# Intervention strategies for limiting the spread of aquatic invasive species by recreational boaters

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

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# THE INVASION PROCES

Present in original location

↓

Transport by vector

↓

Introduction to new site

↓

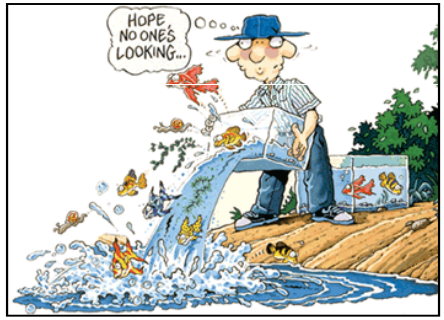
Establishment

↓

Spread

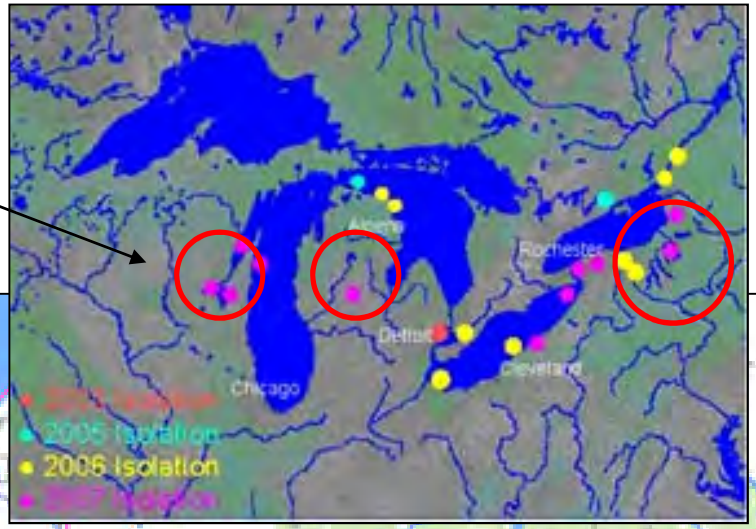
↓

Impacts

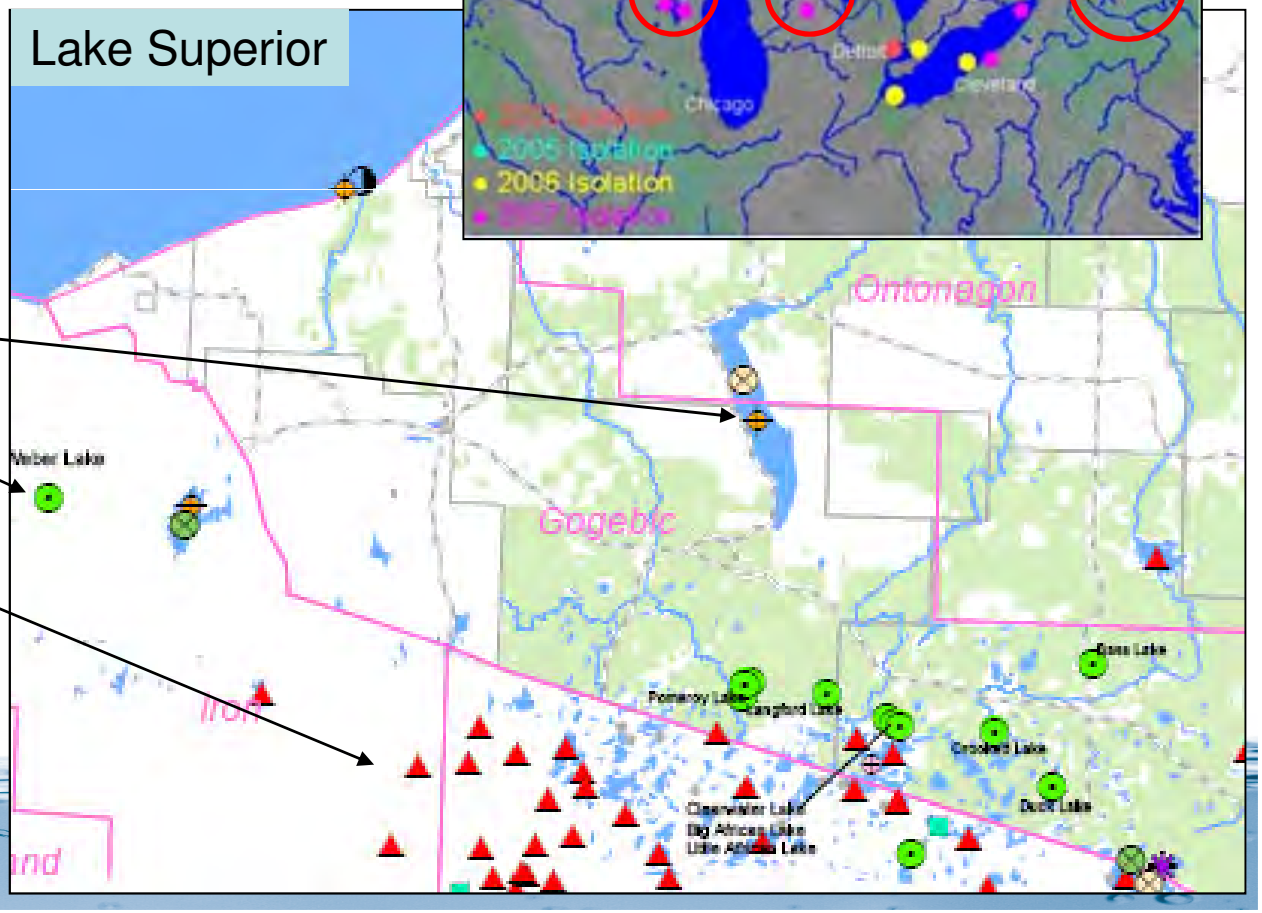


# A MAJOR VECTOR OF SECONDARY SPREAD FROM GREAT LAKES

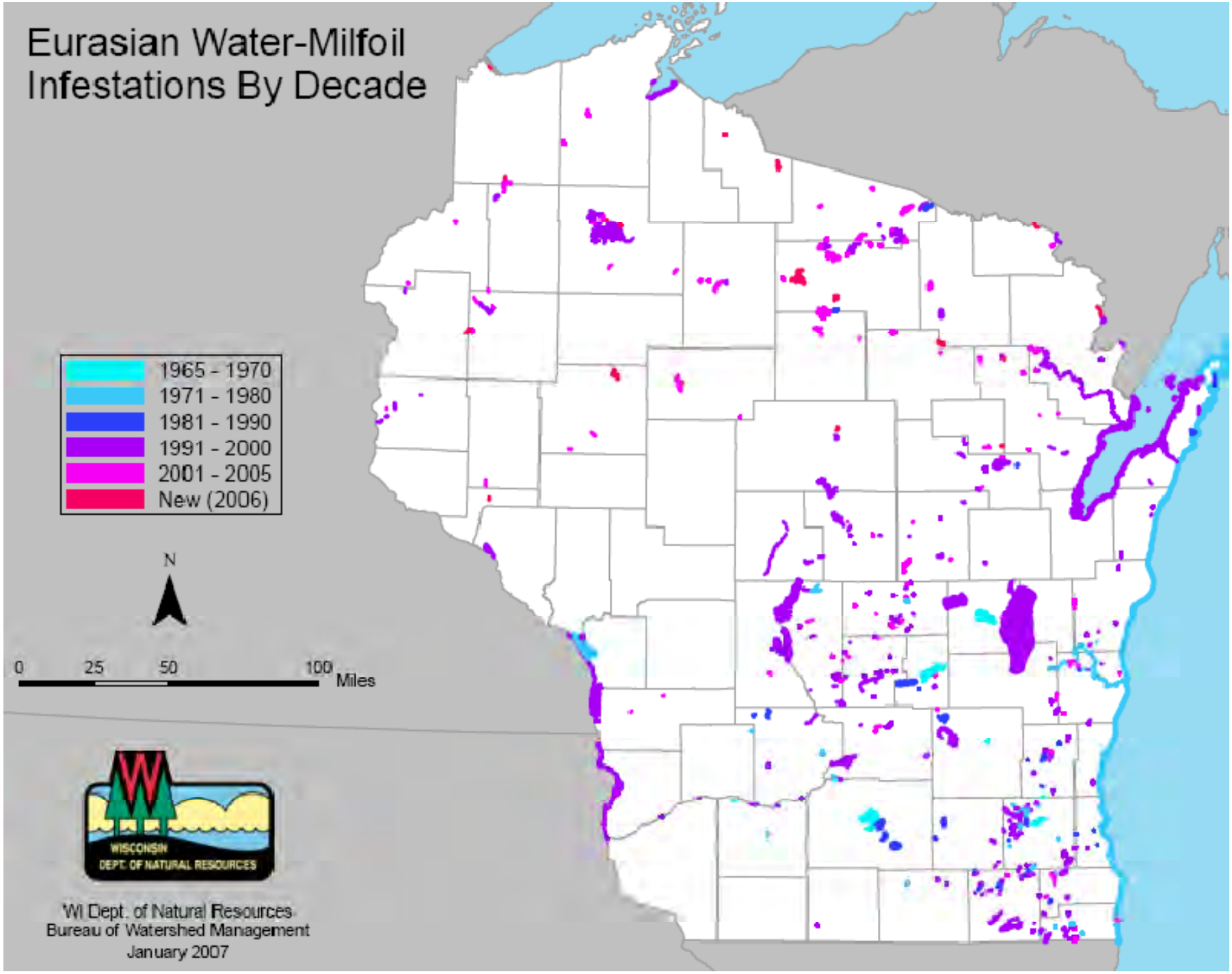
VHS




Lake Superior




- Spiny water flea
- Eurasian milfoil
- Rusty crayfish


Eurasian Water-Milfoil
Infestations By Decade
1965 - 1970
1971 - 1980
1981 - 1990
1991 - 2000
2001 - 2005
New (2006)
N
0
25
50
100
Miles
WISCONSIN
DEPT. OF NATURAL RESOURCES
WI Dept. of Natural Resources
Bureau of Watershed Management
January 2007

