Using quantitative ecology for species conservation in the face of anthropogenic-change

Dr Staci Amburgey

Using quantitative ecology for species conservation ~~in the face of anthropogenic-change~~

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USGS
science for a changing world

PENN STATE
ECOLOGY

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EXTINCTION OF AN ISLAND FOREST AVIFAUNA BY AN INTRODUCED SNAKE[1]

JULIE A. SAVIDGE
Division of Aquatic and Wildlife Resources, P.O. Box 2950, Agana, Guam 96910, and Department of Ecology, Ethology, and Evolution, University of Illinois, Champaign, Illinois 61820 USA

Ecology, 68(3), 1987, pp. 660–668

S. Siers, USDA

DEMISE OF AN INSULAR AVIFAUNA: THE BROWN TREE SNAKE ON GUAM

JOHN ENGBRING, U.S. Fish and Wildlife Service, PO Box 50167, Honolulu, HI 96850

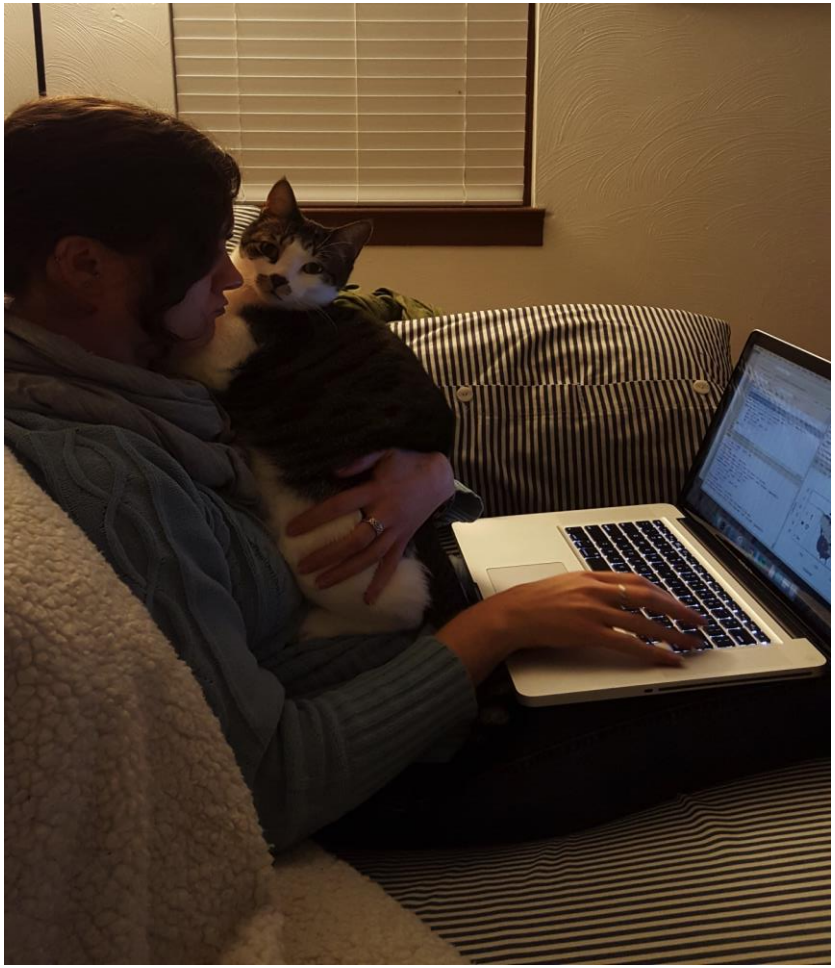
THOMAS H. FRITTS, U.S. Fish and Wildlife Service and Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM 87131

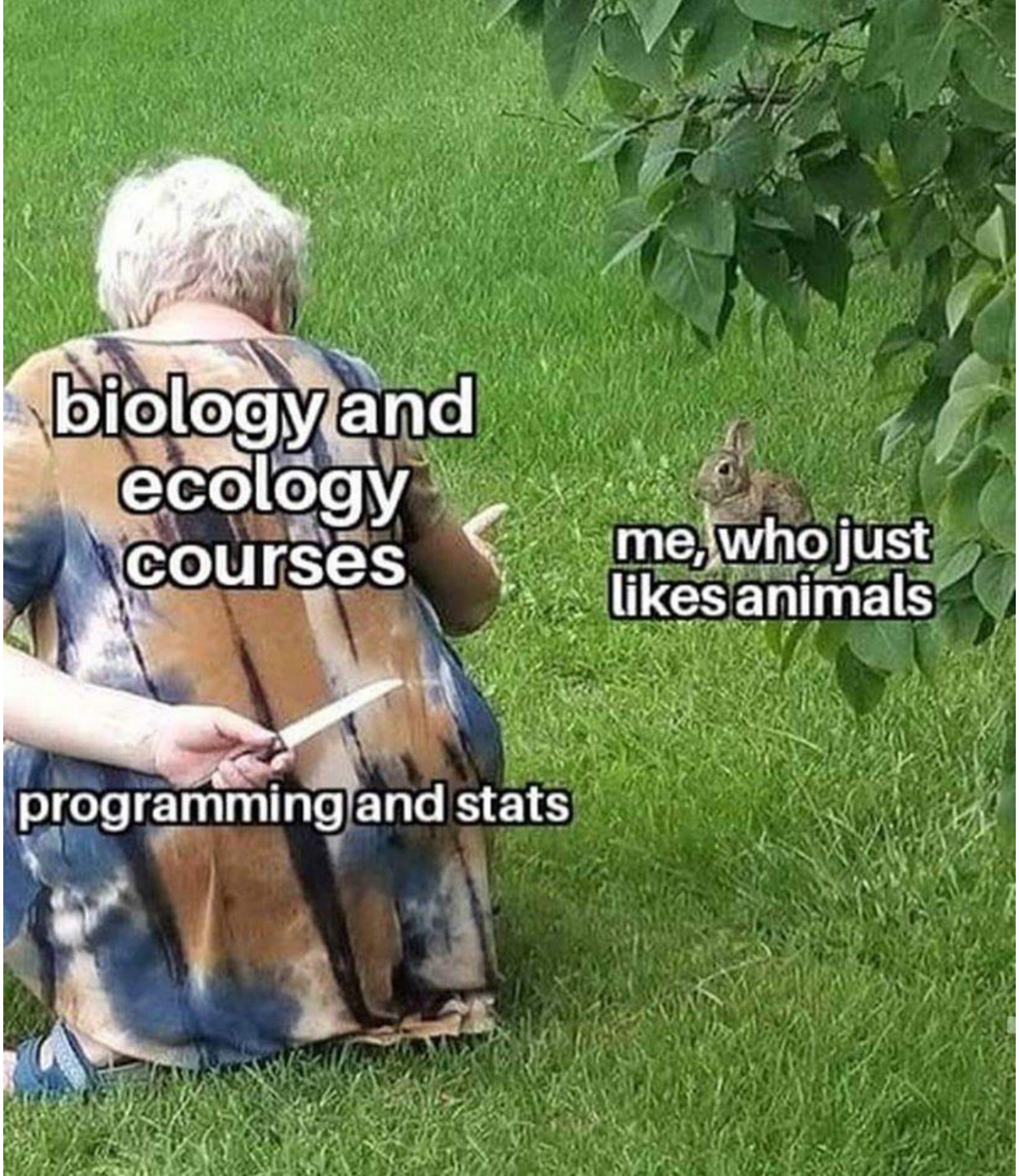
1988 TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 24:31-37

Me trying to talk to people

The many faces of quantitative ecology

The many faces of quantitative ecology




biology and ecology courses
me, who just likes animals
programming and stats

Species conservation in a dynamic world

GLM and beyond...

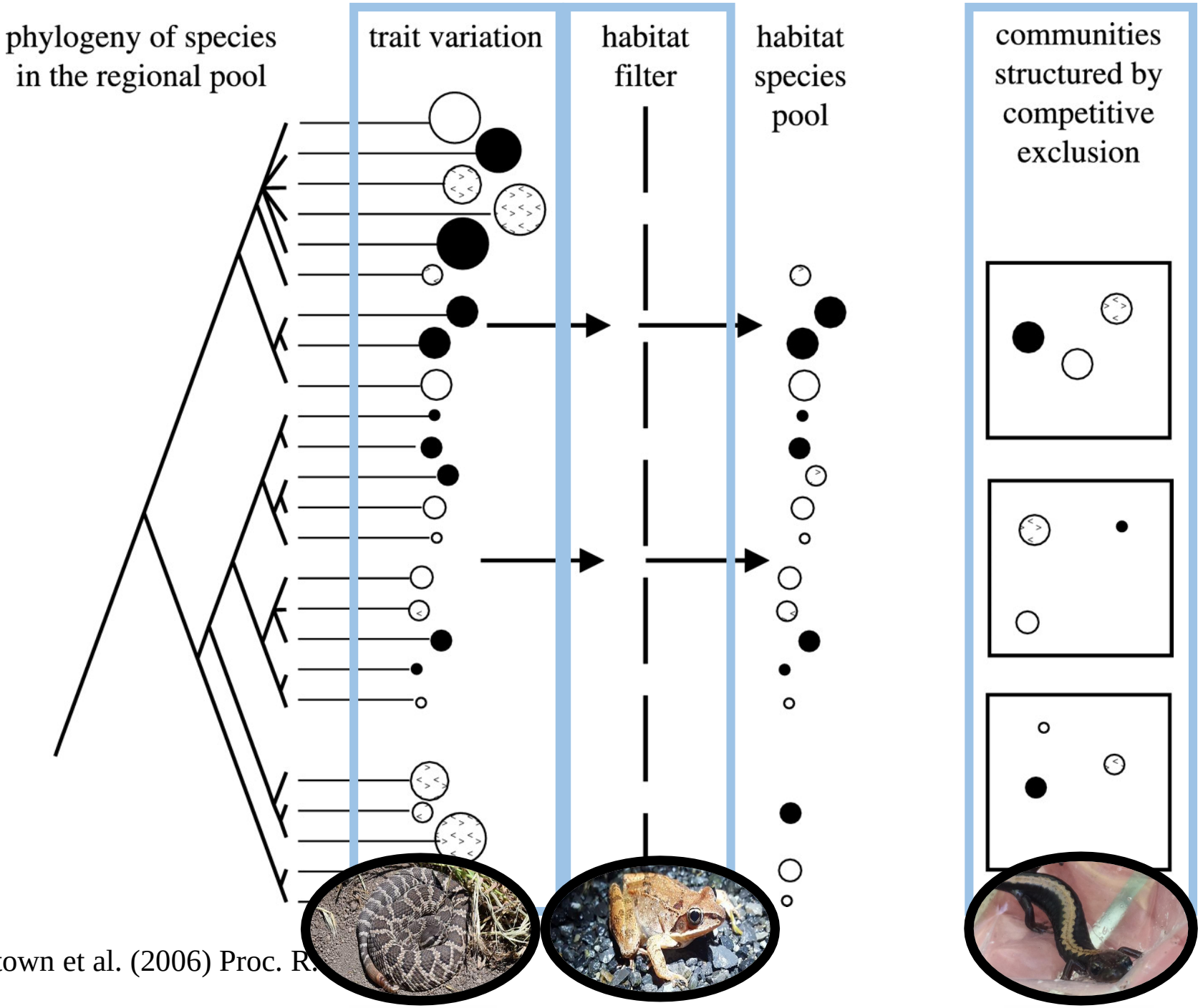
- There are three components to any GLM:

Link function Linear predictor

$$\ln \lambda_i = b_0 + b_1 x_i$$

$$y_i \sim \text{Poisson}(\lambda_i)$$

Probability distribution



Silvertown et al. (2006) Proc. R.

How many people are working on one of these filters?

