Smart Prevention of Aquatic Invasive Species in Wisconsin

M. Jake Vander Zanden

&

Jeffrey Maxted, Norman Mercado-Silva, Pieter Johnson, Julian Olden, Scott Higgins, Katie Hein, Gretchen Hanson, Matt Kornis, John Magnuson

Center for Limnology, UW-Madison

THE UNIVERSITY of WISCONSIN MADISON

University of Wisconsin
Center for Limnology

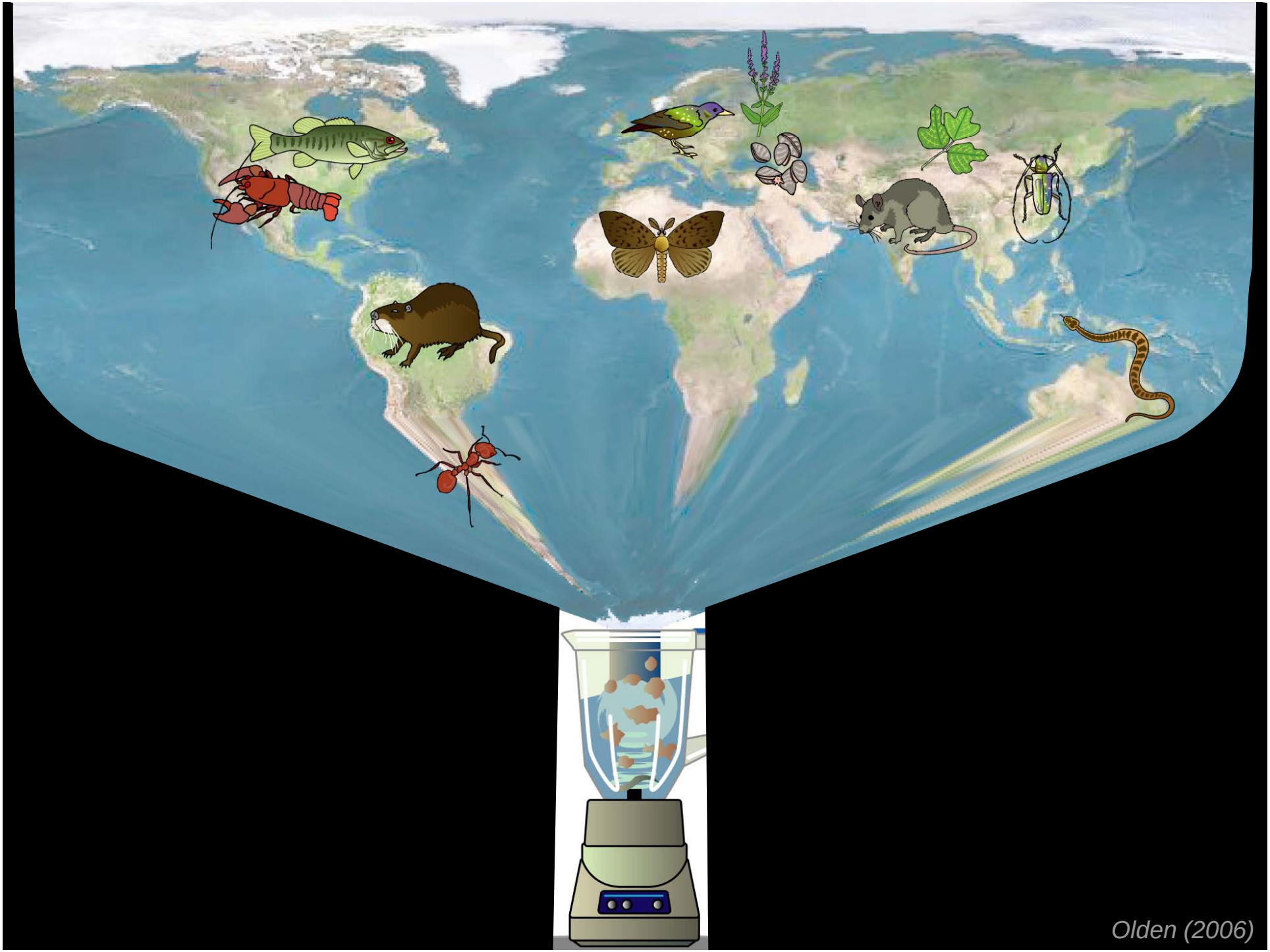
This work made possible by…

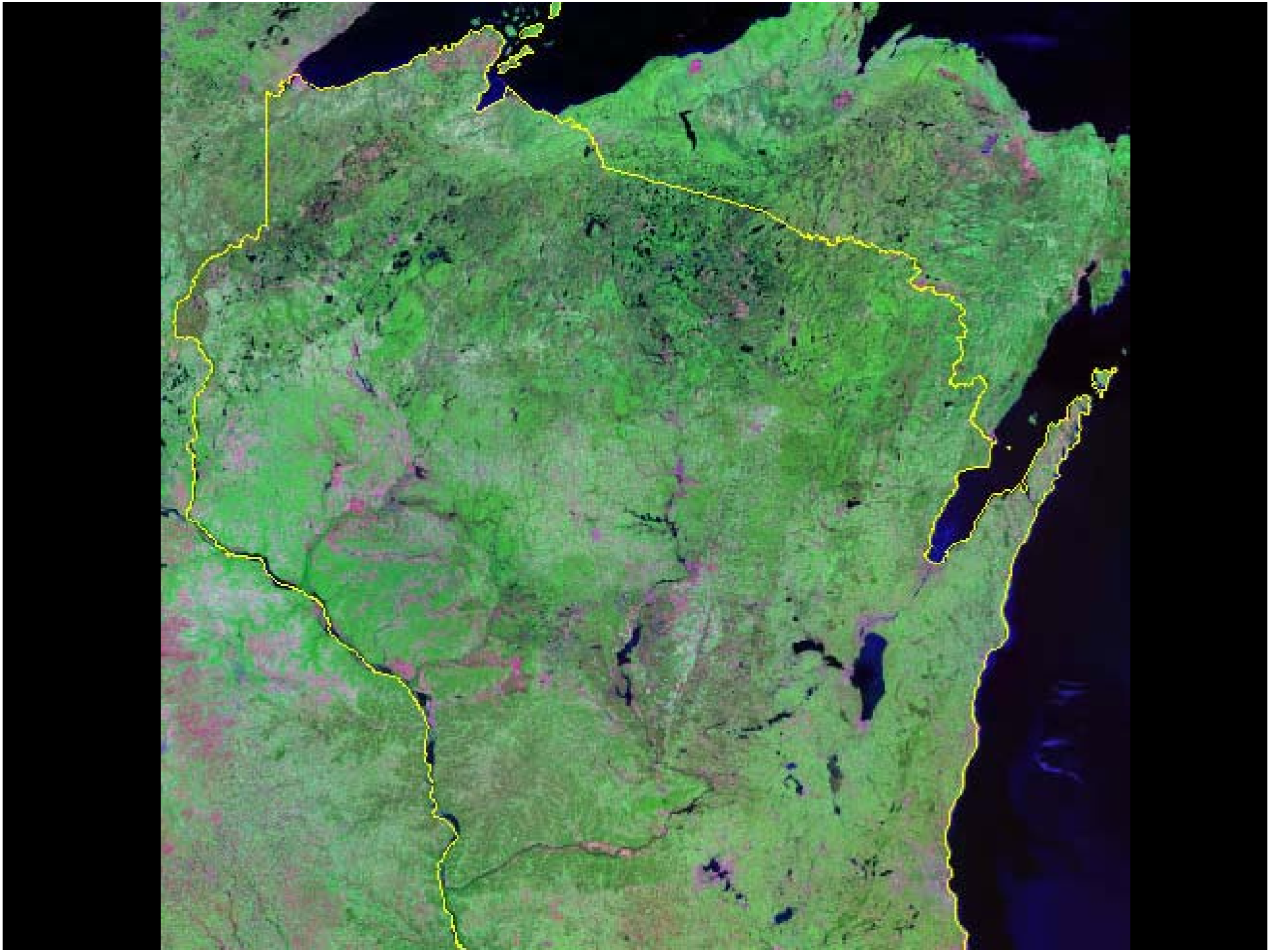
Funding:

- WI Department of Natural Resources
- Wisconsin Coastal Management Program
- Wisconsin Sea Grant
- Baldwin ‘Wisconsin Idea’ Endowment
- National Science Foundation (NTL-LTER)
- UW-Madison

Partners, colleagues, collaborators:

- Wisconsin Lakes Partnership
- Citizens Lake Monitoring Network
- Water Action Volunteers
- Great Lakes Indian, Fish, & Wildlife Commission
- Many, many undergraduate students at UW-Madison
- David Lodge & Lab

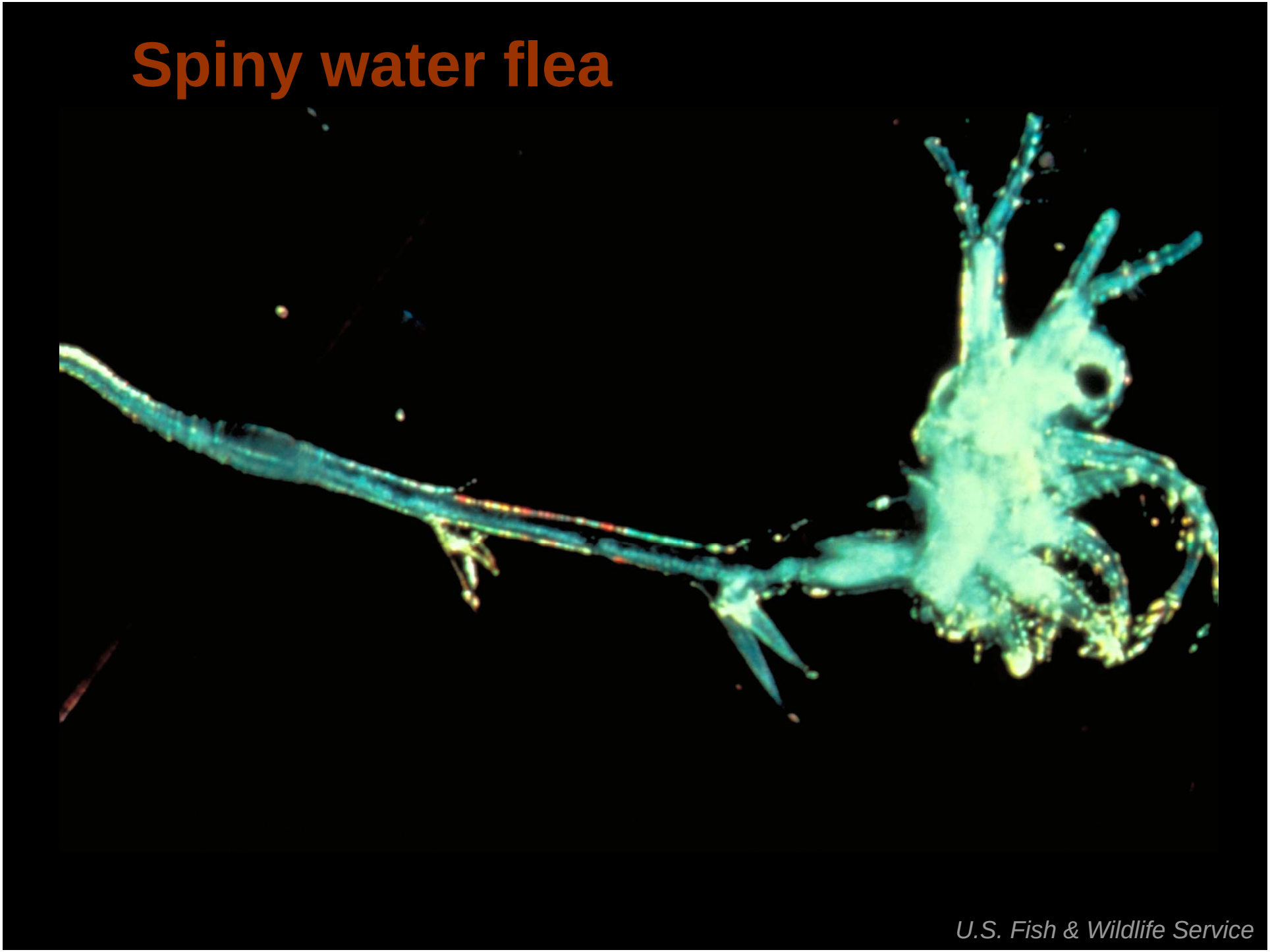

Olden (2006)



Rainbow smelt

Shedd Aquarium

Spiny water flea



U.S. Fish & Wildlife Service

Zebra mussel

Round goby

Rusty crayfish

Thomas Simon

Chinese mystery snail

“An ounce of prevention is worth a pound of cure”

- Benjamin Franklin


How can we apply this wisdom to management of aquatic invasive species in Wisconsin?
Copyright - 2005 - satellite-photos.us

AIS research at Center for Limnology, UW-Madison

Goals:

Understanding aquatic invasive species spread and impact

Translate this knowledge into targeted and more cost-effective AIS prevention and management

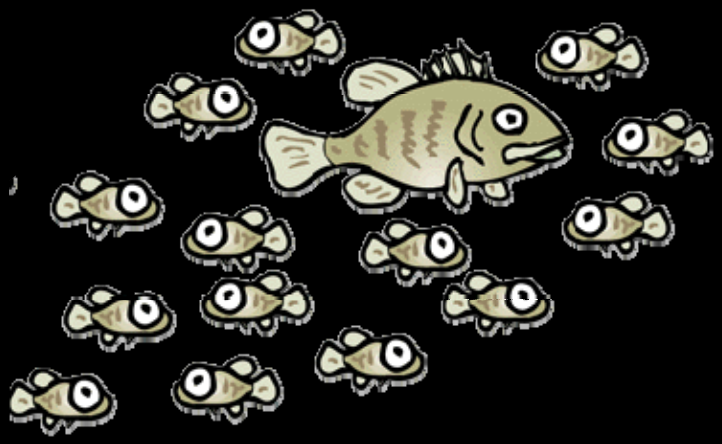
Example: Identifying lakes that are 'vulnerable' to specific invasive species

What do we mean by 'vulnerable'?

1. Colonization

Can it get there?

2. Establishment



Can it establish a population and reproduce?

3. Impact

Will it have adverse impacts on native species?

Lake vulnerability -

Combination of these three factors

Smart prevention -

Strategically direct management and prevention efforts to protect lakes that are vulnerable

Workshop led by Jeff Maxted Friday @ 9 AM

Vander Zanden, M.J. and J.D. Olden 2008 Can. J. Fish. Aquat. Sci.

1. Rainbow Smelt

- Small forage fish
- Invaded Great Lakes, spreading to inland lakes of Wisconsin
- Big teeth!

Ecological role – prey

Adult walleye

↓

Rainbow smelt

Ecological role – predator

Adult walleye

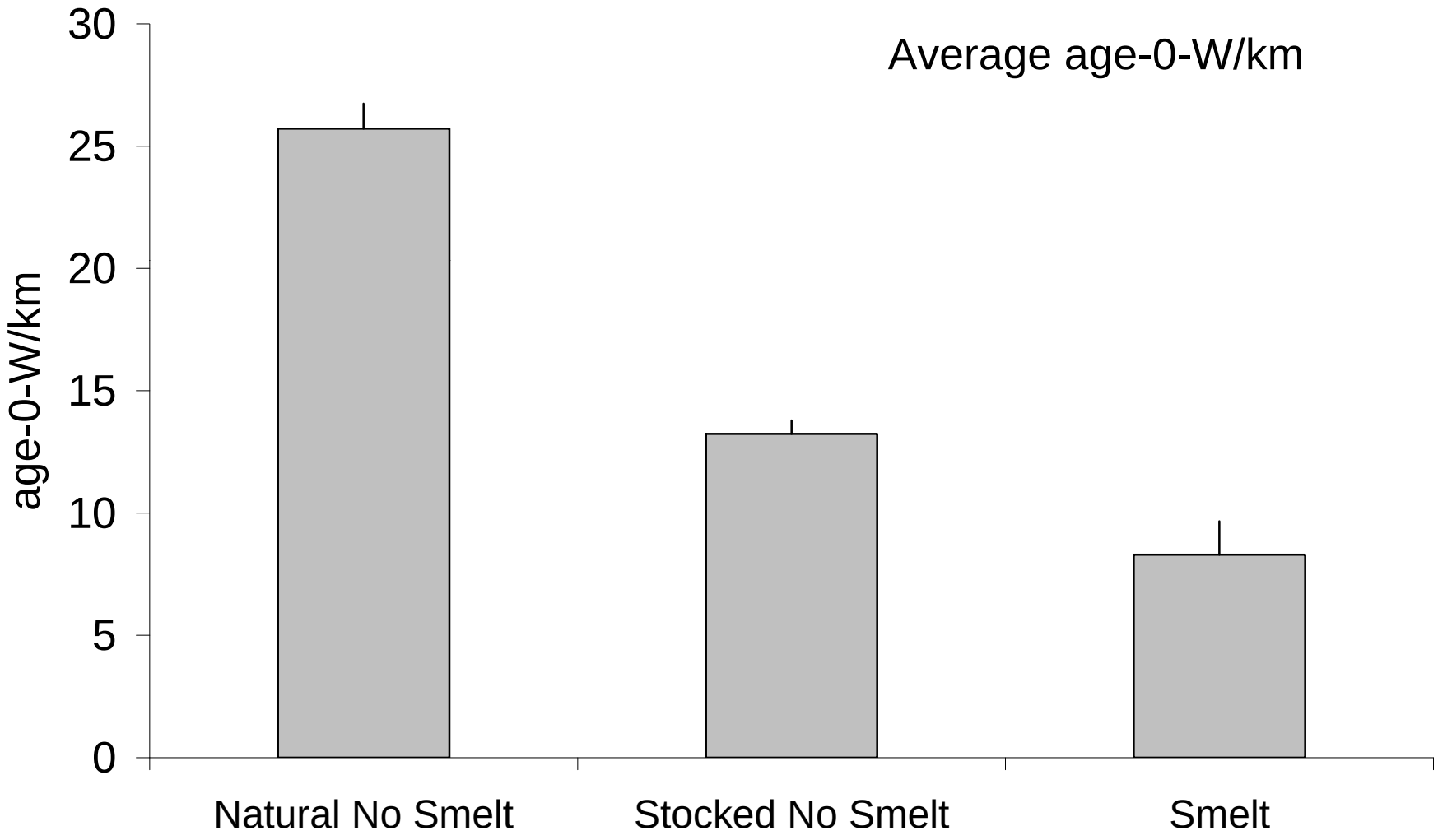
↓

Rainbow smelt

↓

Young walleye, perch, lake herring, rainbow smelt

Smelt reduce walleye reproduction



Mercado-Silva et al. 2007 Can. J. Fish. Aquat. Sci.

