# Predicting phenology, demography and extinction risk due to climate change from eco-physiology and museum records

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# Erosion of Lizard Diversity by Climate Change and Altered Thermal Niches

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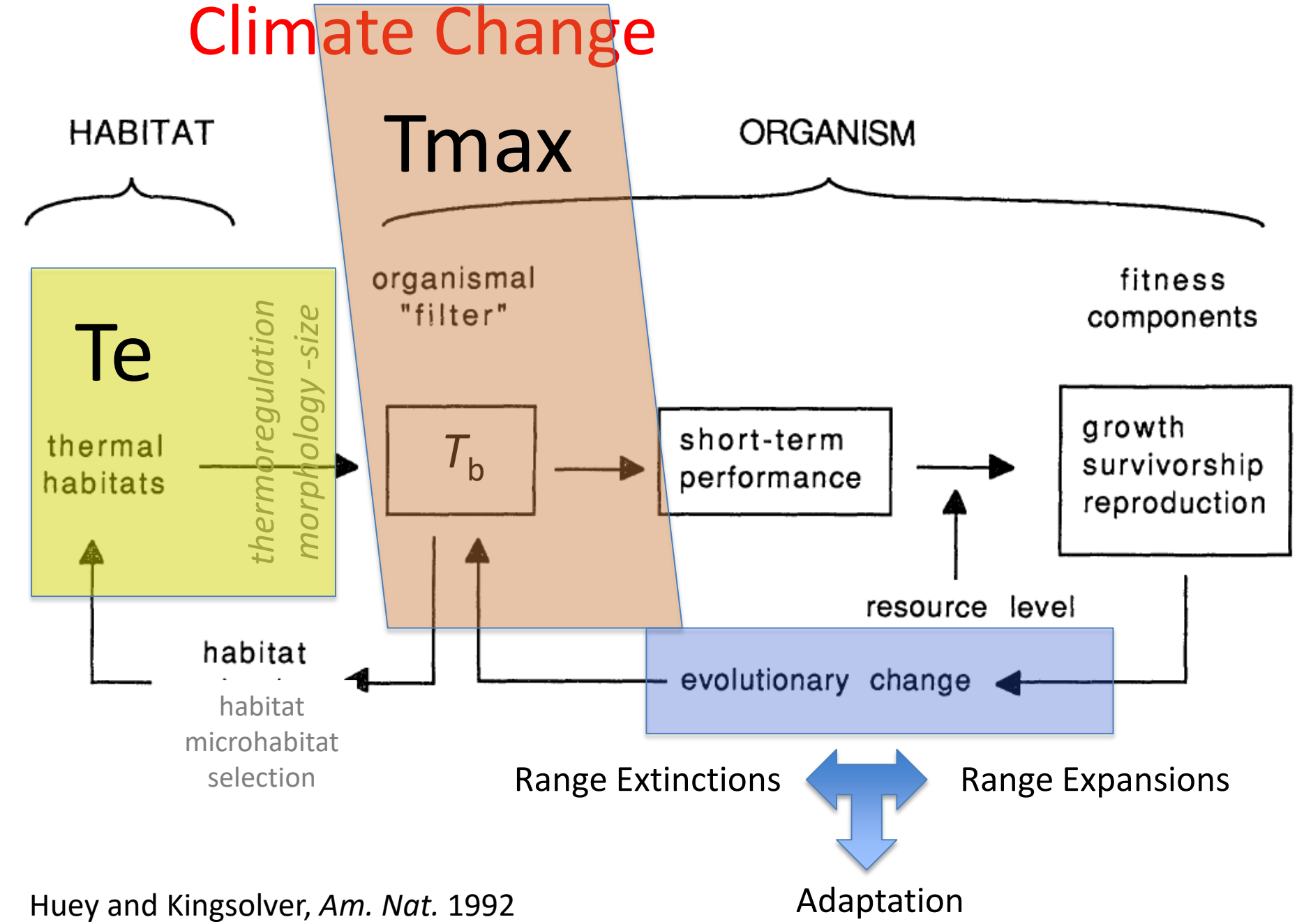
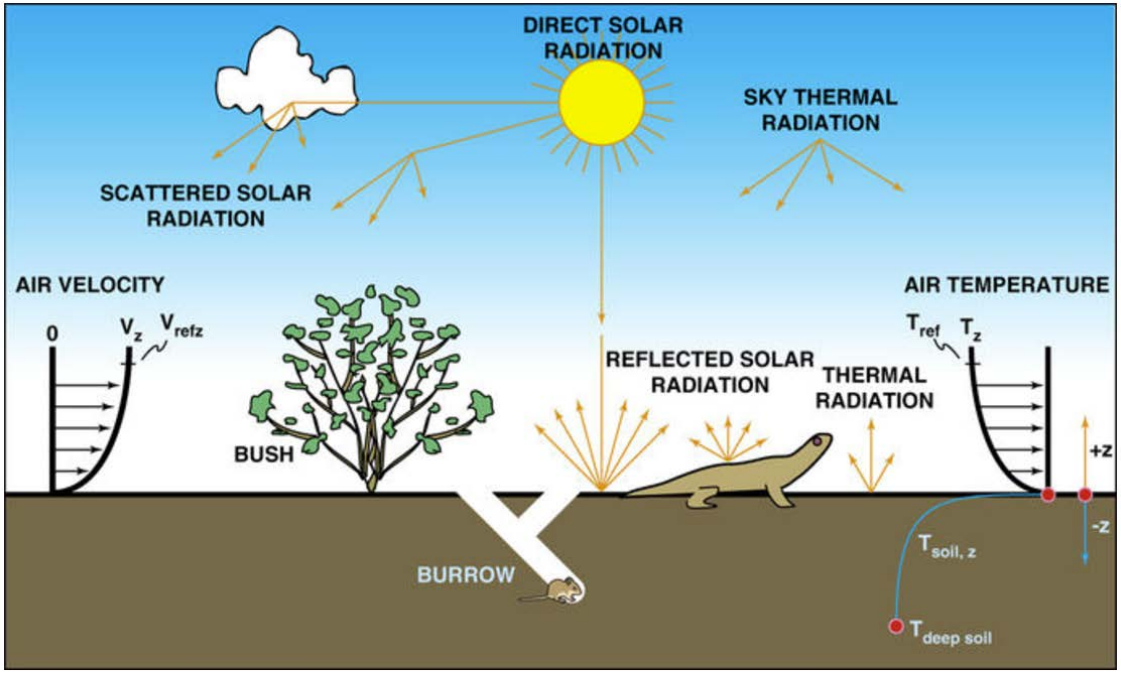
It is predicted that climate change will cause species extinctions and distributional shifts in coming decades, but data to validate these predictions are relatively scarce. Here, we compare recent and historical surveys for 48 Mexican lizard species at 200 sites. Since 1975, 12% of local populations have gone extinct. We verified physiological models of extinction risk with observed local extinctions and extended projections worldwide. Since 1975, we estimate that 4% of local populations have gone extinct worldwide, but by 2080 local extinctions are projected to reach 39% worldwide, and species extinctions may reach 20%. Global extinction projections were validated with local extinctions observed from 1975 to 2009 for regional biotas on four other continents, suggesting that lizards have already crossed a threshold for extinctions caused by climate change.




