Pushing Past AIS Paradoxes Via R & R Shiny

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Goals

1. Reveal woes of being an "AIS* warrior."
2. Celebrate the *majesty* of R for us!
3. Provide a **whirlwind** tour of how R has empowered us *over just the past year or so*.

*AIS = Aquatic Invasive Species

Acknowledgements

Invasive Species Science's Many Paradoxes

Invasive species: Non-native organism excelling so much in a new spot it causes ecological /economic harms.

- Many are *endangered* at home!
- We must *punish* their *success*, even as *we* likely facilitate(d) it!

Starry stonewort, invasive in MN, is endangered in its native Eurasia.

Zebra mussels spread via boats and thrive in waters we pollute.

Eurasian watermilfoil has invaded > 500 MN lakes, lowering property values!

Invasive Species Science's Many *More* Paradoxes

Invasives harm, resist, and spread better when *established*. Early detection is *key*!

But this is saying "Find things at their *rarest*." Where? How?!

- Where you *expect* to find it?
  - You'll only "confirm" what you *already* **think** you know.
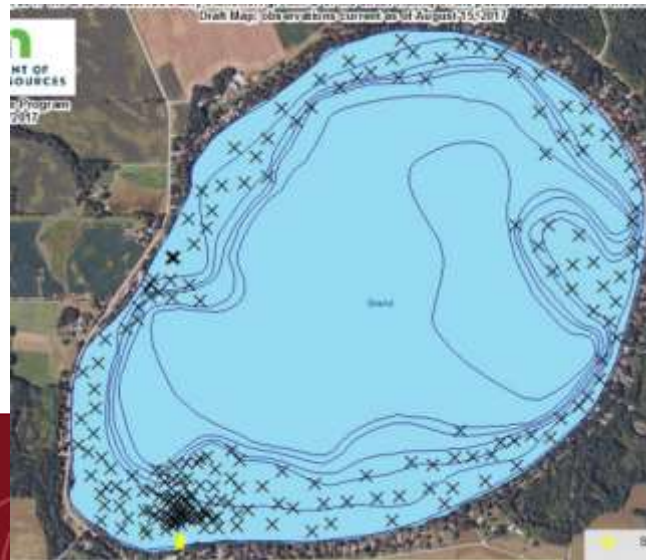- Where a model tells you to look?
  - What *data* will you use to fit it??

AIS are often detected using rakes or nets.

Recent study: Only 30% chance of finding starry stonewort when it's present!

*Only look in X, only find in X, only continue to look in X...*

Still More Invasive Species Science's Paradoxes

Preventing *spread* is just as key.

Here, the reverse: Often far too *many* data!

- Consider just Cass County, MN:
  - 514 lakes (264K possible lake pairs)!
  - 30 already infested (that we know of!)
  - Imagine: Enough inspectors for *just* 25 lakes. Which do **YOU** choose??
    - 2.11E+42 *possible plans*!

