

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

Where is starry stonewort going?

Ranjan Muthukrishnan
mrunj@umn.edu
July. 13, 2017

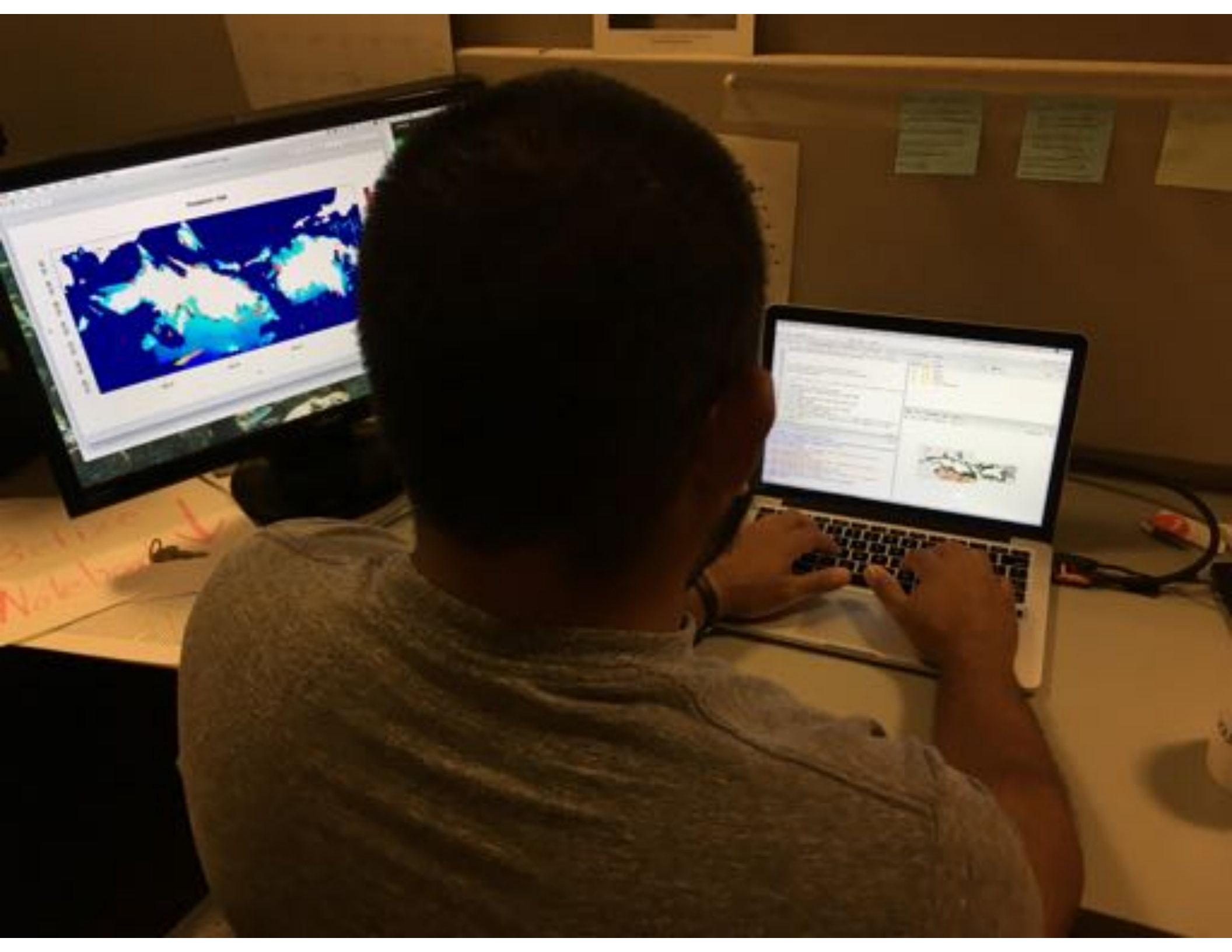


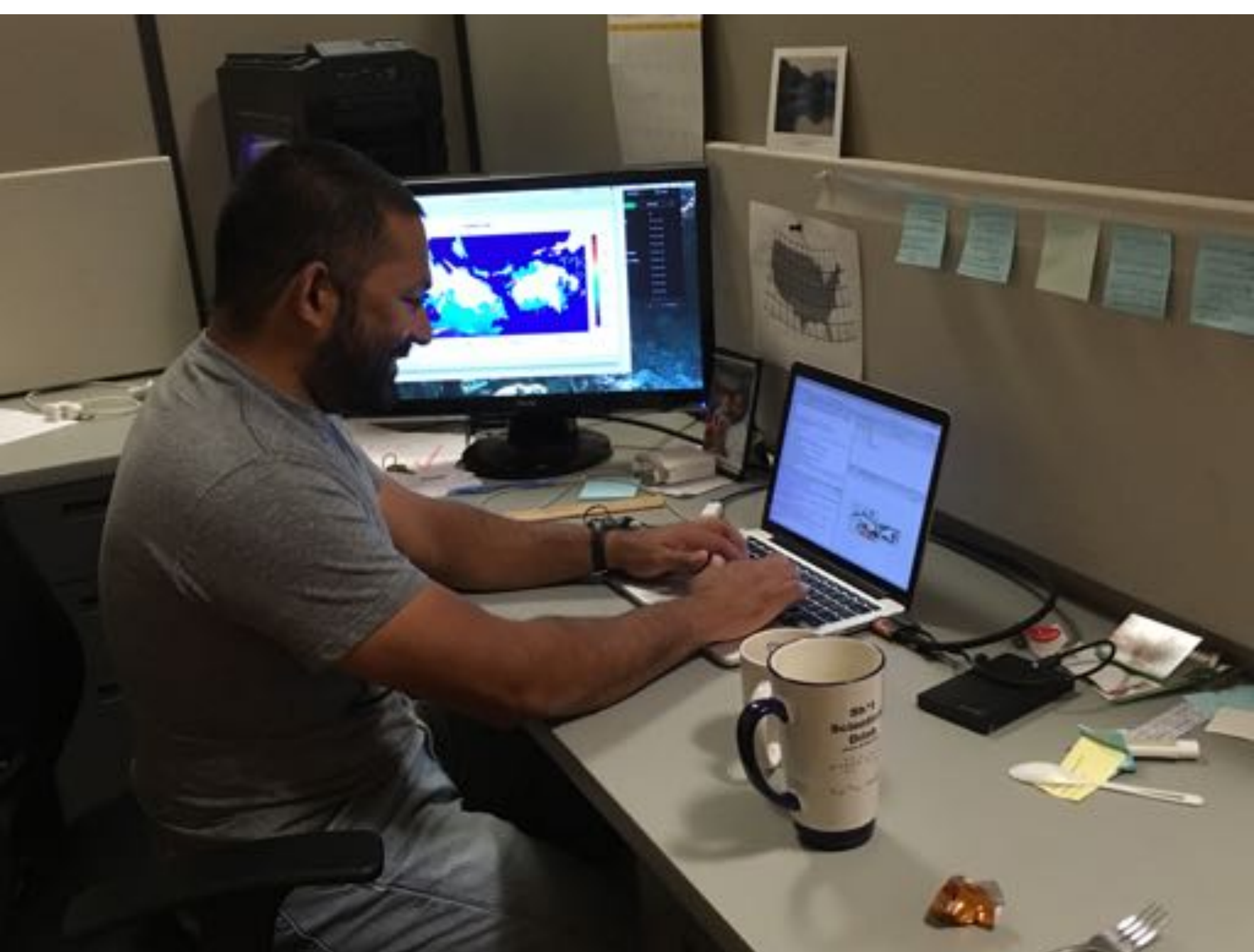
A comparison of eigenvalue decomposition and machine learning approaches for estimating distribution of a non-equilibrium species

Ranjan Muthukrishnan
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July. 13, 2017



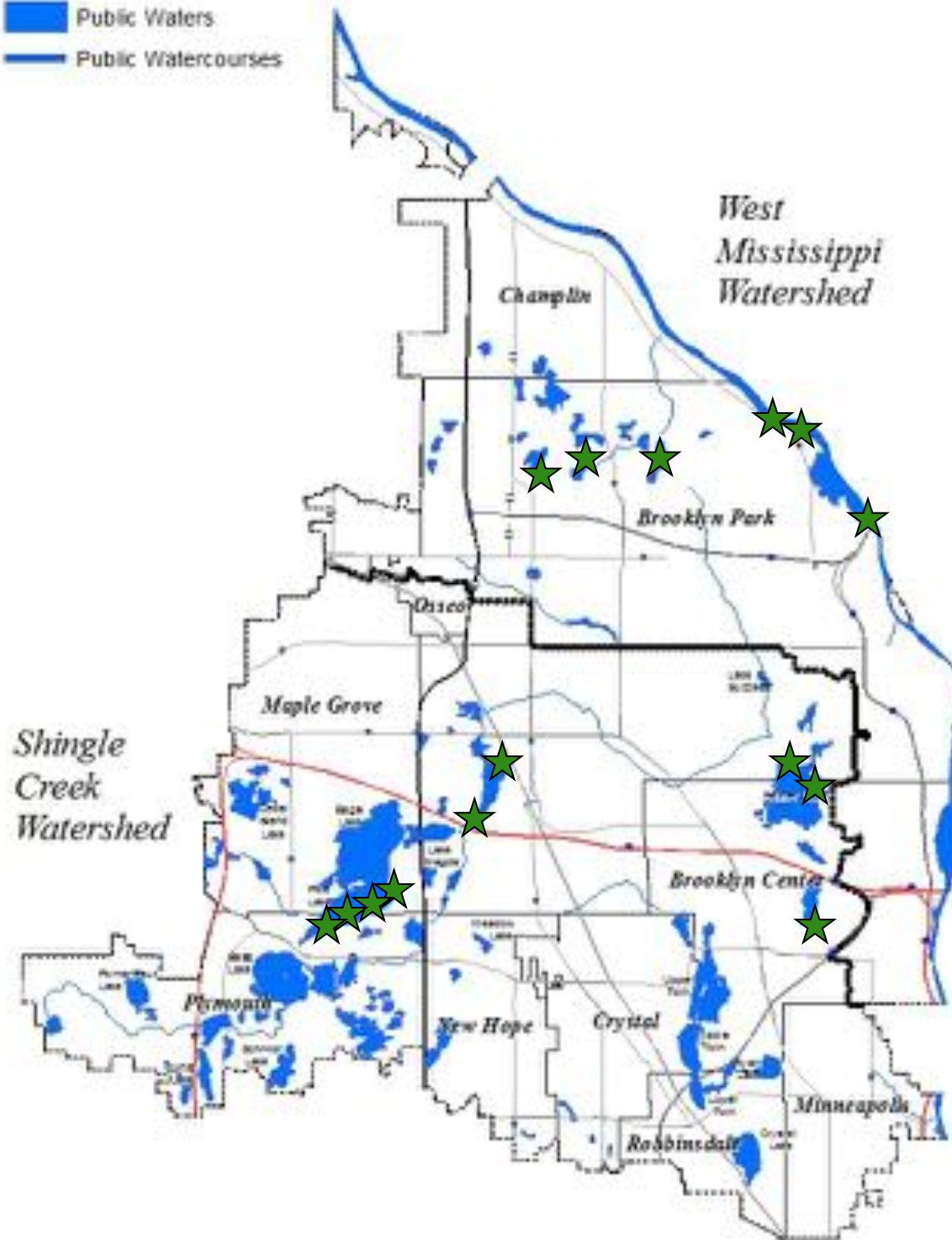






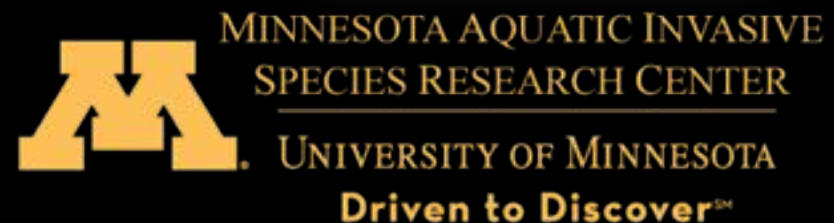


Public Waters
Public Watercourses



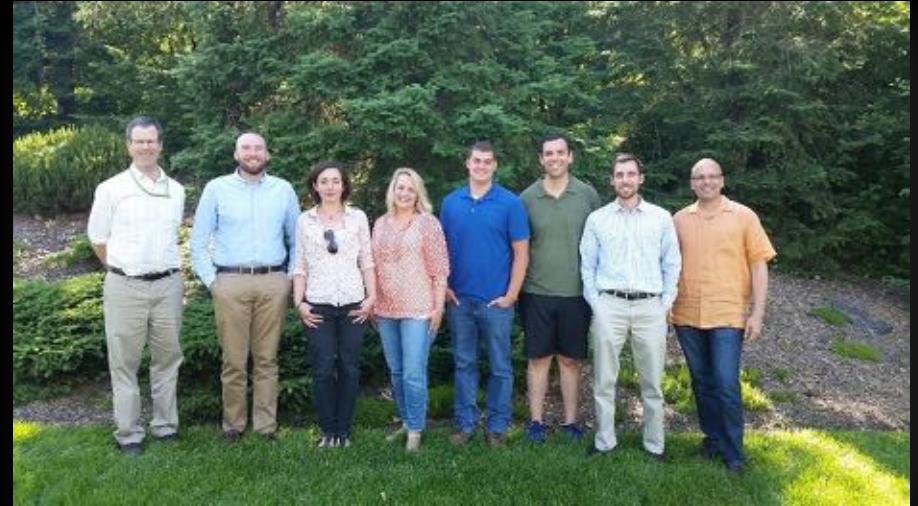
Collaborators

- Dan Larkin
- Wes Glisson (research fellow)
- Mike Verhoeven (grad. student)
- Carli Wagner (undergrad.)
- Luis Escobar
- Nick Phelps
- Megan Weber



