Prediction of starry stonewort invasion risks in Minnesota and Wisconsin based on lake level habitat suitability

Where is starry stonewort going?

Ranjan Muthukrishnan
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July. 13, 2017

MINNESOTA AQUATIC INVASIVE SPECIES RESEARCH CENTER
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A comparison of eigenvalue decomposition and machine learning approaches for estimating distribution of a non-equilibrium species

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Minnesota Aquatic Invasive Species Research Center
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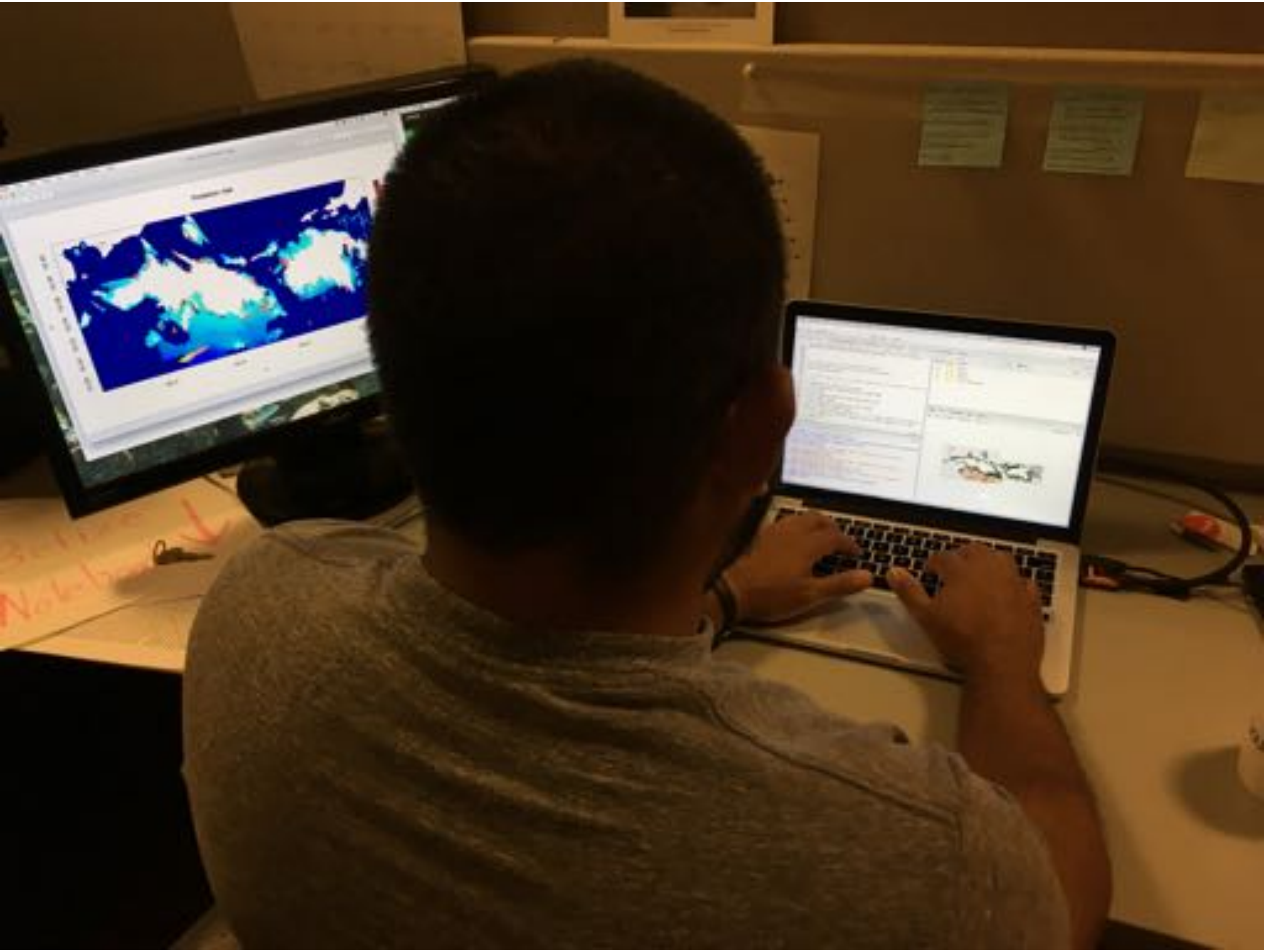

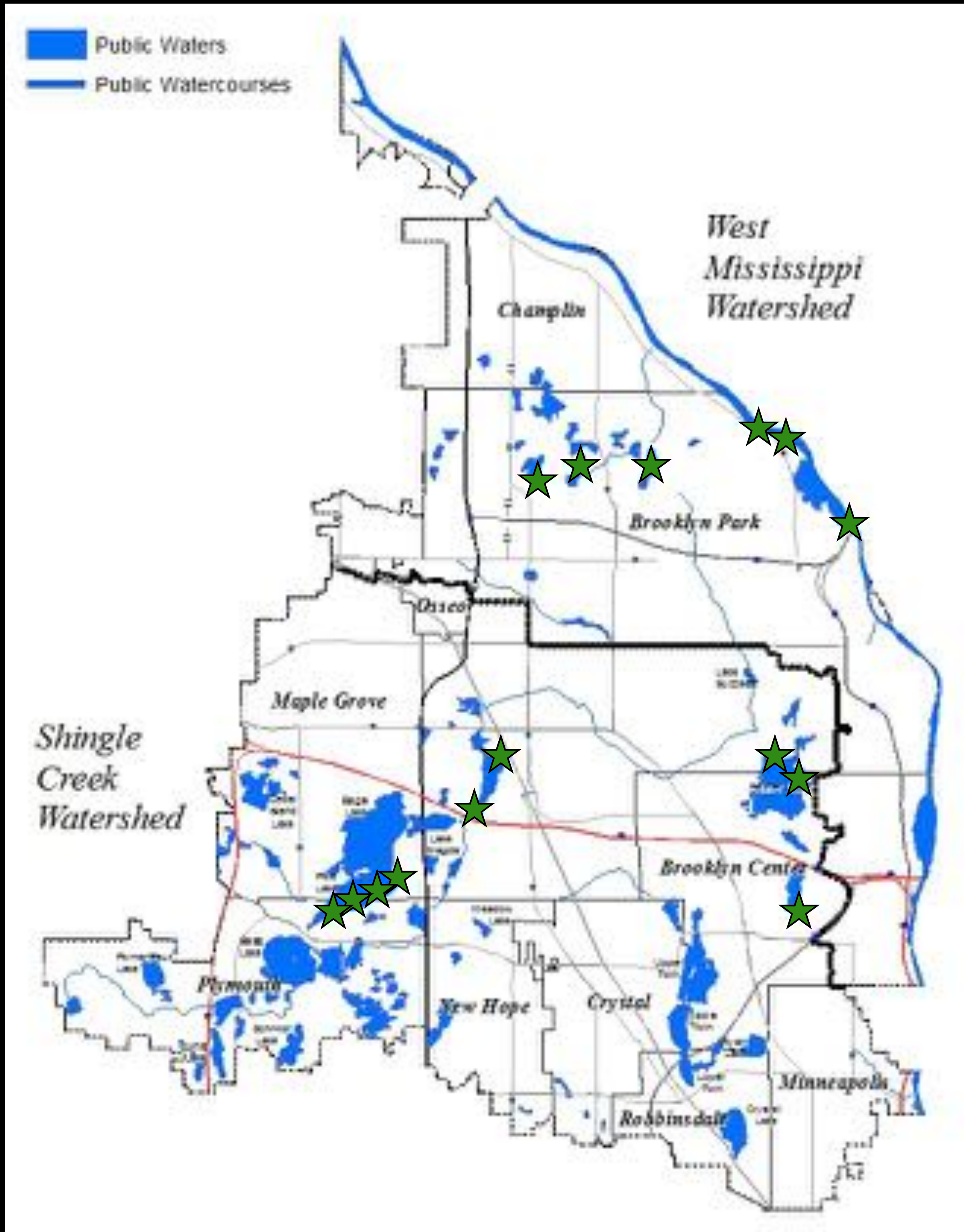

Public Waters
Public Watercourses
West Mississippi Watershed
Champlin
Brooklyn Park
Osseo
Maple Grove
Shingle Creek Watershed
Brooklyn Center
Plymouth
New Hope
Crystal
Robbinsdale
Minneapolis

Collaborators

- Dan Larkin
- Wes Glisson (research fellow)
- Mike Verhoeven (grad. student)
- Carli Wagner (undergrad.)

- Luis Escobar
- Nick Phelps
- Megan Weber

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

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Starry stonewort working group

- MN DNR
- University of Wisconsin
  - Paul Skawiski
- Central Michigan University
- New York Botanical garden
  - Ken Karol and Robin Sleith
- University of Geneva

CLEAN WATER LAND & LEGACY AMENDMENT

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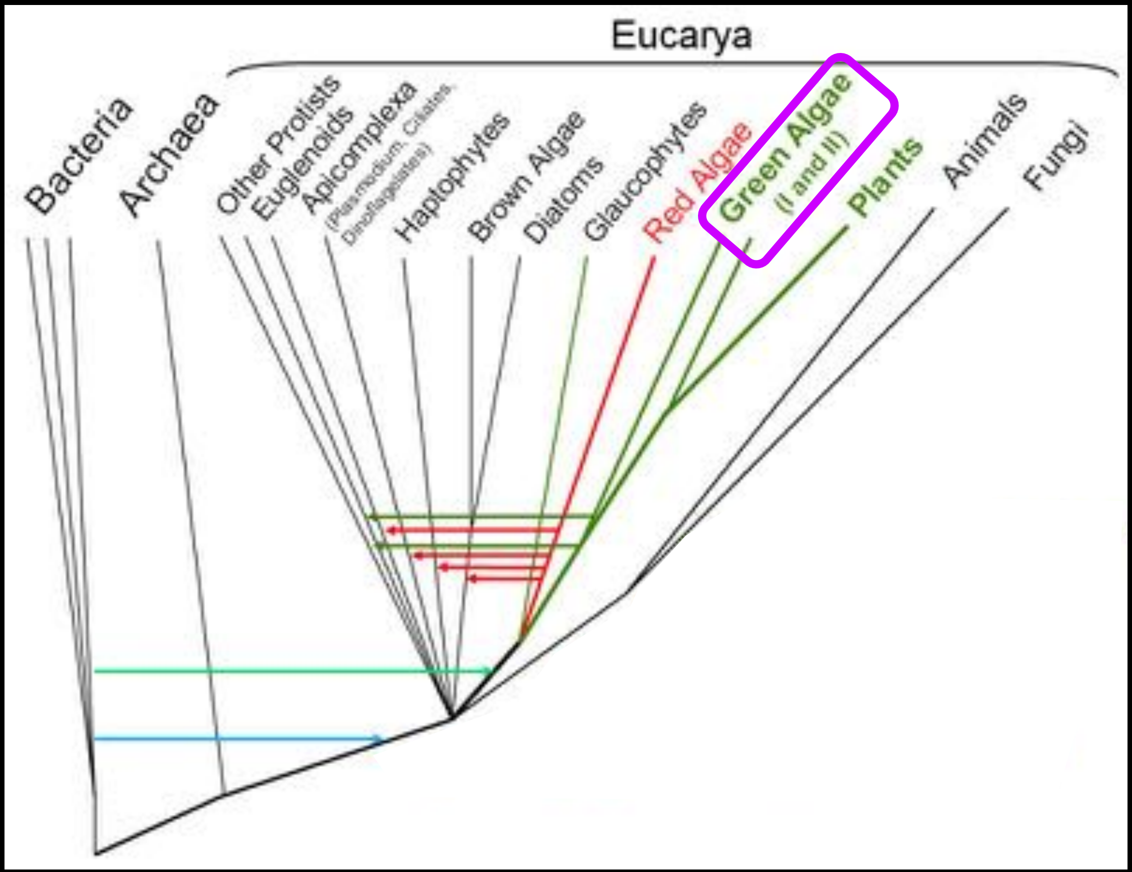
Starry Stonewort

Starry stonewort

Nitellopsis obtusa

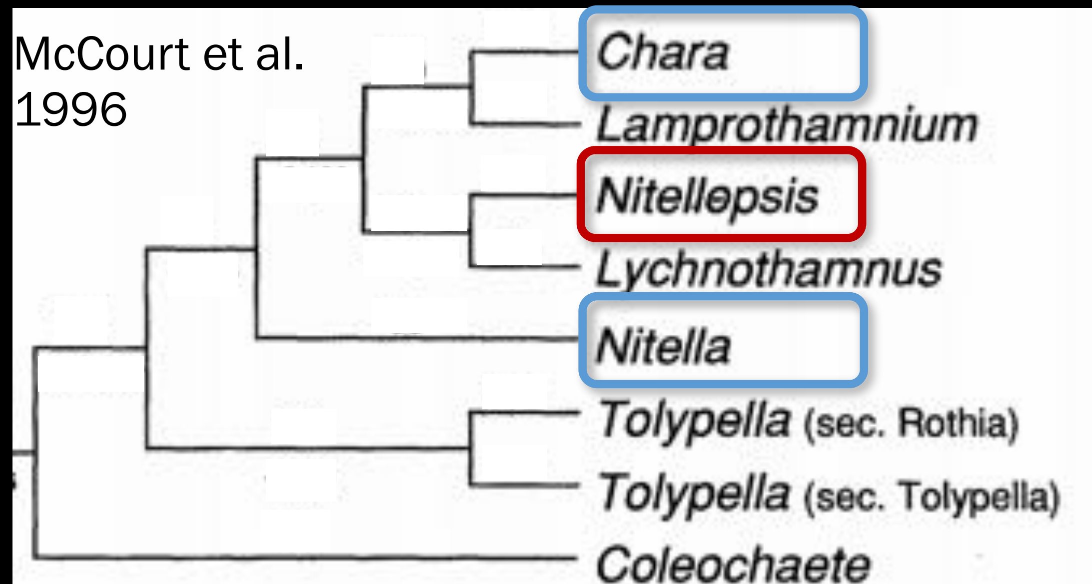
- Green alga



Three domains of living organisms
(Gogarten, Taiz et al. 2015)

Starry stonewort

- Charophyte
- Closely related to stoneworts / muskgrasses native to Minnesota
- Ecologically important
  - Water quality
  - Habitat