Cass County, Minnesota
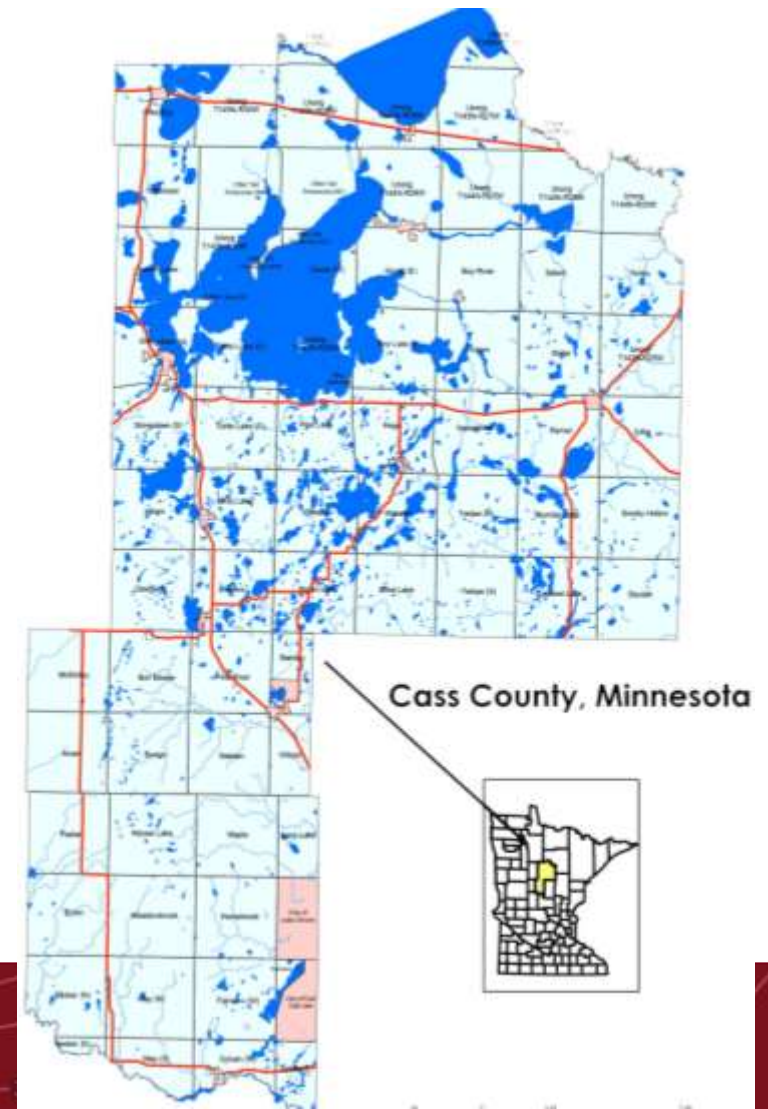
Meet Our SavioR

R is our **go-to tool** for besting the paradoxes of AIS detection and management (DM). R...

- Helps build, clean, and leverage huge new data sets.
- Magnifies rare data to guide detection.
- Collapses abundant data to guide management.
- Let's us share decision-making tools.
- Let's us "predict the future!"

Other platforms could do each thing R does for us; few (if any) could do *everything* R does for us.


From Zero to R Hero 1

R—The BuildeR

R has helped us build, maintain, and grow two *immense* data sets:

#1: Point-Intercept (PI) aquatic plant survey database

- **Systematic** (unbiased) assessment of what plants live where in lakes.
- Collected by state agencies, counties, watershed districts, private companies, researchers, etc.
- No two data sets are alike! So no one has aggregated them...