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



Starry Stonewort



Scott Brown



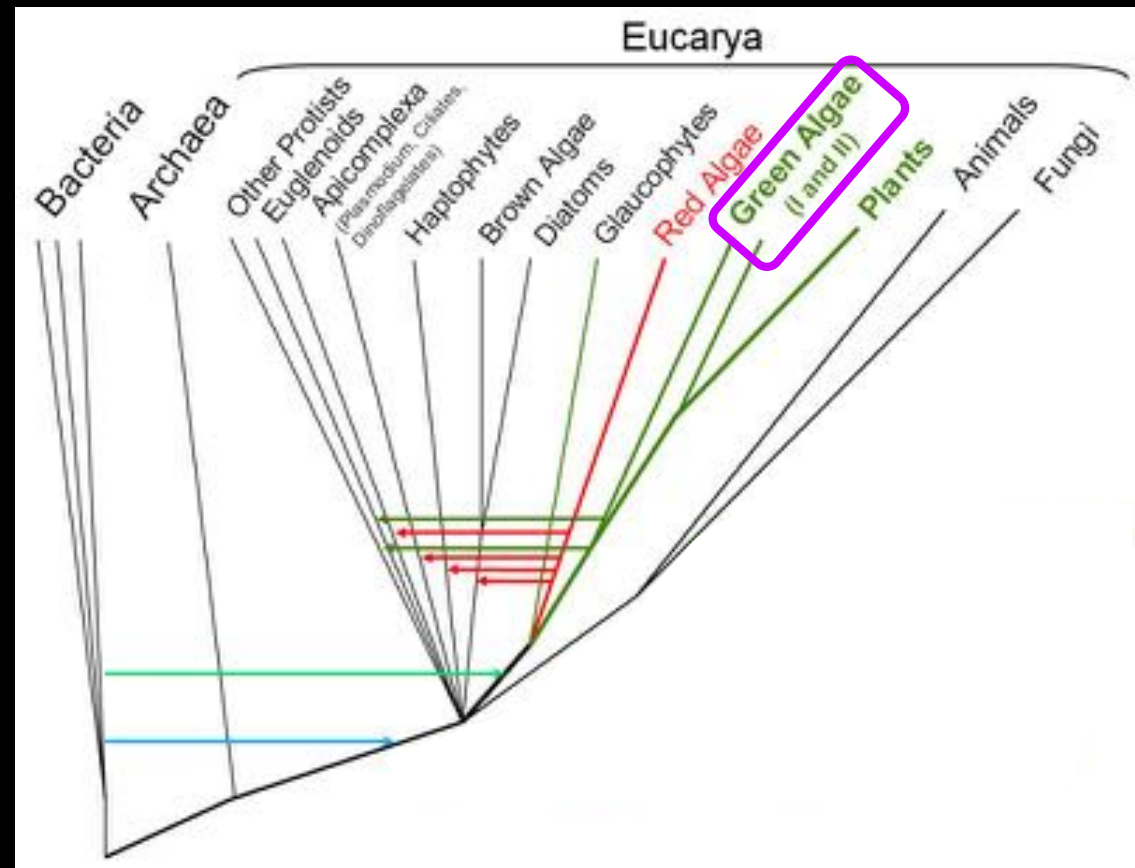
Starry stonewort

Photo by Paul Skawinski

Starry stonewort

Nitellopsis obtusa

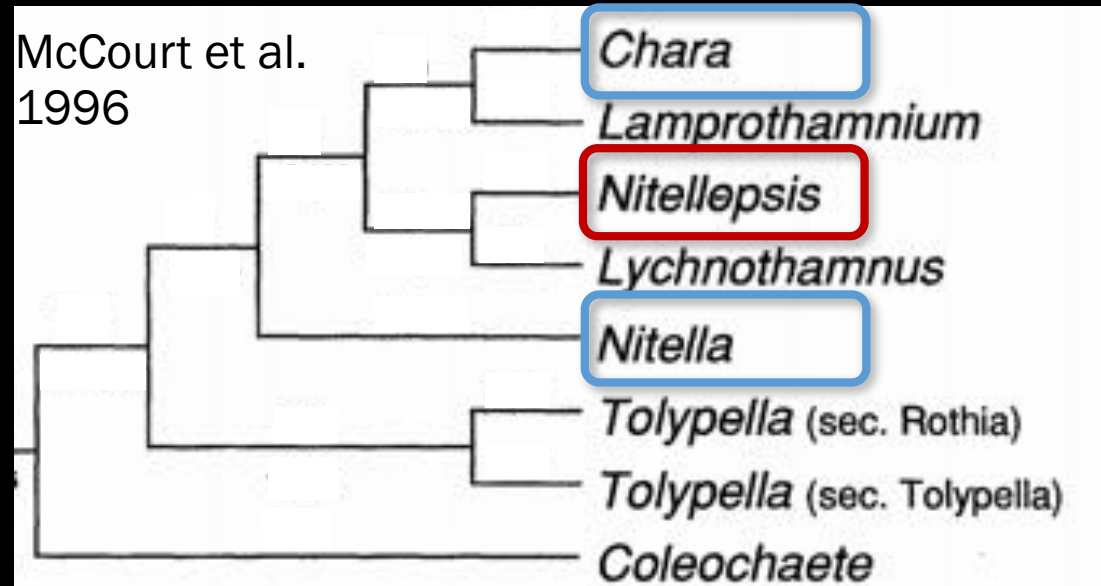
- Green alga



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

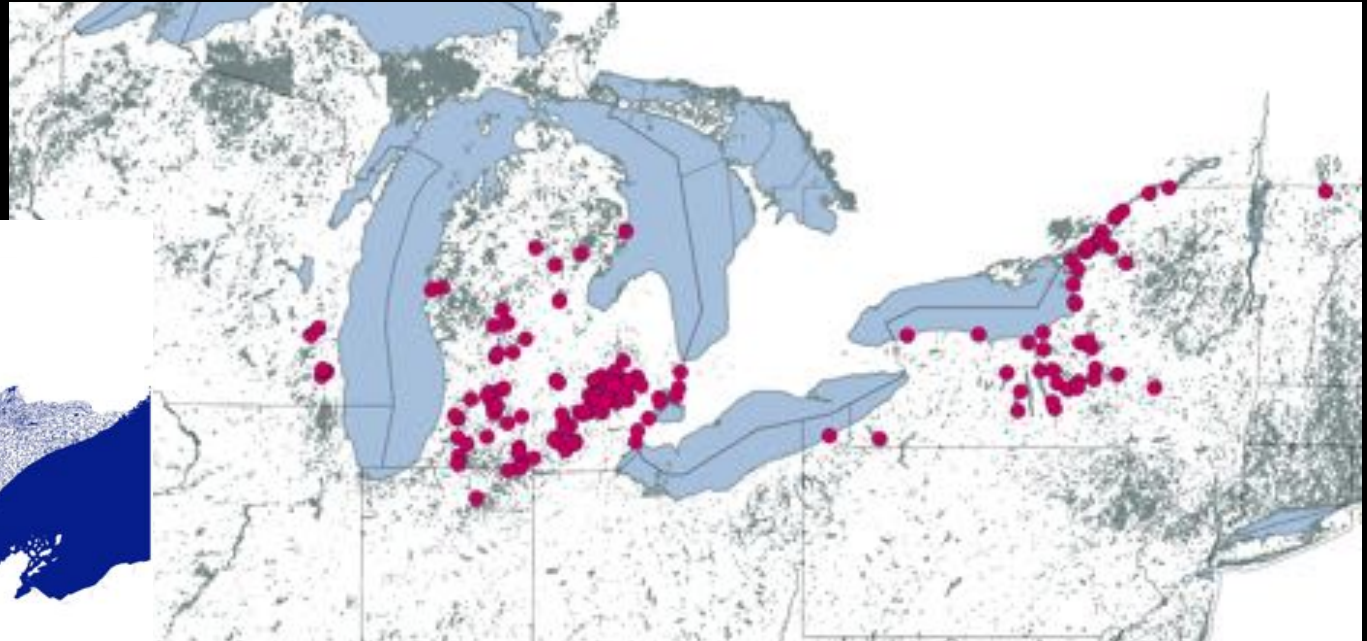
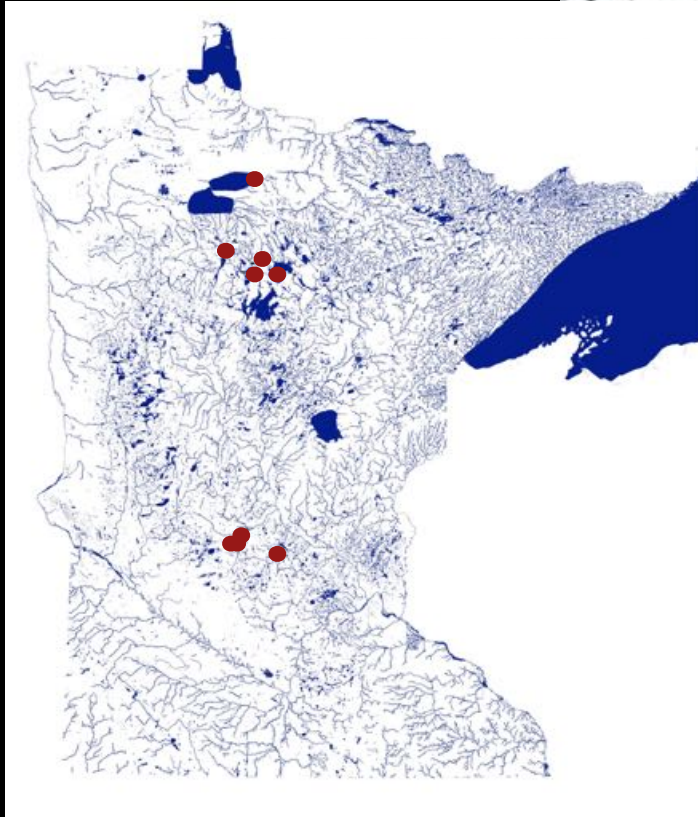


Nitella flexilis

Invasion history

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

Present distribution

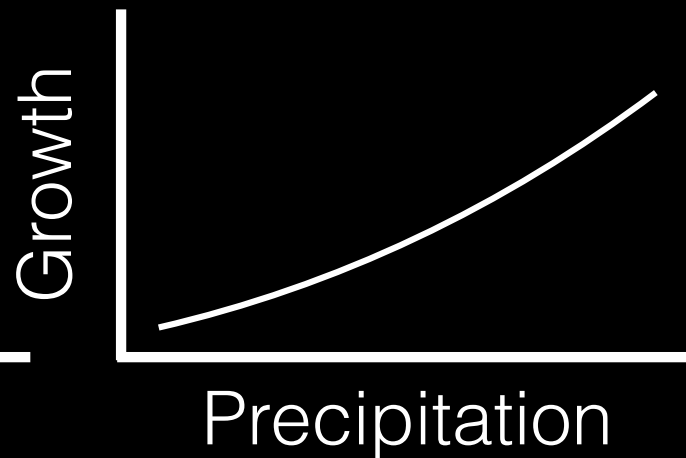
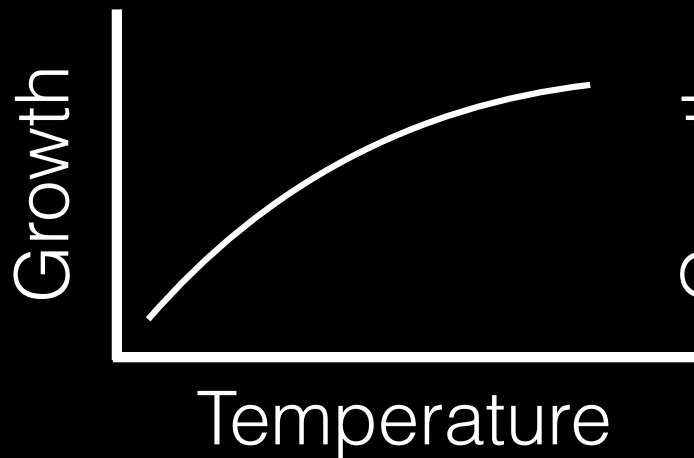
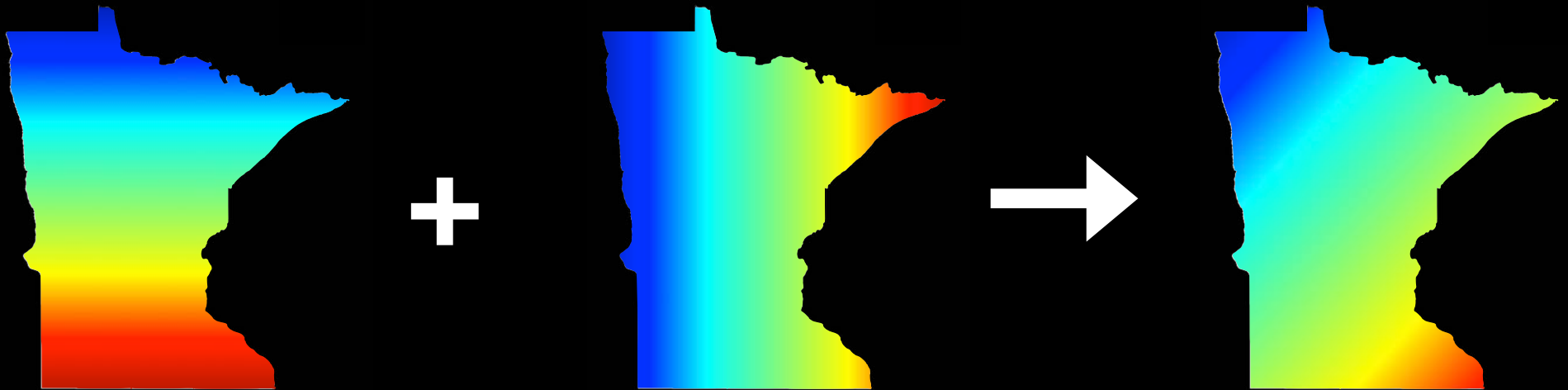


Where will it go?

