

Recreational Boating: AIS Impacts & Prevention Strategies

Lindsay Chadderton, John Rothlisberger, Chris Jerde, Mark Drew, Mark Fedora, Rueben Keller, David Lodge



Acknowledgements

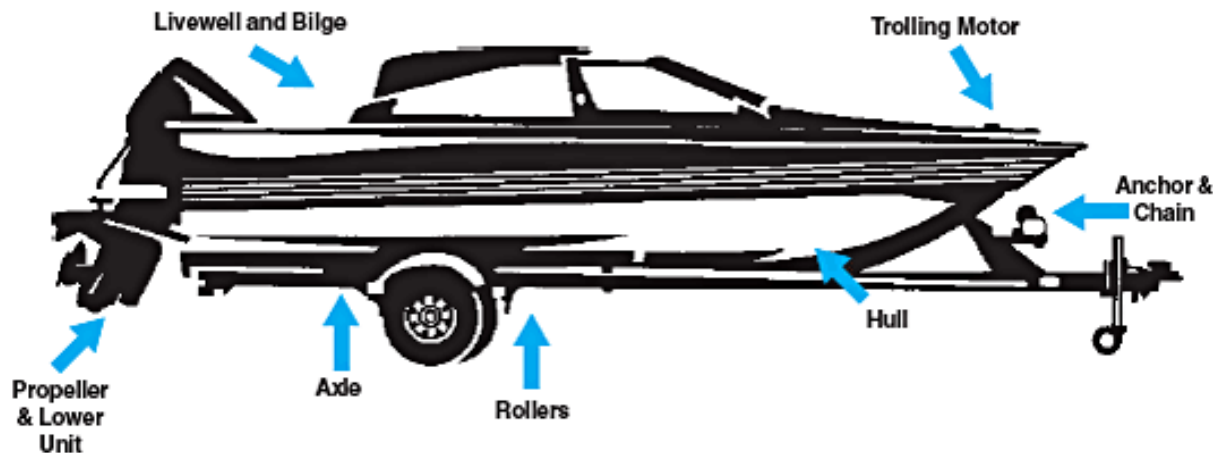
- Great Lakes Protection Fund
- John Rothlisberger, Chris Jerde, Mark Drew, Rueben Keller, David Lodge: University of Notre Dame
- Nick Schmal & Mark Fedora, US Forest Service,
- Watersmeet Township: Upper Peninsula - Michigan
- Ted Ritter: Vilas County - Wisconsin

The Nature Conservancy 
Protecting nature. Preserving life.™



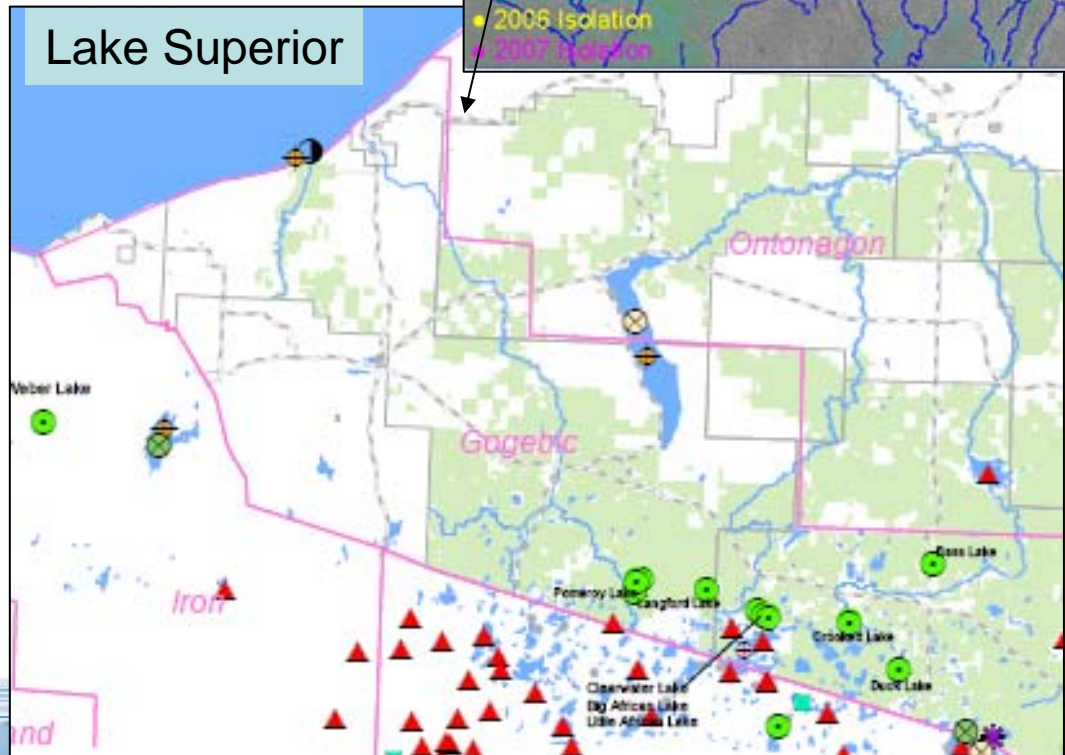
Small craft boaters: A major pathway of spread

- Aquatic invasive species moved on hulls, motors, trailers, fishing lines, anchors, or in live wells, bilges or as bait,

