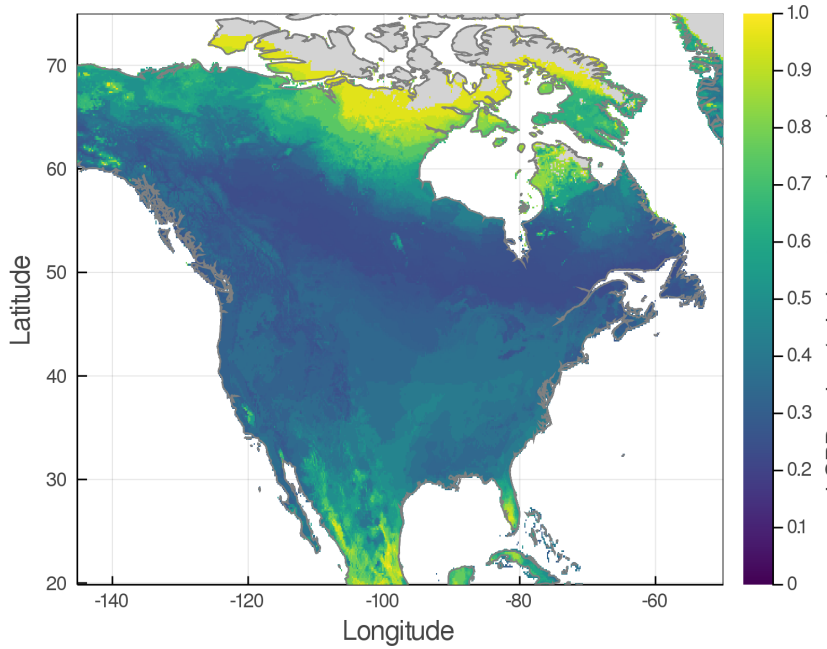
Relevance

Novel ecological insights

- Tool for poorly sampled regions, or with sparse sampling
- Identification of conservation targets

Combination with IPCC climate change scenarios

- Model beta diversity changes
- Identify sites with significant changes



$\Rightarrow$ Reminder: Exploratory analyses for now, insight-oriented approach

Data - Why eBird & Warblers

According to Johnston et al. (2019):

1. Complete checklists to infer absences
2. Sampling effort metadata to reduce biases

Table 1: Structure of the Warblers (*Parulidae*) occurrence data for North America as checklists in the eBird Dataset

Country	Observations	Checklists	Species	Species per checklist (mean)	Species per checklist (median)	Species per checklist (max)
US	19 206 453	7 840 526	56	2.450	2.0	34
CA	3 360 650	1 115 625	45	3.012	2.0	31
MX	407 227	147 599	61	2.759	2.0	21
Total	22 974 330	9 103 750	63	2.523	2.0	34

Data - Why WorldClim 2

- Interpolated climate data
- Global range
- Resolutions from 10 arc-minutes to 30 arc-seconds
- High cross-validation coefficients

Variable	Description
1	Annual Mean Temperature
2	Mean Diurnal Range
3	Isothermality
4	Temperature Seasonality
5	Max Temperature of Warmest Month
6	Min Temperature of Coldest Month
7	Temperature Annual Range
8	Mean Temperature of Wettest Quarter
9	Mean Temperature of Driest Quarter
10	Mean Temperature of Warmest Quarter
11	Mean Temperature of Coldest Quarter
12	Annual Precipitation
13	Precipitation of Wettest Month
14	Precipitation of Driest Month
15	Precipitation Seasonality
16	Precipitation of Wettest Quarter
17	Precipitation of Driest Quarter
18	Precipitation of Warmest Quarter
19	Precipitation of Coldest Quarter