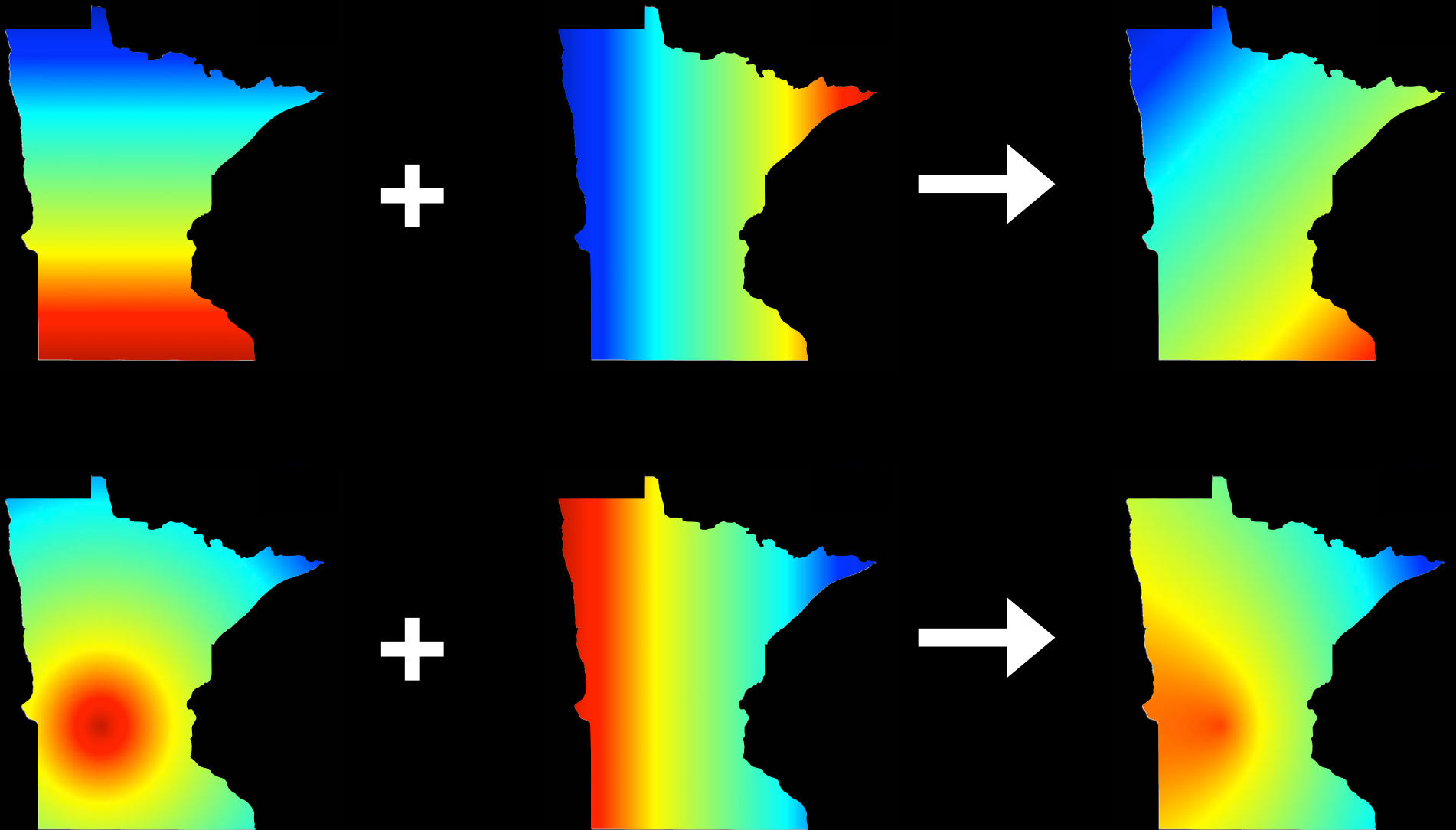
Ecological niche modeling

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

Ecological niche modeling

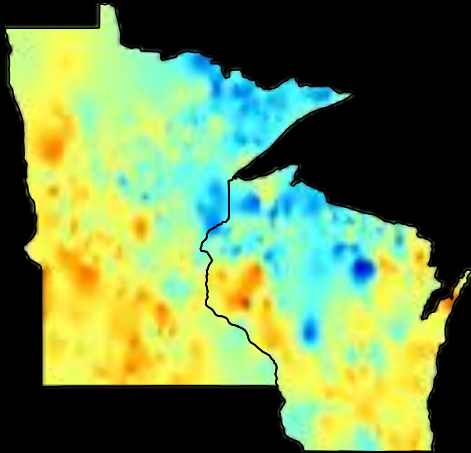


Ecological niche modeling

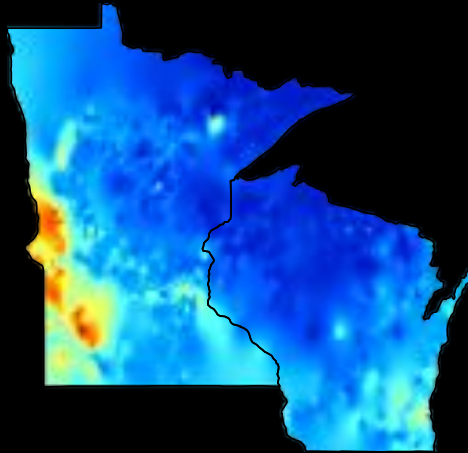


Ecological niche modeling

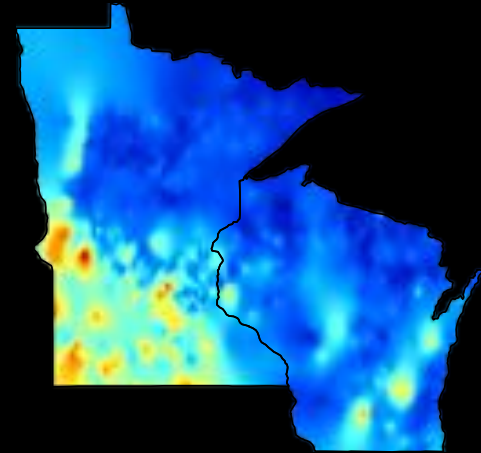
pH



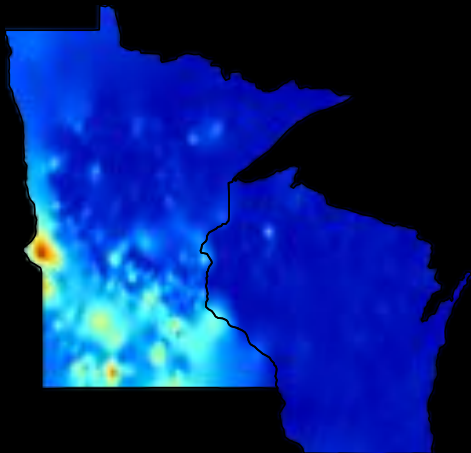
Conductance



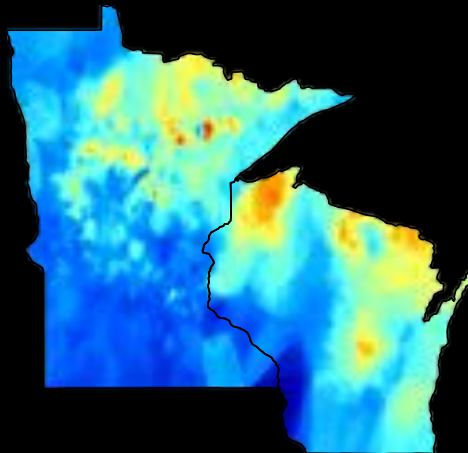
N



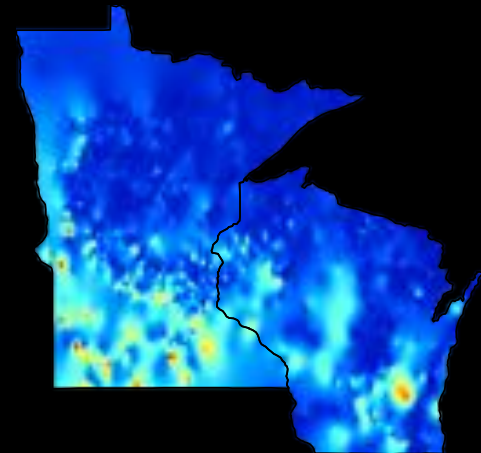
P



Secchi

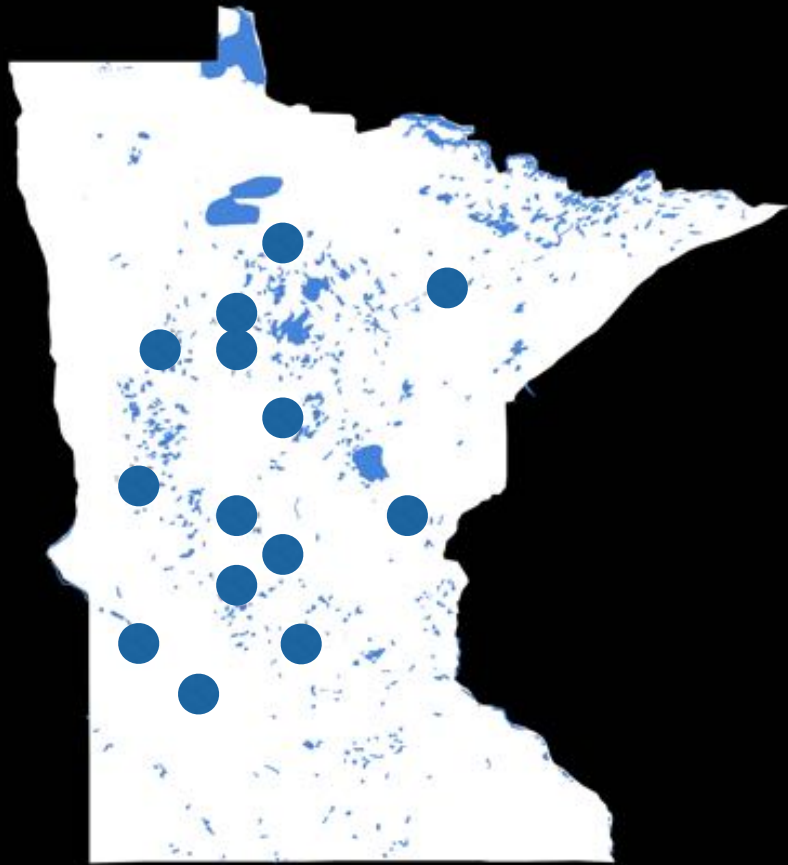


ChlA



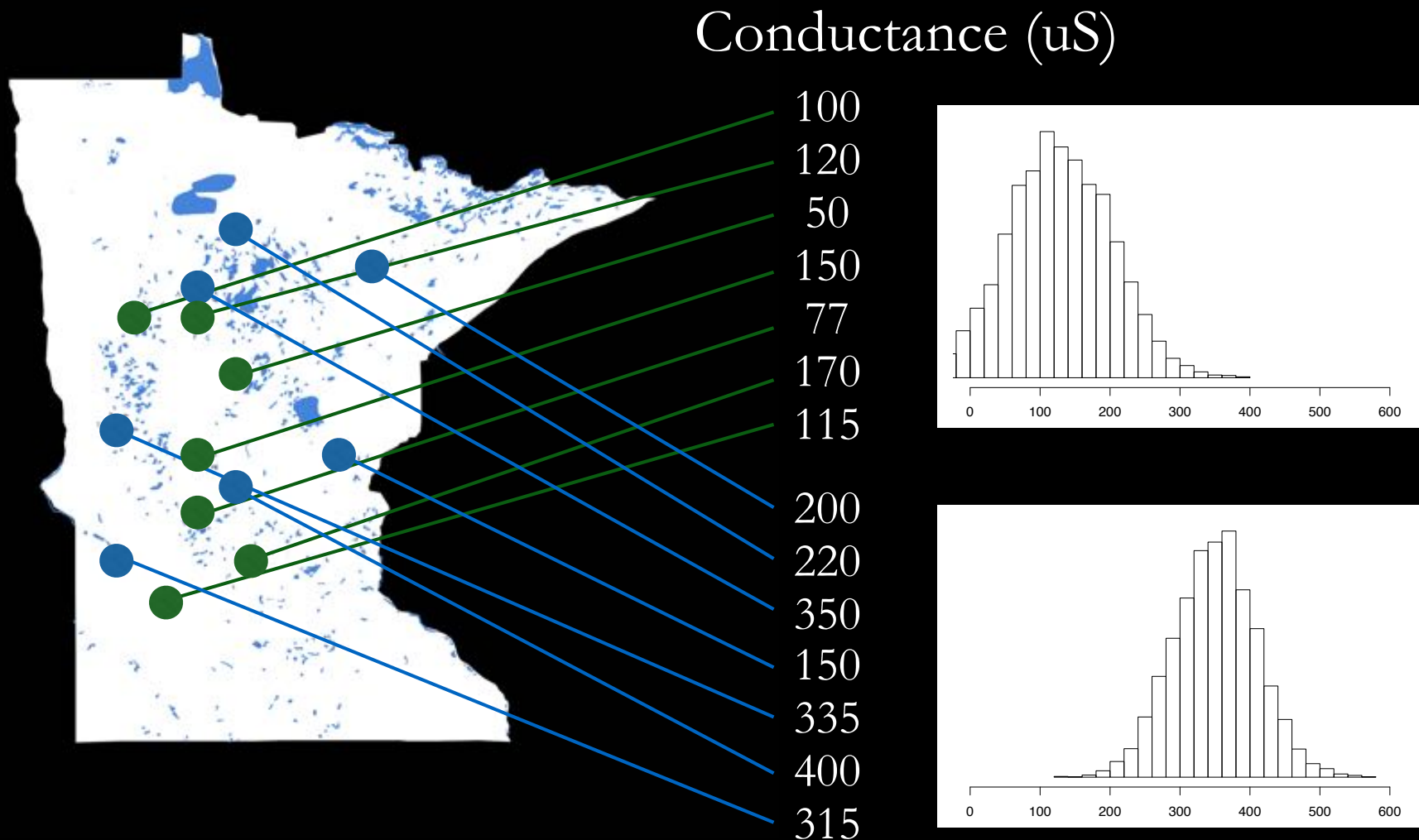
Determining the niche