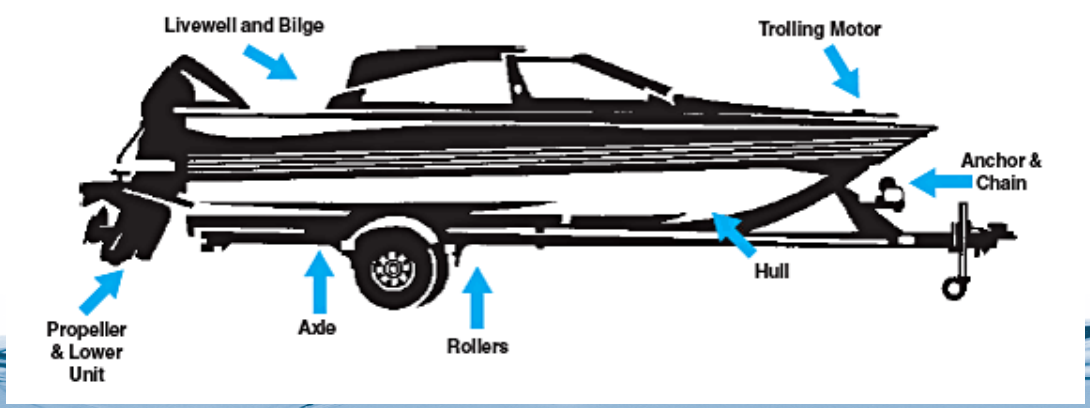
# Large scale problem in Great Lakes region

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

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

# Understanding the problem

- a major pathway of spread with small craft boater includes
  - recreational boaters
  - fishing guides
  - commercial fishers
- AIS moved on hulls, motors, trailers, fishing lines, anchors, or in live wells, bilges or as bait



# DO ALL BOATERS POSE THE SAME RI

# NOT ALL BOATERS POSE THE SAME RISK!

Recreational boaters

- about 30% of boaters visit multiple lakes (in a day, or during a visit)
- less than half wash or inspect boat regularly

Fishing guides:

- fish often, multiple lakes/day, many different lakes
- few clean their boats regularly

| Activity | Always | Sometimes | Never |
|---|---|---|---|
| Pressure Wash Boat | 0 | **75** | **17.9** |
| Rinse Boat | 0 | **46.4** | **39.3** |
| Wipe Down Boat | 10.7 | **46.4** | **39.3** |

n= 35

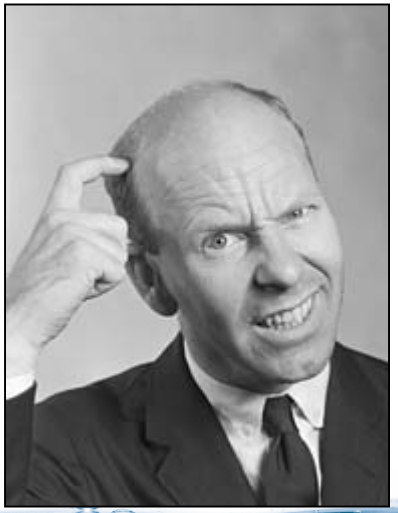
| | Frequency of activities between lakes (fishing guides) | | | |
|---|---|---|---|---|
| Activity | Always | Sometimes | Never | N/A |
| Pressure Wash Boat | 0 | **75** | **17.9** | 7.1 |
| Rinse Boat | 0 | **46.4** | **39.3** | 3.6 |
| Wipe Down Boat | 10.7 | **46.4** | **39.3** | 3.6 |
| Notice Weeds 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 |
| *Drain Bilge* | *85.7* | *10.7* | *3.6* | *0* |
| *Drain Transom Well* | *89.3* | *7.1* | *0* | *0* |
| *Clean Fishing Tackle* | *96.4* | *0* | *0* | *3.6* |
| *Clean Anchor* | 78.6 | *3.6* | *3.6* | *14.3* |

# Boater hygiene (n=424)

| Activity | Frequency of activity between lakes (Summer 2007) | | | |
|---|---|---|---|---|
| | 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 |
| *Drain Bilge* | *49.2* | *18.5* | *8.5* | *23.1* |
| *Drain Transom Well* | *47.7* | *14.6* | *5.4* | *31.5* |
| *Drain Motor* | *50.8* | *13.8* | *17.7* | *16.9* |
| *Clean Fishing Tackle* | *29.2* | *38.5* | *21.5* | *10.0* |
| *Clean Anchor* | *37.7* | *26.2* | *18.5* | *16.9* |
| *Clean Downrigger* | *3.1* | *3.8* | *8.5* | *83.8* |

# Interventions: Limited resources and many sites

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



# MANAGEMENT AT INVADED SIT

Present in original location

↓ ← Source Intervention

Transport by vector

↓

Introduction to new site

↓

Establishment

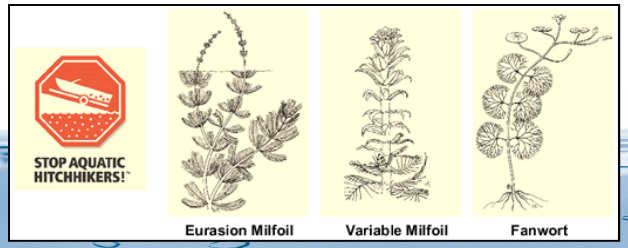
↓

Spread

↓

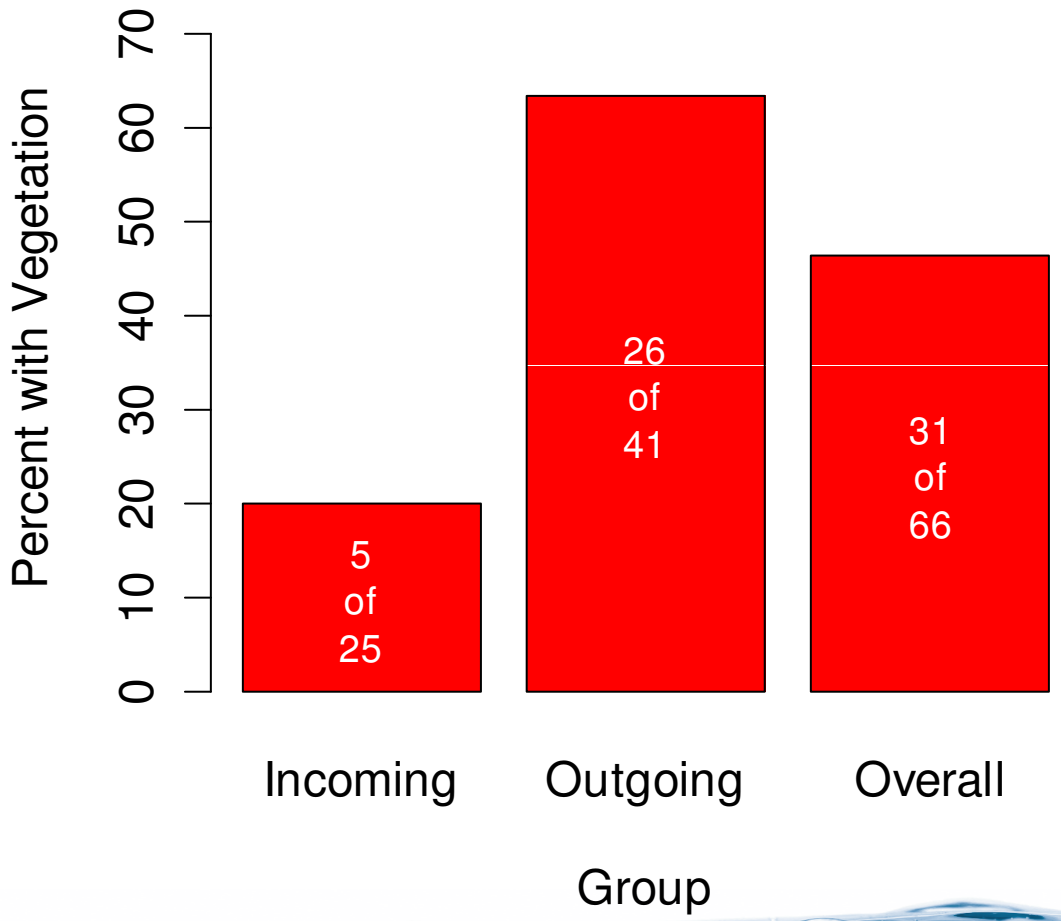
Impacts

- Prevention: educate, inspect, boat wash, manage access
- Control – eradication (limit supply)



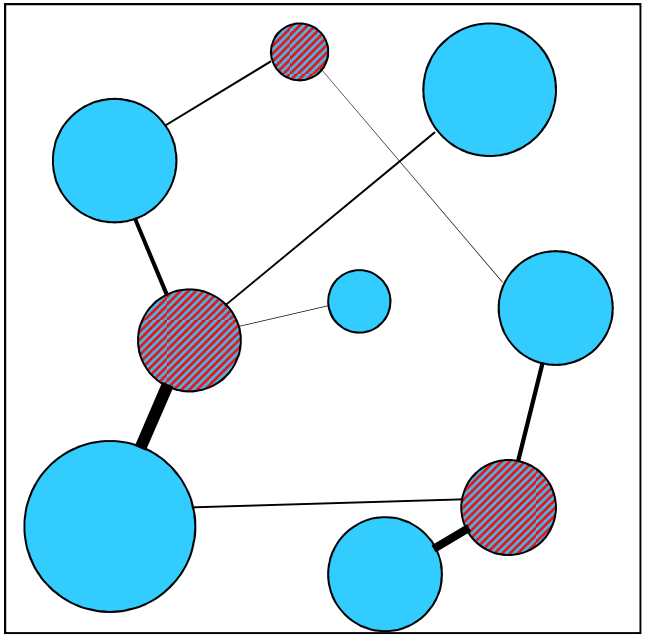
# EDUCATION ALONE IS NOT ENOUGH

Boat landing surveys summer 2006



# Gravity Models: Predicting high risk invasion sites

- Probability of invasion related to:
  - an encounter rate [*how attractive is a site to boaters, or how many boats visit a site*]
  - and distance to invasion sources [*probability of invasion declines with increasing distance*]