Methods - BIOCLIM

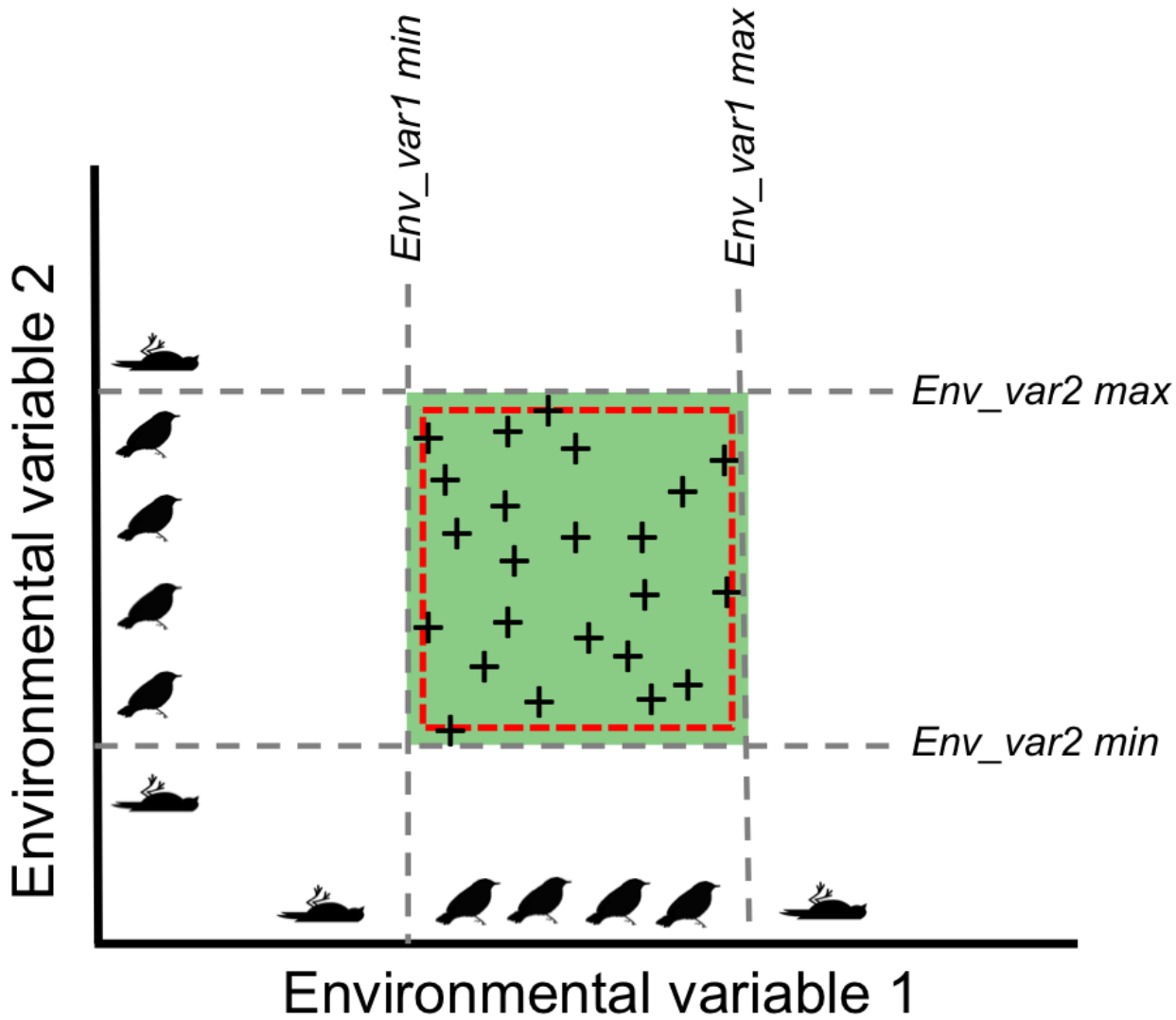


Figure 4: Representation of the climate envelope in the BIOCLIM method[1]