A rake is thrown overboard at every site and retrieved. What gets stuck is what's recorded.
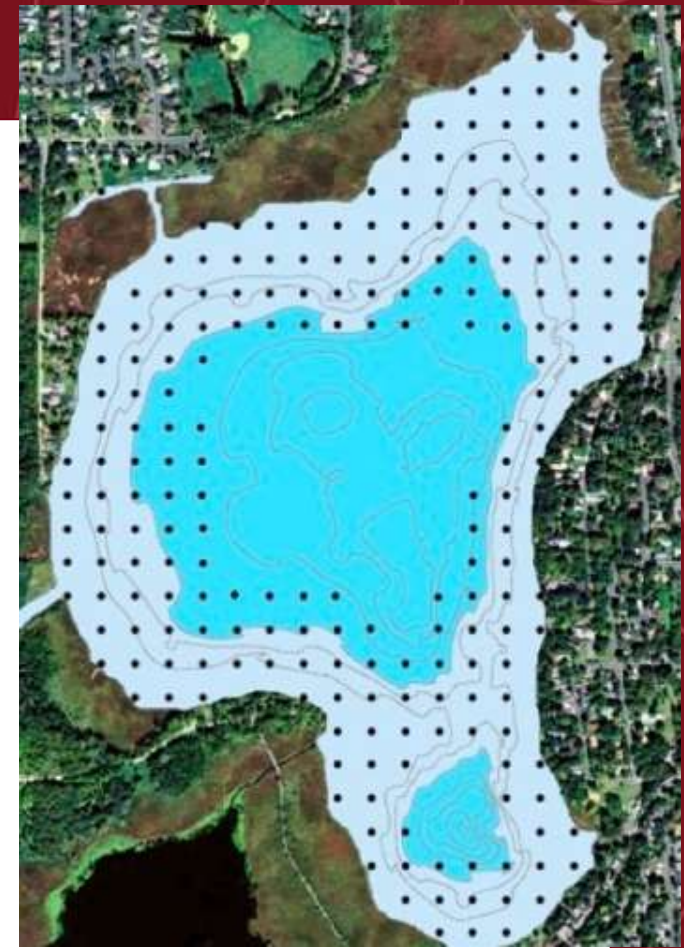
A grid is put on a lake. ALL points are sampled, no matter what, and ALL plants found are recorded, invasive or not.
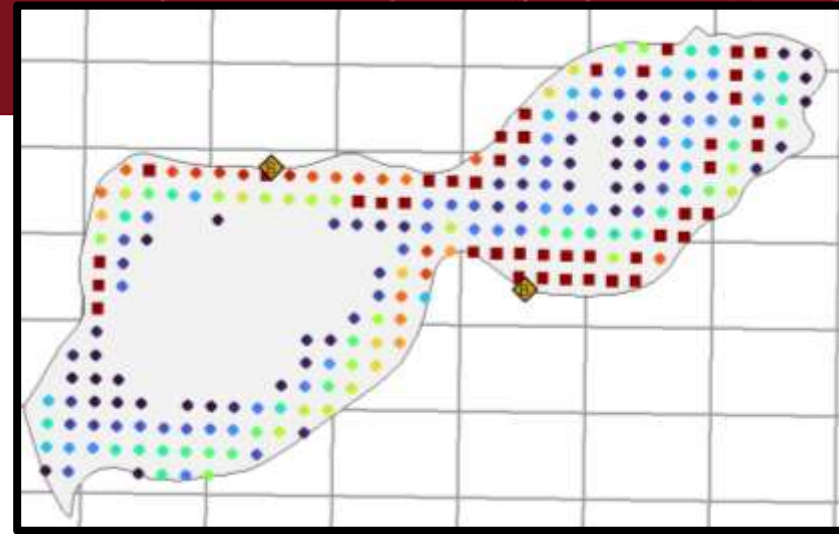
R—The MagnifieR

Hot colors = more likely to have starry stonewort

Meet **PI Charter**, our R Shiny Hub World for our PI survey database!

- R Shiny enabled a portal for data set submission straight to our database!

- R Tidyverse enabled fast data cleaning and homogenizing—no humans needed!

- R JAGS allowed us to magnify these data via a Bayesian predictive model to guide early detection of starry stonewort.

Check it out at z.umn.edu/PICharter!

R—The BuildeR

R has helped us build, maintain, and grow two *immense* data sets:

Inspectors survey boats *and* their people.

#2: The Minnesota Boater Movement Network database

- Inspectors survey boaters during inspections.

- These data are *immense*, complex, and contain inconsistencies—but have **great** potential for understanding boater movements!

R—The ShareR

- R *Tidyverse* helped us clean and process the data *way* faster and more easily!
- R *Quarto* allows us to document and share our process for greater transparency and reproducibility.
- R *igraph* turns these data into "network diagrams."
- R *Shiny* helps us share this info digestibly with stakeholders!

