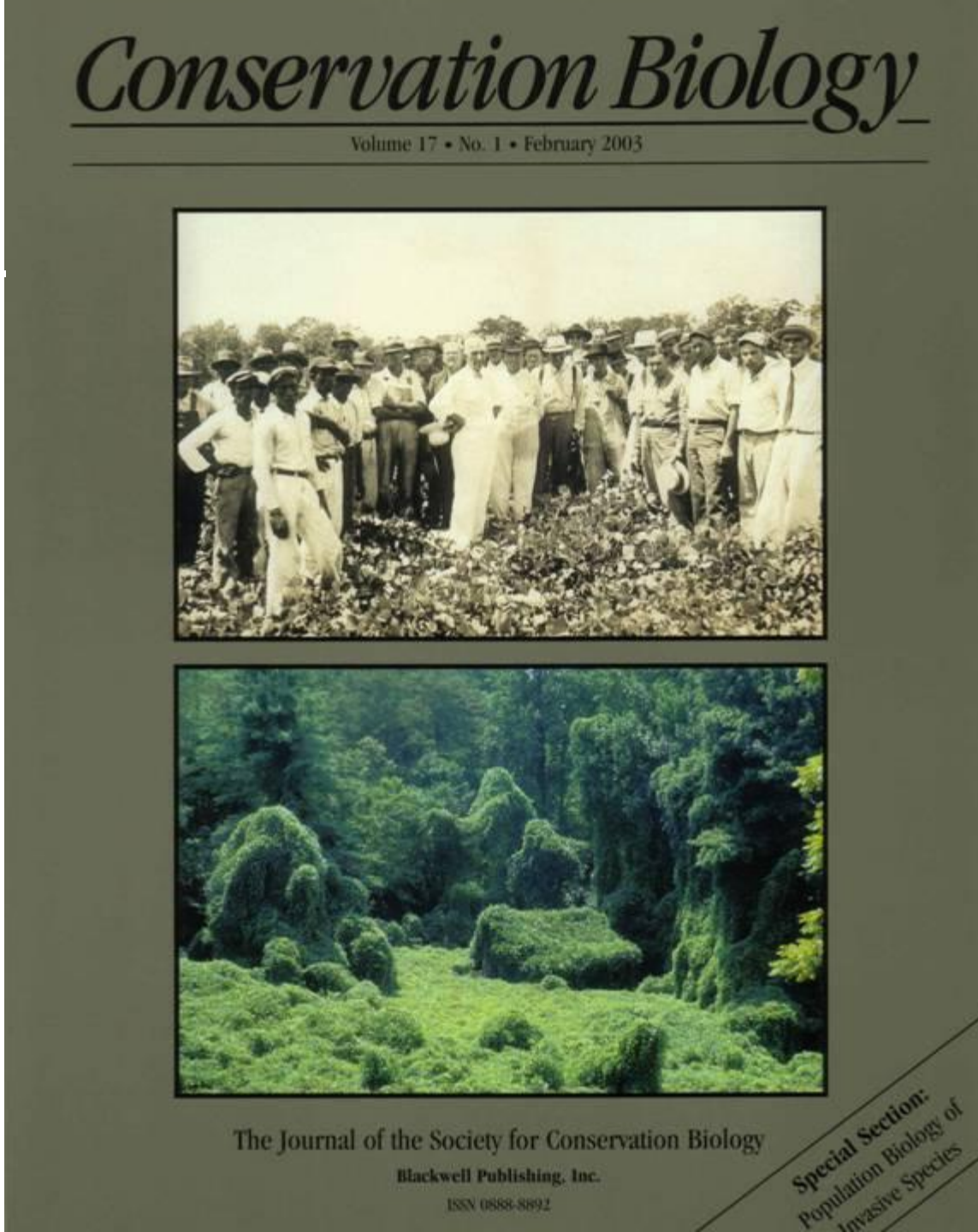