[1] https://support.bccvl.org.au/support/solutions/articles/6000083201-bioclim

Preliminary Results

Single species SDM example

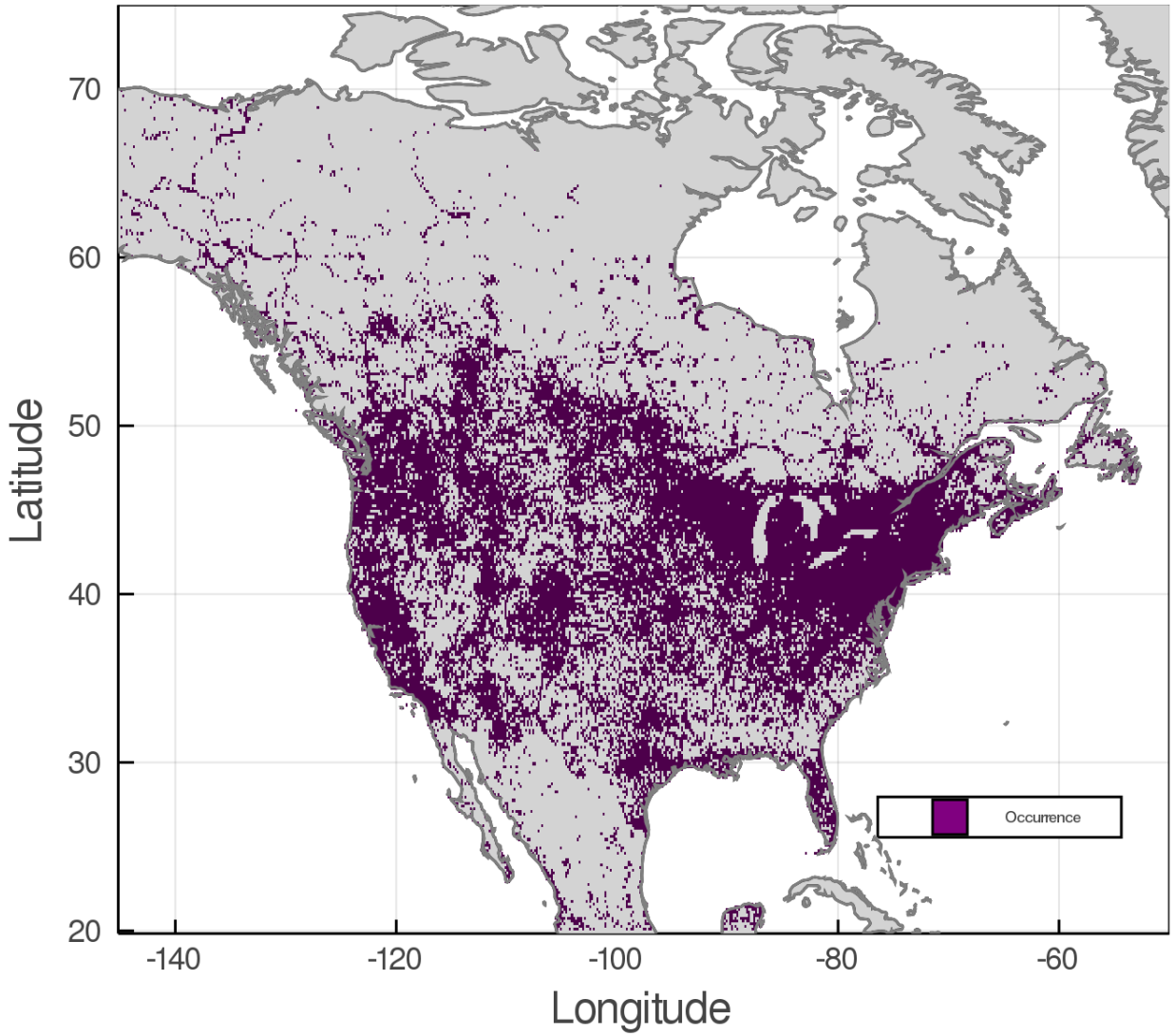


Figure 5: Yellow Warbler Distibution based on the raw data (presence-absence per site)

Single species example - Raw data

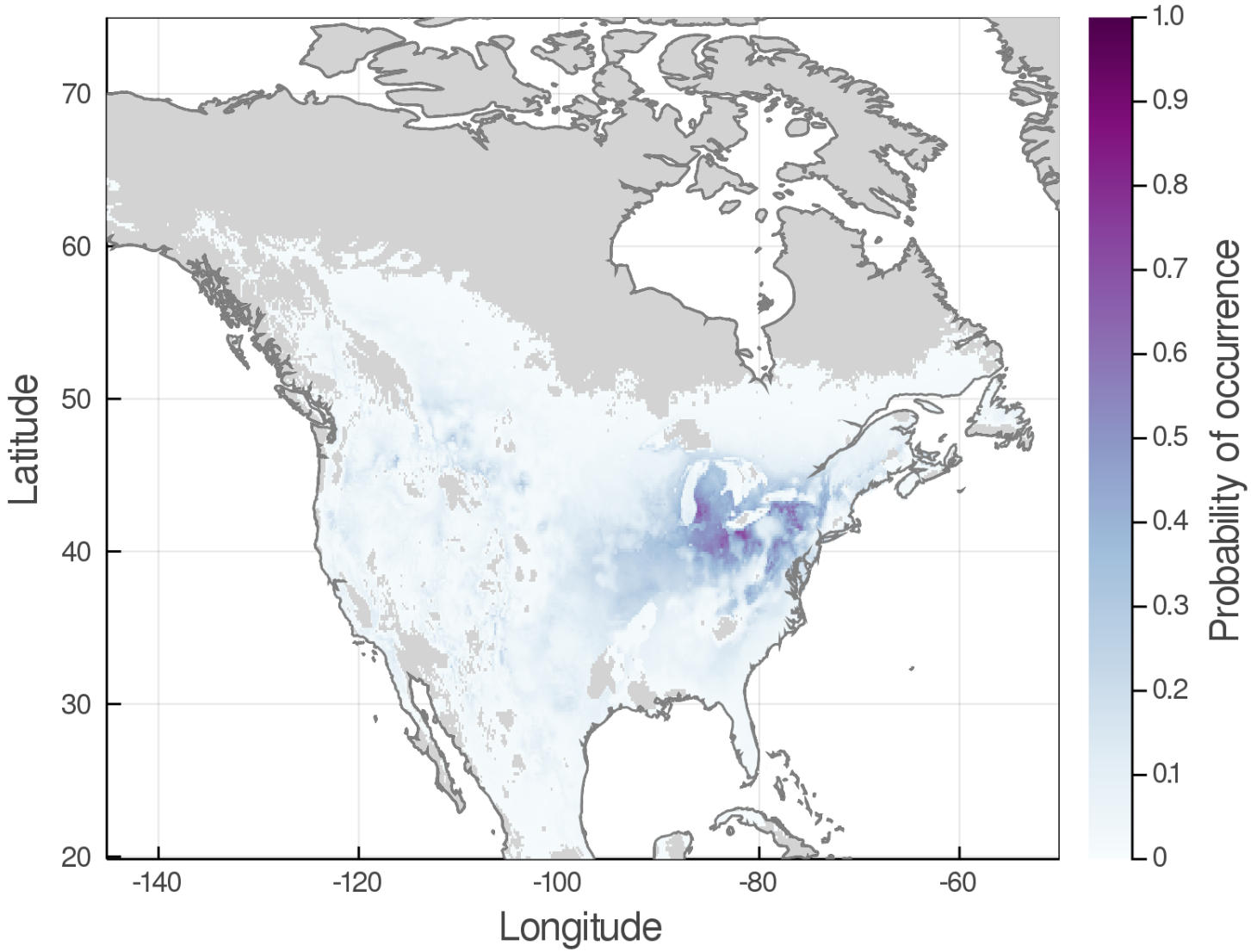


Figure 6: SDM predictions with threshold (5%) for the distribution of Yellow Warblers