Chara aspera

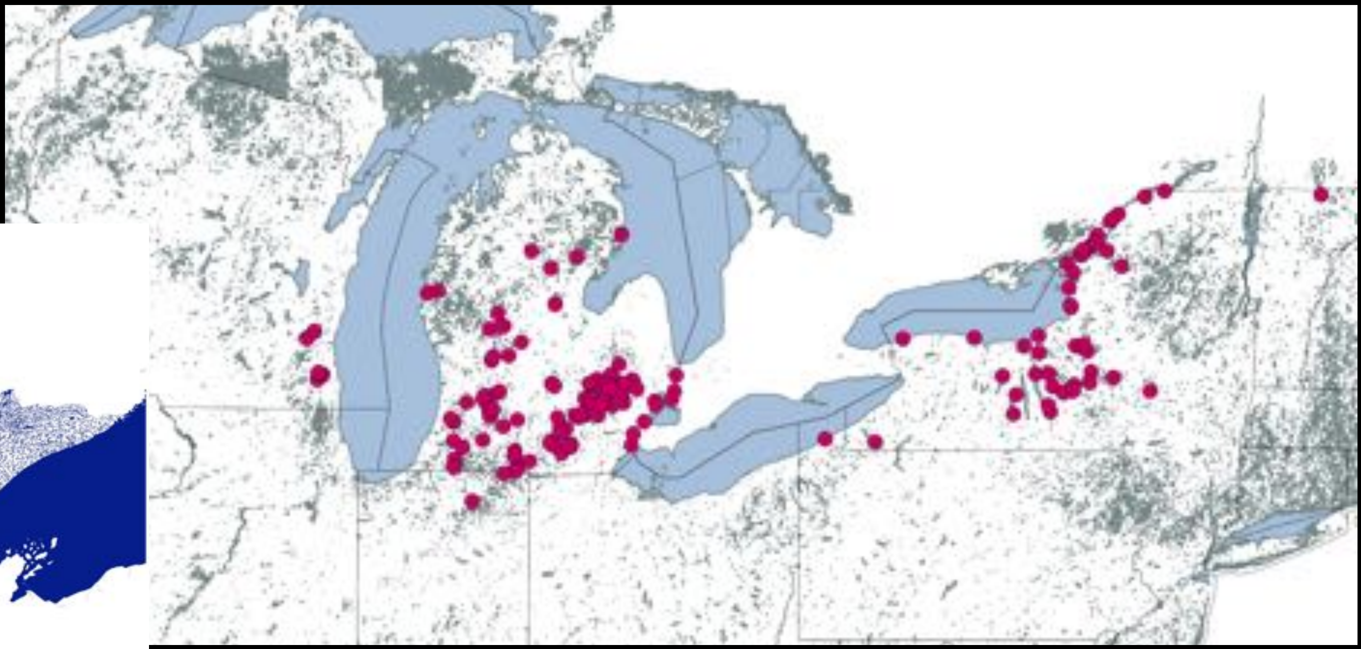

C. contraria

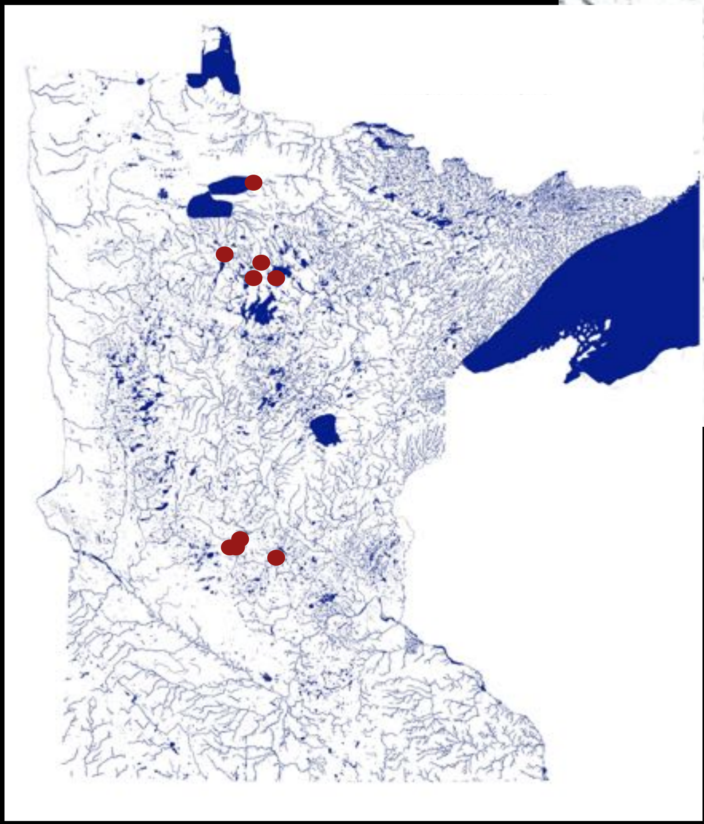

Nitella flexilis

Invasion history

- Relatively new invader
- Quickly gaining ground
- Increasing concern for AIS management
- Currently in 9 lakes in MN

Present distribution



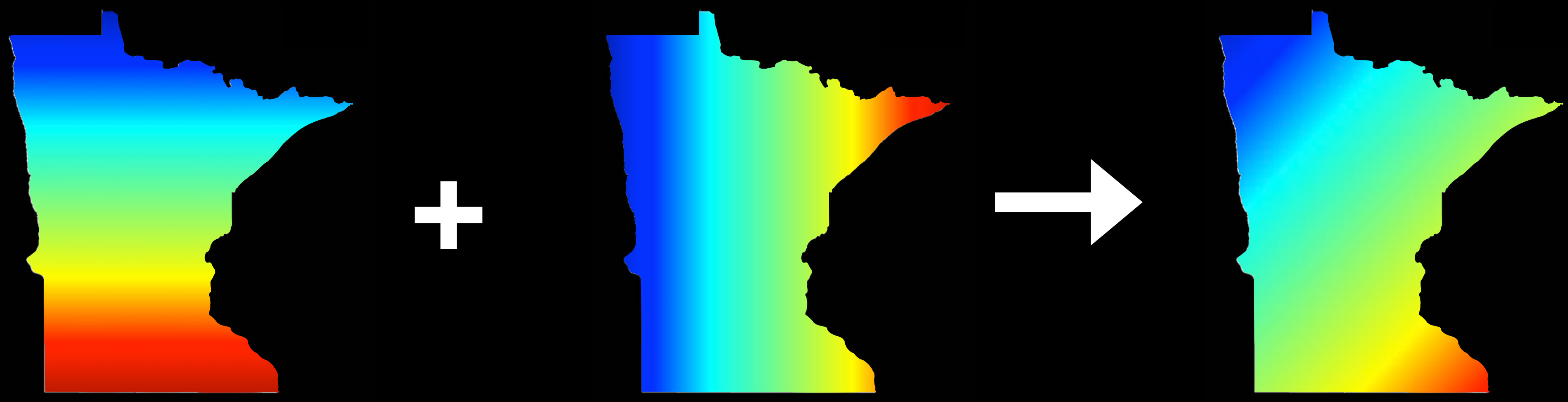


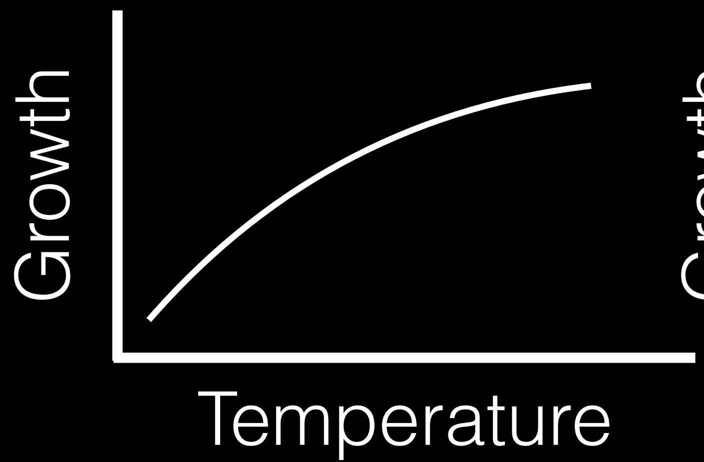
Where will it go?

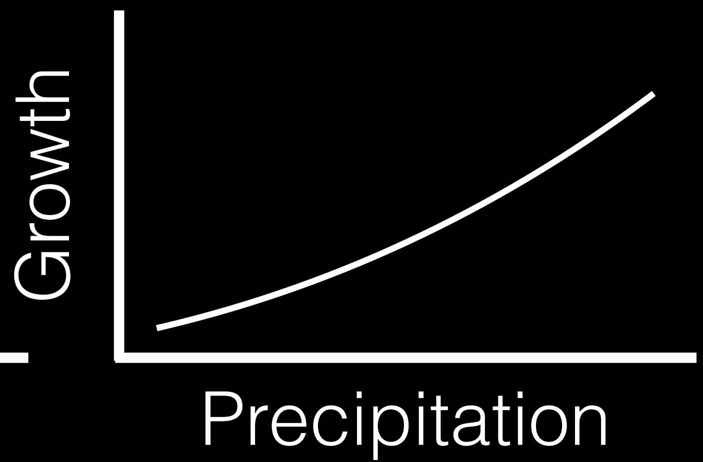
Ecological niche modeling

- Species distribution models
- Habitat suitability models
- Bioclimatic models
- MaxEnt