# CONTAINING INVADED LAKES REDUCES INVASION RISK MORE THAN PROTECTING UNINVADED LAKES

Total lakes = 100

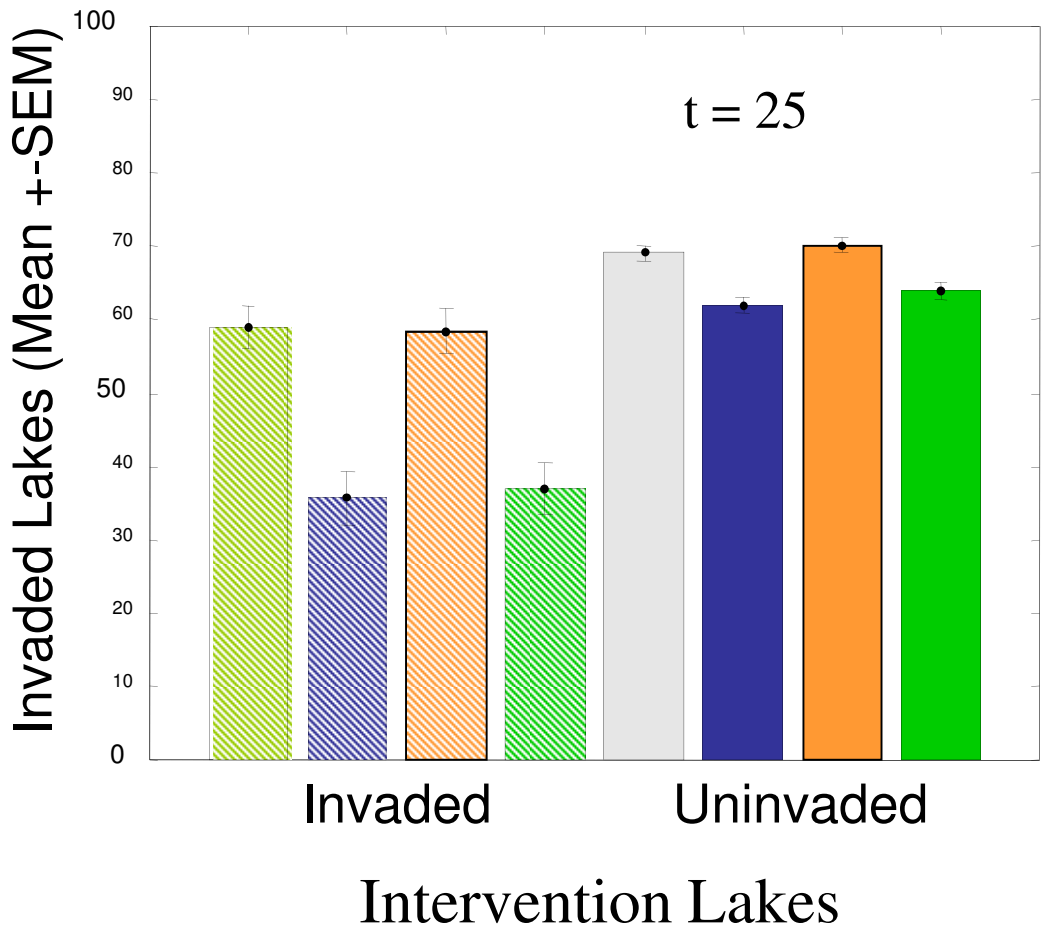
Initially invaded = 10

Intervention sites = 8

Efficacy = 99%

LEGEND: Selection rules

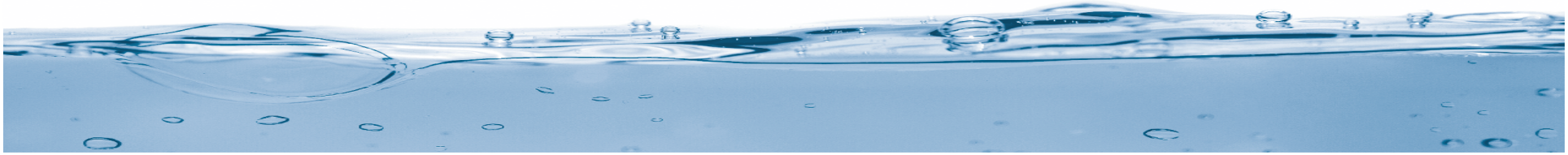
- Random
- Largest
- Nearest neighbors
- Highest connectivity



# QUARANTINE SUPER SPREADERS TO PREVENT SPREAD

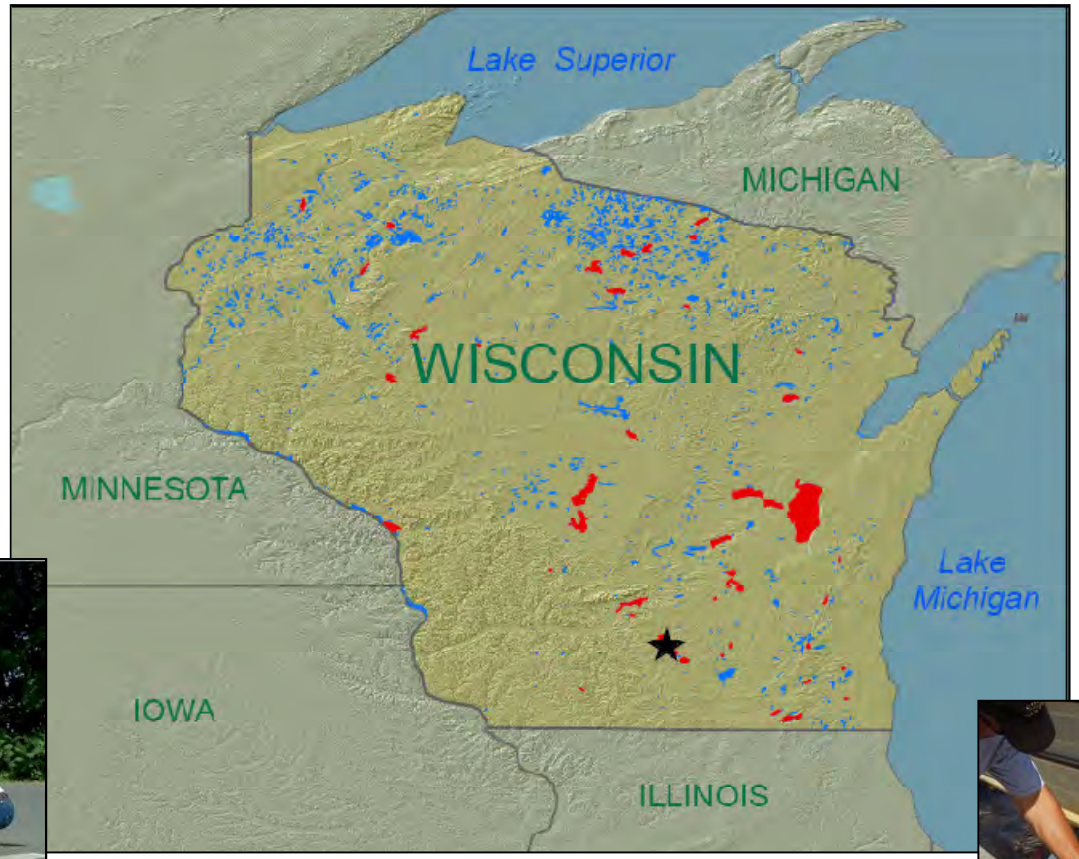
- Analogous to human health
  - (i.e. small number of infected individuals often responsible for spread of new diseases into another region)
  - (e.g. SARs introduction to Canada, swine flu spread in U.S.)
- Super spreader lakes: high boater use, highly invaded

(*Good distribution data for rusty crayfish, eurasian milfoil, spiny water flea, zebra mussels, rainbow smelt*)