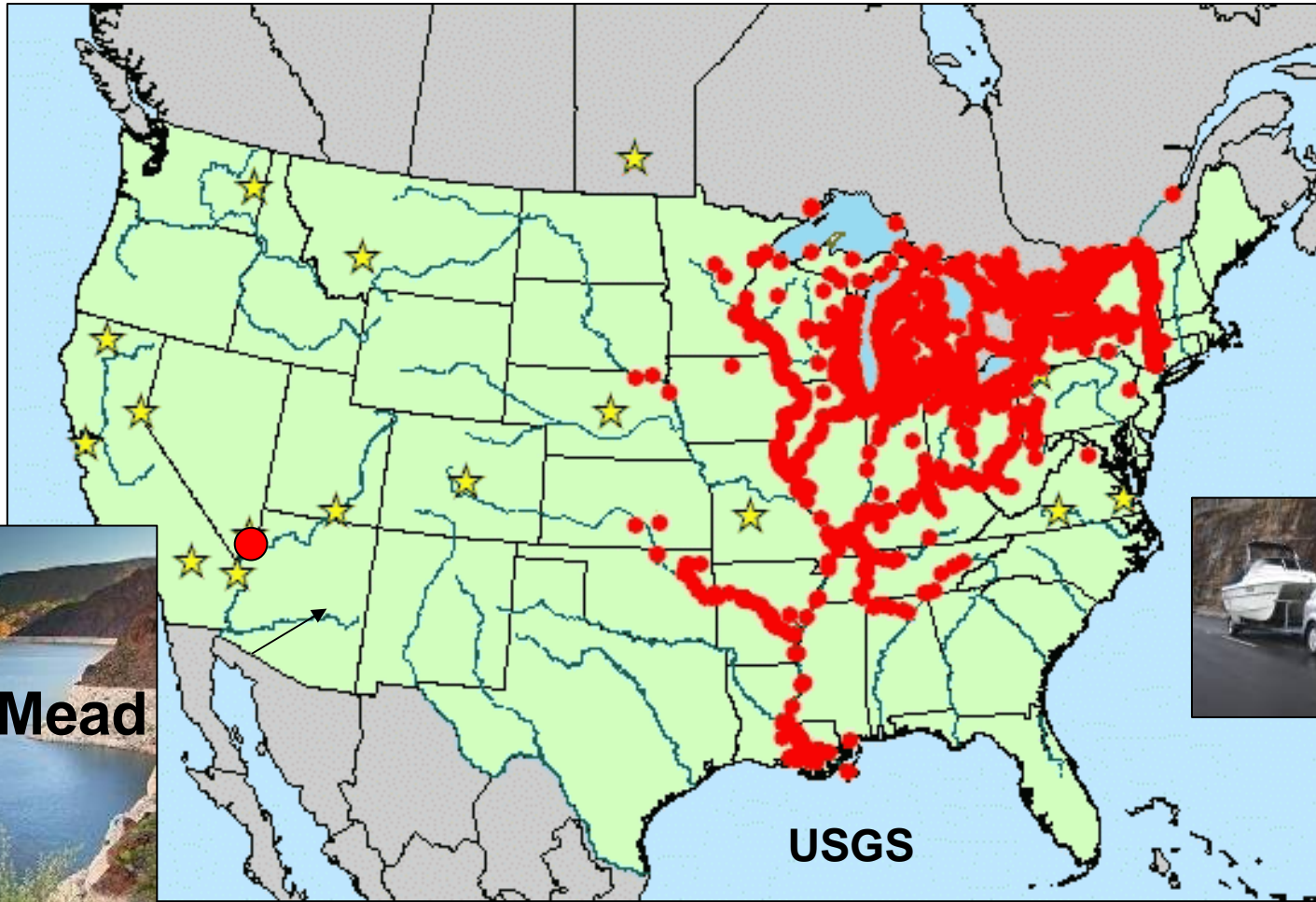


Inland spread from Great Lakes

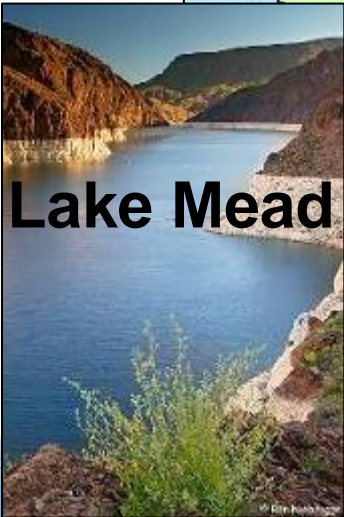
- VHS →
- Bythotrephes ○
- Eurasian milfoil ●
- Rusty crayfish ▲



Across major watersheds boundaries

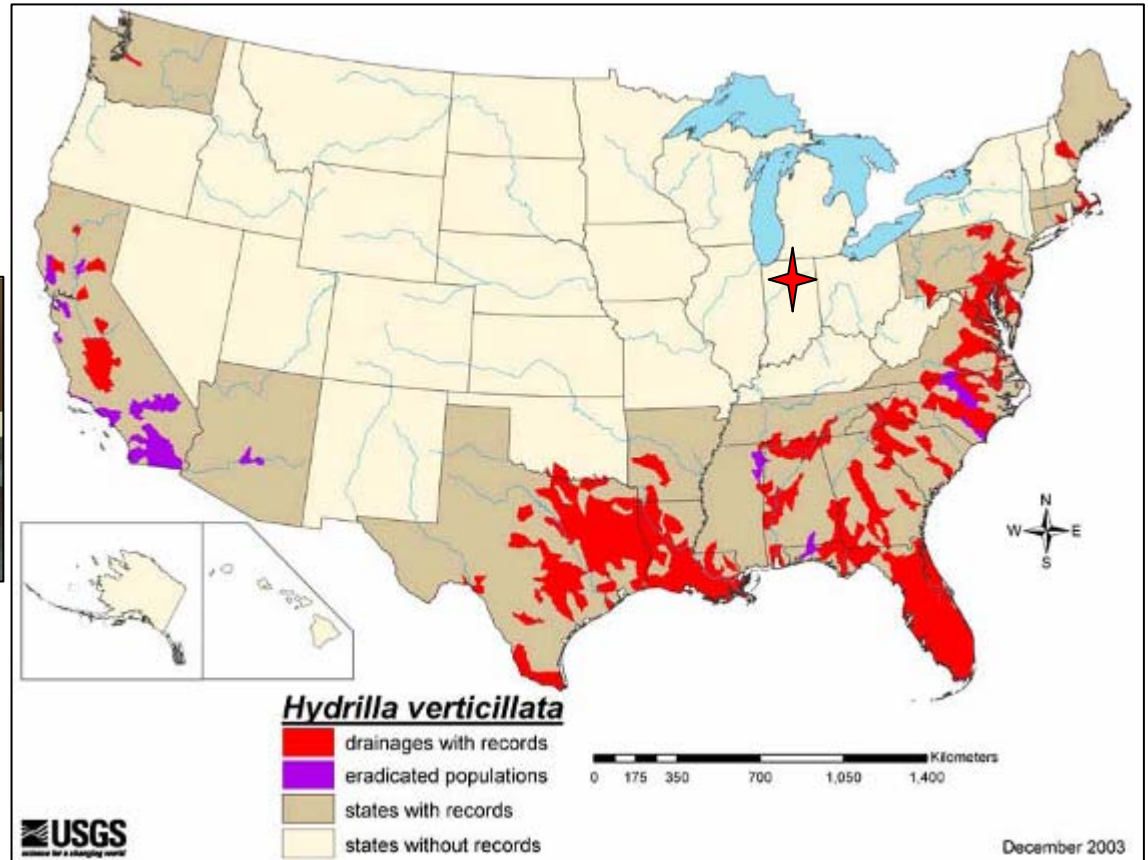


Lake Mead



Spread of zebra and quagga to western US

Into the Great Lakes upper Miss. region (*hydrilla* into northern Indiana 2007)



Interventions: Limited resources and many sites

- *Where should interventions occur to limit spread?*
- *What are the most effective intervention strategies?*



Recreational boater intervention strategies

Source intervention
(Containment)



STOP AQUATIC HITCHHIKERS!

Prevent the transport of nuisance species.
Clean all recreational equipment.
www.ProtectYourWaters.net

Destination Intervention
(Protection)

are inspected and
before they enter

leaving contamin
waterways
iii. Control
est

education



STOP AQUATIC HITCHHIKERS!



Eurasian Milfoil



Variable Milfoil



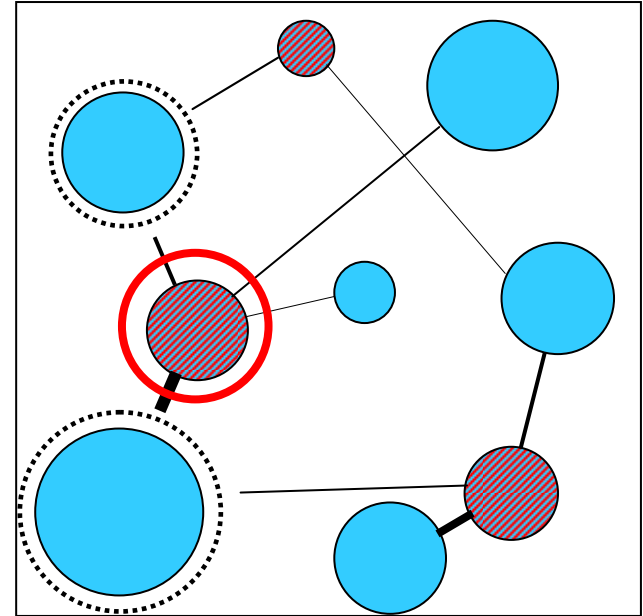
Fanwort



Recreational boater intervention strategies

Source intervention (Containment)

- i. Inspect & clean all boats leaving contaminated waterways
- ii. Control or restrict boating access to infected systems
- iii. Control & eradications of establish populations



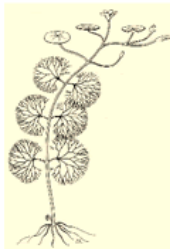
STOP AQUATIC
HITCHHIKERS!