Information from the current distribution



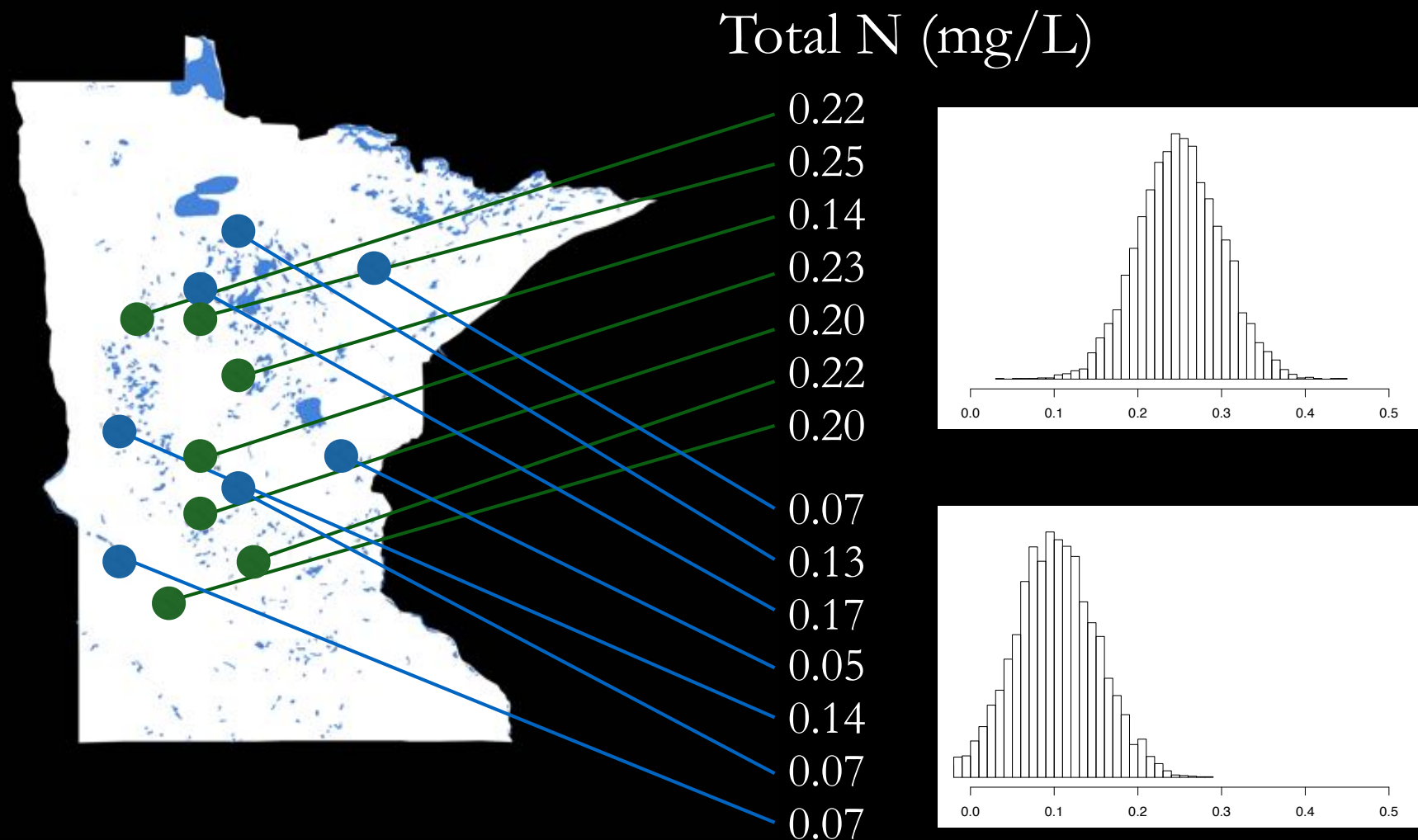
Determining the niche

Information from the current distribution



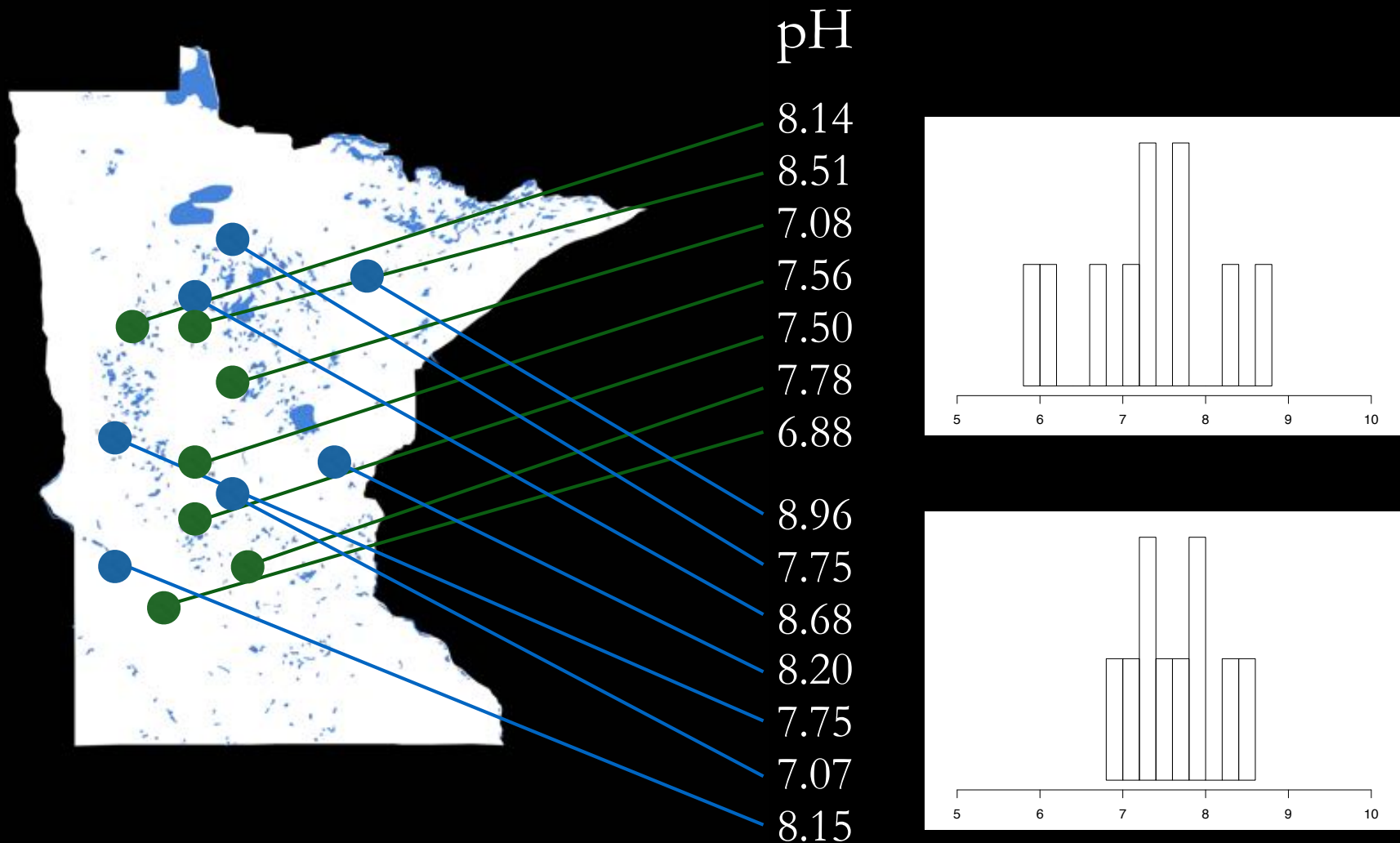
Determining the niche

Information from the current distribution



Determining the niche

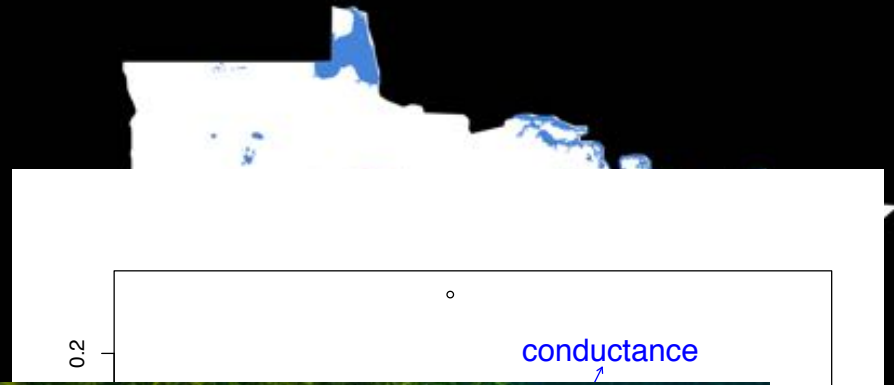
Information from the current distribution



Challenges for predicting risk

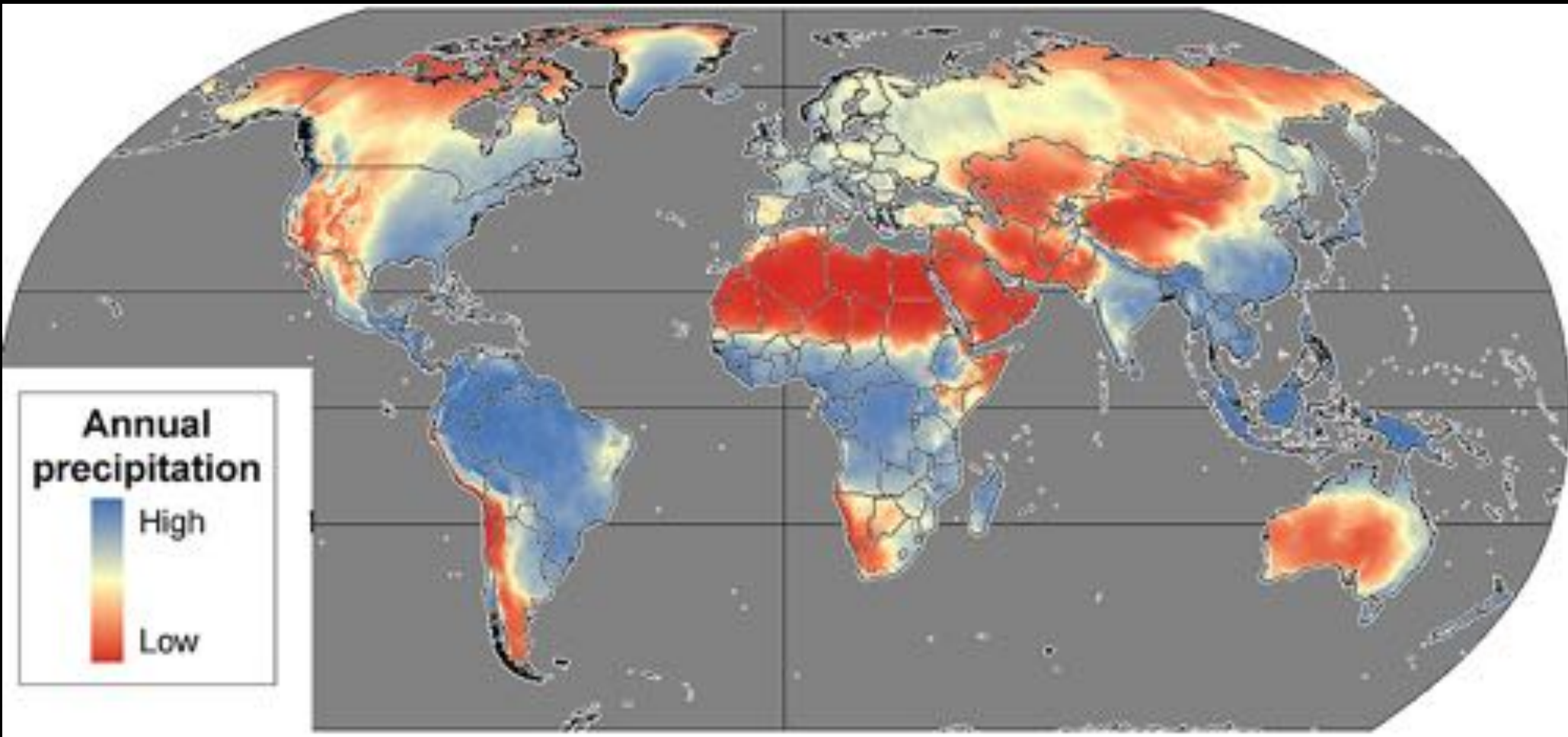
- Is the current range all of the suitable habitat?
- Have you measured all the important factors?
- Biotic vs Abiotic constraints

DATA!