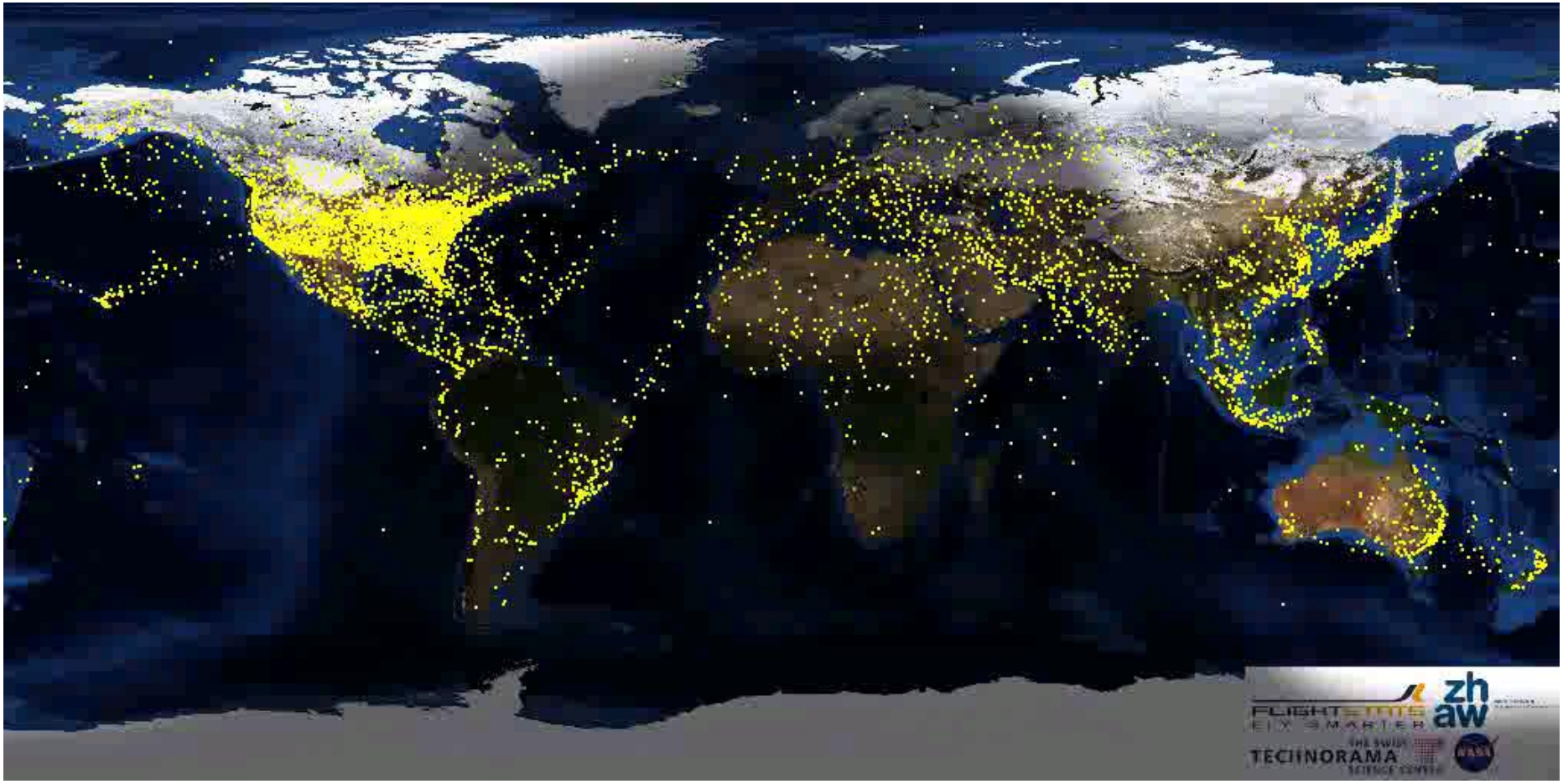
Alien Invasive Species