Eurasian Milfoil



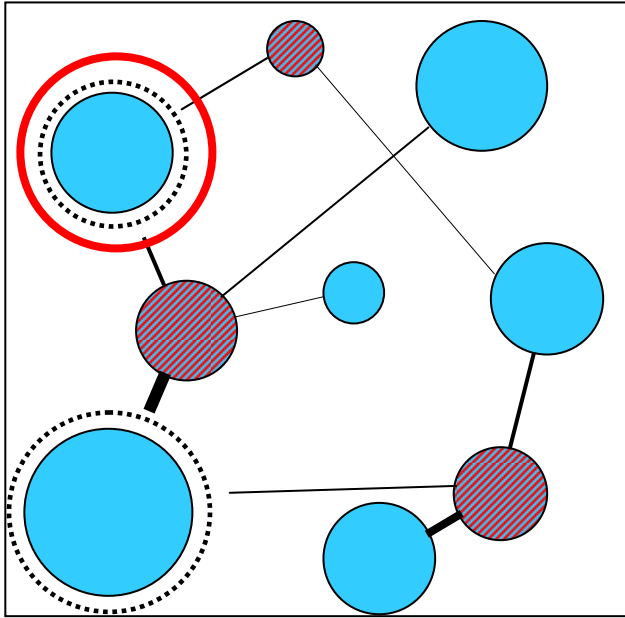
Variable Milfoil



Fanwort

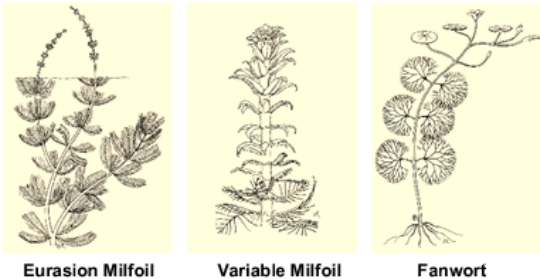


Recreational boater intervention strategies



Destination Intervention (Protection)

- i. All boats are inspected and cleaned before they enter AIS free systems
- ii. Limit access to high risk boaters
- iii. Surveillance for EDRR



Eurasian Milfoil

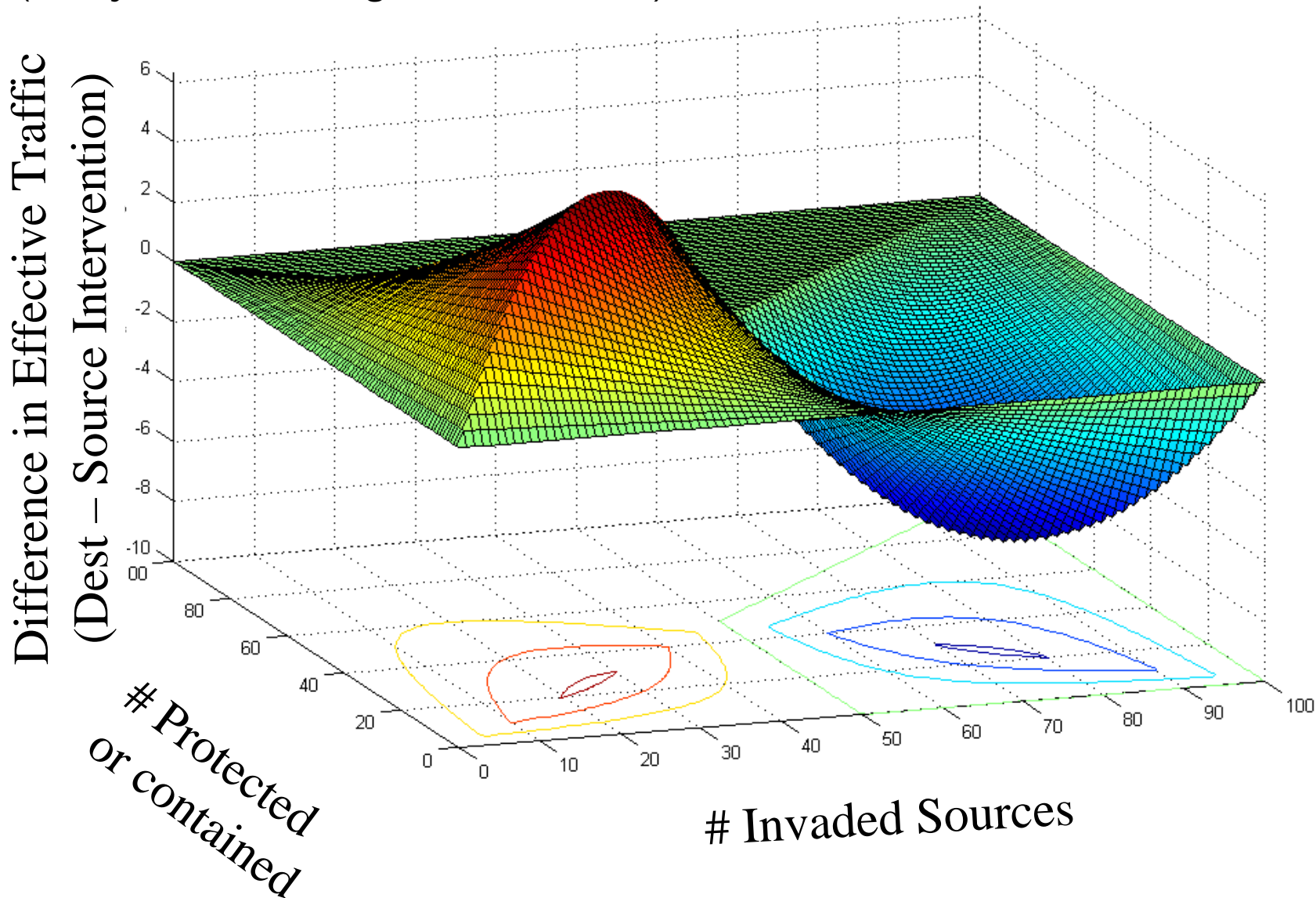
Variable Milfoil

Fanwort



If goal is to slow spread of invasive species

(*Drury & Rothlisberger 2007: Oikos*)