NMDS1

Environmental data



Environmental data

www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

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 Qiao³, Nicholas B

Nitellopsis obtusa (starry stonewort) is a dioecious emerged as an aquatic invasive species in North of its native range, but has spread rapidly in no interfere with recreation and may displace native of *N. obtusa*, making it difficult to forecast future investigated environmental variables associated data, and remotely sensed environmental variable distribution. We found that *N. obtusa* is exploiting which may help explain its invasiveness. While there appears to have been a shift in its realized portions of the United States are predicted to results can inform early detection and rapid response estimates of the physiological tolerances of the

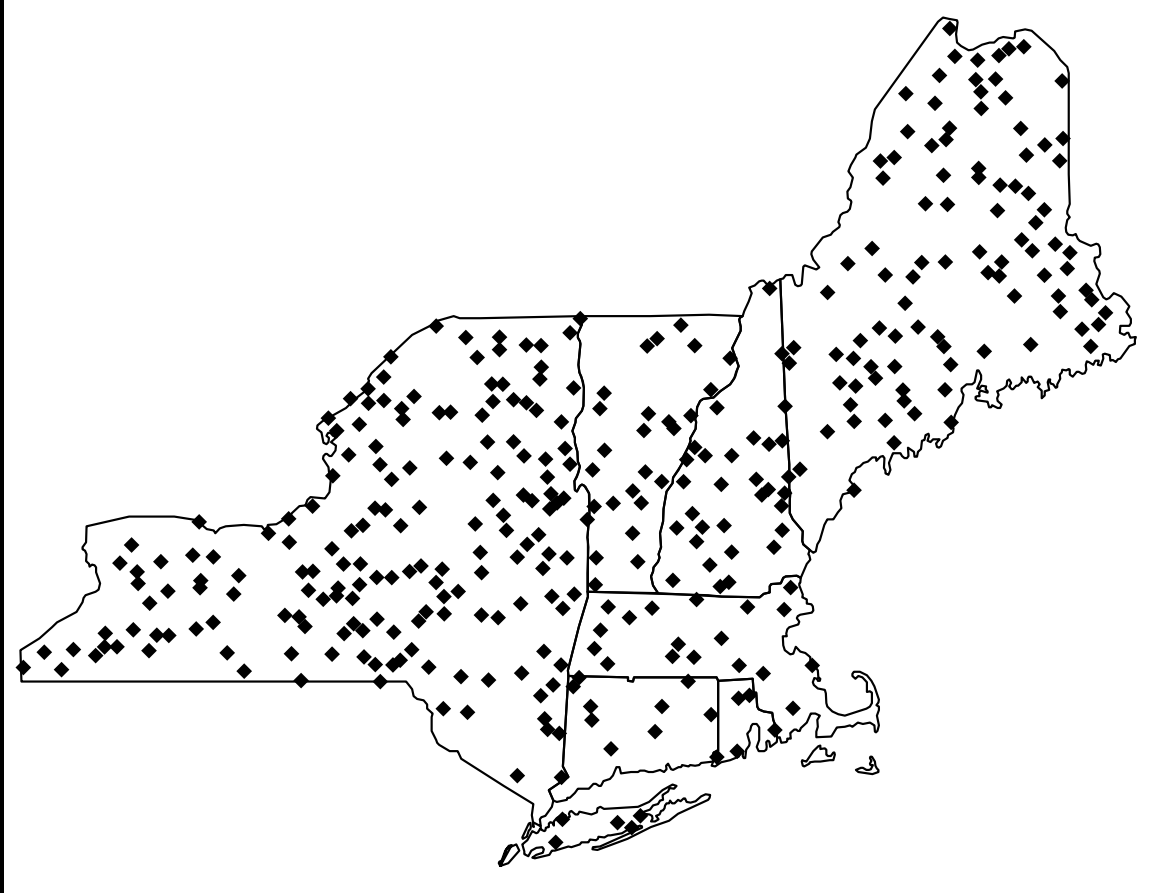
Understanding how certain species experience greater ecological dominance than their performance as biology and has important implications for assessing phenomenon are numerous: Common reed (*Phragmites*) Eurasian genotypes have expanded throughout North to five native populations in California, United States invasive in Chile, Australia, and New Zealand². However, as an introduced species despite declining in their fortune, including escape from natural enemies hybridization, novel allelopathic weapons, and unexplored Regardless of the underlying mechanisms, the ability to occupy an ecological niche in their introduced range in their native range¹¹. It is true that many introduced native ranges¹², but for others an expanded realized niche of new types of habitats¹³, or growth in a niche in a species' native range and its potential to even rare species can potentially become dominant conditions^{1,15,16}.

¹Minnesota Aquatic Invasive Species Research Center, Population Medicine, College of Veterinary Medicine, Laboratory of Animal Ecology and Conservation, Beijing, China. ²Department of Fisheries, Wildlife, and Conservation, USA. Correspondence and requests for materials should be addressed to



May not be best strategy for aquatic species

Environmental data



Environmental data

Environmental Data Application

https://cf.pca.state.mn.us/water/watershedweb/wdip/waterunit.cfm?wid=73-0200-02

Minnesota Pollution Control Agency

Data

Surface water data
Lake and stream water quality dashboard

Koronis: main lake: 3 MI S OF PAYNESVILLE (Lake)

Lake identification number: 73-0200-02

Overall Conditions:
Concentrations of mercury in fish tissue exceed the water quality standard, for specific fish consumption advice refer to the Minnesota Department of Health website at <http://www.health.state.mn.us/dhs/wh/fish/consumption/fishspecific.html>

Description Assessments Monitoring Data Water Quality Summary Transparency Trend Land Use

Water Quality Summary

The **Trophic State Index (TSI)** is a number that summarizes a lake's overall nutrient richness. Nutrient richness ranges from clear lakes, low in nutrients (oligotrophic), to green lakes, with very high nutrient levels (hypereutrophic). The chart below shows the overall TSI rating for this lake (top bar), followed by TSI ratings for the individual parameters that contribute to nutrient richness. The TSI calculations are based on data collected between June and September 2006 to 2015.

Parameter	10-Year average of all summer samples	Parameter TSI	Expected TSI range for lakes in same ecoregion	Number of samples
Transparency (meters)	2	49	N/A	114
Chlorophyll-a (parts per billion)	34	54	N/A	39
Total Phosphorus (parts per billion)	33	55	N/A	36

Overall Trophic State Index for This Lake: 54

Water transparency is an excellent indicator of water quality, and the majority of these data are collected by volunteers. Join the MPCA's [Citizen Lake Monitoring Program](#) and help collect this important information for your lake.

nwis.waterdata.usgs.gov/NY/nwis/qwdata

USGS science for a changing world

National Water Information System: Web Interface

USGS Water Resources

Data Category: Water Quality Geographic Area: New York

Click to hide News Bulletins

- Data formats changed in August 2016, and additional water-data changes will be coming through 2017. [Read more here](#)
- Full News

Water Quality Samples for New York

Click to hide state-specific text

ALL DATA ARE EASTERN STANDARD TIME

Some complex retrievals may take a few minutes.

Choose Site Selection Criteria

There are 12,837 sites with water-quality data. Choose at least one of the following criteria to constrain the number of sites selected.

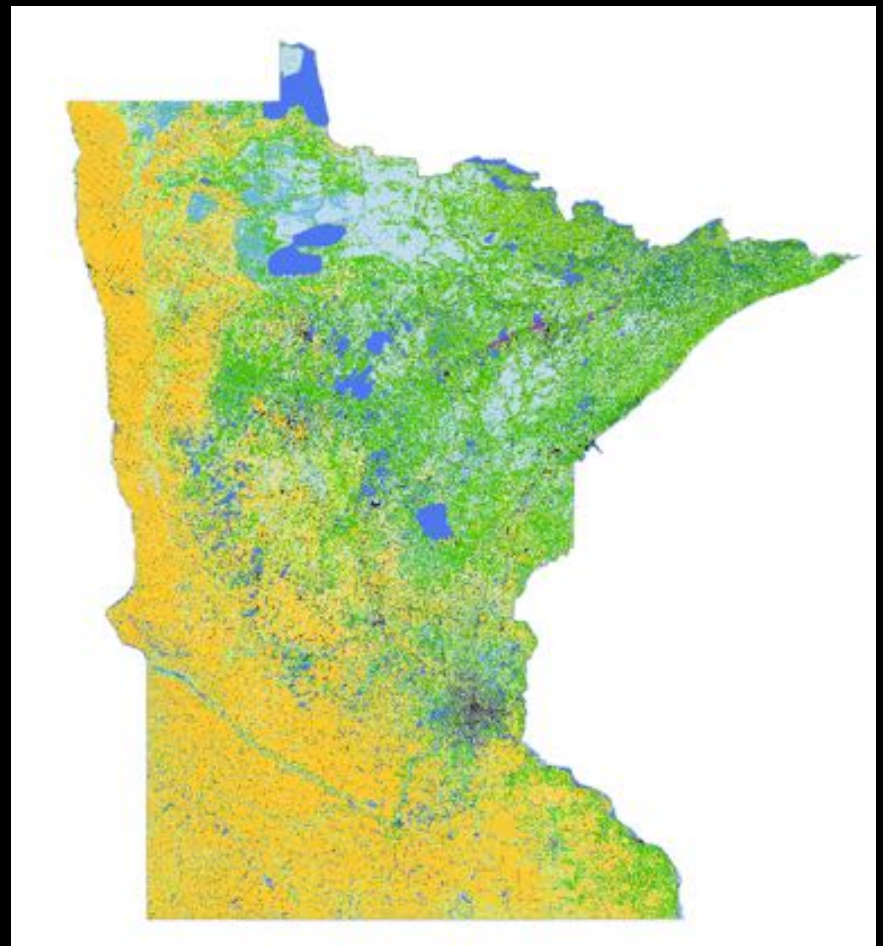
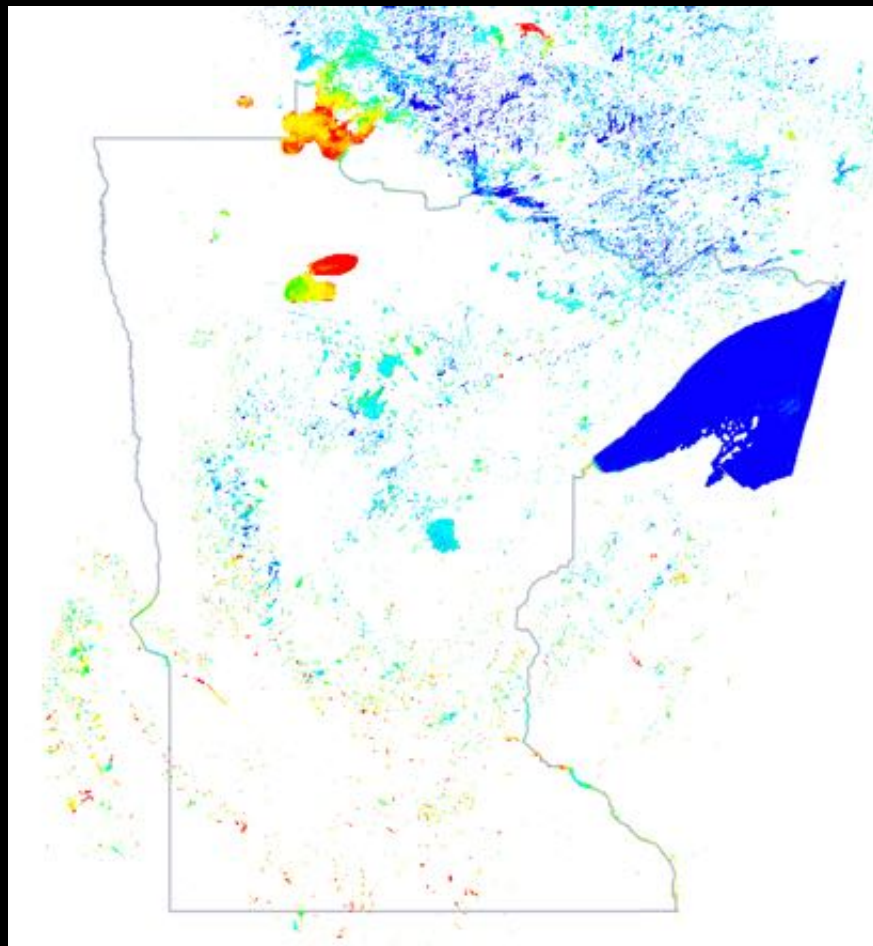
Site -- Location --	Site -- Identifier --	Site -- Attribute --	Data -- Attribute * --
<input checked="" type="checkbox"/> County	<input type="checkbox"/> Site Name	<input type="checkbox"/> Site type	<input type="checkbox"/> Number of observations
<input type="checkbox"/> Hydrologic Unit (by Code)	<input type="checkbox"/> Site Number	<input type="checkbox"/> Drainage area	<input type="checkbox"/> Period of record
<input type="checkbox"/> Hydrologic Unit (by Name)	<input type="checkbox"/> Multiple Site	<input type="checkbox"/> Well depth	<input type="checkbox"/> Sample medium type