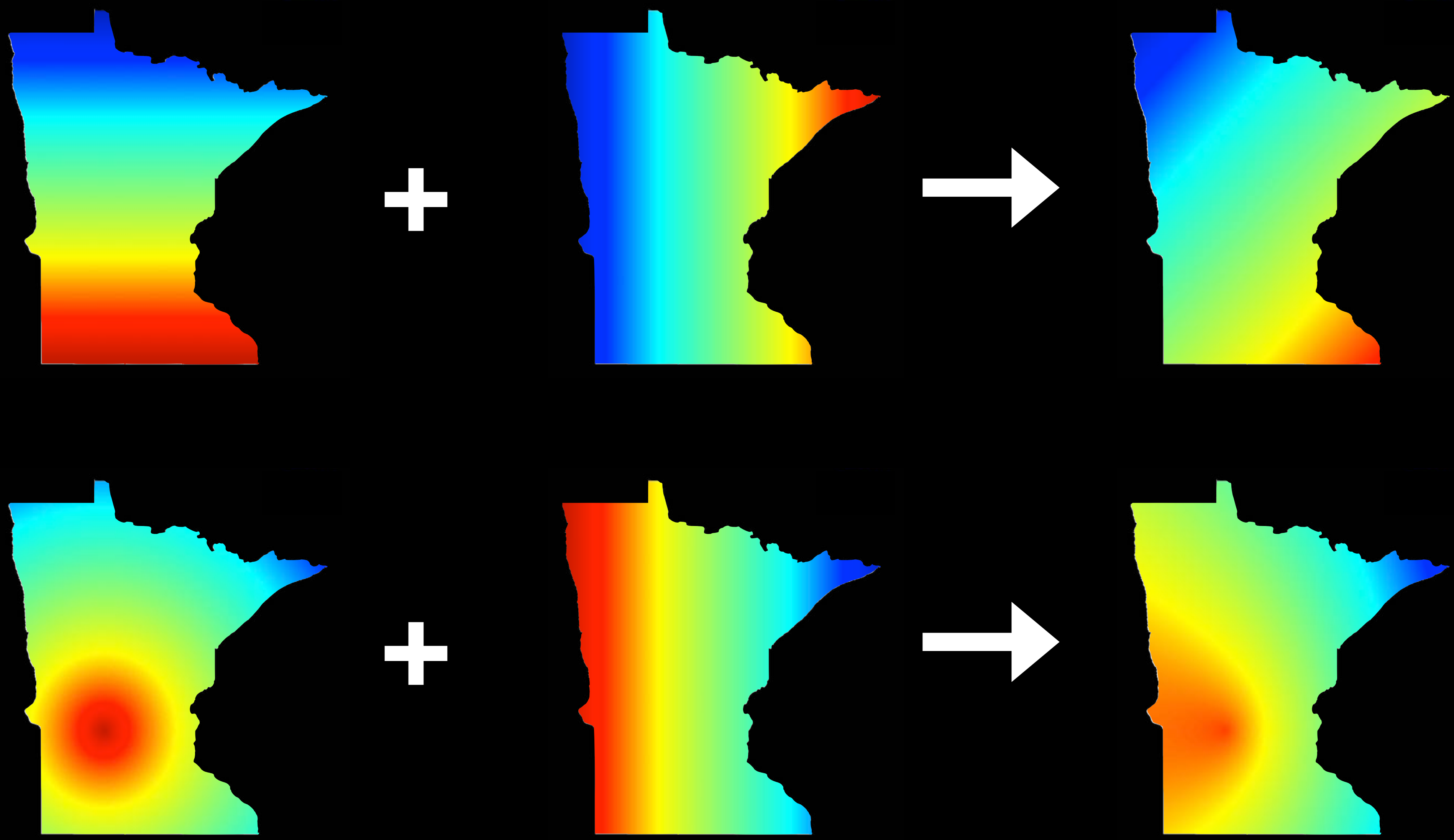
Ecological niche modeling



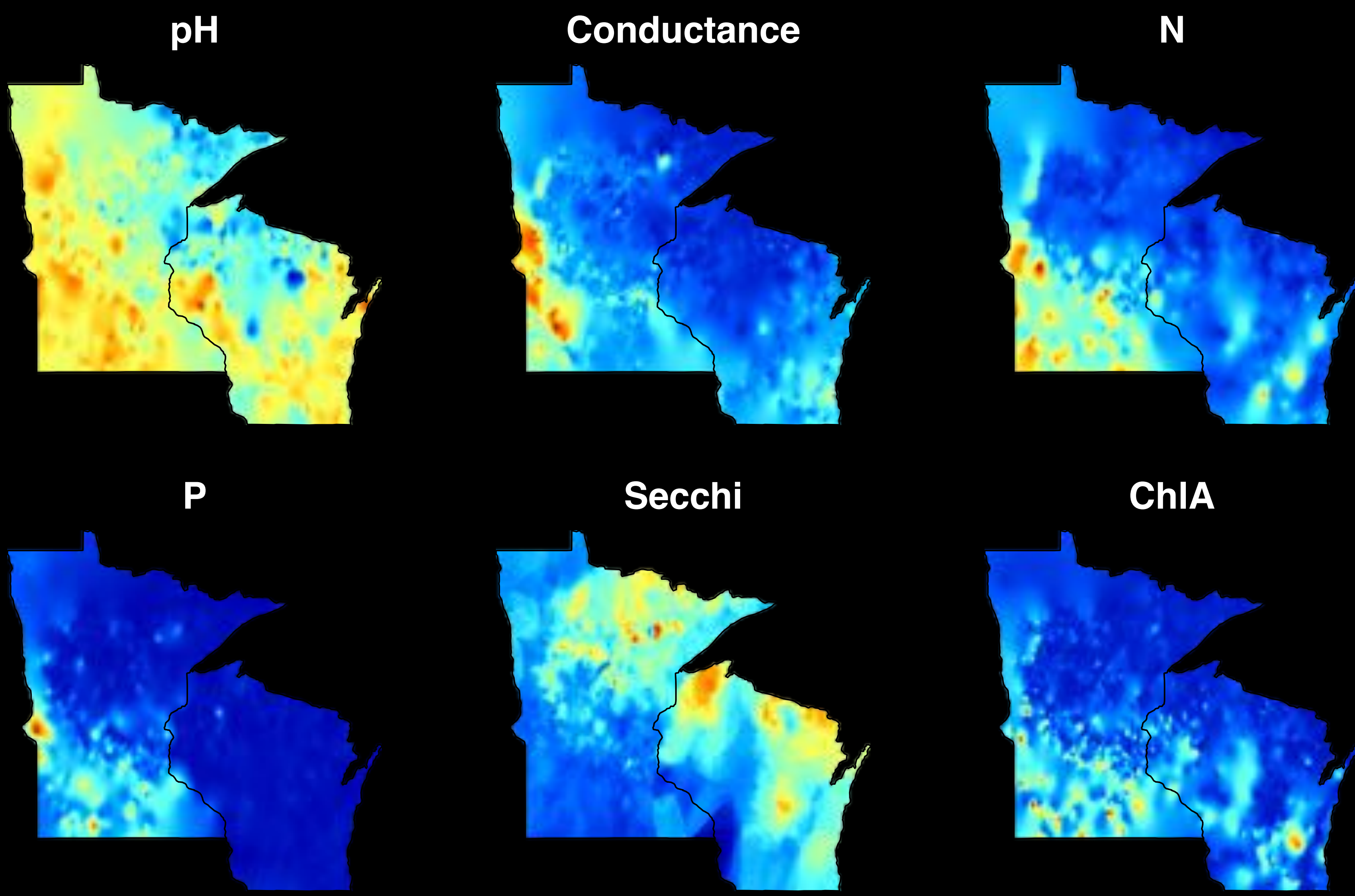




Ecological niche modeling

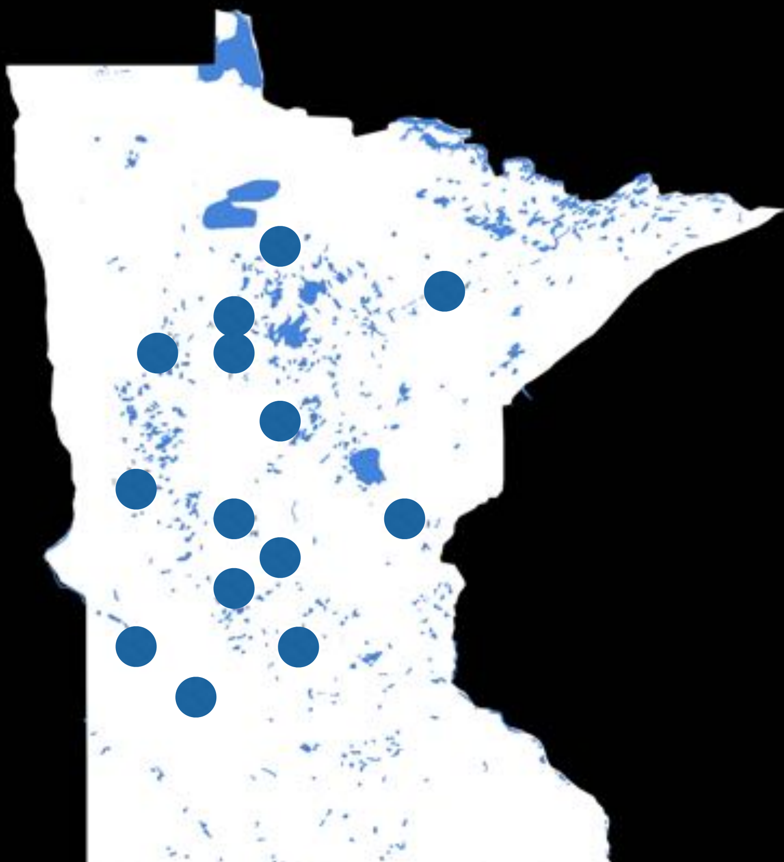


Ecological niche modeling



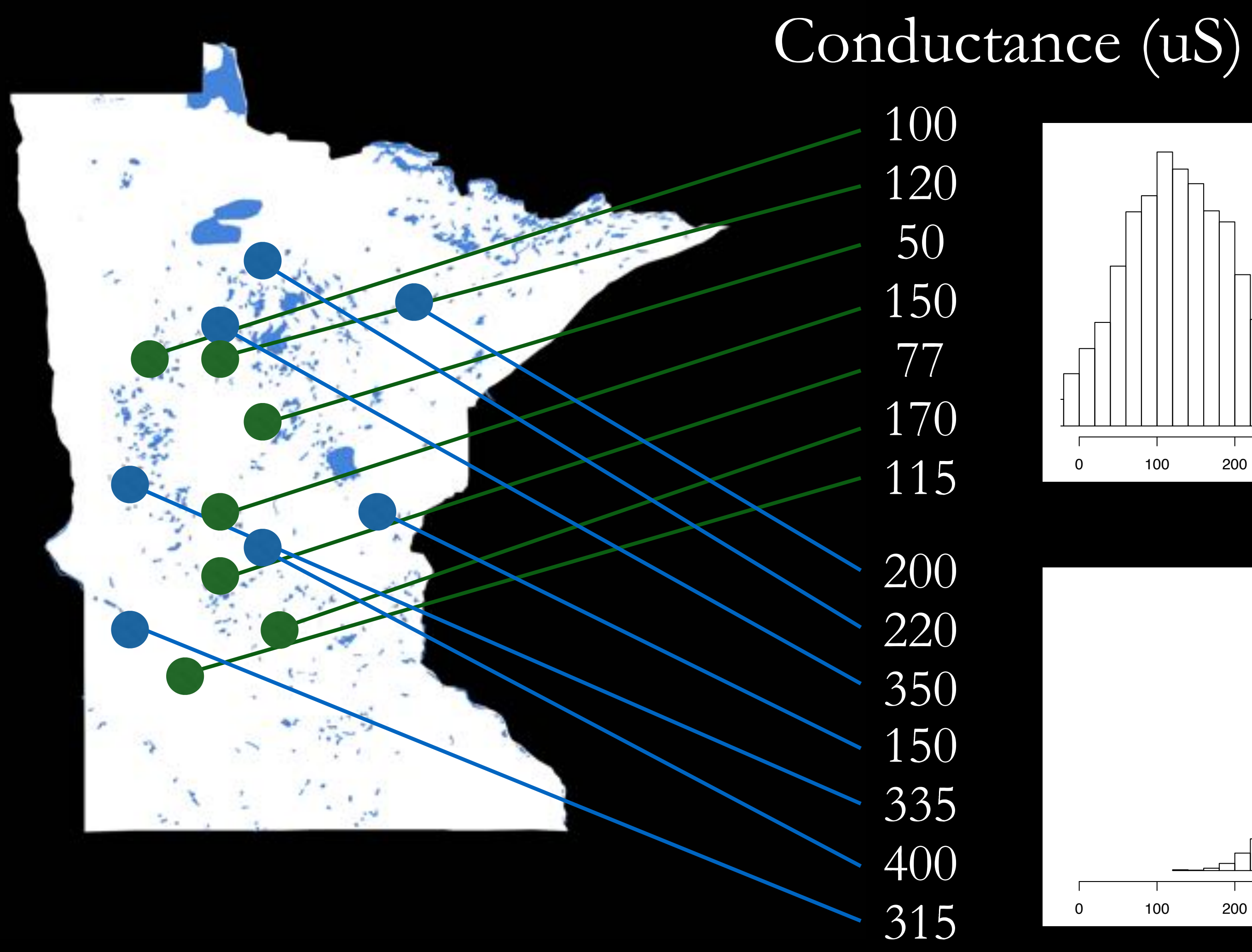
Determining the niche

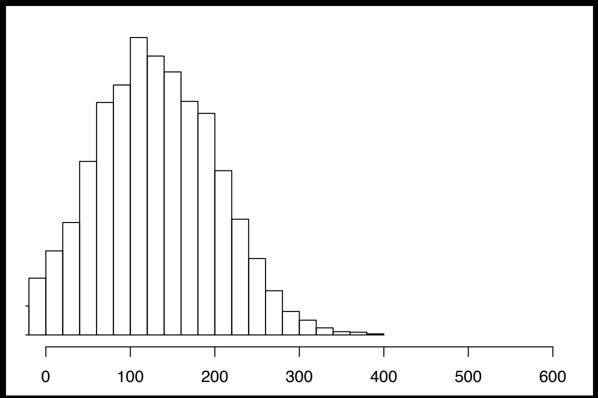
Information from the current distribution