Recreational boaters: solutions

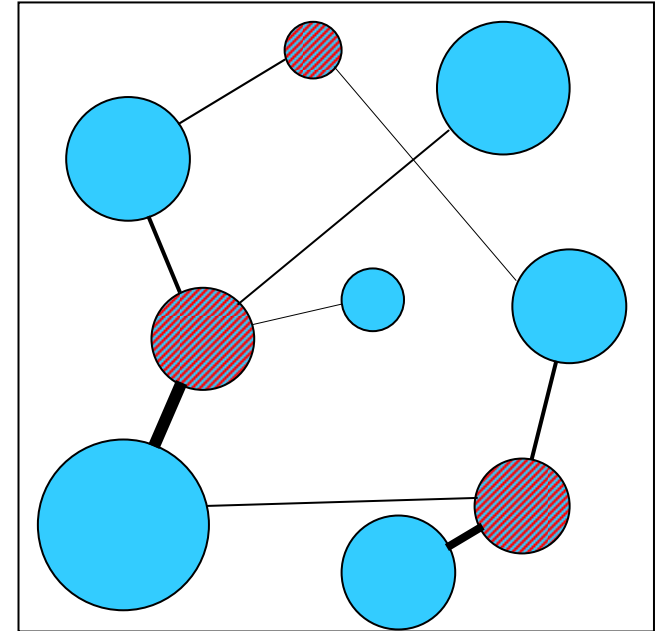
Identify and quarantine super spreaders



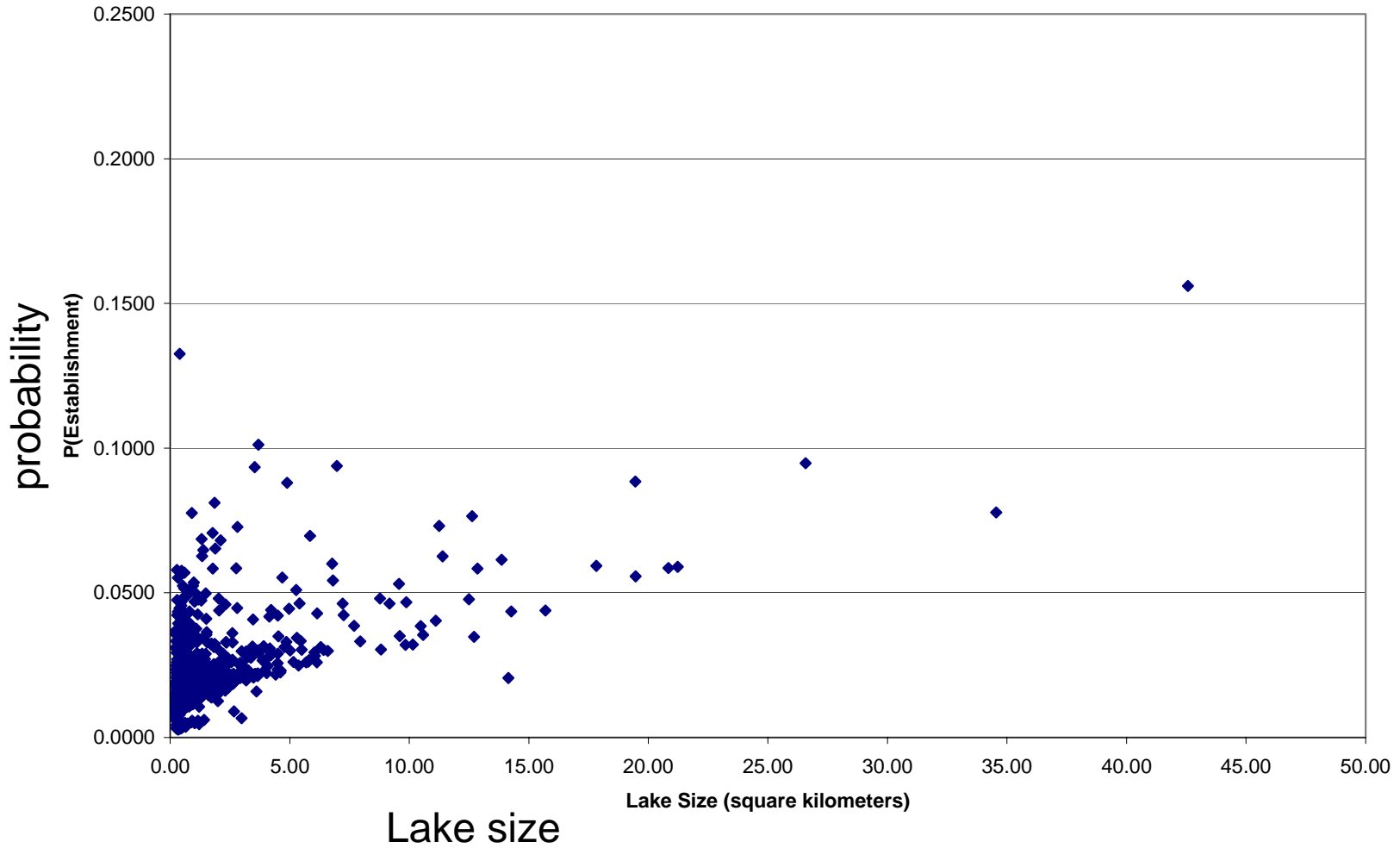
Inspections, cleaning stations, education

Destination intervention

- Gravity Models: used to predict high risk invasion sites
- Used in geography and other social sciences to describe human movement
- Probability of invasion related to
 - an encounter rate [*how many boat visit a site*],
 - and distance to invasion sources [*probability of invasion declines with increasing distance*]



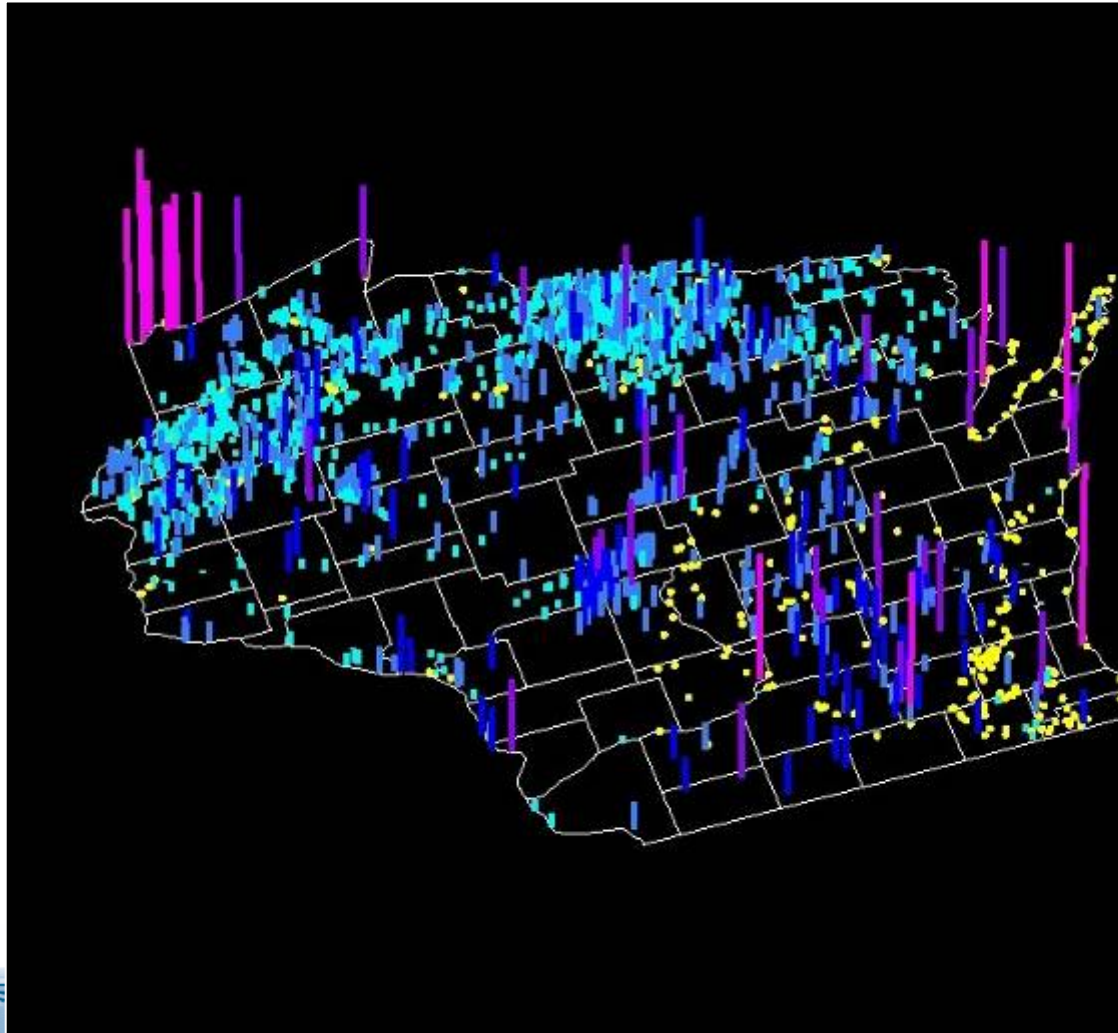
P(Establishment) versus Lake Size, EWM in WI, 2007