Single species example - SDM with threshold

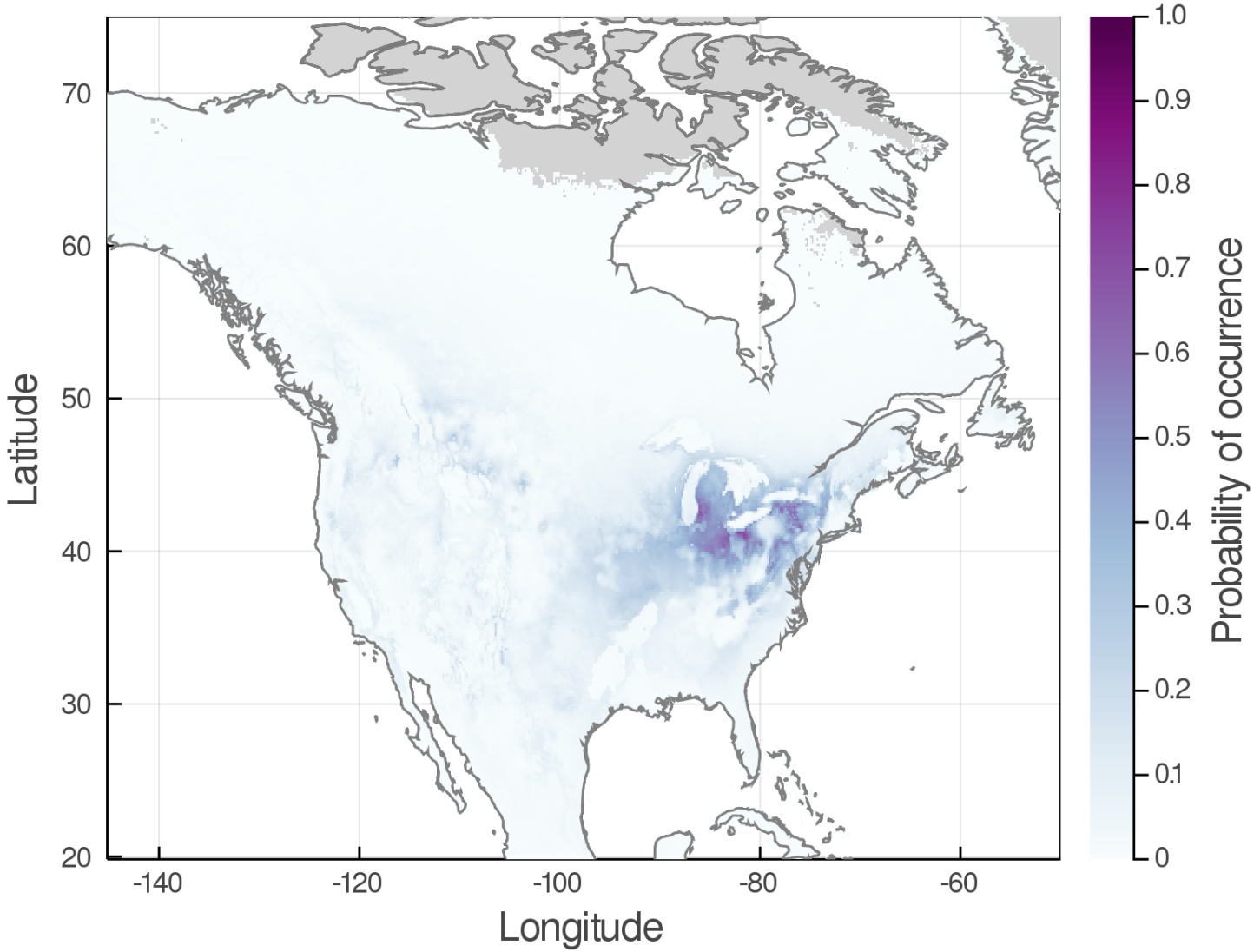