Huey and Kingsolver, *Am. Nat.* 1992

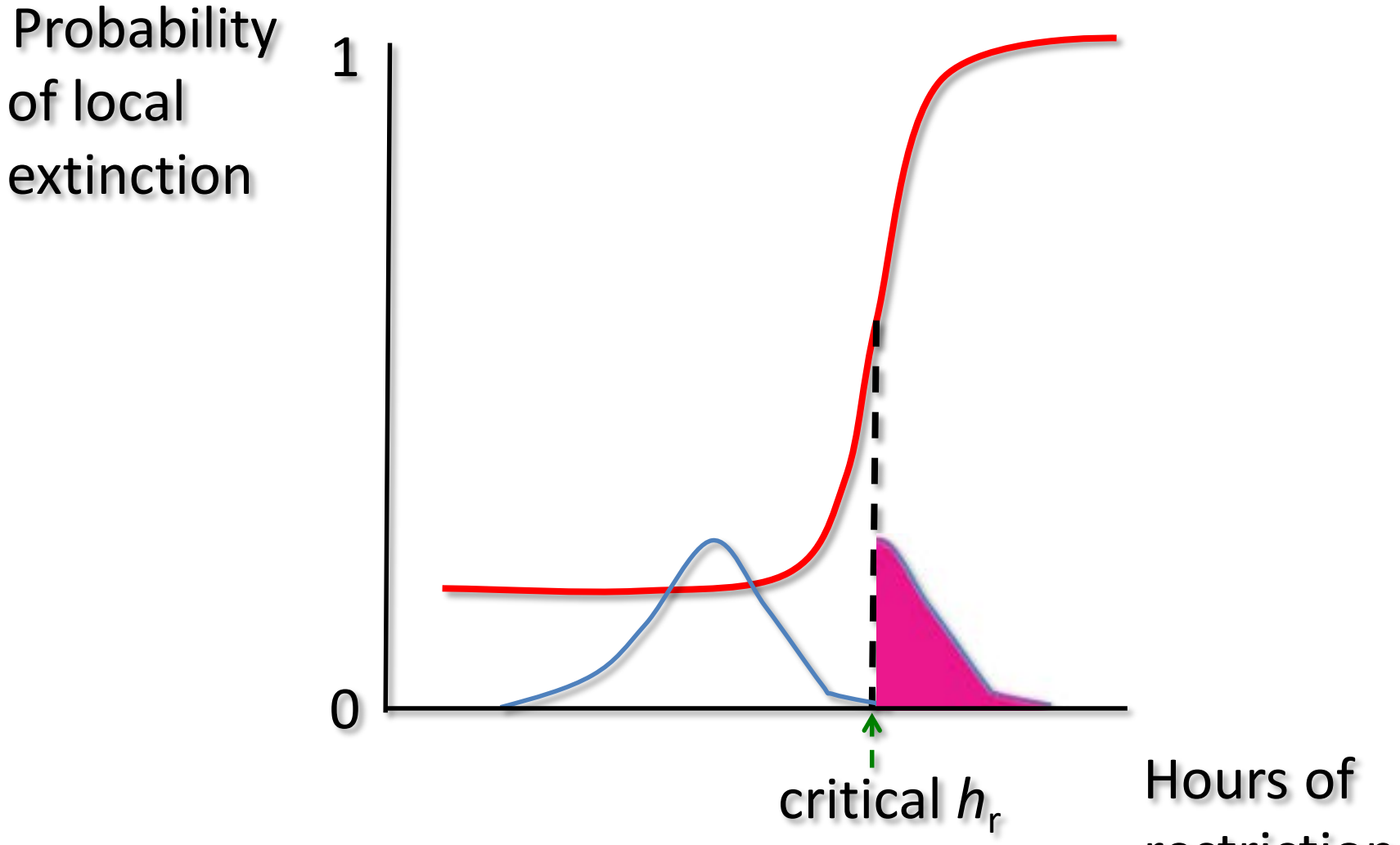
# Merge Biophysical Equations to iDigBio records

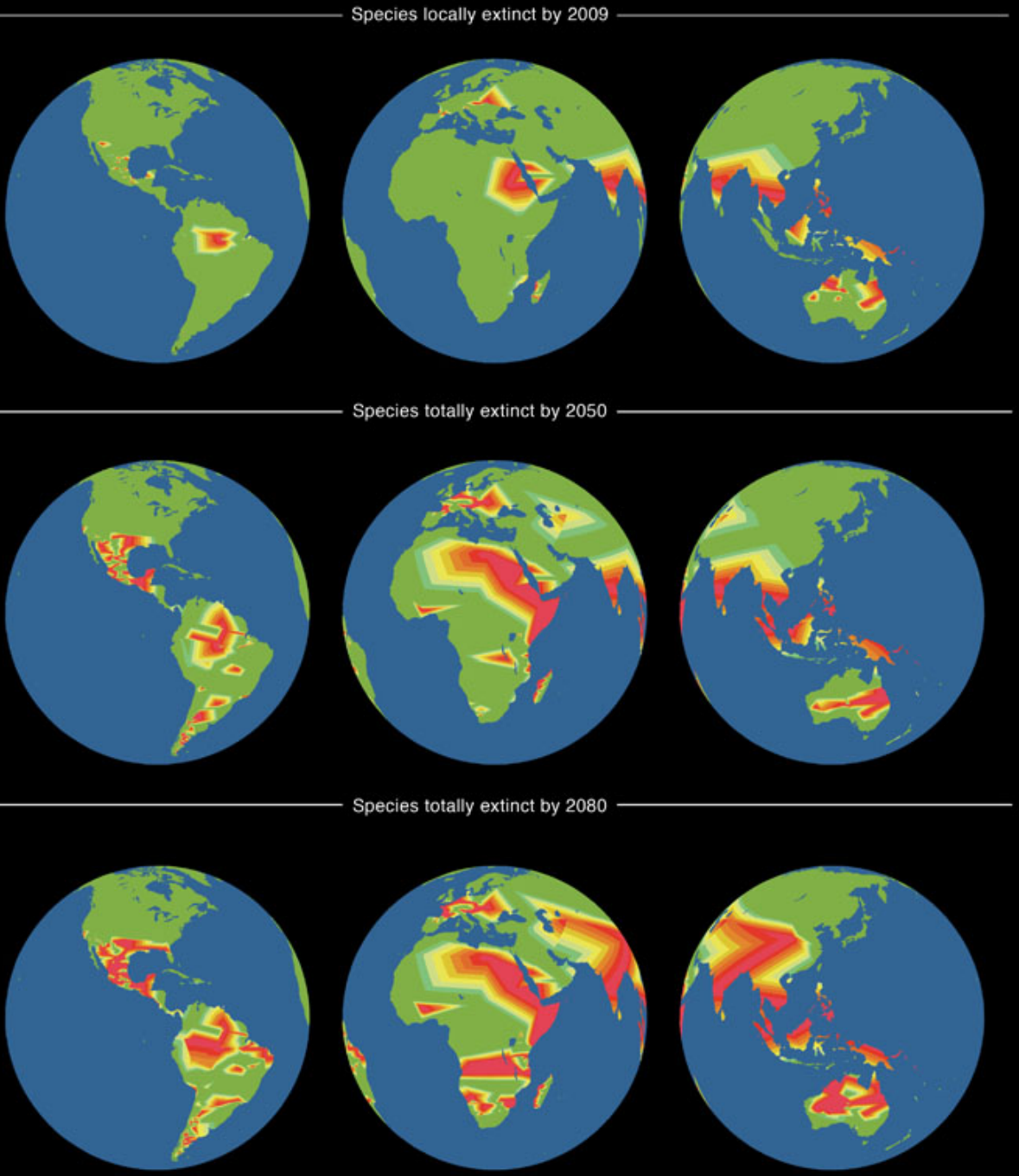
## Hours of restriction – Too hot to be out!