Input variables include:

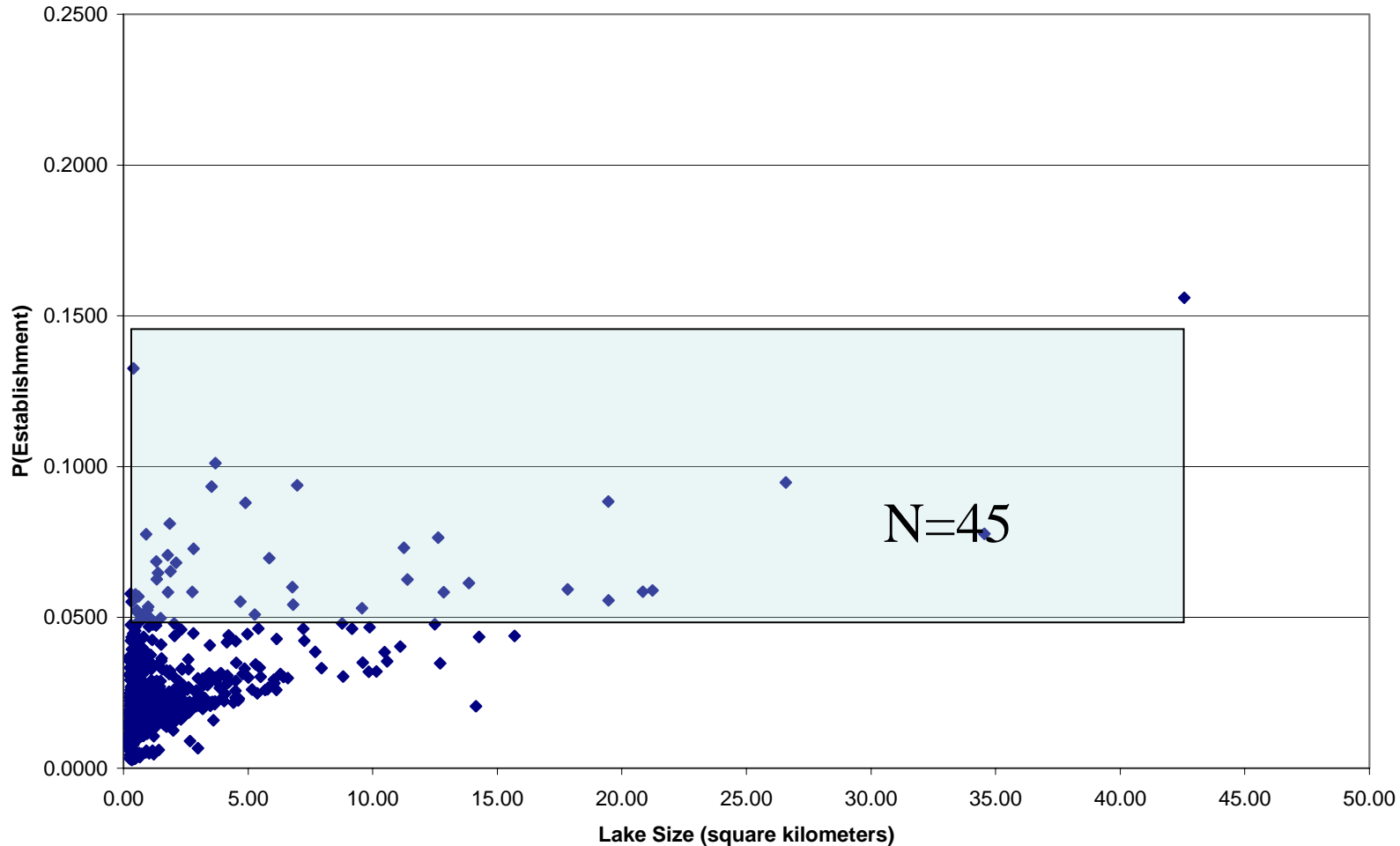
Lake size, distance to source and population centers, traffic scores

Probability of invasion Eurasian water milfoil (Wisconsin)



Possible priority sites surveillance monitoring

P(Establishment) versus Lake Size, EWM in WI, 2007



The problem with managing rare events and the limits to which invasions can be predicted

The number of infested boaters arriving at a lake is certainly a predictor of the invasion probability... **but look at the scale**. Many lakes do not have 50,000 or more boaters, let alone infested boaters.

[Bossenbroek, Kraft & Nekola. 2001 estimated probability an infested boater causing establishment of zebra mussels at 0.0000411]

From Bossenbroek, Kraft & Nekola. 2001

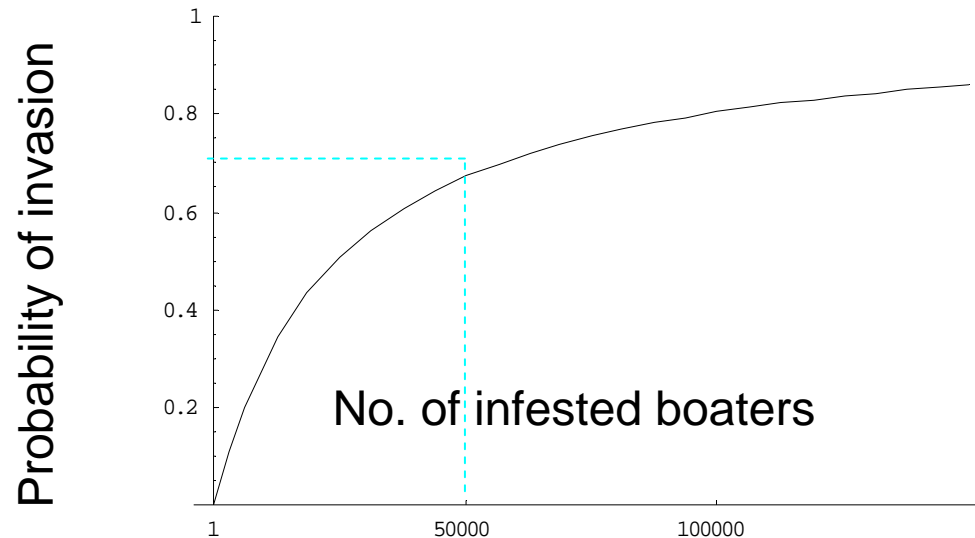
Supported by:

Schneider et al. 1998

Leung et al. 2004

Leung et al. 2006

Bossenbroek et al. 2007



Many, if not most, lakes have low probabilities of invasion.