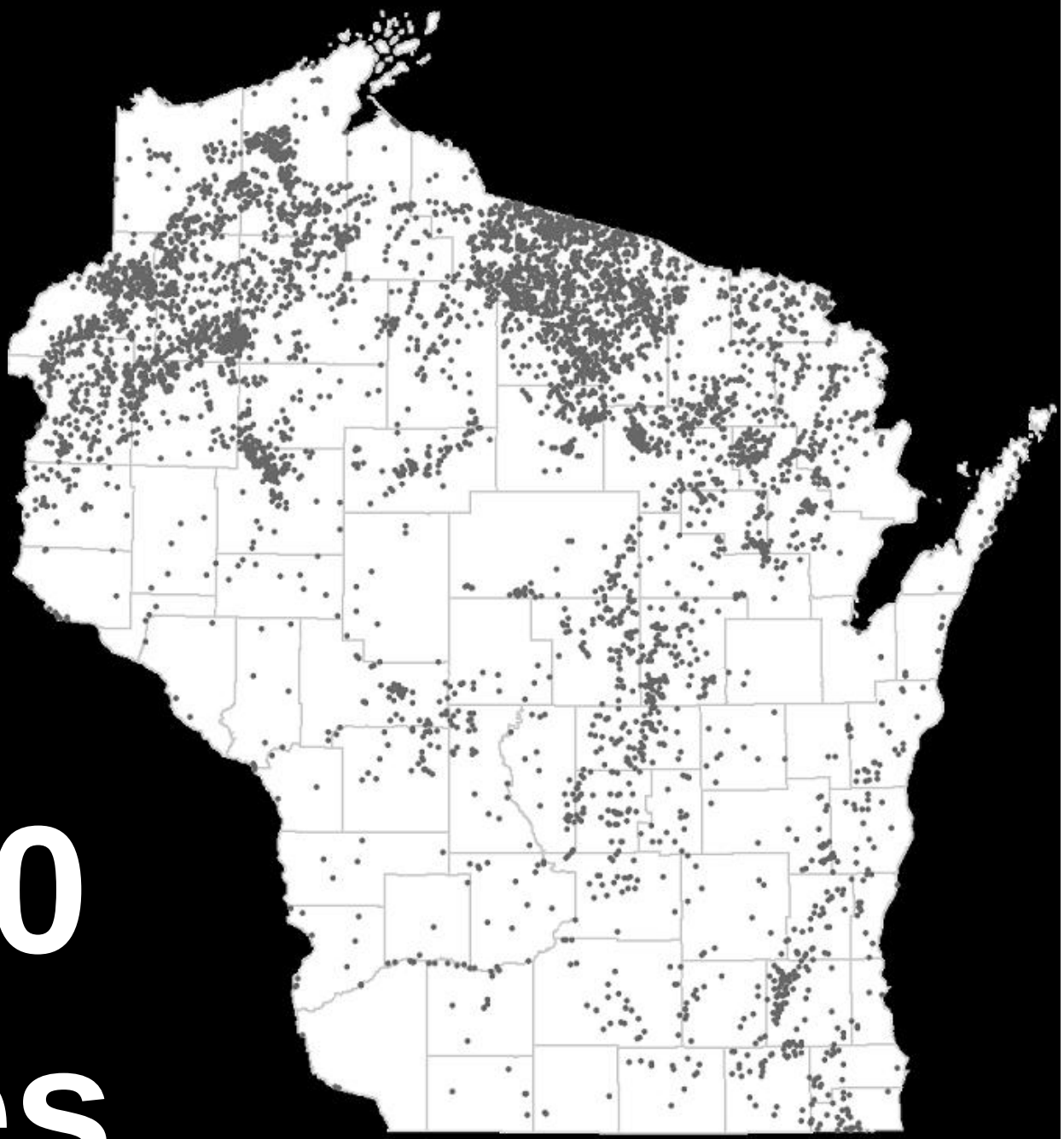
Application of ‘smart prevention’ to rainbow smelt in Wisconsin

Mercado-Silva et al. 2006 Conservation Biology

Colonization

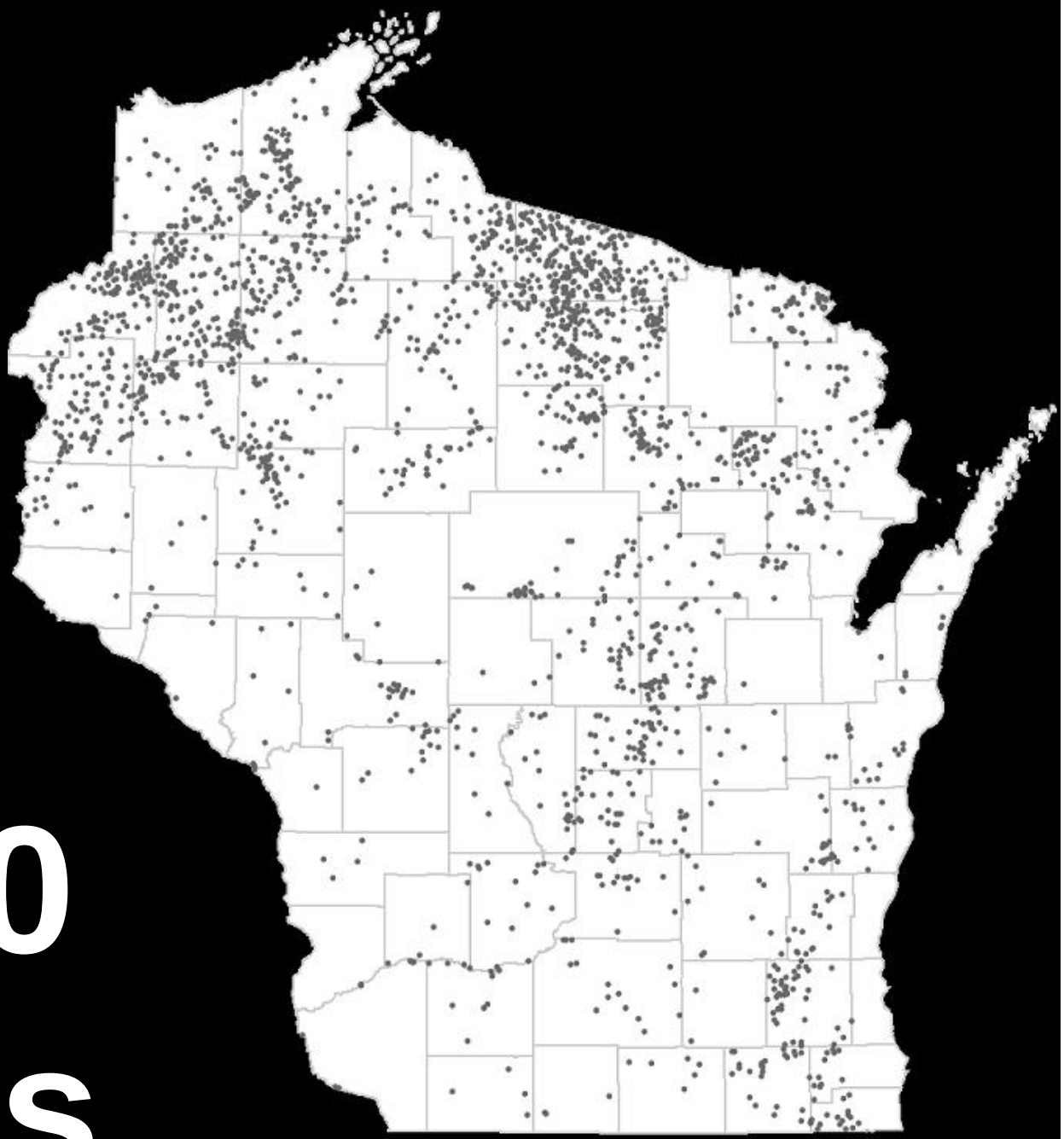
Can it get there?

All Lakes



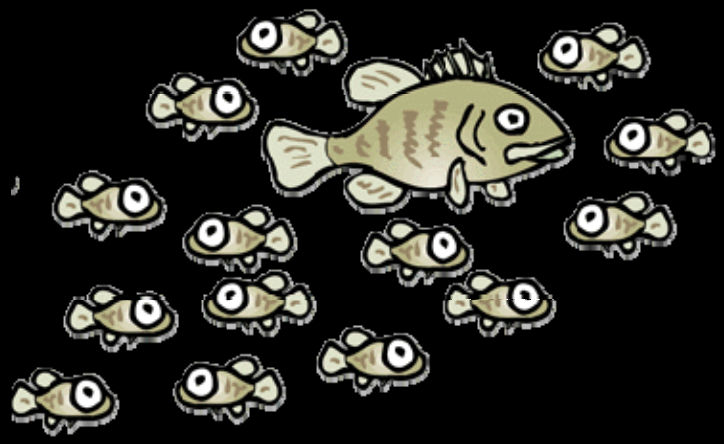
5100 lakes

Can smelt get there?



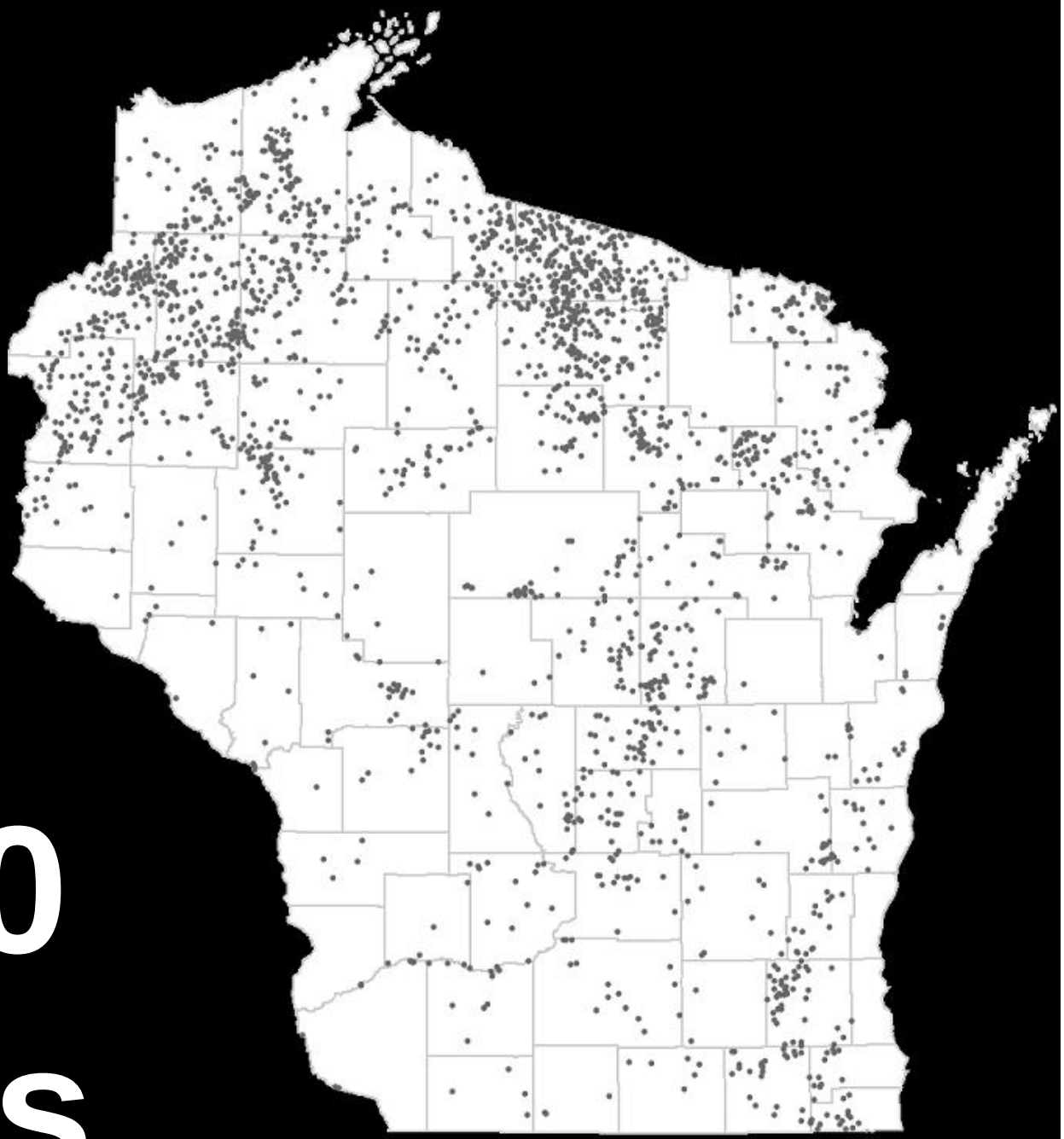
2200 lakes

Establishment



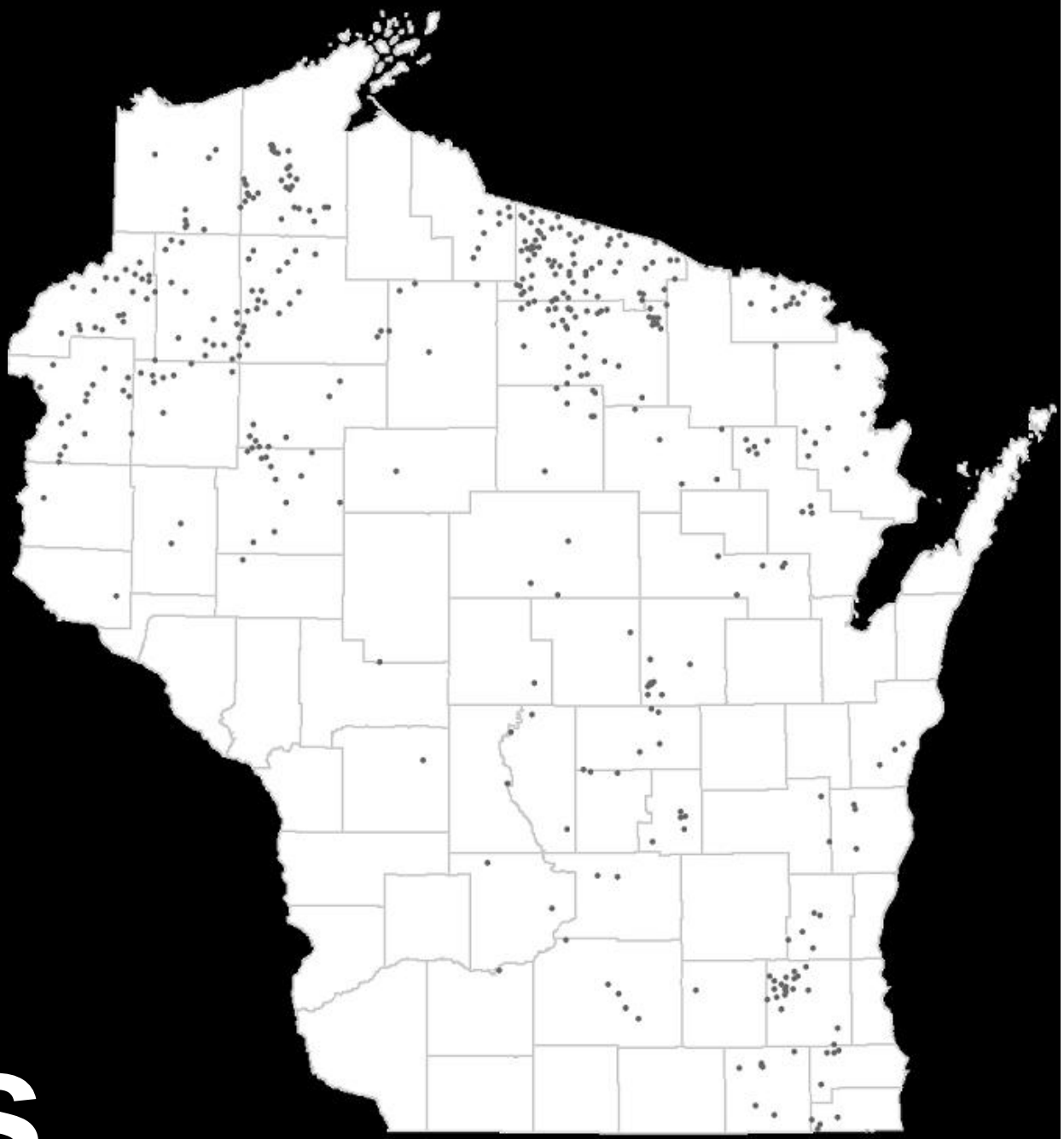
Can it establish a population?

Can smelt get there?



2200 lakes

Can smelt live there?

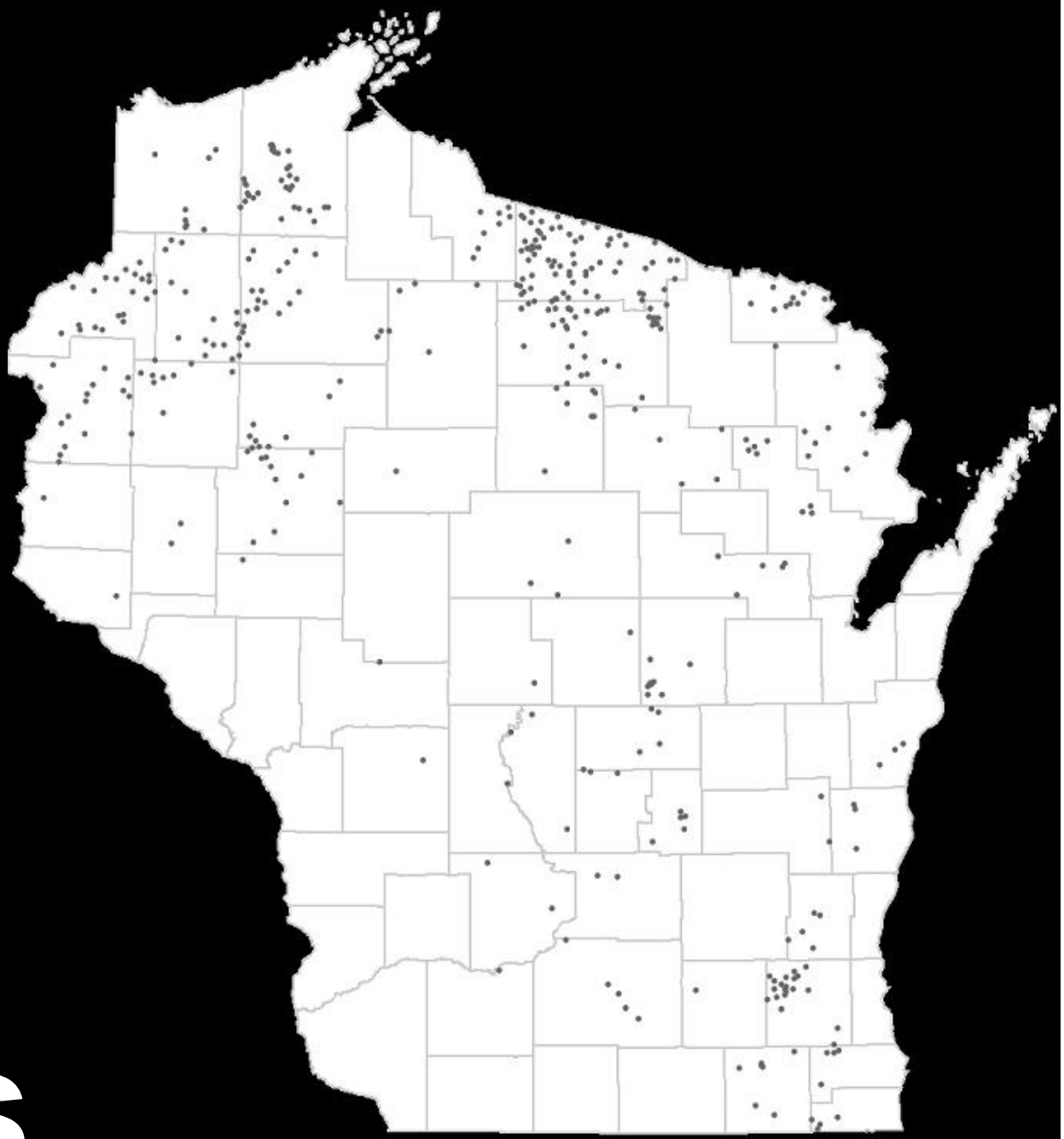


553 lakes

Impact

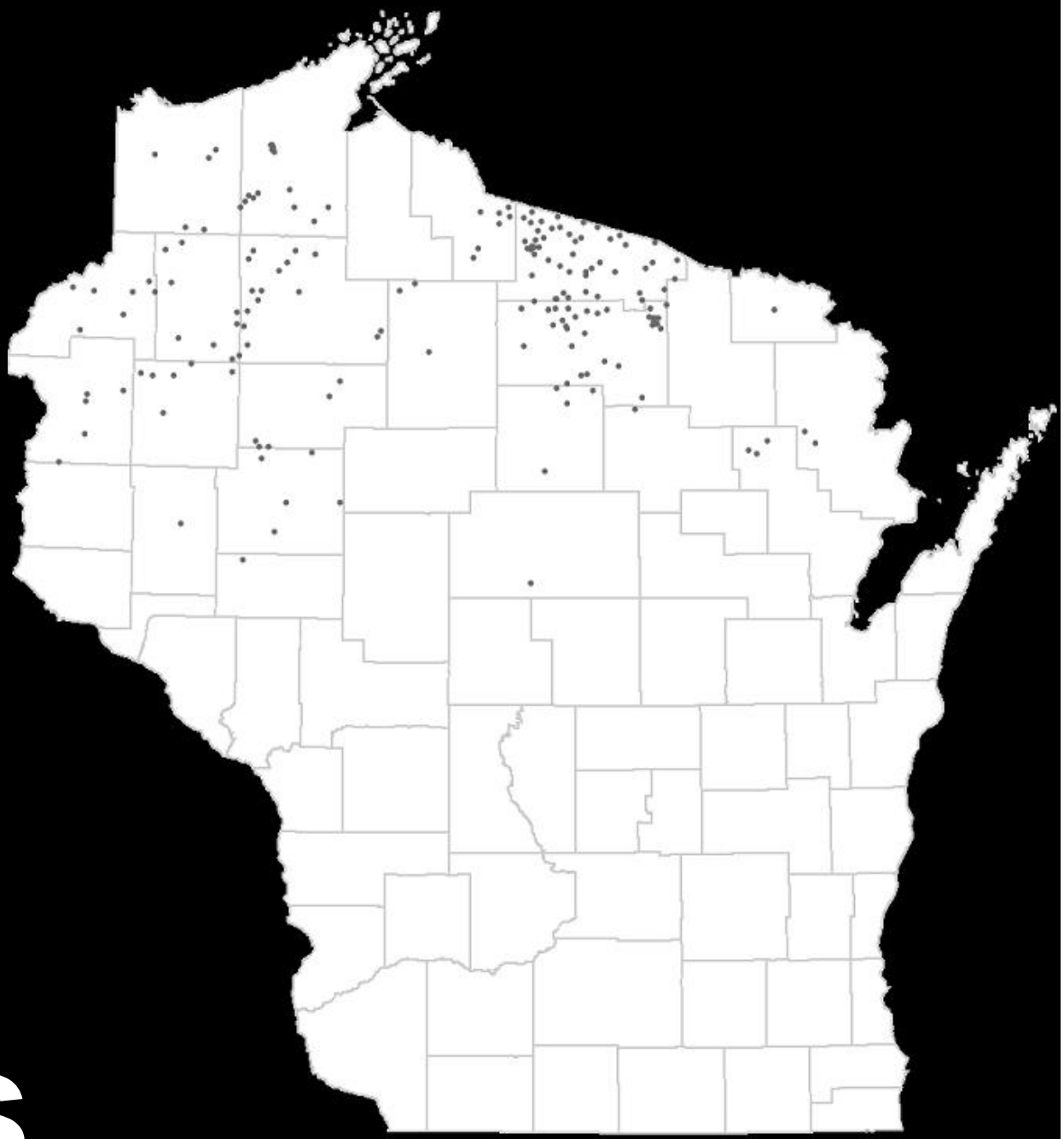
Will it have adverse impacts on native species?

Can smelt live there?



