Stoneflies (Plecoptera), pre-European distributions and climate influenced future ranges in the Midwest

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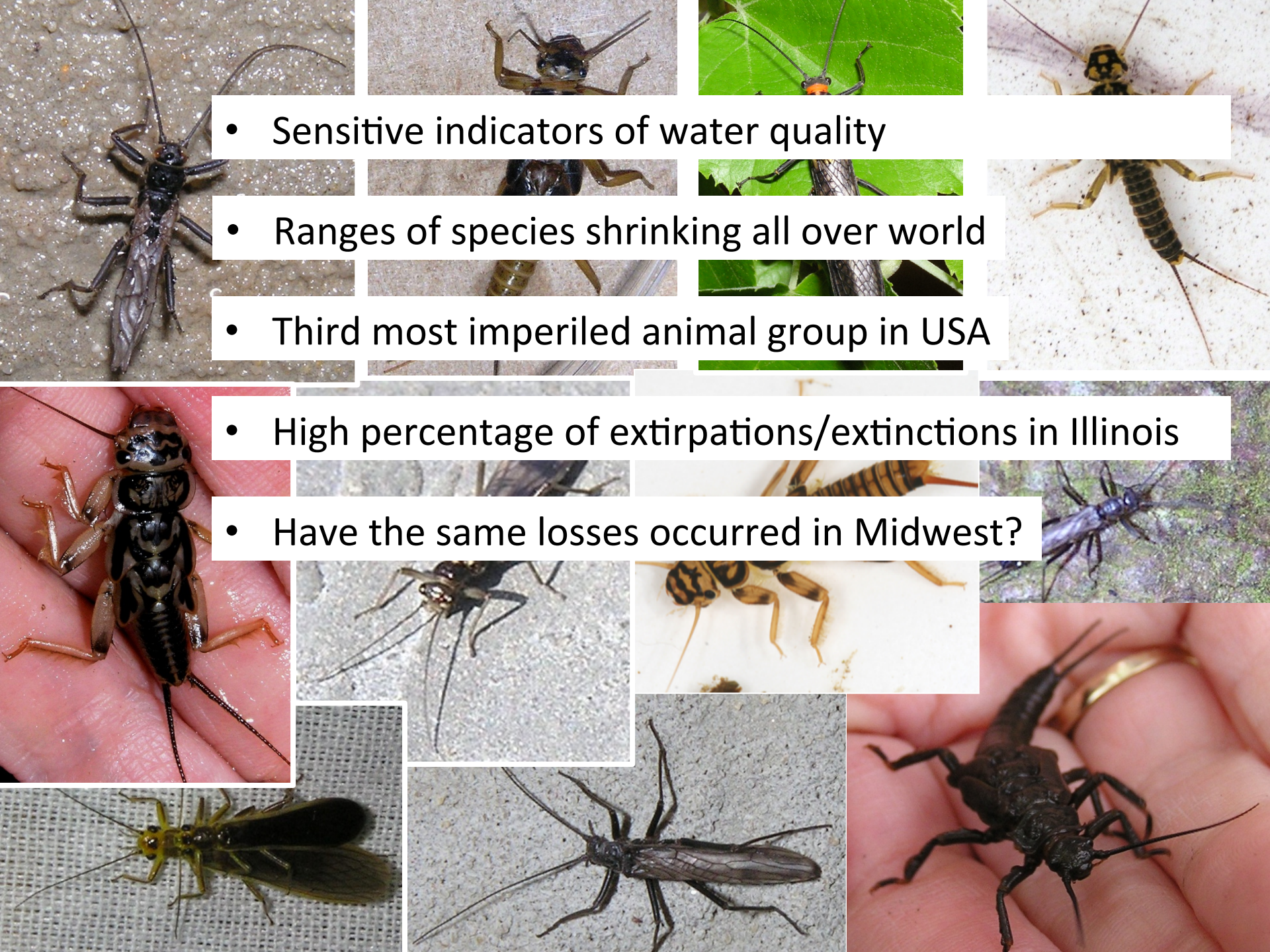
- Museum curators, collection managers, and private collectors



- Sensitive indicators of water quality
- Ranges of species shrinking all over world
- Third most imperiled animal group in USA
- High percentage of extirpations/extinctions in Illinois
- Have the same losses occurred in Midwest?