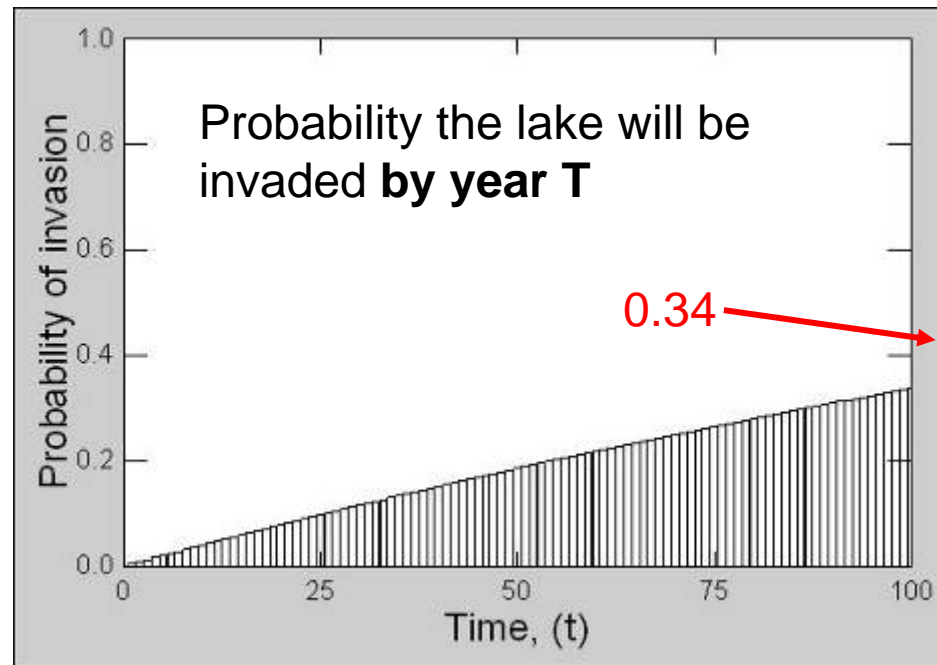
The problem with managing rare events and the limits to which invasions can be predicted

Example: Assume that every year, approximately 100 infested boaters arrive at a lake. This implies that every year there is a $1-(1-0.0000411)^{100} = 0.004$ chance of an invasion.



Jerde & Lewis 2007

Jerde & Bossenbroek, In press



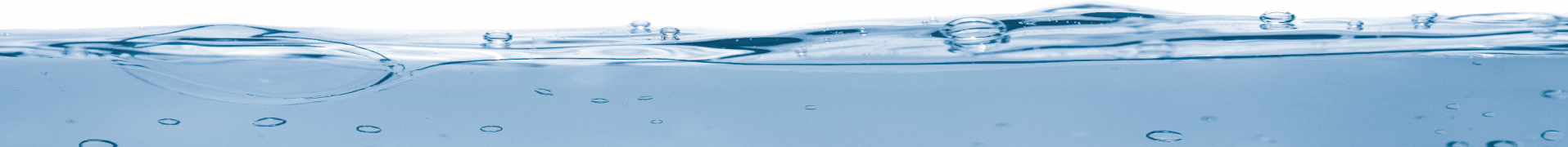
Slower spreading AIS are even more unpredictable:

Pattern is holding for other NIS: Water milfoil, emerald ash borer, Chinese mitten crab

The problem with managing rare events and the limits to which invasions can be predicted

Key points:

1. Most lakes have low probabilities of becoming invaded in a given year.
2. Predicting when a specified lake will become invaded is effectively impossible, unless propagule pressure is large. (See Jerde & Lewis 2007)
3. Real risks that attempting to manage invasion by focussing on AIS destinations and preventing new invasions may in many cases be less effective and misplaced effort
4. Still value in protecting really high value sites that where invasion could cause irreversible loss (e.g. endangered species)



Recreational boater: solutions

- Quarantine super spreaders: source lakes
- Protect high value sites



Not all boaters pose the same risk



Not all boaters pose the same risk

*Interviews boat landings Upper Peninsula Michigan
Northern Wisconsin (summer 2007)*

	Count	%
Total boaters (non-guides)	424	100
Non movers	289	68.2
Movers Surveyed	135	31.8
Great lakes landings	20	4.7



Boater hygiene (n=424)

Frequency of activity between lakes (Summer 2007)

Activity	Always	Sometimes	Never	N/A
Pressure Wash Boat	6.9	33.8	53.8	4.6
Rinse Boat	13.8	40.8	33.8	10.8
Wipe Down Boat	23.8	41.5	30.8	3.1
Notice Weeds on Boat or Trailer	42.3	45.4	9.2	2.3
Remove Weeds	86.9	10.0	0.8	1.5
Empty Live Well	58.5	7.7	1.5	31.5
Empty Bait Containers	37.7	17.7	3.8	40.0
<i>Drain Bilge</i>	49.2	18.5	8.5	23.1
<i>Drain Transom Well</i>	47.7	14.6	5.4	31.5
<i>Drain Motor</i>	50.8	13.8	17.7	16.9
<i>Clean Fishing Tackle</i>	29.2	38.5	21.5	10.0
<i>Clean Anchor</i>	37.7	26.2	18.5	16.9
<i>Clean Downrigger</i>	3.1	3.8	8.5	83.8

Fishing guides (N=35)



days fishing	# lakes / day
-----------------	------------------

79.8

1.4



average # lakes used	total number of individual lakes visited
-------------------------	--

5.4

269

Frequency of activities between
lakes (fishing guides)

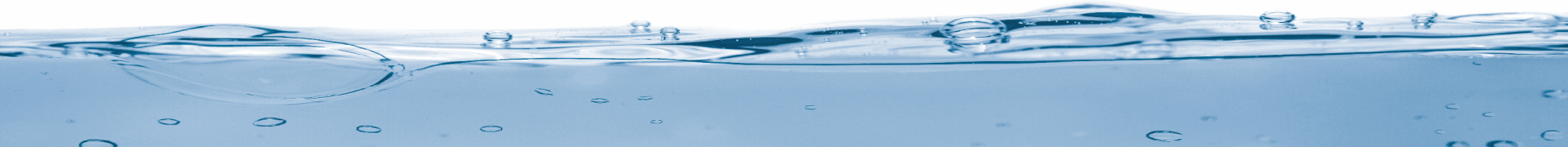
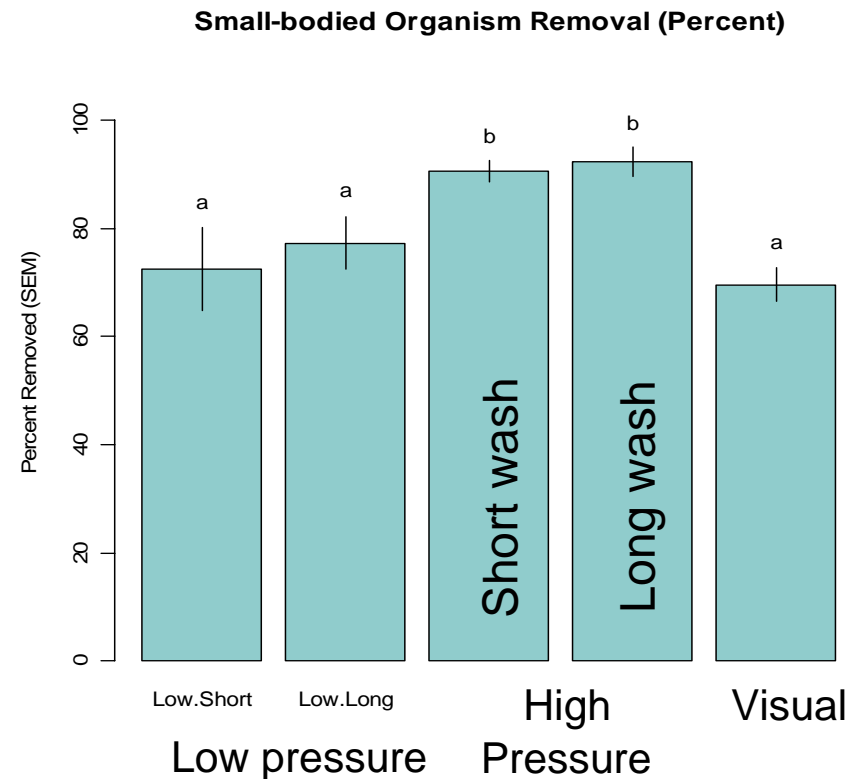
Activity	Always	Sometimes	Never	N/A
Pressure Wash Boat	0	75	17.9	7.1
Rinse Boat	0	46.4	39.3	3.6
Wipe Down Boat	10.7	46.4	39.3	3.6
Notice Weeds on Boat or Trailer	10.7	85.7	0	3.6
Remove Weeds	96.4	0	0	3.6
Empty Live Well	78.6	3.6	3.6	14.3
Empty Bait Containers	32.1	14.2	32.1	21.4
<i>Drain Bilge</i>	<i>85.7</i>	<i>10.7</i>	<i>3.6</i>	<i>0</i>
<i>Drain Transom Well</i>	<i>89.3</i>	<i>7.1</i>	<i>0</i>	<i>0</i>
<i>Clean Fishing Tackle</i>	<i>96.4</i>	<i>0</i>	<i>0</i>	<i>3.6</i>
<i>Clean Anchor</i>	<i>78.6</i>	<i>3.6</i>	<i>3.6</i>	<i>14.3</i>

