Landscape approaches for understanding and managing lakes

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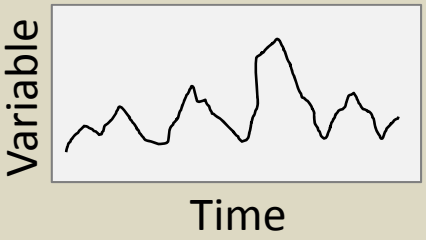
Scottish Freshwater Group

24 October 2013

landscapelimnology

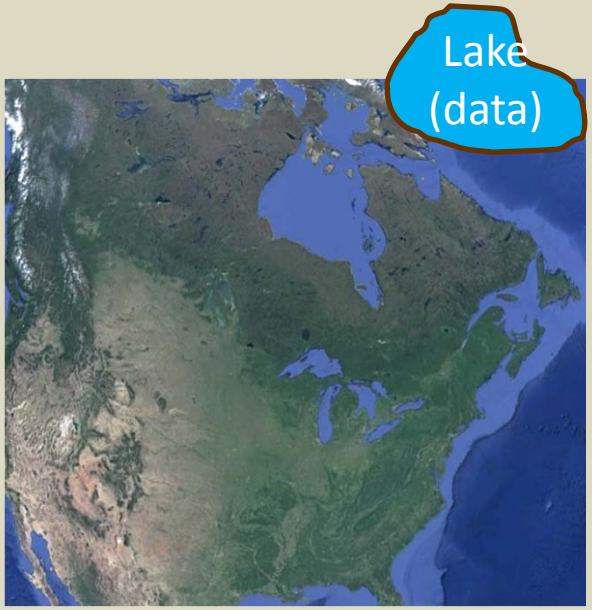
Queen's University Belfast

Making inferences from well-studied ecosystems



Making inferences from well-studied ecosystems

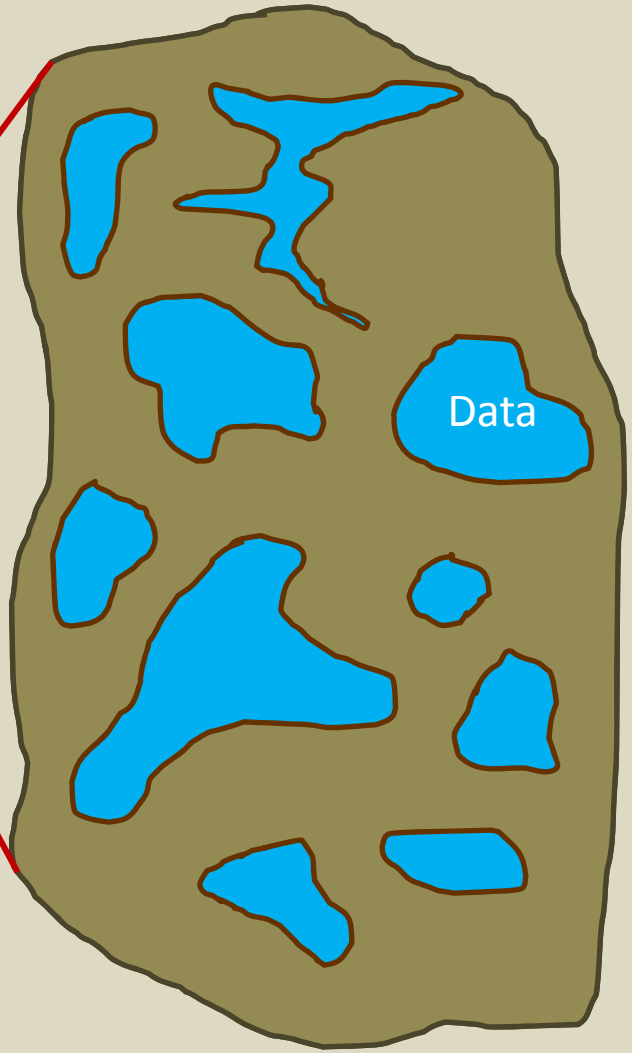
Option 1



Making inferences from well-studied ecosystems

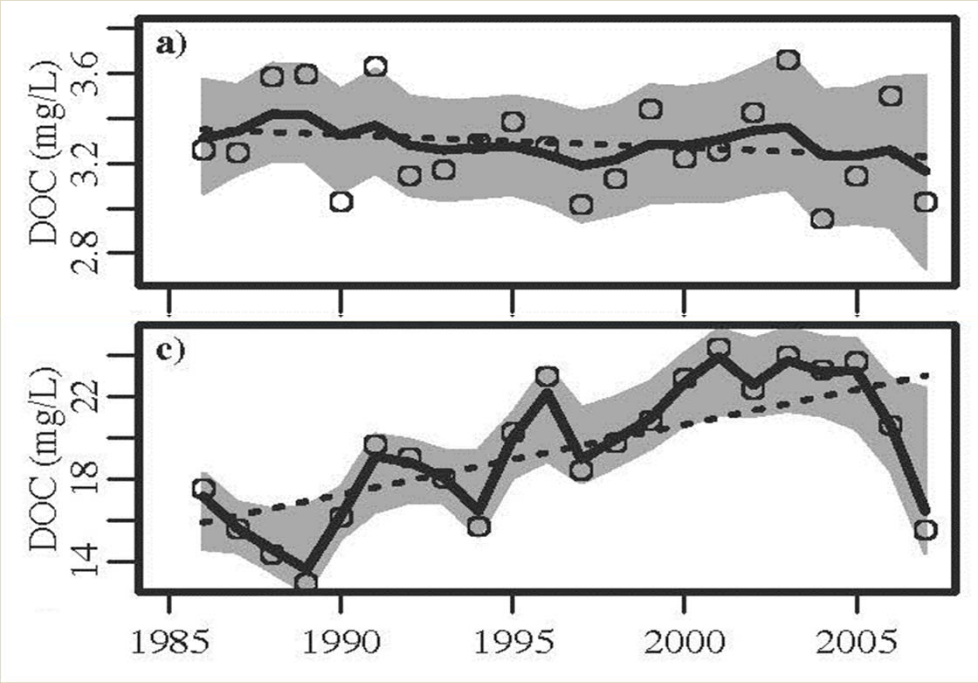
Option 1

Option 2



Making inferences from well-studied ecosystems

Within-region variability

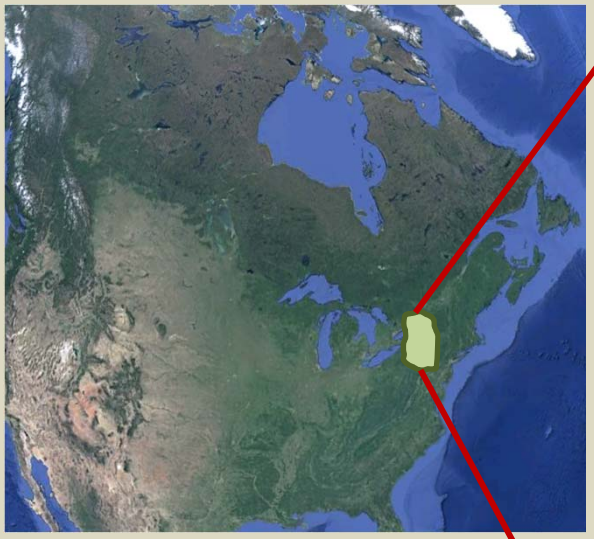


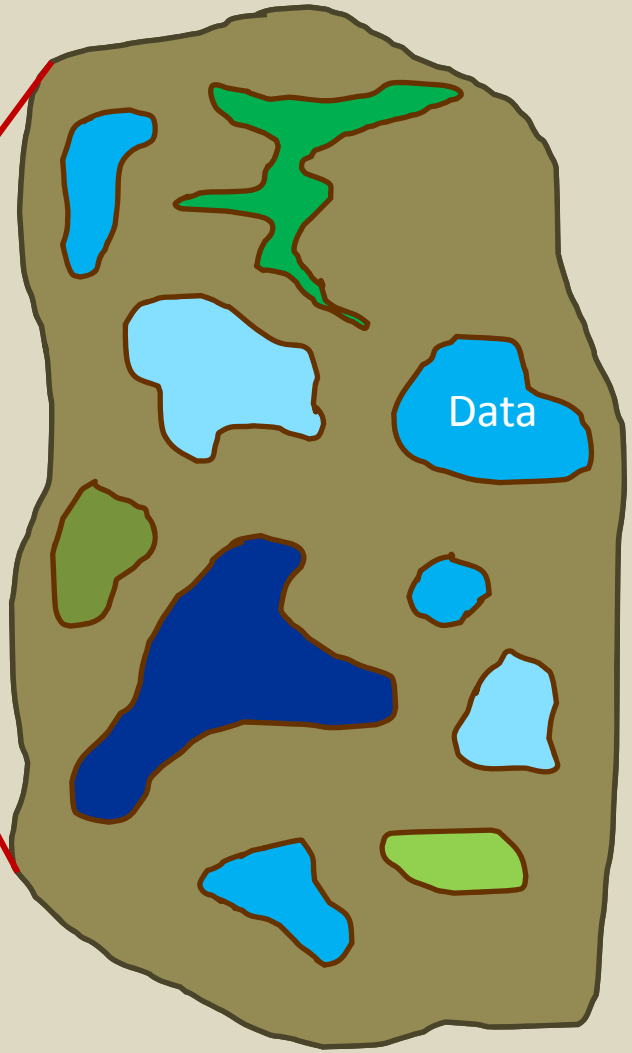
Levy et al. under review Frontiers in Ecology & the Environment