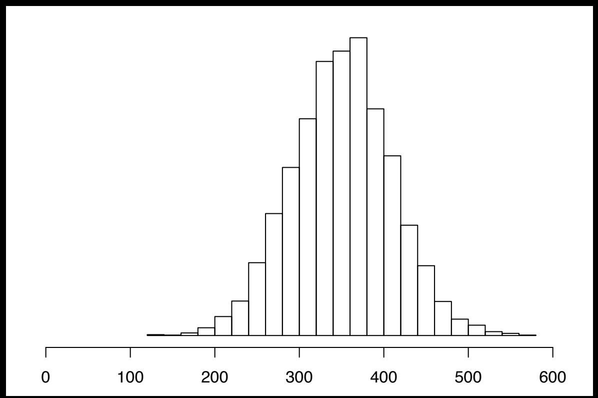


Determining the niche

Information from the current distribution

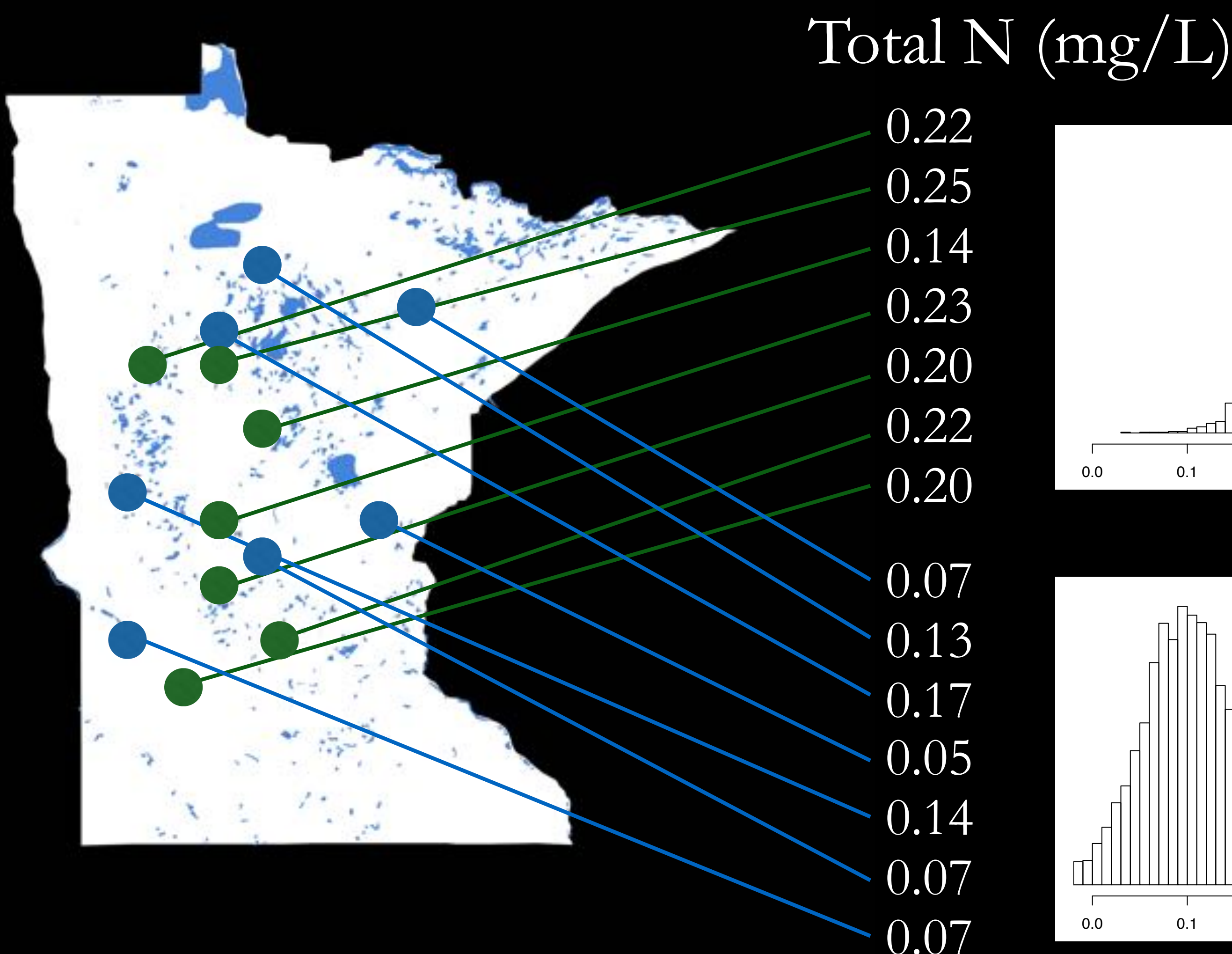


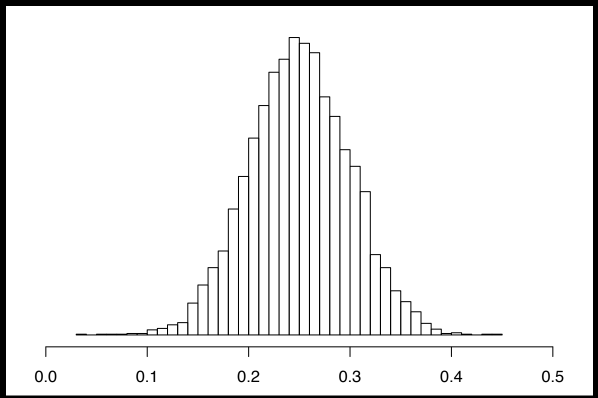


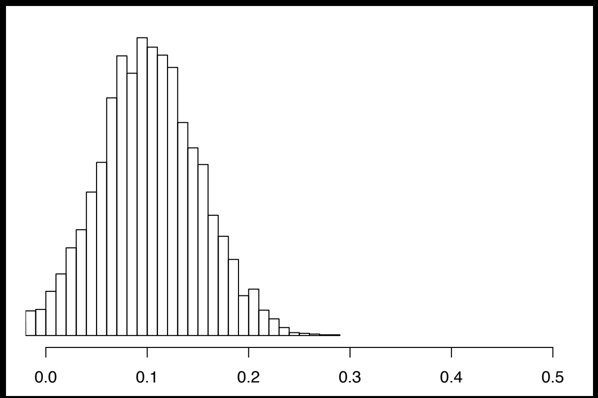


Determining the niche

Information from the current distribution

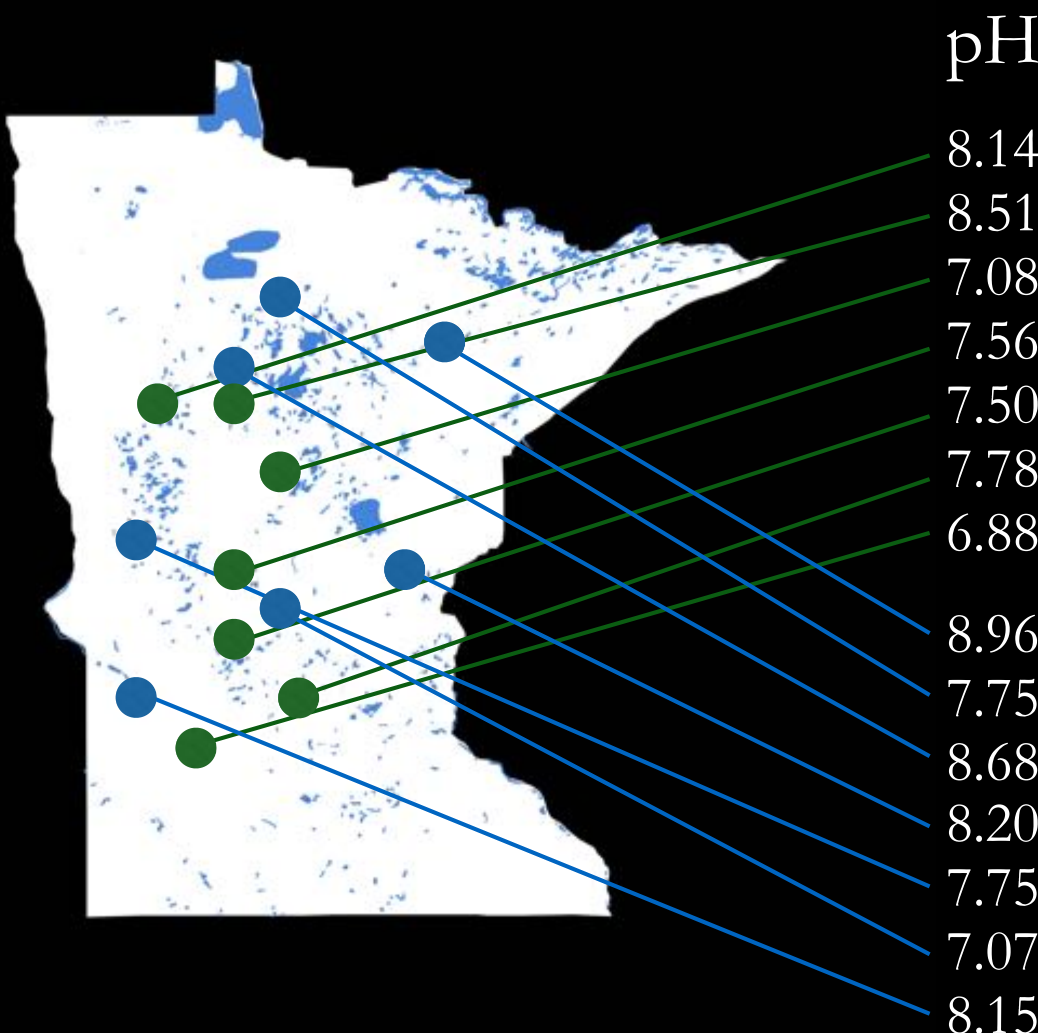


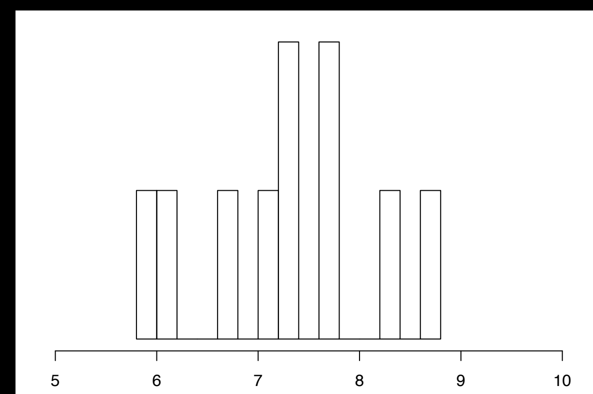


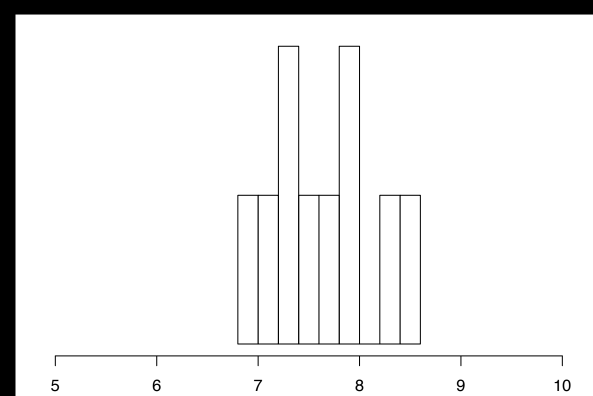


Determining the niche

Information from the current distribution



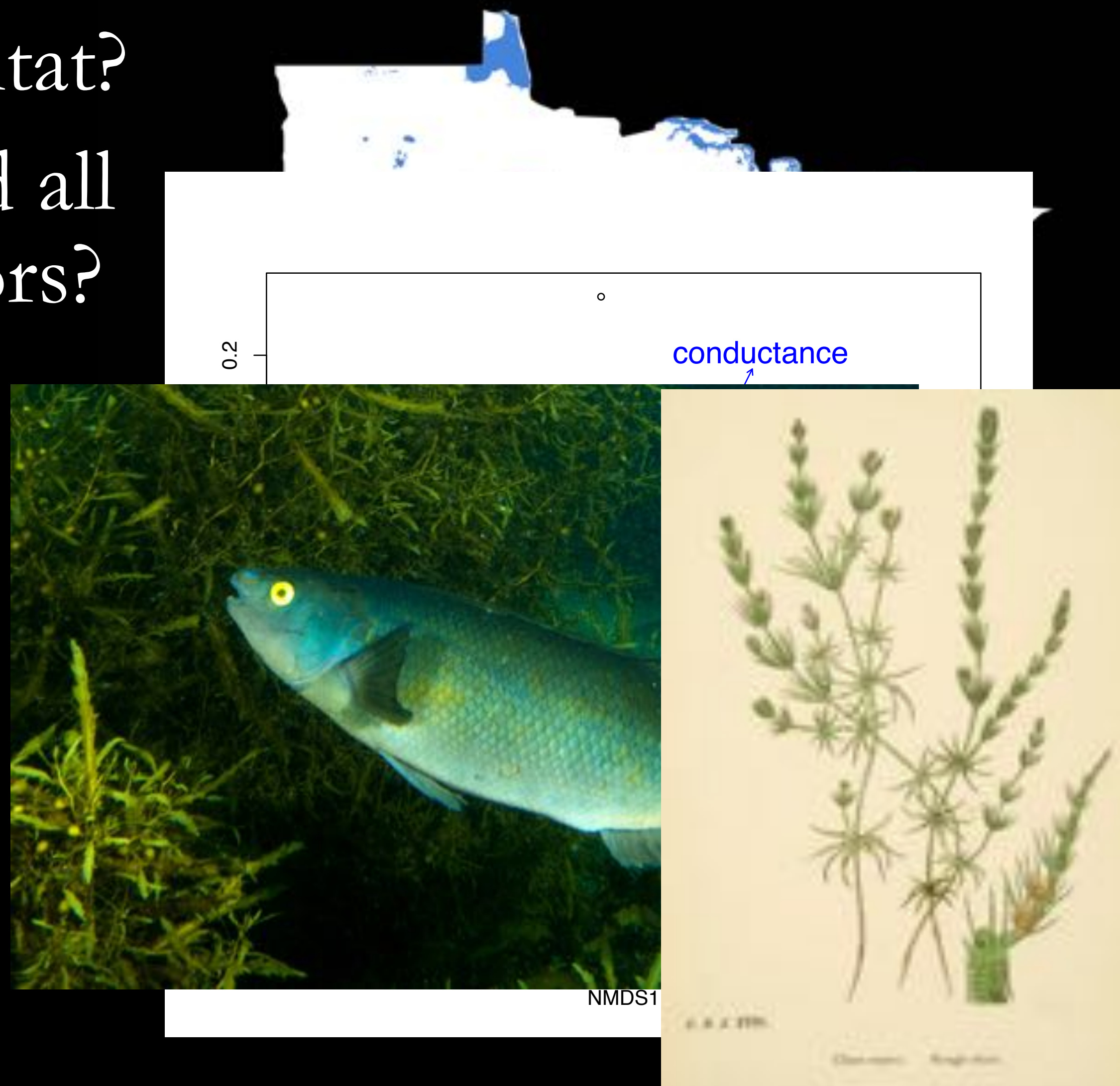




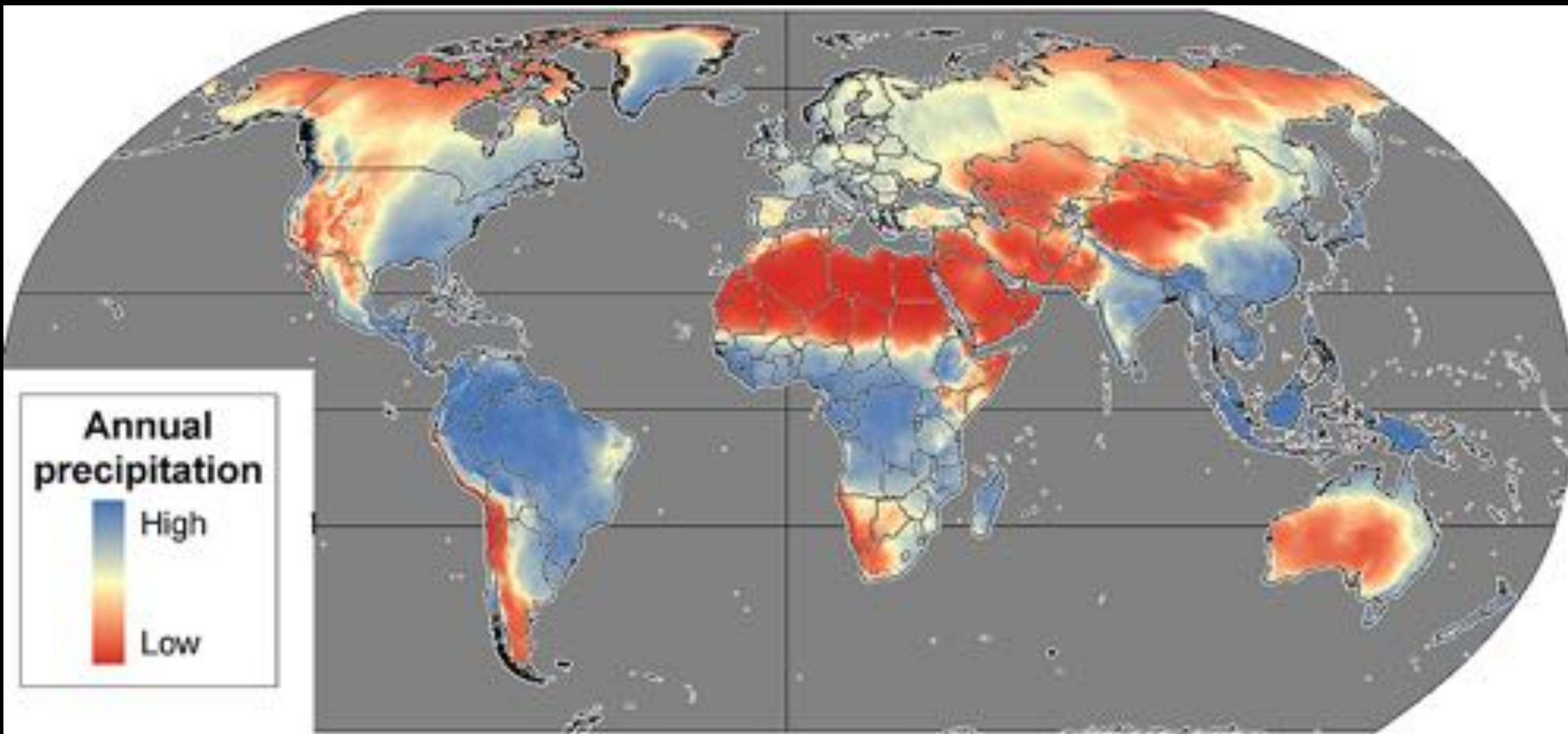
Challenges for predicting risk

- Is the current range all of the suitable habitat?
- Have you measured all the important factors?
- Biotic vs Abiotic constraints

DATA!