Data collected prior to VHS rules

Encourage high use mobile boaters to install and use washing facilities

Examples:

- Fishing guides
- Commercial fishers
- Fishing tournaments



Some research needs:

1. Better quantitative data on boater/ramp use patterns: (numbers broken down by seasons)
2. Up to date inventory of AIS distributions
3. Data on the movement and hygiene behaviours of the full range of boater groups (who are the high risk boaters)
4. Assessments of AIS survival times (out of water) and movements windows (when are they most likely to be spread)



Challenges:

1. How do we optimally design sampling strategies (EDRR monitoring) for rare invasion events?
2. *How do we better target the high risks boaters*
3. *What management strategies can effectively reduce the rate of invasions (Quarantine – Drury and Rothlisberger 2007)*
4. How do we communicate invasion risk to the public and policy makers to affect behaviour change?

Thank you



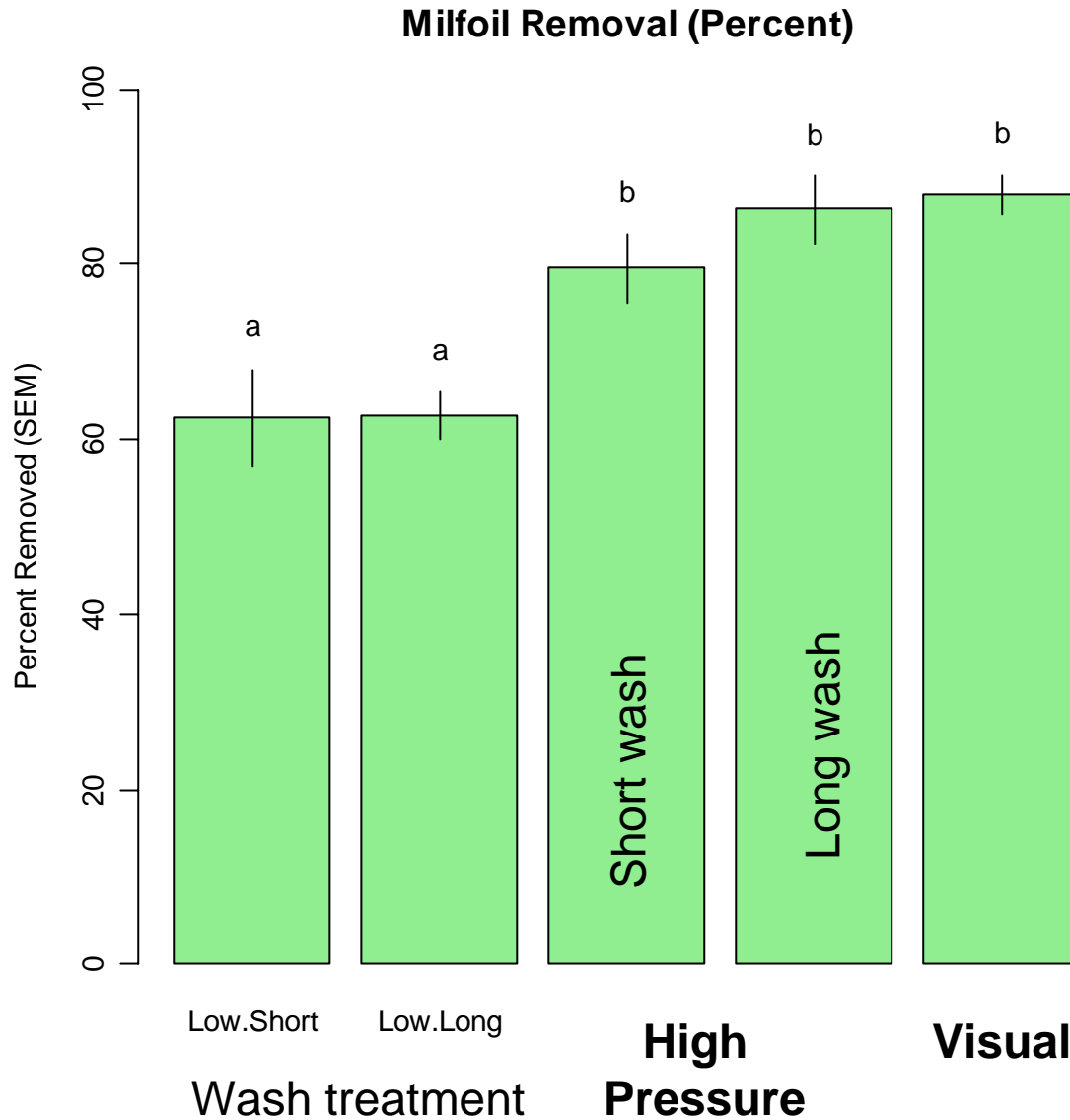
Take home message

Small craft boaters: solutions

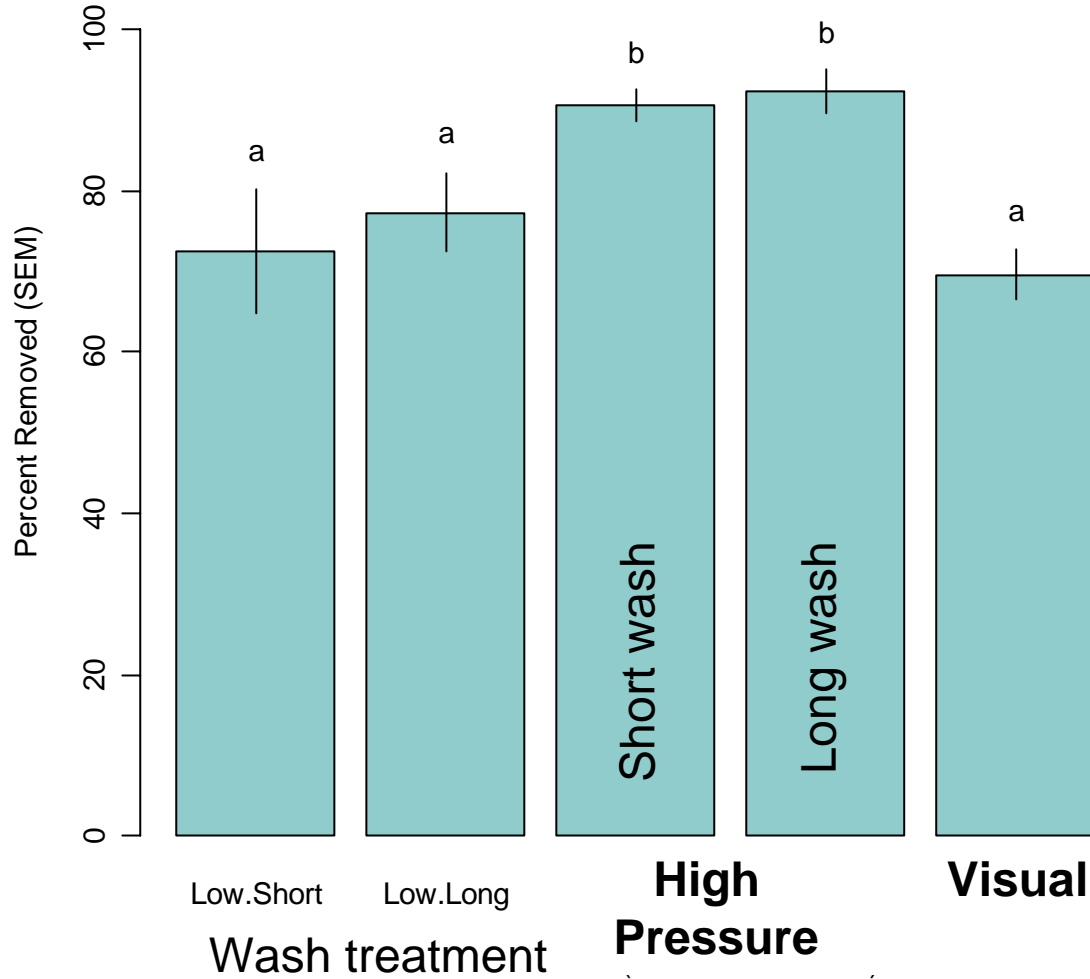
- Identify and quarantine super spreaders (key sources)
- Identify and target high risk boating groups
 - Encourage them to use of boat cleaning facilities