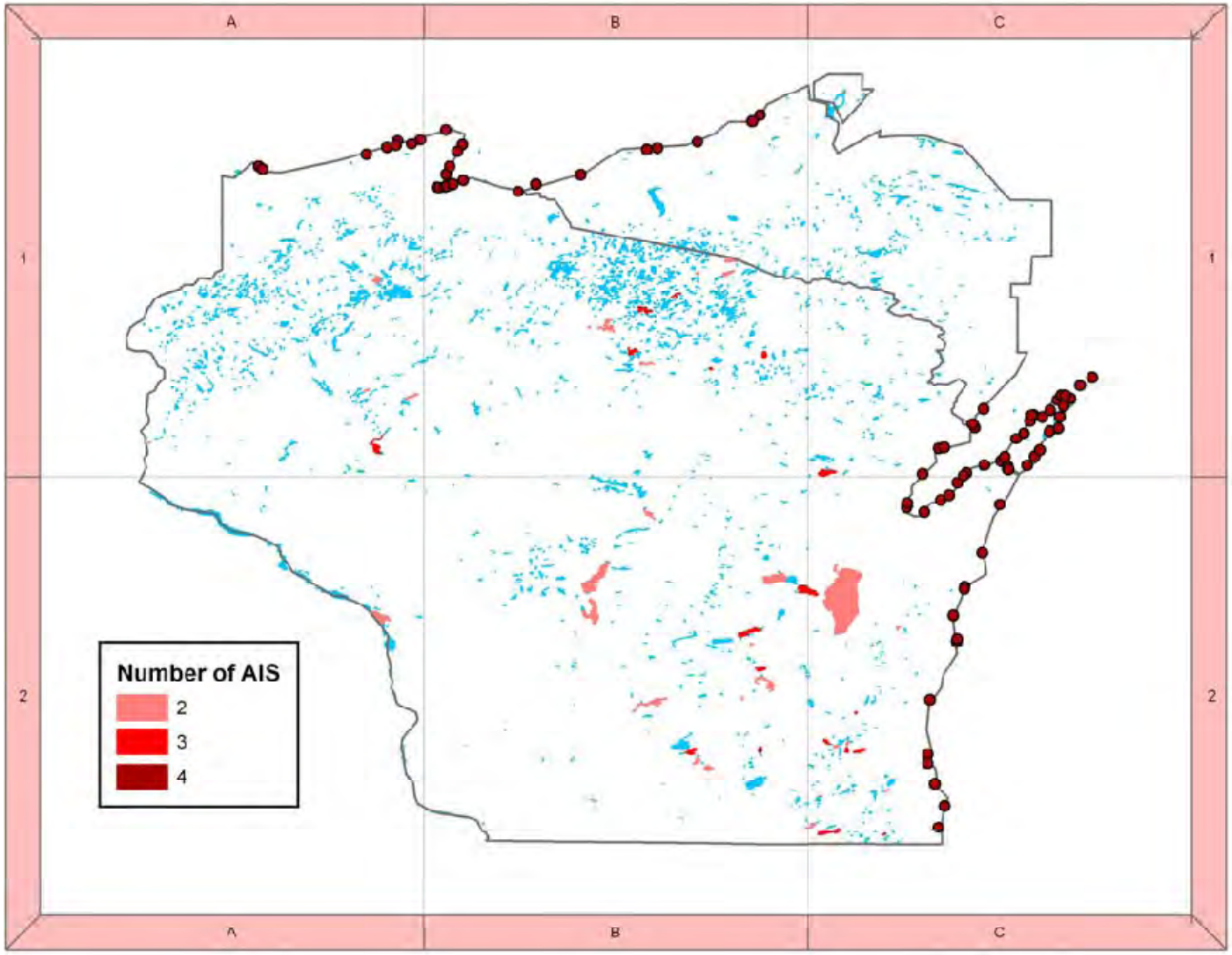


# IDENTIFY AND QUARANTINE SUPER SPREADERS

Inspections, cleaning stations, education, control of pests at site



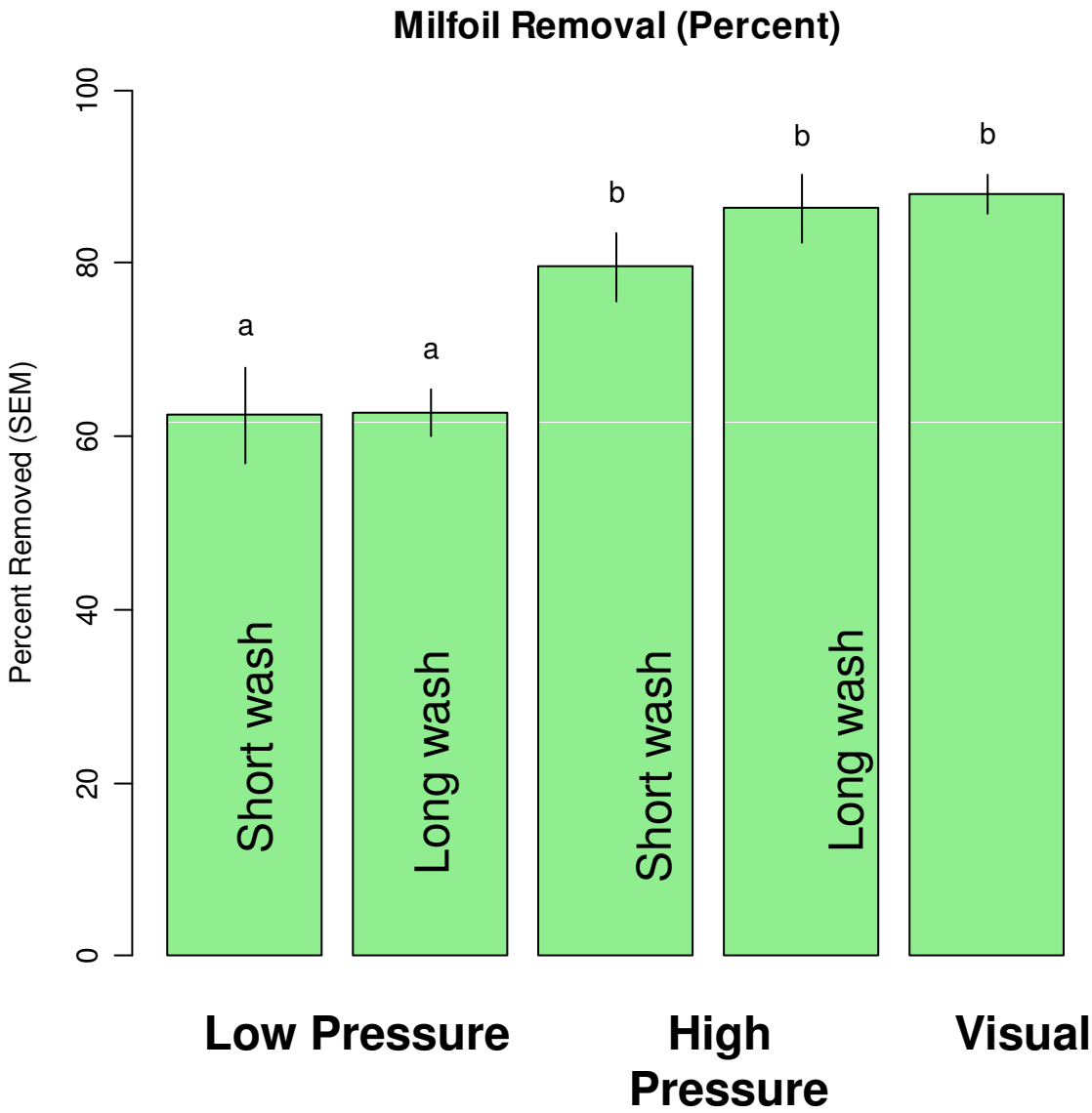
# HIGH USE GREAT LAKES BOAT LANDINGS ULTIMATE SUPER SPREADERS: E.G. GREEN BAY



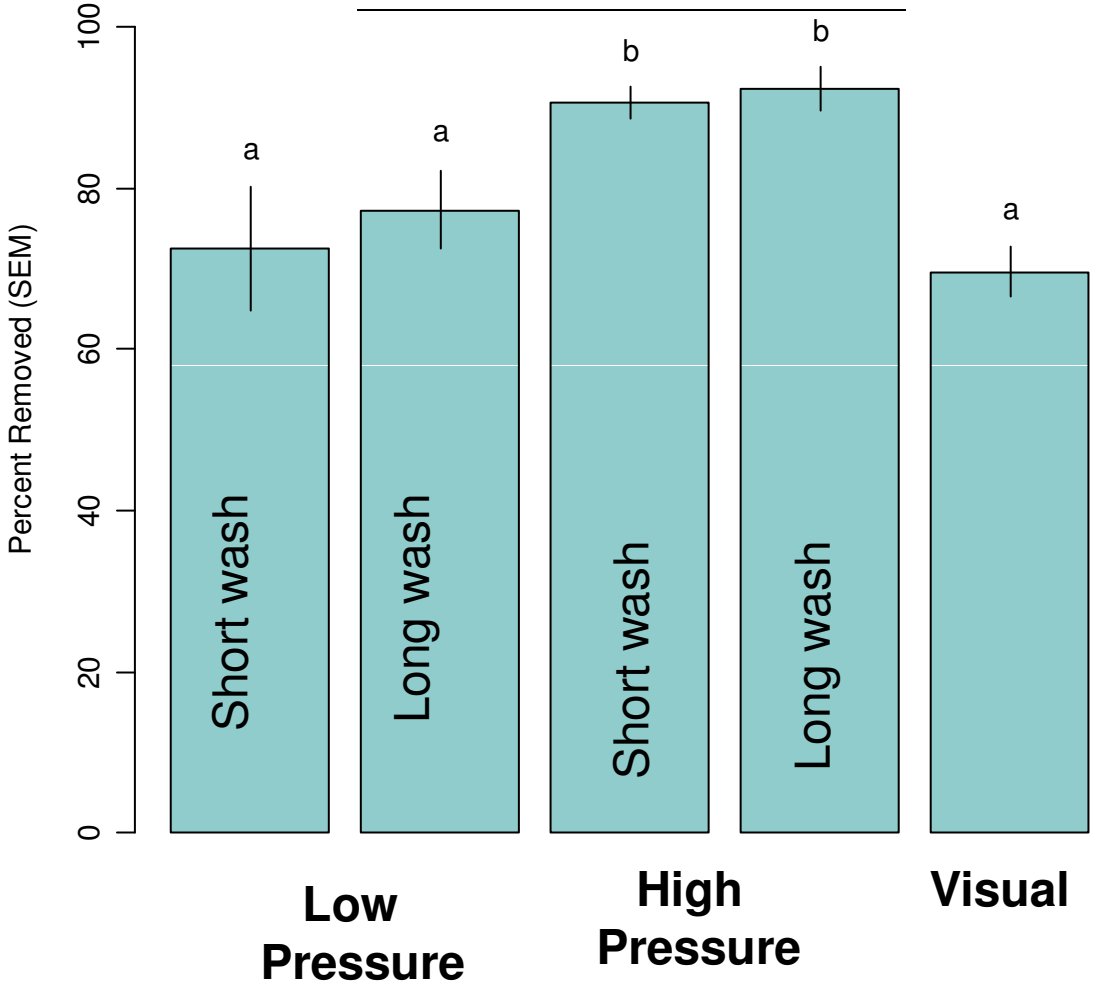
# Identifying super spreaders

- Which lakes are high use? (traffic, tournaments, landing conditions, high risk boaters…)
- Which lakes have easily transported AIS? (spiny waterflea, EWM, zebra mussels, pondweed, VHS)
- Use local knowledge