Environmental data



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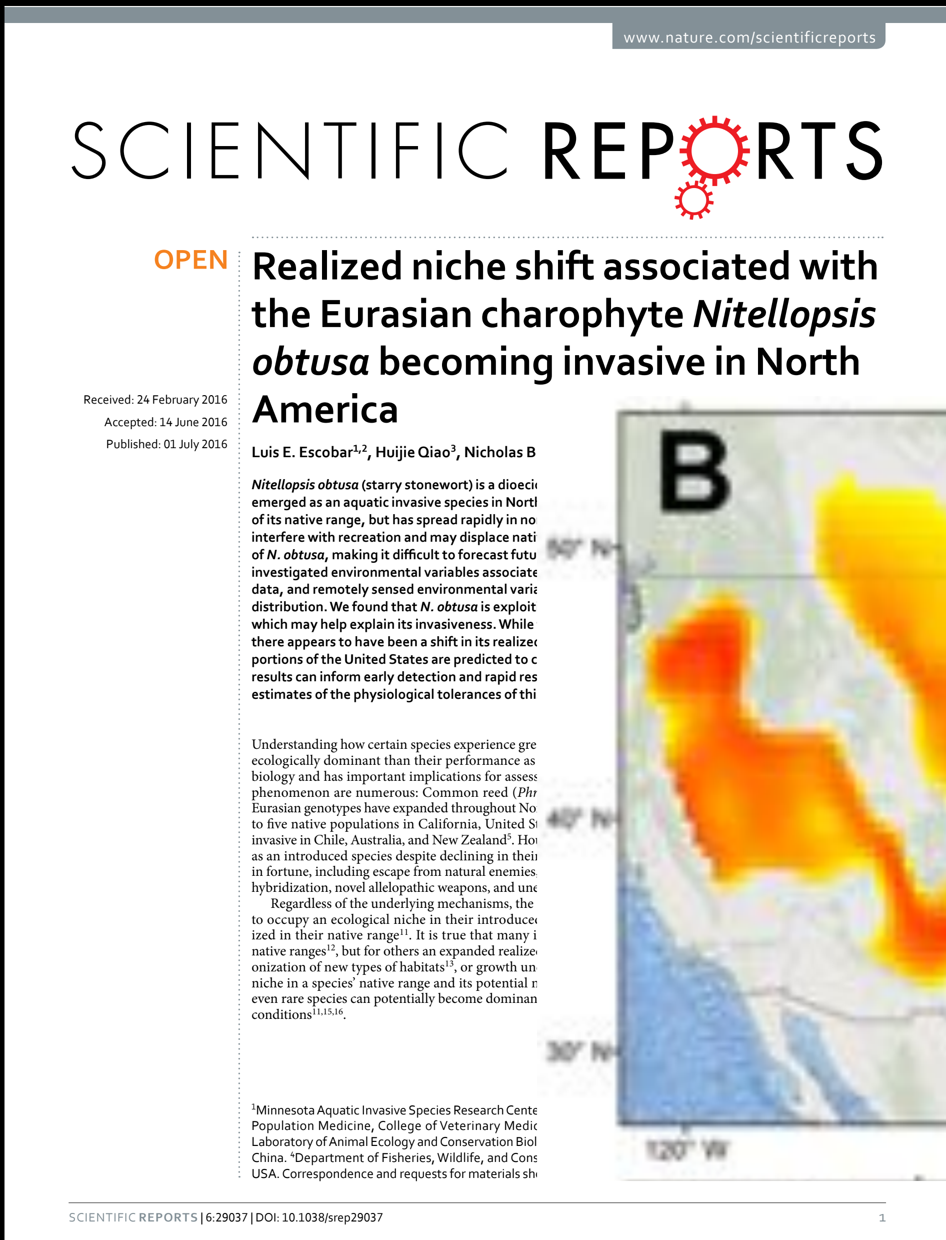

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Realized niche shift associated with the Eurasian charophyte *Nitellopsis obtusa* becoming invasive in North America

Received: 24 February 2016
Accepted: 14 June 2016
Published: 01 July 2016

Luis E. Escobar[1,2], Huijie Qiao[3], Nicholas B

Nitellopsis obtusa **(starry stonewort) is a dioeci emerged as an aquatic invasive species in Nortl of its native range, but has spread rapidly in no interfere with recreation and may displace nati of** ***N. obtusa*****, making it difficult to forecast futu investigated environmental variables associate data, and remotely sensed environmental vari distribution. We found that** ***N. obtusa*** **is exploit which may help explain its invasiveness. While there appears to have been a shift in its realize portions of the United States are predicted to c results can inform early detection and rapid res estimates of the physiological tolerances of thi**

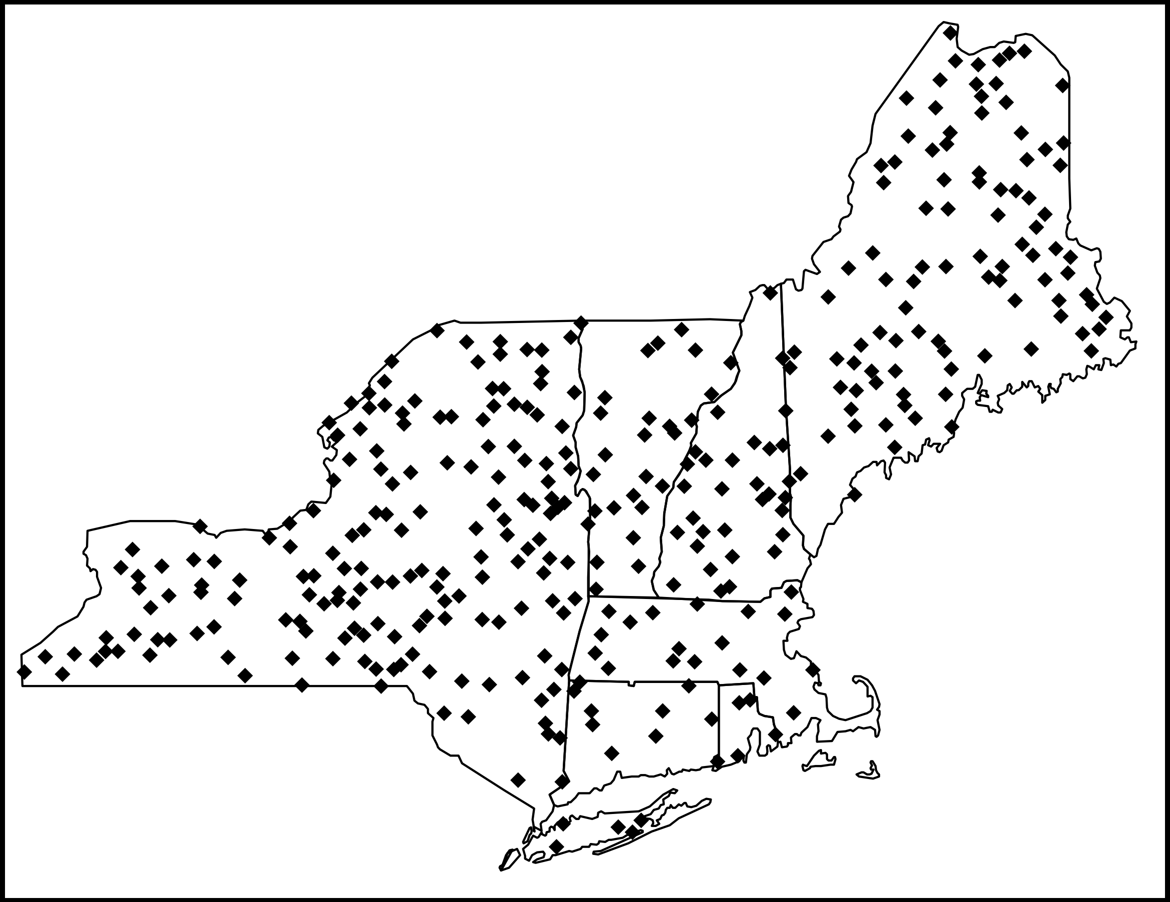
Understanding how certain species experience gre ecologically dominant than their performance as biology and has important implications for assess phenomenon are numerous: Common reed (*Phr* Eurasian genotypes have expanded throughout No to five native populations in California, United S invasive in Chile, Australia, and New Zealand[5]. Ho as an introduced species despite declining in thei in fortune, including escape from natural enemies hybridization, novel allelopathic weapons, and une

Regardless of the underlying mechanisms, the to occupy an ecological niche in their introduce ized in their native range[11]. It is true that many i native ranges[12], but for others an expanded realiz onization of new types of habitats[13], or growth un niche in a species' native range and its potential r even rare species can potentially become dominan conditions[11,15,16].

[1]Minnesota Aquatic Invasive Species Research Cente Population Medicine, College of Veterinary Medic Laboratory of Animal Ecology and Conservation Biol China. [4]Department of Fisheries, Wildlife, and Cons USA. Correspondence and requests for materials sh

May not be best strategy for aquatic species

Environmental data



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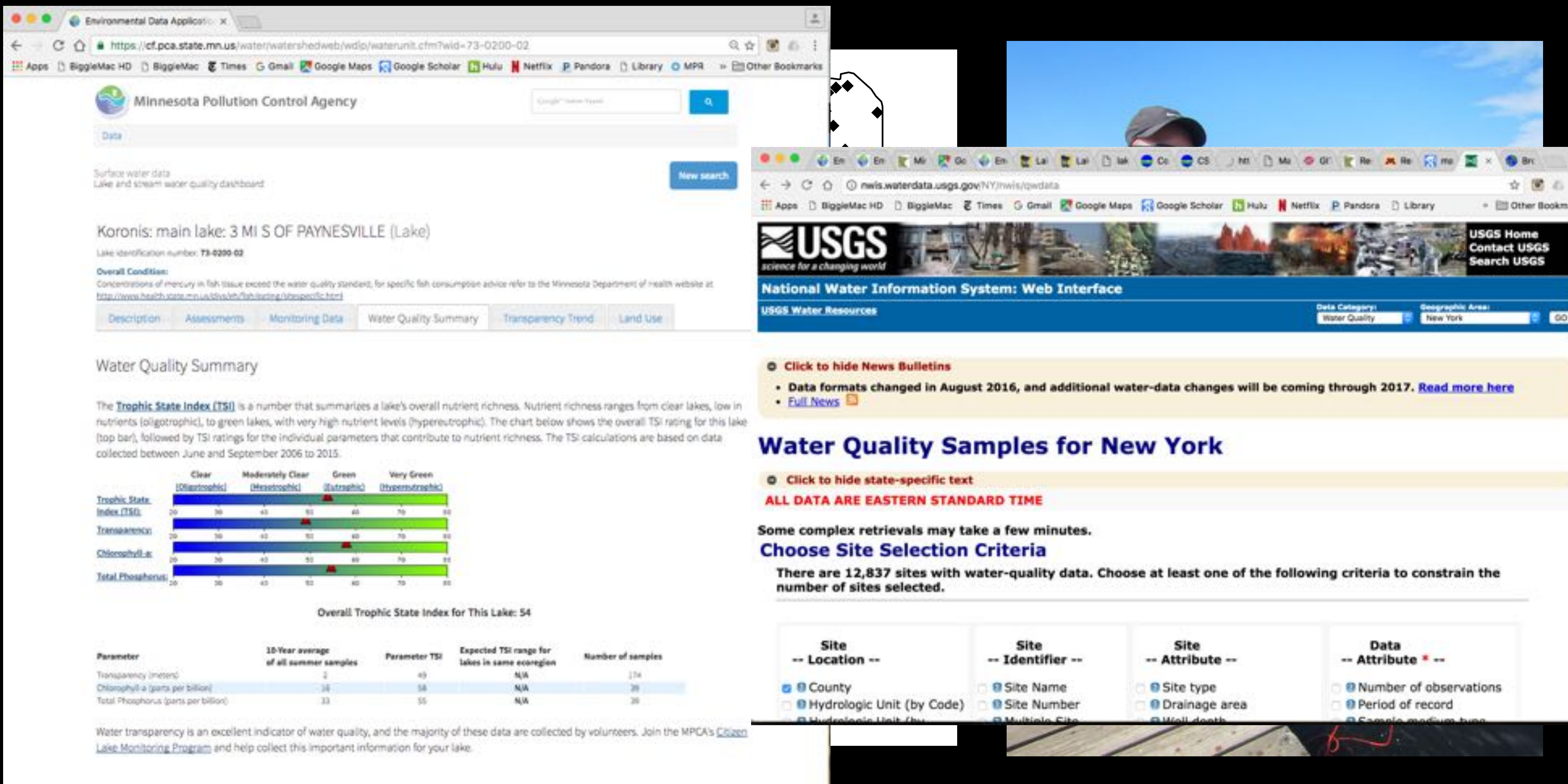