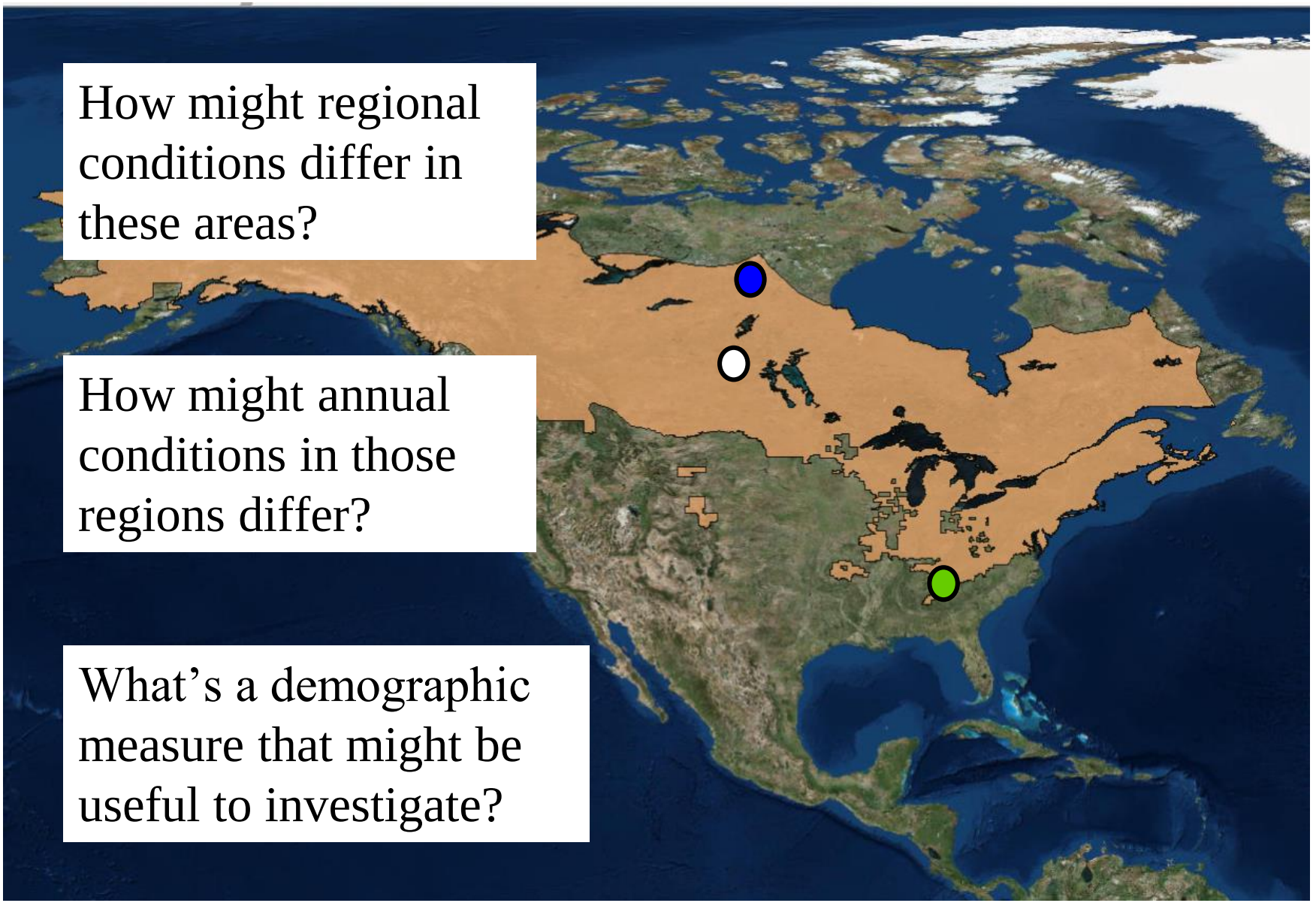
E.g.,
Variation in a trait being acted on by a stressor?
Habitat or abiotic conditions?
Species interactions?

Range position and climate sensitivity: The structure of among-population demographic responses to climatic variation

Amburgey et al. 2017. Global Change Biology 24: 439-454

Wood Frog (*Lithobates sylvaticus*)

Setting Range Limits

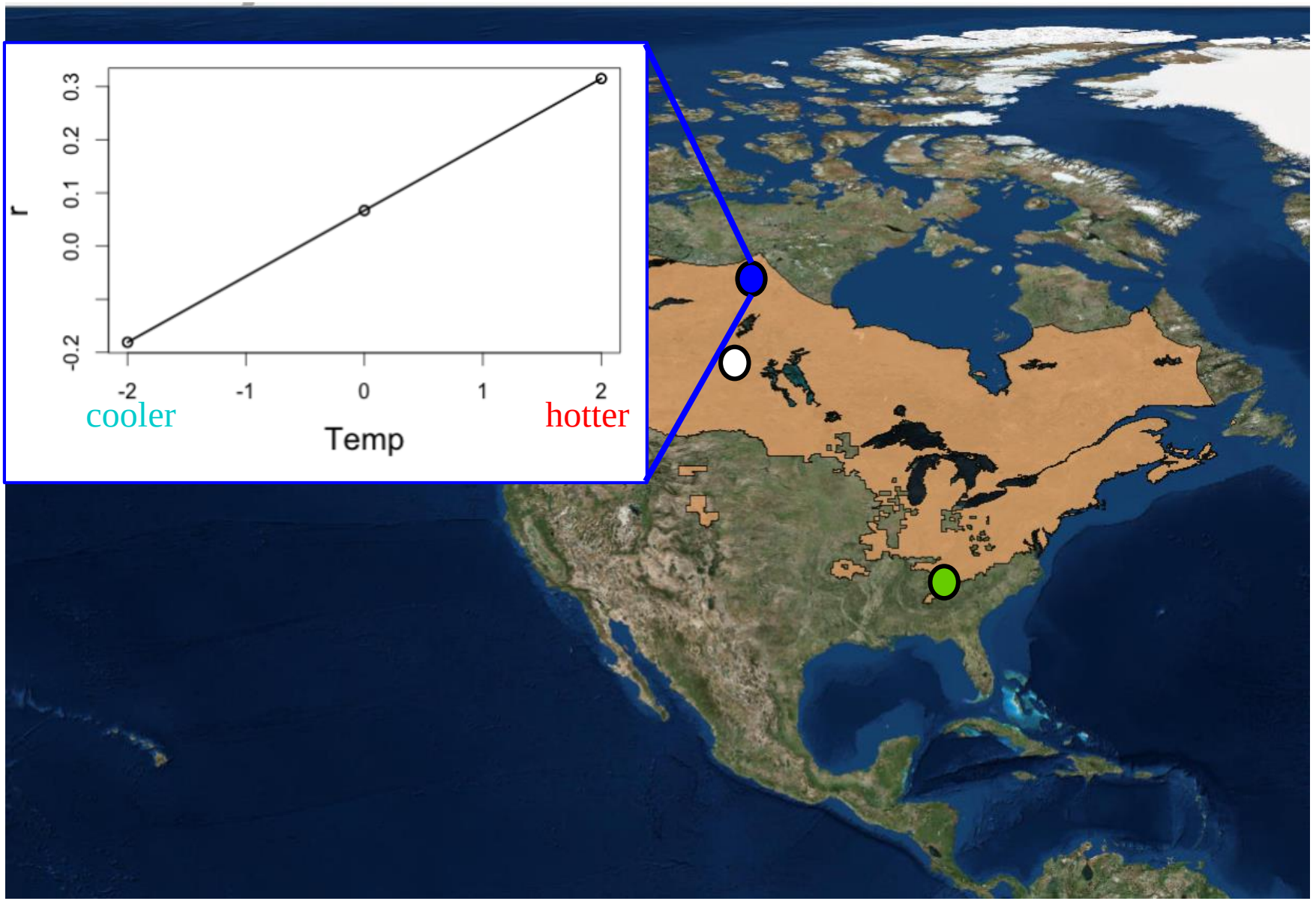


How might regional conditions differ in these areas?

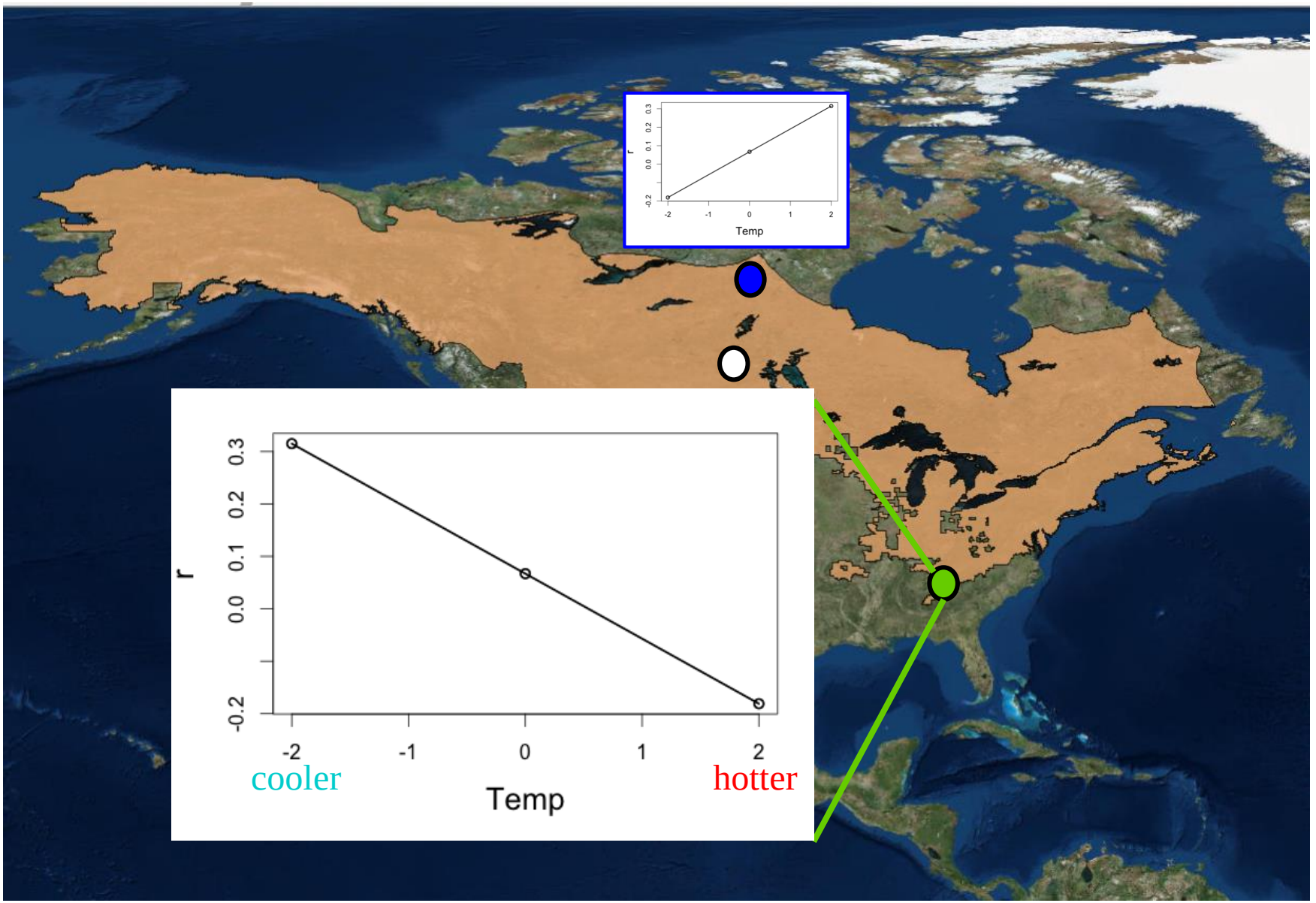
How might annual conditions in those regions differ?

What's a demographic measure that might be useful to investigate?