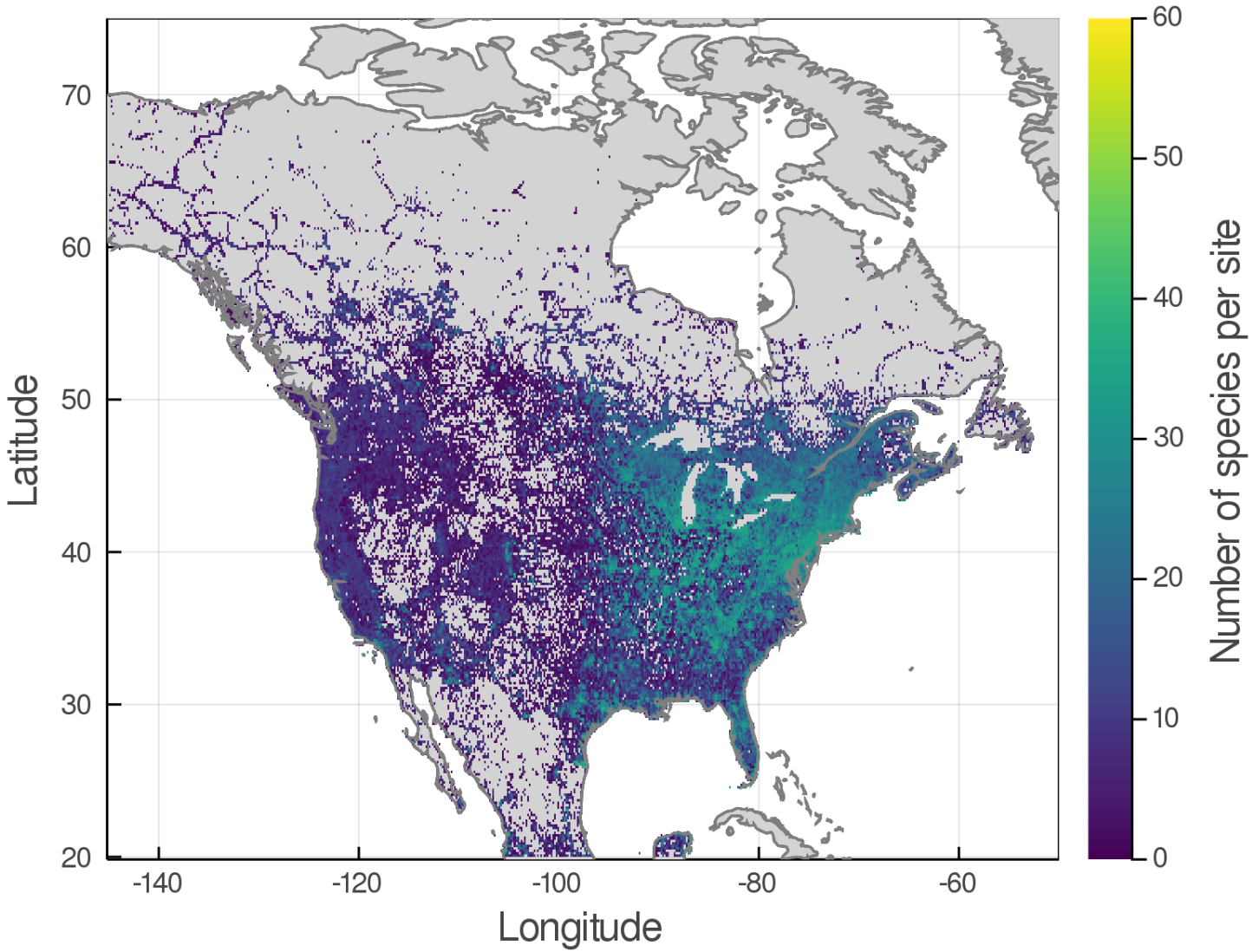
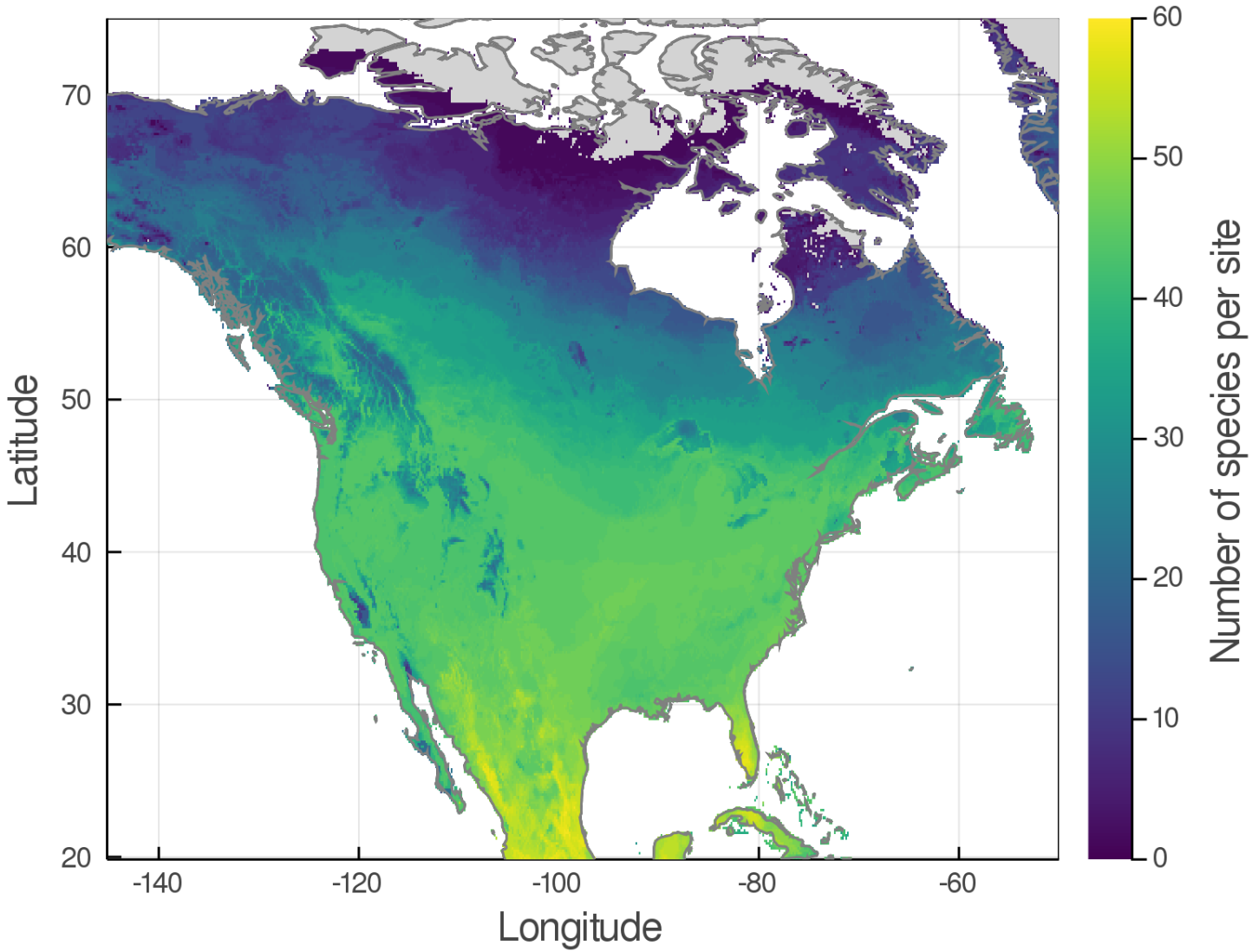