What Are The Challenges to Reconstructing Distributions?

- Range loss has already occurred

- Published distributions are often inadequate:
  - Lack vouchers
  - Obsolete taxonomy
  - Low taxonomic resolution
  - Incomplete location information

- Where do we get data adequate for the question?

Museum Specimens Are a Source of Data

Pros	Cons
Oldest records/greatest range	Presence data-only
Identifications verifiable	Sample effort unclear
Many specimens available	Some inexact locations

Imperfect data, yes, but often the best available!

Objectives

Reconstruct the historic range of stoneflies in Midwest

- Characterize fauna
- Predict ranges of individual species
- Predict species richness patterns

Methods

- New samples in intact habitat
  - Multi-season
  - Adults and nymphs, rearing
  - Multi-method
- Museum specimens from regional institutions
  - 25 museums
  - ID to current standards
  - Digitize: unique identifier, verbatim, value added
  - Return fully curated collection and data
- Characterize assemblage
  - Observed richness inHUC6 drainages
  - EstimateS richness predictions and rare species

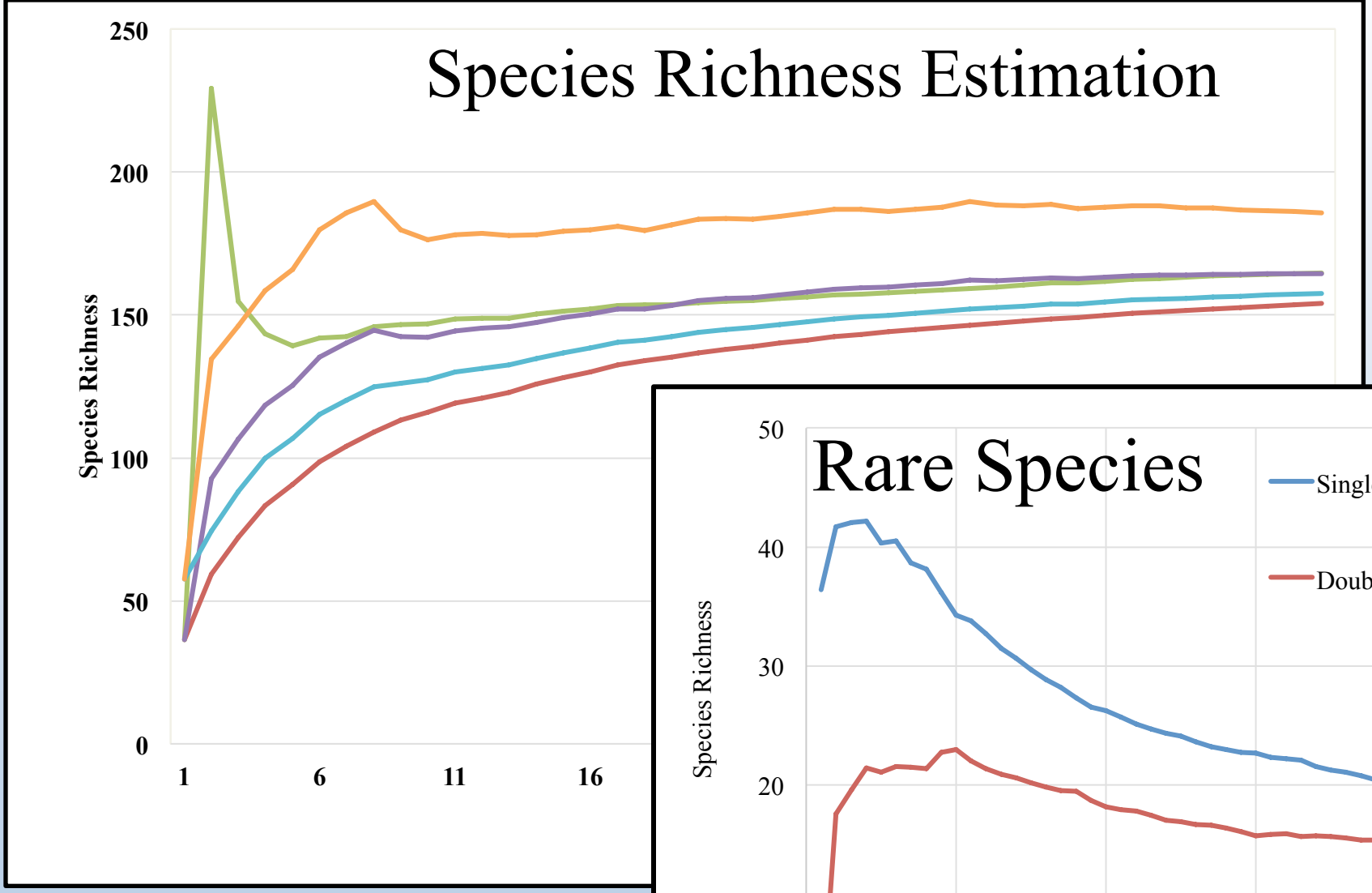
Single Species Distribution Modeling

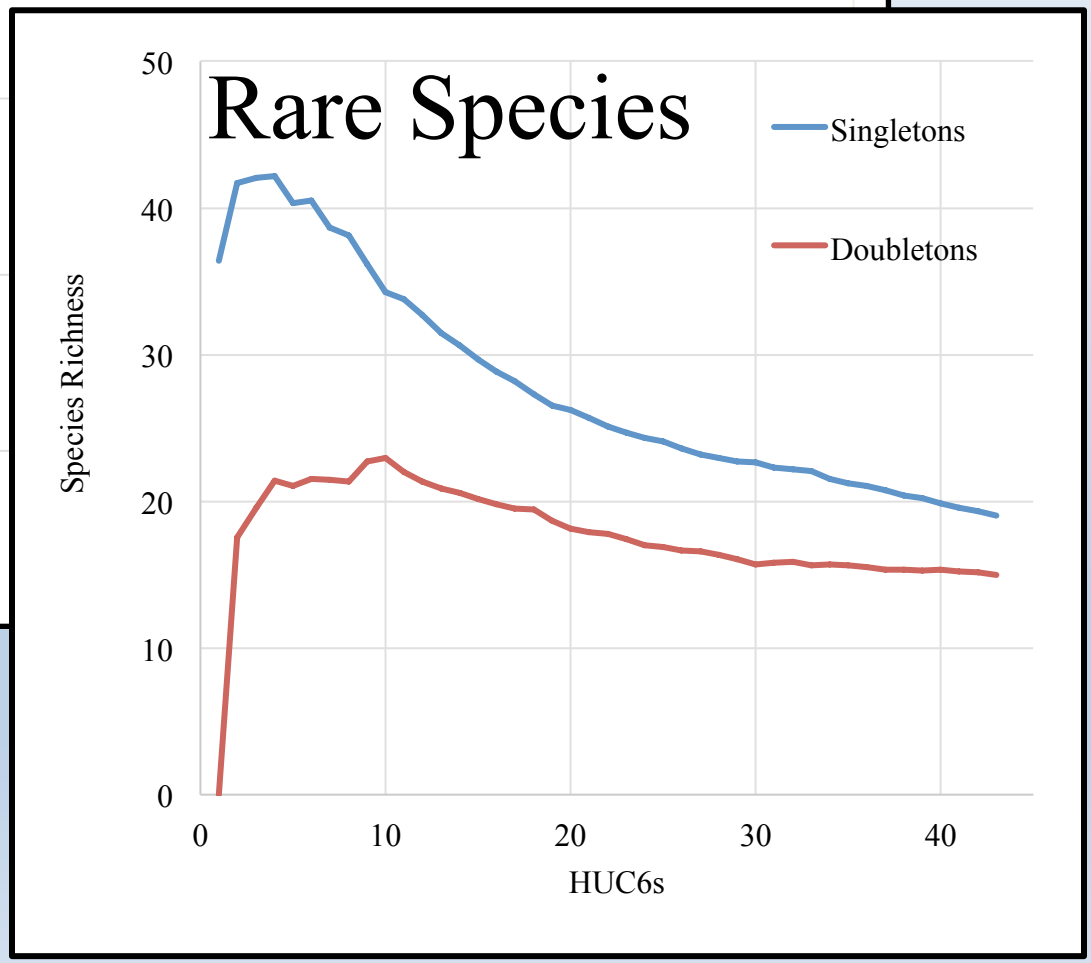
- Environmental variables
  - Scale: 8700 HUC12 drainages, ~20,000 acres
  - 300 variables, eco-hydrology & historical vegetation
  - Variable reduction through cluster analysis