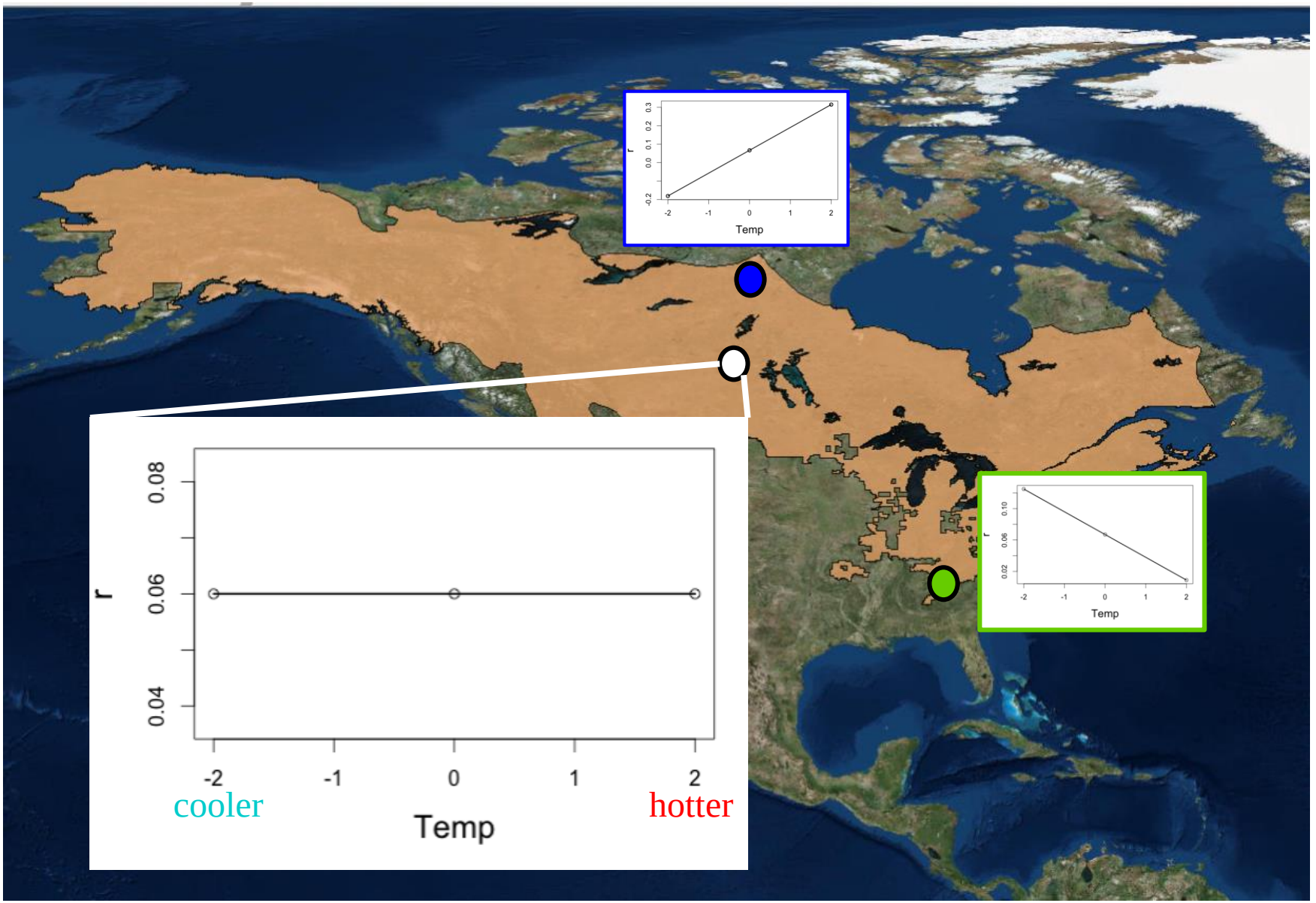
Setting Range Limits



Setting Range Limits



Setting Range Limits



Forming a broad-scale database

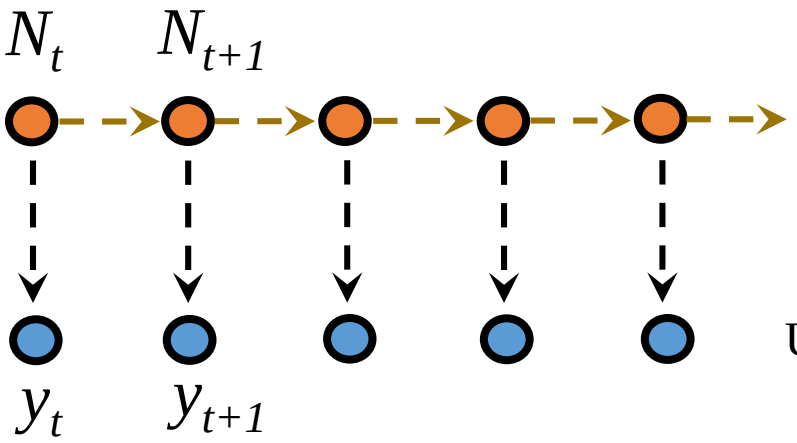
- 3-22 years (1993-2014)
- 747 sites in 27 study areas
- 18 states/admin subdiv/provinces
- Egg mass counts
  - Proxy for # females

State-space models

Model process variation and observation error

State process
Population Size

Observation process
Population Count



Why are these not the same?

Uncertainty, imprecision, error

Kalman (1960) J Basic Engineering

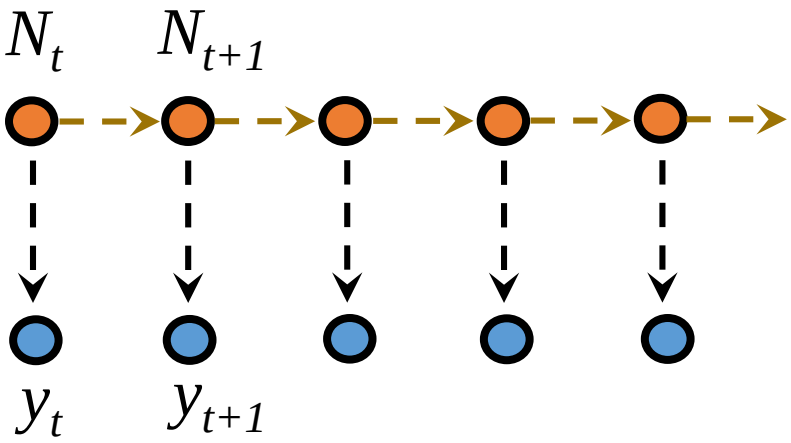
Sensu Kéry & Schaub (2012) Bayesian Pop Analysis

State-space models

Model process variation and observation error

State process
Population Size

Observation process
Population Count



Population Size $N_{t+1} = N_t * e^r$

Population Count $y_t = \log(N_t) + \varepsilon_t$

Kalman (1960) J Basic Engineering

Sensu Kéry & Schaub (2012) Bayesian Pop Analysis

Dynamic growth model

Indexing by time and site

$$\log(N_{ti}) = \log(N_{(t-1,i)}) + r_{ti}$$

AnnualClim RegionalClim Interaction

$$r_{ti} = \beta_0 + \beta_1 * x_{1,ti} + \beta_2 * x_{2,ti} + \beta_3 * \text{int}_{ti} + \delta_i + \varepsilon_{ti}$$