# VISUAL INSPECTION AS EFFECTIVE AS WASHING FOR MILFOIL REMOVAL



# BUT WASHING NECESSARY FOR REMOVAL OF SMALL BODIED ORGANISMS

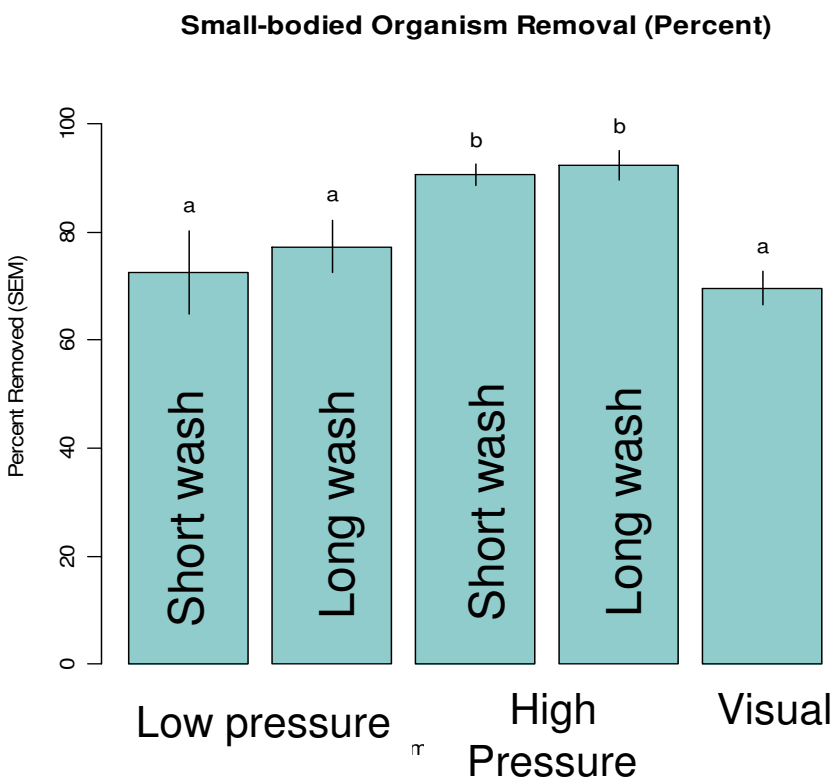


Spiny waterflea

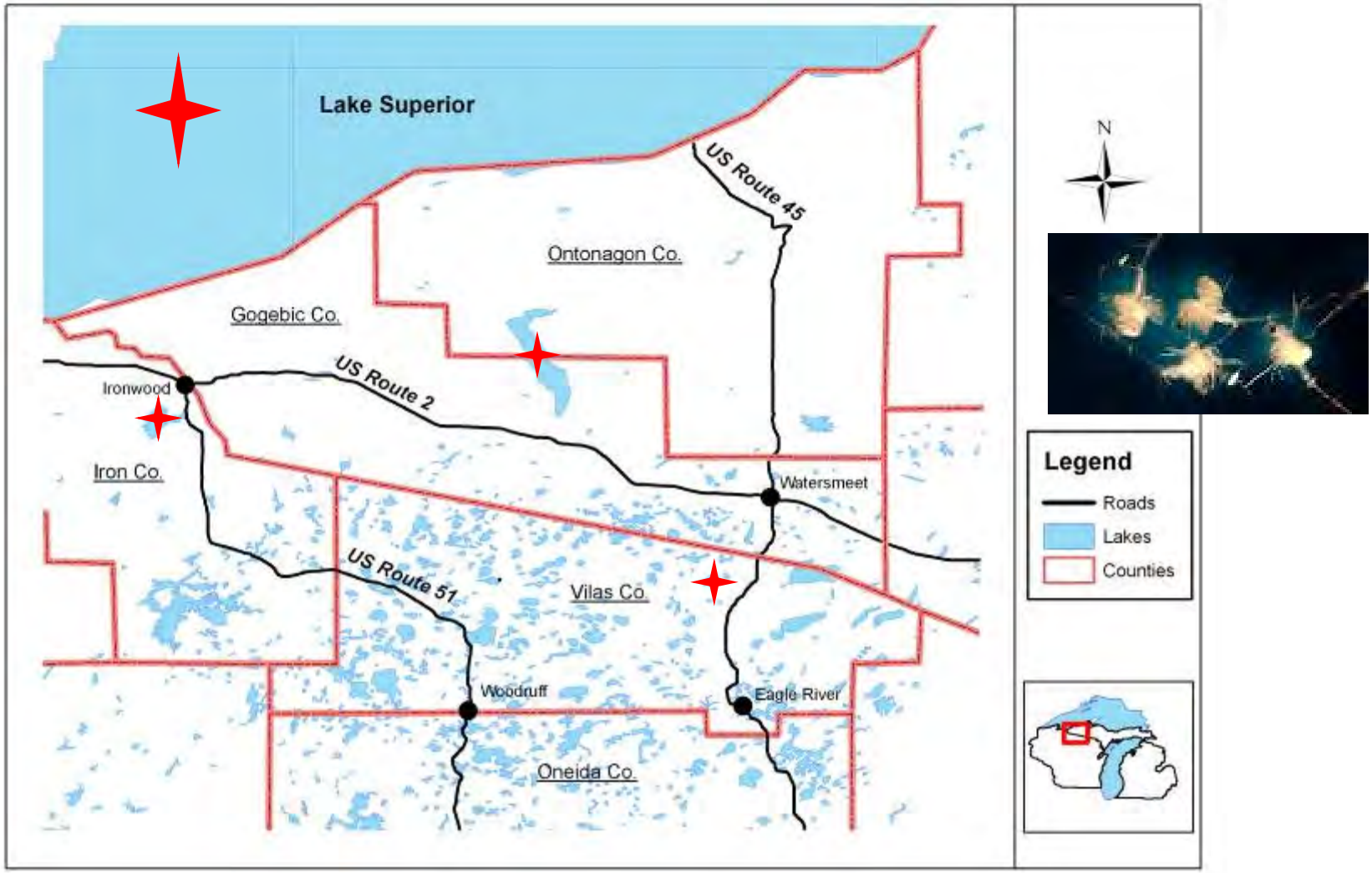
# ENCOURAGE HIGH USE MOBILE BOATERS TO INSTALL AND/OR USE WASHING FACILITIES

Examples:

- Fishing guides
- Commercial fishers
- Fishing tournaments



# For example if the goal is to prevent the spread of spiny water flea



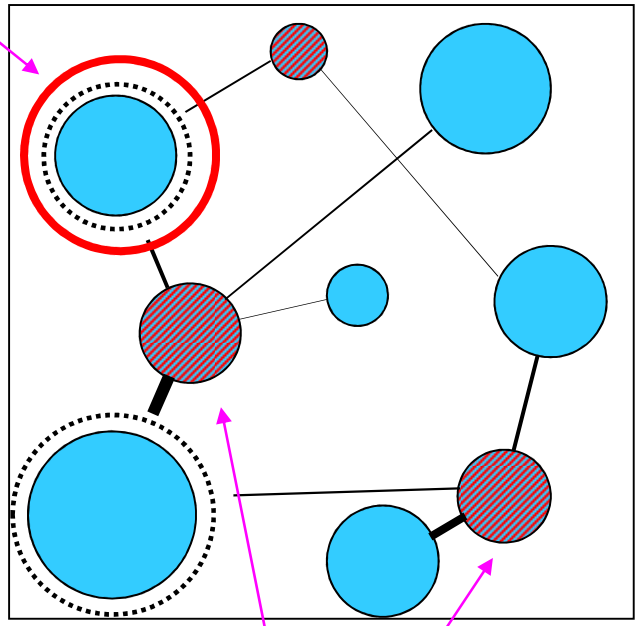

Spiny water flea

# Pause for time check

Any questions?