Producing "**Full Model**" for using Maxent

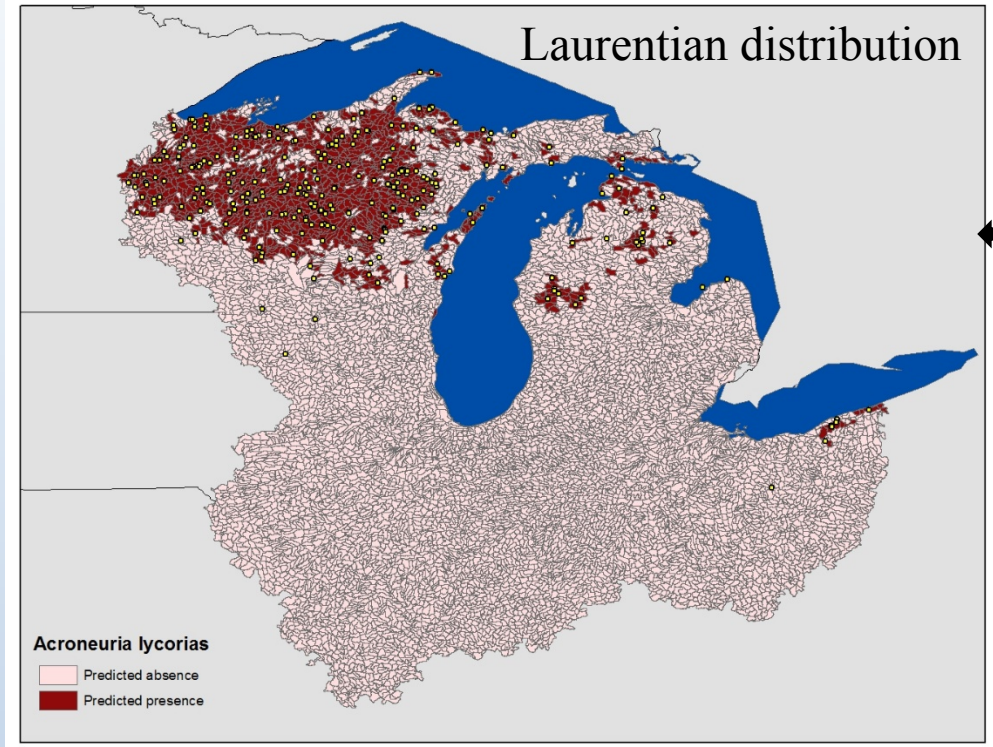
- No data withheld for validation
- Single record/species/HUC12
- Threshold for entry ≥14 HUC12s
- Richness from summing presences