Making inferences from well-studied ecosystems

Option 1

Option 2

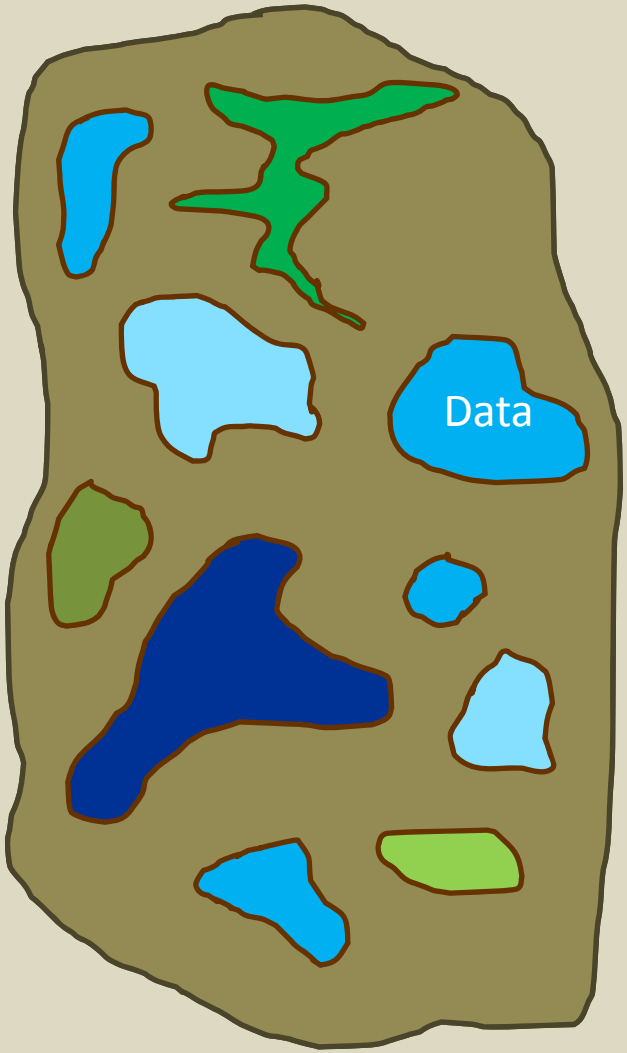




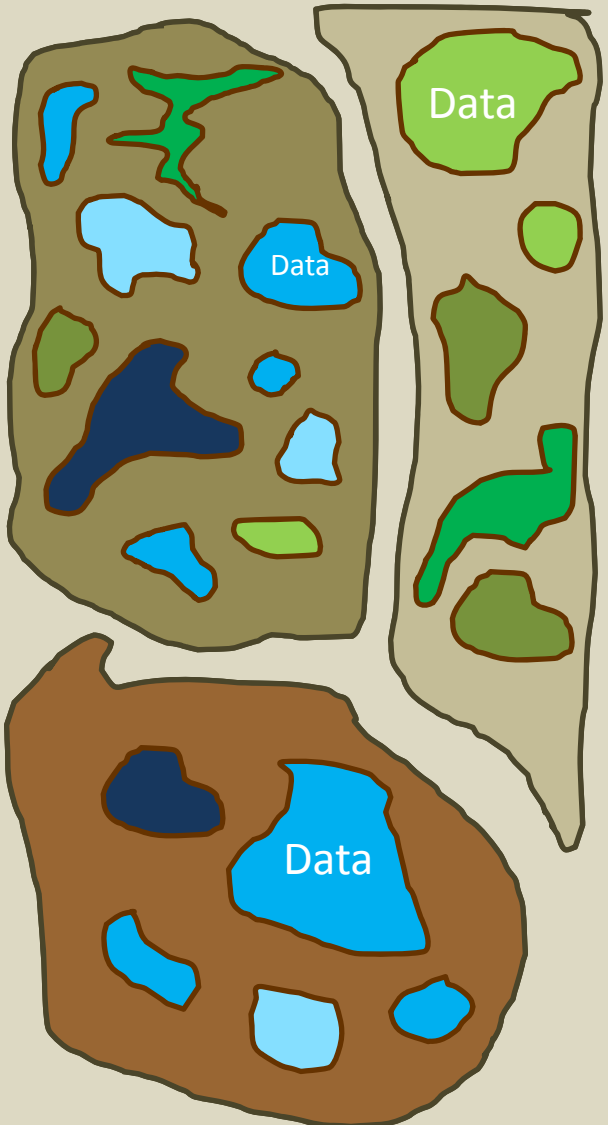
Making inferences from well-studied ecosystems

Option 1

Option 2



Option 3



What do we need to make better inferences?

- **Conceptual models** of relationships across scales
- **Large datasets** - Multi-scaled, multi-themed
- **Robust modeling approaches** for multi-scaled data

Conceptual Underpinning: Landscape limnology

The **spatially explicit** study of lakes, streams, and wetlands as they **interact with freshwater, terrestrial, and human landscapes** to determine the effects of pattern on ecosystem processes across temporal and spatial scales

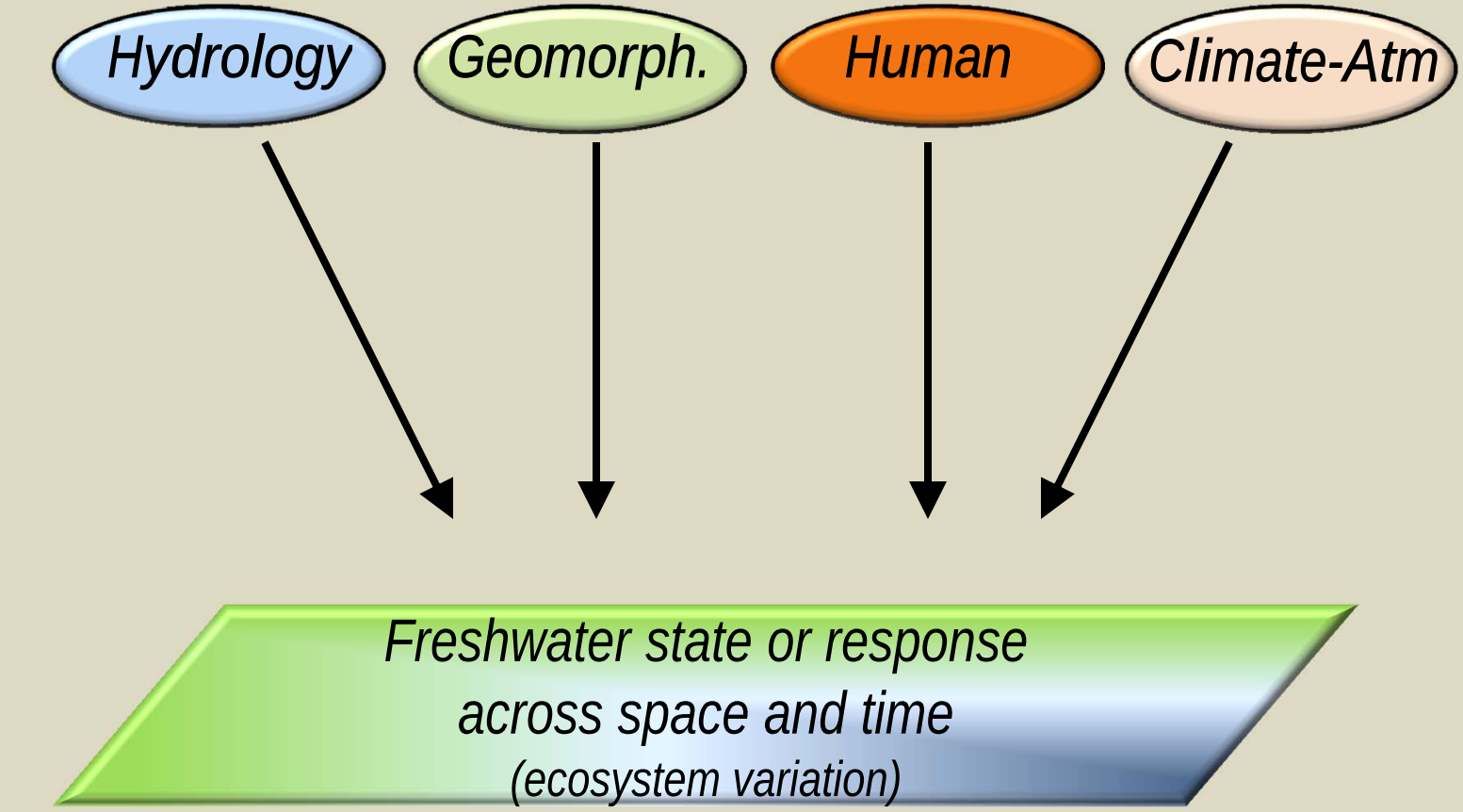
From left to right: Patricia Soranno, Kendra Spence Cheruvelil, Katherine Webster, Mary Tate Bremigan