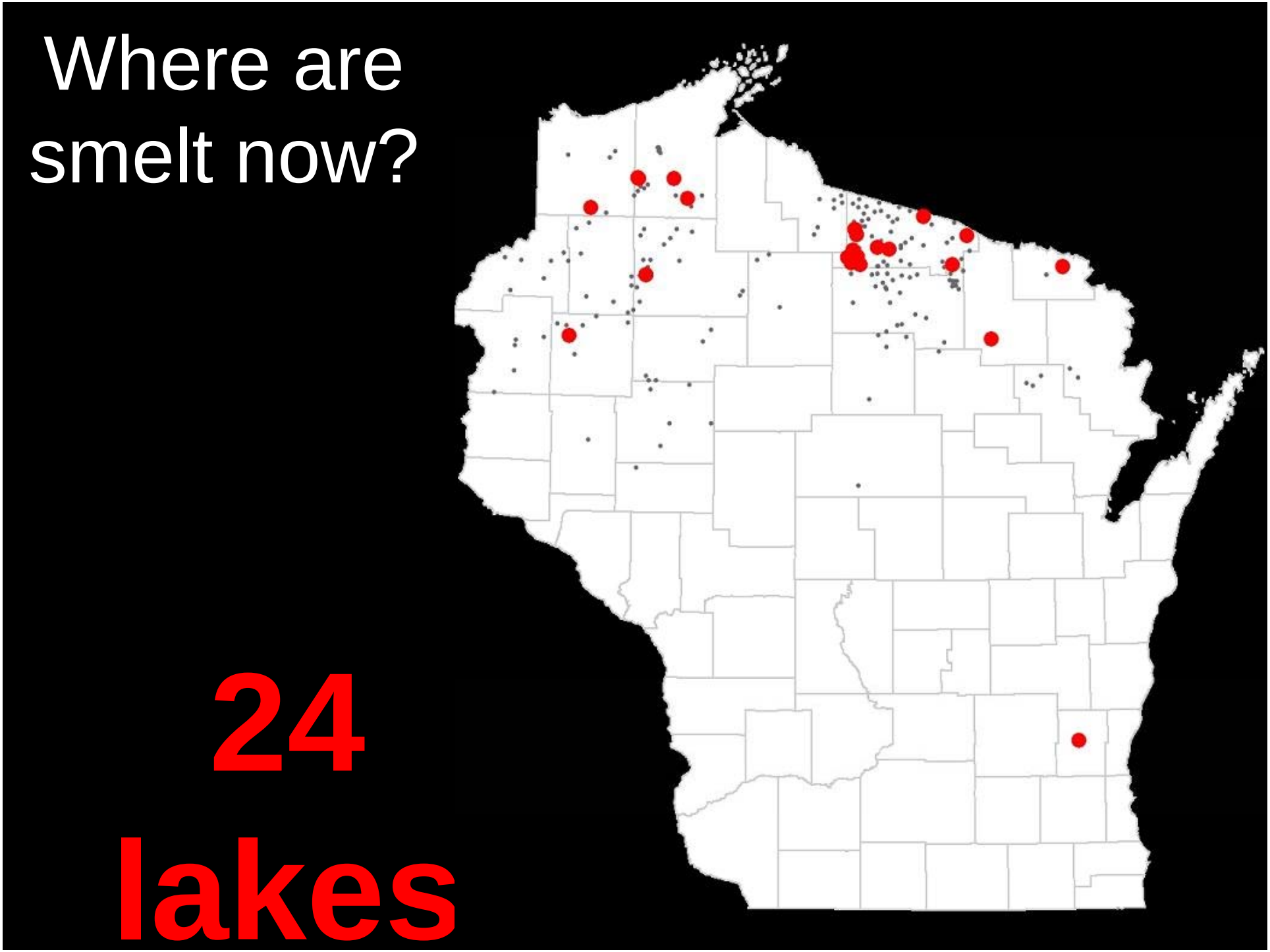
553 lakes

Will smelt have an impact?



180 lakes

Where are smelt now?



24 lakes

Take home message for rainbow smelt

- Rainbow smelt impact fisheries in Wisconsin
- Only a small percentage of lakes are currently invaded or ‘highly vulnerable’
- This knowledge provides guidance for targeting management efforts to protect vulnerable lakes

See talk by Chris Solomon (Thurs 3:00 PM)

2. Spiny water flea

Native to Eurasia

Large and predatory on native zooplankton

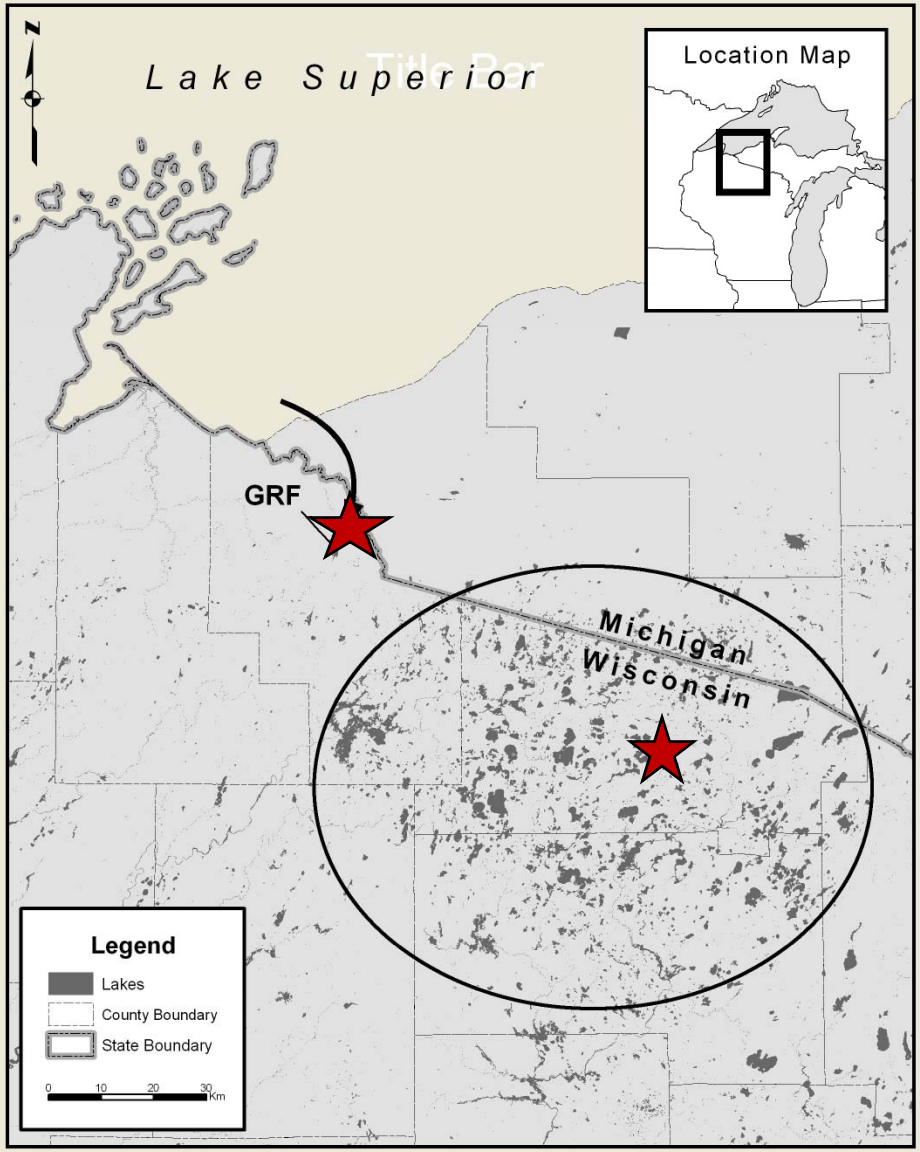
Spiny – difficult for fish to eat

Discovered in Gile Flowage in 2003

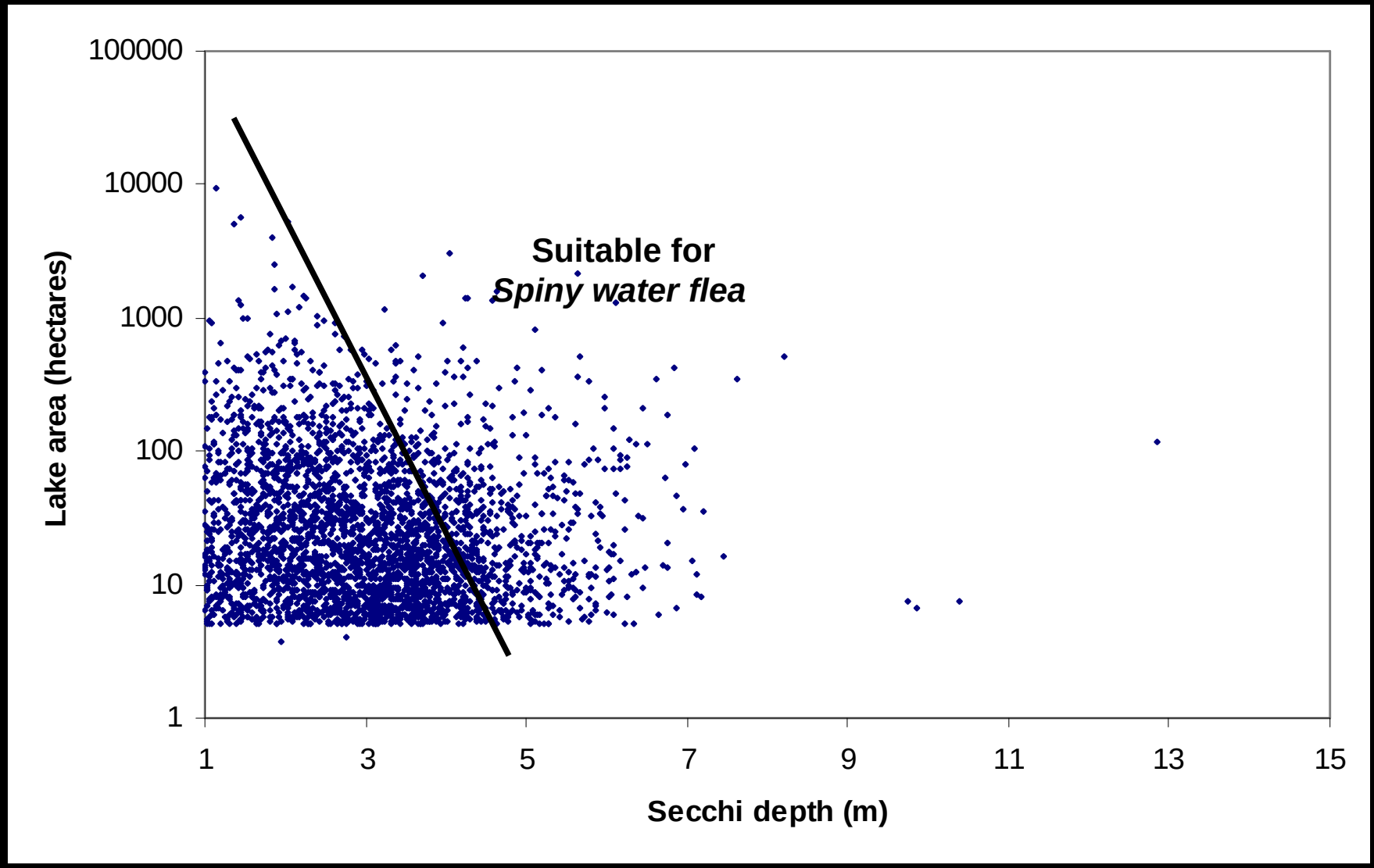
Possible stepping stone to the thousands of lakes of the Northern Highlands Lake District

Discovered in Stormy Lake (Vilas County) in 2006

See poster by Samantha Mueller Thurs PM



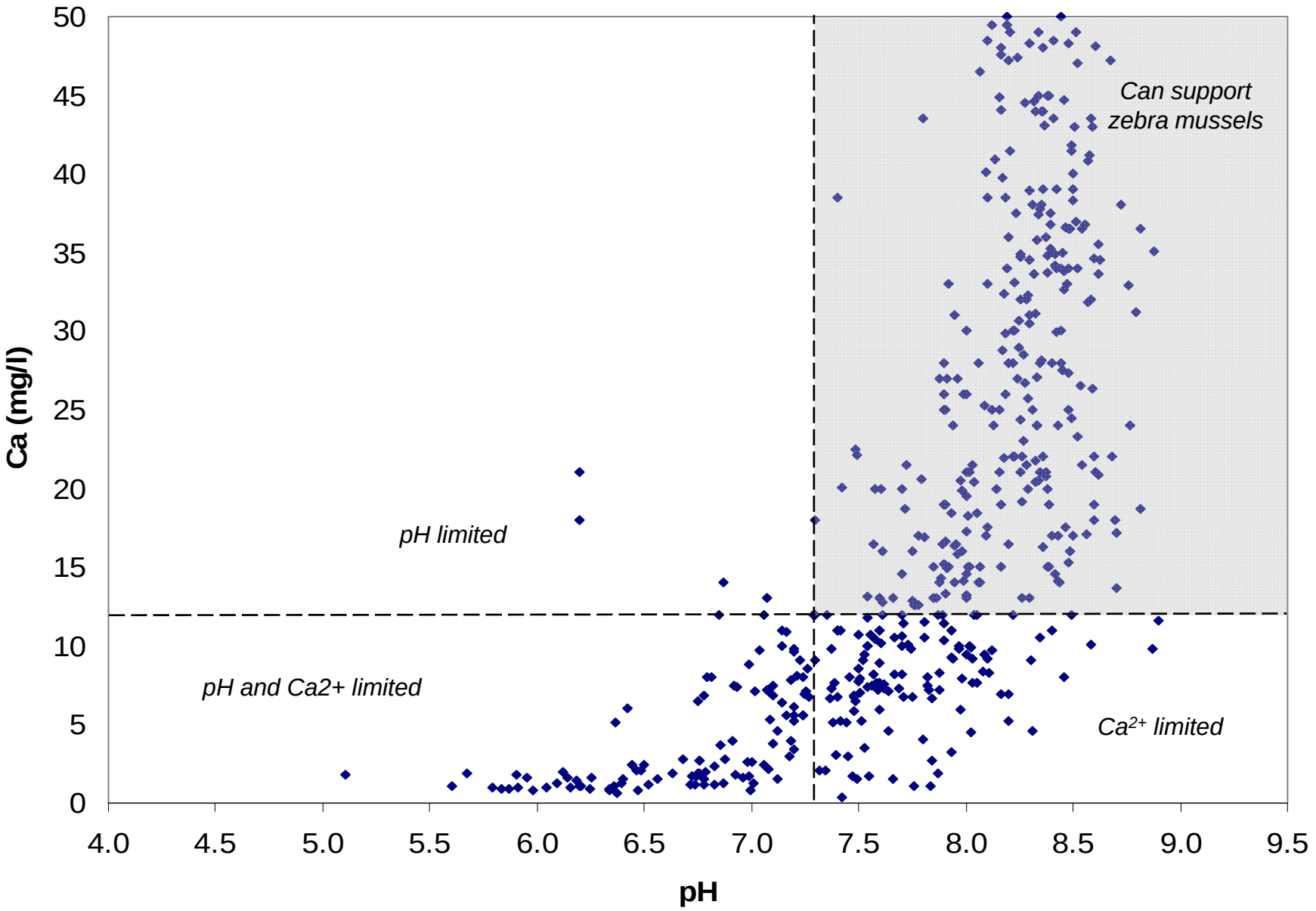
Predicting spiny water flea in Wisconsin



Threshold based on model of *MacIsaac et al. 2000*

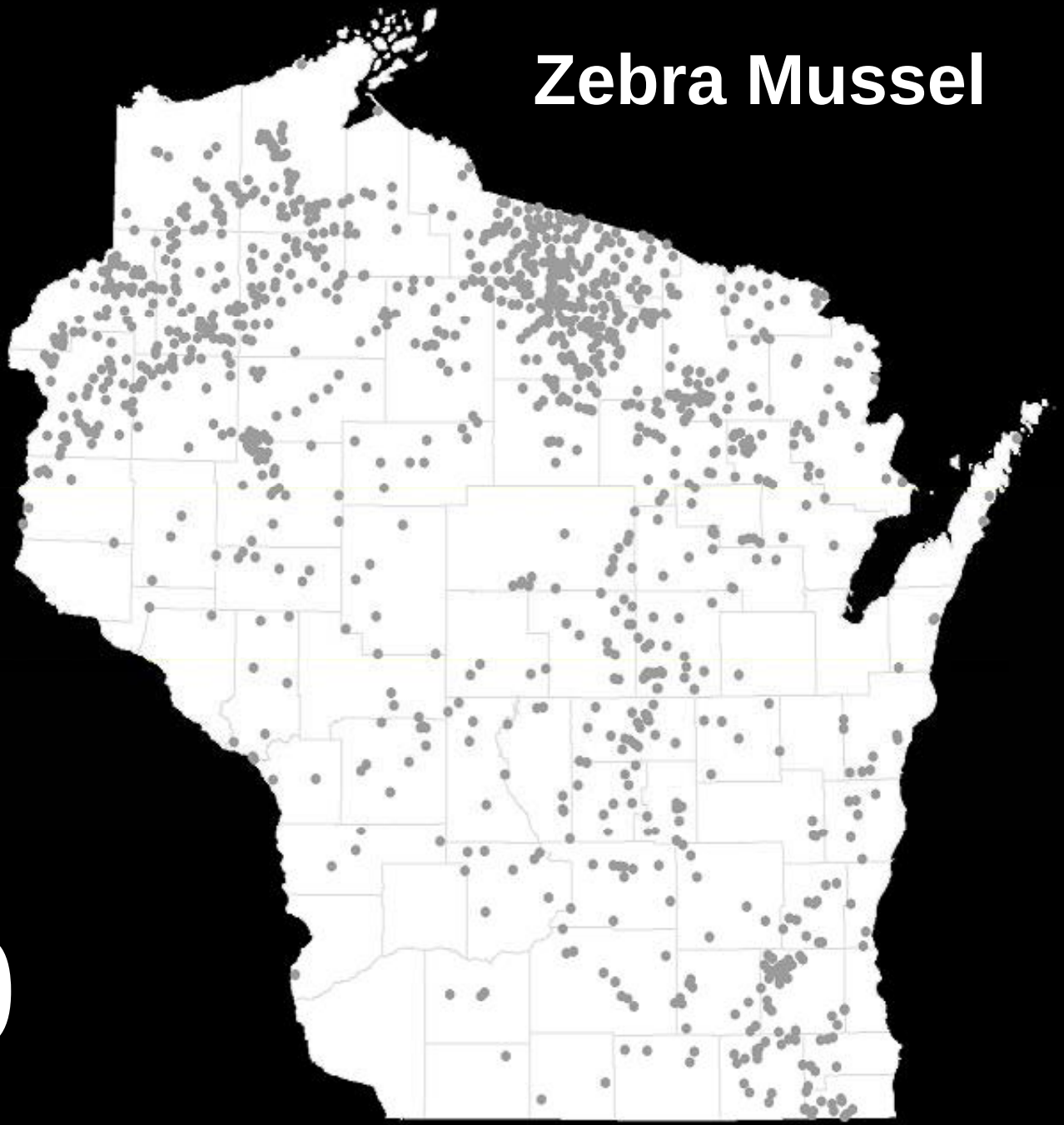
3. Zebra mussel

Ecology and impacts - see talk by Scott Higgins Thurs @ 4:20


Ca (mg/l)
50
45
40
35
30
25
20
15
10
5
0
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
pH
Can support zebra mussels
pH limited
pH and Ca2+ limited
Ca2+ limited