Washing effectiveness for milfoil removal

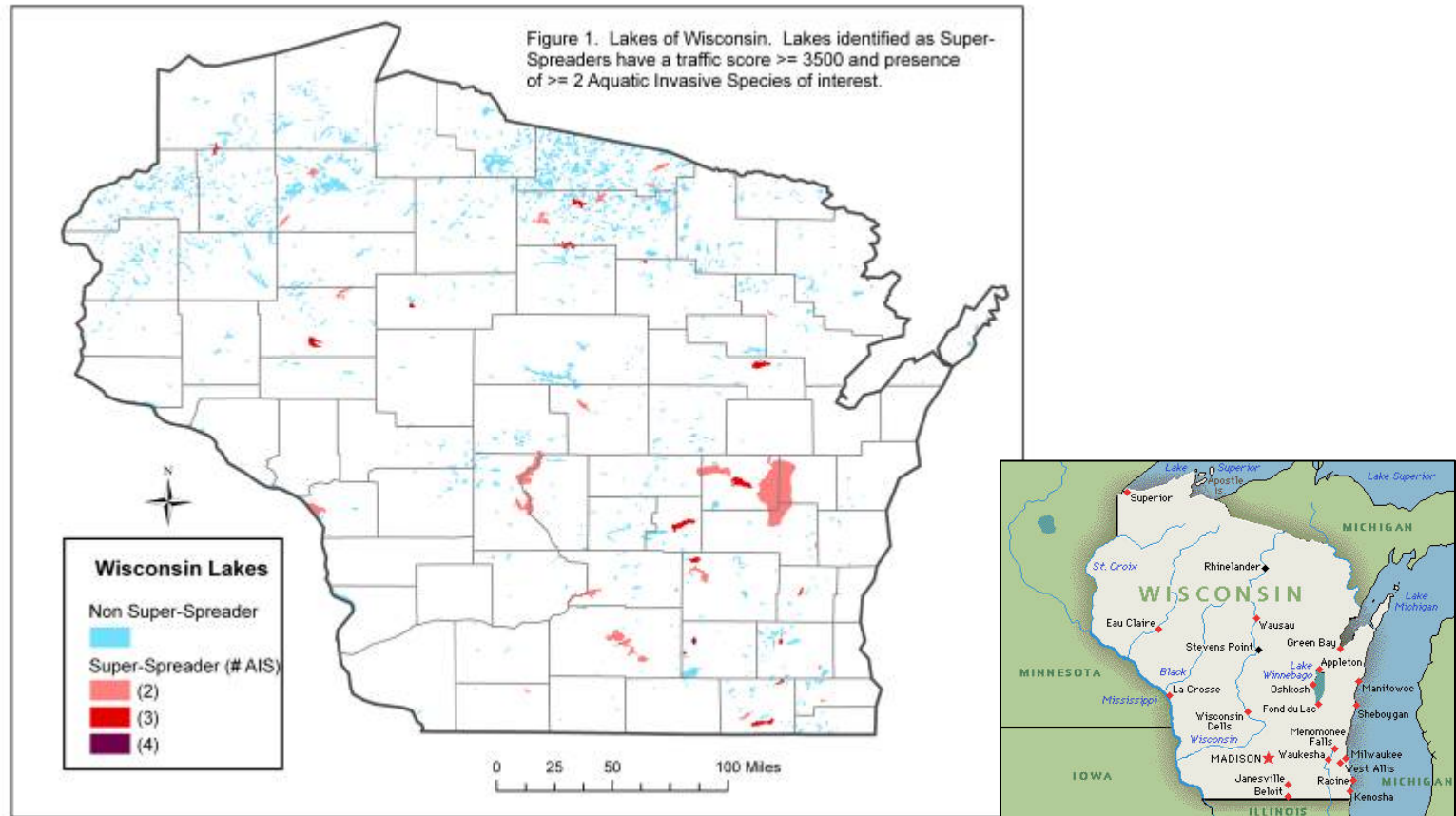


Small-bodied Organism Removal (Percent)



Spiny waterflea

Source interventions: Identify and quarantine super spreaders



Recreational boater intervention strategies

Source intervention (Containment)

- i. Close infected systems to boating
- ii. Inspect & clean all boats leaving contaminated waterways
- iii. Control & eradications of establish populations

Destination Intervention (Protection)

- i. All boats are inspected and cleaned before they enter AIS free systems*
- ii. Close to high risk boaters*
- iii. Surveillance for EDRR*



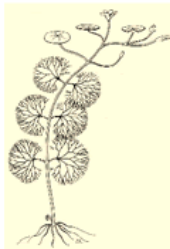
STOP AQUATIC HITCHHIKERS!



Eurasian Milfoil



Variable Milfoil



Fanwort



Large scale problem in Great Lakes region

- Large numbers of registered boaters
- Large number of Lakes (20,000+)
- Multiple introduced species at different stages of invasion, with different detection capabilities

	Registered boaters	licenses
Michigan	639,198	1,393,630
Wisconsin	944,138	1,271,245
Total	1,583,336	2,664,875

The problem with managing rare events and the limits to which invasions can be predicted

- A rare event is an outcome that has a small probability of occurring.

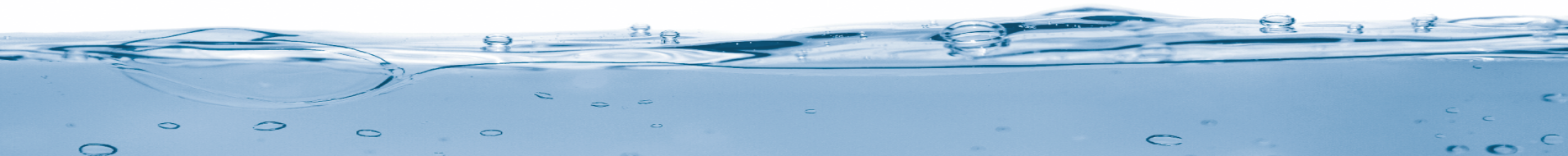
Common examples: 100 year flood, location of lightning strikes, winning the lottery

- Are aquatic invasions rare events?



- Zebra mussels are one of the best studied AIS
- Have spread across the Eastern United States faster than many other AIS
- Probability an infested boater causes an establishment: 0.0000411

Bossenbroek, Kraft & Nekola. 2001



Education alone is not enough!!

Boat landing surveys summer 2006