landscapelimnology

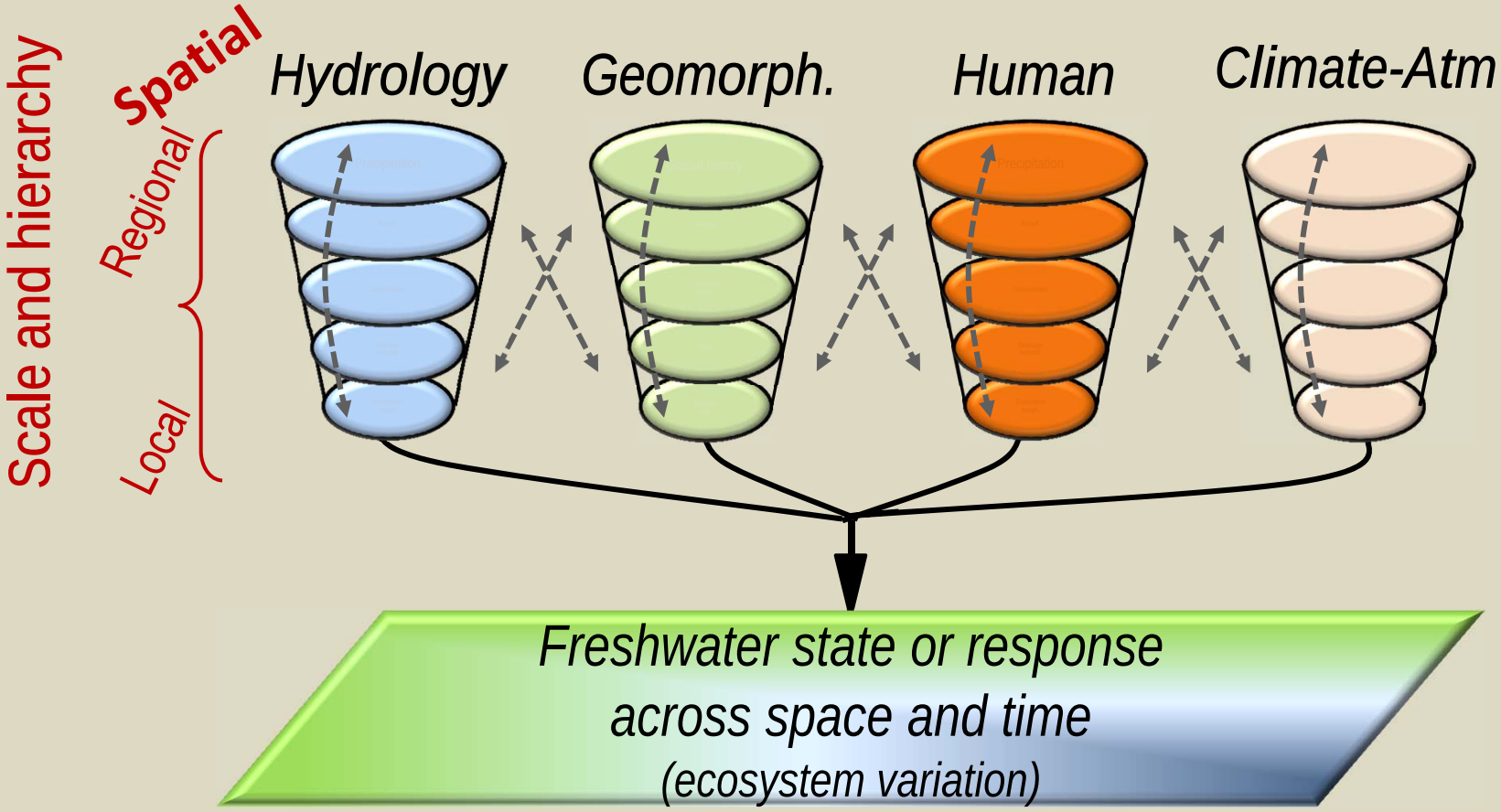
www.fw.msu.edu/~LLRG

Soranno et al. 2010 *BioScience*

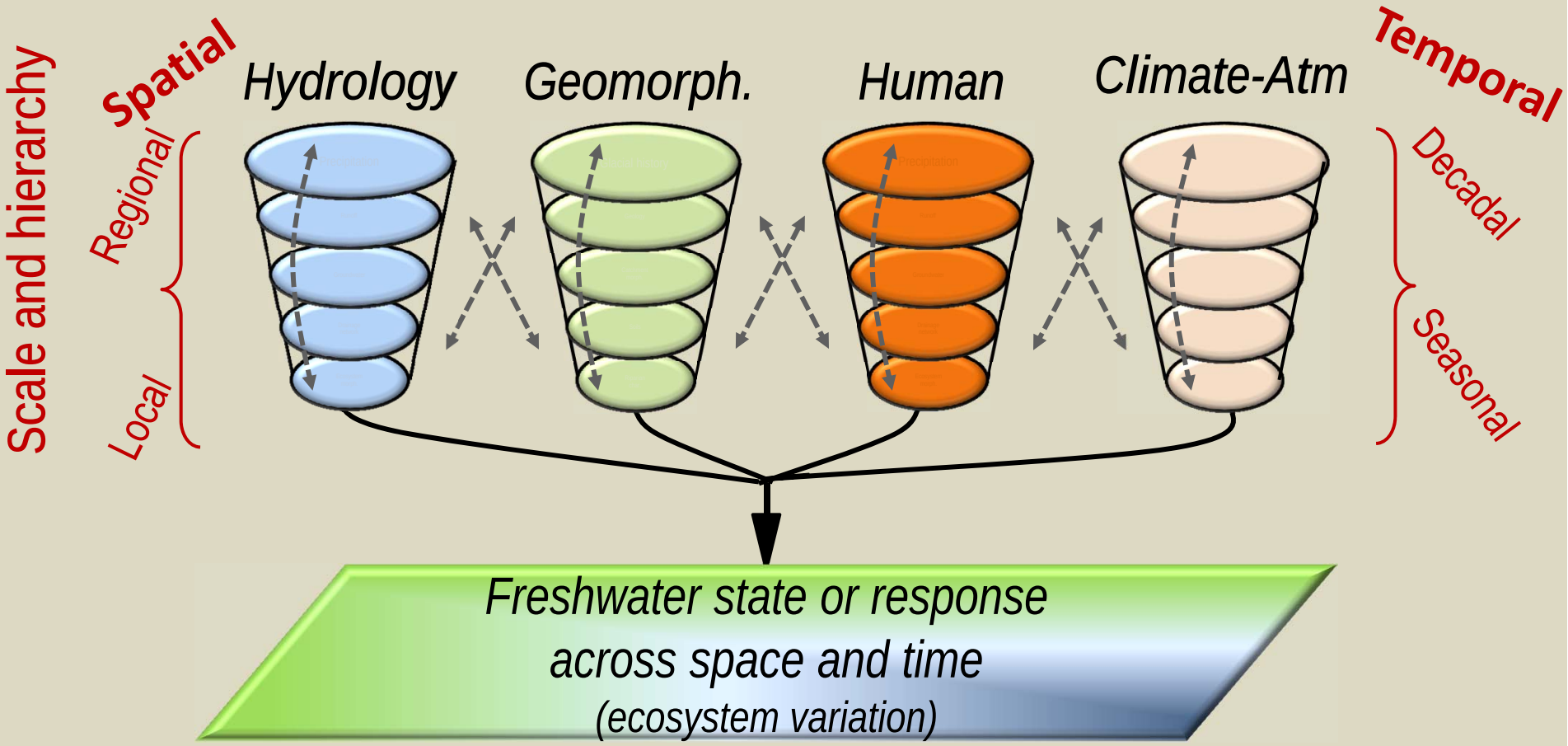
Conceptual Underpinning: Landscape limnology



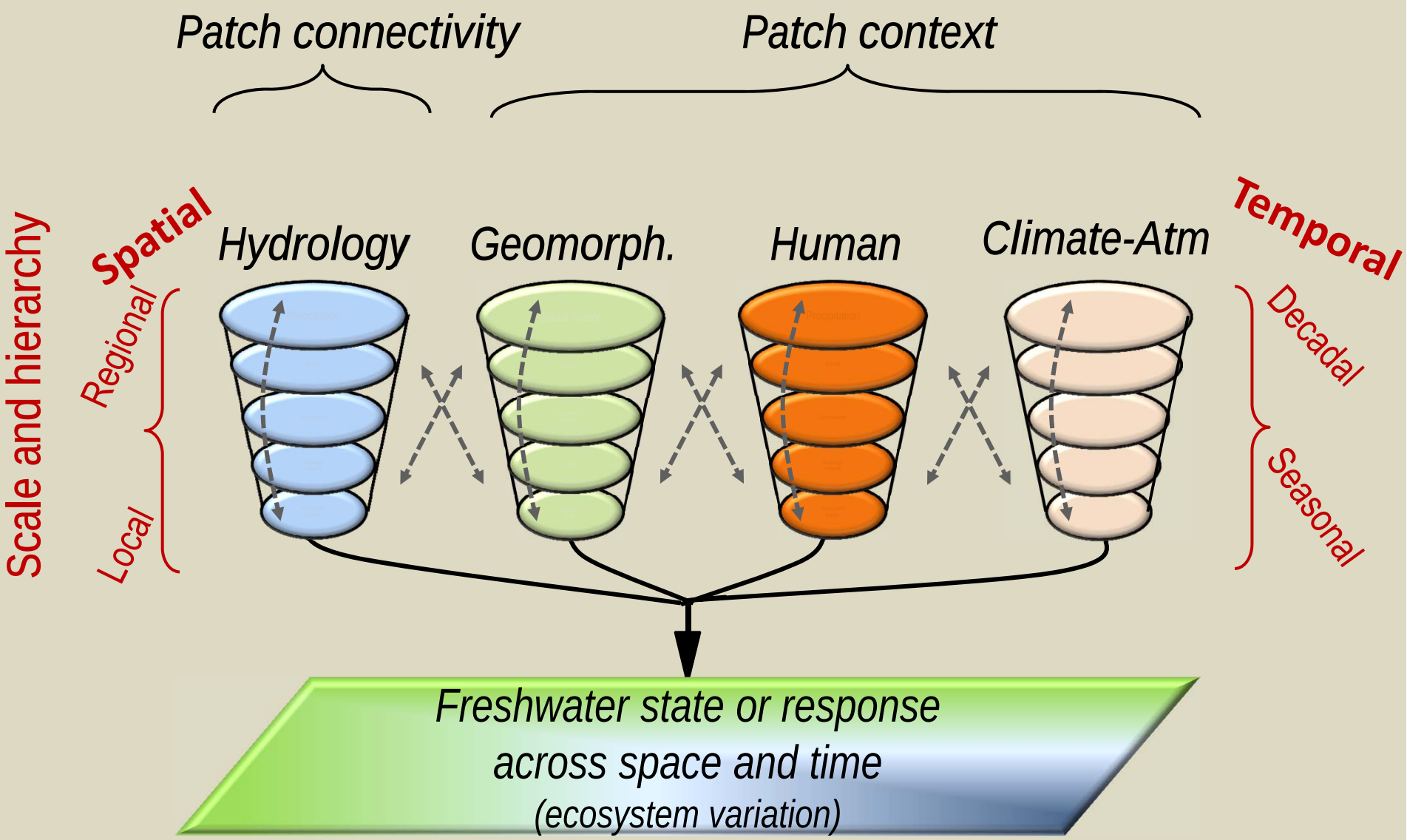
Conceptual Underpinning: Landscape limnology