Climate covariates

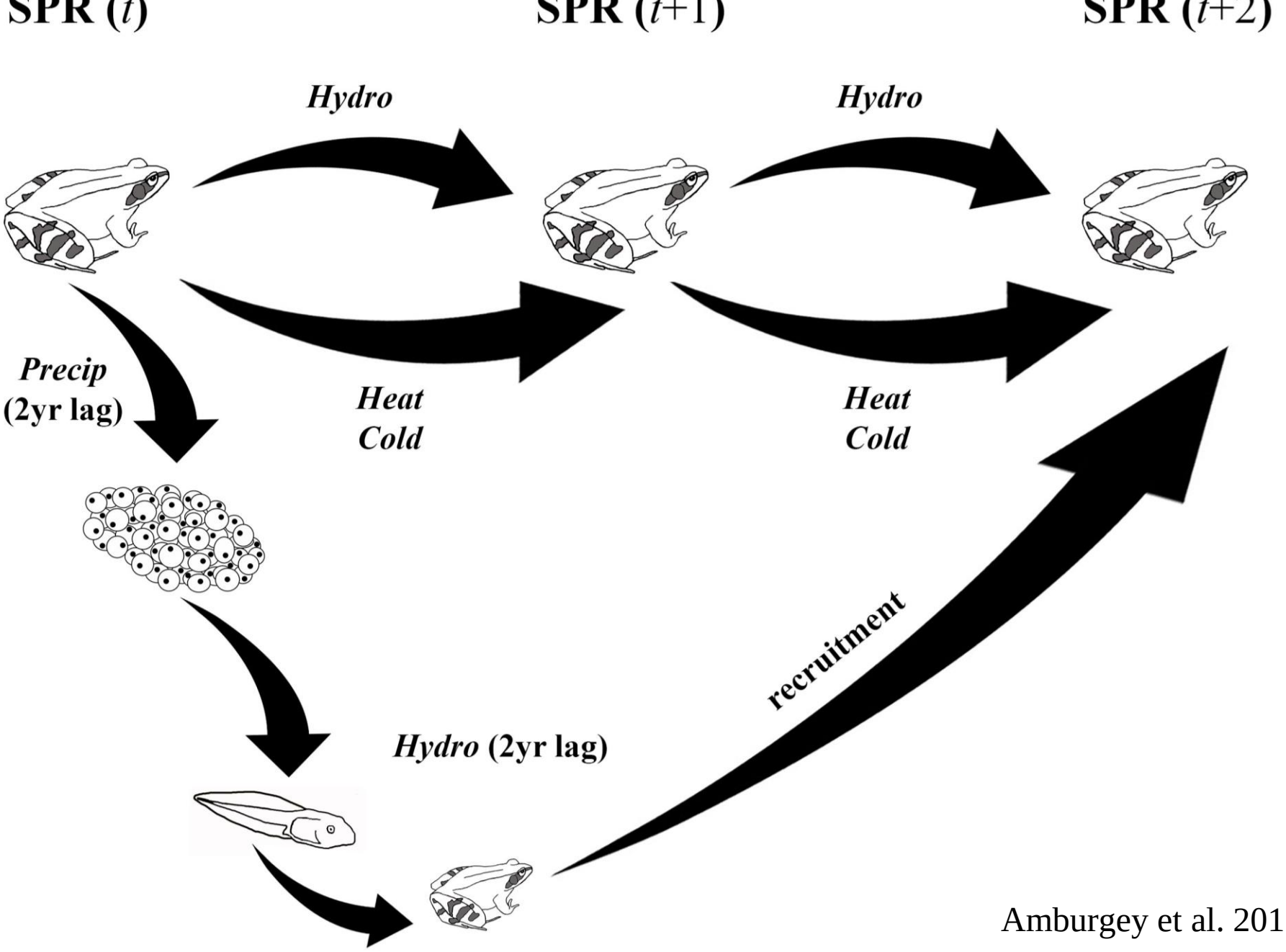
Random Effects

Factor 1: Precip

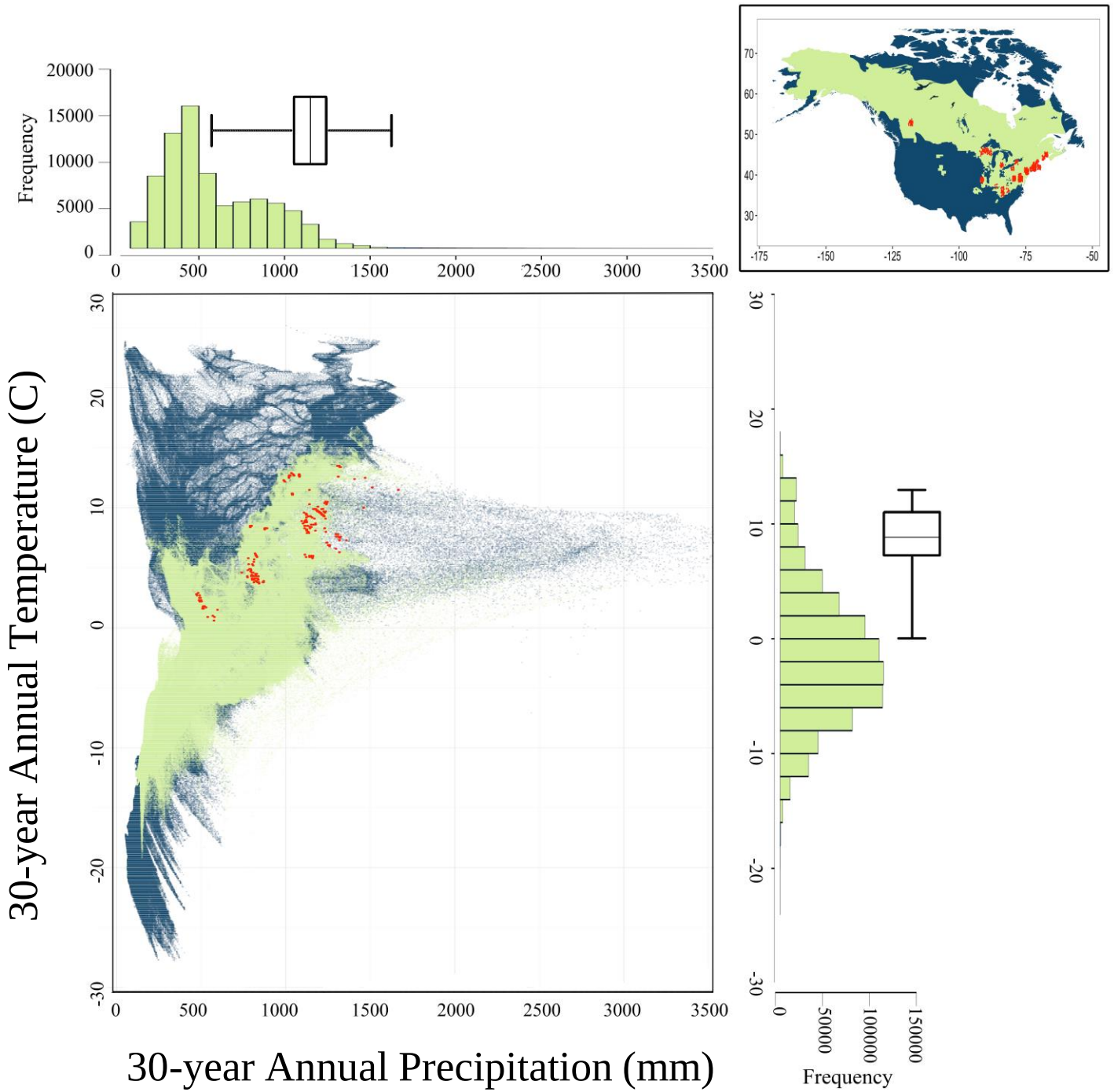
Factor 2: Hydro

Factor 3: Heat

Factor 4: Cold

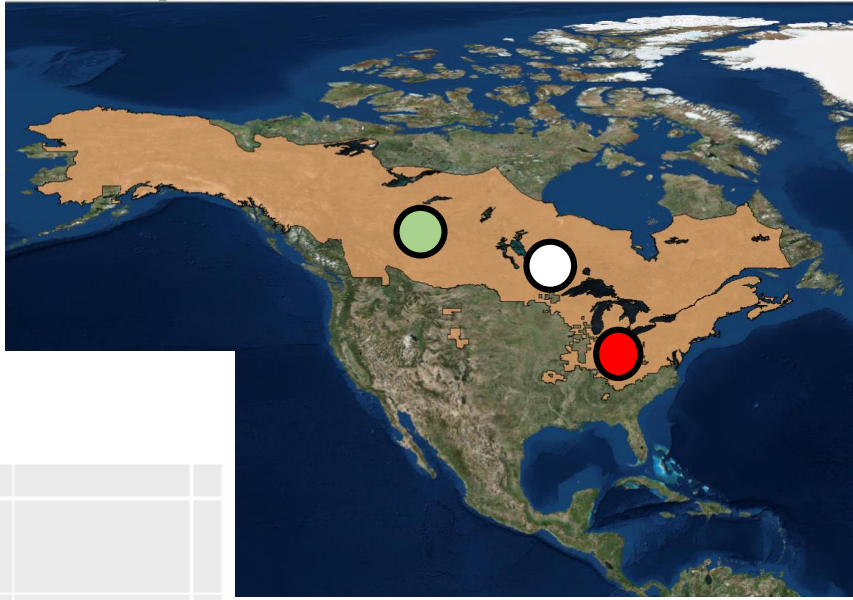


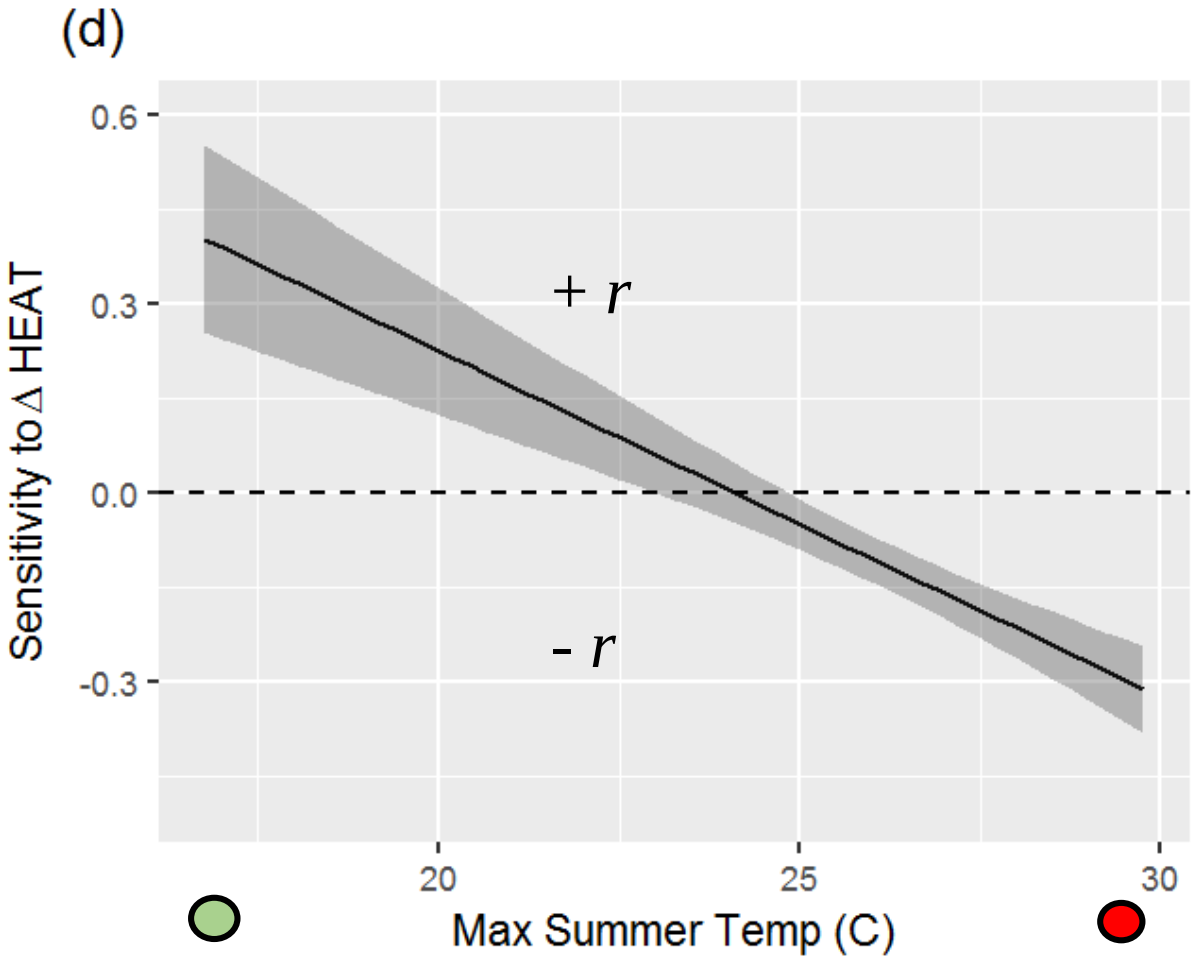
Amburgey et al. 2017



Hijmans et al. 2005; http://www.worldclim.org/

Results- Heat (summer)



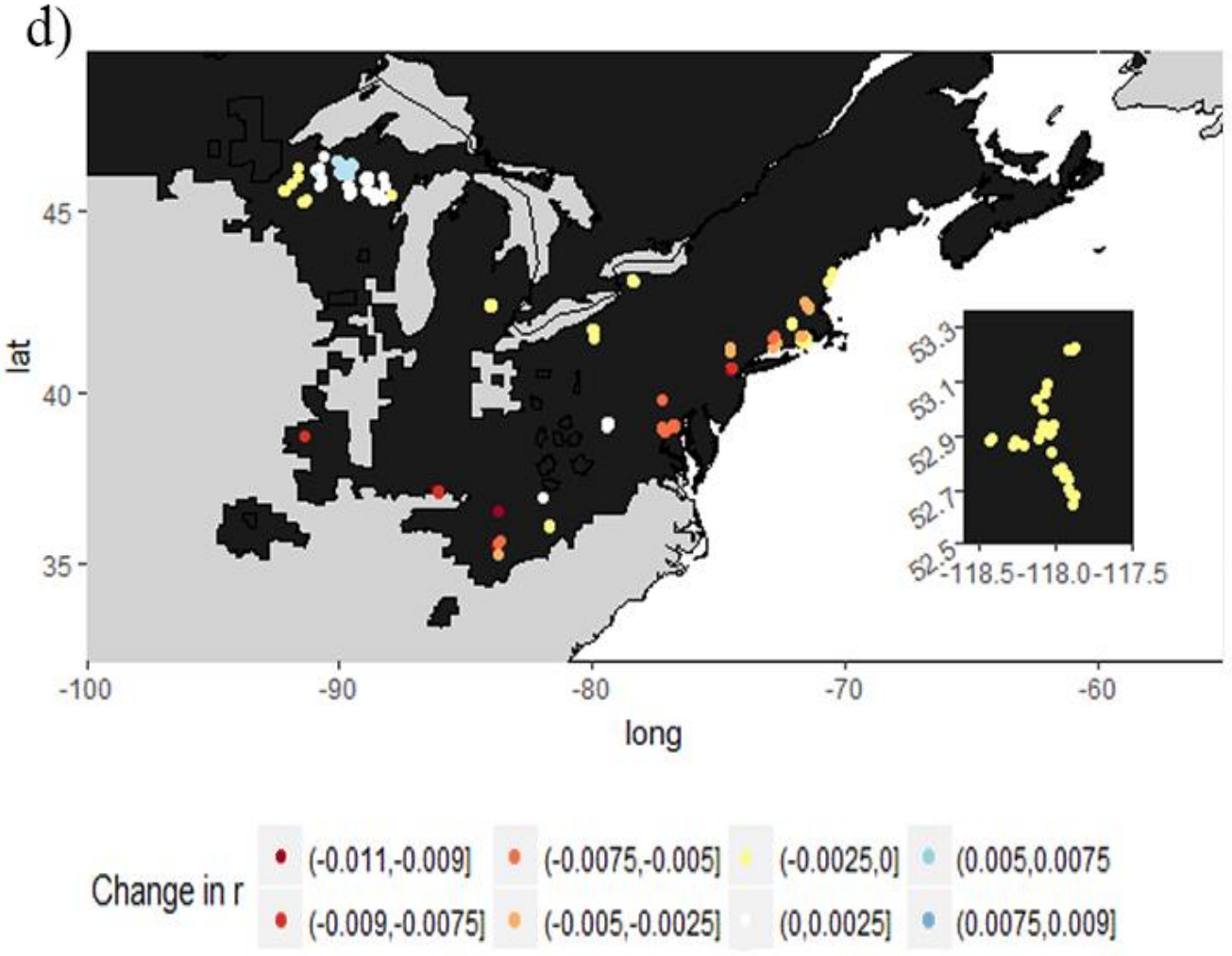


Cold (winter) had no real correlation to *r*

Why?

https://www.youtube.com/watch?v=pLPeehsXAr4

Hindcasting – Heat (summer)