Environmental data

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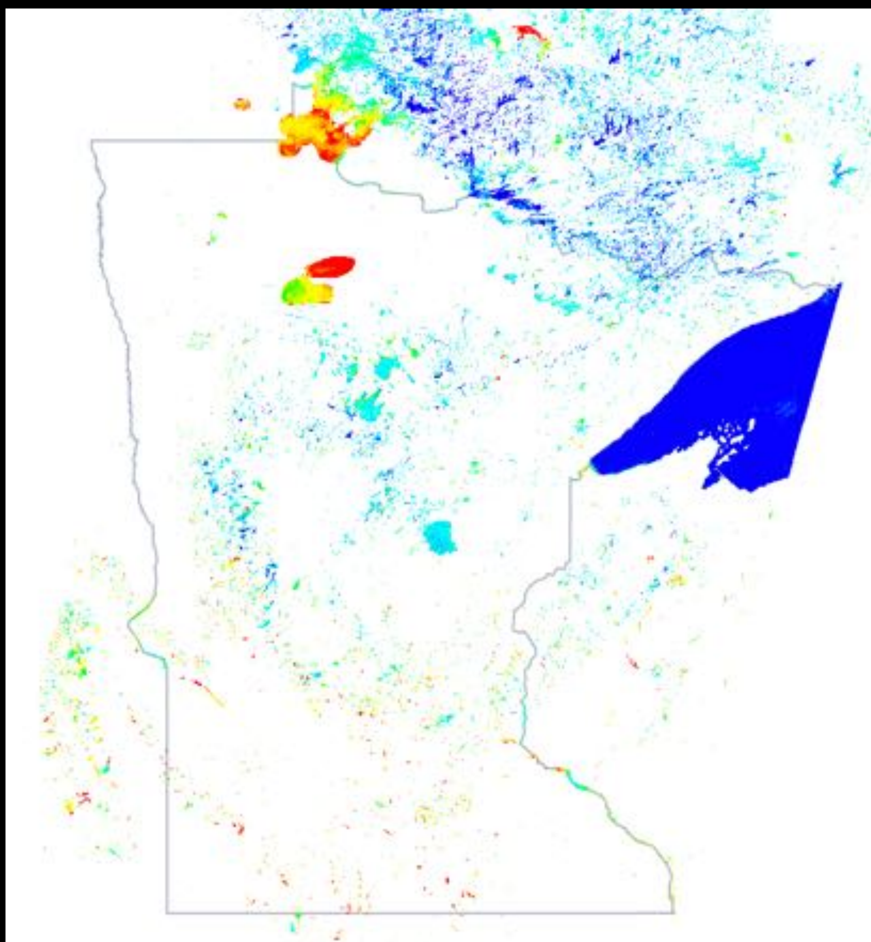
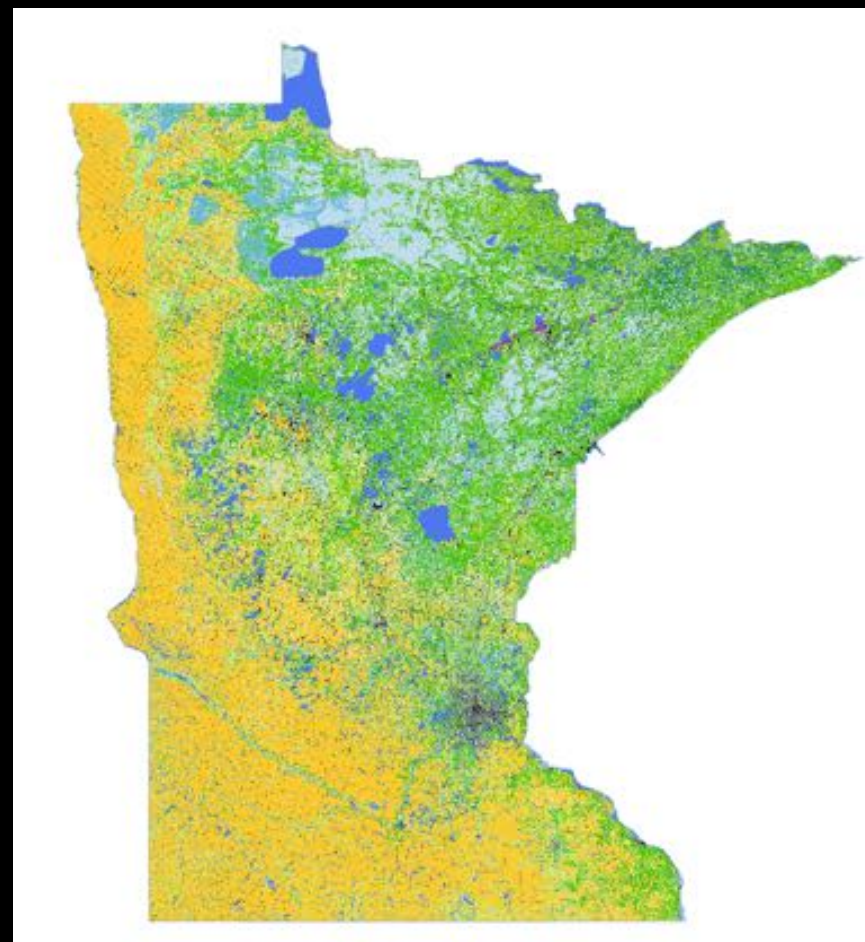
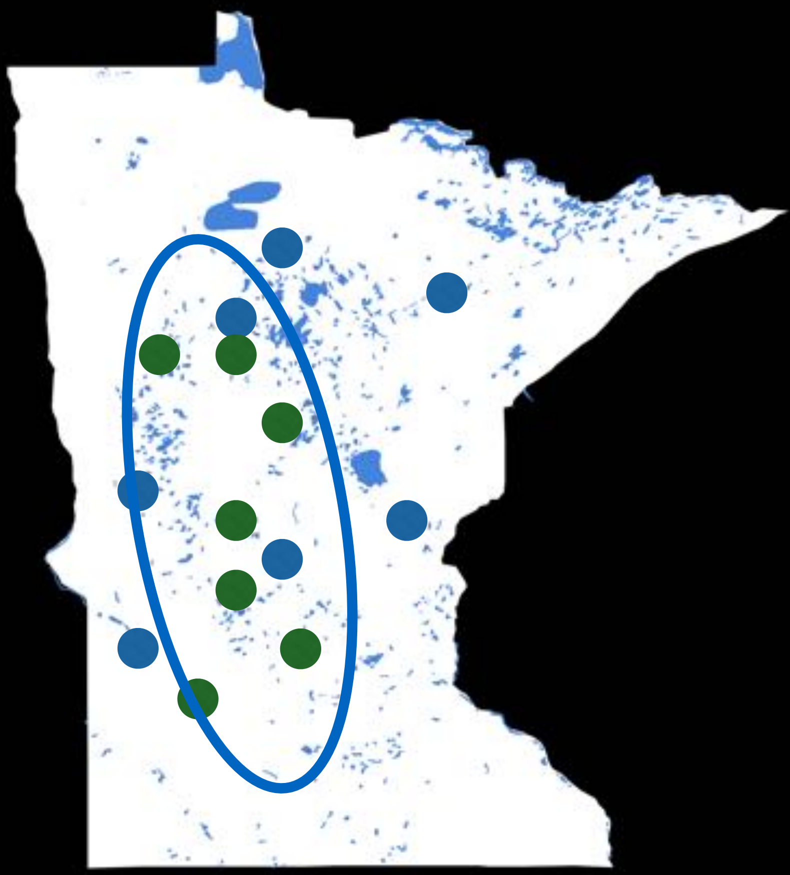
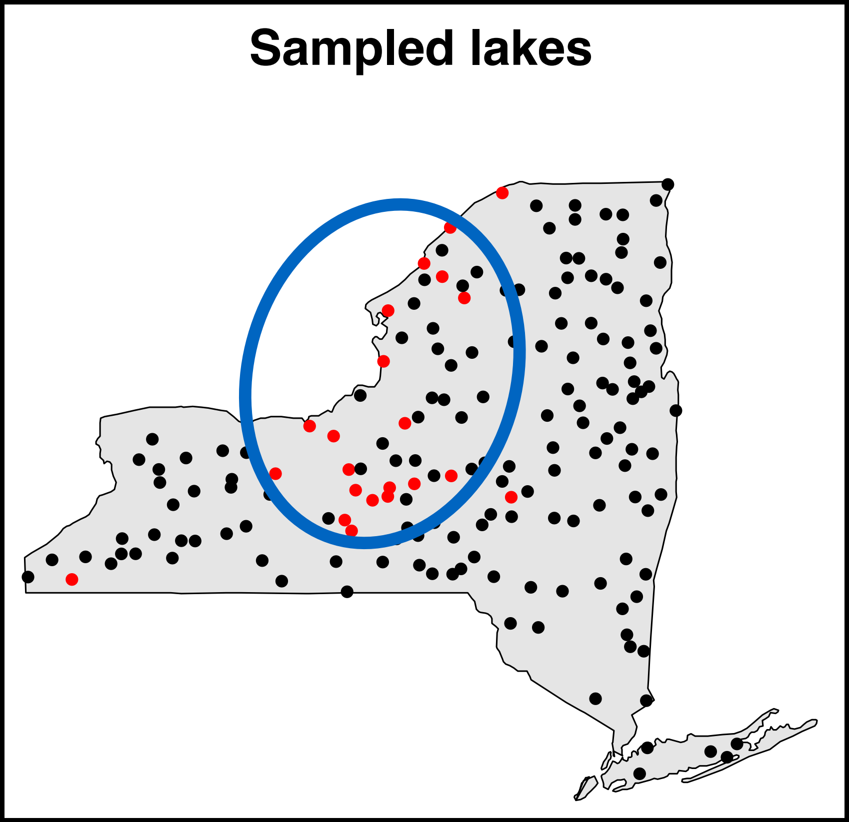




Estimating the niche

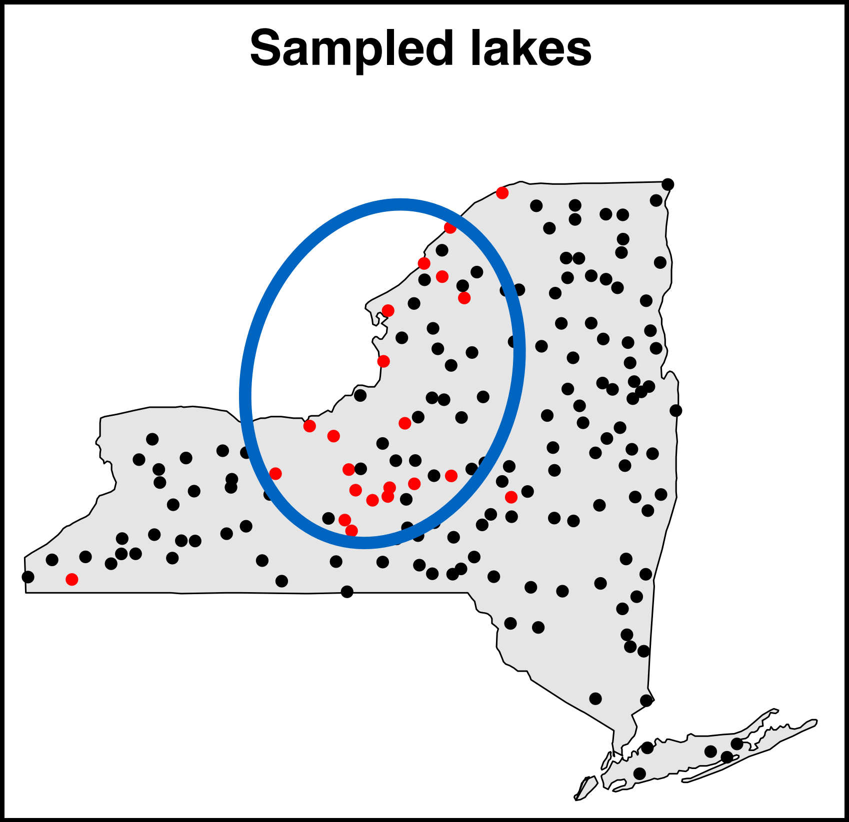


Estimating the niche



Dissolved oxygen
Dissolved oxygen saturation
pH
Alkalinity
Hardness
Conductance
N
Ammonia
Nitrate
P
Ortho-P
Temp
Secchi depth
Chlorophyll A
Color
Salinity
S
Lead

Estimating the niche



pH
Alkalinity
Hardness
Conductance
N
Ammonia

Nitrate
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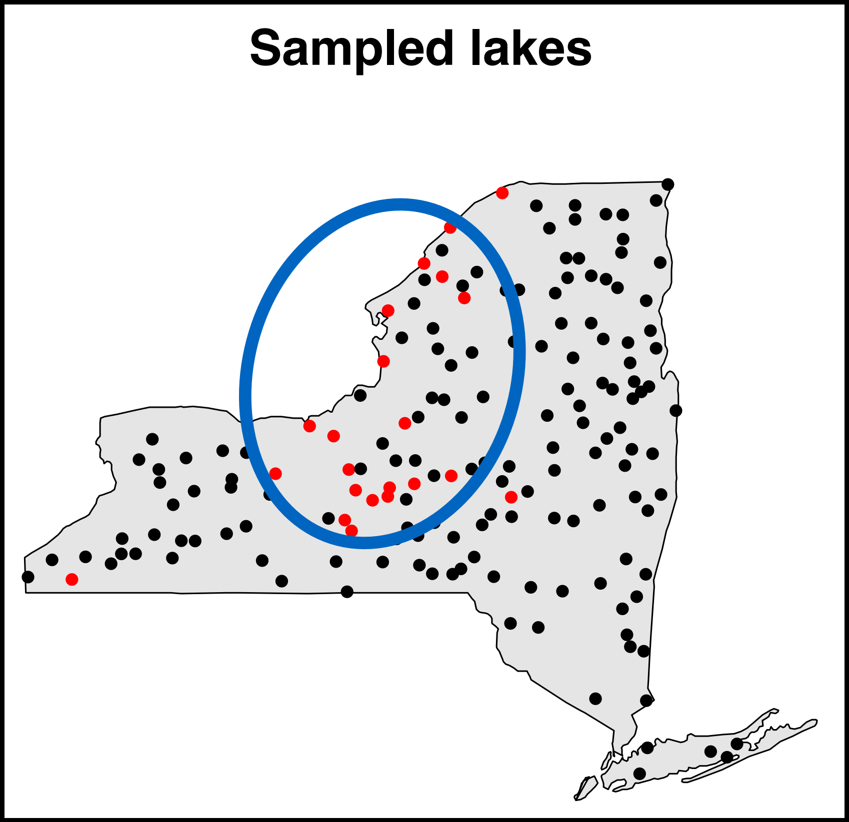
Ortho-P