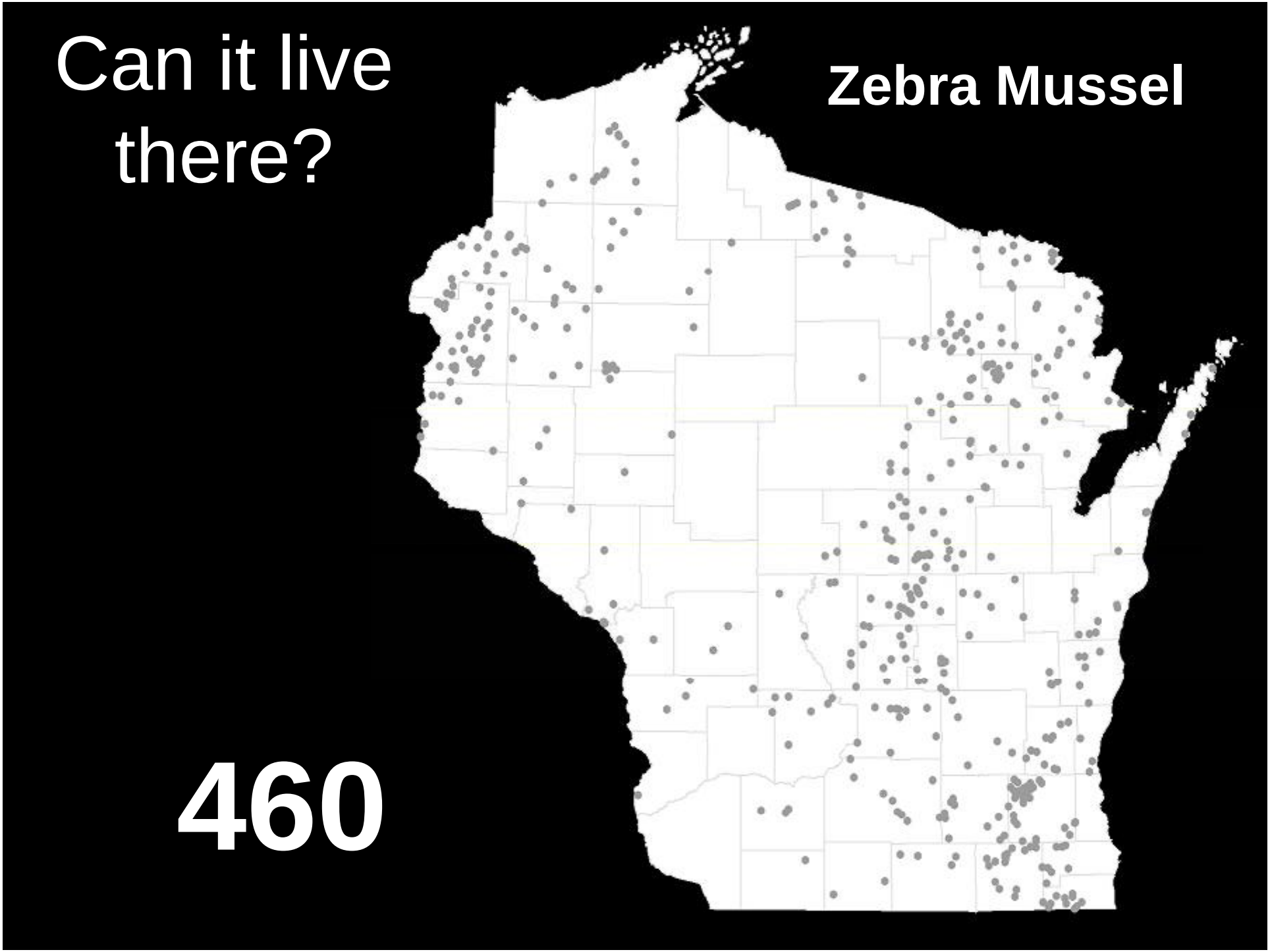
All Lakes

Zebra Mussel



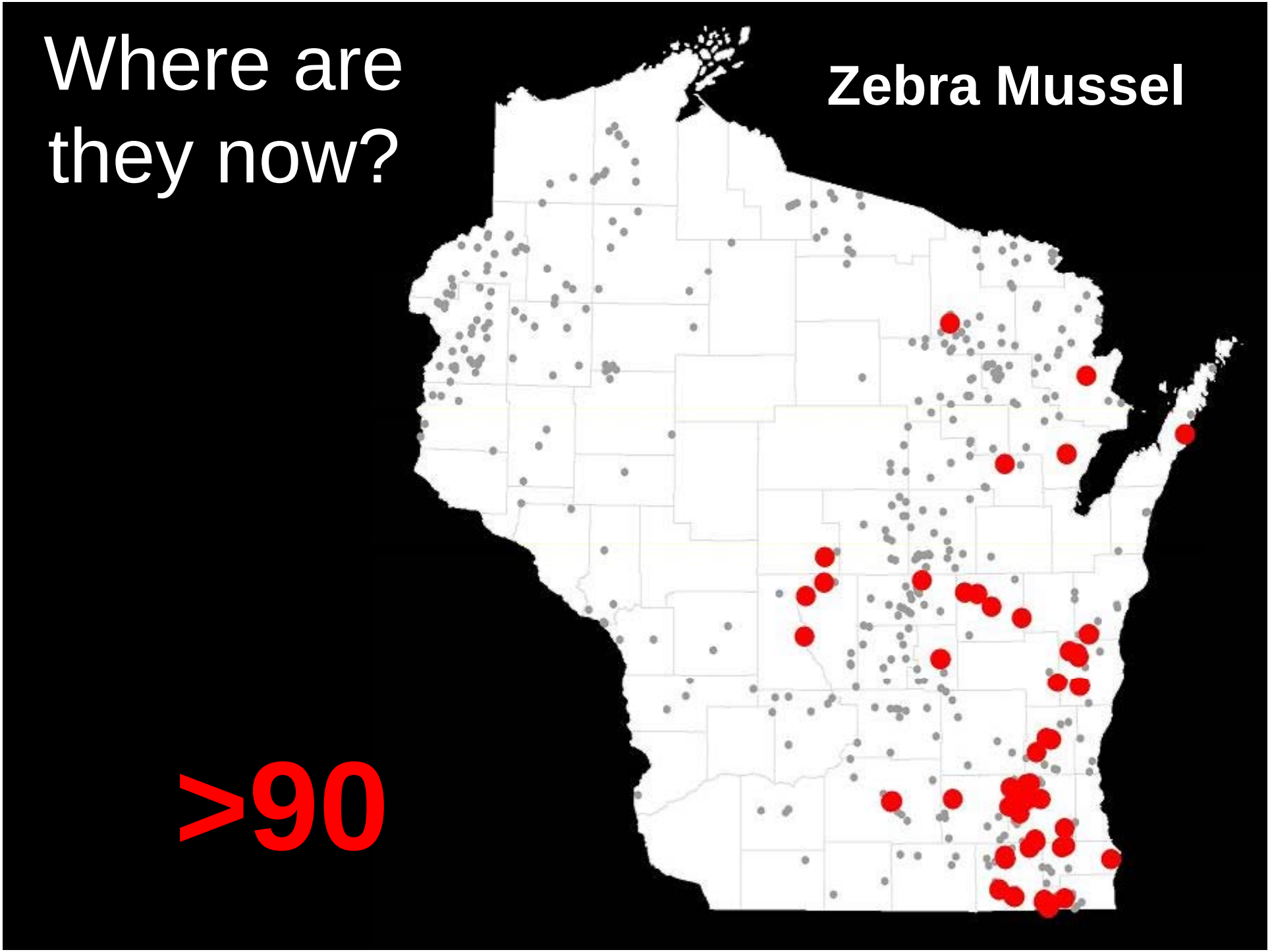
1100

Can it live there?



460

Where are they now?

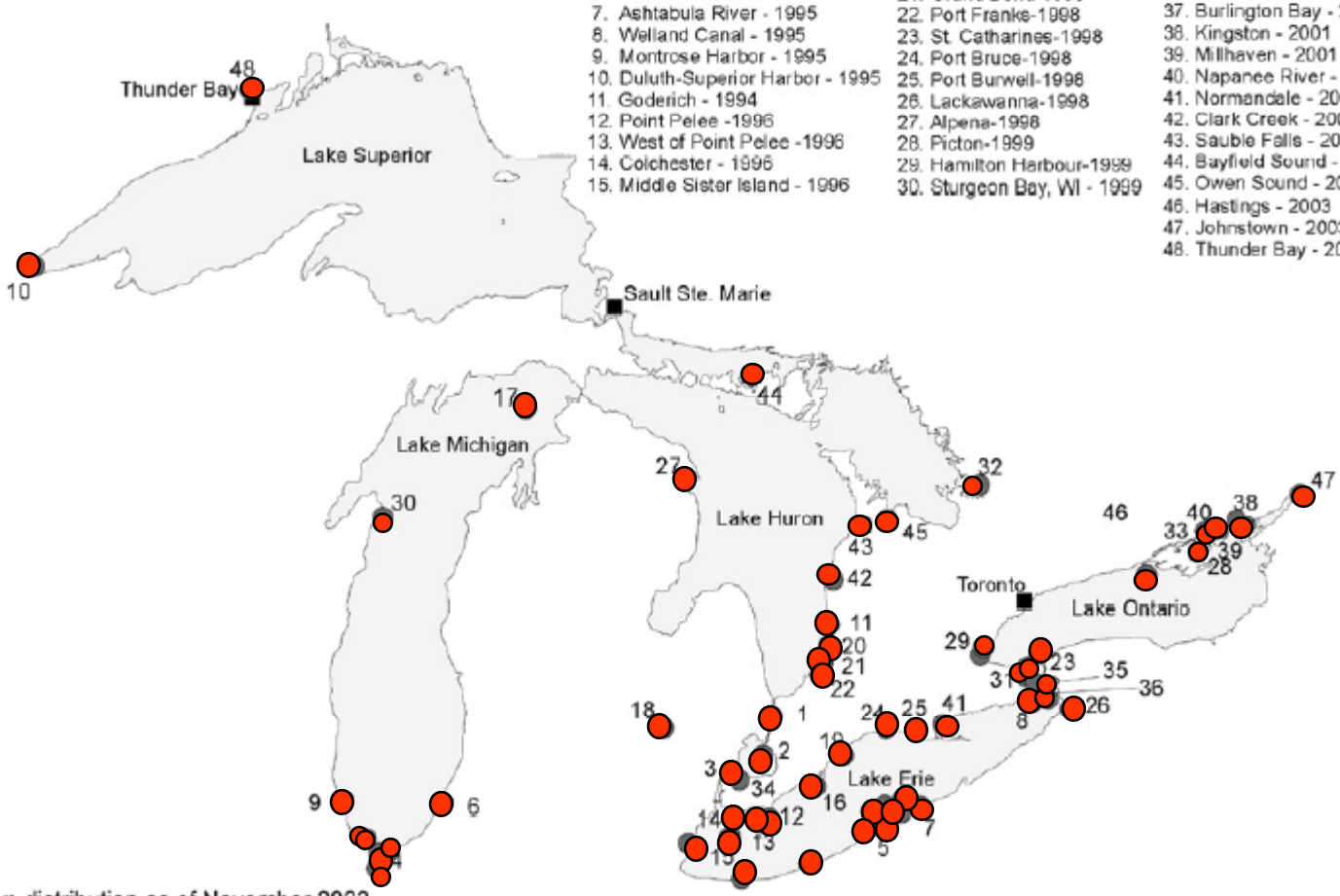


>90

4. Round Goby

Native to Black and Caspian Seas

Round Goby Distribution



1. St. Clair River - 1990
2. Lake St. Clair - 1993
3. Detroit River - 1993
4. Calumet River - 1993
5. Grand River - 1993
6. South Haven - 1994
7. Ashtabula River - 1995
8. Welland Canal - 1995
9. Montrose Harbor - 1995
10. Duluth-Superior Harbor - 1995
11. Goderich - 1994
12. Point Pelee -1996
13. West of Point Pelee -1996
14. Colchester - 1996
15. Middle Sister Island - 1996
16. Erieau - 1996
17. Beaver Island - 1996
18. Shiawassee River - 1995
19. Port Glasgow - 1997
20. Bayfield-1998
21. Grand Bend-1998
22. Port Franks-1998
23. St. Catharines-1998
24. Port Bruce-1998
25. Port Burwell-1998
26. Lackawanna-1998
27. Alpena-1998
28. Picton-1999
29. Hamilton Harbour-1999
30. Sturgeon Bay, WI - 1999
31. 12 Mile Creek/ Lake Gibson - 1999
32. Port Severn - 1999
33. Telegraph Narrows - 2000
34. Perch Creek - 2000
35. Martindale Pond-2000
36. Point Abino-2000
37. Burlington Bay - 2001
38. Kingston - 2001
39. Millhaven - 2001
40. Napanee River - 2001
41. Normandale - 2001
42. Clark Creek - 2001
43. Sauble Falls - 2001
44. Bayfield Sound - 2002
45. Owen Sound - 2002
46. Hastings - 2003
47. Johnstown - 2003
48. Thunder Bay - 2003

1990

1994

1996

1998

2000

2003

Known distribution as of November 2003.
For updated information call the Invading Species Hotline 1-800-563-7711.
Produced jointly by the Ontario Federation of Anglers and Hunters and Ontario Ministry of Natural Resources.

Discovery: spread to inland waters of Wisconsin

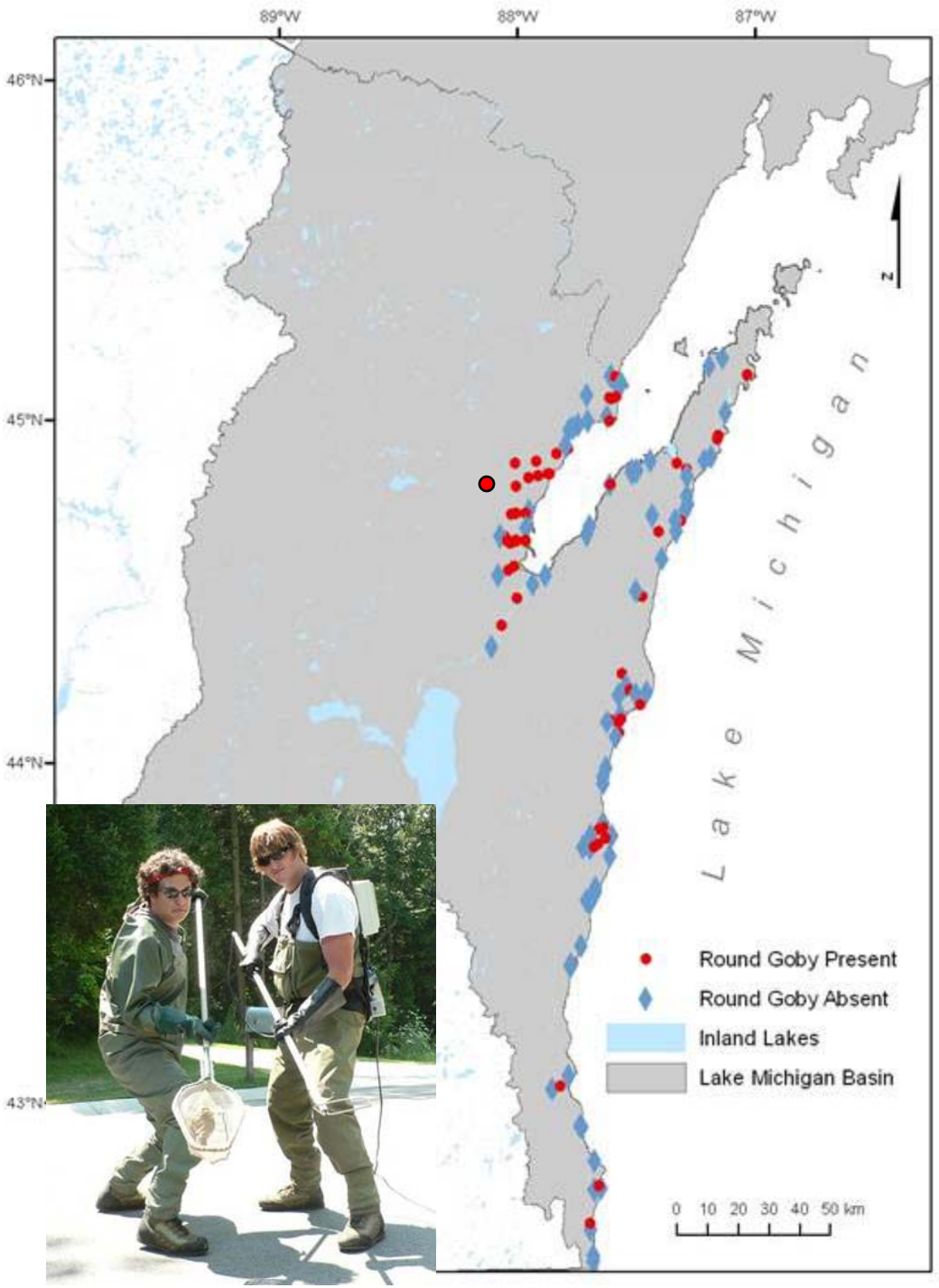
26 of 73 watersheds (36%)

54 of 119 sites (45%)

Furthest inland: 34 km

~280 km of stream documented as invaded

Kornis and Vander Zanden in review



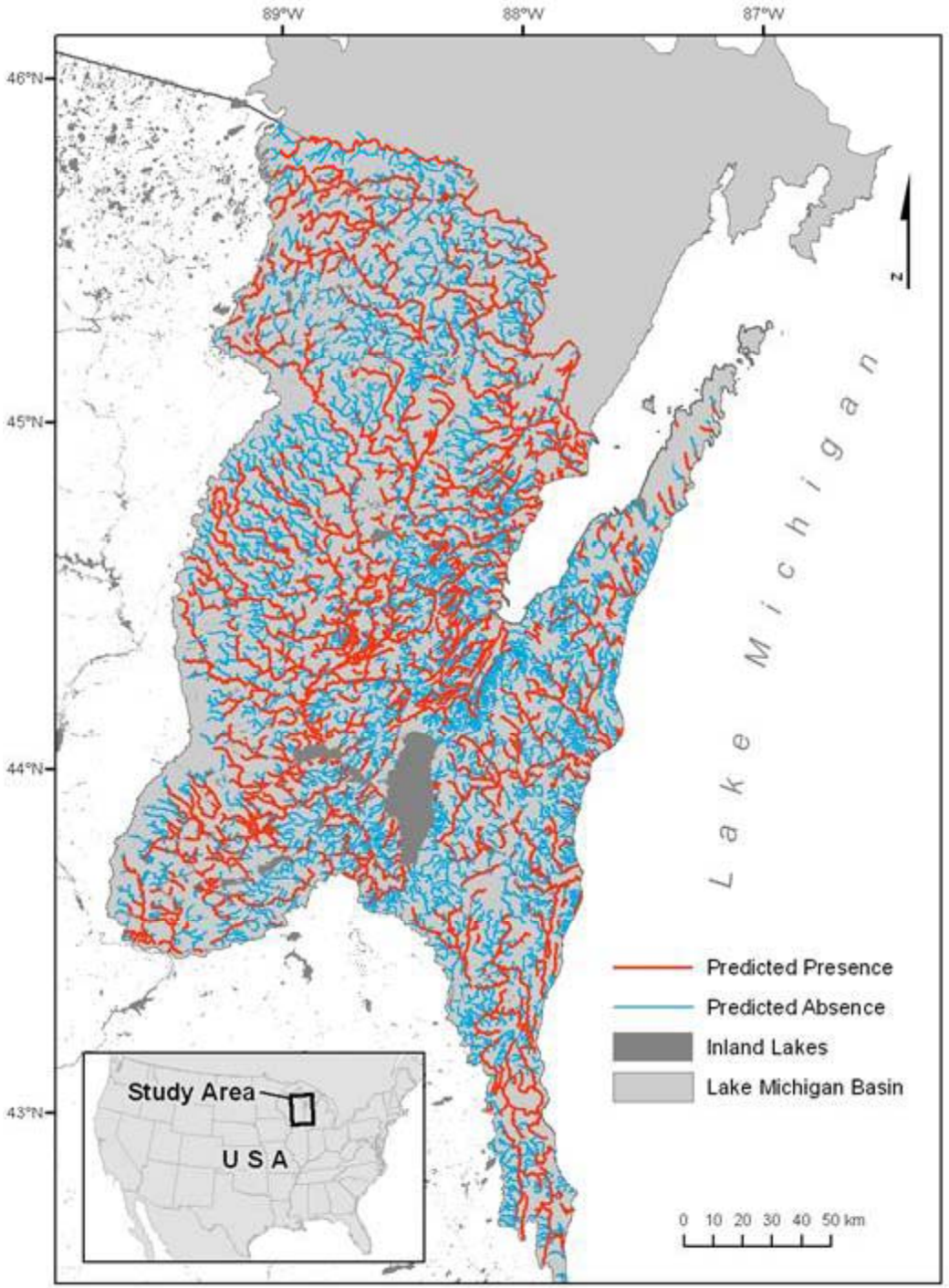
Where will round goby invade next?