# DESTINATION INTERVENTION STRATEGIES

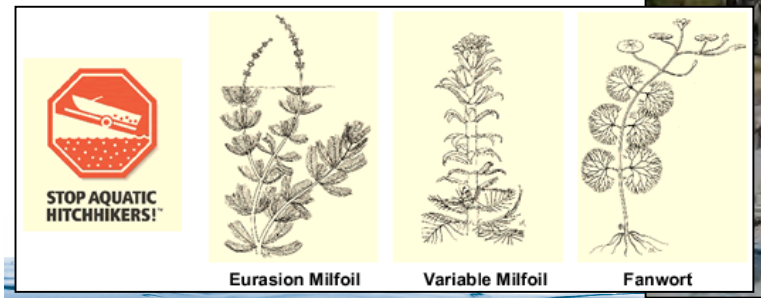
Ring of protection

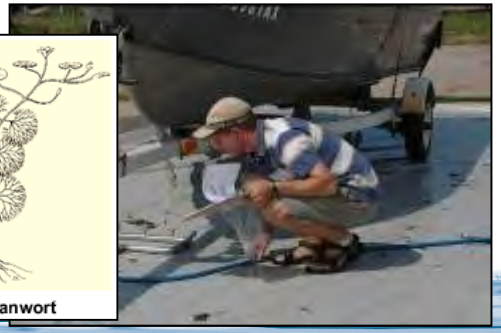


Invaded lakes

## Protection

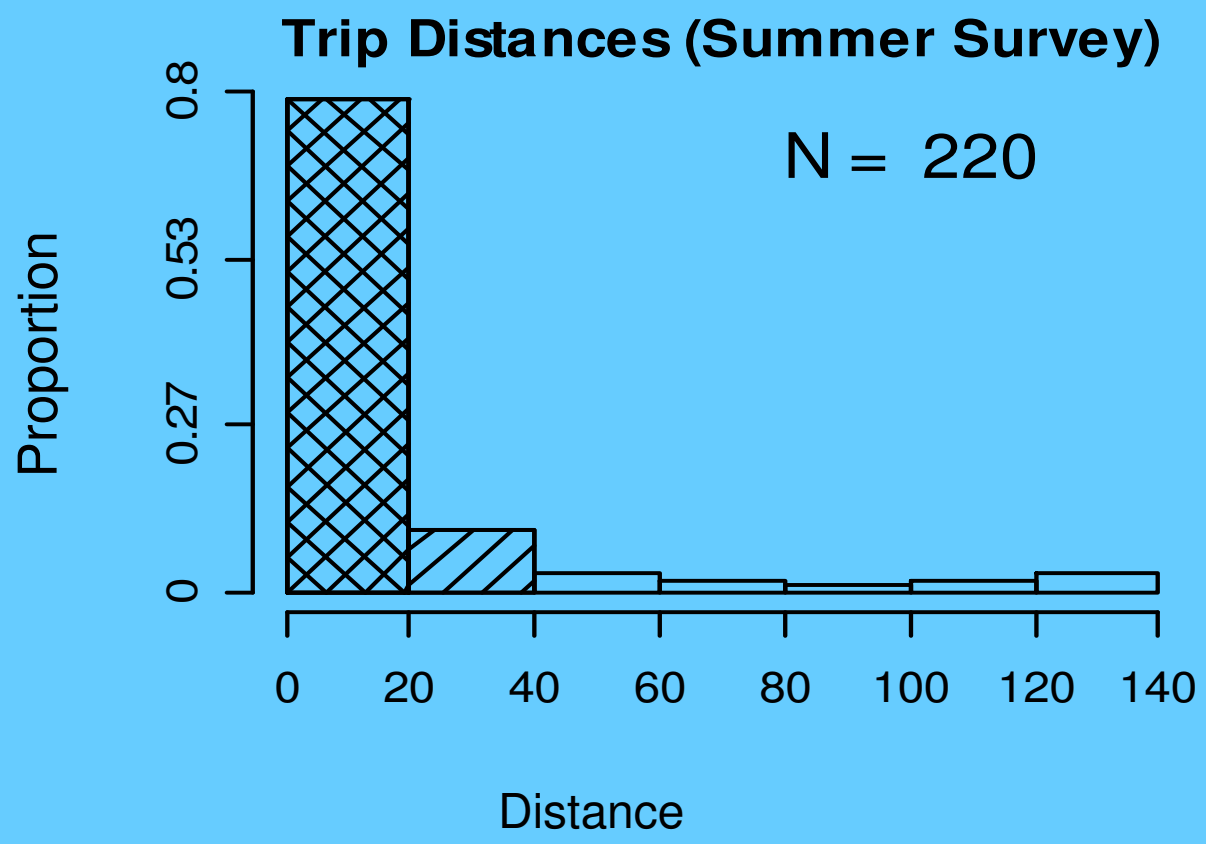
i. All boats are inspected and cleaned before they enter AIS free systems
ii. Close to high risk boaters
iii. Surveillance for EDRR



# Trip distances (summer survey n= 135)

**Movers:** 135 boaters and 220 individual movements

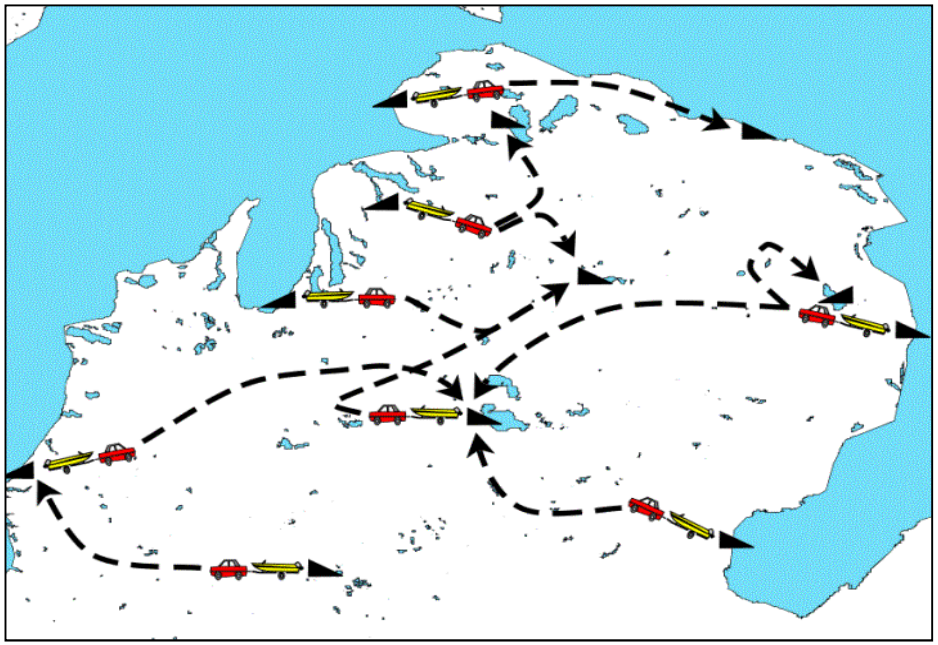


# HOW WE ESTIMATE BOATER MOVEMENT PATTERNS

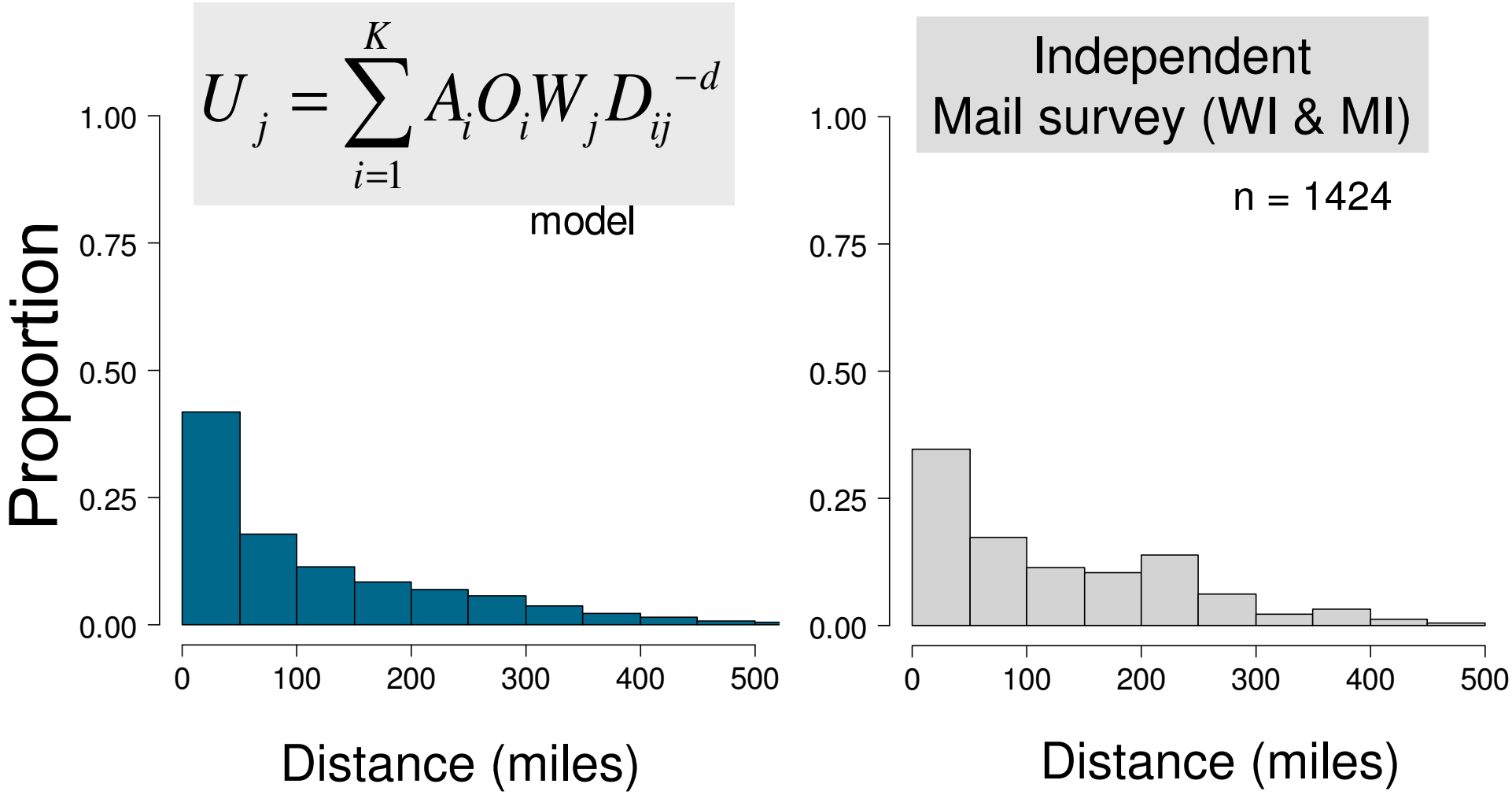
$$U_j = \sum_{i=1}^{K} A_i O_i W_j D_{ij}^{-d}$$

Traffic vector | # Boaters at Origins | Attractiveness of Destinations | Origin-Destination Distance and Distance Exponent