Dynamic growth model

- Indexing by time and site
- Modeling true process that will allow for predicting change

$$\log(N_{ti}) = \log(N_{(t-1,i)}) + r_{ti}$$

$$r_{ti} = \beta_0 + \beta_1 * x_{1,ti} + \beta_2 * x_{2,ti} + \beta_3 * \text{int}_{ti} + \delta_i + \varepsilon_{ti}$$

Climate covariates
- Urbanization
- Habitat
- Disease
- And many more…

Random Effects

Species conservation in a dynamic world

Knowing your limits: Understanding the role of interspecific interactions in structuring range boundaries

Amburgey et al. 2019. Ecosphere 10: e02727

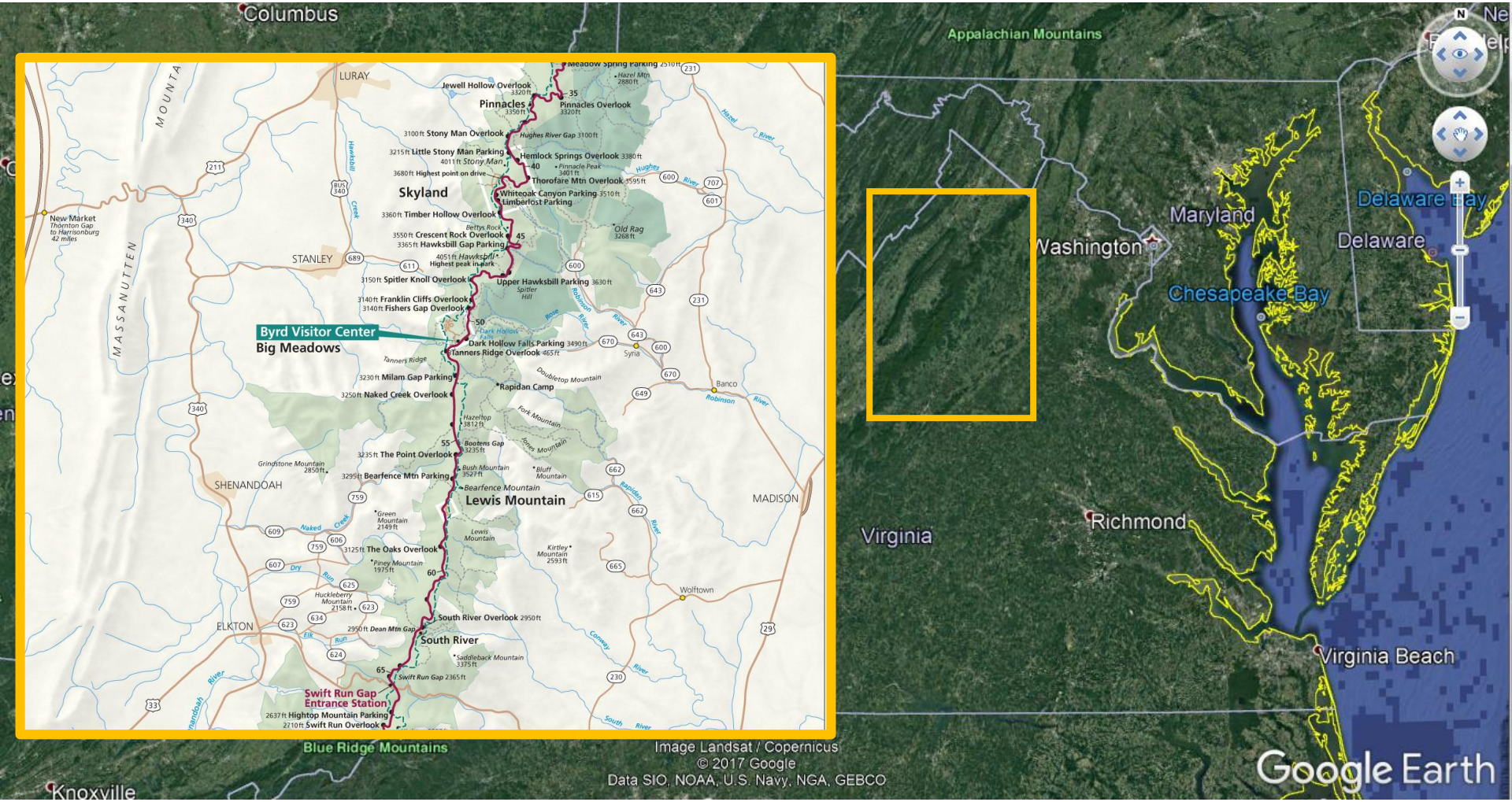
Factors Facilitating Co-occurrence at the Range Boundary of Shenandoah and Red-Backed Salamanders

Amburgey et al. 2020. Journal of Herpetology 54, 125-135


A. Ormiston


A. Ormiston

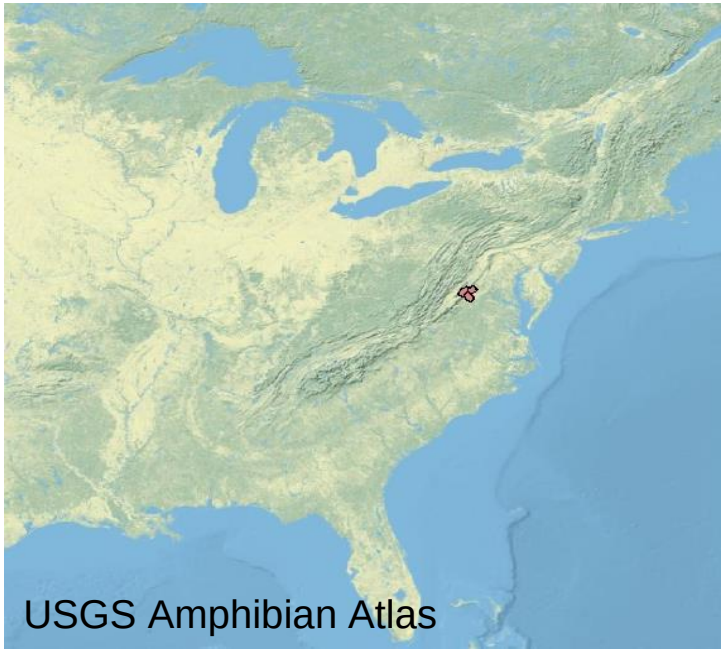
Shenandoah National Park



Shenandoah salamander
(*Plethodon shenandoah*)

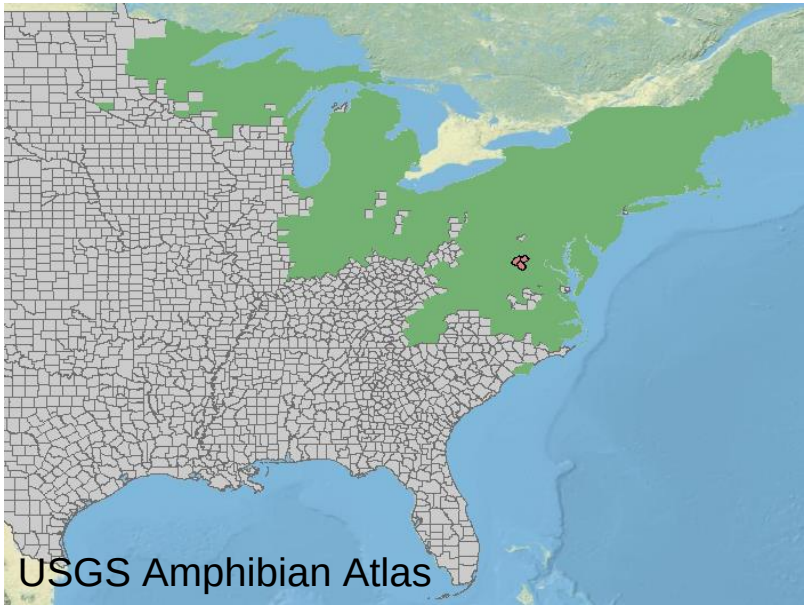
At risk of extinction in near future

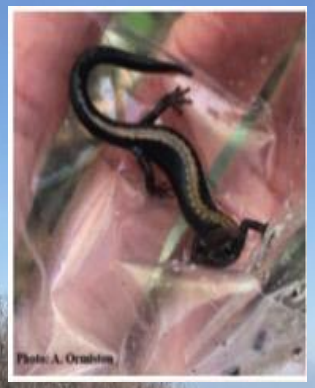
- Range restricted
- Federally endangered
- 3 mountain peaks, > 850m
- North-facing talus slopes



Red-backed salamander
(*Plethodon cinereus*)

- Widespread
- Least Concern
- Forested slopes
- Deeper, moist soil





"I suggested that *shenandoah* is at a competitive disadvantage with *cinereus* in a soil habitat and survives now only in suitable areas of talus that *cinereus* cannot penetrate."
-R. Jaeger 1971, Ecology 52(4)


D. Muñoz

"...The recovery objective for this species is, therefore, stabilization of known populations by minimizing human impacts on the Shenandoah salamander."

Jaeger 1970, 1971a&b, 1972, Griffis and Jaeger 1998

What are some things we can ask about this study system?

Why Occupancy?

Why Occupancy?

Cats=

1

Why Occupancy?

Cats=

1

?

Why Occupancy?

Cats=

1??

0??

Occupancy Model Framework

State process
Occupancy

$$z_i \sim Bernoulli(\psi_i)$$

Observation process
Detections

$$y_{it} \sim Bernoulli(z_i * p_t)$$

$$\text{logit}(\psi_i) = \beta_0 + \beta_1 * \text{Covariate}_i$$

$$\text{logit}(p_t) = \alpha_0 + \alpha_1 * \text{Covariate}_t$$

Occupancy Modeling

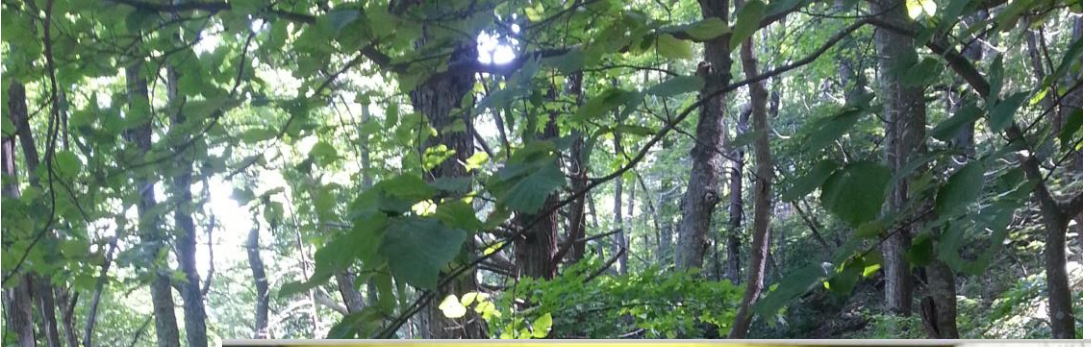
Survey 1 

Survey 2 

Survey 3  

Survey 4 

Survey 5



Survey 1

Rite in the Rain
ALL-WEATHER WRITING PAPER

Name _____

_____

Address _____

_____

Phone _____

Project _____

_____

_____

_____

Clear Vinyl Protective Slipcovers (Item No. 32) are available for this style of notebook. Helps protect your notebook from wear & tear. Contact your dealer or the J.L. Darling Corporation