Problem:
Net Effect =
Harm > Benefit

Solutions:
Managing species,
mostly people

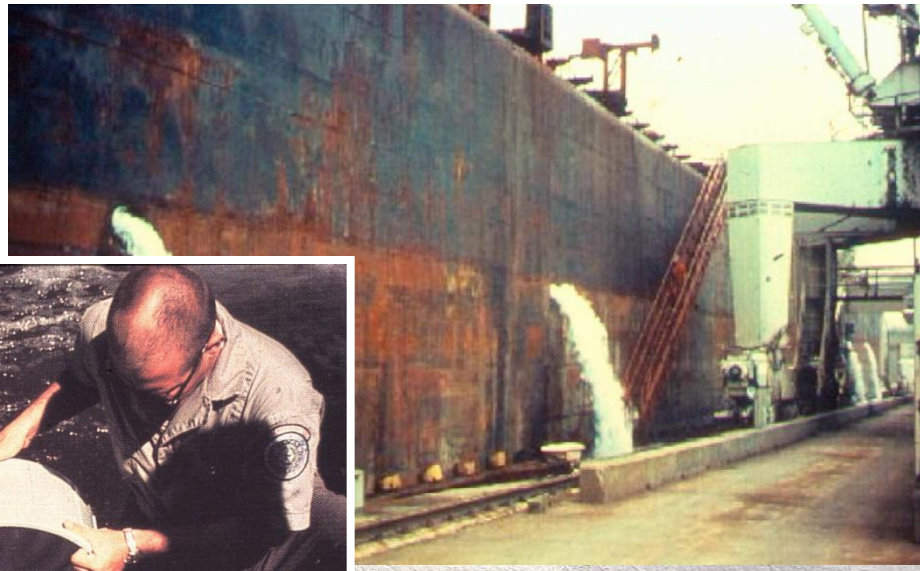


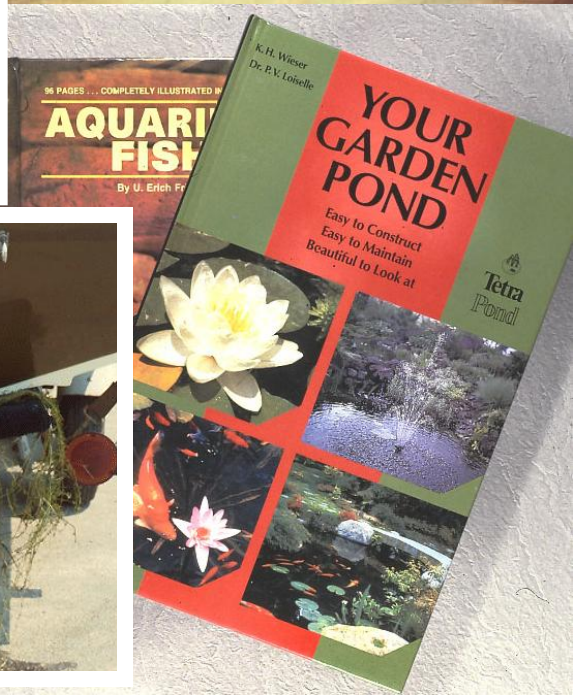
Networks of Species Spread
Global Air Traffic as a Pathway
Intentional and Inadvertent Transport