Figure 7: SDM predictions without threshold for the Yellow Warbler

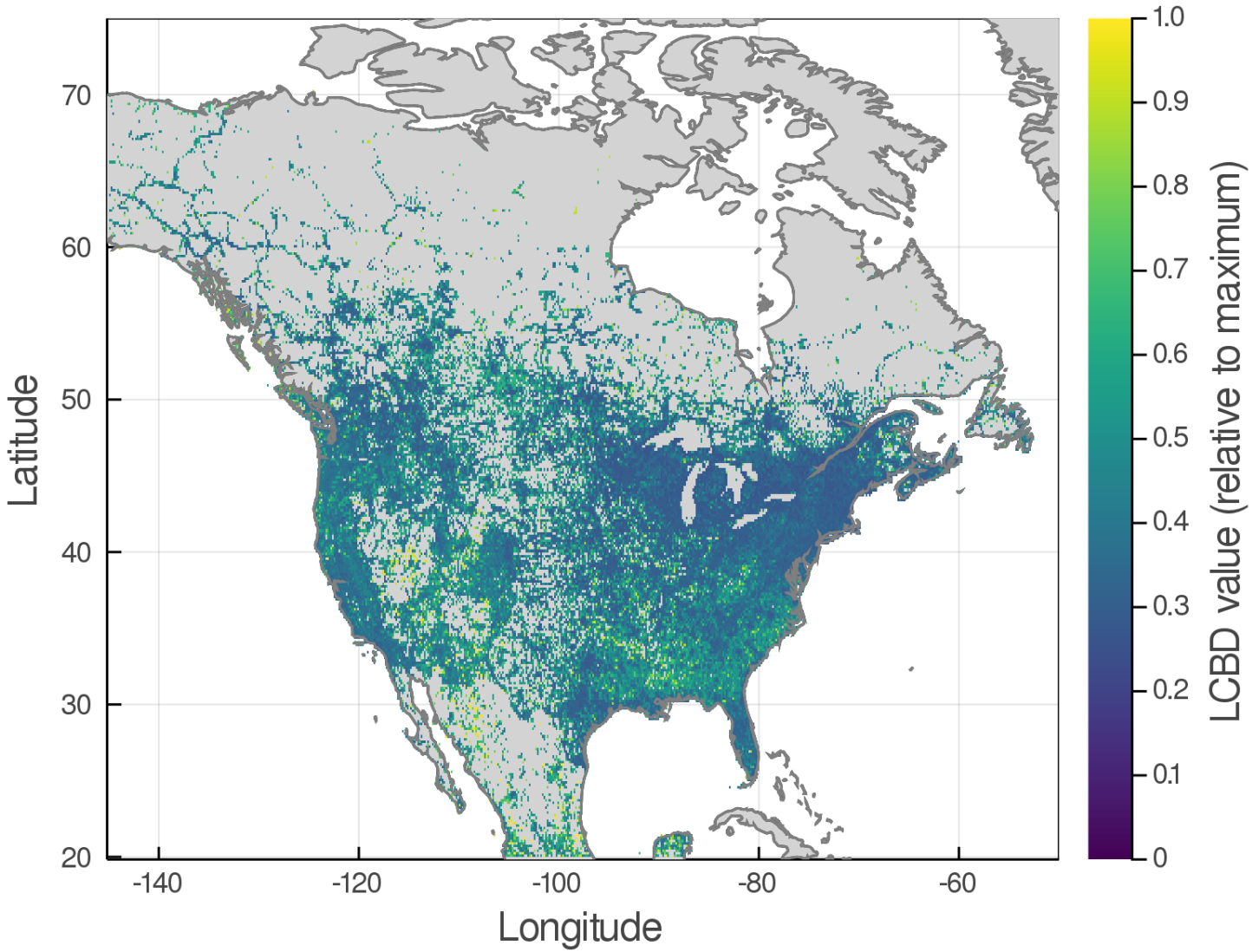
Species richness - Raw data