Conceptual Underpinning: Landscape limnology



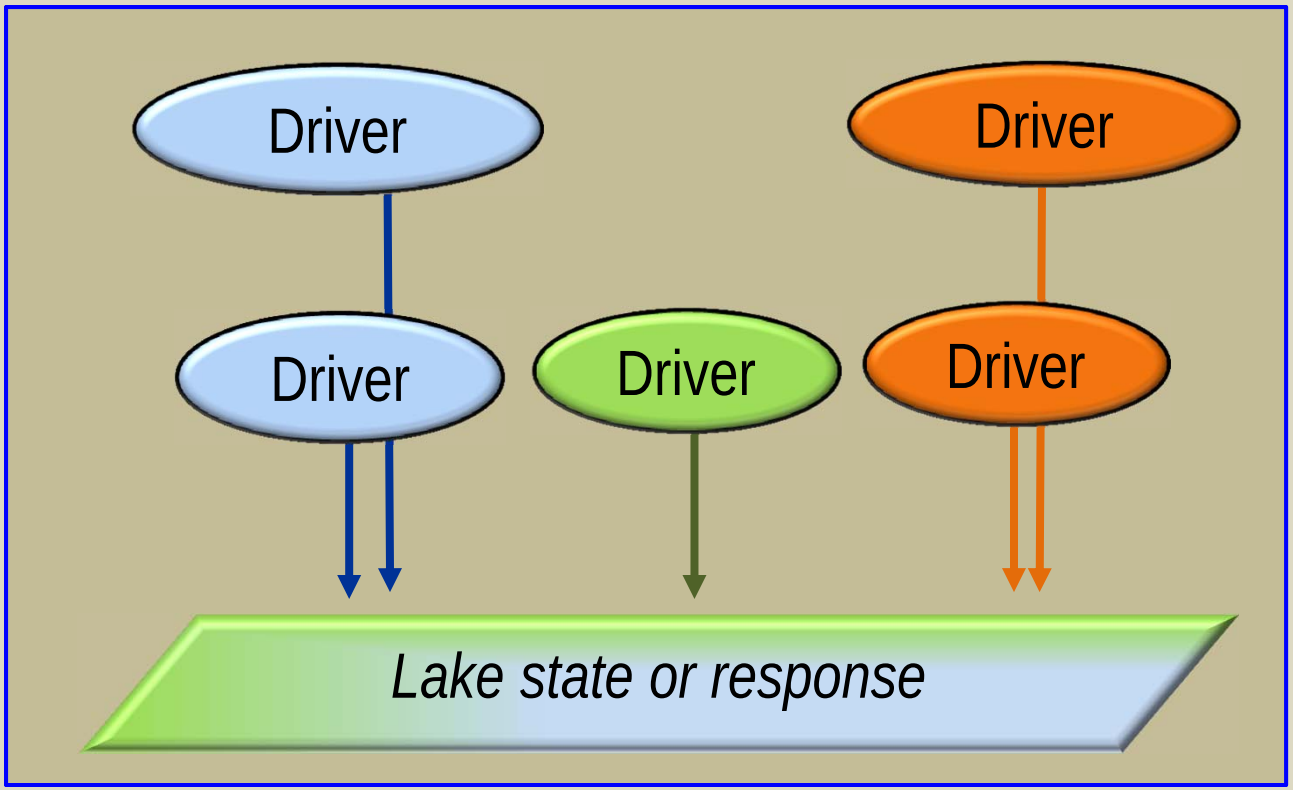
Conceptual Underpinning: Landscape limnology



Conceptual model

Regional-scale drivers:

Local-scale drivers:

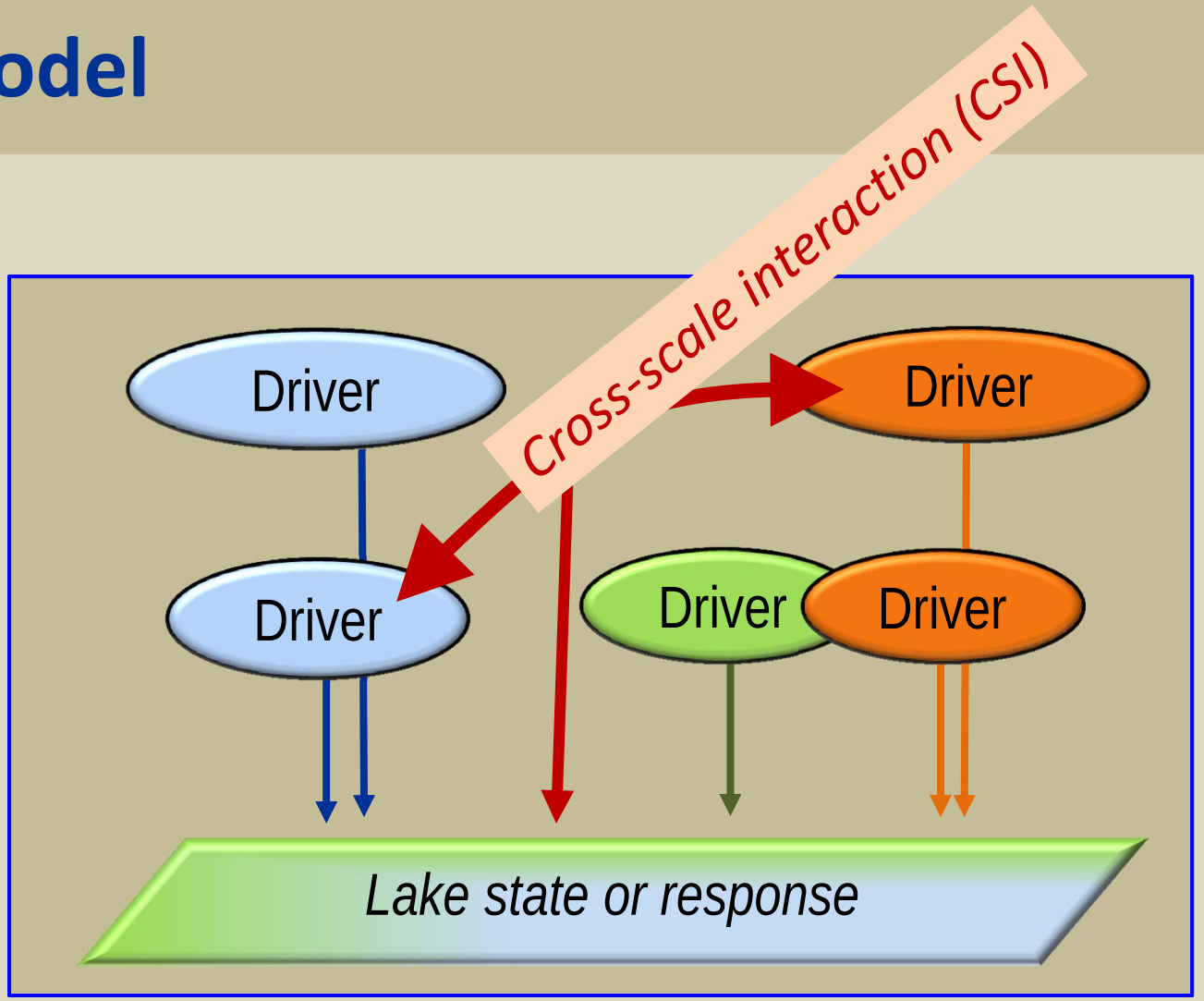


Soranno et al. In press. Frontiers in Ecology & the Environment

Conceptual model

Regional-scale drivers:

Local-scale drivers:



CSI = Process occurring at one scale interacting with process at another scale (Peters et al. 2007 Ecosystems)

Soranno et al. In press. Frontiers in Ecology & the Environment

Conceptual model

Cross-scale interactions (CSIs)

What do we need to make better inferences?

- **Conceptual models** of relationships a[illegible]ss scales
- **Large datasets** - Multi-scaled, m[illegible]nemed
- **Robust modeling approaches** for multi-scaled data