Schematic of microclimatic processes relating to heat and water transfer of an organism, after Porter *et al.*[20]

# Sinervo et al. model – general pattern






By the numbers:

2009

- 4% local extinction
- $R^2$ = 0.72 in a global validation with 8 other lizard families

IN **NEW species-level models $R^2$ = 0.86**

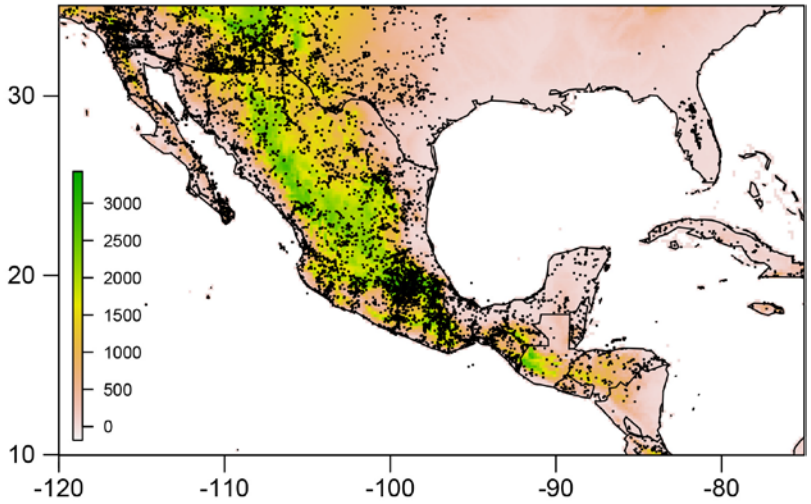
2050

- 6% species extinction
- 100% in some areas

2080

- 20% species extinction
- 100% in many areas

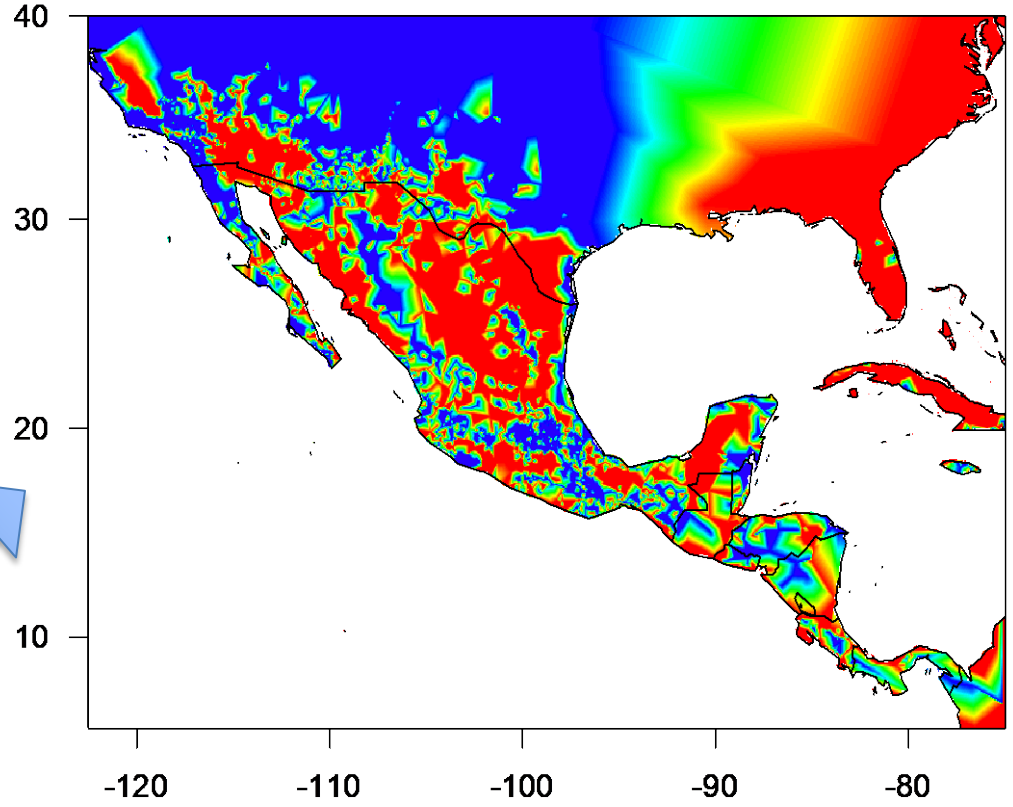
# Extinction (red) risk in Desert Reptiles by 2070
# N=142 Spp, 15 Families
# 3 Families go Extinct



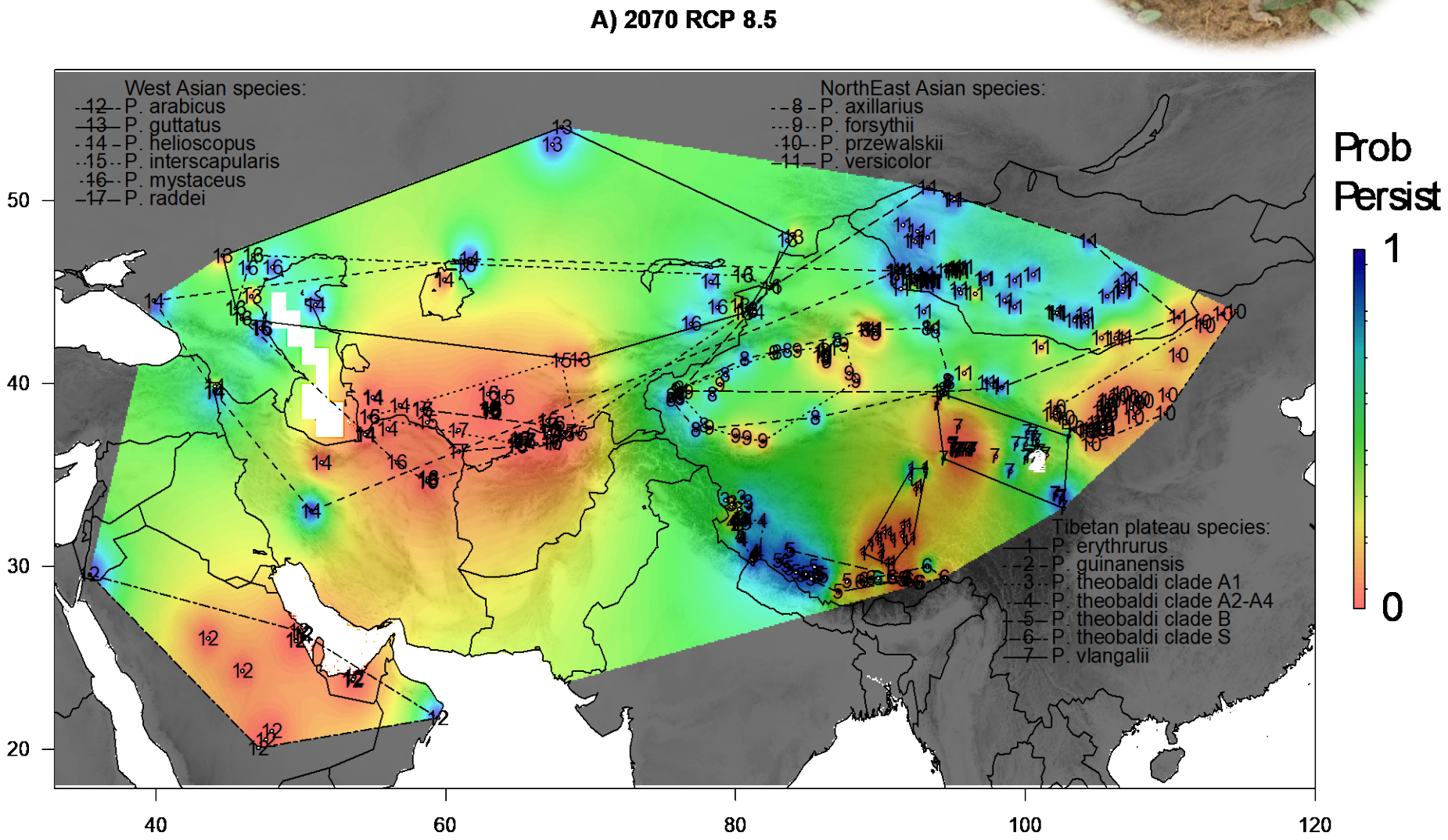

N=22981 occurrence records of Mexican endemic and widespread species (N=142) from museums