42% (1,369 km) identified as suitable

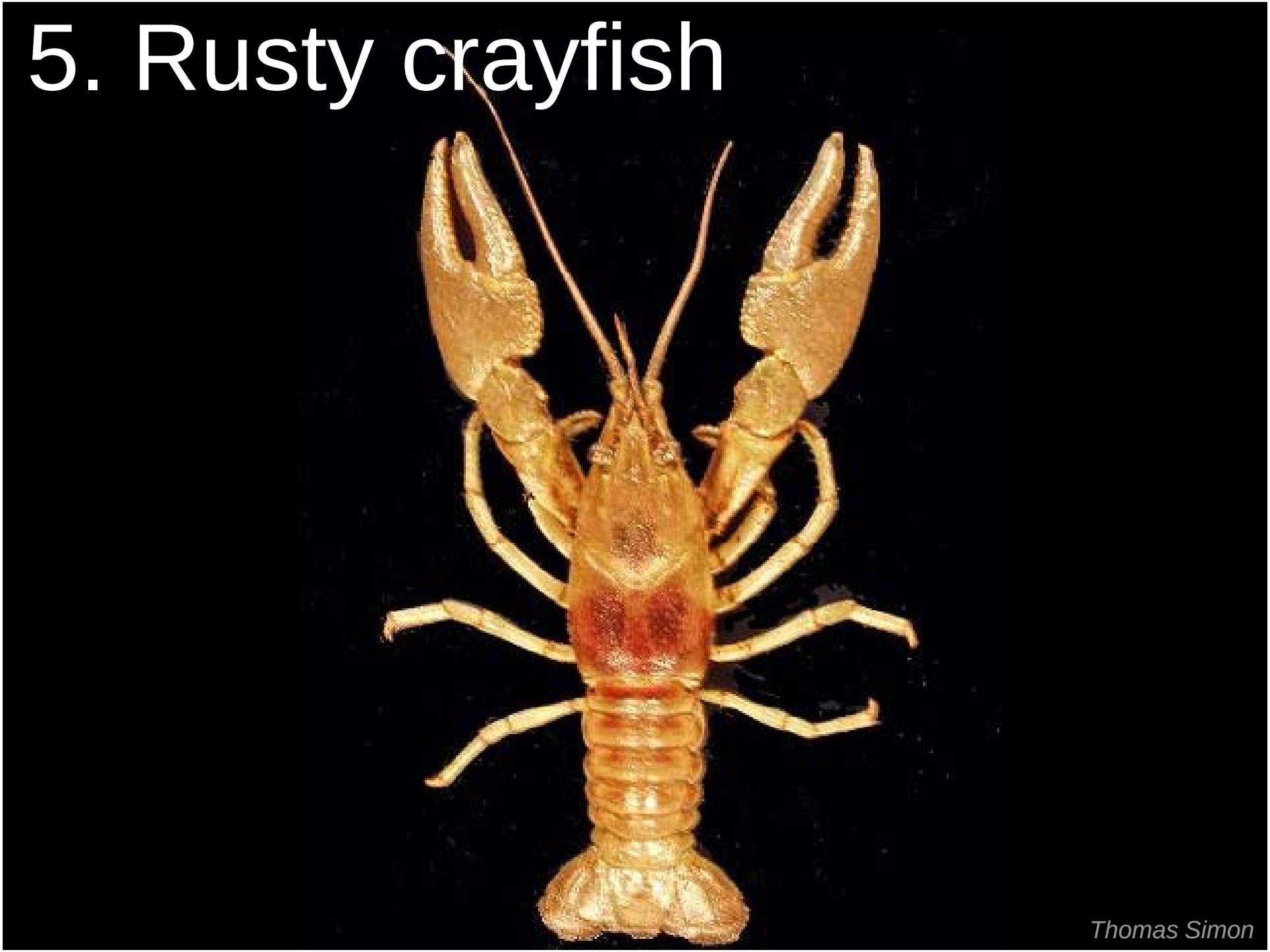
44% (8,878 km) identified as suitable

For more info, see poster by Matt Kornis

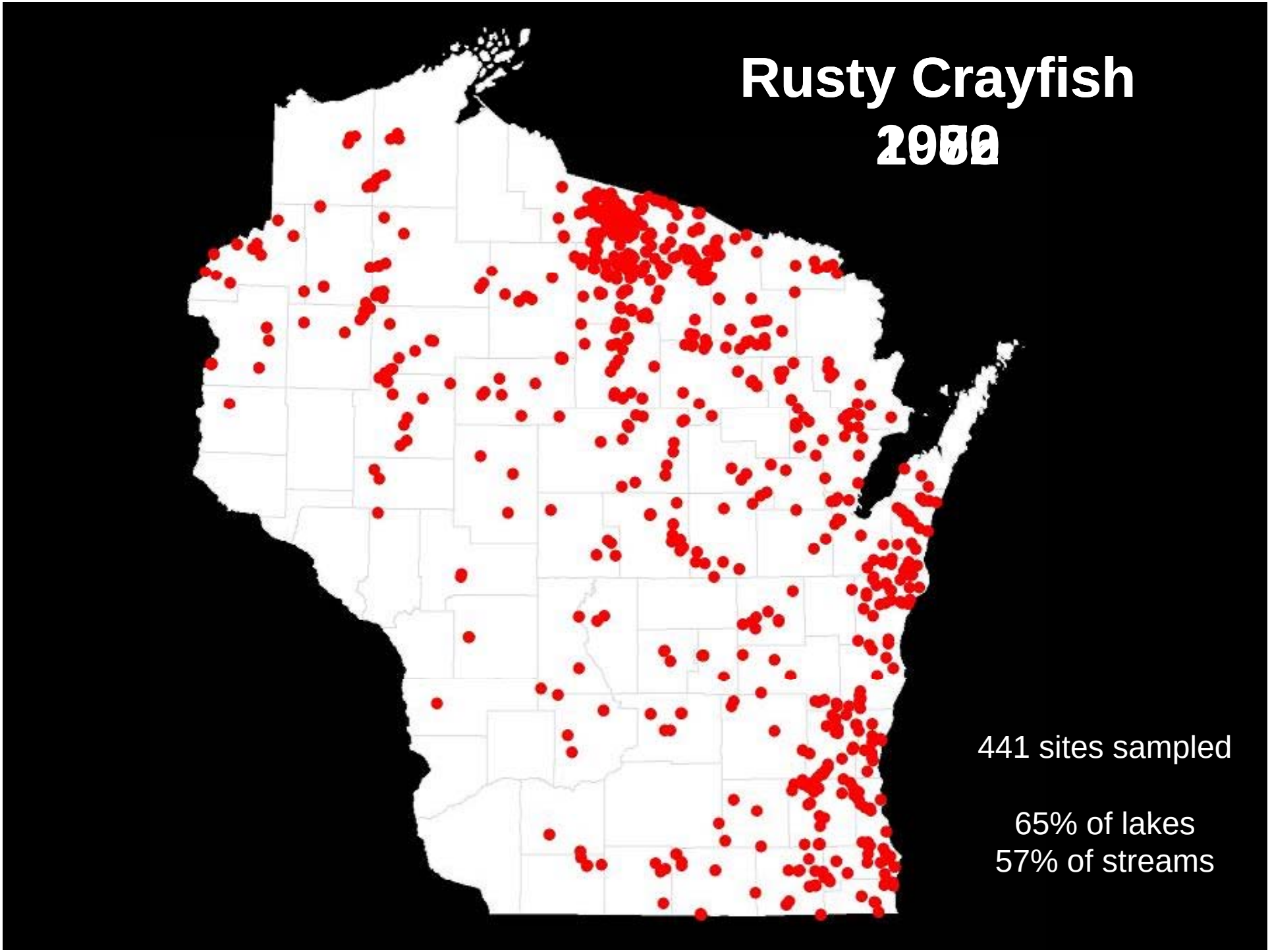
Kornis and Vander Zanden in review



5. Rusty crayfish



Thomas Simon


Rusty Crayfish
2000
441 sites sampled
65% of lakes
57% of streams

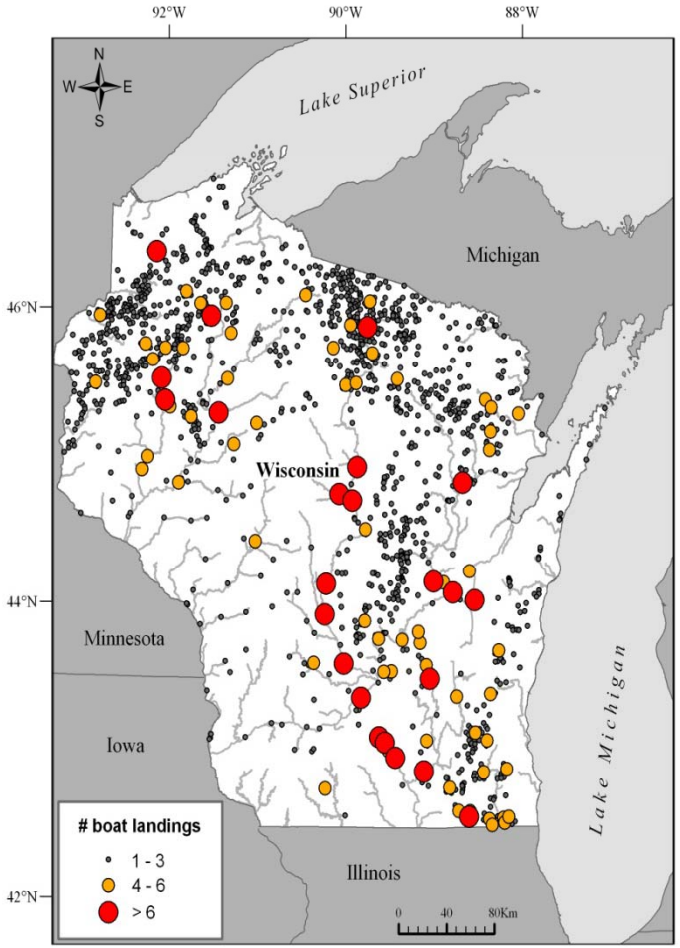
Rusty crayfish invasions

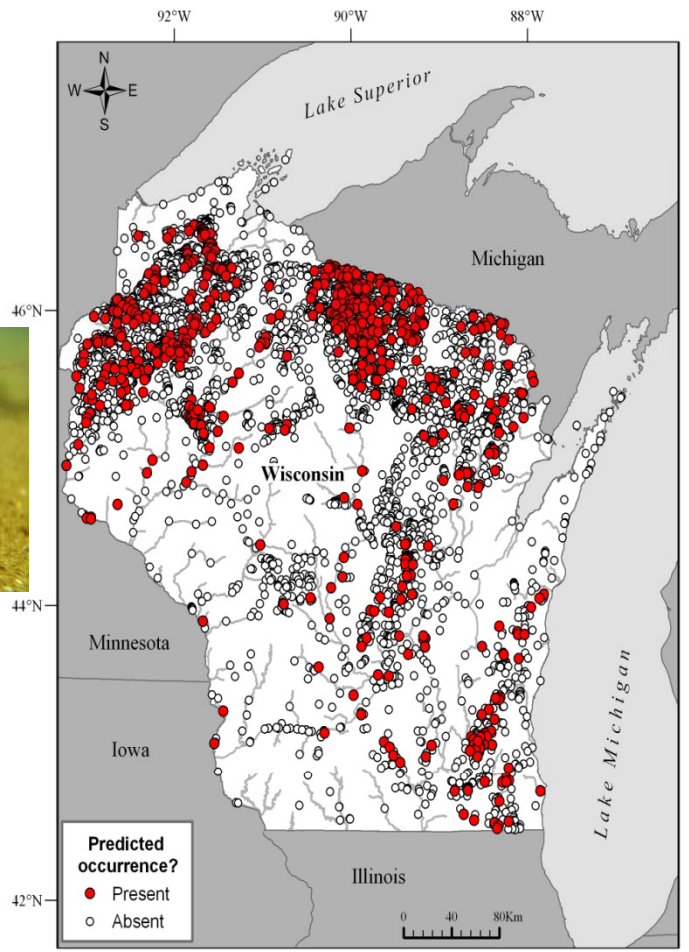
INTRODUCTION

- Bait bucket release is the primary transport vectors for crayfish

SUITABILITY

- Rusty crayfish tend to occupy small, productive lakes with modified shorelines



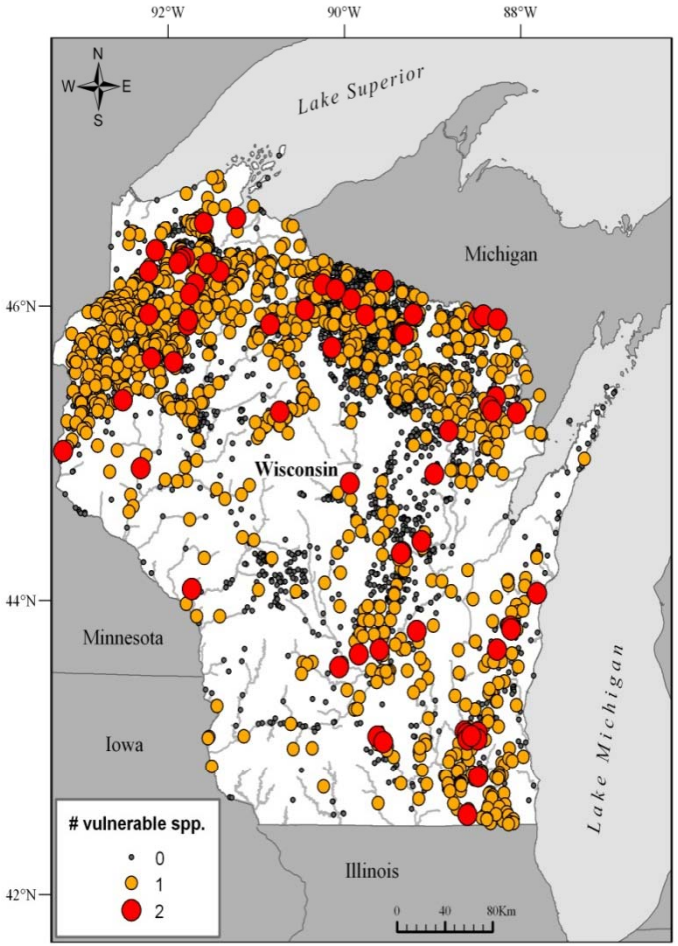


Olden et al. (2006, unpubl.)

Rusty crayfish invasions

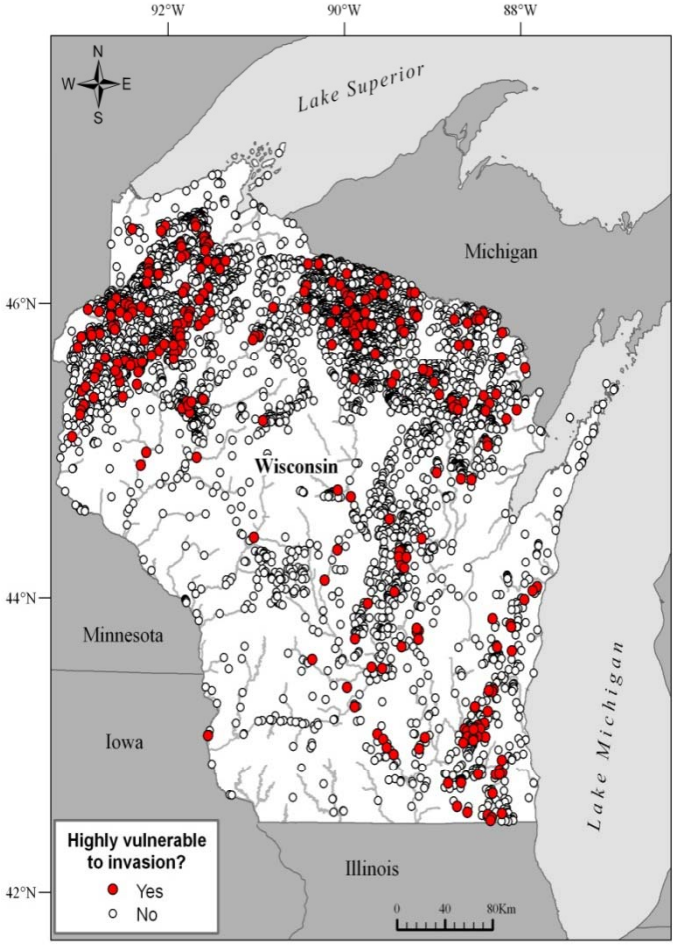
IMPACT

- Invasions by rusty crayfish is associated with the local extirpation of two native crayfishes



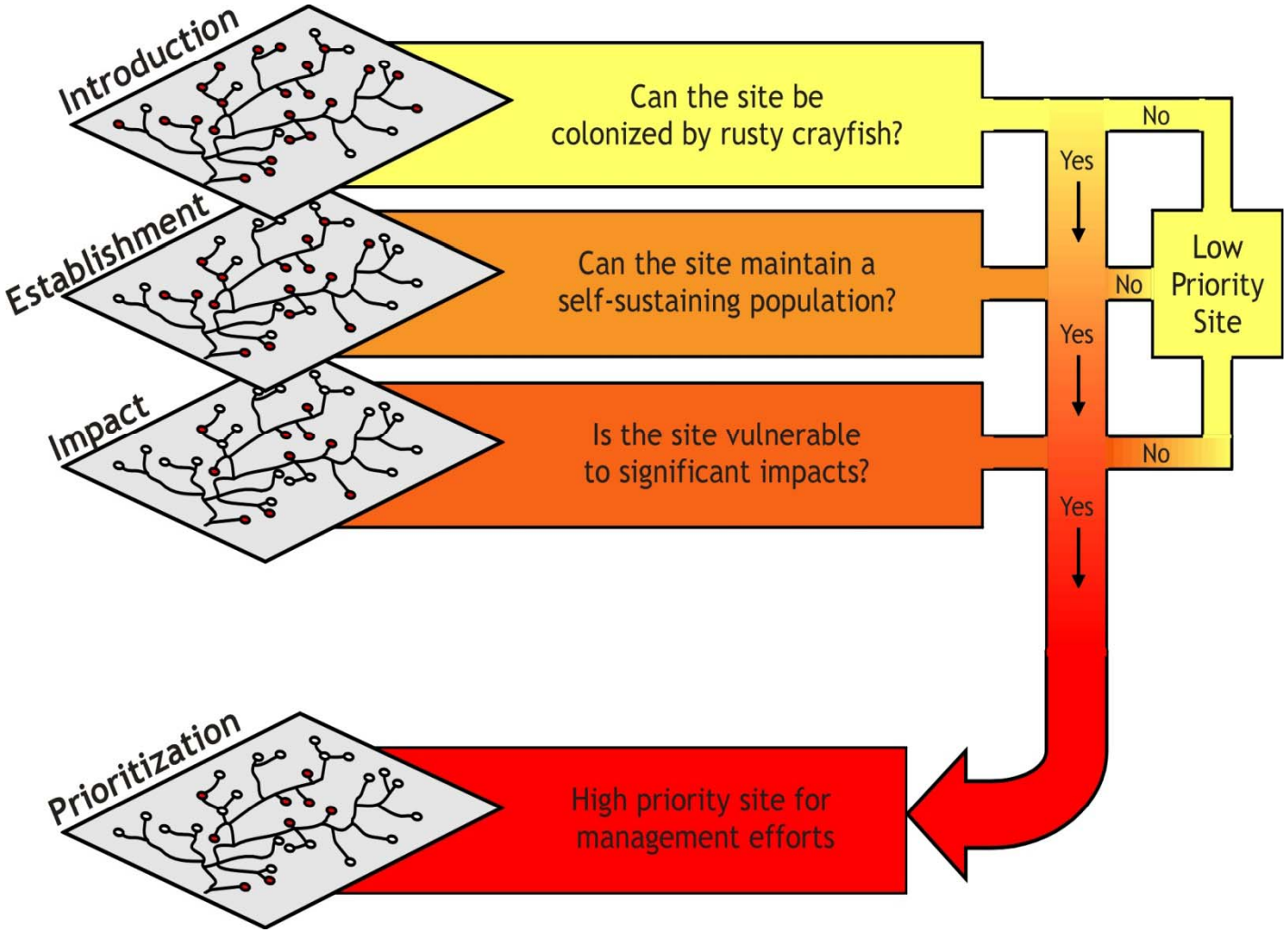
VULNERABILITY

- Lake-specific vulnerability to the introduction, establishment and impact of invasive rusty crayfish



Olden et al. (2006, unpubl.)