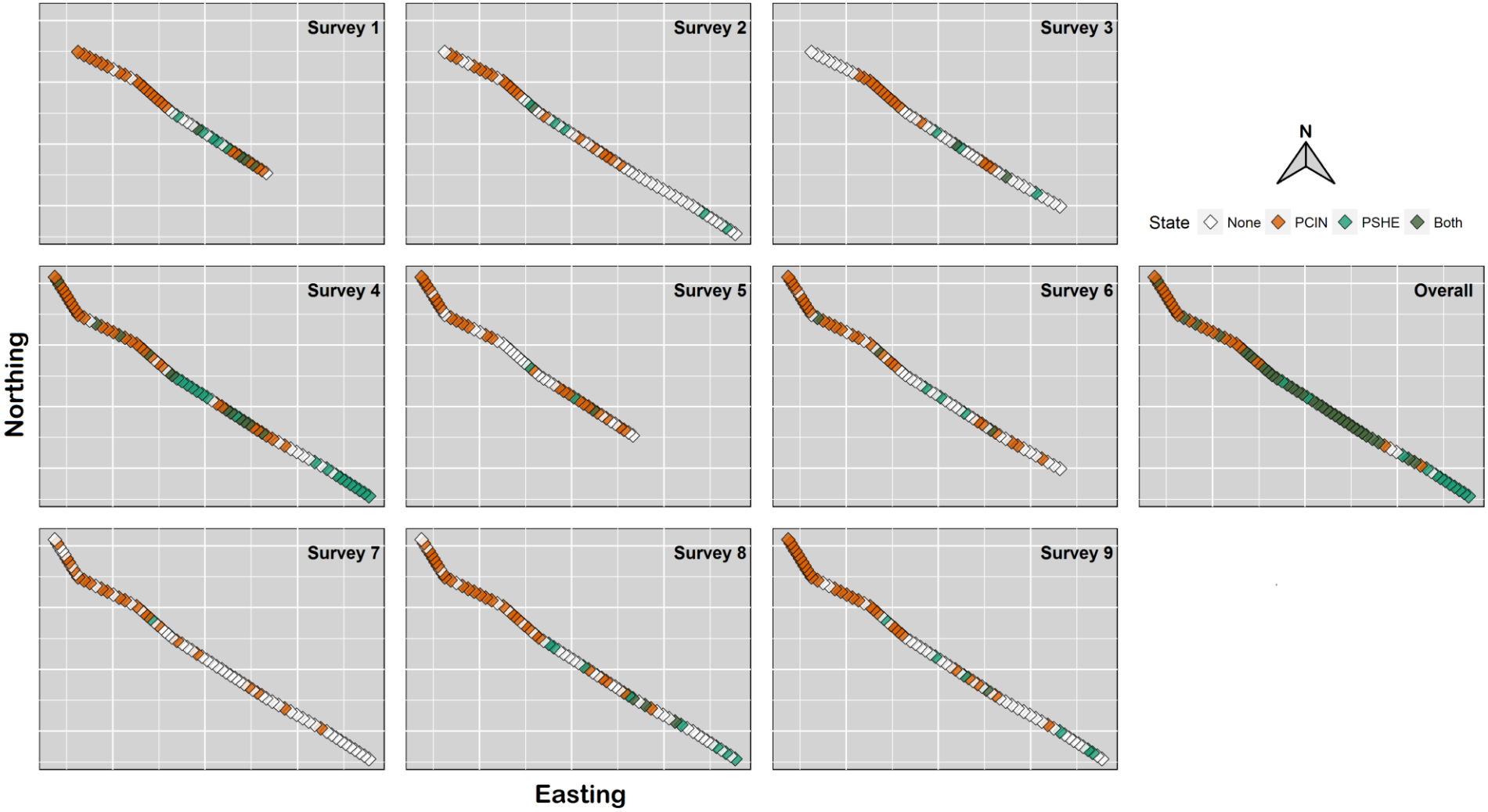
1

CONTENTS

PAGE	REFERENCE	DATE
	Salamanders	
	Do they exist?	