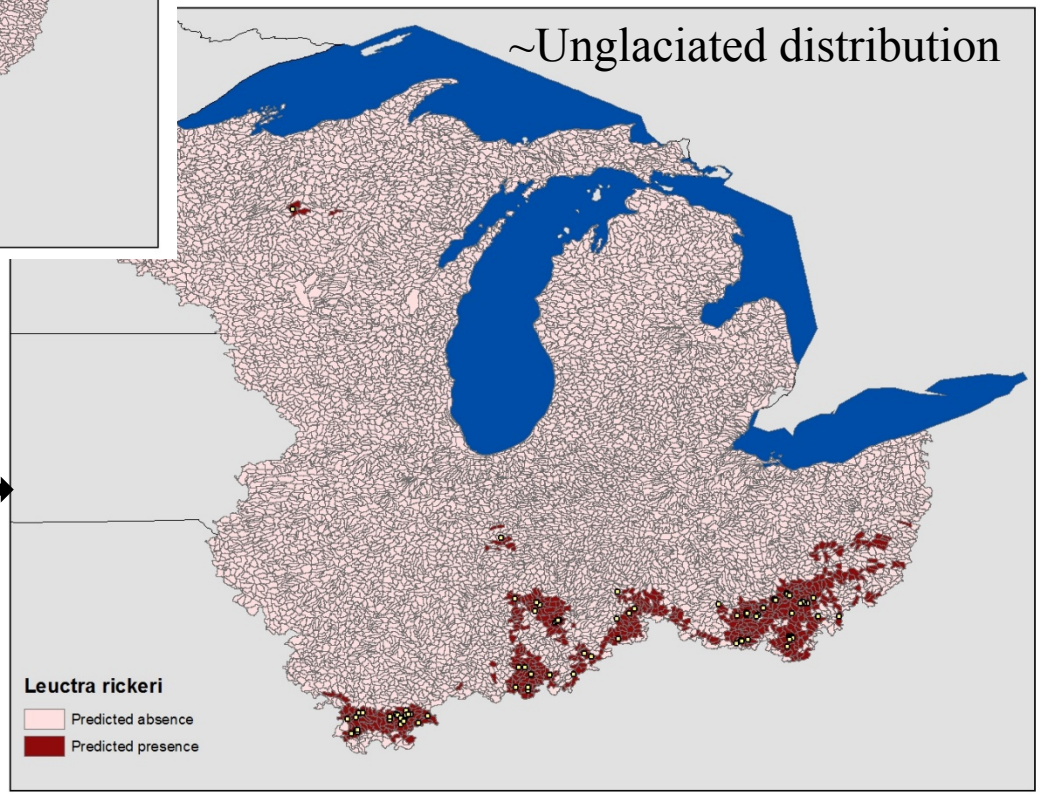
30,000 records
25 museums & new collections
7,300 unique locations