Example: Rusty crayfish invasions



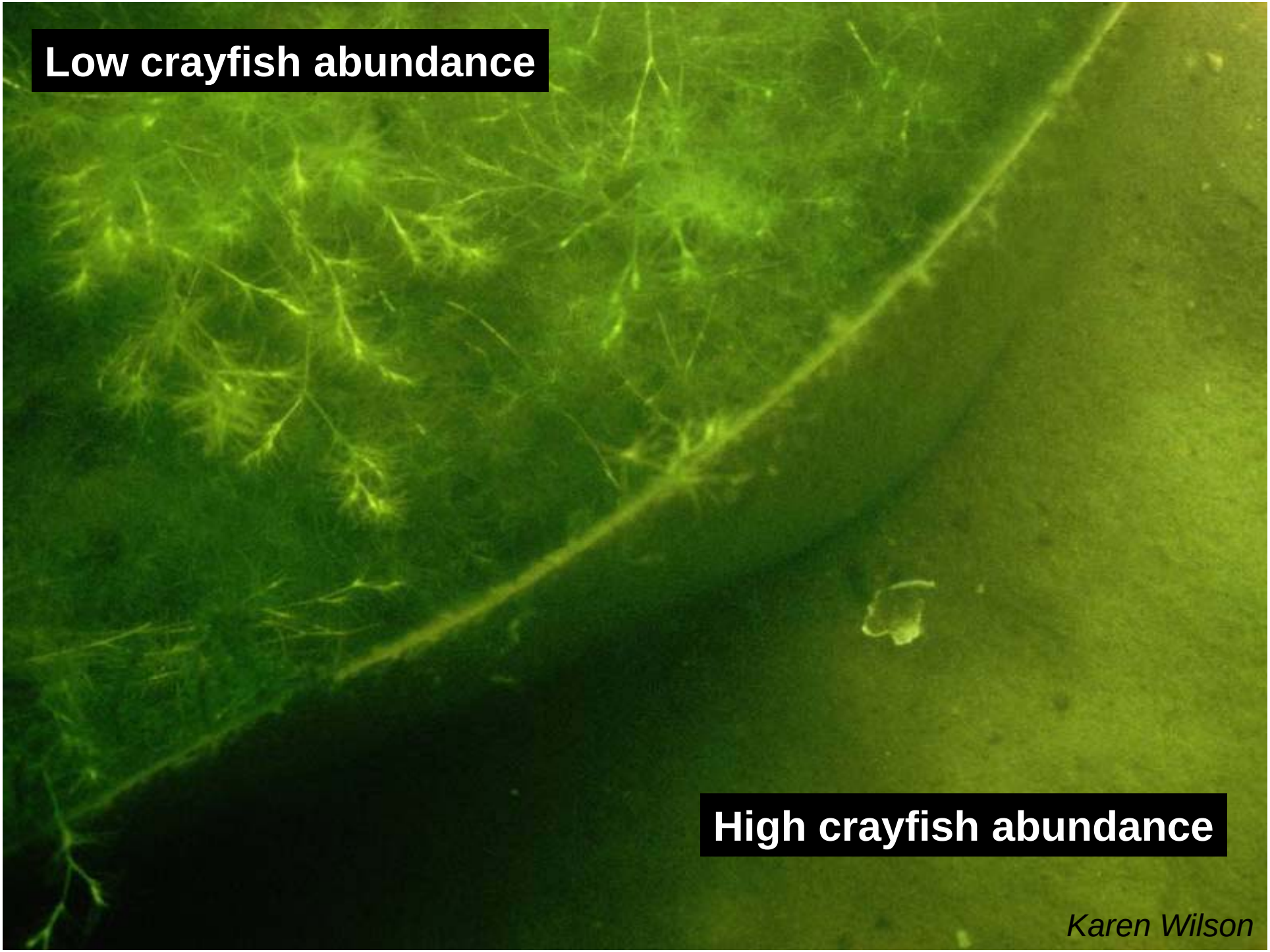
5,164 lakes

1,350 lakes with 1+ boat landings

553 lakes that are environmental-suitable

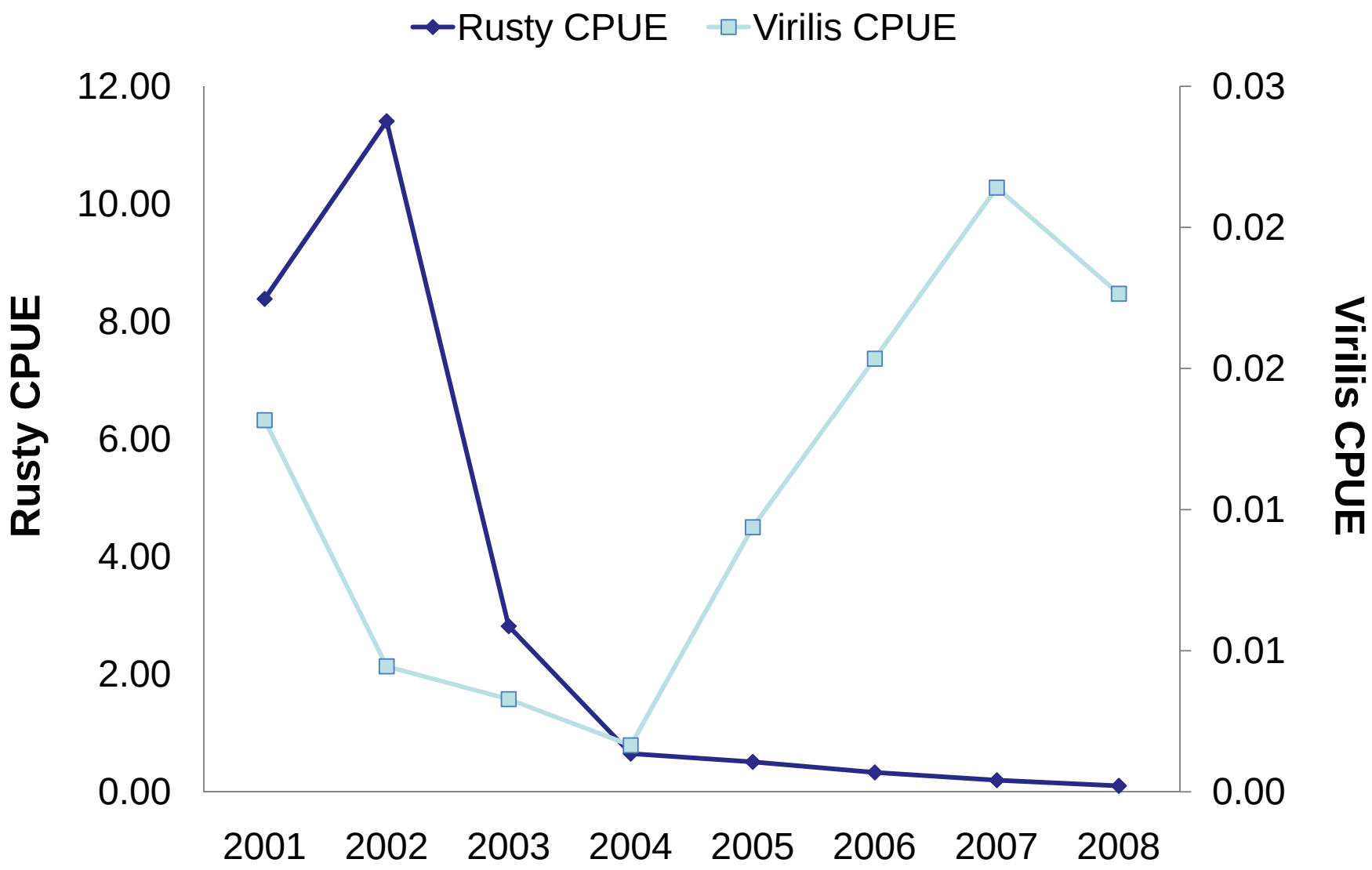
1,255 lakes with 1+ at-risk species

358 highly vulnerability lakes


Low crayfish abundance
High crayfish abundance
Karen Wilson

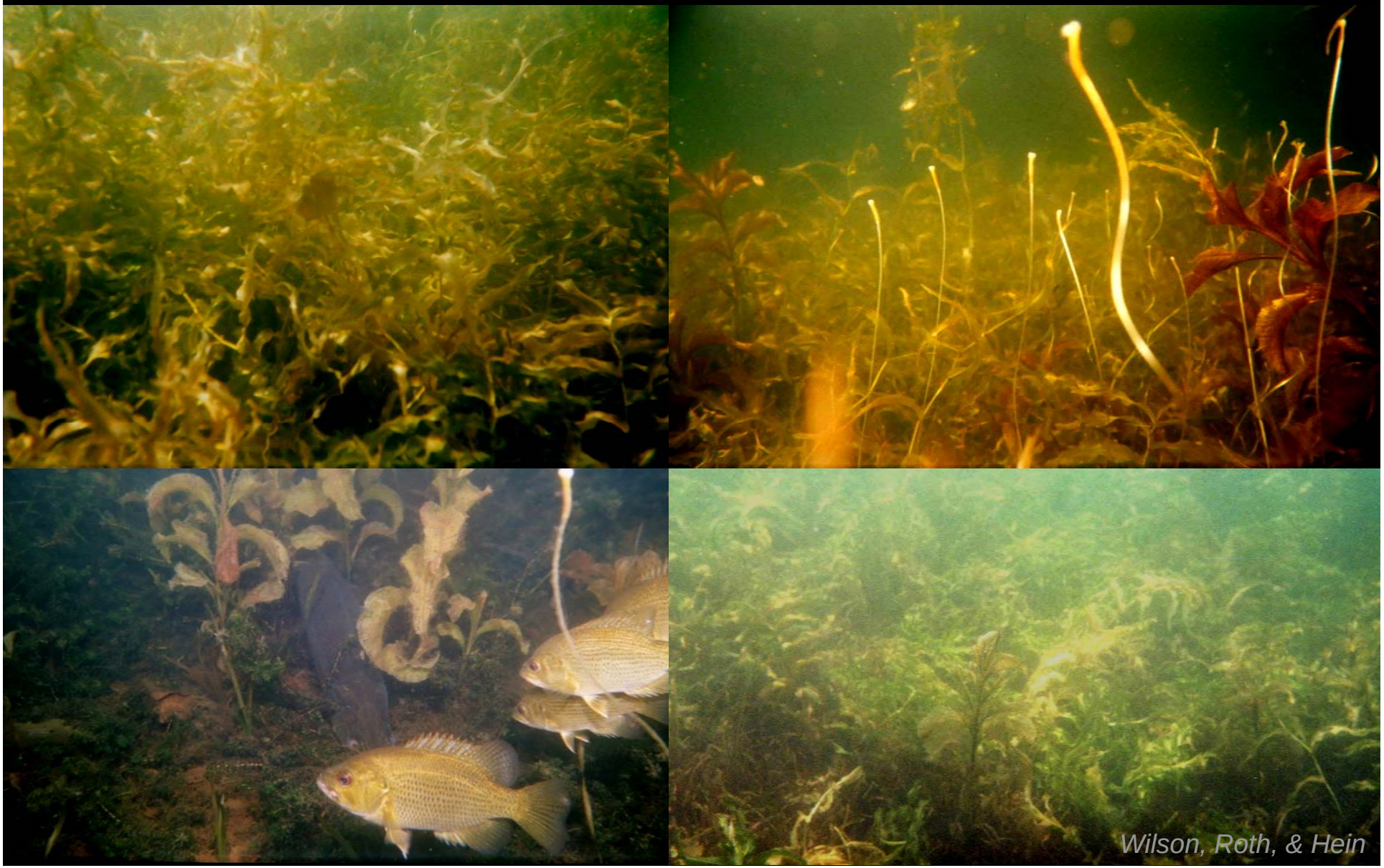
Eight years of rusty crayfish removal in Sparkling Lake

- 158 acre lake in Vilas Co.
- Changed fishing regulations to favor more and larger smallmouth bass
- Intensive trapping for last eight years
  - 76,656 trapping days
  - 91,930 rusty crayfish removed


Rusty CPUE
Virilis CPUE
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.03
0.02
0.02
0.01
0.01
0.00
Rusty CPUE
Virilis CPUE
2001
2002
2003
2004
2005
2006
2007
2008

From This…

To This…



Lessons from Sparkling Lake experiment

- Trapping and fish predation caused a population collapse of rusty crayfish
- Aquatic plants, fish, invertebrates recovered – 'flipped' lake back to a non-exotic dominated state.
- Is this non-exotic state 'stable'? What happens when we stop removal?

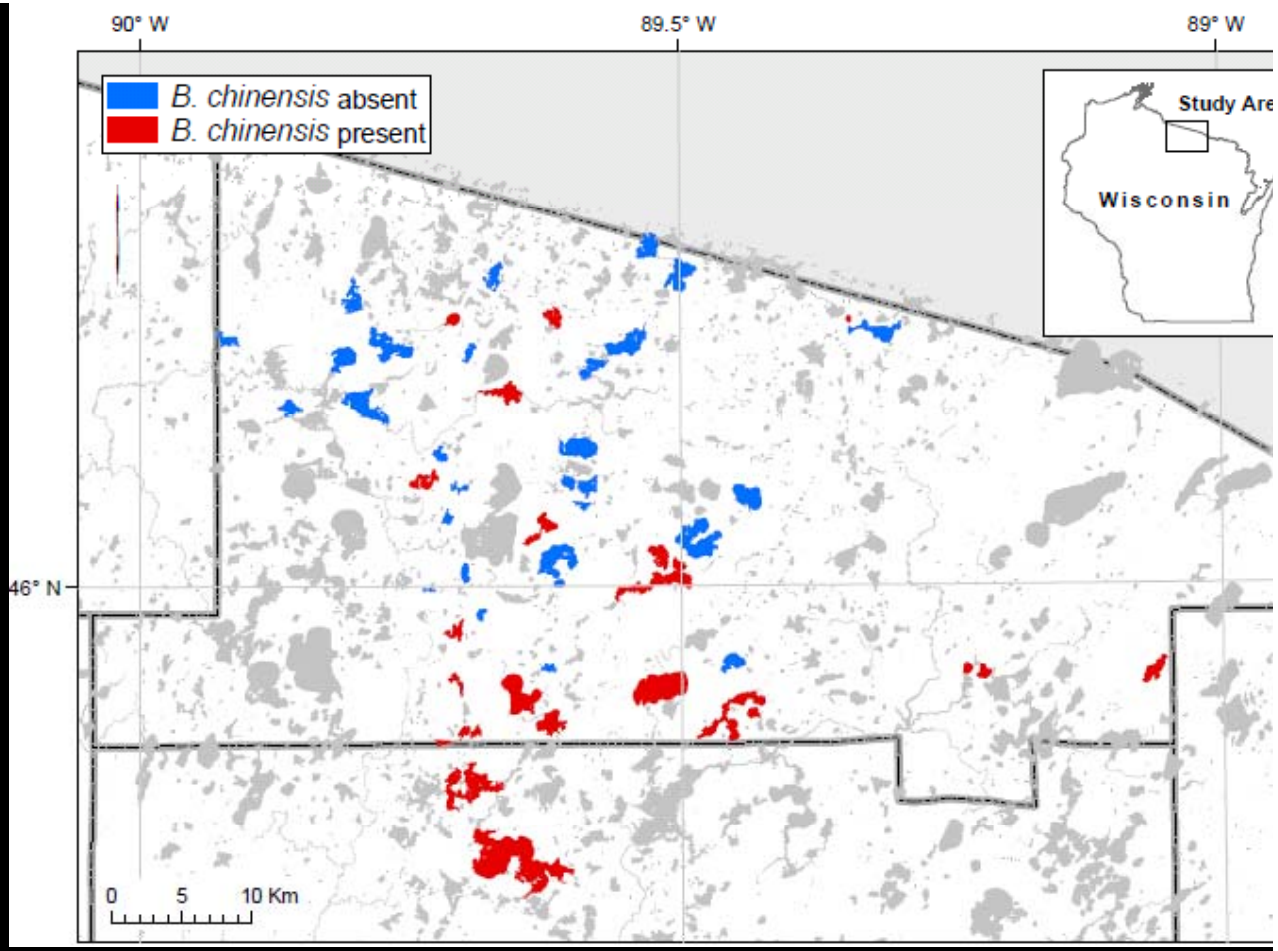
  – *See talk by Gretchen Hansen (TH 3:25 PM)*

6. Chinese Mystery Snail


Carpenter Lake, Wisconsin, 2006

-Survey of ~ 45 Vilas and Oneida County lakes

-Present in ~50% of lakes



Association with:

-nutrient-rich lakes

-lakes close to a population center

-lakes with high shoreline housing density

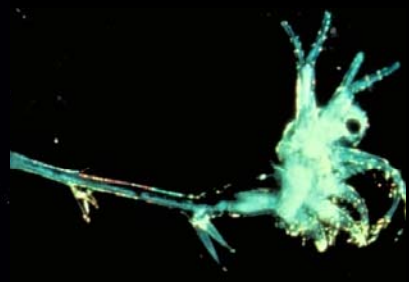
Chinese Mystery Snail

-Remarkably widespread in northern WI
-Vectors poorly understood
-Ecological impacts subtle and unclear
-More research is needed to determine whether CMS are of management concern

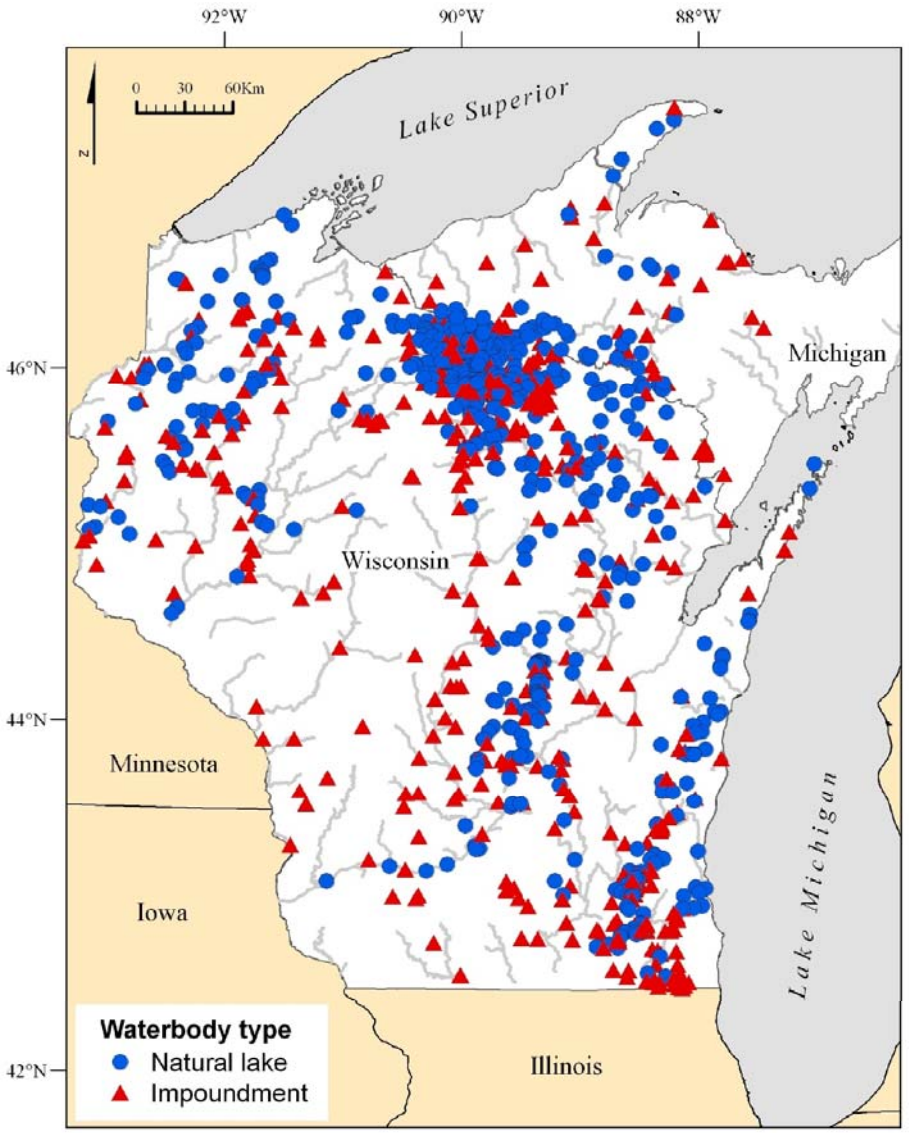
See poster by Chris Solomon Thurs PM

Bringing it together

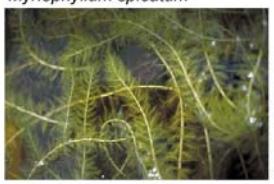
- Impacts unfold within broader ecological and food web context – highly site dependent
- Interactions among invaders
- Interactions with other forms of environmental change



Dam invaders: Are impoundments more vulnerable to invasion?



Eurasian watermilfoil
Myriophyllum spicatum



zebra mussel
Dreissena polymorpha

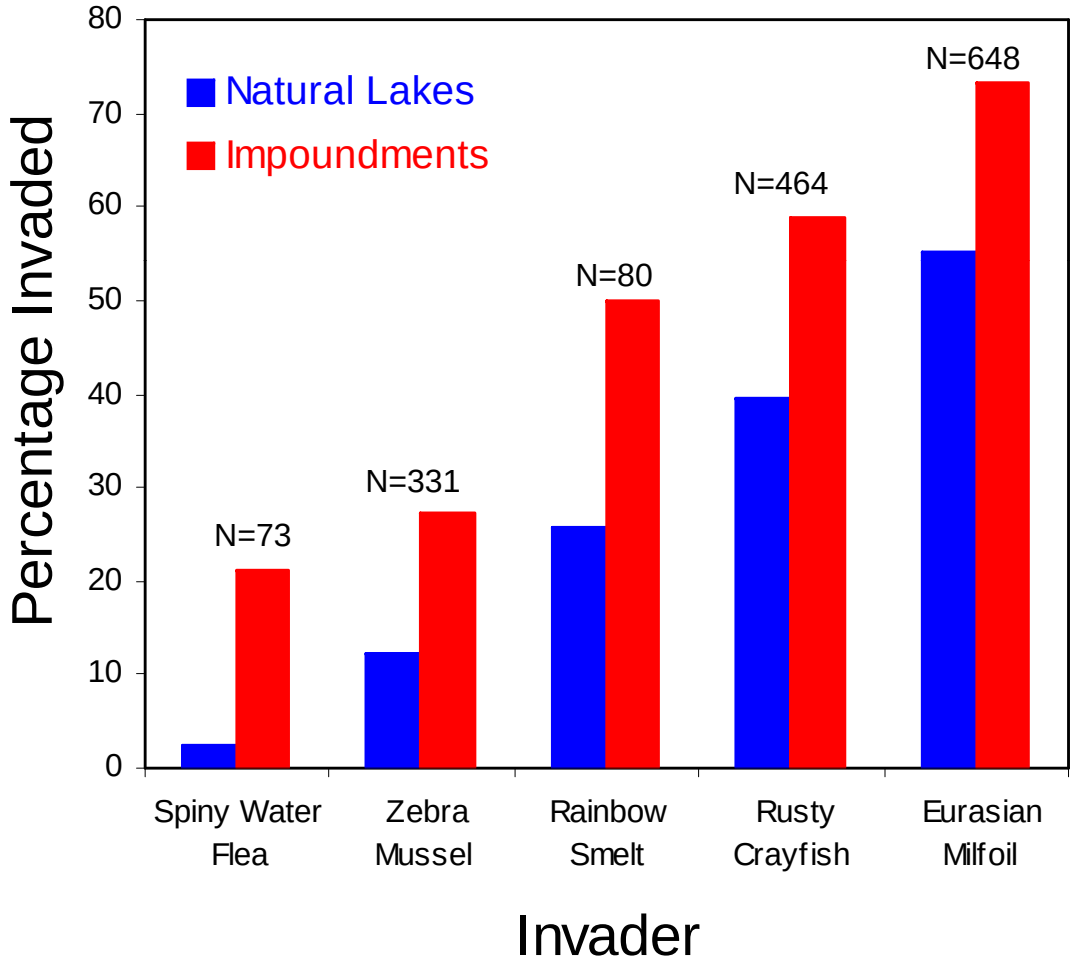
spiny water flea
Bythotrephes longimanus

rainbow smelt
Osmerus mordax

rusty crayfish
Orconectes rusticus

Johnson, P.T, J.D. Olden & M.J. Vander Zanden 2008. Front. Ecol. Environ.

Impoundments are over-invaded



Johnson, P.T, J.D. Olden & M.J. Vander Zanden 2008. Front. Ecol. Environ.

What to take away from all of this?