Oc

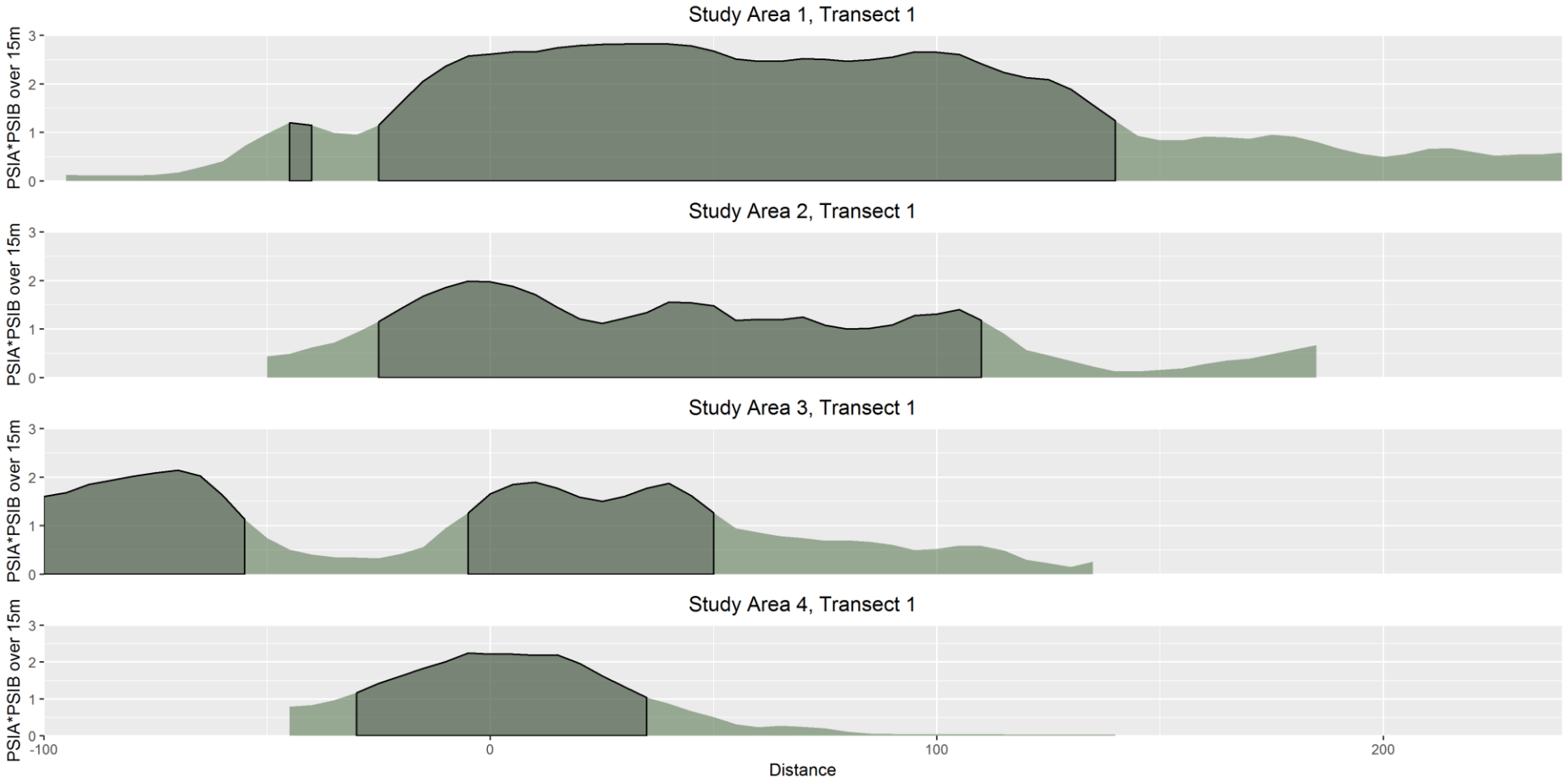
Snapshot of detection



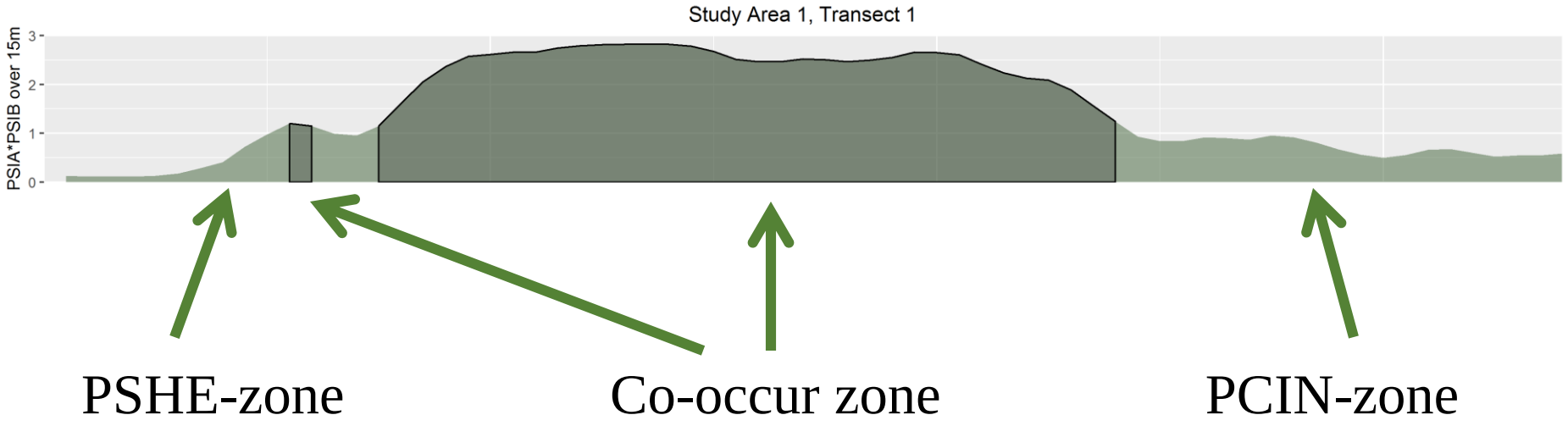
Broader Area of Co-occurrence

<100m, Jaeger 1972

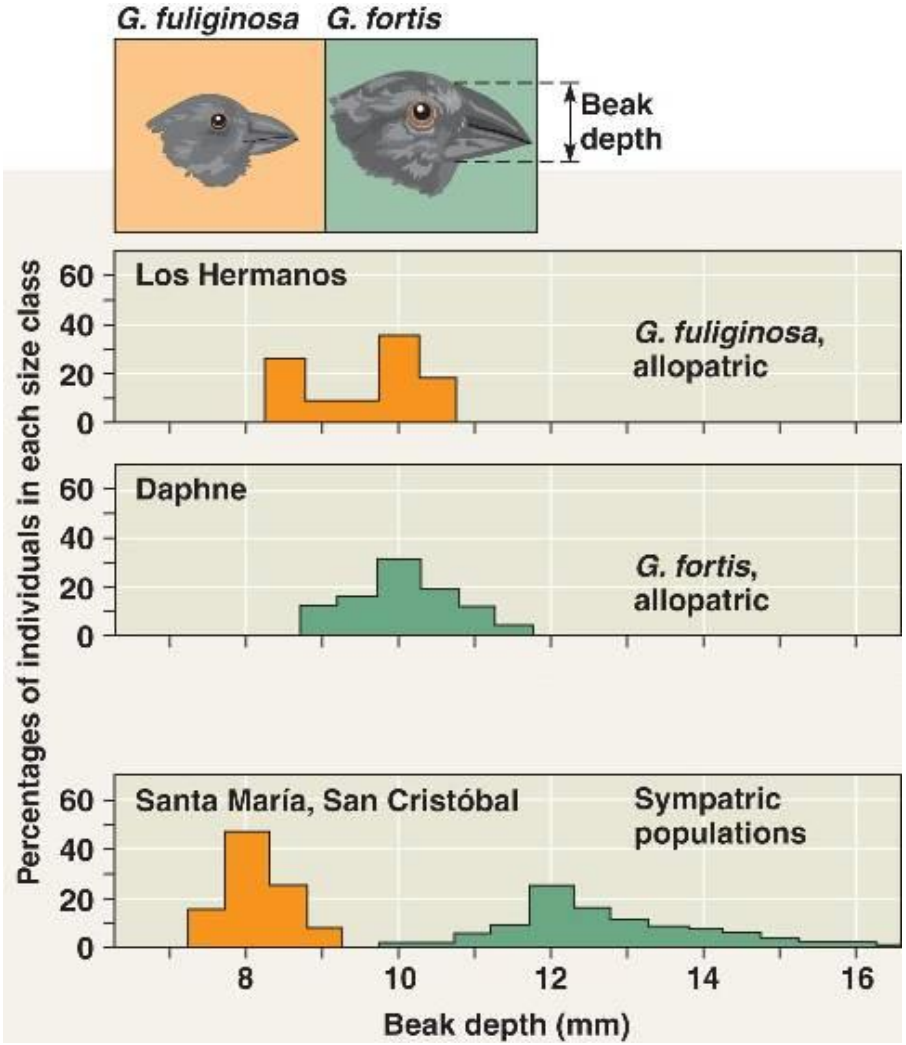
>100m in >50% transects

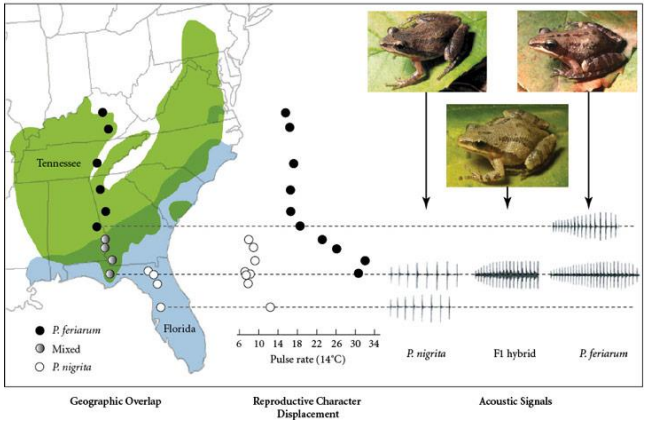


Broader Area of Co-occurrence

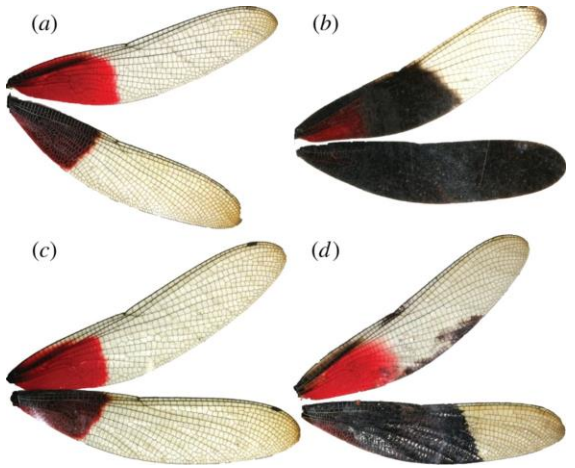


Character Displacement?

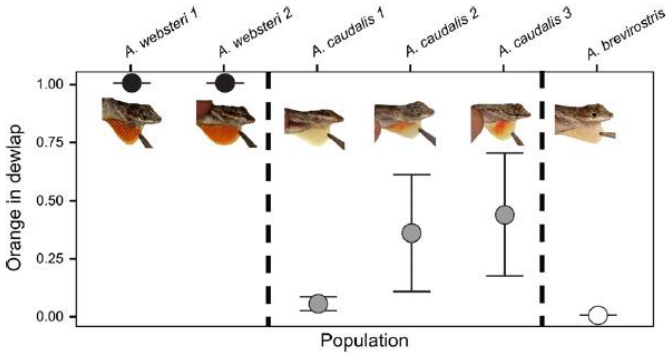




Lemmon and Lemmon

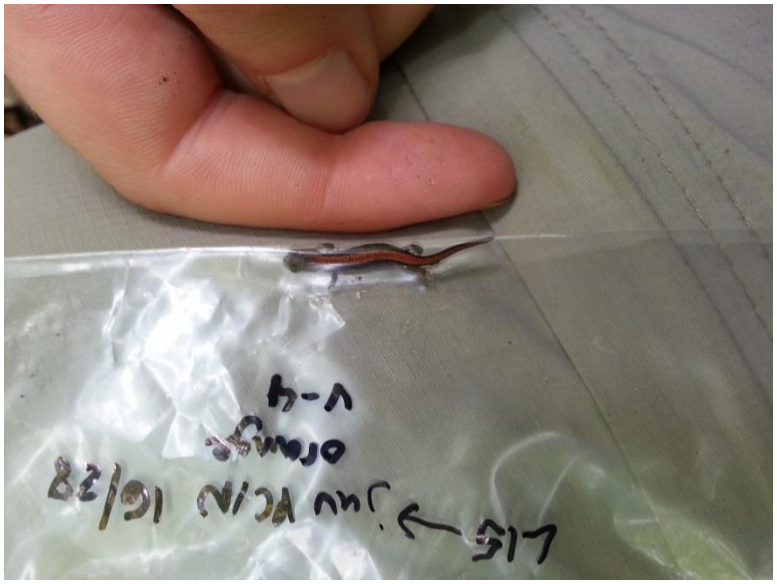


Drury and Grether 2014



Lambert et al. 2013

What are some traits, behaviors, etc. we can measure?