Environmental data

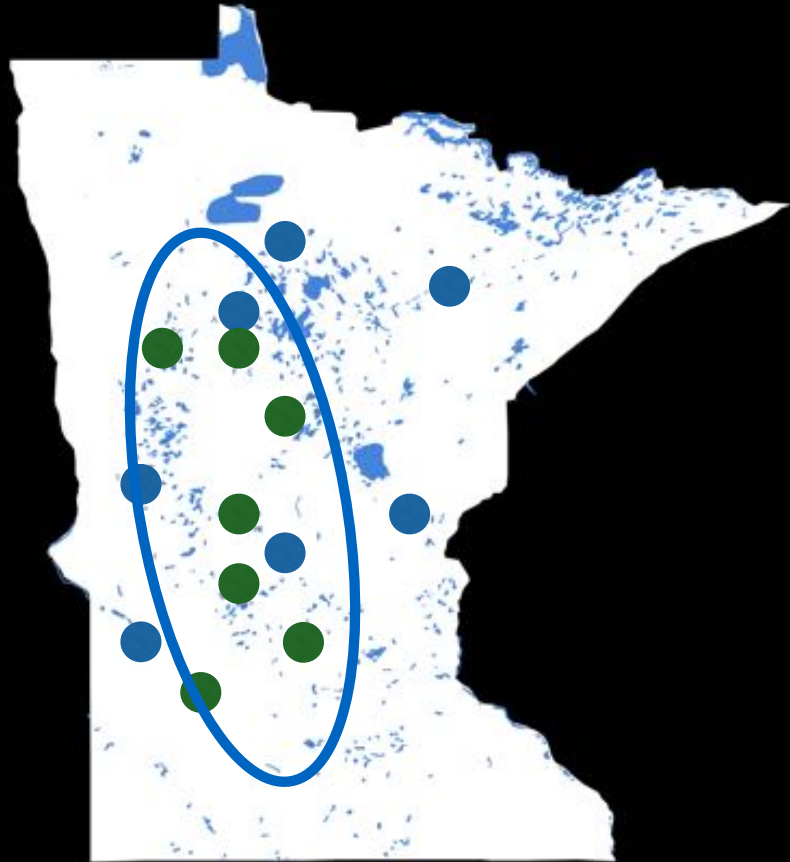


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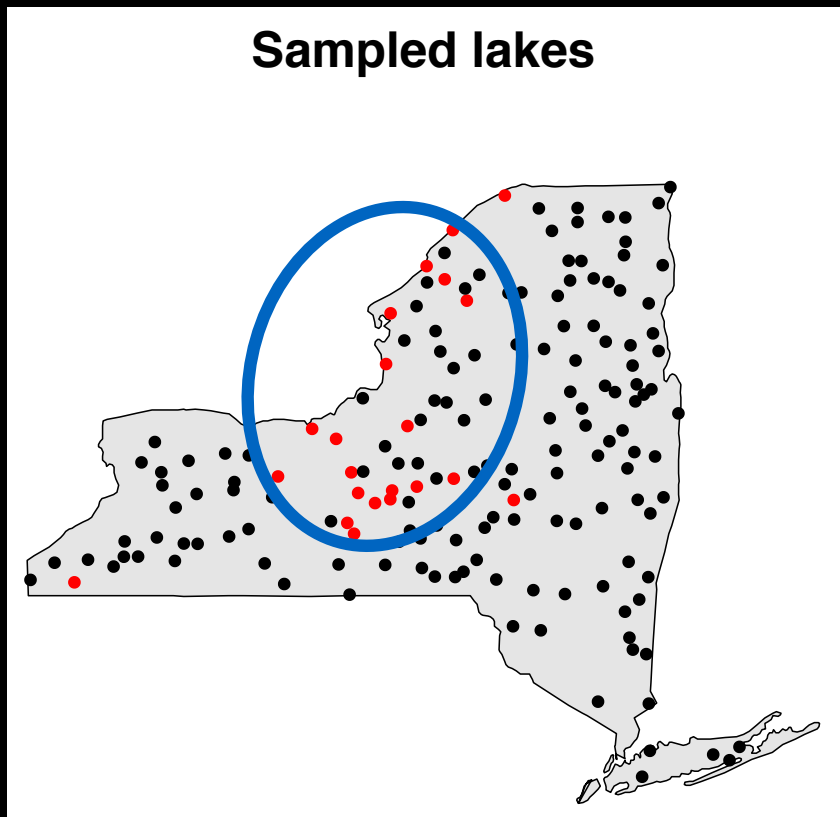
Remote Sensing and Geospatial Analysis Laboratory



Estimating the niche



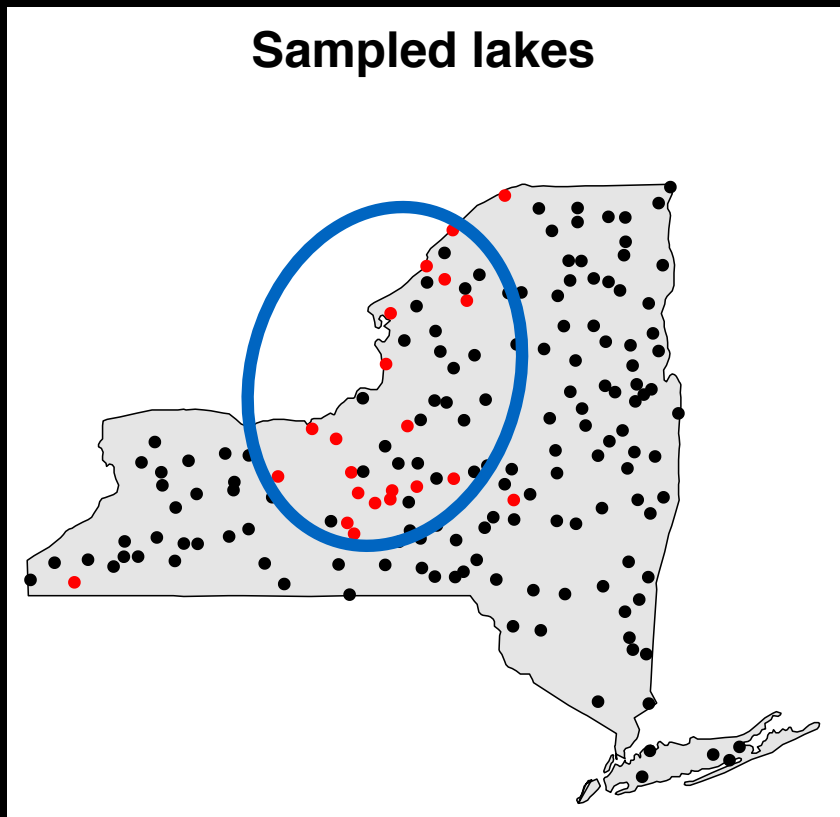
Estimating the niche



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

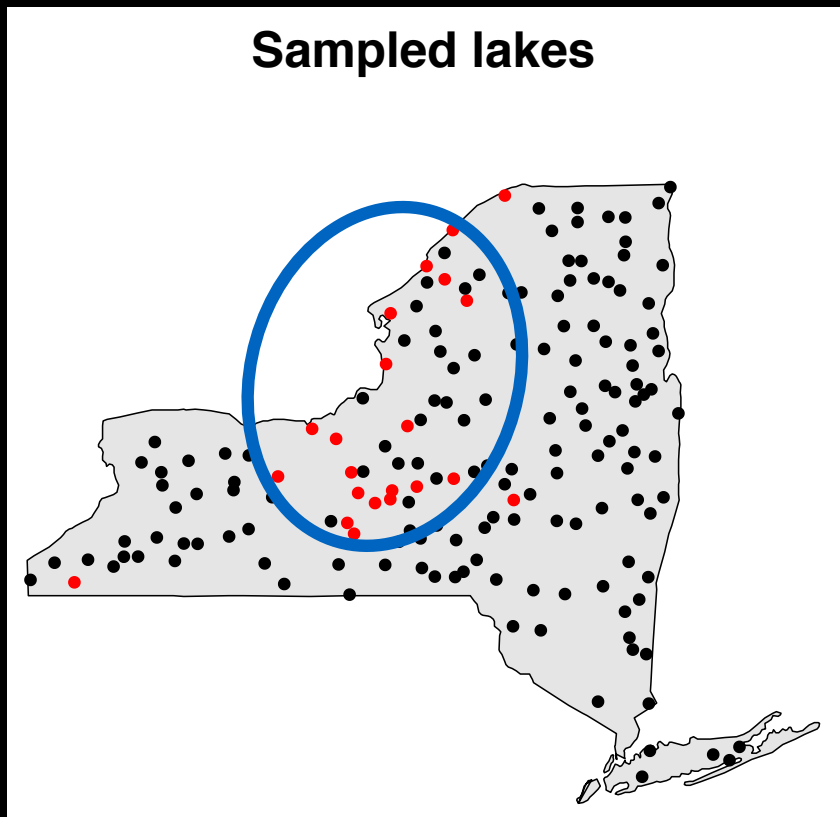


pH
Alkalinity
Hardness
Conductance
N
Ammonia

Nitrate
P
Ortho-P

Secchi depth
Chlorophyll A
Color
Salinity
S

Estimating the niche



P

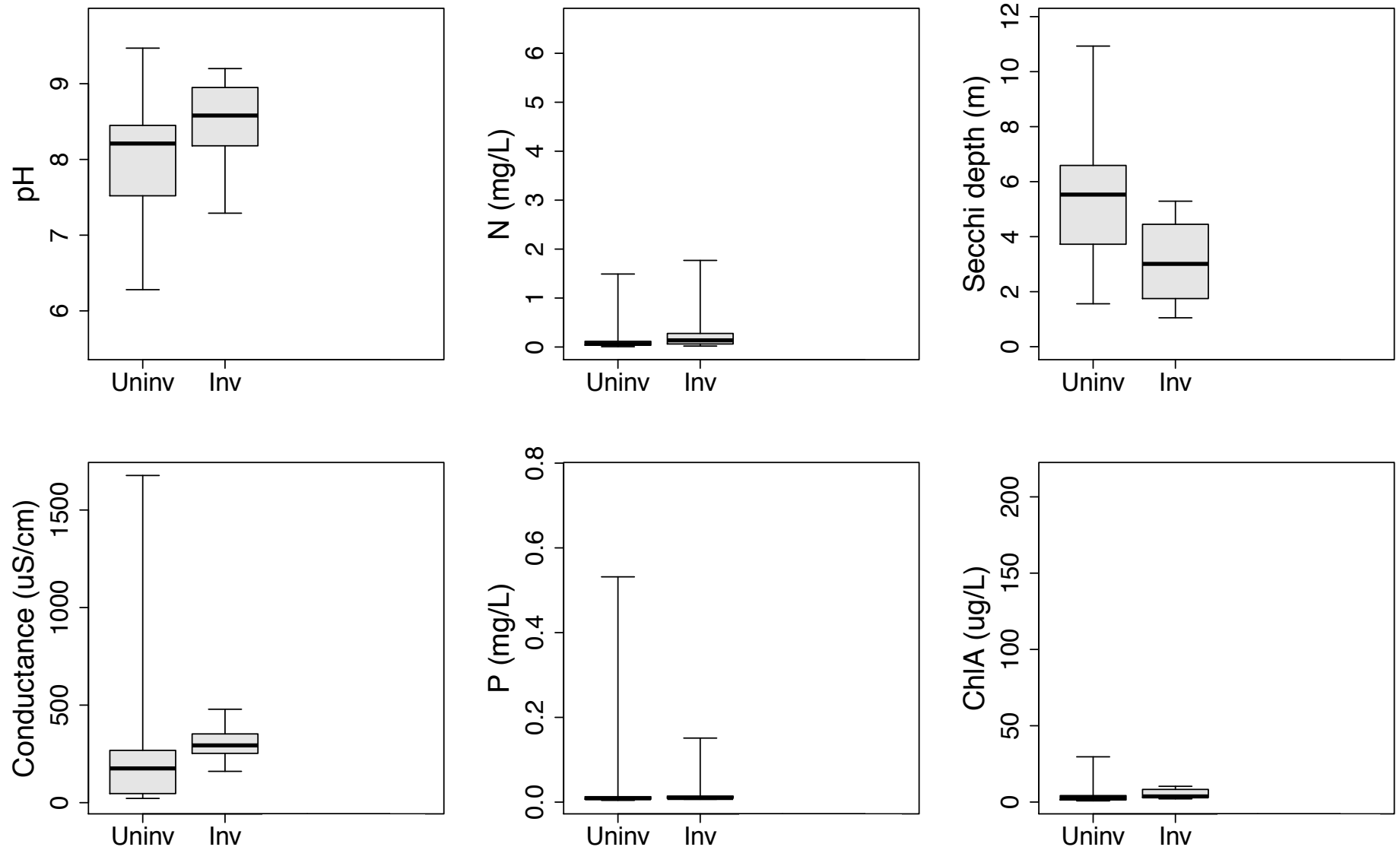
Secchi depth
Chlorophyll A

pH

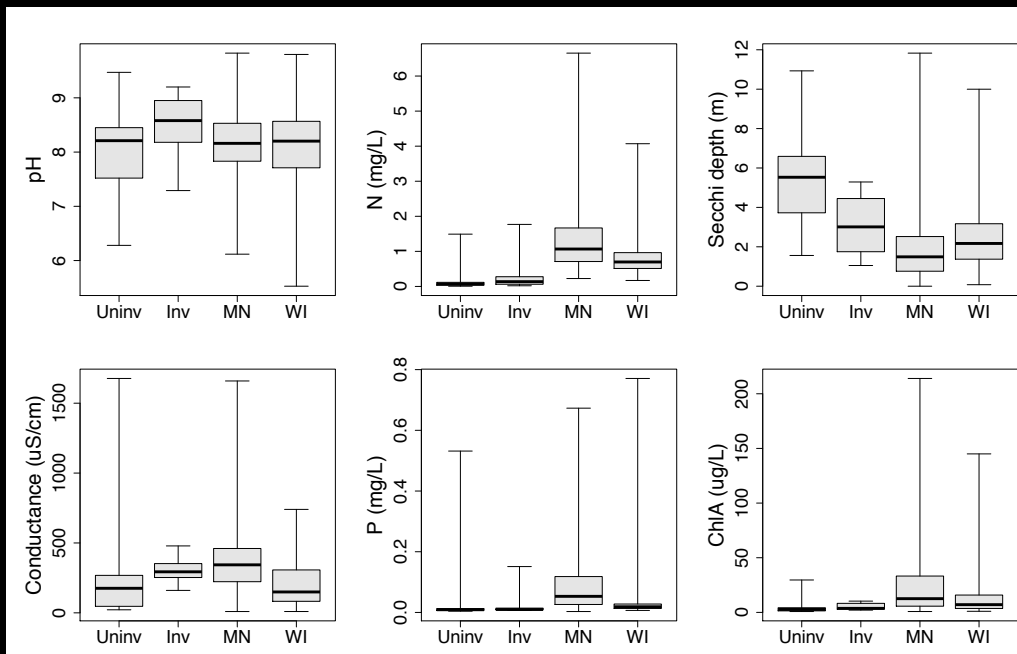
Conductance

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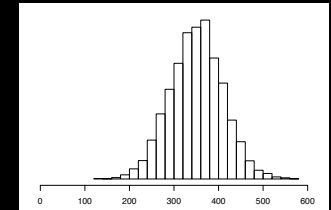
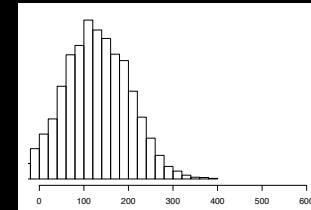
Estimating the niche