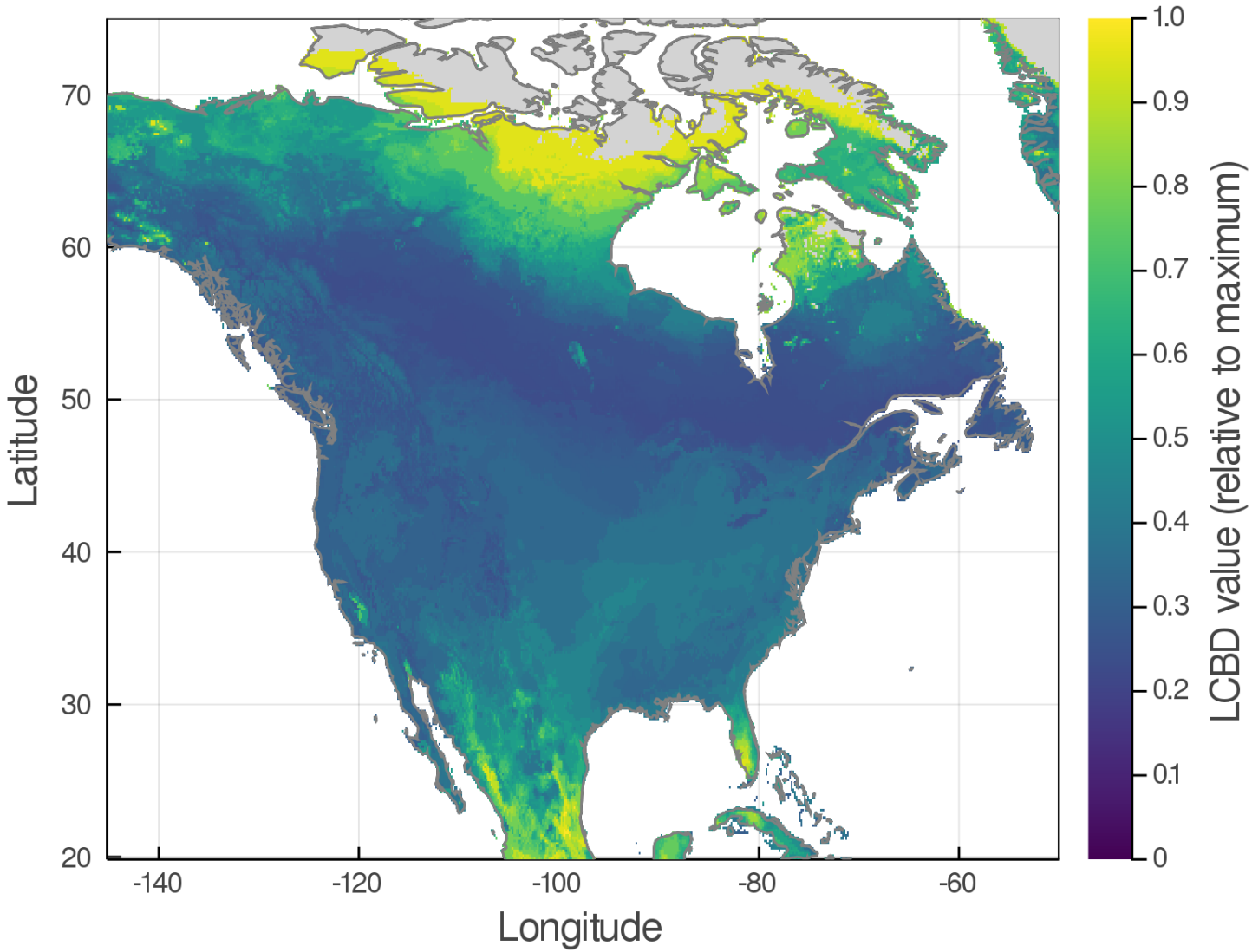
Species richness - SDM without threshold



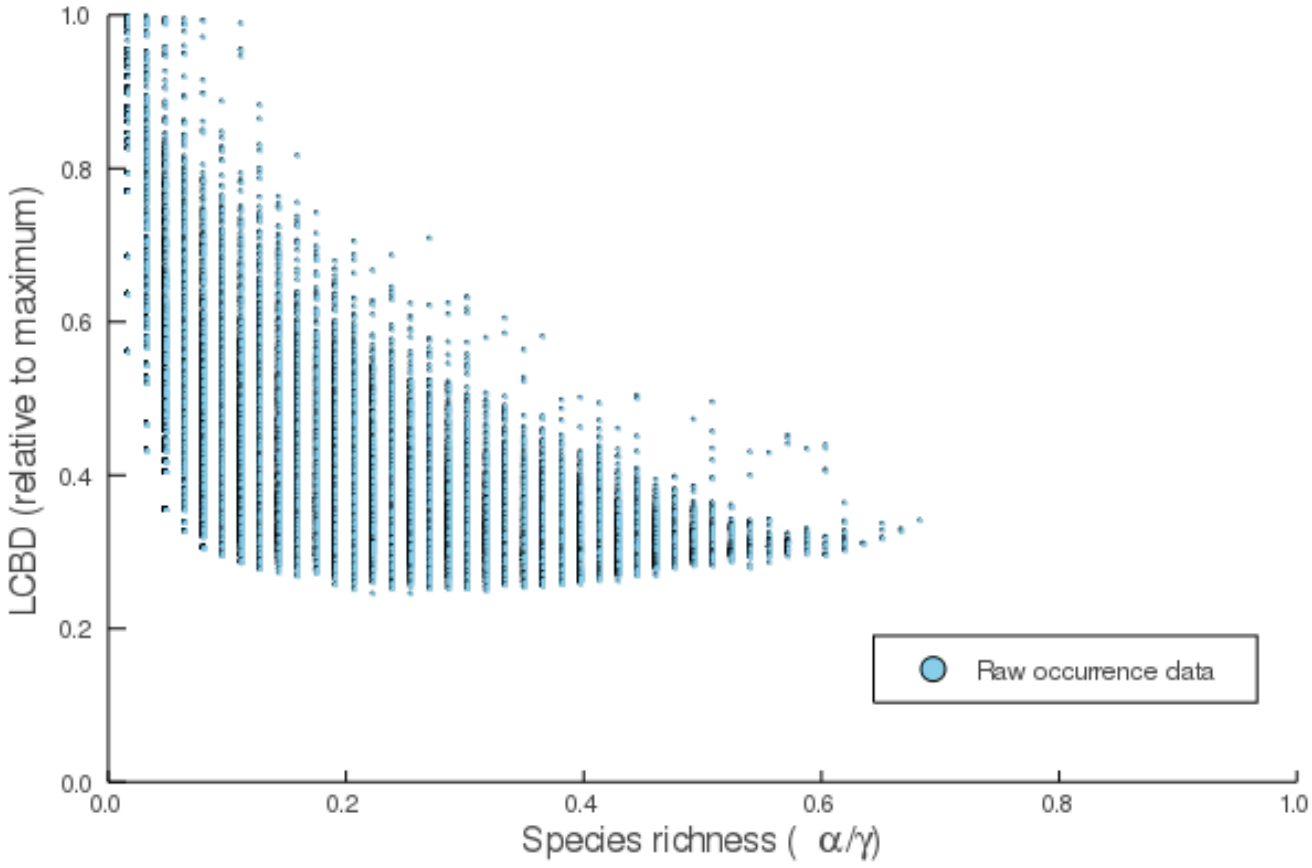
LCBD - Raw data (with Hellinger transformation)