Case study

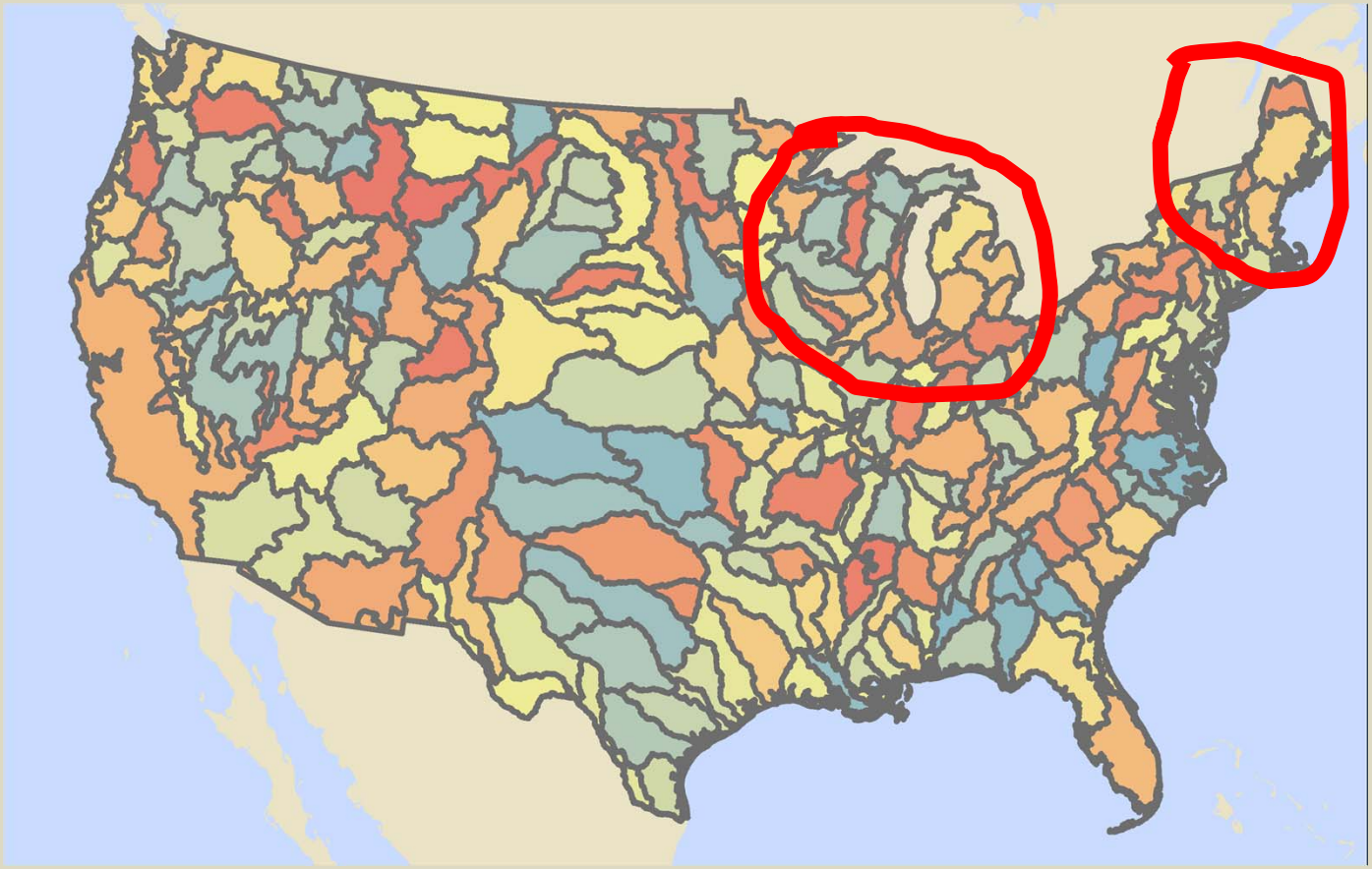
Case Study: BIG data across scales

Local: *Lake watershed*

Soranno et al. In press. Frontiers in Ecology & the Environment

Case Study: BIG data across scales

Regional: *Ecological Drainage Units*



Cheruvelil et al. 2013 Ecological Applications; Soranno et al. In press. FEE

Case study: Testing for CSIs

Q: Does regional agriculture affect local wetland relationships with lake phosphorus?

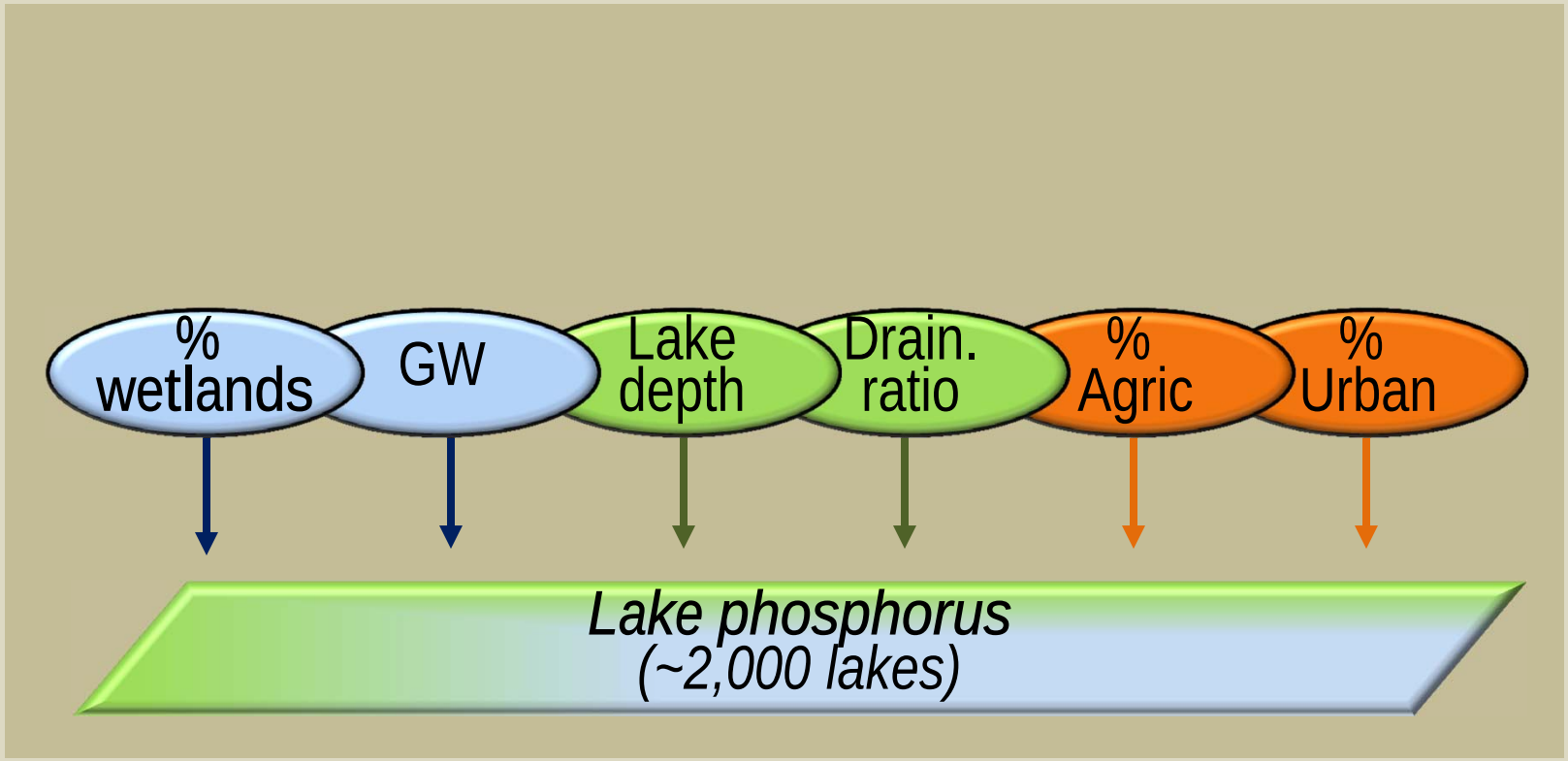
http://michpics.wordpress.com/2009/12/19/michigan-farming-and-other-success-stories/