- Each of these ‘big six’ are a unique challenge for Wisconsin’s lakes
- Highlights the need to view each lake as part of a broader and highly inter-connected landscape
- Research in WI documenting spread and impact, forecasts of future spread
- This sort of understanding is the foundation for a ‘smart prevention’ approach for targeting management and prevention programs

Big questions remain

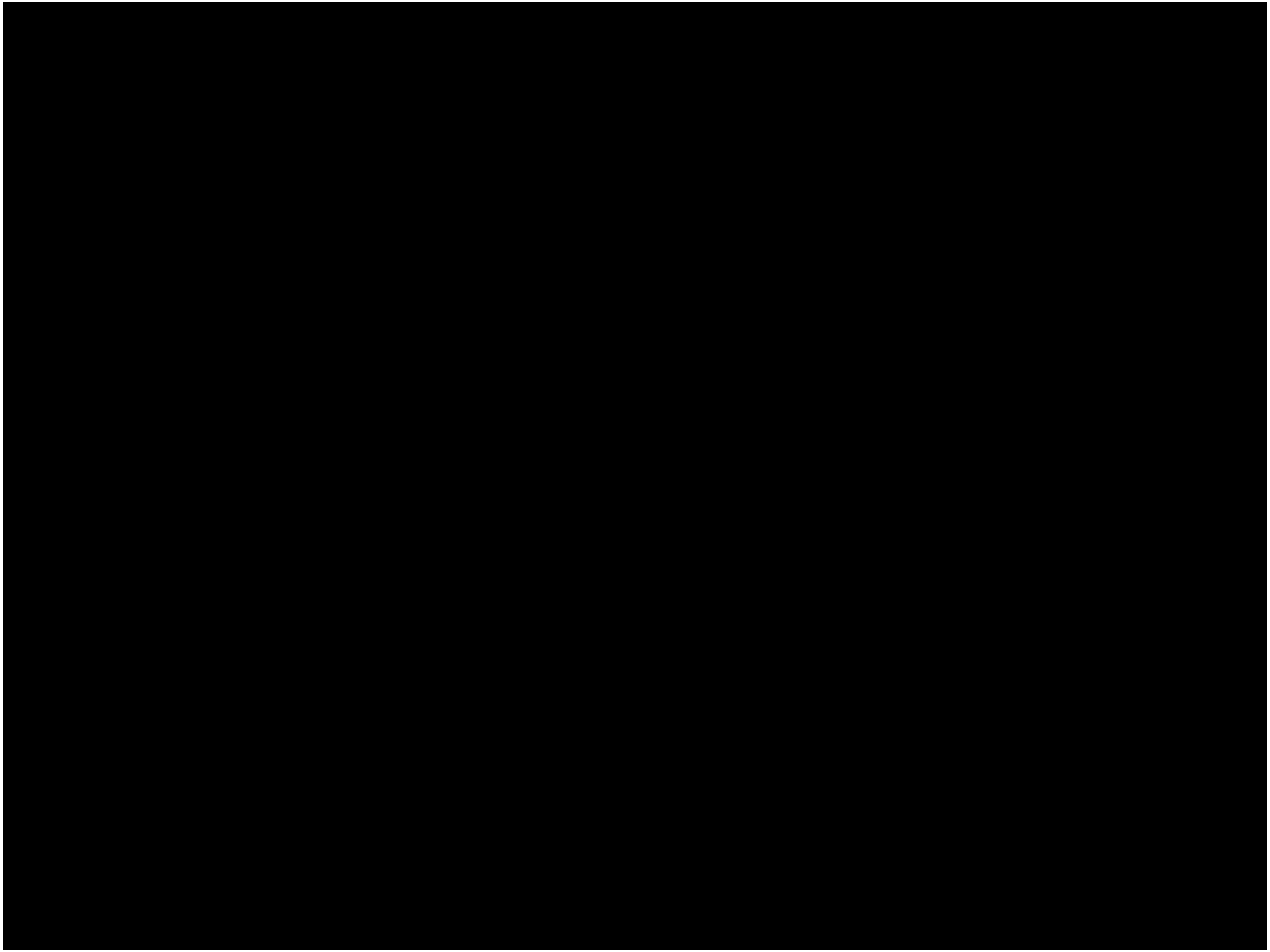
How do we best translate knowledge about vulnerability to on-the-ground action?

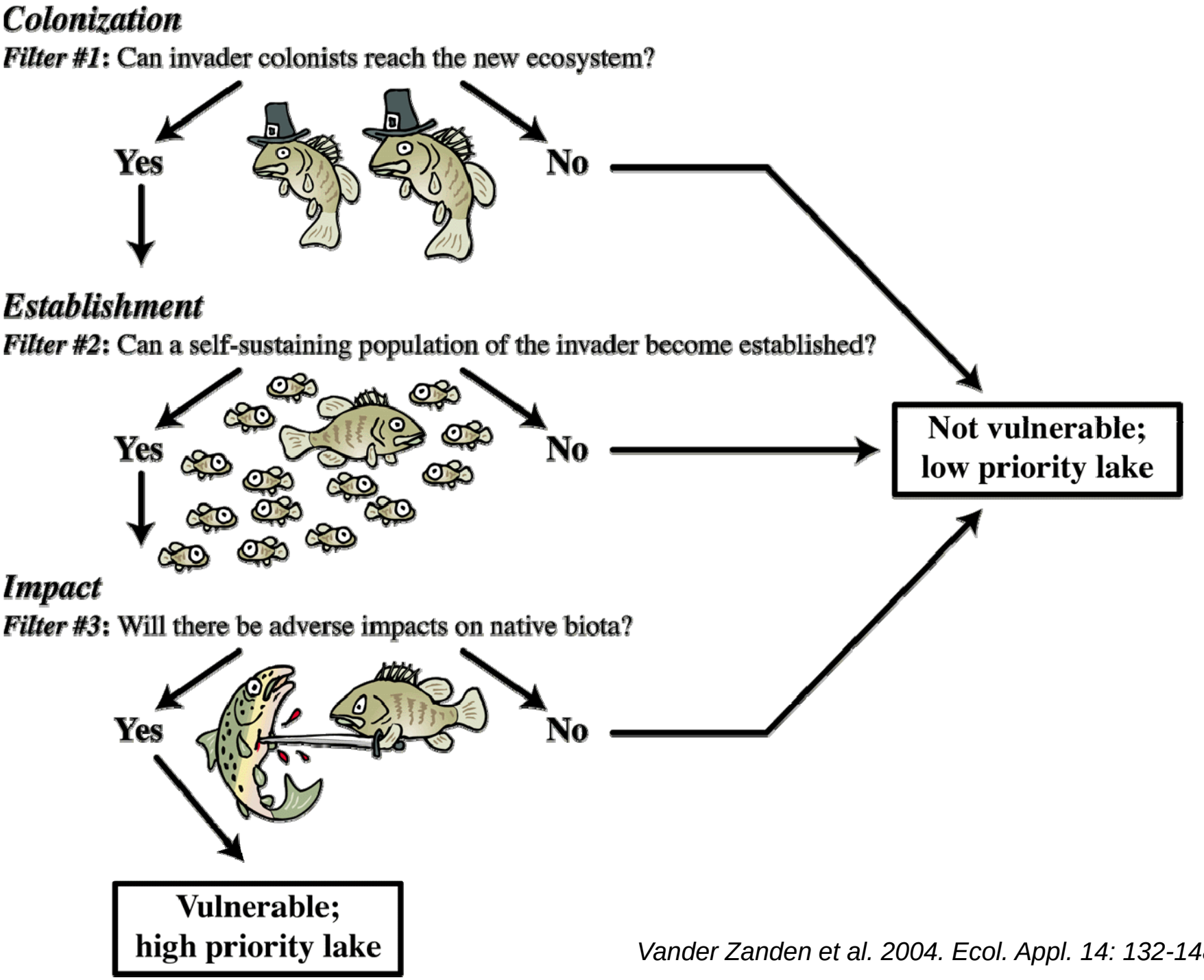
How do we allocate effort between containment and protection?

How do we allocate effort among different invasive species?

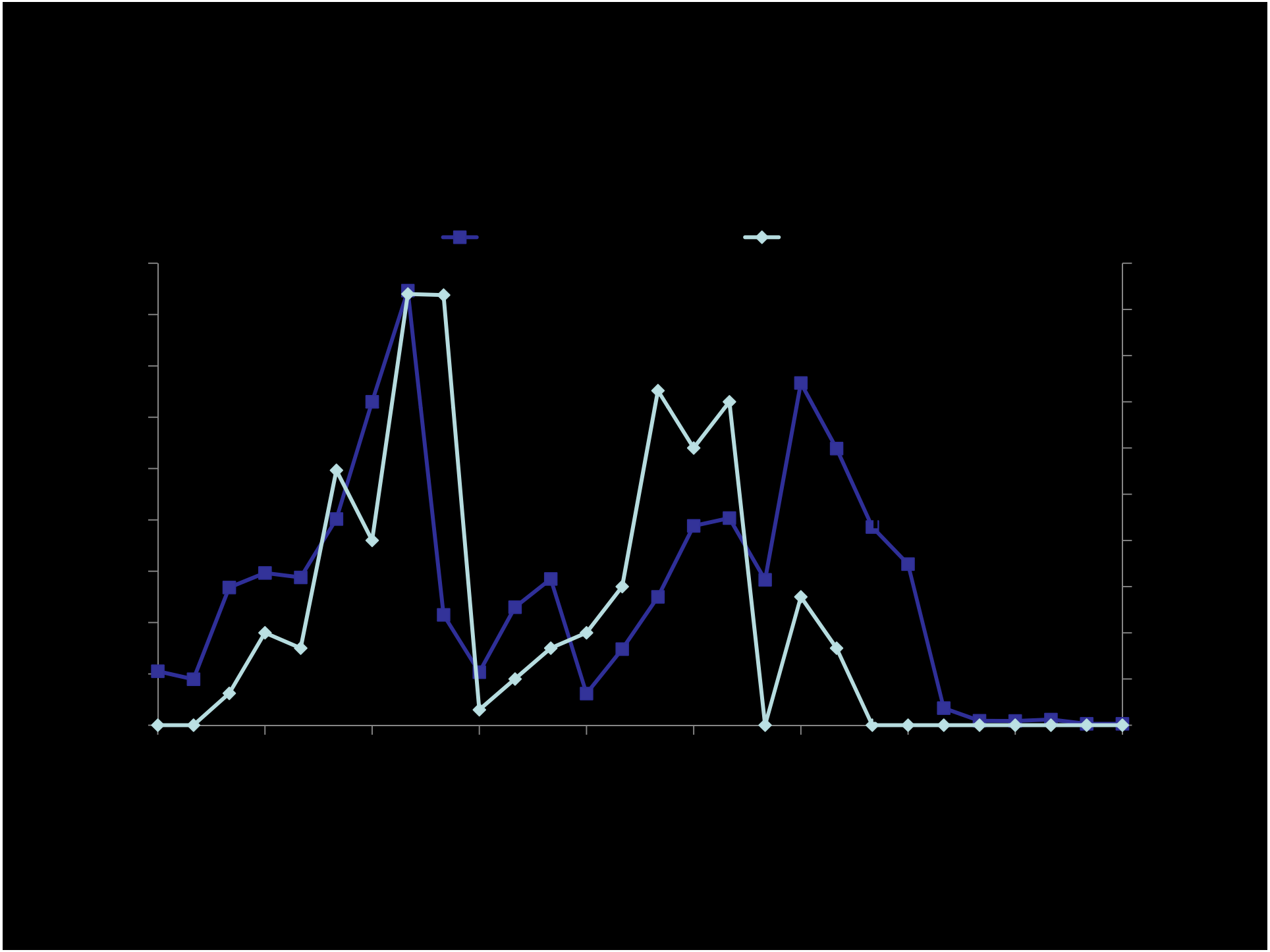
Thank you!!!

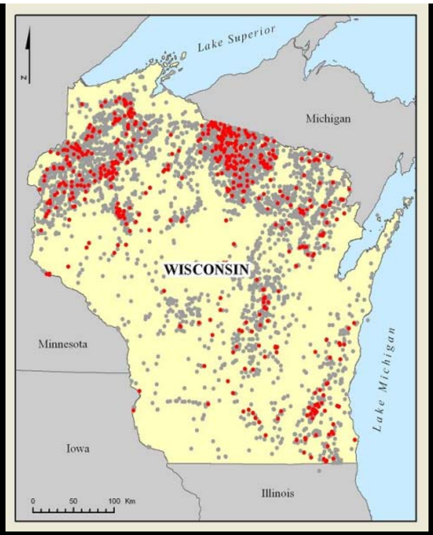
More information at:
http://limnology.wisc.edu/personnel/jakevz/

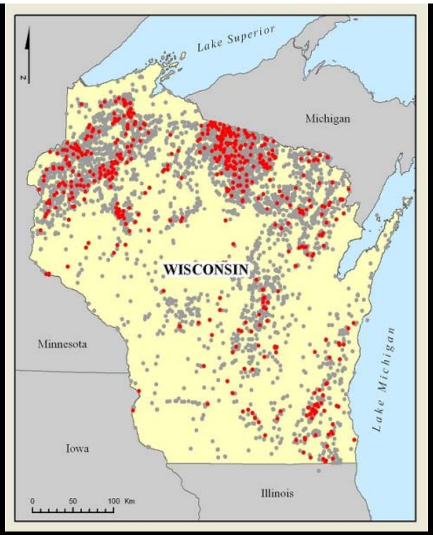


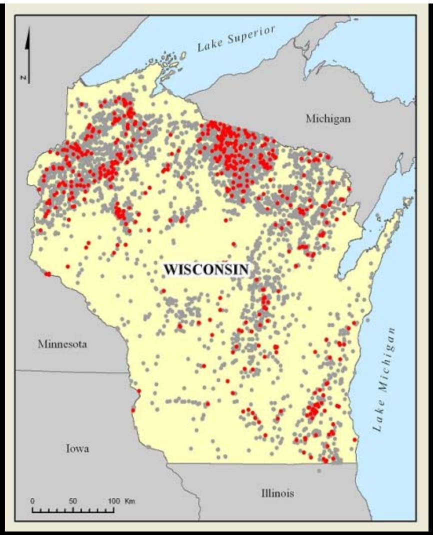


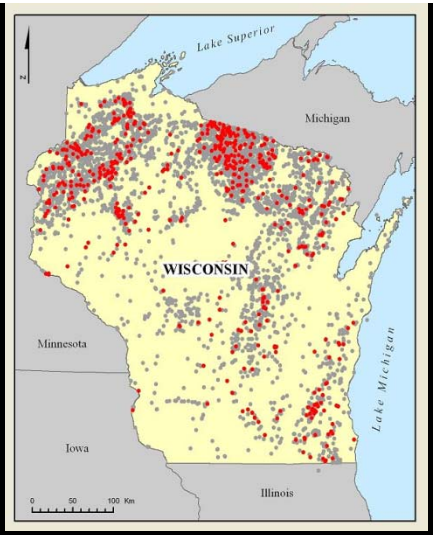
Vander Zanden et al. 2004. Ecol. Appl. 14: 132-148

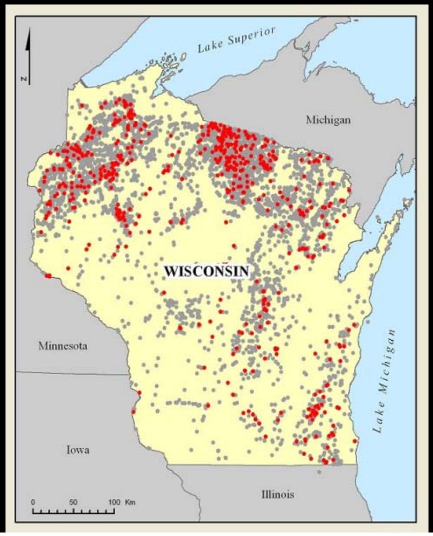



Lake Superior
Michigan
WISCONSIN
Minnesota
Iowa
Illinois
Lake Michigan
0 50 100 Km

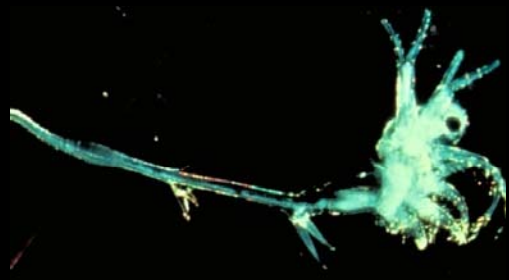

Lake Superior
Michigan
WISCONSIN
Minnesota
Iowa
Illinois
Lake Michigan
0 50 100 Km

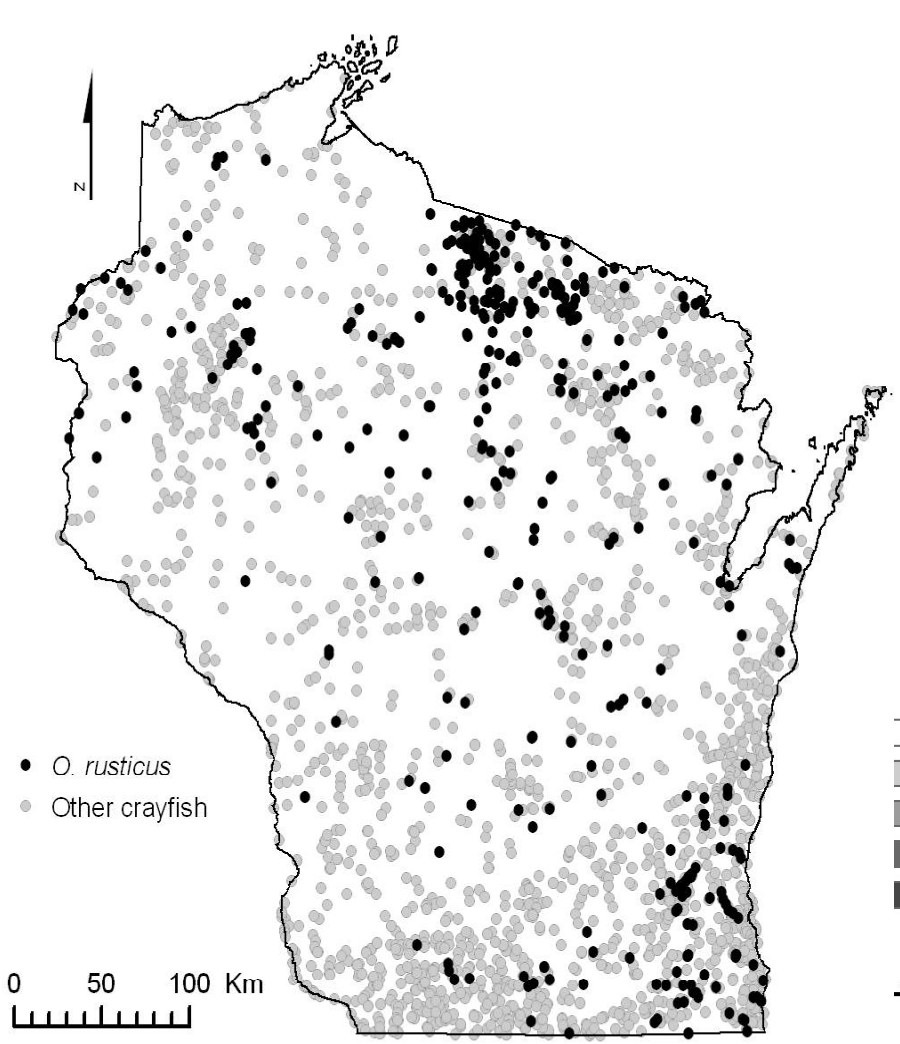

Lake Superior
Michigan
WISCONSIN
Minnesota
Iowa
Illinois
Lake Michigan
0 50 100 Km

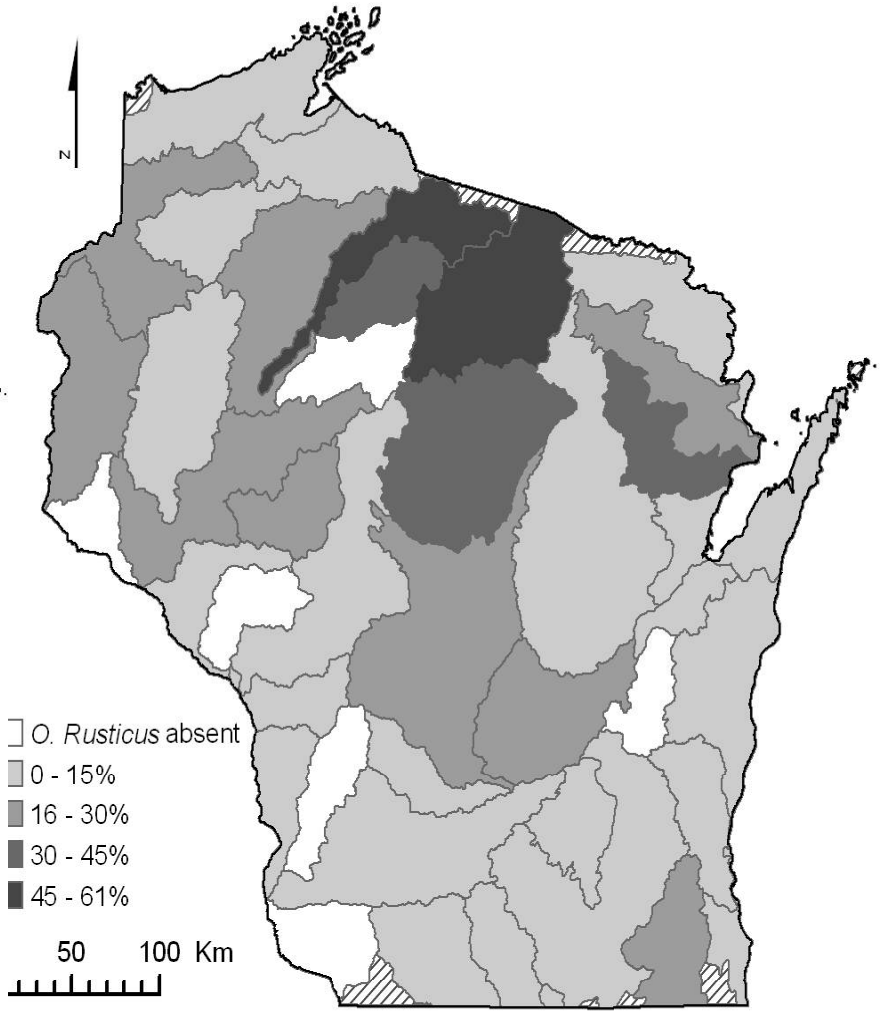

Lake Superior
Michigan
WISCONSIN
Minnesota
Iowa
Illinois
Lake Michigan
0 50 100 Km


Lake Superior
Michigan
WISCONSIN
Minnesota
Iowa
Illinois
Lake Michigan
0 50 100 Km