**Structural Equations Models**

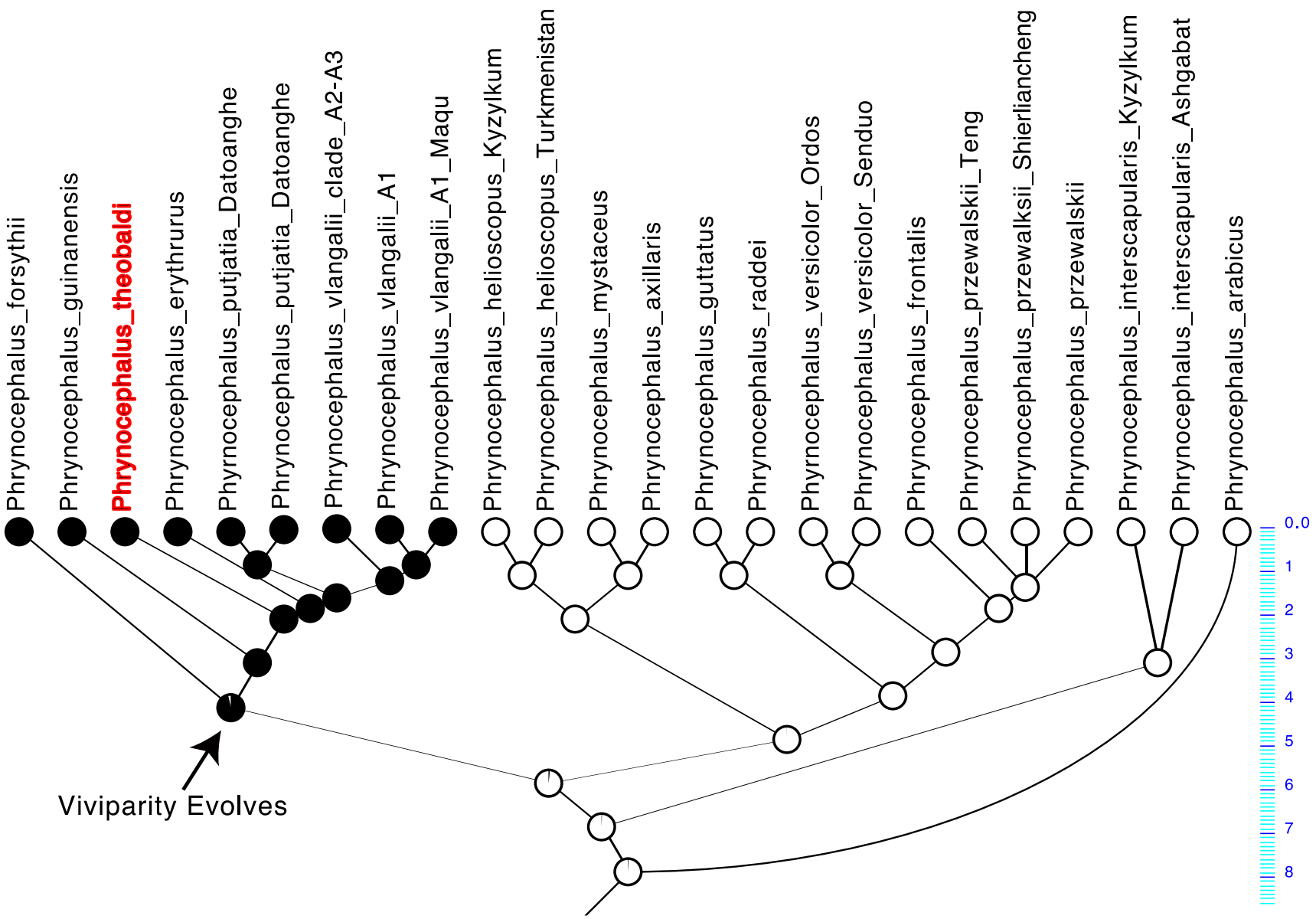
**Biophysical**
Phenological
**Eco-Physiological**
Demographic



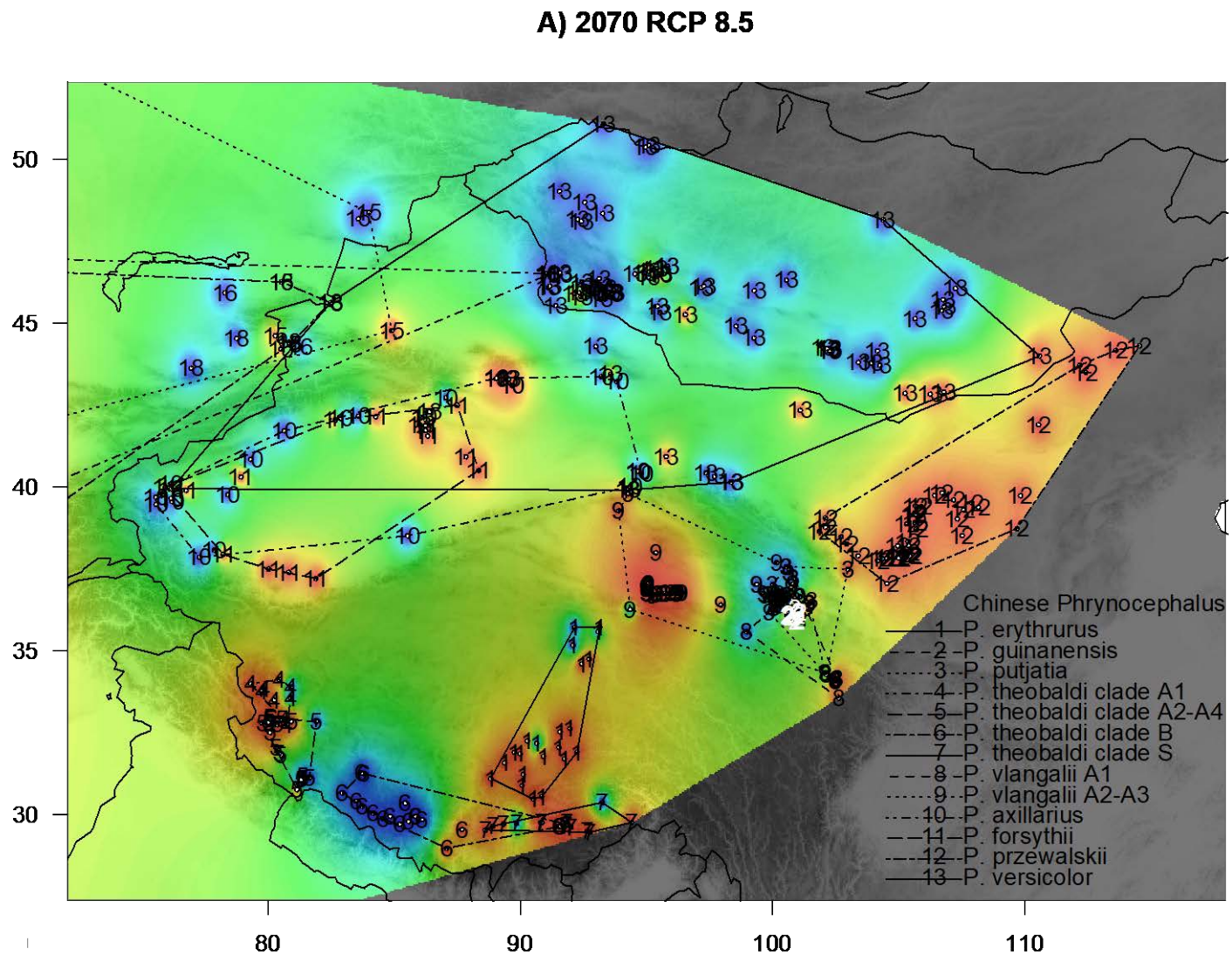
# 8.5 RCP - Extinction of *Phrynocephalus* with Yin, Mendez, Miles, Wu