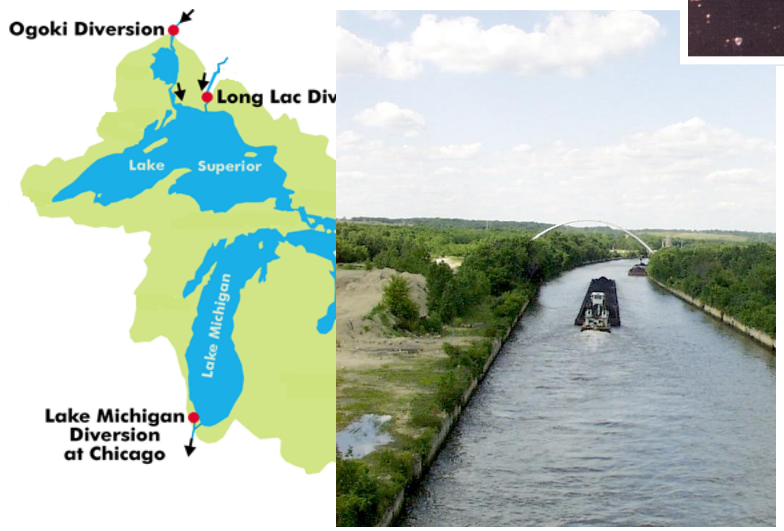


Other Pathways

seedman.com
Seeds From Around the World
Jim Johnson, Seedman, 3421 Bream St., Gautier, MS 39553
Phone: 800-336-2064 Fax: 228-497-5488







Other Pathways

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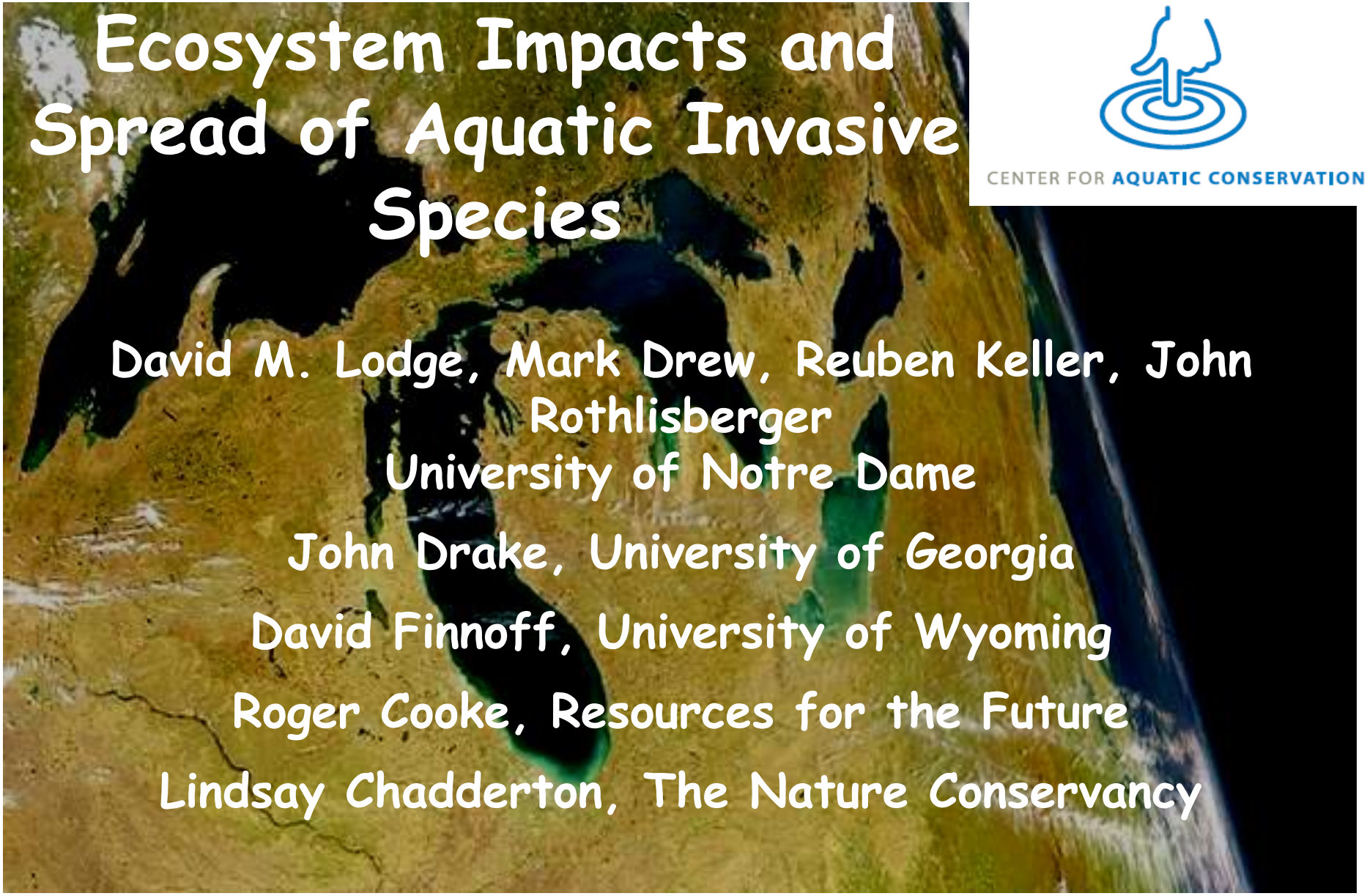
Ecosystem Impacts and Spread of Aquatic Invasive Species