Mid-west US region

http://www.visitusa.com/maine

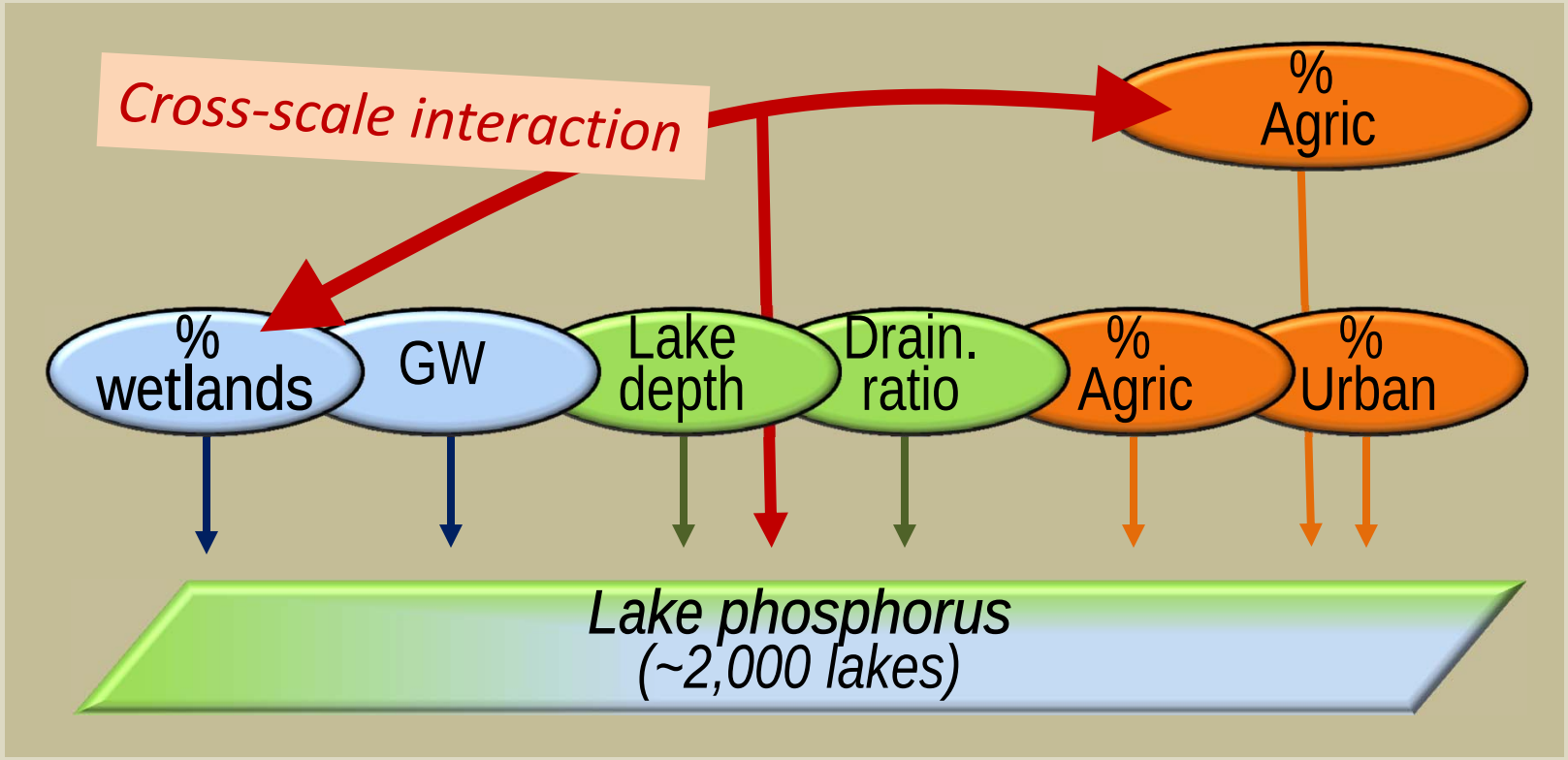
Northeast US region

Case study: Conceptual model

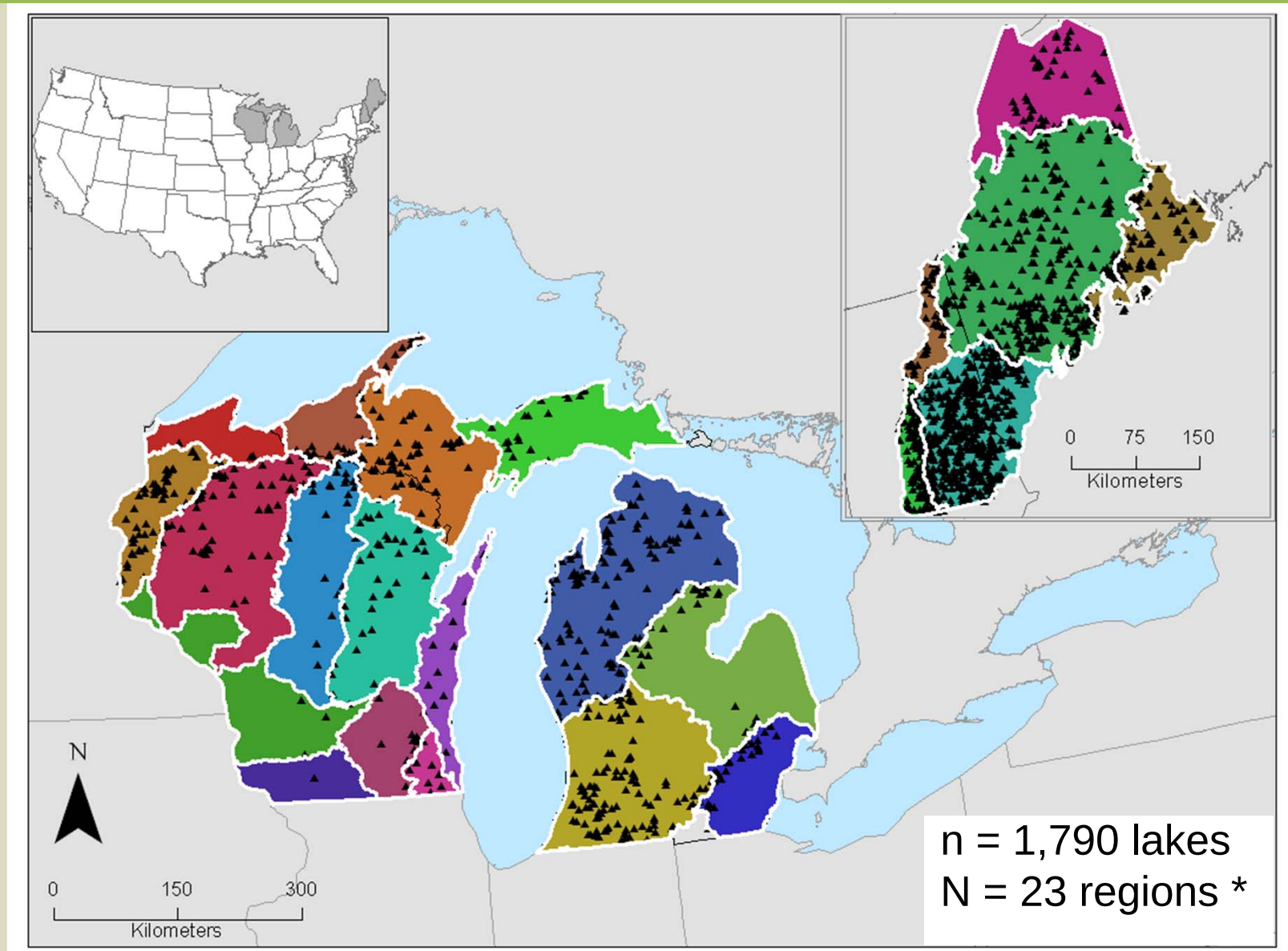


Case study: Conceptual model

Cross-scale interaction between
regional agriculture and **local wetlands**



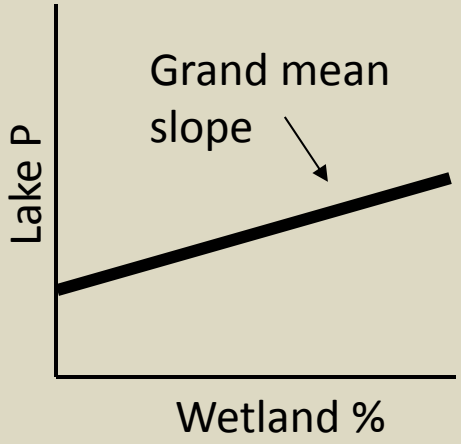
Case study: Study lakes & data



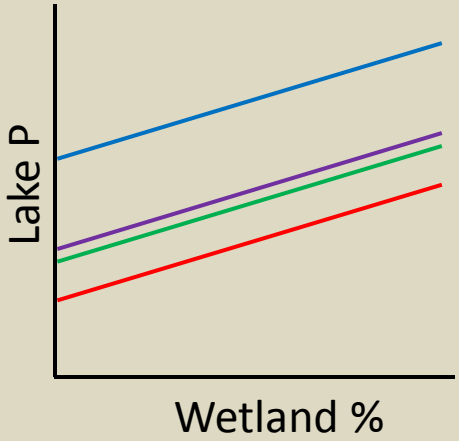
* *Ecological Drainage Units*

Case study: Multilevel mixed effect models

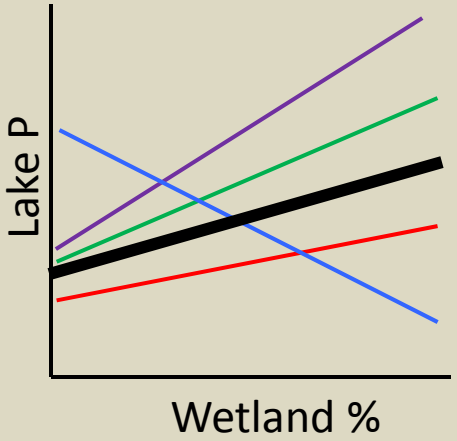
Fixed-Effect



Random-Intercept



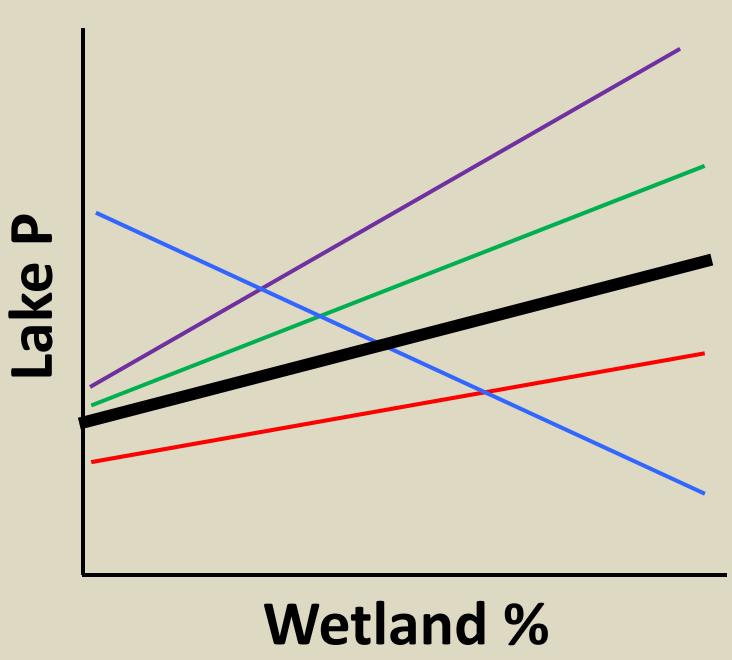
Random-Intercept & Slope

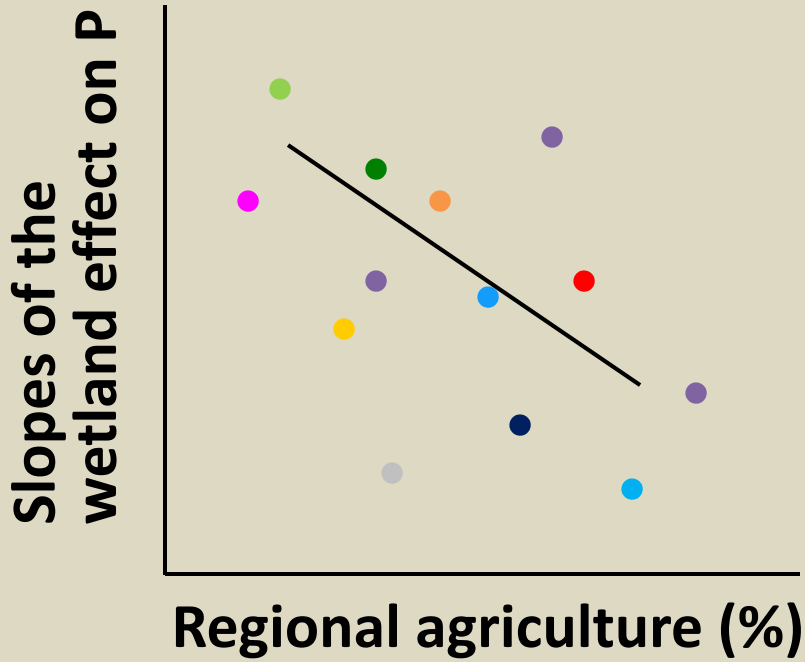


Emi Fergus

Case study: Multilevel mixed effect models

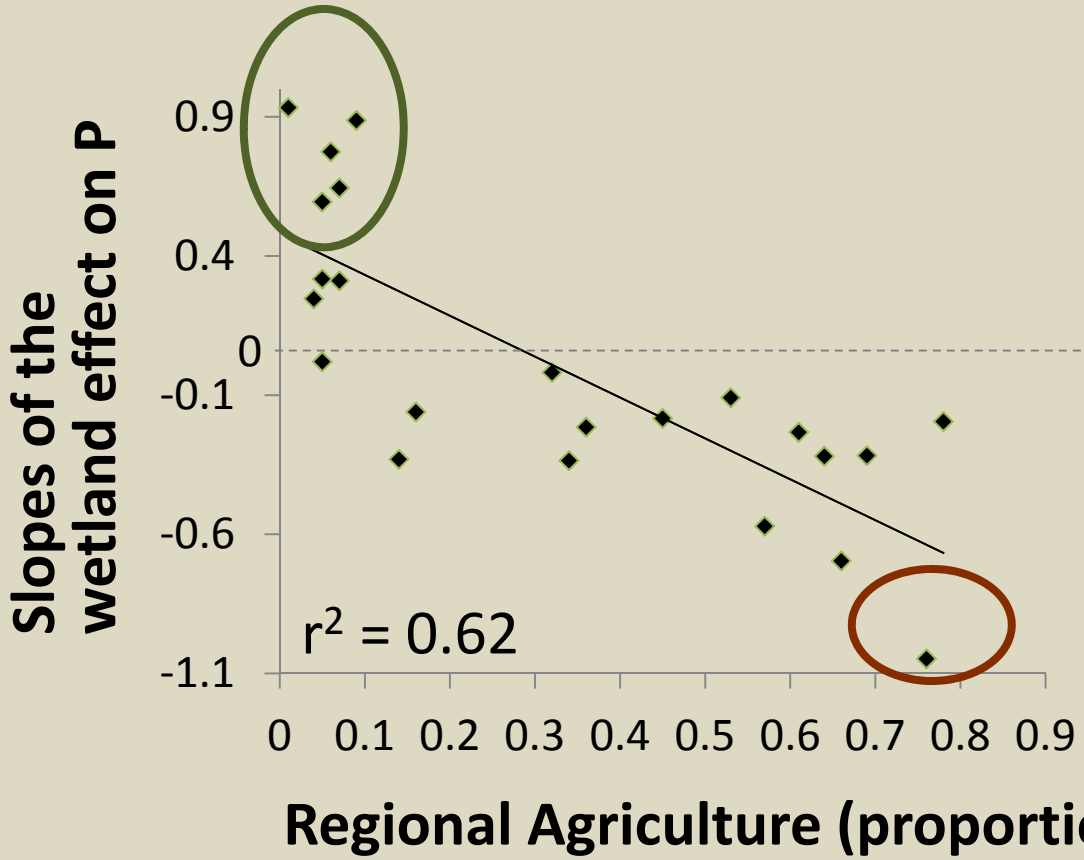
Random-Intercept & Slope





Case study: Results