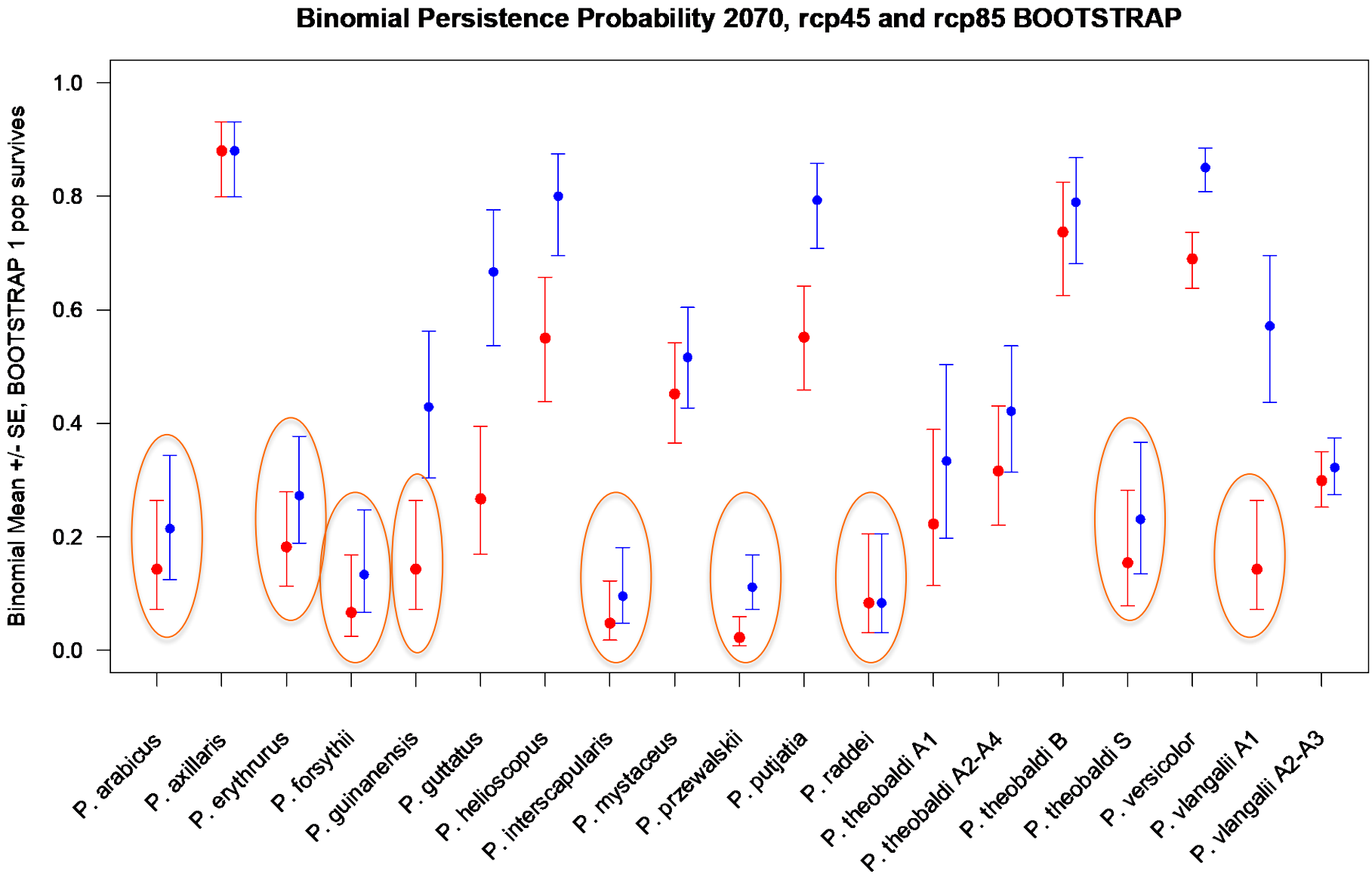
# Phylogeny and Imputation of $T_{pref}$