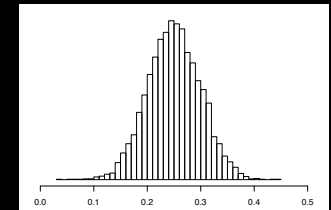
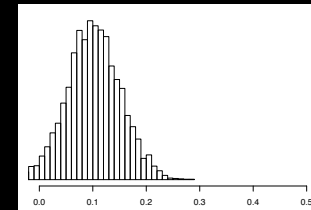
Estimating the niche



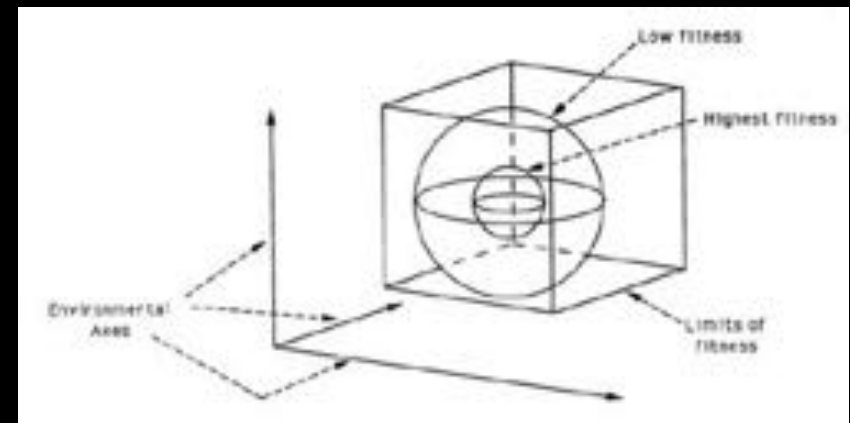
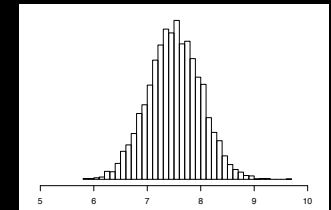
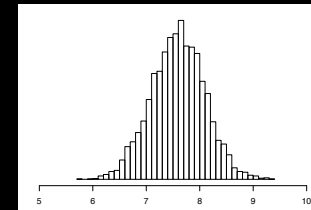
Env 1



Env 2



Env 3



Predicting suitable habitat

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

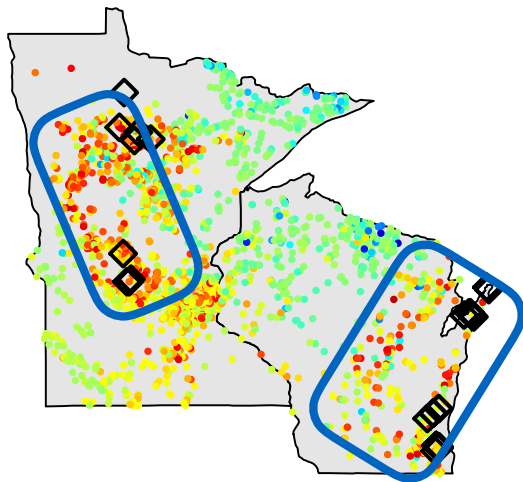
Predicting suitable habitat

Low risk

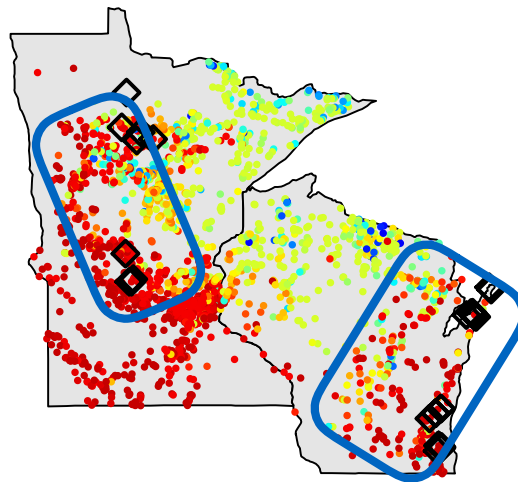
High risk



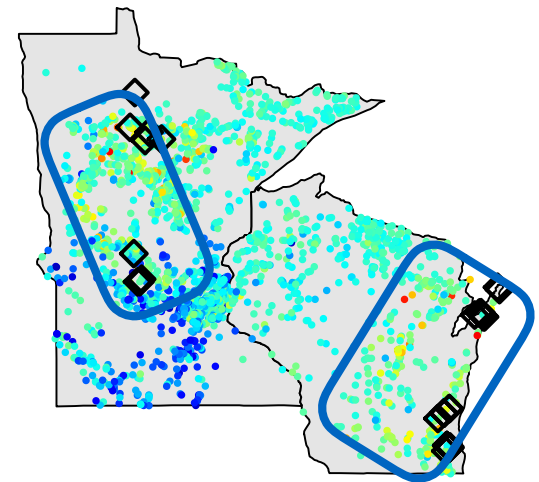
Random forest



Boosted regression tree



ENFA



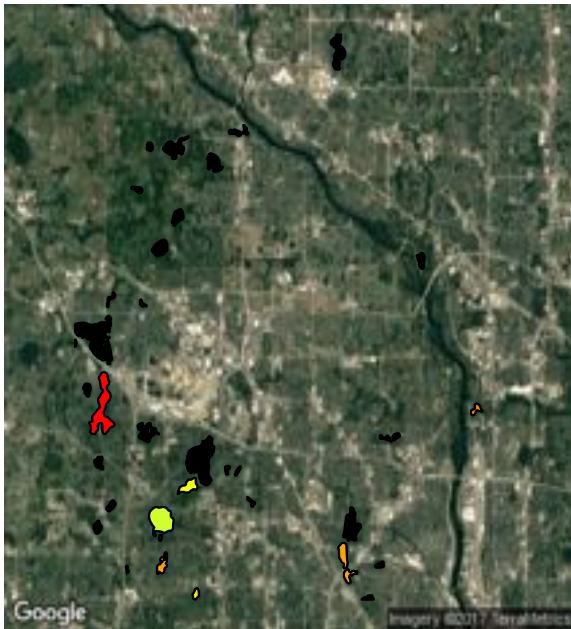
Predicting suitable habitat

Low risk

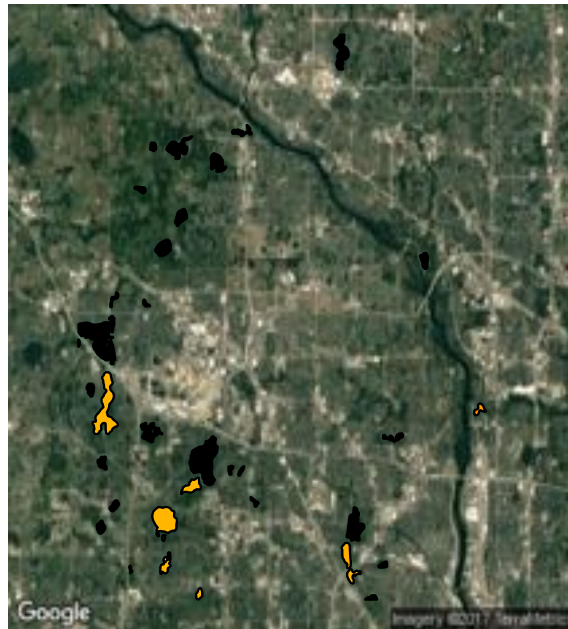
High risk



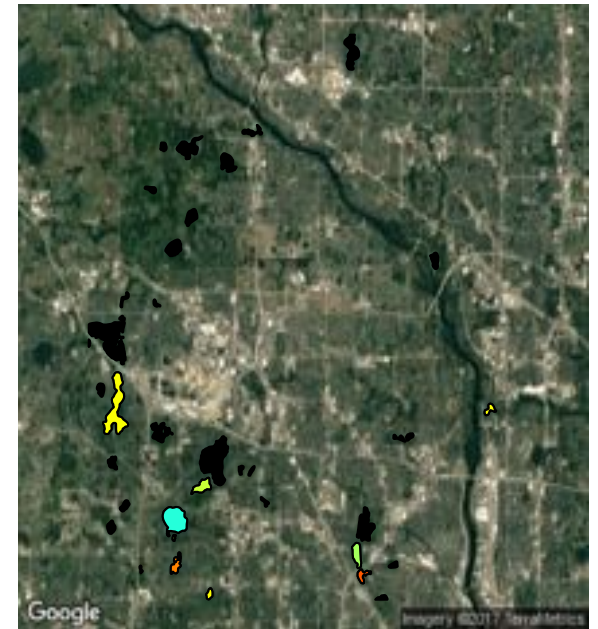
Random forest



Boosted regression tree



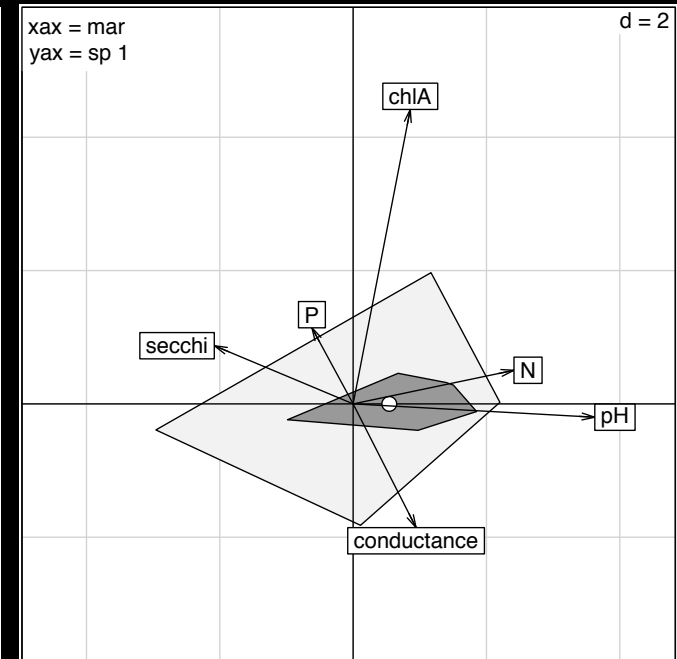
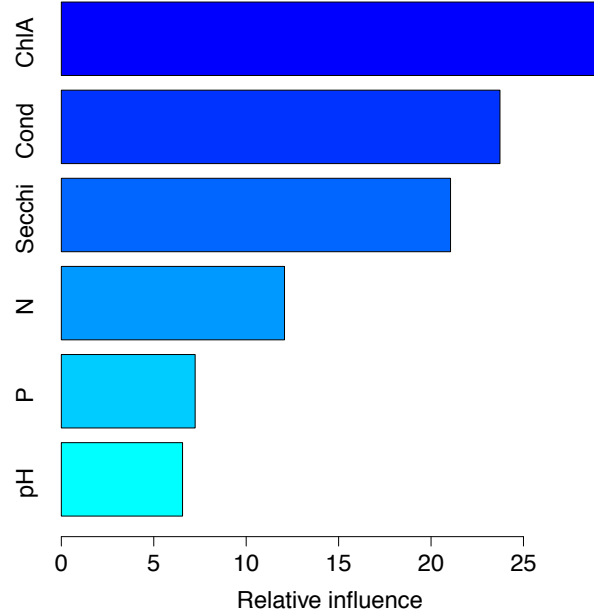
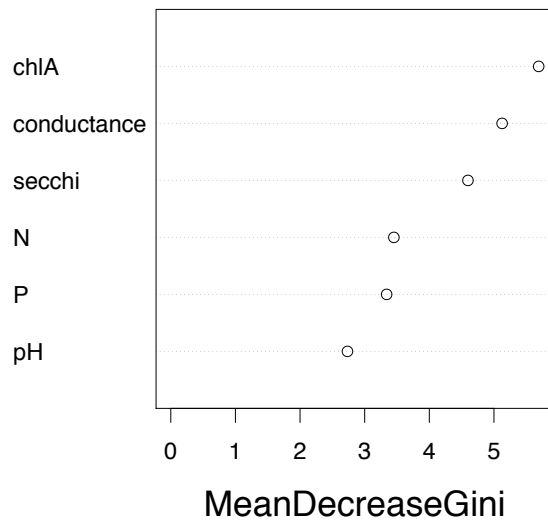
ENFA