Species Richness Estimation
Species Richness
250
200
150
100
50
0
1
6
11
16

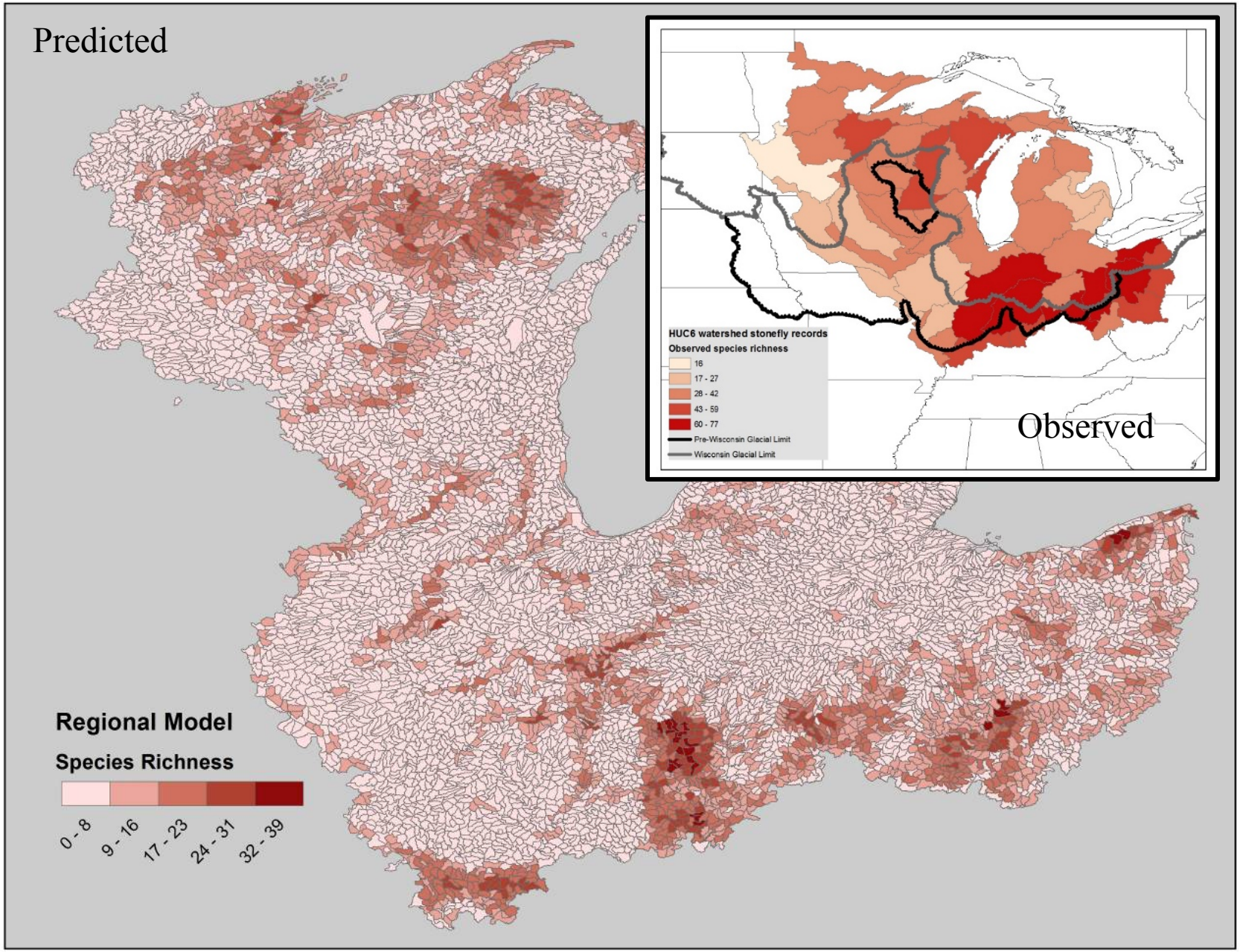

Rare Species
Singletons
Doubletons
Species Richness
50
40
30
20
10
0
0
10
20
30
40
HUC6s

Full Models for 78 of 154 Species





Regional Species Richness Model



Model Calibration

- 80 “best” watersheds removed from **Full Model** to form **Calibration Model**

- Correlation of incidence between the calibration model and observed values in 80 watersheds