CSI: Regional agriculture modifies the relationship between local wetlands and lake P



LOW regional agric.:
Wetlands have POS effect

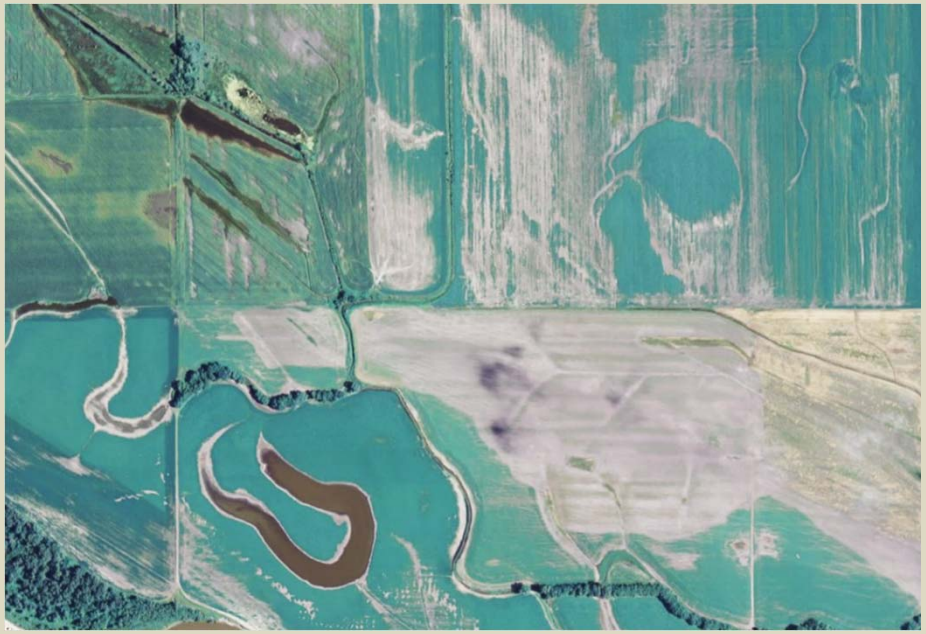
HIGH regional agric.:
Wetlands have NEG effect

Case study: Results

Wetland and lake P relationships are affected by regional context

Low regional agriculture

High regional agriculture



Making inferences from well-studied ecosystems

What about time?

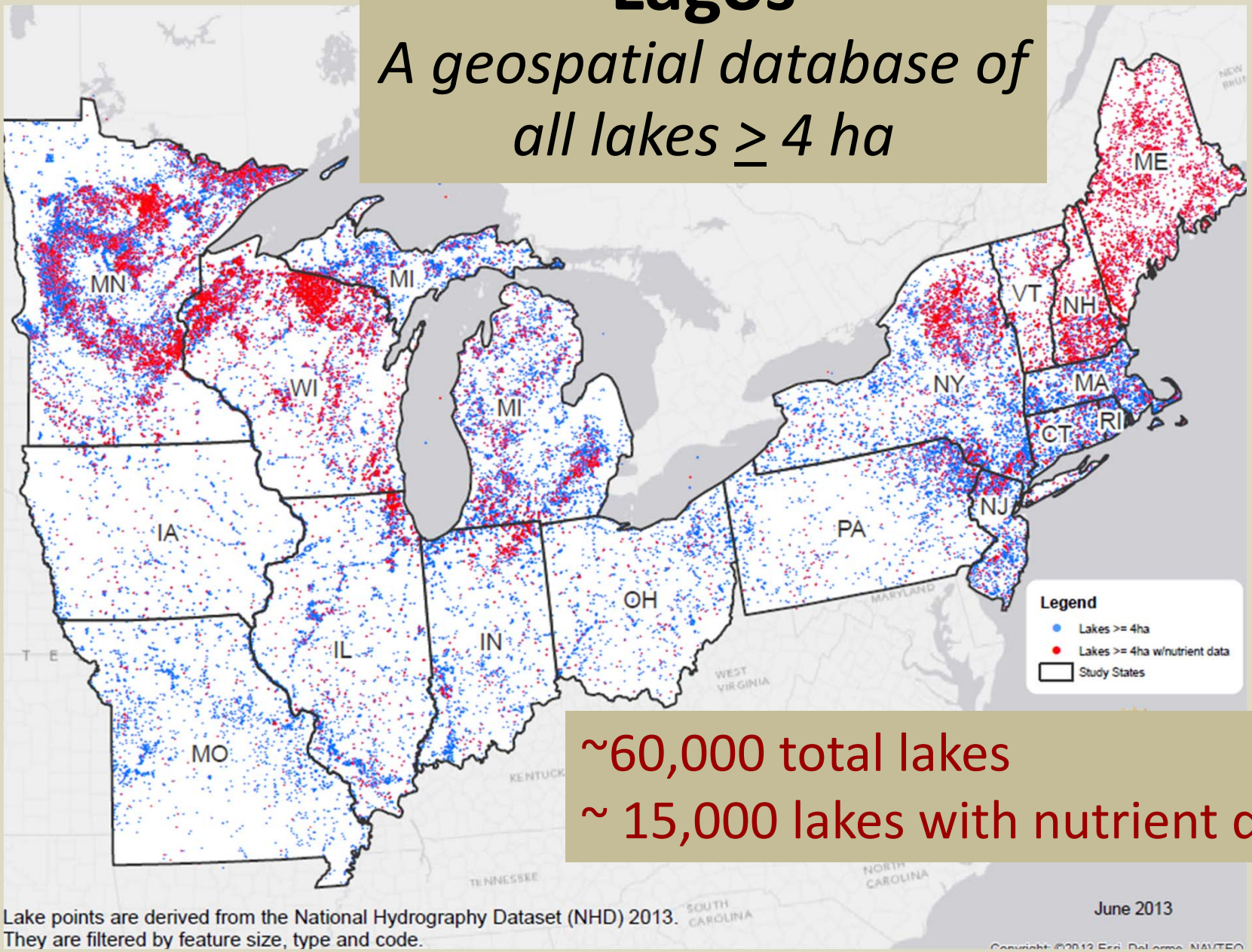
NSF-MSB Project: *The effects of cross-scale interactions on freshwater ecosystem state*

www.CSI-limnology.org

C. Filstrup, K. Webster, K. Spence Cheruvelil, E. Norton Henry, N. Lottig, E. Stanley, J. Downing, C.E. Fergus, P-N. Tan, P. Soranno, C. Stow, E. Bissell, T. Kratz, S. Oliver, S. Yuan, L. Winslow, E. Erdman.
(missing, M. Tate Bremigan, T. Wagner, P. Hanson) *not in order of appearance!*