Expanding what we know

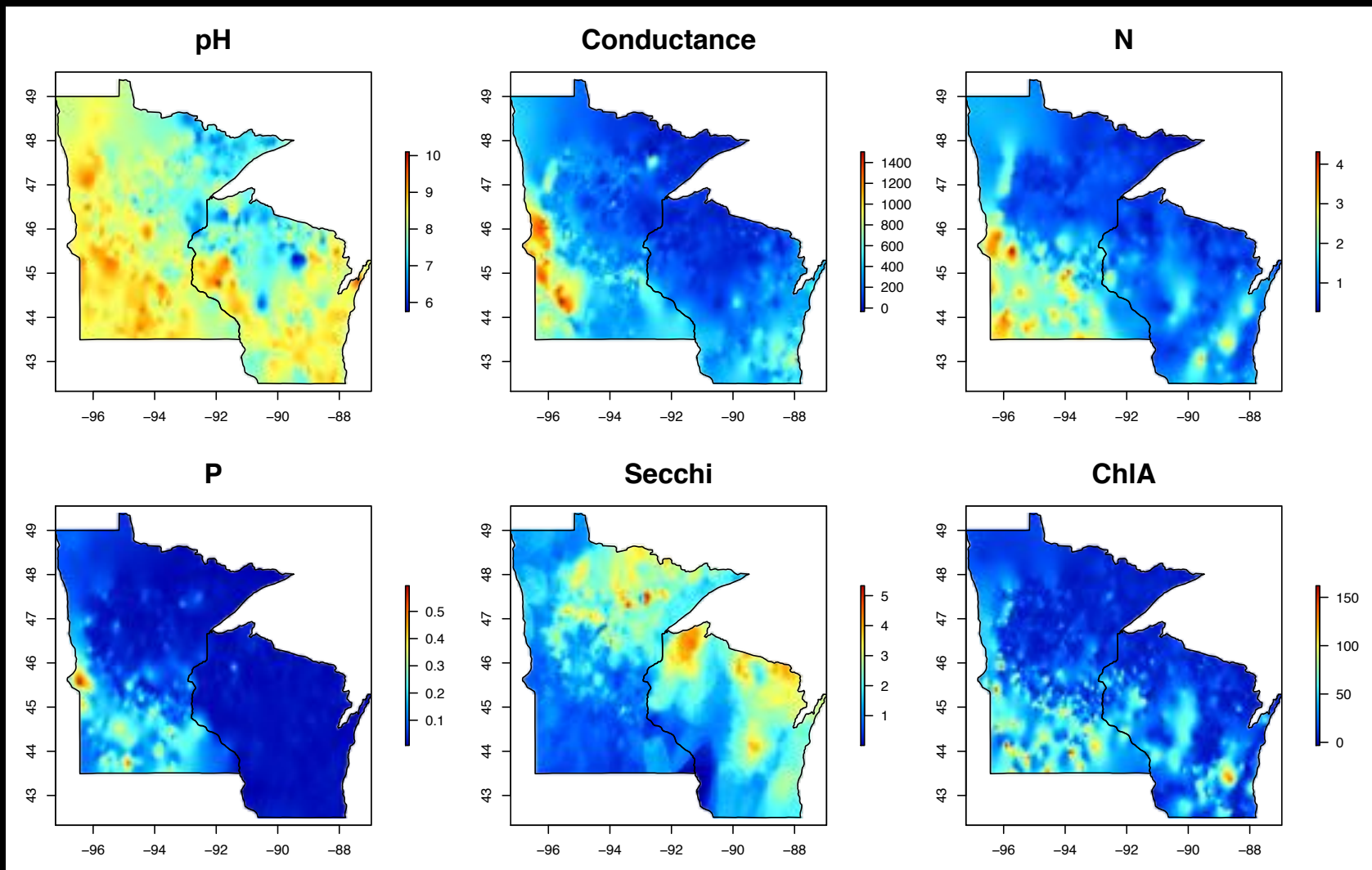
Boosted Random forest Regression trees ENFA

sswRF



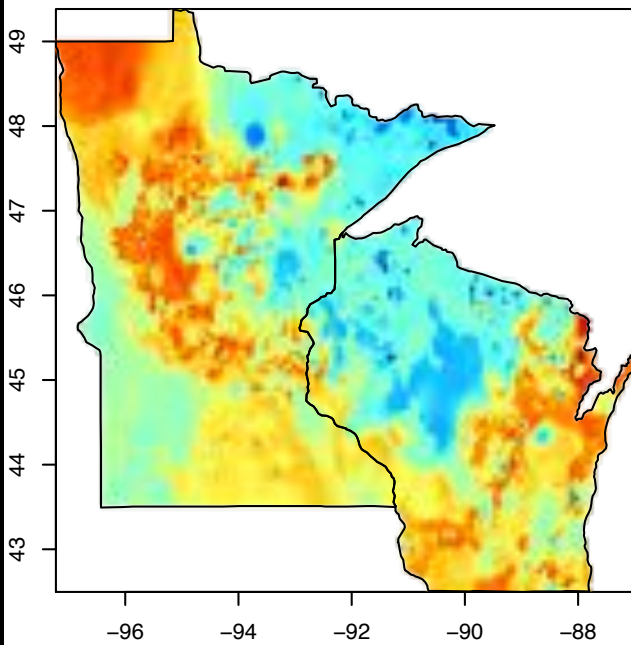
Expanding what we know

- Field sampling → Spatial interpolation

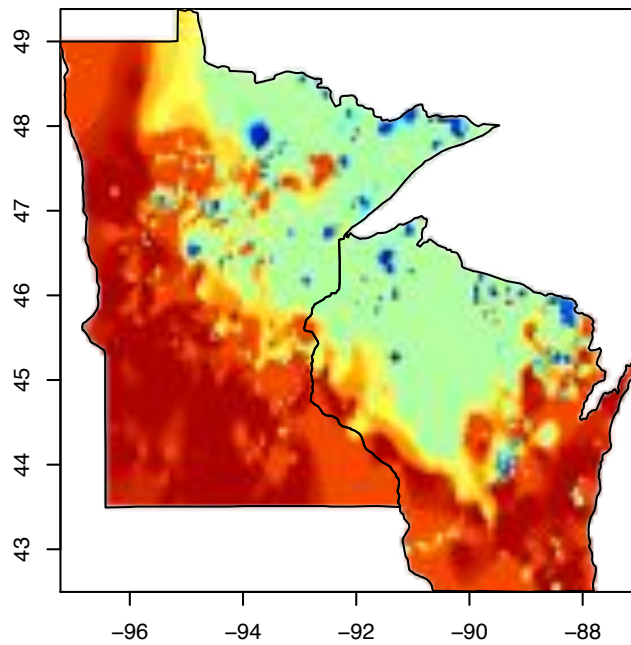


Expanding what we know

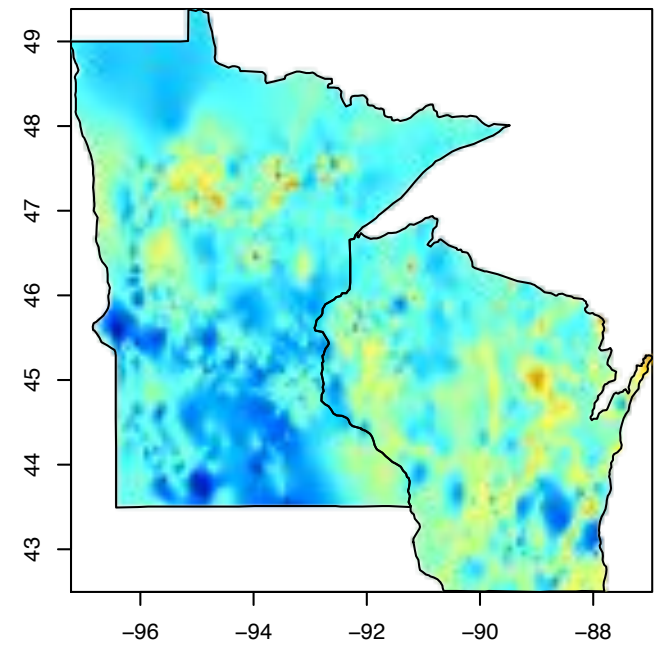
Random forest



Boosted regression tree



ENFA

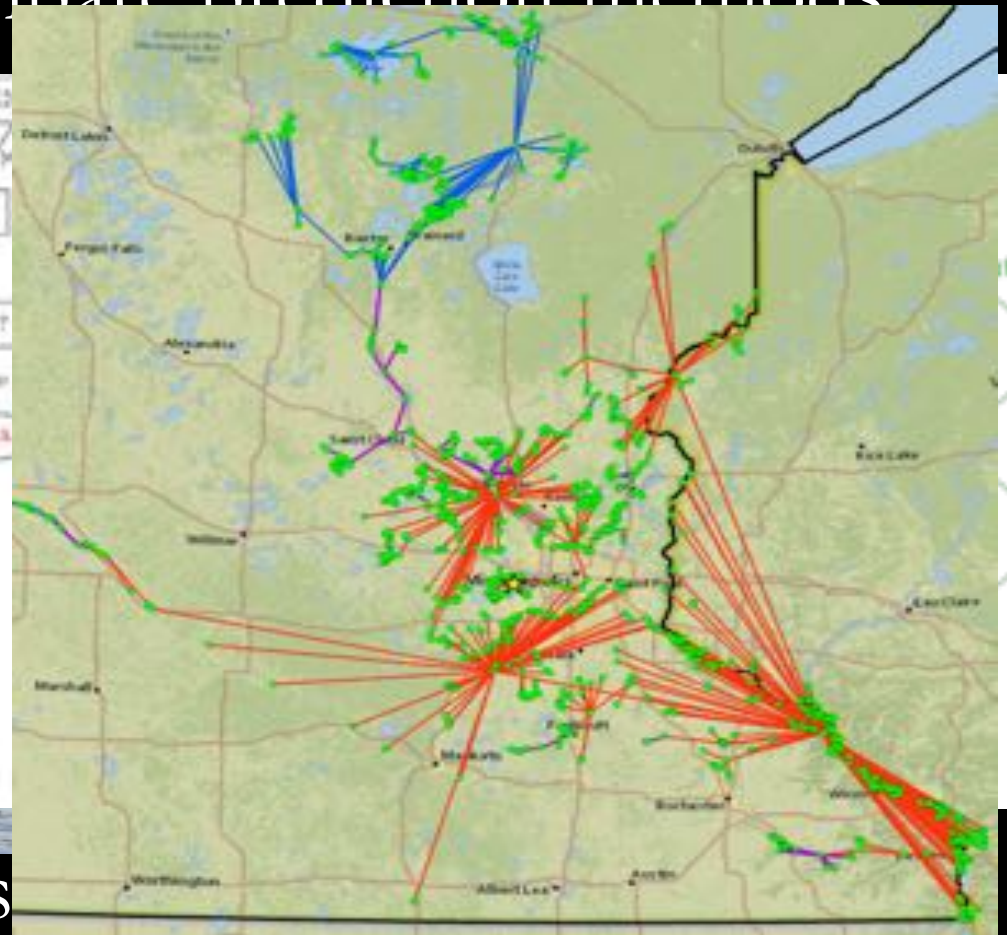
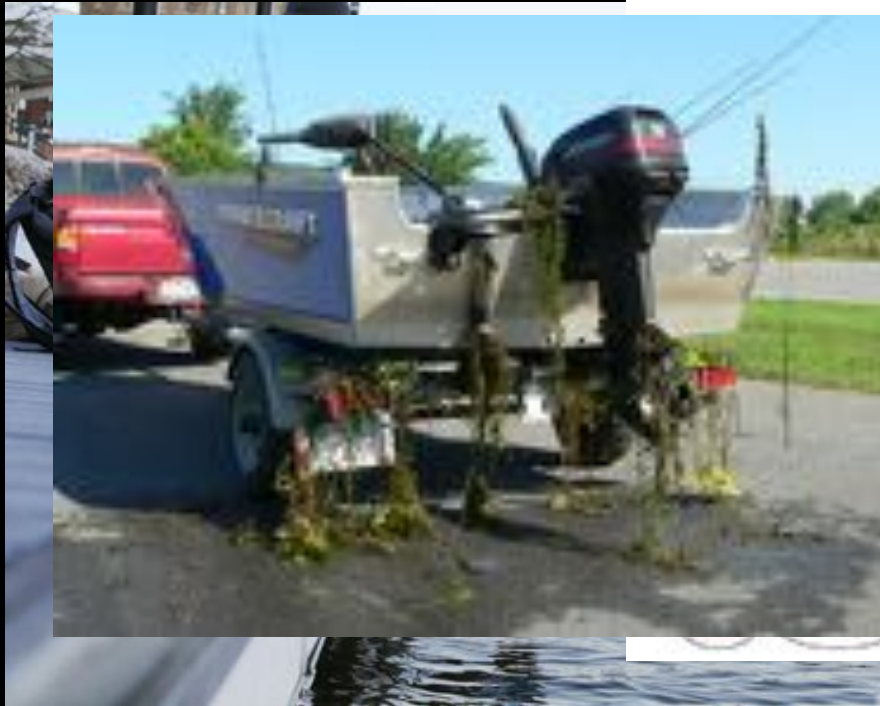


Expanding what we know

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



UNIVERSITY OF MINNESOTA | EXTENSION
in partnership with the

MINNESOTA AQUATIC INVASIVE SPECIES RESEARCH CENTER



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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