David M. Lodge, Mark Drew, Reuben Keller, John Rothlisberger
University of Notre Dame

John Drake, University of Georgia

David Finnoff, University of Wyoming

Roger Cooke, Resources for the Future

Lindsay Chadderton, The Nature Conservancy

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Alien Species in Aquatic Ecosystems

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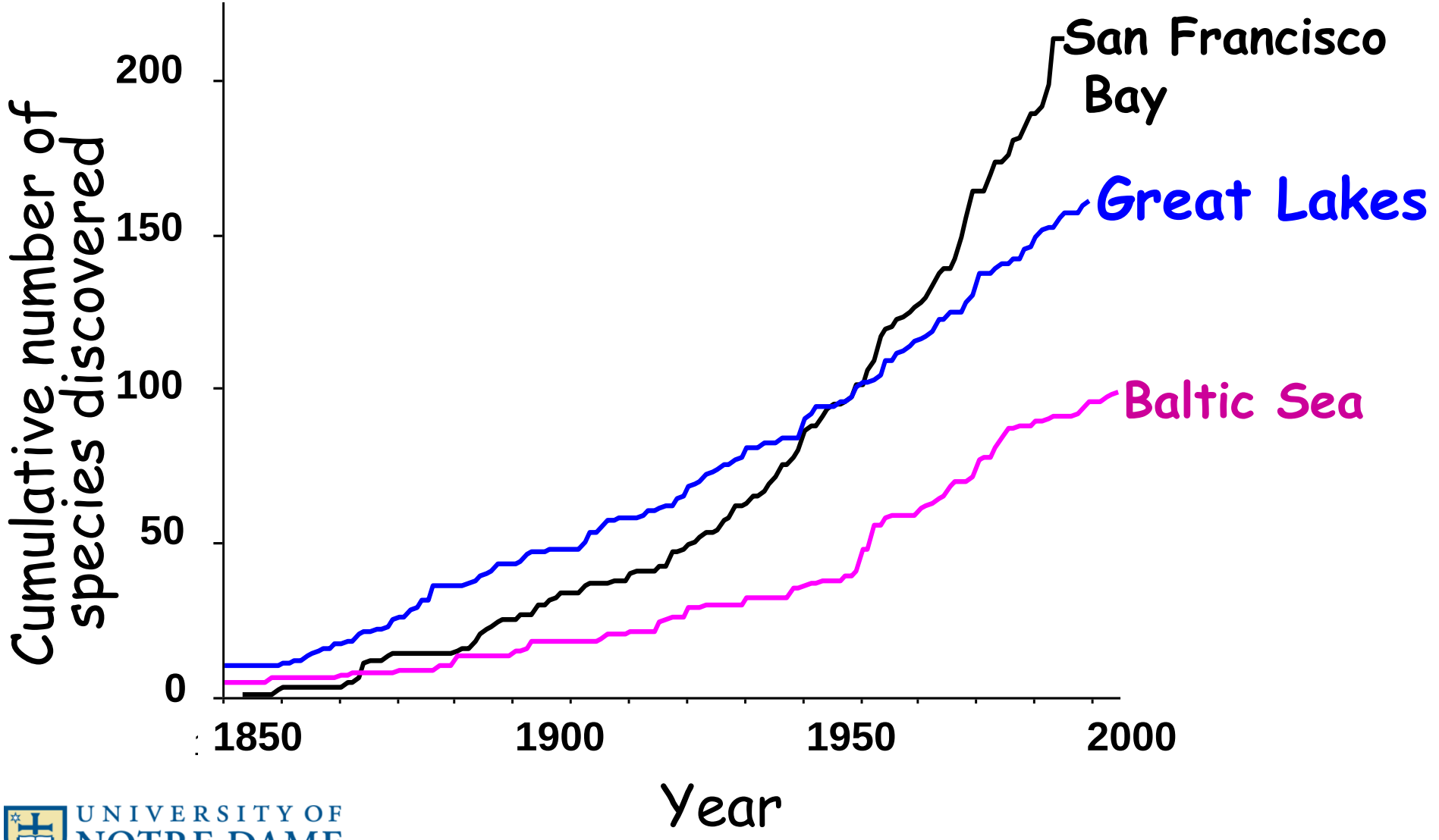