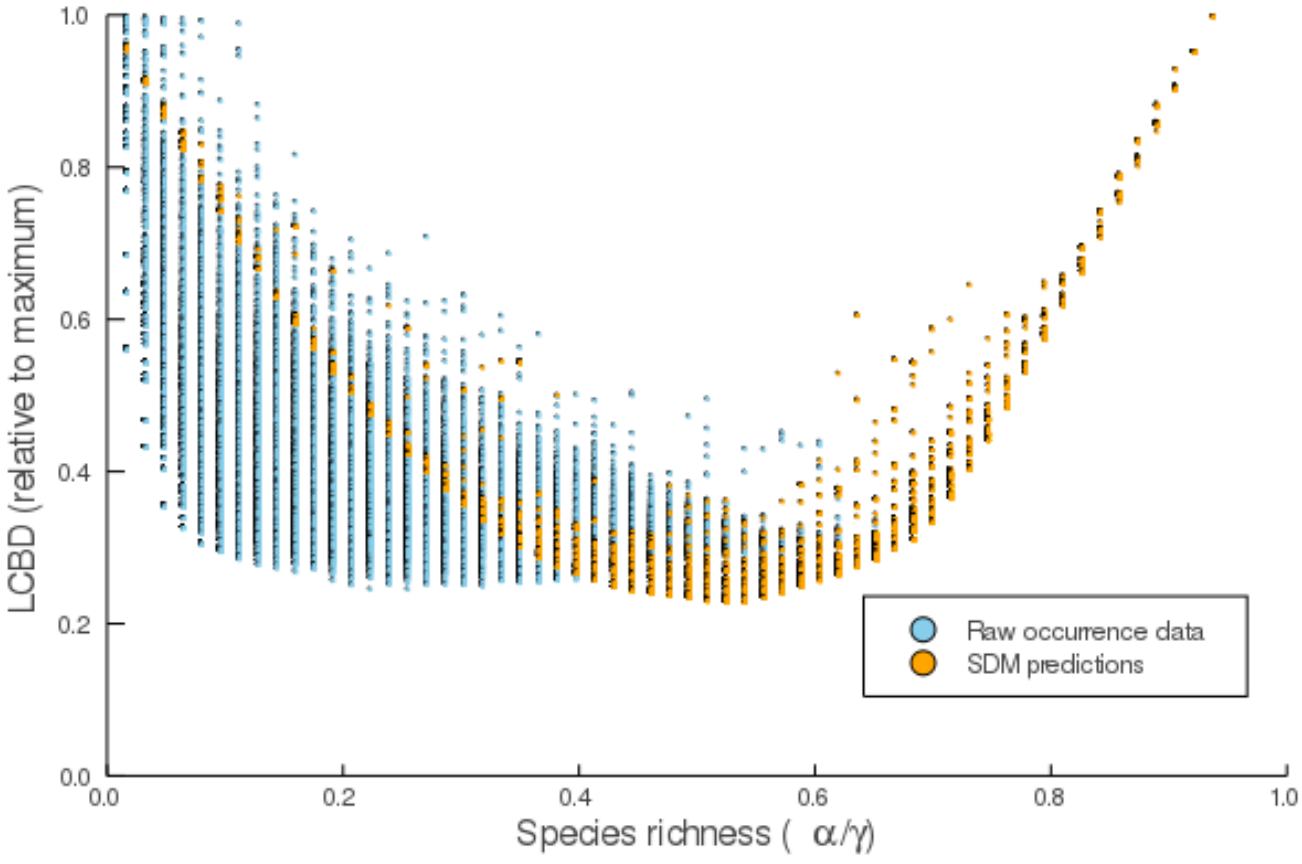
LCBD - SDM without threshold (no transformation)



LCBD-richness relationship



LCBD-richness relationship



Elements to discuss

- Relevance of the approach
- Improving SDM predictions: MAXENT, Random Forests, Neural Networks, Joint SDMs
- Data transformation for LCBD calculation
- Scales to focus on

References

Johnston, A., W. M. Hochachka, M. E. Strimas-Mackey, V. Ruiz Gutierrez, O. J. Robinson, E. T. Miller, T. Auer, S. T. Kelling, and D. Fink. 2019. "Best Practices for Making Reliable Inferences from Citizen Science Data: Case Study Using eBird to Estimate Species Distributions." bioRxiv, March, 574392. https://doi.org/10.1101/574392.

Legendre, Pierre. 2019. "A Temporal Beta-Diversity Index to Identify Sites That Have Changed in Exceptional Ways in Space–Time Surveys." Ecology and Evolution 9 (6): 3500–3514. https://doi.org/10.1002/ece3.4984.

Poisot, Timothée, Richard LaBrie, Erin Larson, Anastasia Rahlin, and Benno I. Simmons. 2019. "Data-Based, Synthesis-Driven: Setting the Agenda for Computational Ecology." Ideas in Ecology and Evolution 12 (July). https://doi.org/10.24908/iee.2019.12.2.e.