Network diagrams of how major lakes in 5 counties send each other boats.
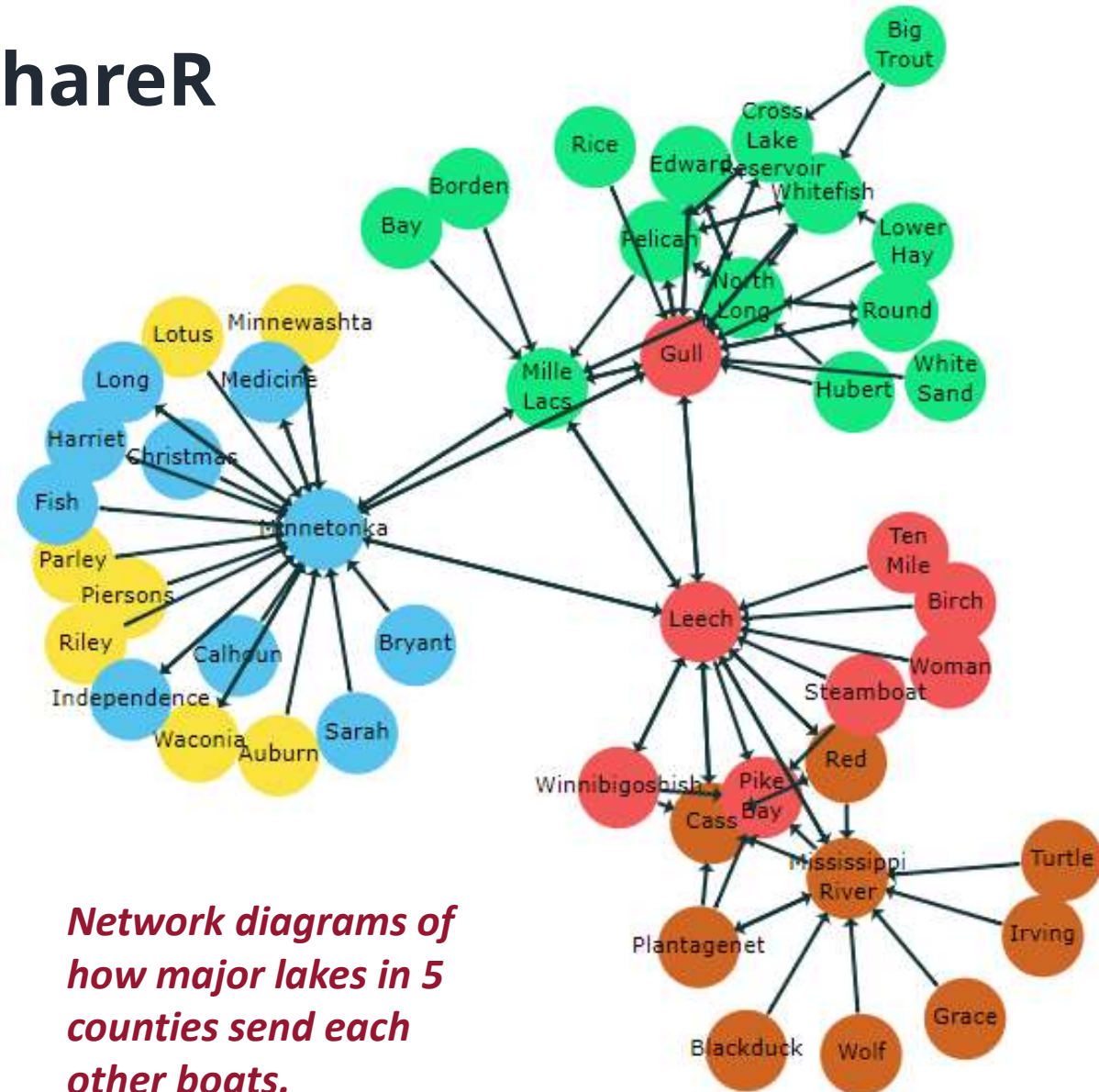
R—The CollapseR

For each county, an optimized digest of which lakes to inspect in what order.

R also helps us "collapse" data when there's *too* much.

Meet **AIS Explorer**, our flagship R Shiny App for AIS D&M!

- R *OMPR* enables optimization models to find the *mathematically* best choices.
- R *Shiny* enables displaying optimized plans to stakeholders!