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Shipping Network: Great Lakes as the Beachhead

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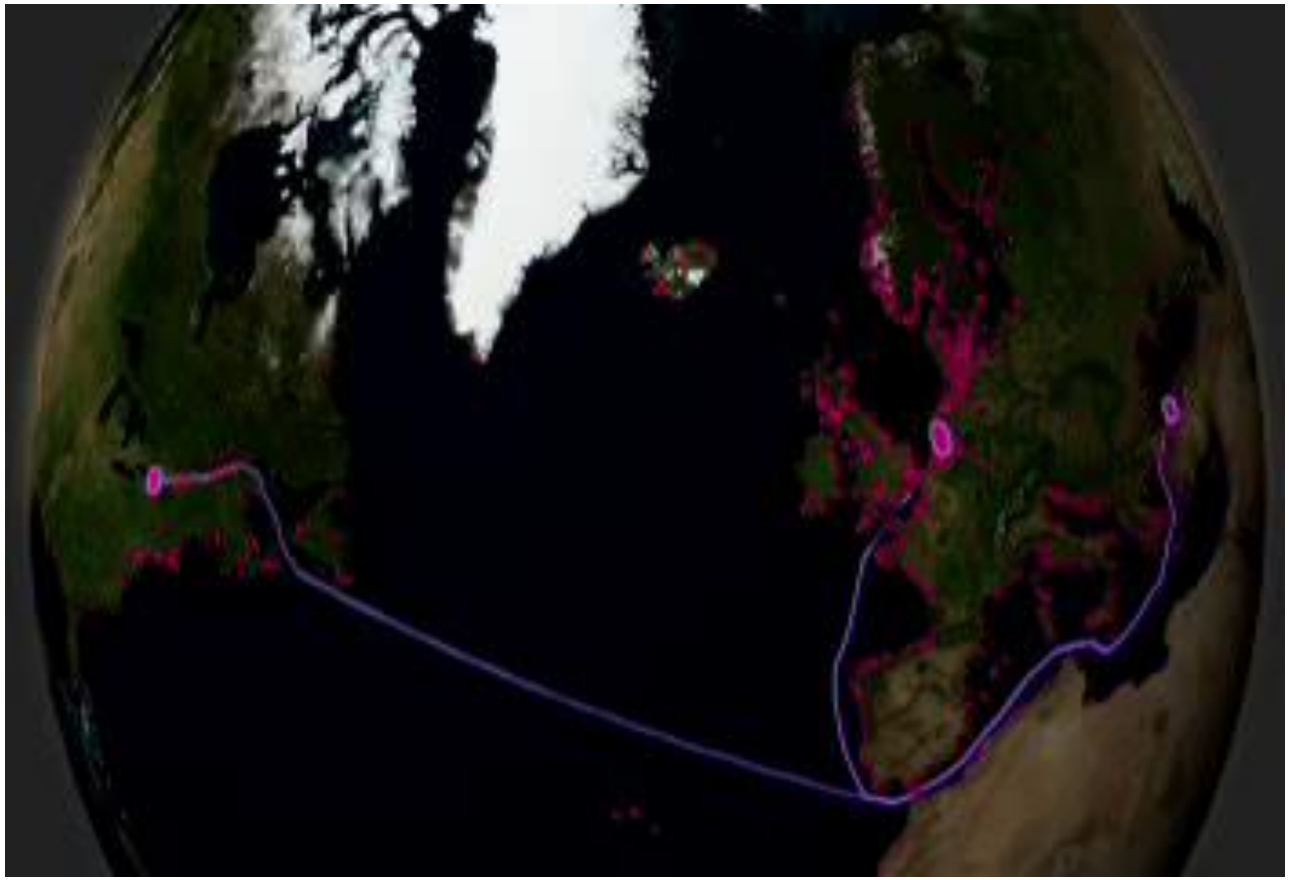