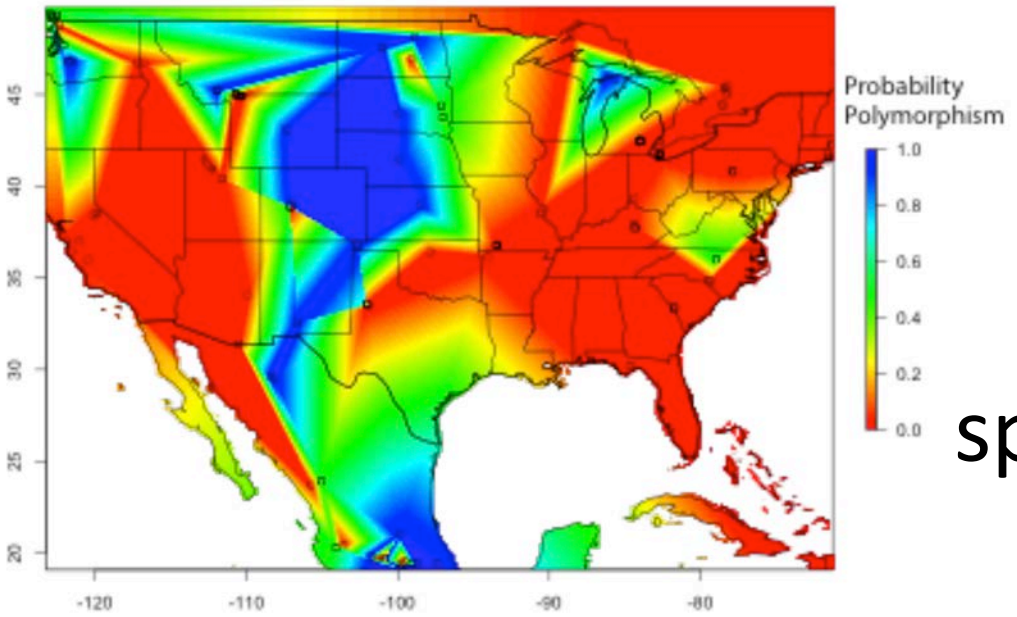
# Zoom in on Chinese Species



# 9 of 19 species are likely to go extinct



# Paedomorphism in Salamanders & Climate

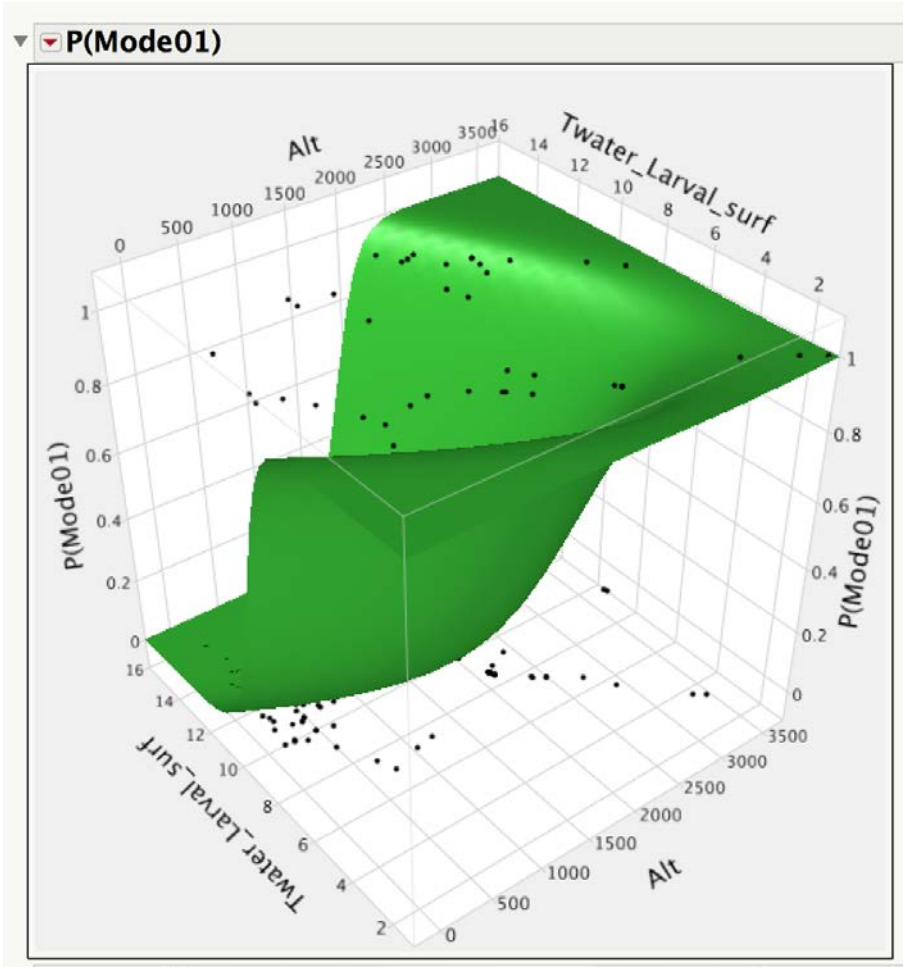


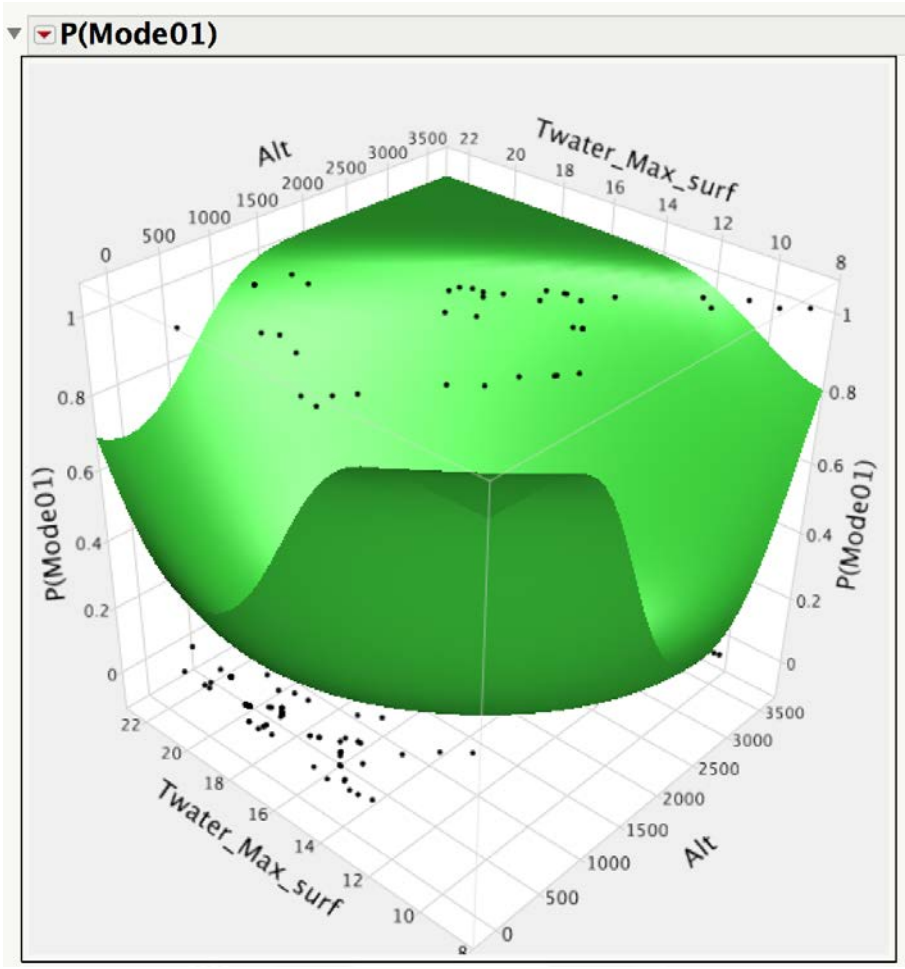

Observed Data
N=264 ecological Records on all 38 species of *Ambystoma*


# Paedomorphic vs. Metamorphic Build a Structural Equation Model for Breeding Temperatures and Larval Temperatures

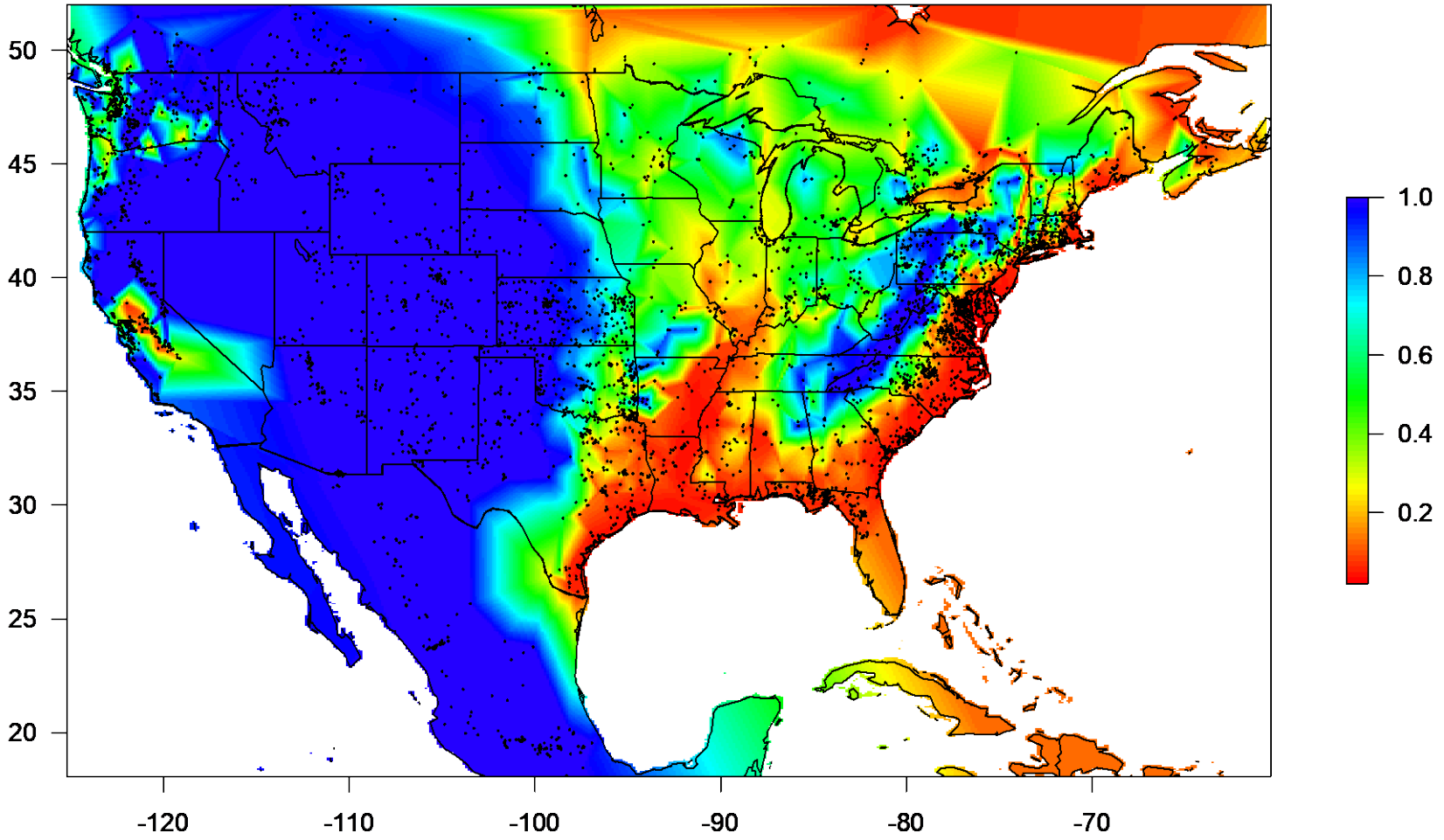
**Effect Tests**

| Source | DF | L-R ChiSquare | Prob>ChiSq |
|---|---|---|---|
| Alt | 1 | 3.4957173 | 0.0615 |
| Alt*Alt | 1 | 9.0025134 | 0.0027* |
| Twater_Larval_surf | 1 | 16.879293 | <.0001* |
| Twater_Larval_surf*Twater_Larval_surf | 1 | 10.43725 | 0.0012* |
| Twater_Max_surf | 1 | 1.5285129 | 0.2163 |
| Twater_Max_surf*Twater_Max_surf | 1 | 5.6587623 | 0.0174* |
| Alt*Twater_Larval_surf | 1 | 29.549613 | <.0001* |
| Alt*Twater_Max_surf | 1 | 5.2982402 | 0.0213* |