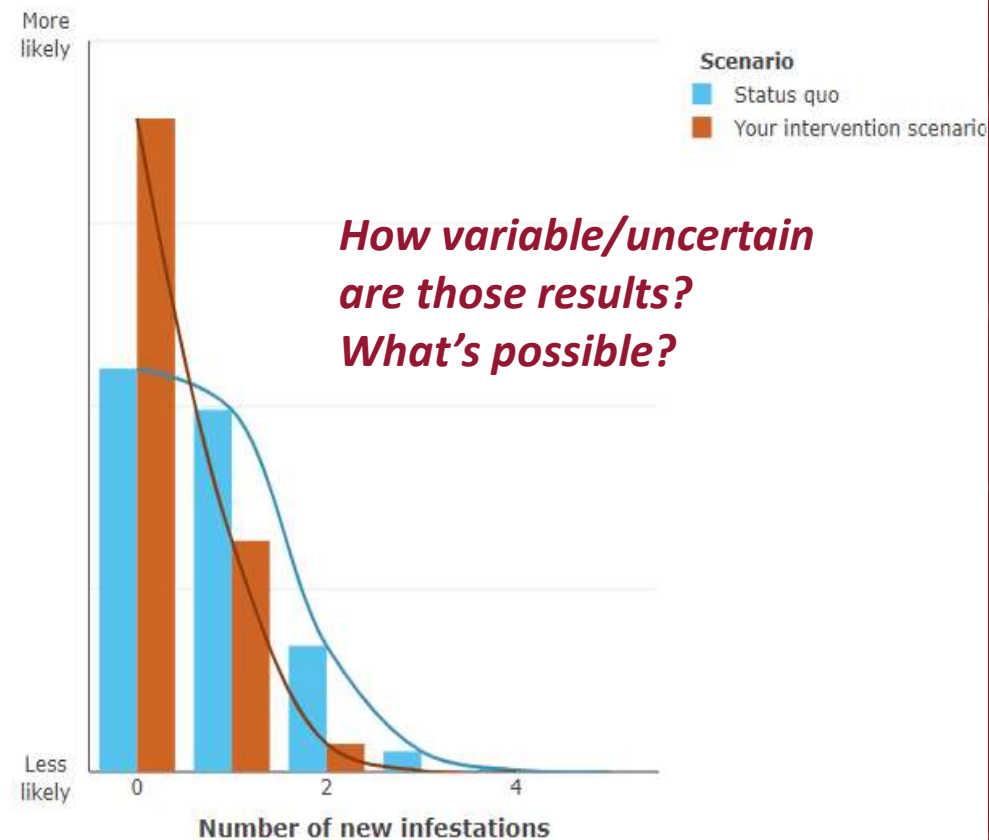*Check it out at www.aisexplorer.umn.edu!*
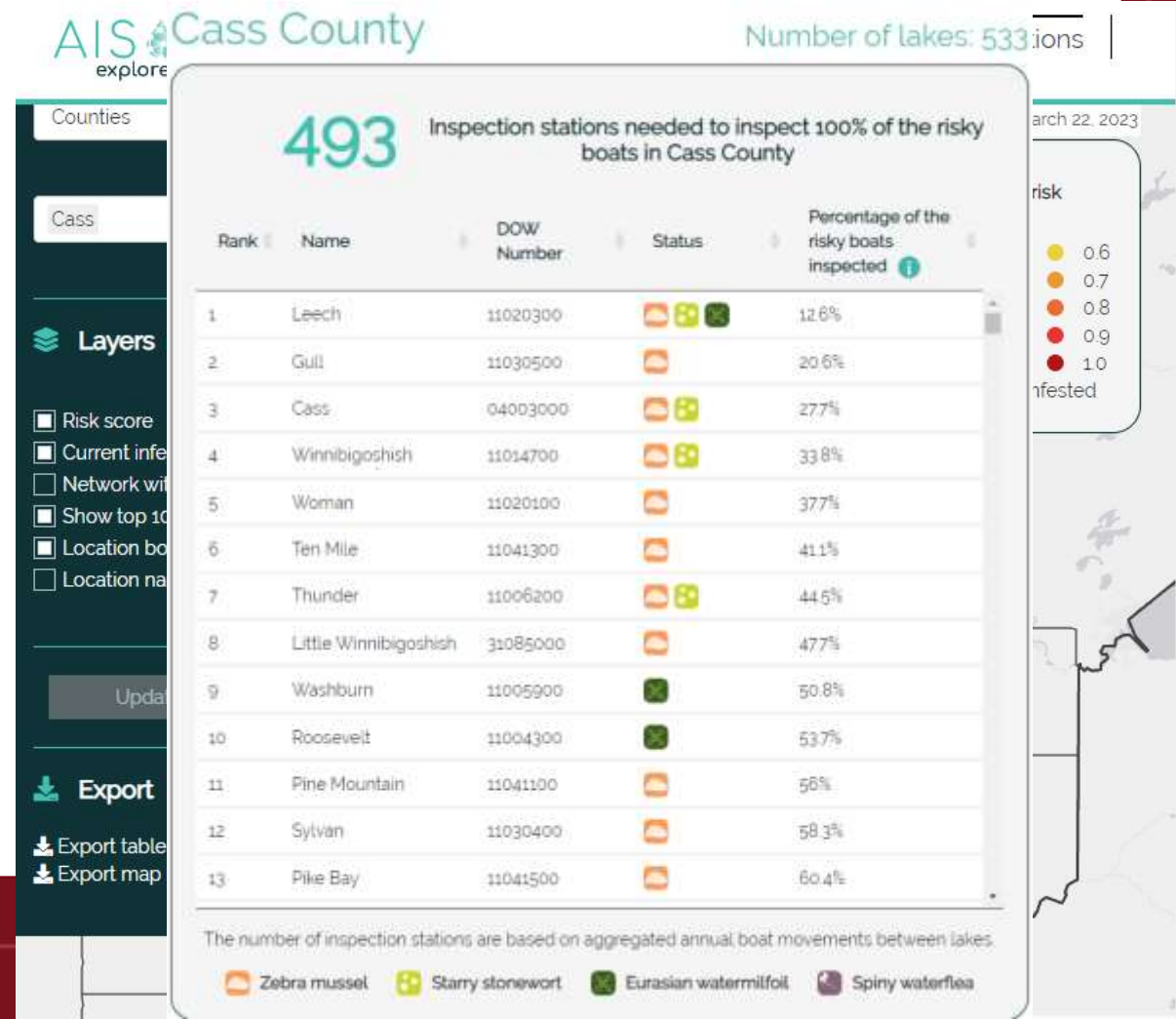
R—The PredictoR

R even lets us "peer into our crystal ball!"

- Using R, we've made a simulation model that predicts which lakes will be infested in 5 years—unless we act! *Coming to **AIS Explorer**!*

- Another sim helps stakeholders understand the associated uncertainty.

The model projects your intervention scenario would avert approximately 0.43 (0.75-0.32) new, boat-driven infestations over a five-year period.

More likely

Scenario
- Status quo
- Your intervention scenario

Less likely

0   2   4

Number of new infestations

How variable/uncertain are those results? What's possible?

AIS explorer

Introduction Risk for Surveillance | Intervention Impact | Prioritization for Watercraft Inspections |

About   Contact

Based on DNR infested water list - updated October 28, 2022

| 1 Choose lakes | 2 Define effort | 3 Define effectiveness | 4 Define costs | 5 Review settings |

Build a plan and simulate how life will be different 5 years from now under it!

My goals today

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2. Celebrate the majesty of R for us!
3. Provide a **whirlwind** tour how R has empowered us *over just the past year or so*.
4. Inspire and encourage you to take the plunge--tap R to fight for you in your sphere!

And if you'd appreciate an ally, reach out!
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or find me on LinkedIn!