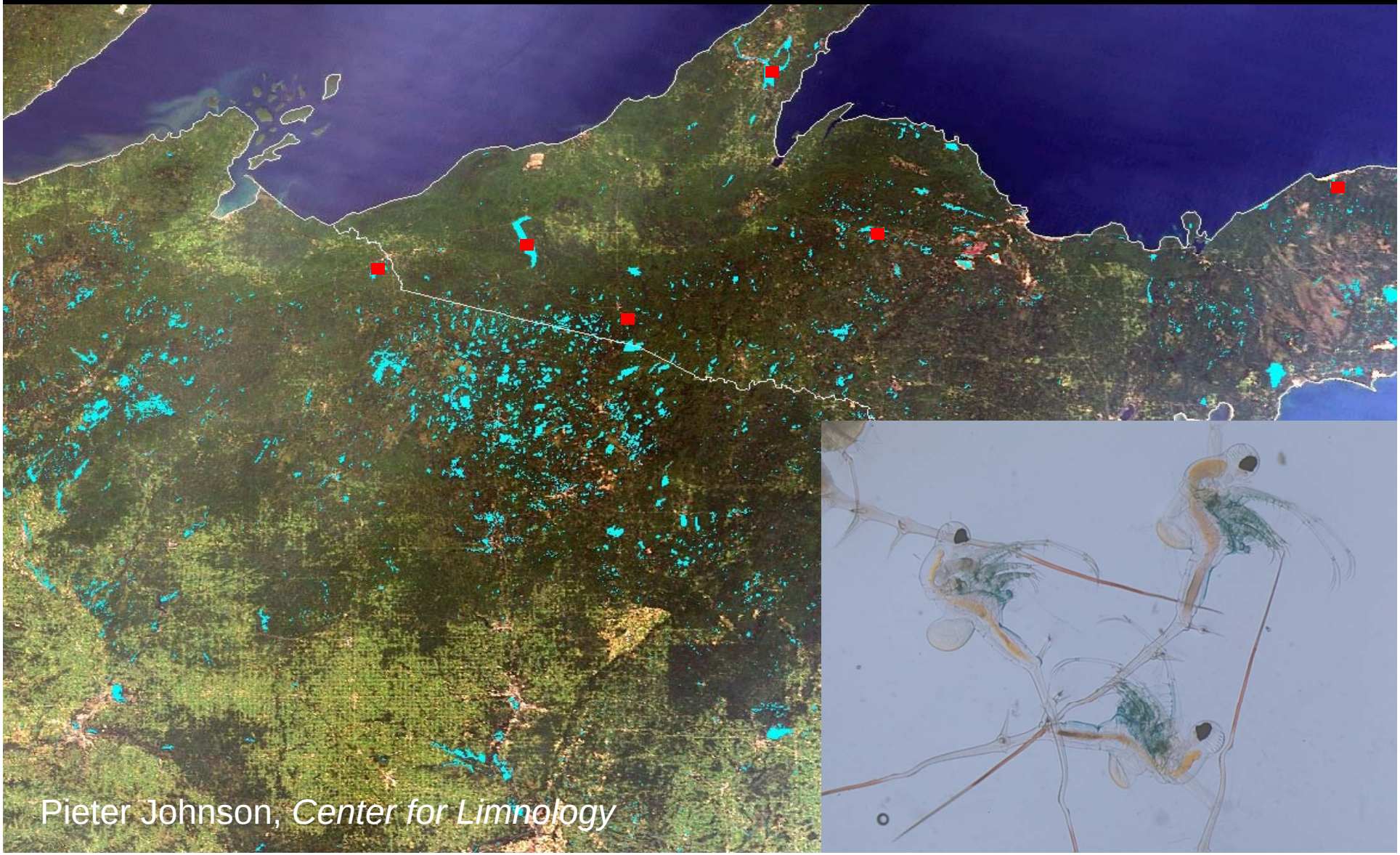

©Shedd Aquarium



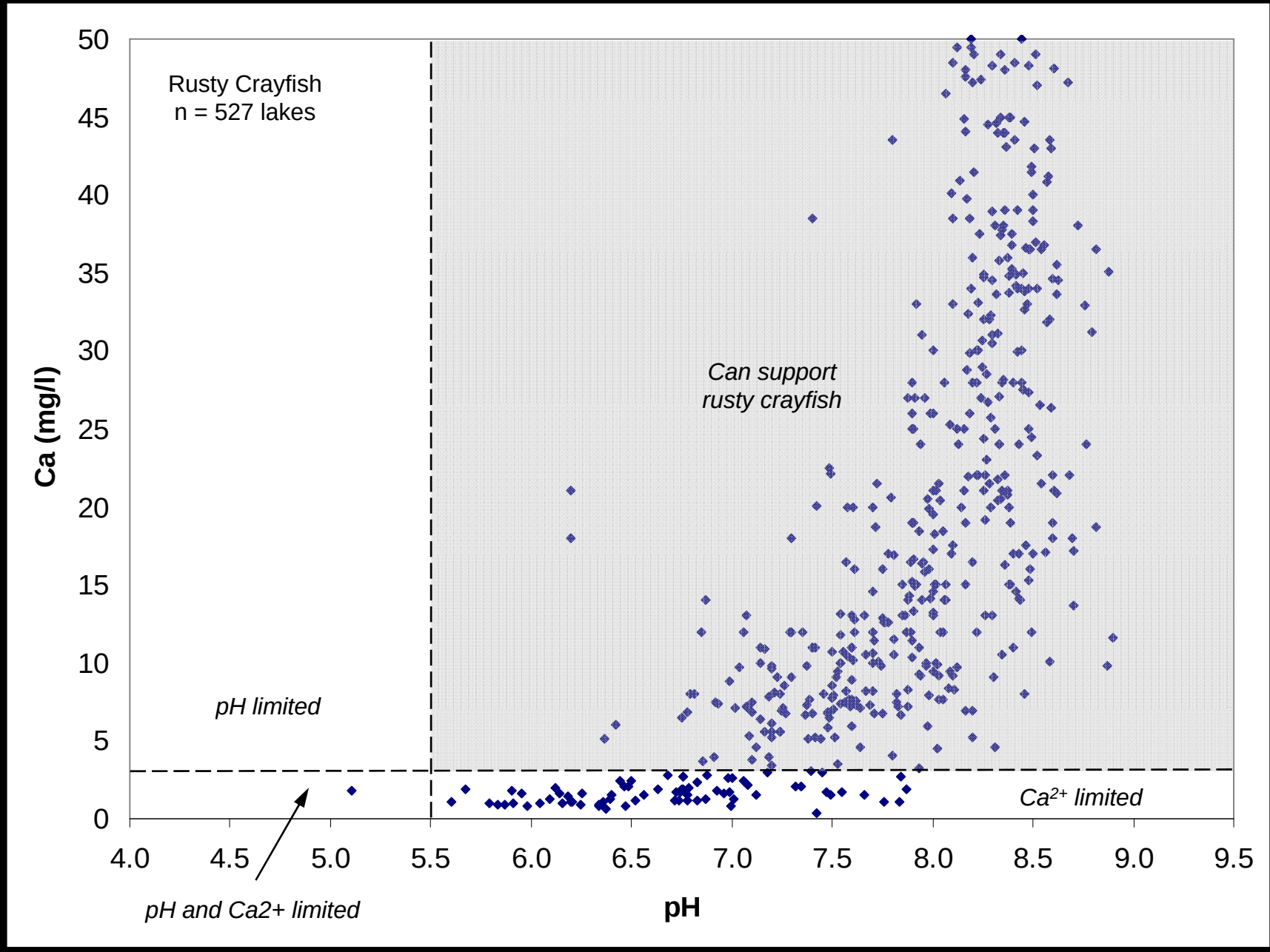

N
O. rusticus
Other crayfish
0 50 100 Km

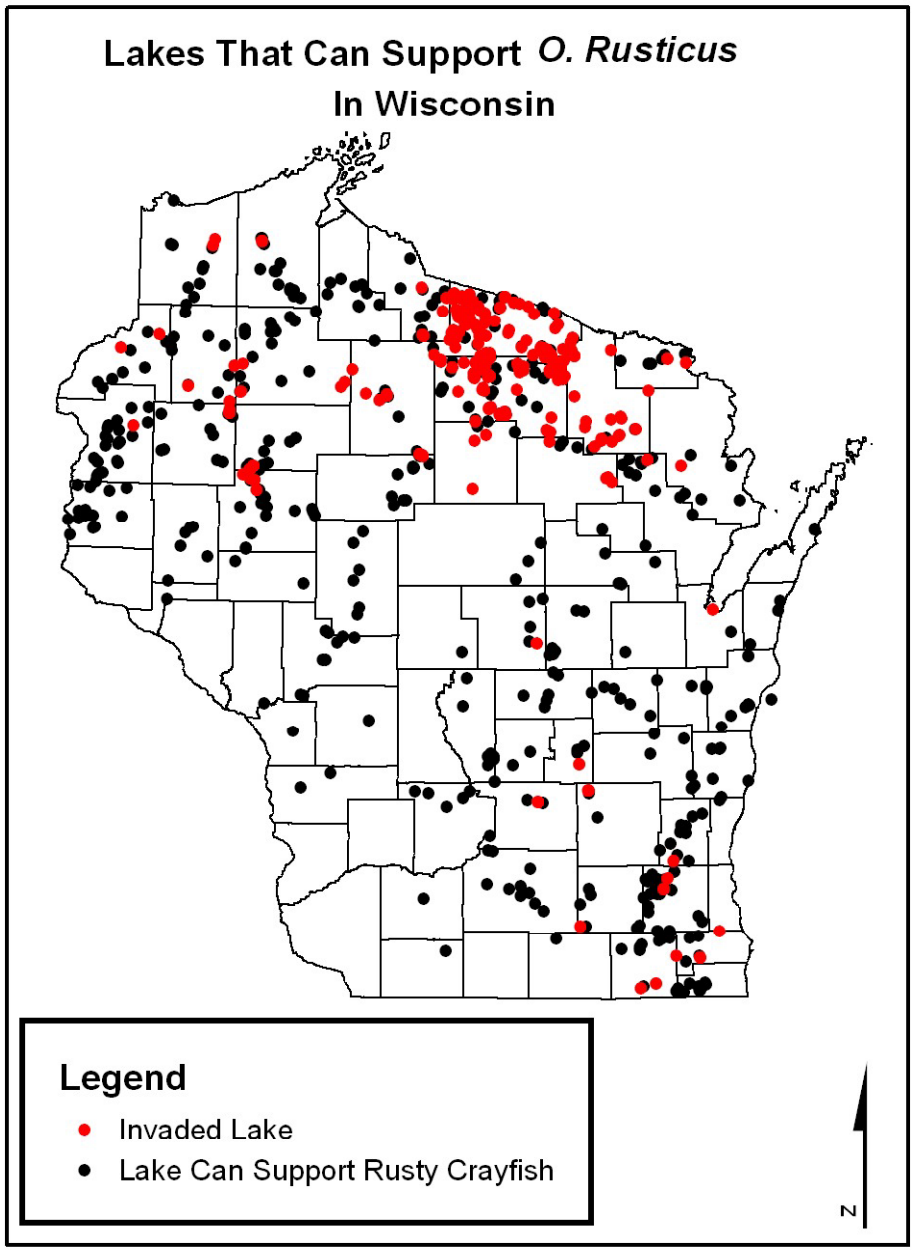

N
O. Rusticus absent
0 - 15%
16 - 30%
30 - 45%
45 - 61%
50 100 Km

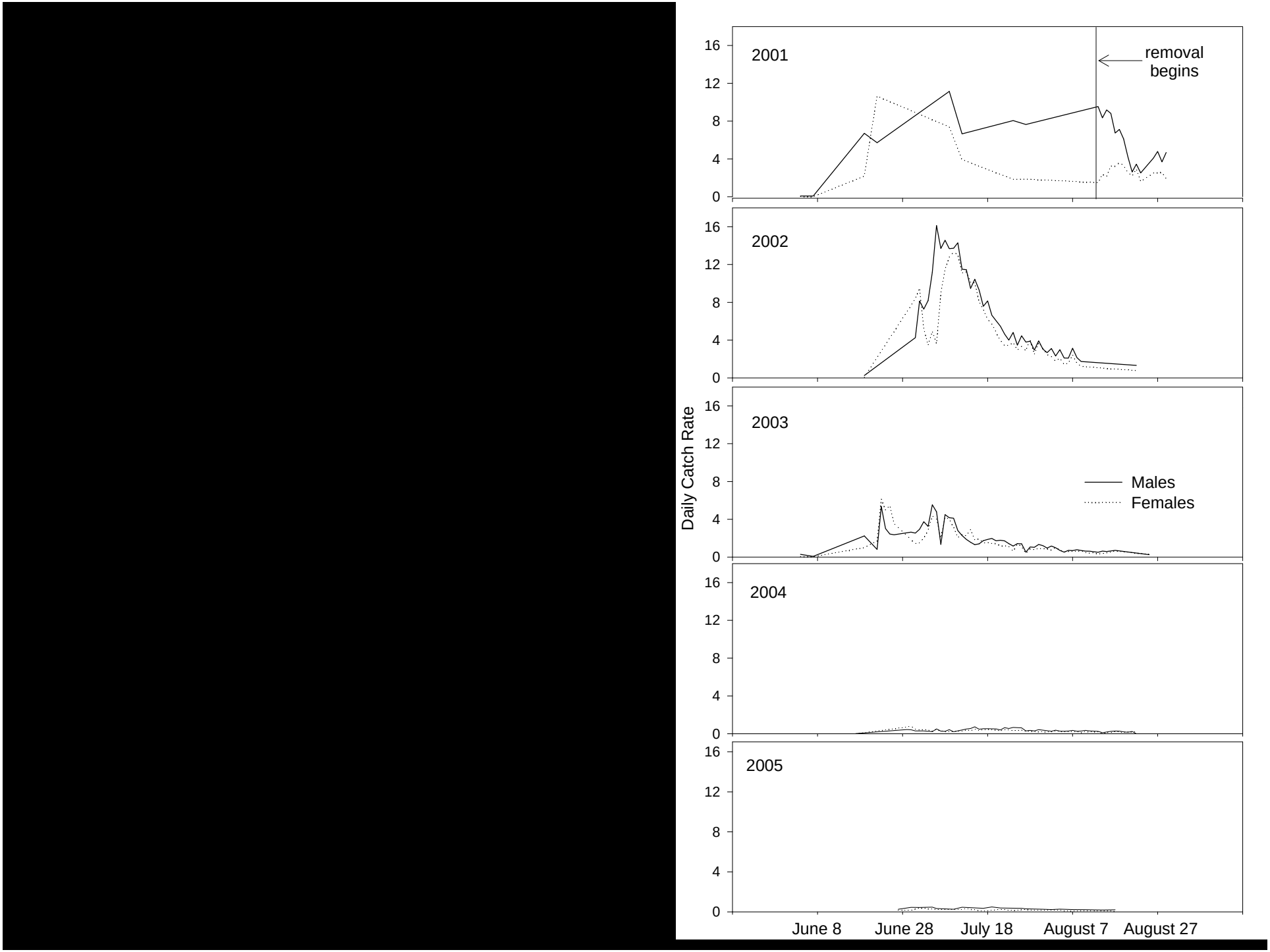
Spiny water flea



Pieter Johnson, *Center for Limnology*


Rusty Crayfish
n = 527 lakes
Can support
rusty crayfish
pH limited
Ca2+ limited
pH and Ca2+ limited
Ca (mg/l)
pH
50
45
40
35
30
25
20
15
10
5
0
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5


Lakes That Can Support O. Rusticus
In Wisconsin
Legend
Invaded Lake
Lake Can Support Rusty Crayfish
N


2001
removal
begins
2002
2003
Males
Females
2004
2005
Daily Catch Rate
0
4
8
12
16
June 8
June 28
July 18
August 7
August 27

Confirmed Round Goby Sightings

(Apollonia melanostomus)

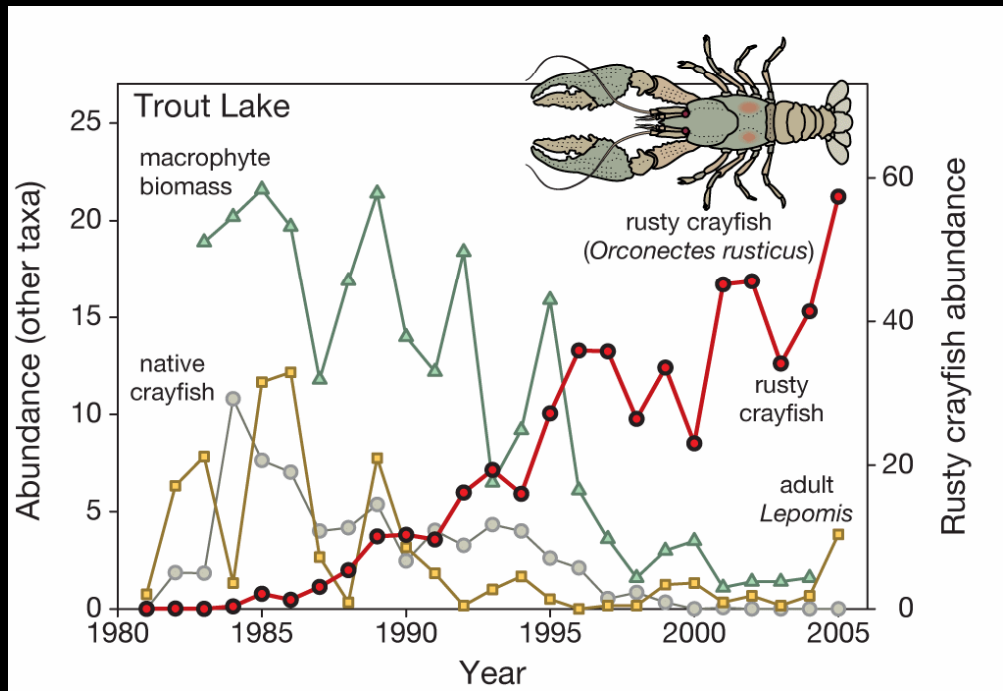
About Round Gobies

- Native to Caspian and Black seas
- First U.S. appearance, St. Clair R., 1990
- Adapted to marine and fresh water
- Fused pelvic fins, spot on dorsal fin
- Aggressive behavior
- Populations expanding rapidly

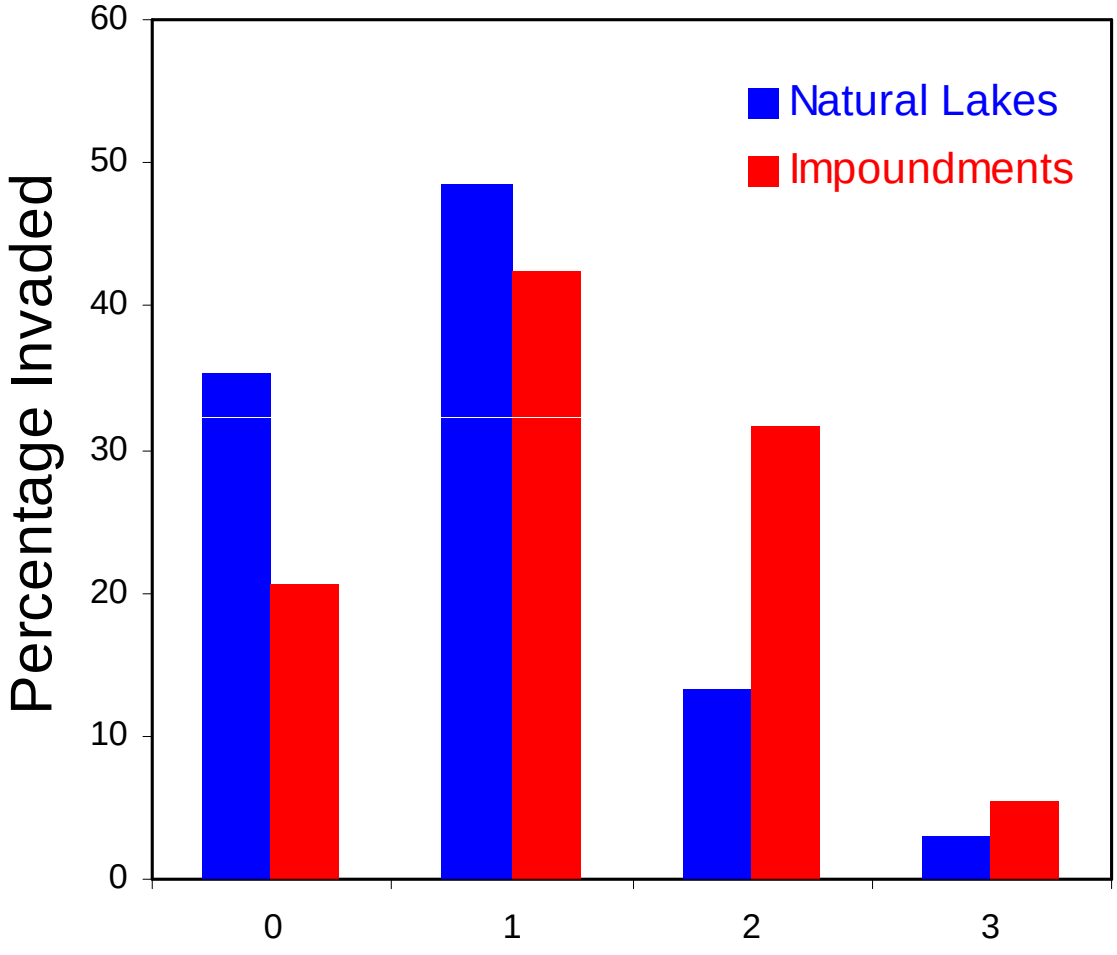
Long-term study of rusty crayfish in Trout Lake, Vilas County

Massive declines in:

- Aquatic plants
- Bluegill and pumpkinseed
- Snails
- Aquatic insects
- Native crayfish



Wilson et al. 2004 Can. J. Fish. Aquat. Sci.


Percentage Invaded
60
50
40
30
20
10
0
Natural Lakes
Impoundments
0
1
2
3
Number of Invaders

Personal actions

Inspect boat and remove plants

Drain water

Dispose of bait in trash

Zebra mussel

- Fouls water intakes and equipment
- Filters phytoplankton, causes overgrowth of bottom algae
- Increased blue-green algae blooms
- Avian botulism