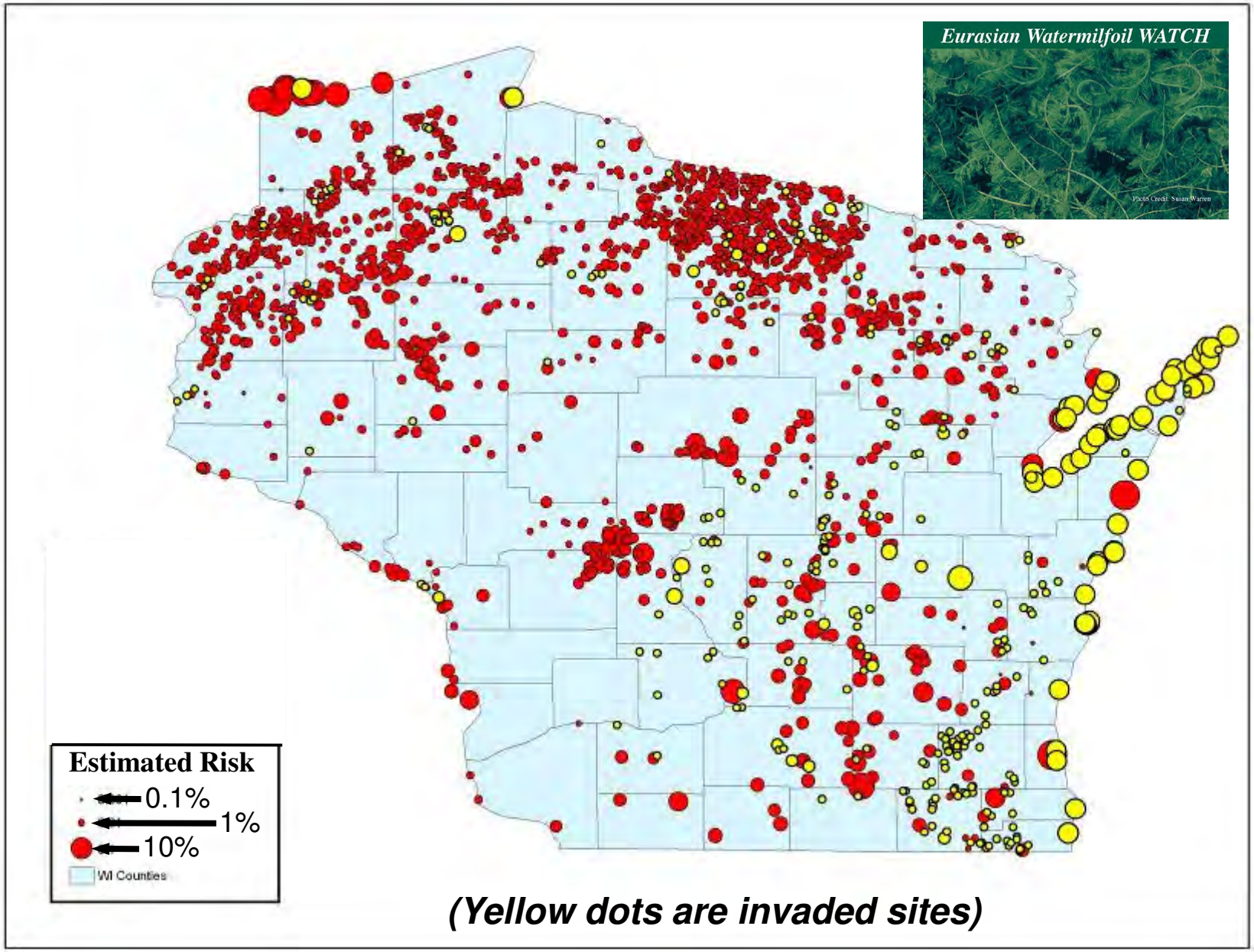
Gravity model goals:
- Estimate risk
- Predict invasions