Lagos

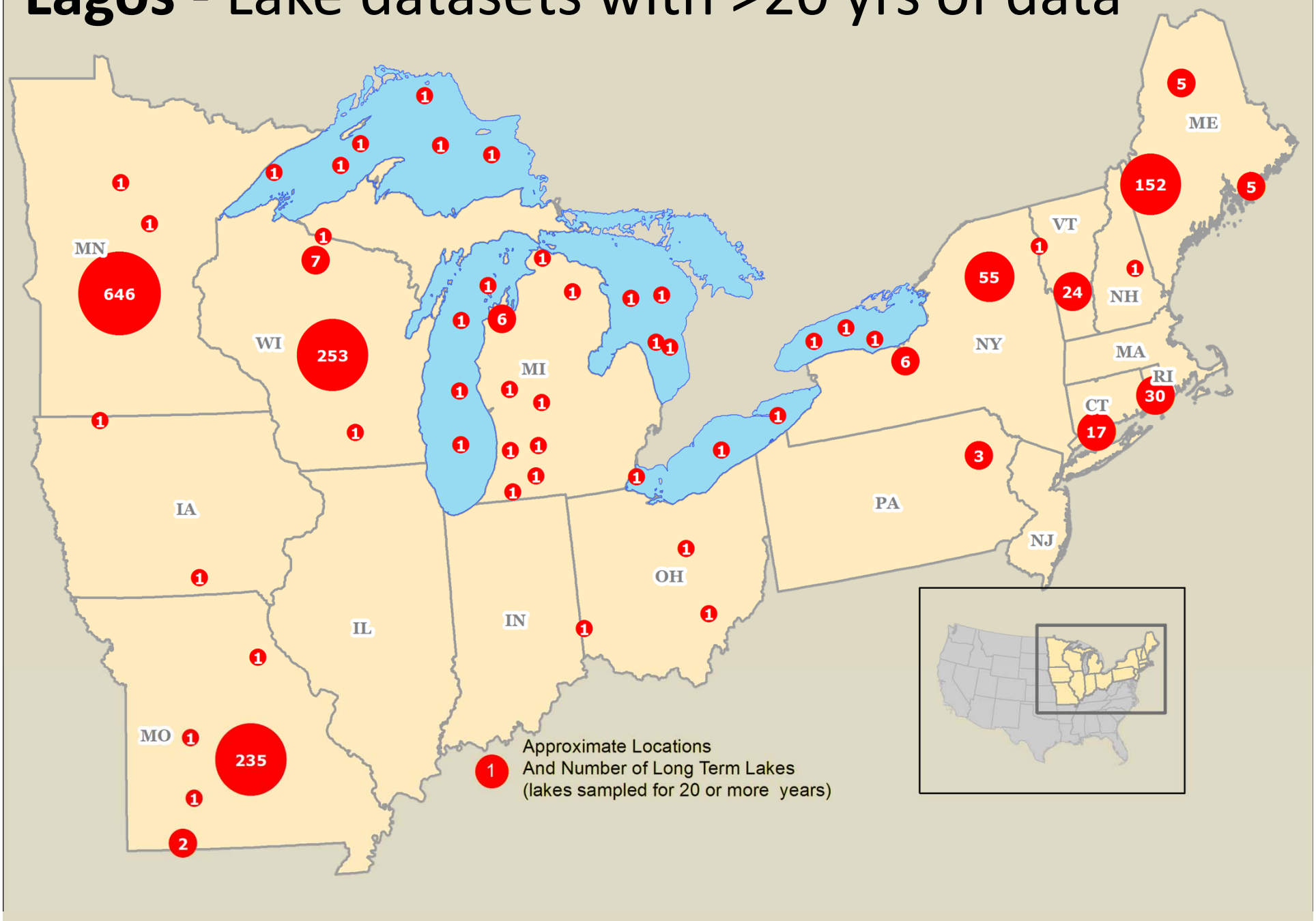
A geospatial database of all lakes ≥ 4 ha



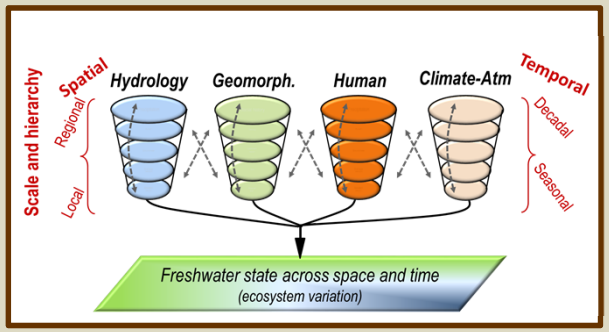
~60,000 total lakes

~ 15,000 lakes with nutrient data

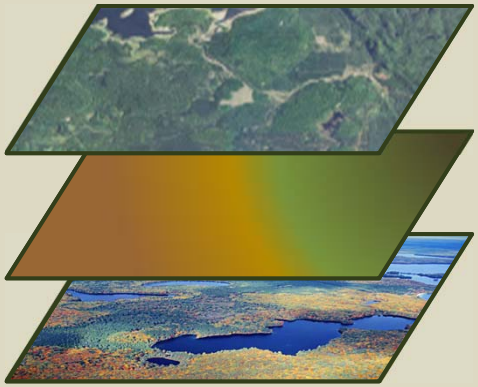
Lagos - Lake datasets with >20 yrs of data



Summary: Landscape approaches for understanding and managing lakes



- Develop conceptual models – ***Landscape limnology***



- Compile multi-scaled, multi-themed databases - ***Lagos***

- Test for CSIs ***– Hierarchical models (Bayesian)***

Soranno et al. *In Press.* Frontiers in Ecology and the Environment

Summary: Landscape approaches "across the pond"

- Understanding variation in biota among lakes at different scales (Scotland, UK, EU)
- Making better inferences → GLOBO Lakes, UK Lake Hydromorphology Typology (Rowan 2010)
- Building capacity and training → high-performance research teams

Creating and maintaining **high-performing** collaborative research teams: the importance of **diversity** and **interpersonal skills**

Lead

KS Cheruvelil

PA Soranno

KC Weathers

PC Hanson

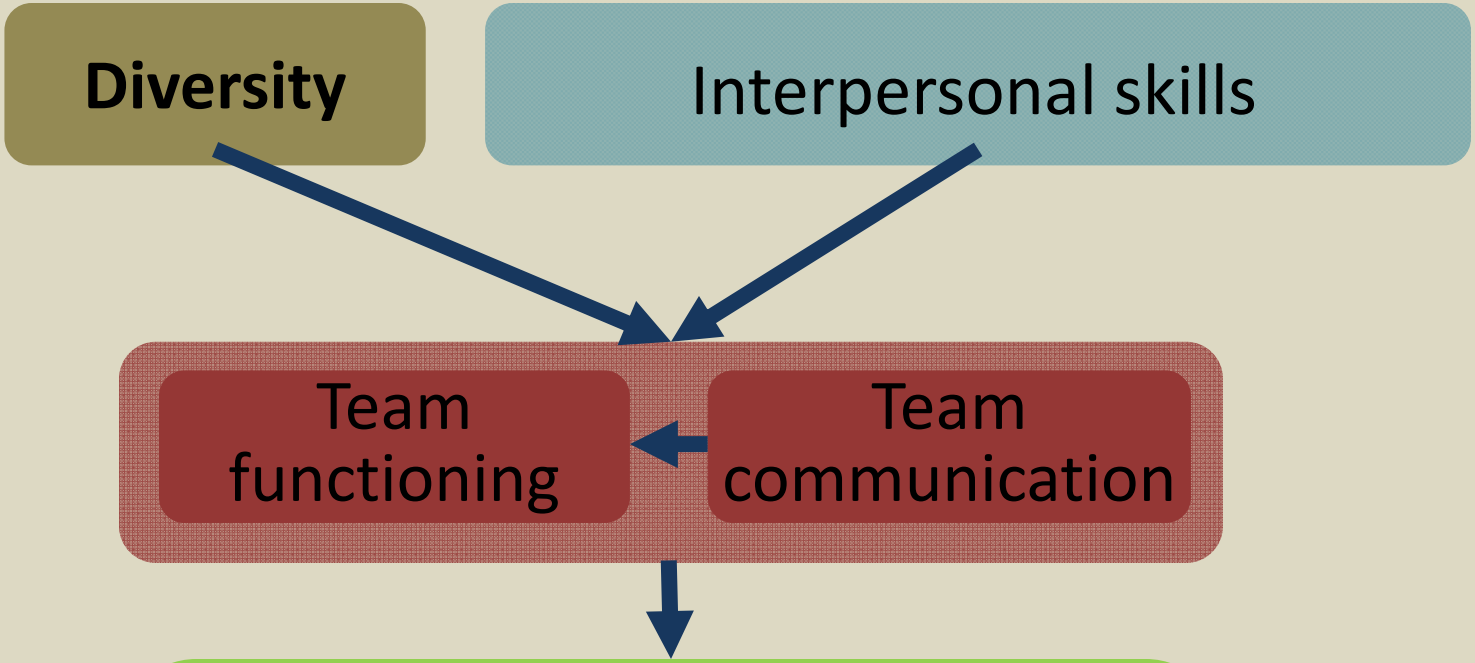
SJ Goring

CT Filstrup

EK Read

Cheruvelil et al. In press. Frontiers in Ecology and the Environment

How can you make great research teams?



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Acknowledgements

Award# EF-1065786

STRIVE AWARD: EPA-2011-W-FS-7

More Qs? Email me!

Kendra Spence Cheruvelil

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