Secchi depth
Chlorophyll A
Color
Salinity
S

Estimating the niche



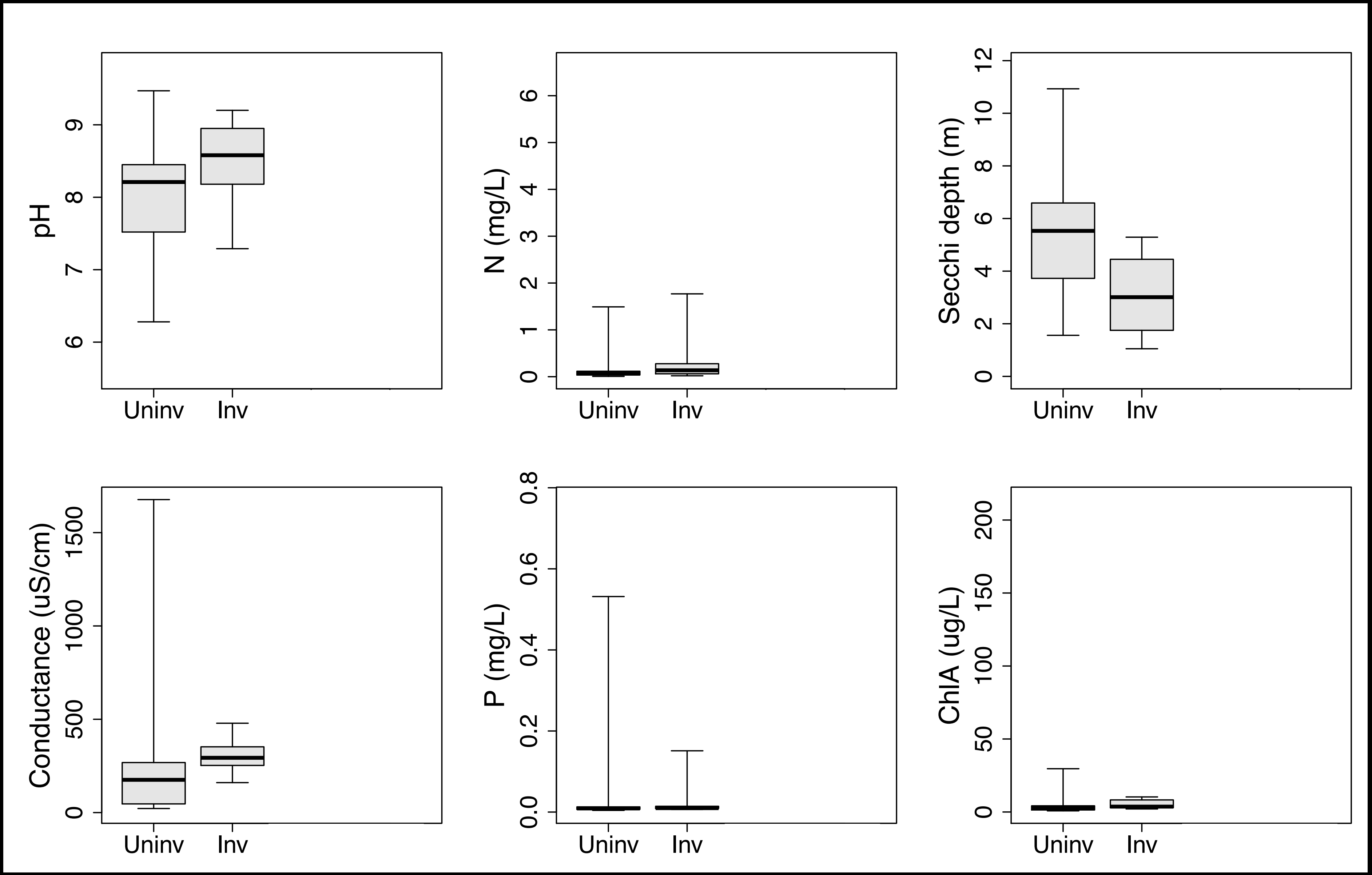
P

Secchi depth
Chlorophyll A

pH

Conductance
N

Estimating the niche



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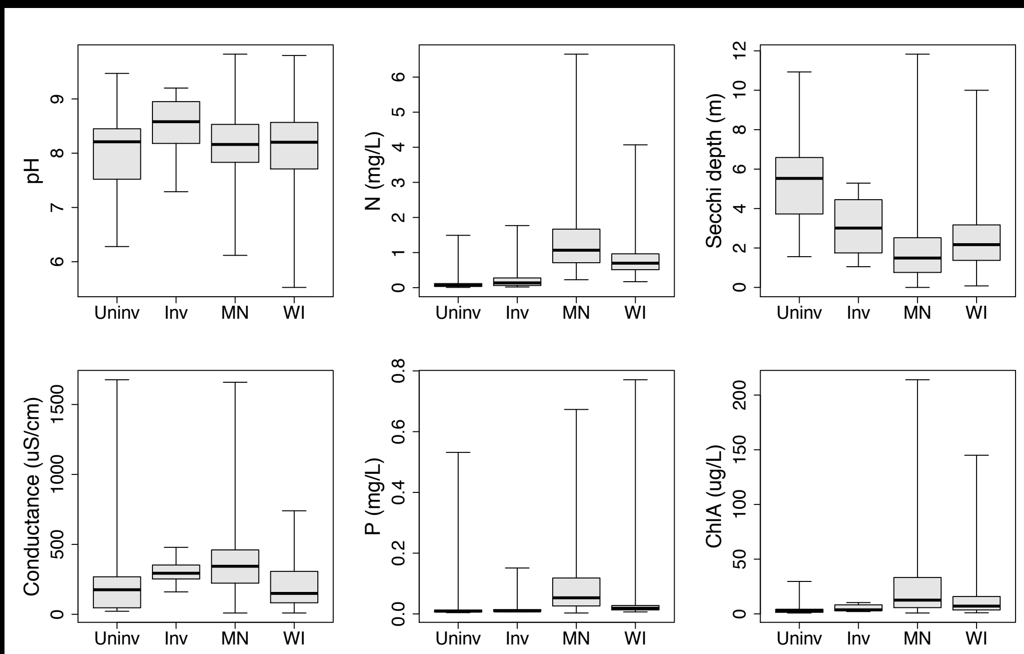
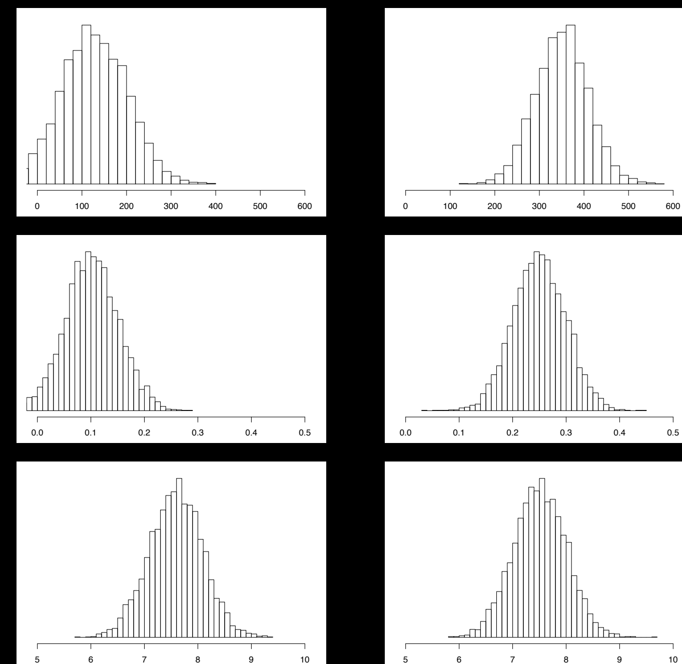
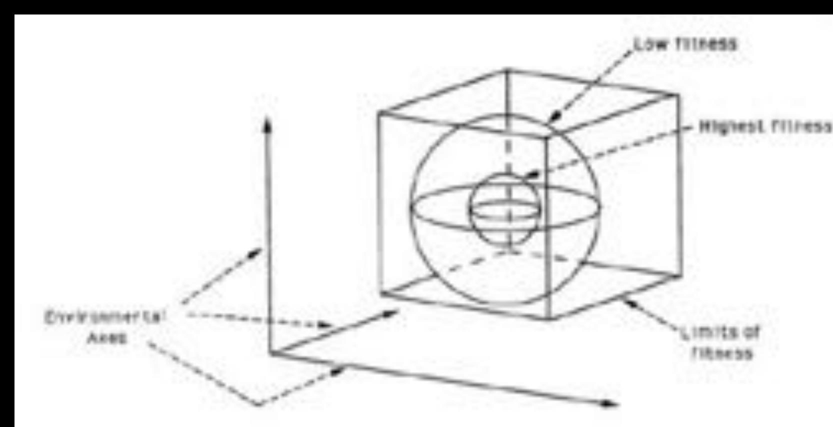


Env 1

Env 2

Env 3



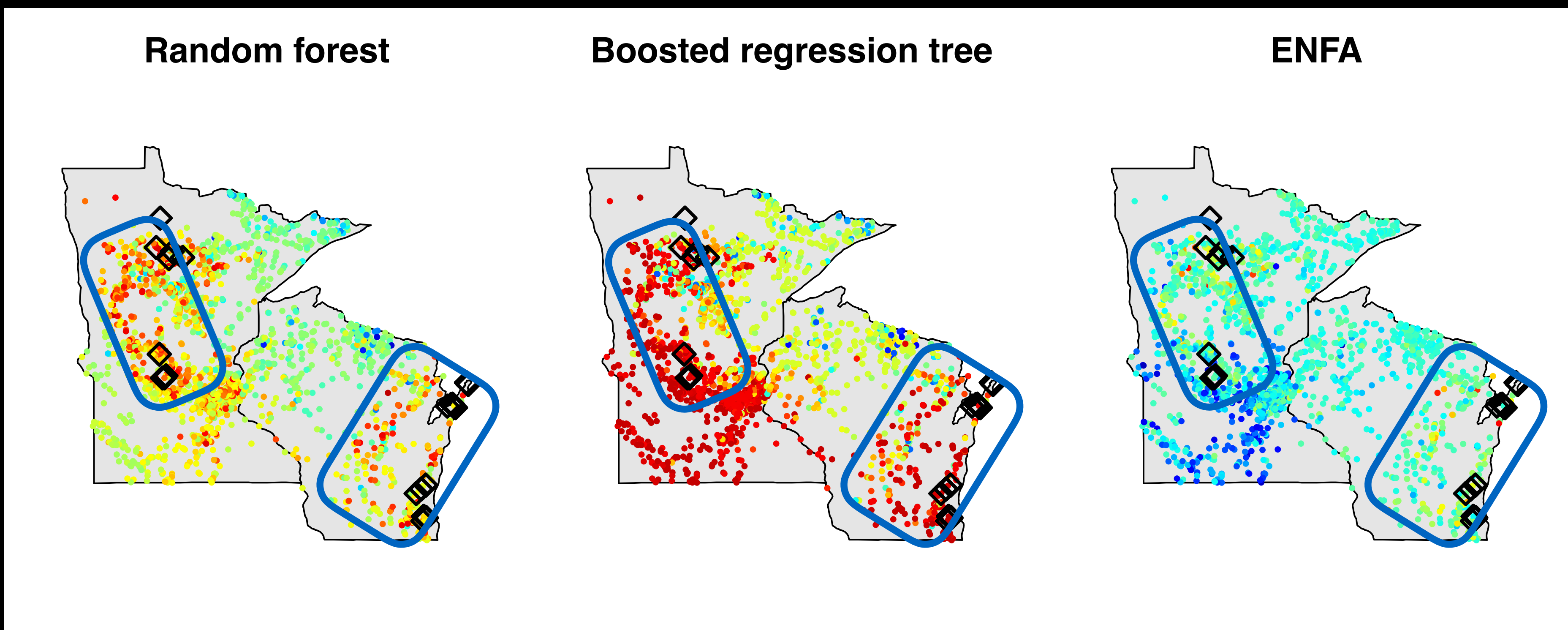


Predicting suitable habitat

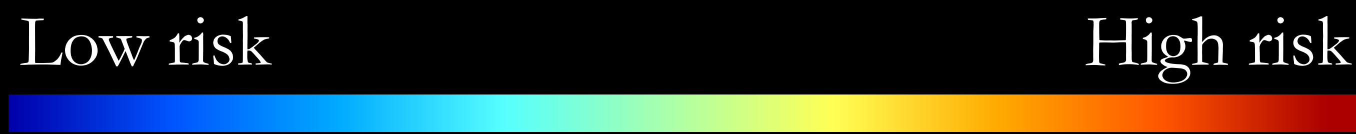
- Three approaches
  - Random forests
  - Boosted regression trees
  - Ecological niche factor analysis (presence only)