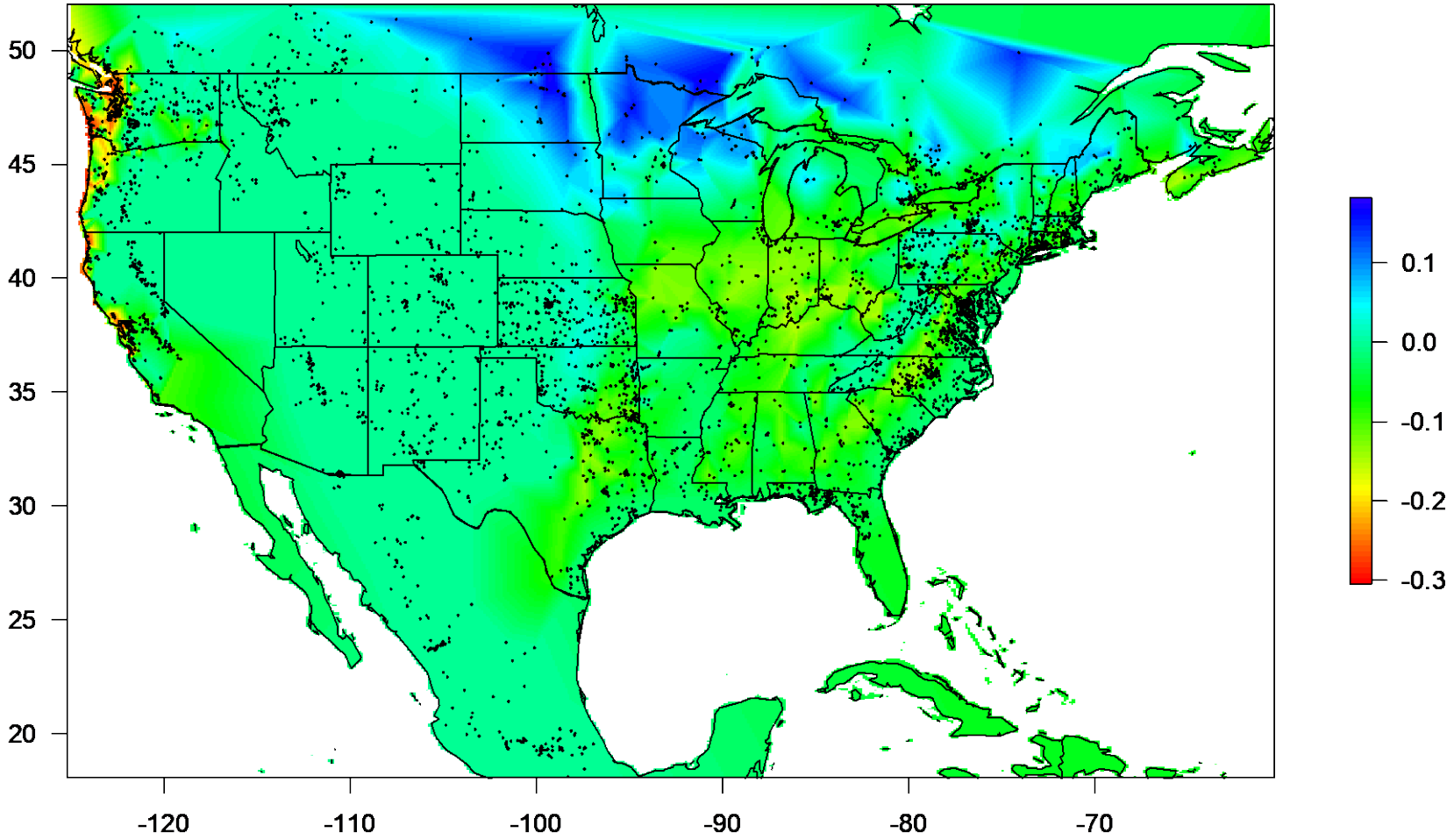


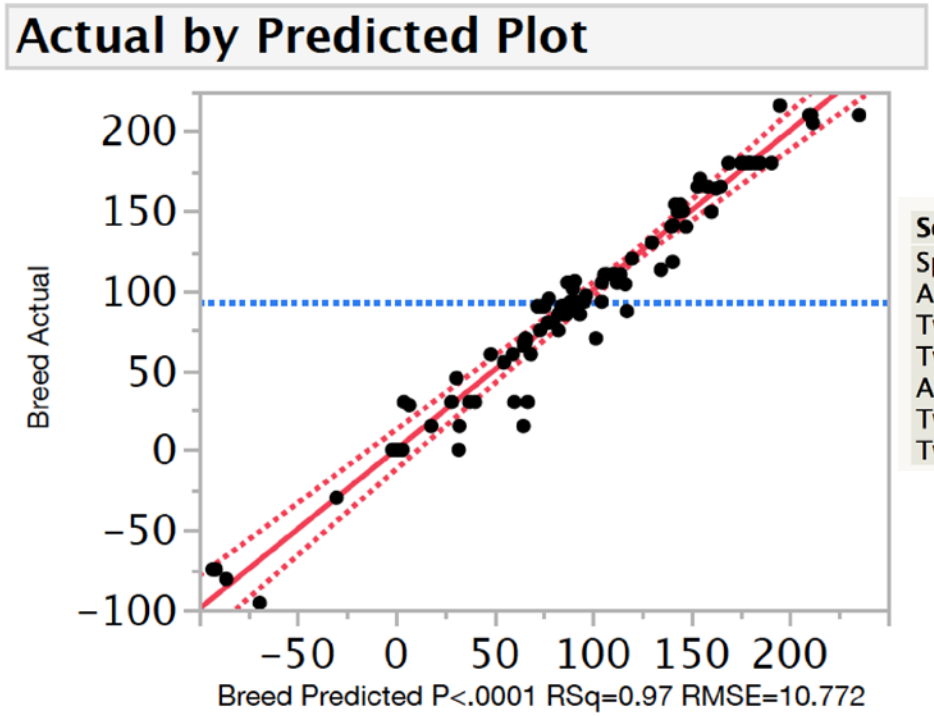
# Paedomorphs probability in 1975



# Change in probability of Paedomorphs 1975 to 2070
# Paedomorphs are quite well-buffered

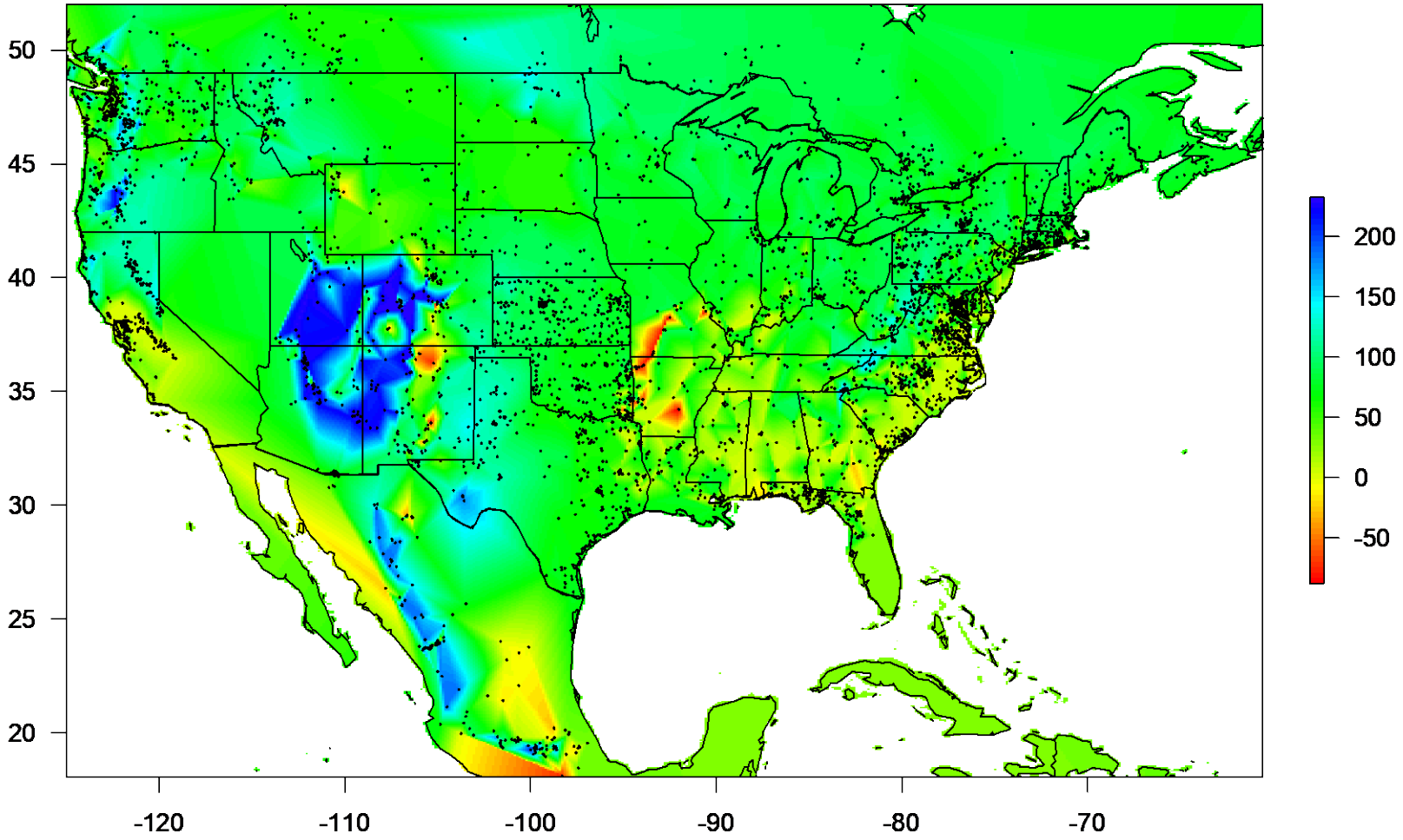


# Structural Equation Model of Breeding Date (0=Jan 1, dates < 0 are fall breeders)

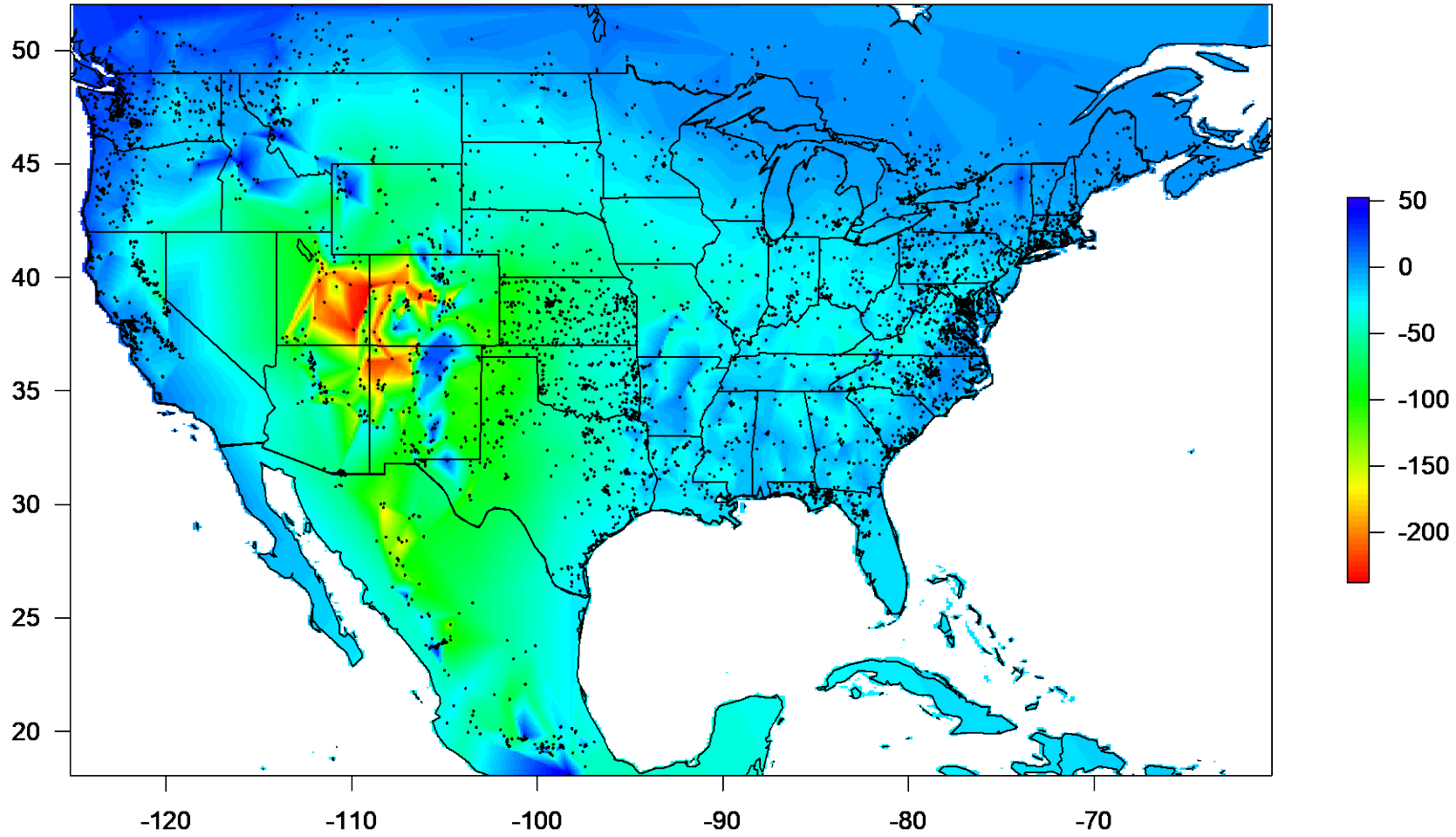



| Source | LogWorth | PValue |
|---|---|---|
| Species | 76.703 | 0.00000 |
| Alt | 18.937 | 0.00000 |
| Twater_Breed_surf | 12.116 | 0.00000 |
| Twater_Breed_surf*Alt | 9.744 | 0.00000 |
| Alt*Alt | 8.230 | 0.00000 |
| Twater_Max_surf*Alt | 3.590 | 0.00026 |
| Twater_Max_surf | 0.642 | 0.22794 ^ |

# Breeding dates in 1975 – Blue is Montane



# Change in Breeding Date 1975 to 2070



***Species of Reptiles and Amphibians have begun going extinct from climate change. We are using iDigBio records to predict these events.***

***WORKFLOW:***

***1) Proofing the museum records with molecular phylogenies***

***2) Merging the museum records to Ecological variables, biophysics, and climate surfaces (downscaling with Structural Equation Models)***

***3) Dishing up the plots online – in the works for North America and Vertnet.org***

***…***

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