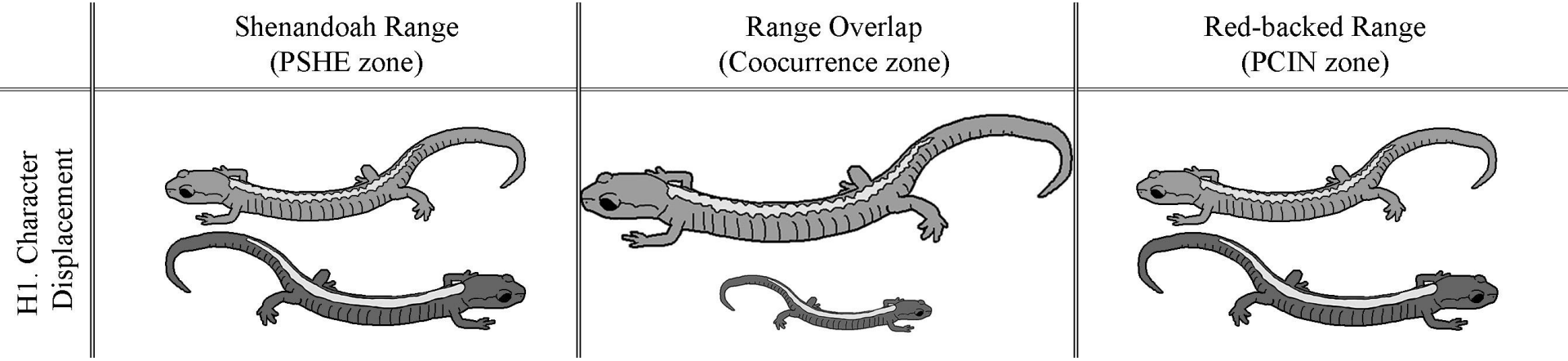
Analyzing Traits

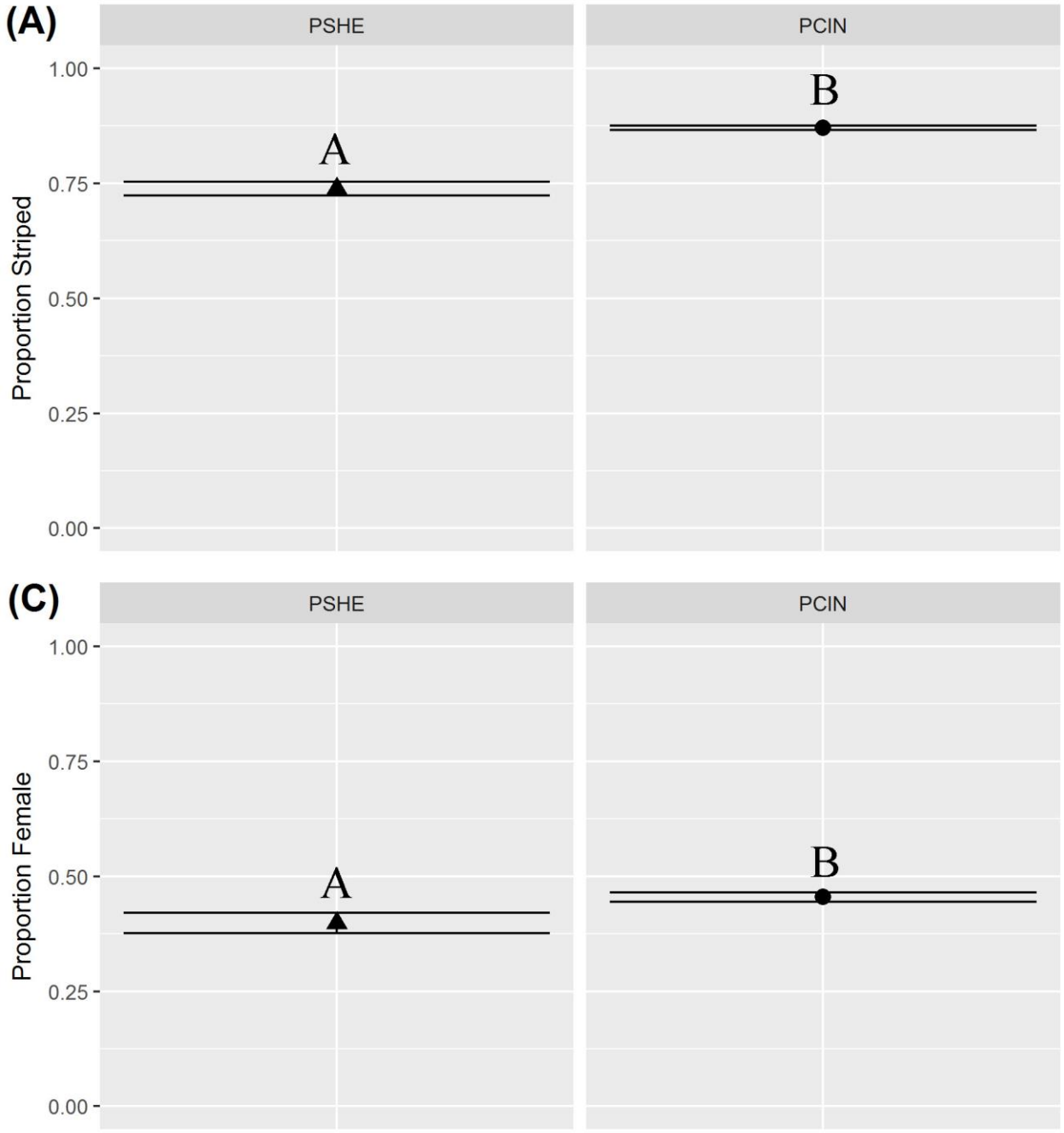
Logistic and linear regression

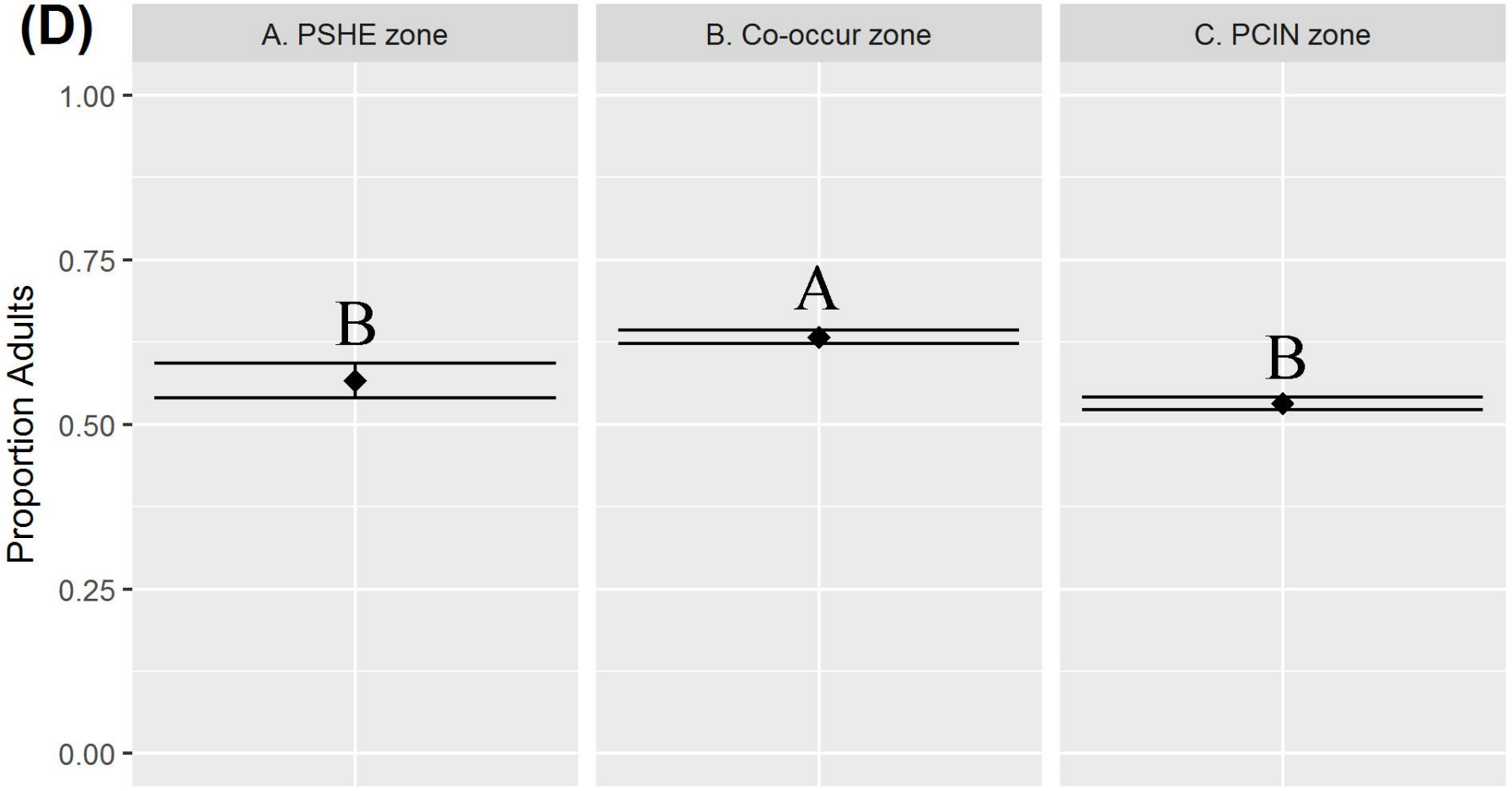
- Species
- Zone
- Species + Zone
- Species * Zone

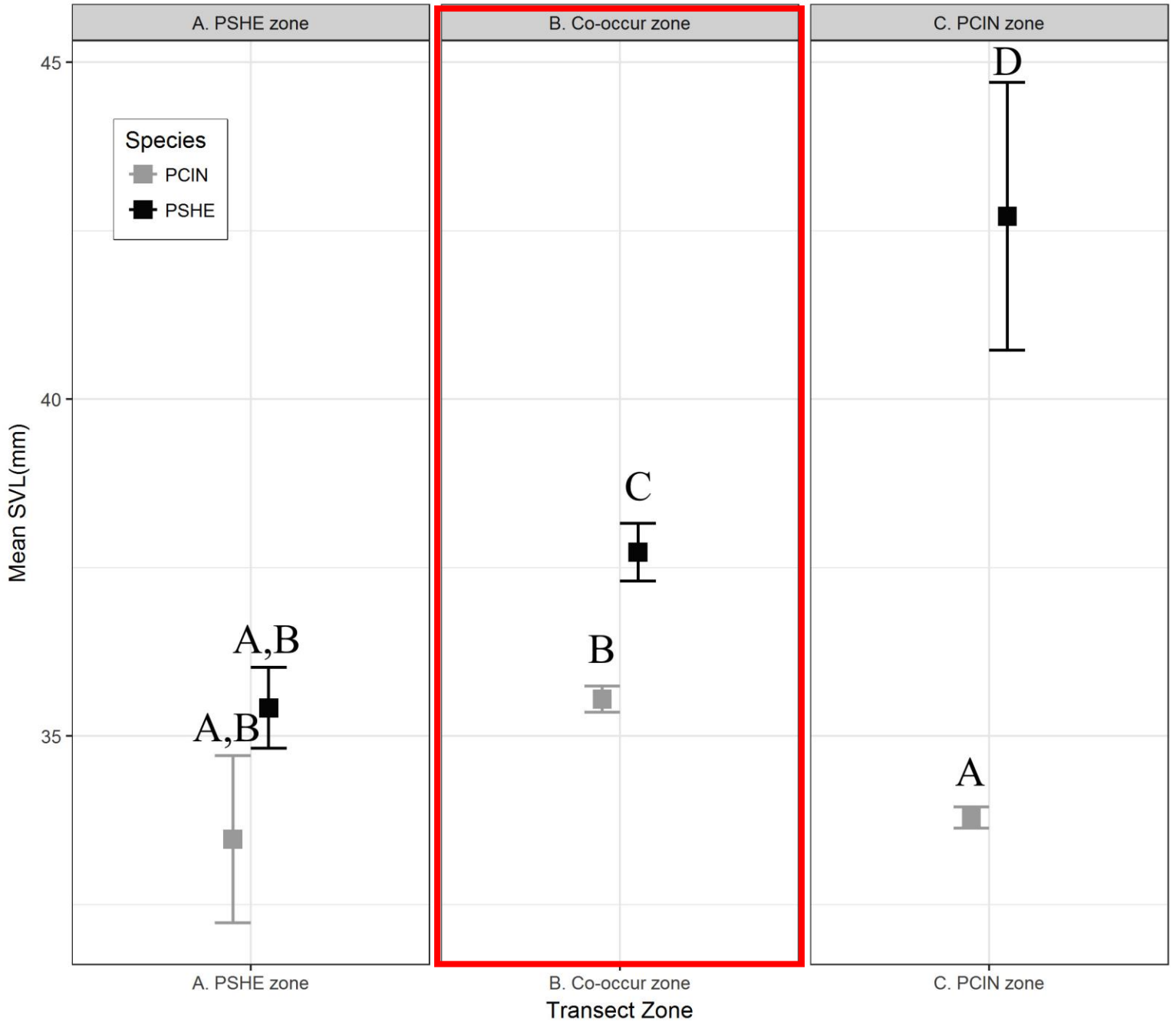
Model selection
via AIC
(QAICc technically...)

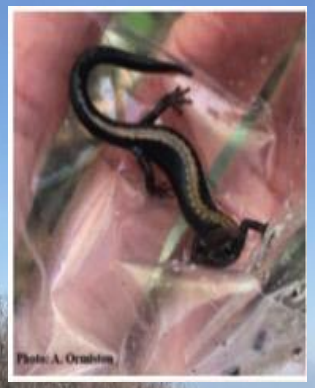
Post-hoc comparisons (e.g., Tukey's HSD)




(A)
PSHE
PCIN
1.00
0.75
0.50
0.25
0.00
Proportion Striped
A
B
(C)
PSHE
PCIN
1.00
0.75
0.50
0.25
0.00
Proportion Female
A
B


(D)
A. PSHE zone
B. Co-occur zone
C. PCIN zone
Proportion Adults
1.00
0.75
0.50
0.25
0.00
B
A
B


A. PSHE zone
B. Co-occur zone
C. PCIN zone
Species
PCIN
PSHE
45
40
35
Mean SVL(mm)
A,B
A,B
C
B
D
A
A. PSHE zone
B. Co-occur zone
C. PCIN zone
Transect Zone



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Jaeger 1970, 1971a&b, 1972, Griffis and Jaeger 1998

Models today

- There are three components to any GLM:

Link function Linear predictor

$$\ln \lambda_i = b_0 + b_1 x_i$$

$$y_i \sim \text{Poisson}(\lambda_i)$$

Probability distribution

Species conservation in a dynamic world

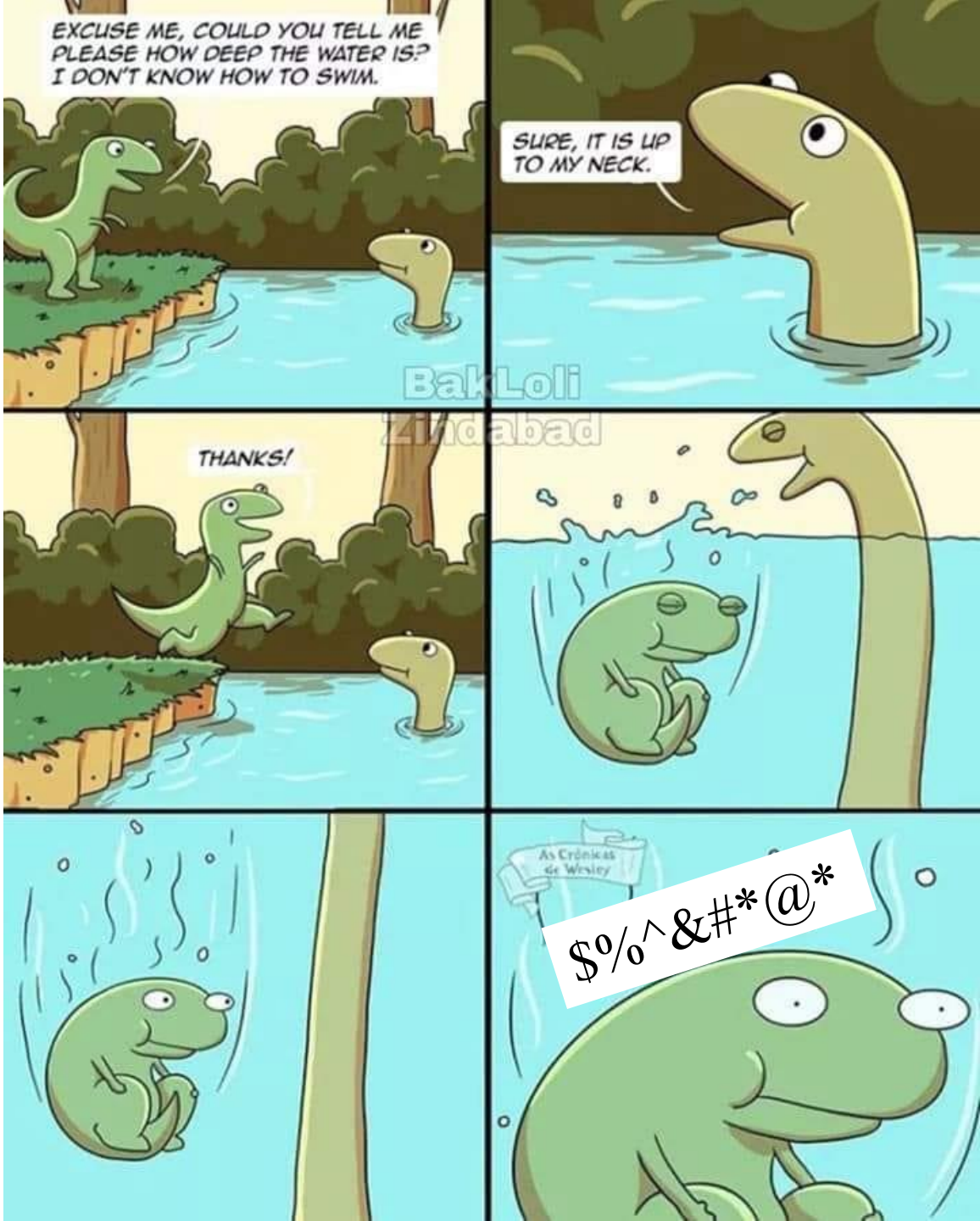
The Benefits of Quantitative Ecology

The Benefits of Quantitative Ecology

Programming skillz!

The Benefits of Quantitative Ecology

Digging deeper!



The Benefits of Quantitative Ecology

Study all the things!

Charley Harper

Questions?

❖sma279@uw.edu

Bonus game!

Find that brown treesnake!


2015-03-13 18:54:00 T
27°C
CAM7
RECONYX


2015-03-13 18:54:00 T
27°C
CAM7
RECONYX


2015-03-16 23:11:30 T
24°C
R5
CAM5
RECONYX


2015-03-16 23:11:30 T
24°C
R5
CAM5
RECONYX


2015-03-22 03:32:30 T
26°C
R5
CAM5
RECONYX


2015-03-22 03:32:30 T
26°C
R5
CAM5
RECONYX