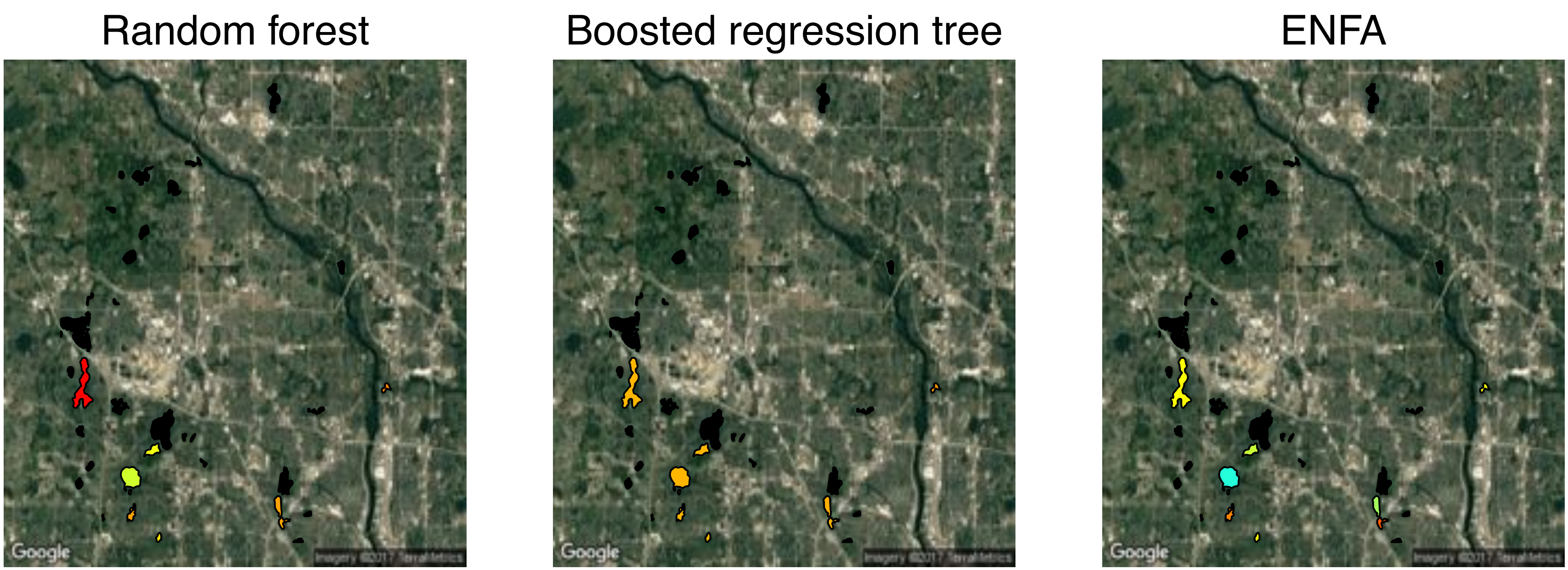
Predicting suitable habitat

Low risk High risk



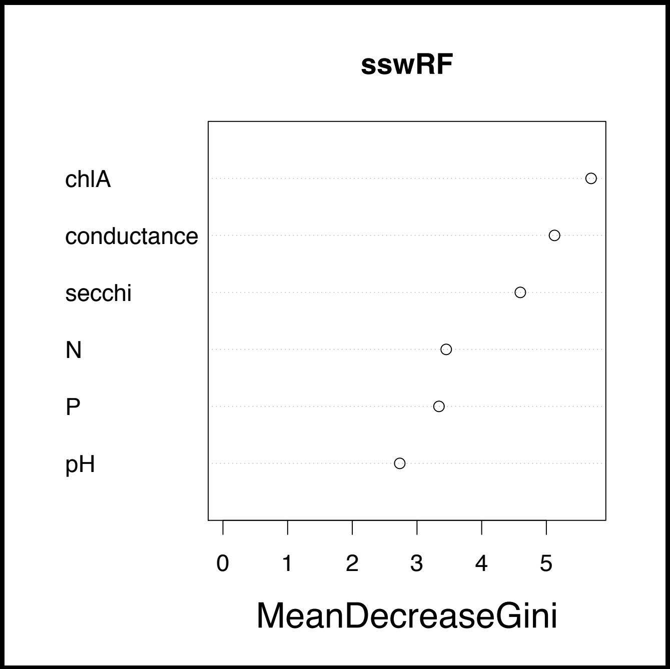
Predicting suitable habitat

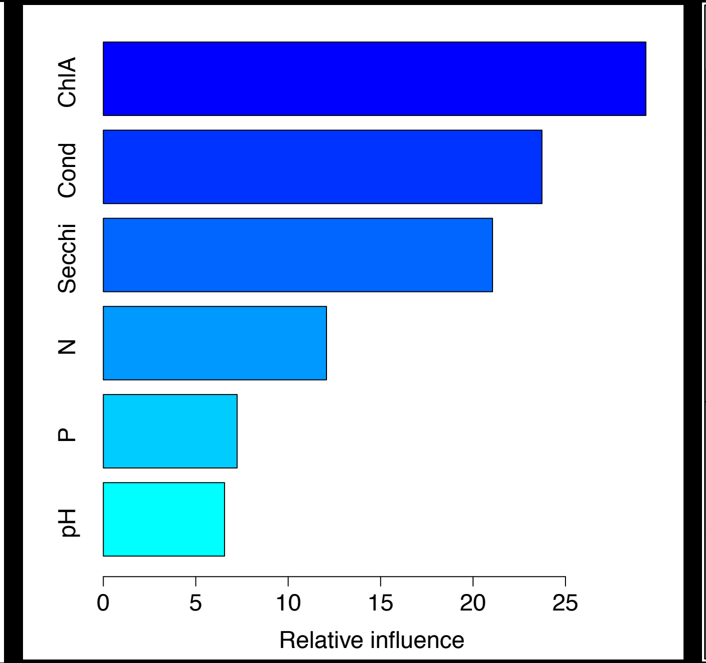


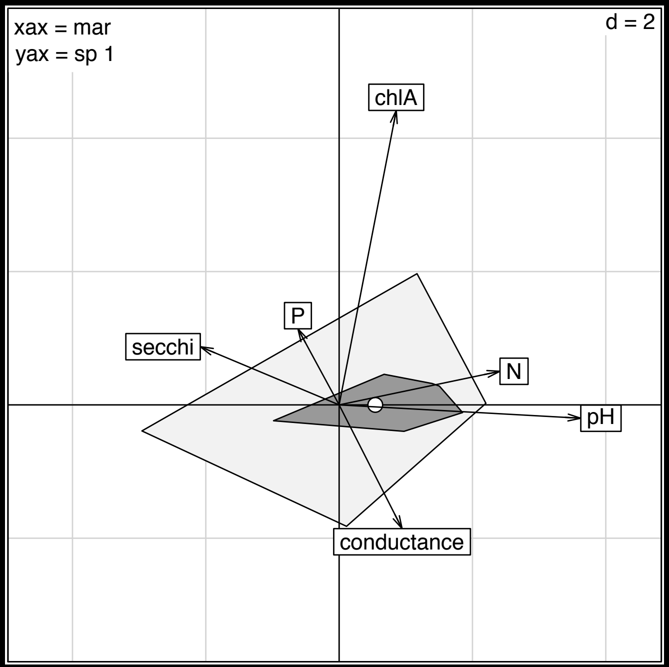


Expanding what we know

Random forest | Boosted Regression trees | ENFA

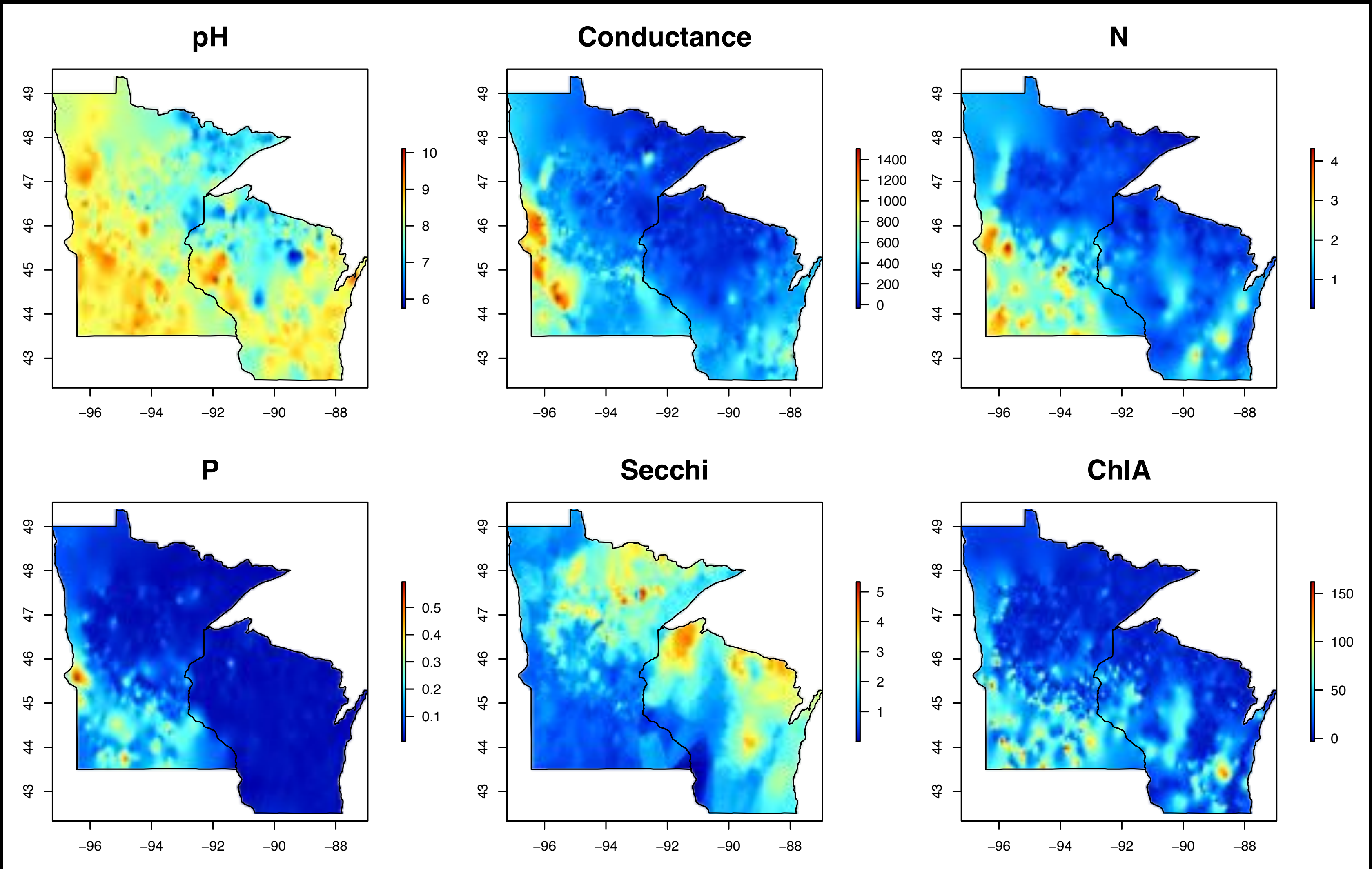




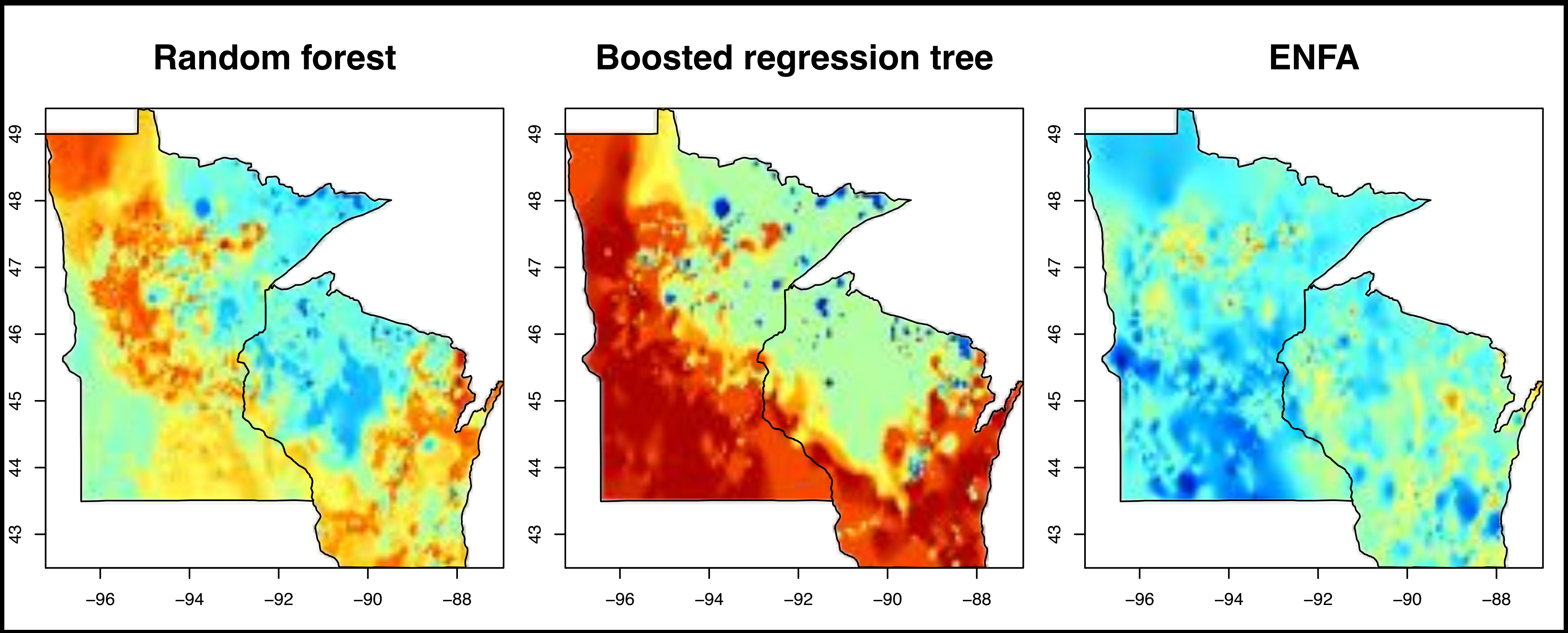


Expanding what we know

- Field sampling ⟶ Spatial interpolation



Expanding what we know

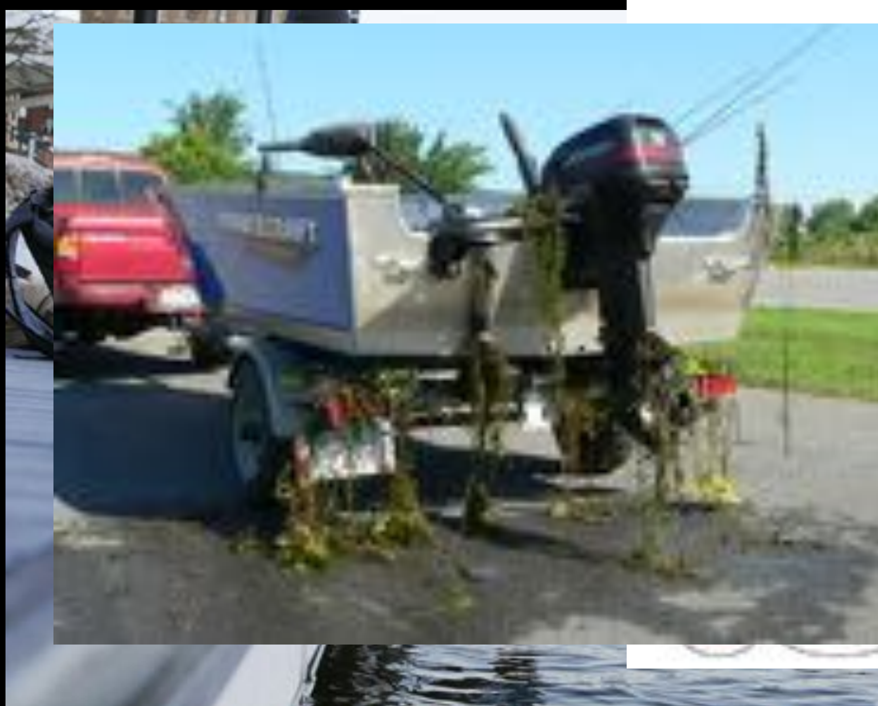


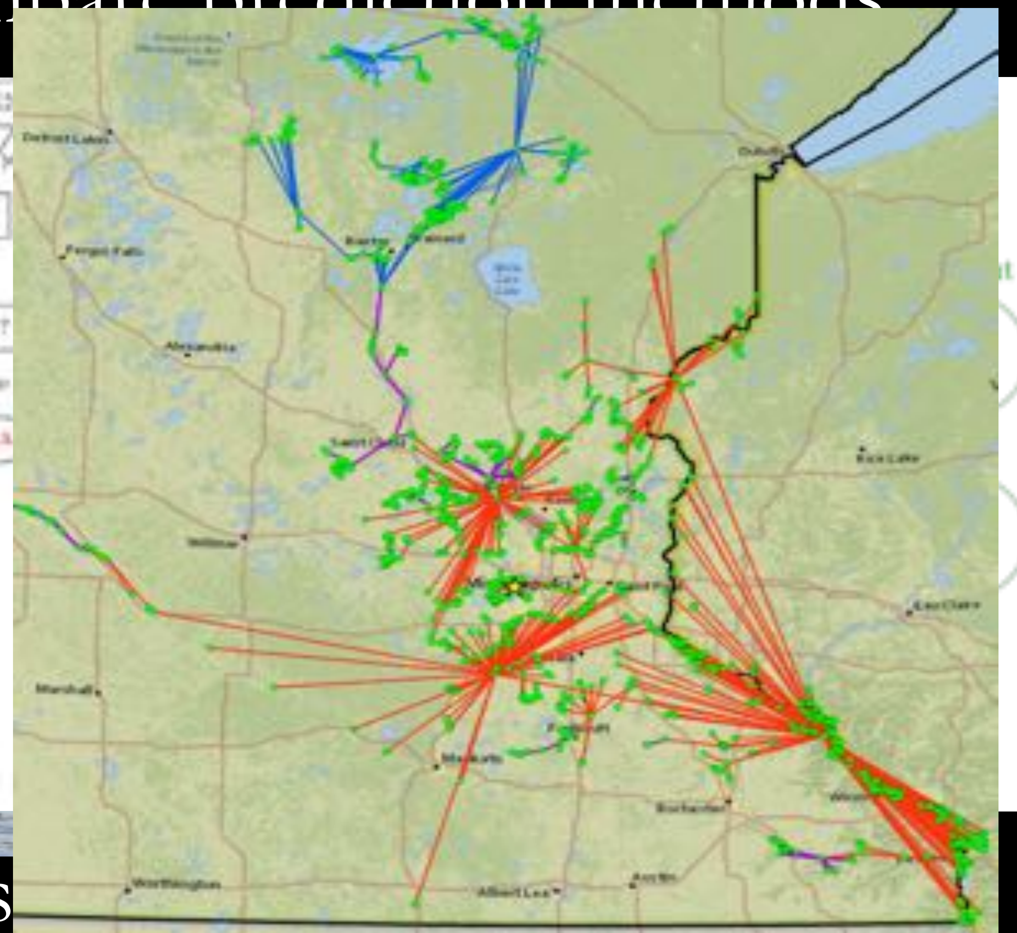
Expanding what we know

Connectivity

Compare prediction methods

More samples





Regress

networks

Expanding what we know

Keep looking !

Starry trek - How you can help

- Minnesota & Wisconsin
- Statewide, coordinated shoreline searches

Saturday, Aug. 5th, 2017

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UW Extension
University of Wisconsin-Extension

Photo: Dave Hansen

Final thoughts

- "All models are wrong; some are useful"
- Models give the impression of precision
- More levels of extrapolation or interpolation mean more sources of error
- Use models for planning and prioritization

Questions?

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