- Correlation of **Full** & **Calibration** model incidences per species

Calibration Model Performance: Incidence

Predicted species incidence

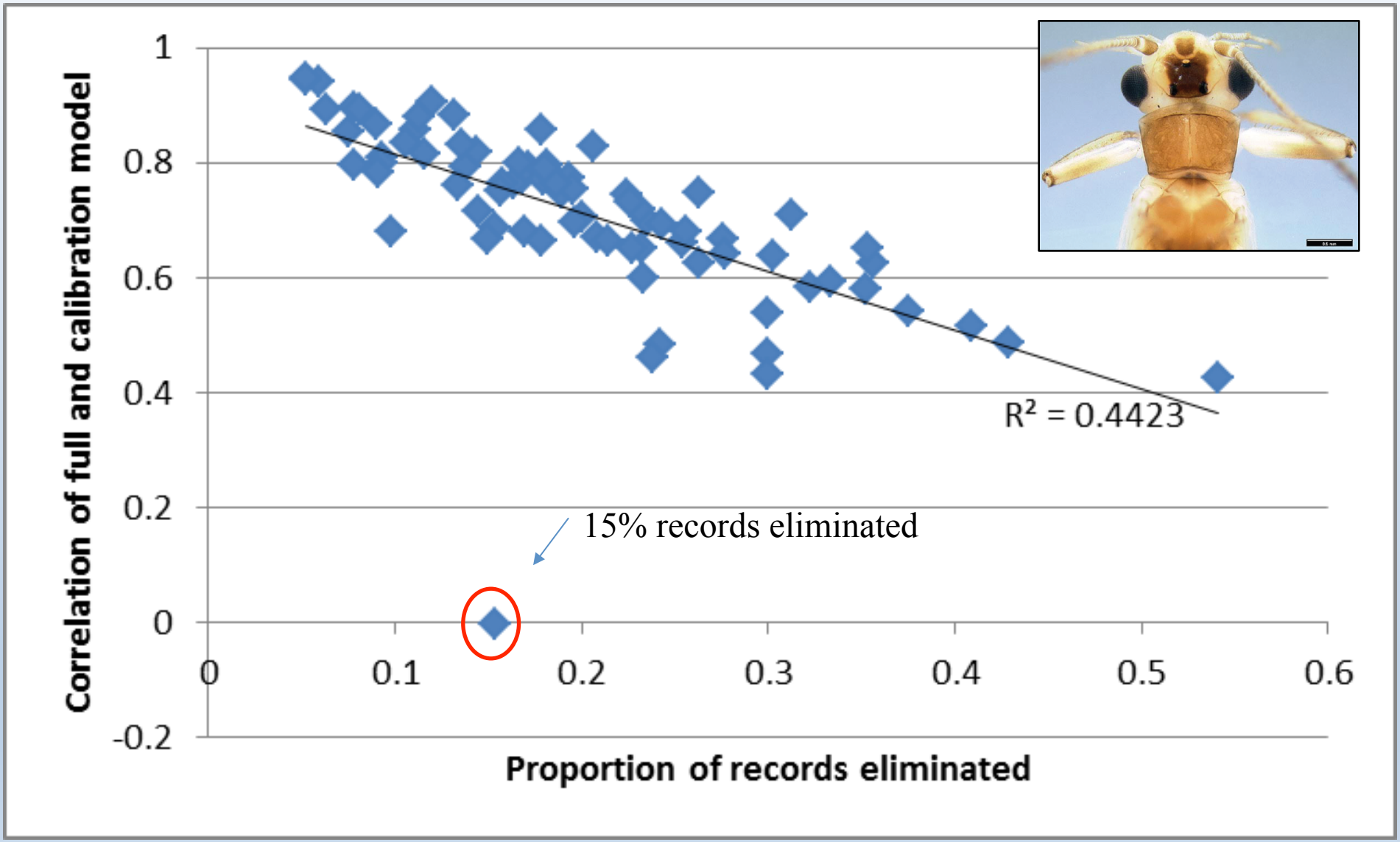
Observed species incidence (regional 80)

N=78

$R^2 = 0.6365$

p<0.0005

Model Correlation vs. proportion records eliminated



One outlier, when removed, improves the R^2 to 0.69.

Conclusions

- Past distributions
  - Museum data provided >50% of 30K records for modeling, many were for areas where species no longer occurs
  - 78 of 154 species modeled
  - Species incidence well predicted
  - predicted richness followed observed richness patterns
- Much more than digitization needed to answer questions
  - >50 specimens not identified to species or incorrectly IDed
  - Much value added work necessary
  - New specimens were indispensable to answering questions
- Future research
  - Past and future (climate) models for 450 EPT in Midwest
  - Use “least-cost path analysis” and distr. model outputs to examine pathways and barriers to dispersal