# MODEL REFLECTS ACTUAL BOATER MOVEMENT PATTERNS

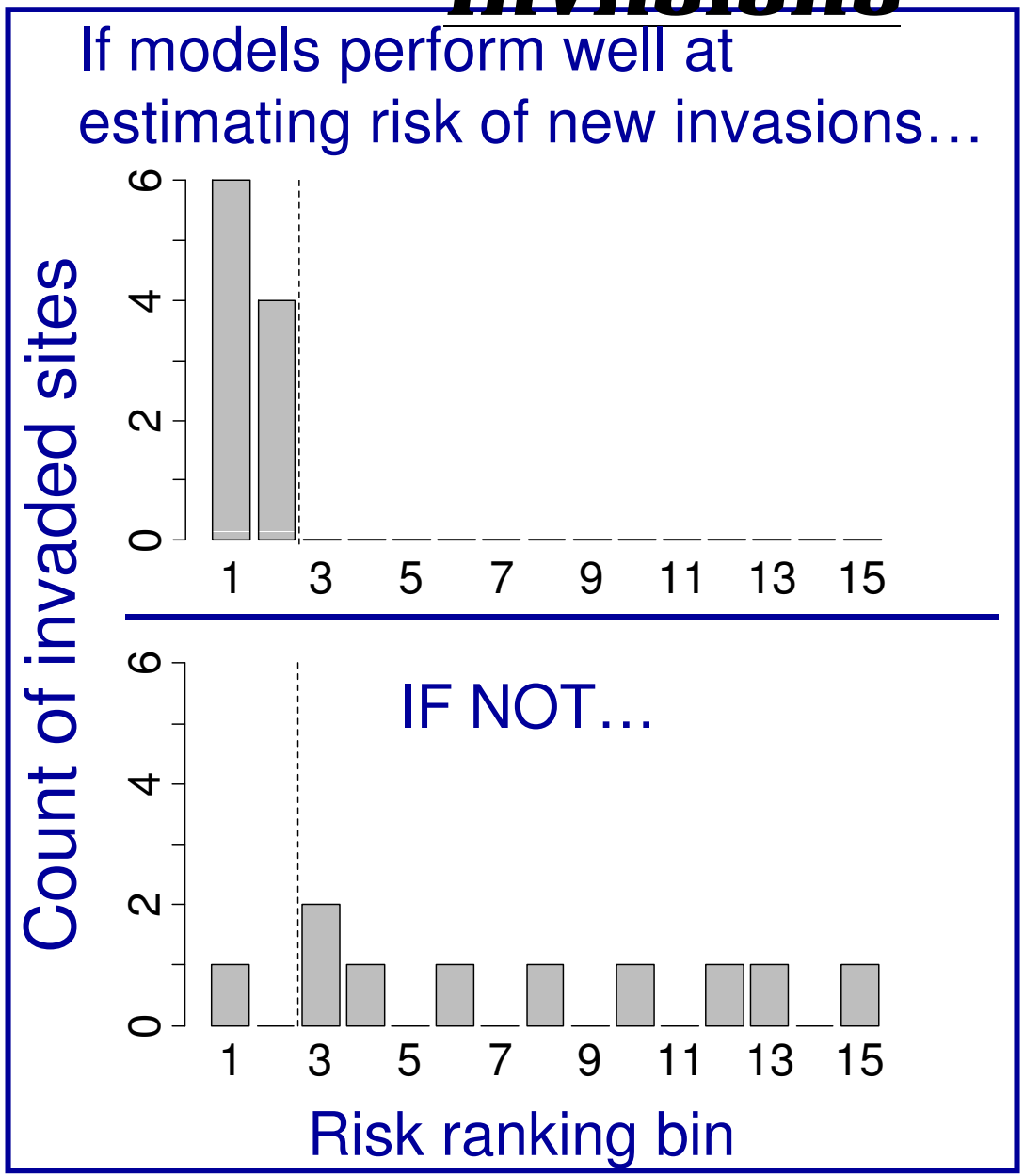


# WI GRAVITY MODEL RISK ESTIMATES



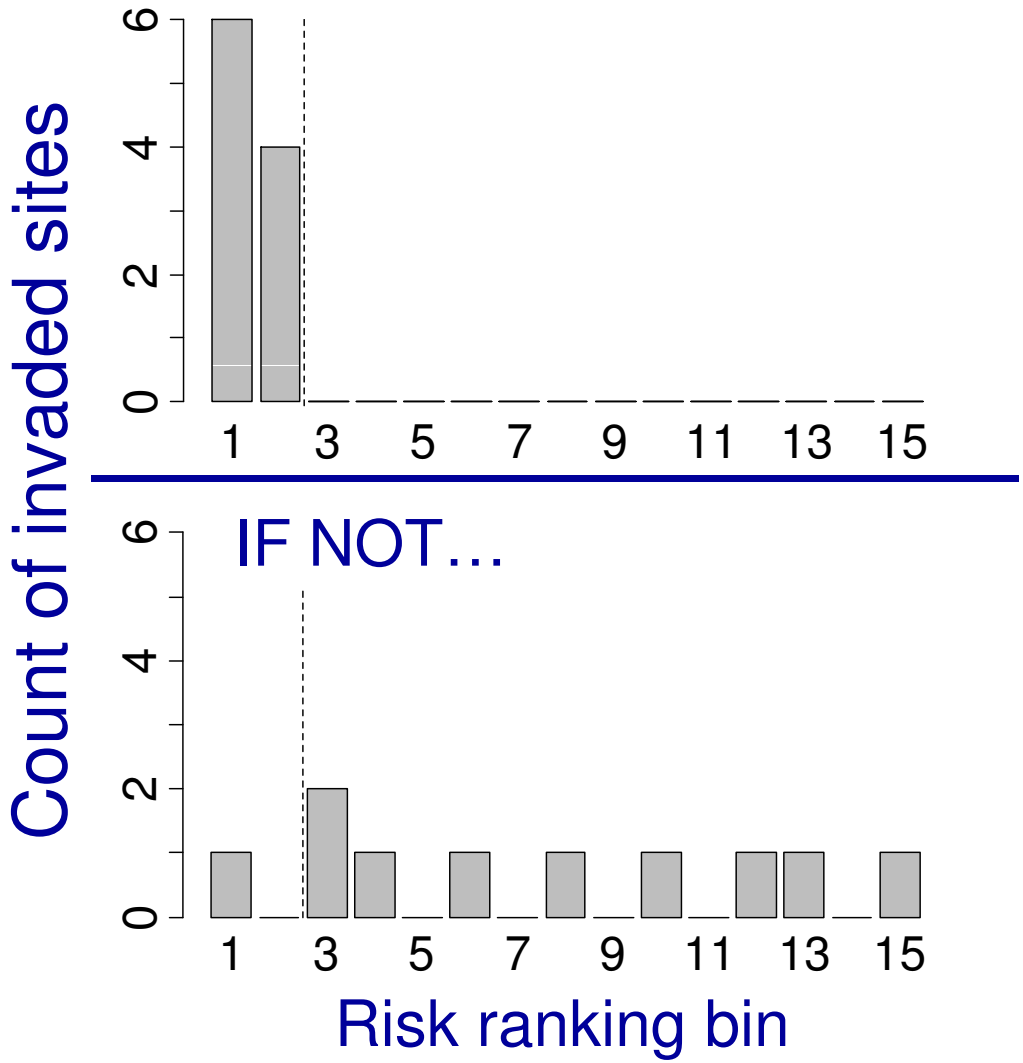

*(Yellow dots are invaded sites)*

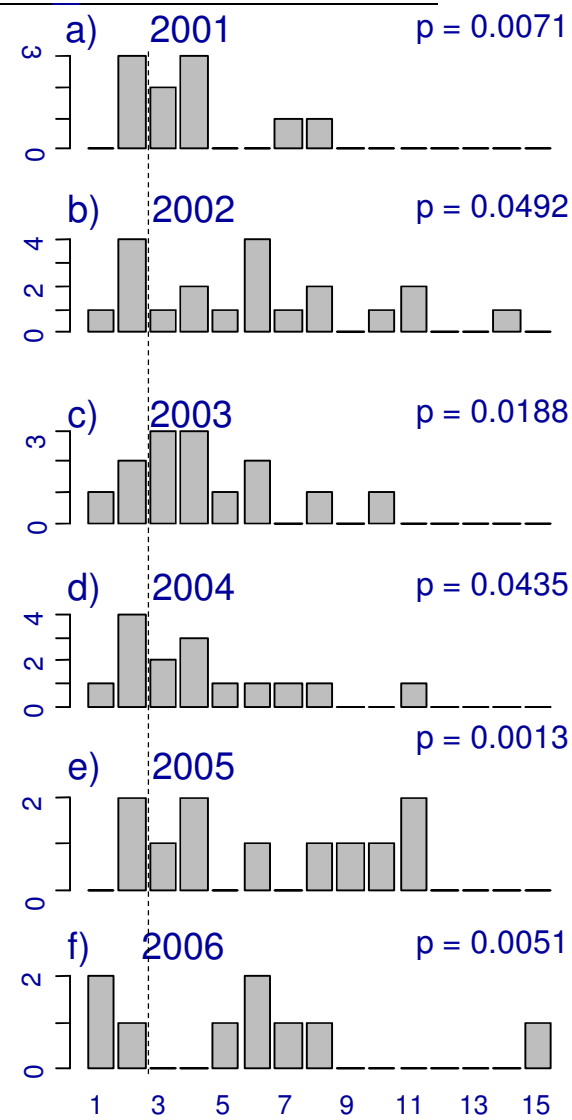
# ESTIMATED RISK VS. ACTUAL INVASIONS



# MODEL ESTIMATES ACTUAL INVASION PATTERN POORLY

If models perform well at estimating risk of new invasions…




Actual risk ranking bin

# THE PROBLEM IS WE ARE TRYING TO MANAGE RARE EVENTS

- 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
- Aquatic invasions are usually rare events?

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

Bossenbroek, Kraft & Nekola. 2001

# 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)

# HOW DO WE MANAGE RARE EVENTS

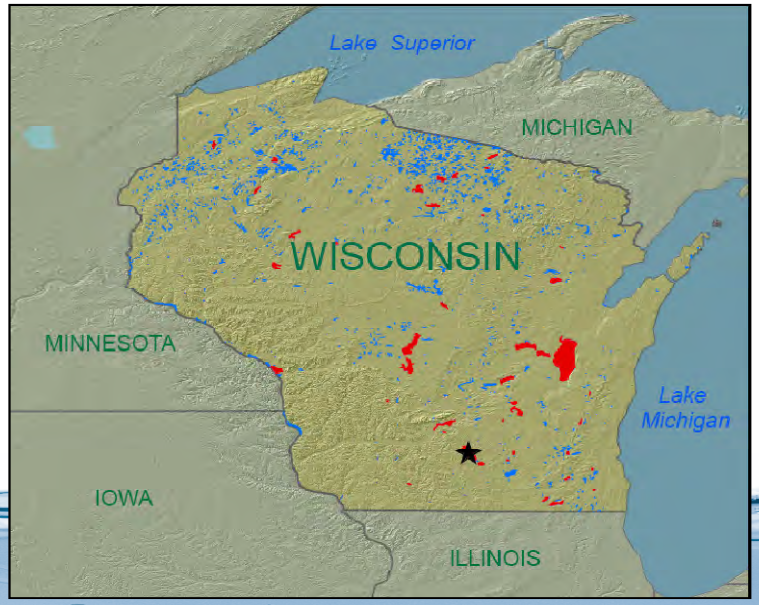
**Key points:**

1. Attempting to manage invasion by focussing on AIS destinations and preventing new invasions may in many cases be less effective and misplaced effort
2. Still value in **protecting really high value sites** where invasion could cause irreversible loss (e.g. endangered species) and
3. **Value in protecting important potential sources**: sites that once invaded eradication is impossible and they will become important sources

# TAKE HOME MESSAGE

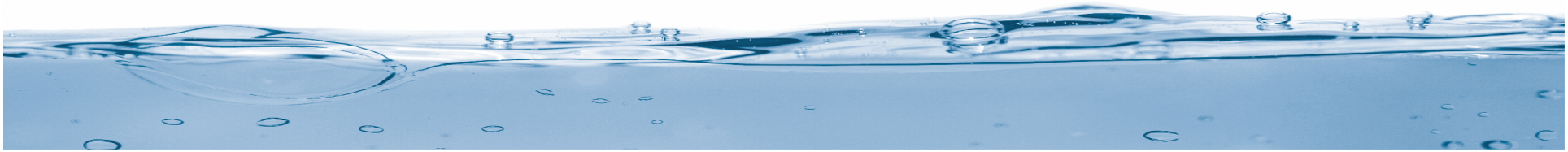
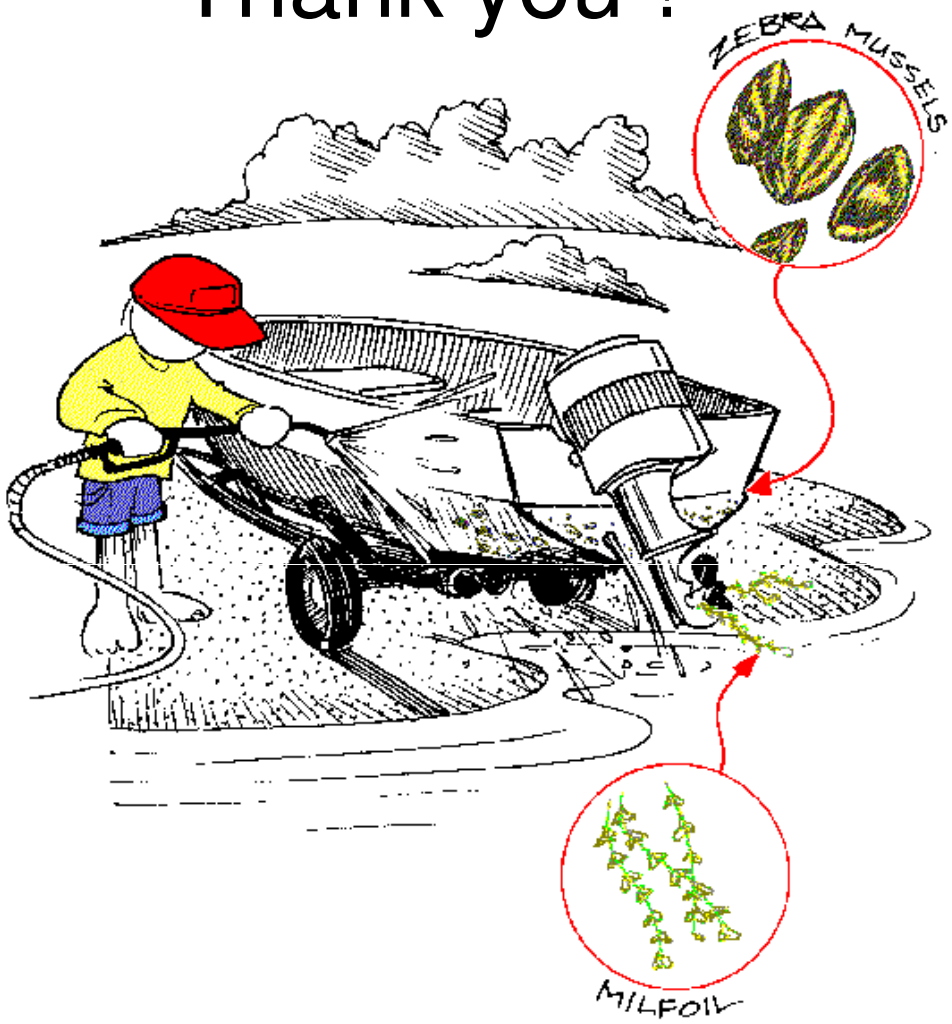
- Identify and quarantine super spreaders (key sources: high use & highly invaded waters; easily transported)

- Identify and target high risk boating groups
  - Encourage them to use clean boat practices



# PROTECT HIGH VALUE SITES: SYSTEMATIC SURVEILLANCE FOR EDRR

- Systematic surveillance to enable EDRR of species vulnerable to early intervention
- Identify and monitor invasive free system that could **become super spreaders**
  - headwater lakes with high natural connectivity to other systems
  - large systems where control/eradication effectively impossible (too big)
- High valued fisheries or vulnerable systems (threatened species)



# Thank you !