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Great Lakes as the Beachhead

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Great Lakes as the Beachhead

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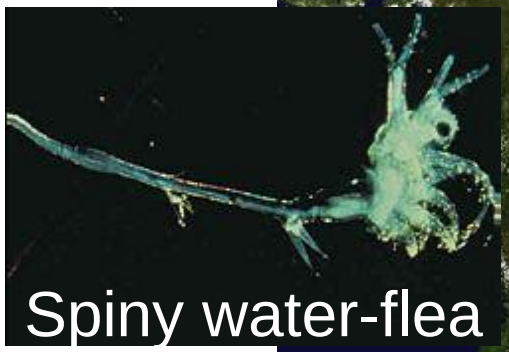

Spiny water-flea

Round goby

Dave Jude. Center for Great Lakes Aquatic Sciences.

Zebra mussel

VHS

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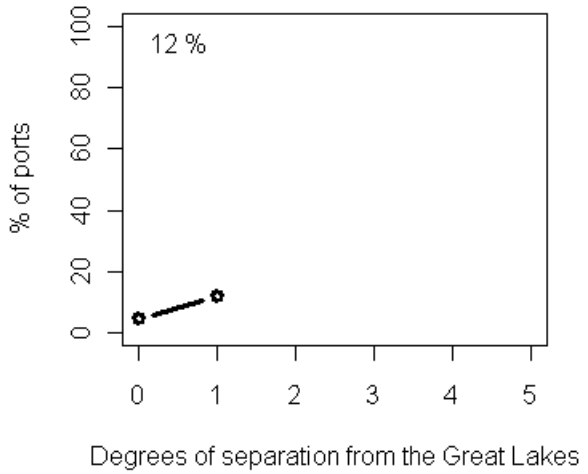
Great Lakes Connections to Global Shipping Network

CENTER FOR AQUATIC CONSERVATION

12% of Global Ports connected by 1 degrees of separation



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Great Lakes Connections to Global Shipping Network

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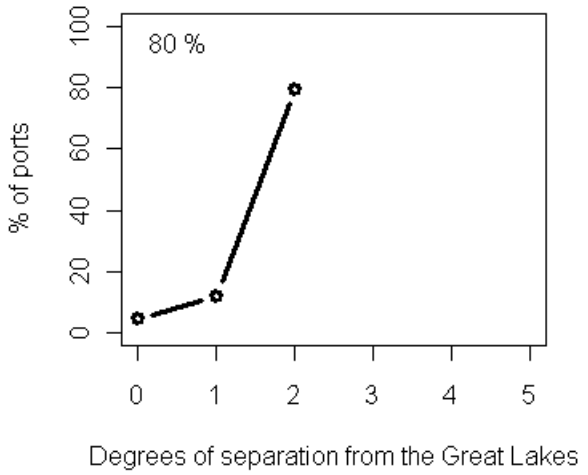
80% of Global Ports connected by 2 degrees of separation



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Great Lakes Connections to Global Shipping Network

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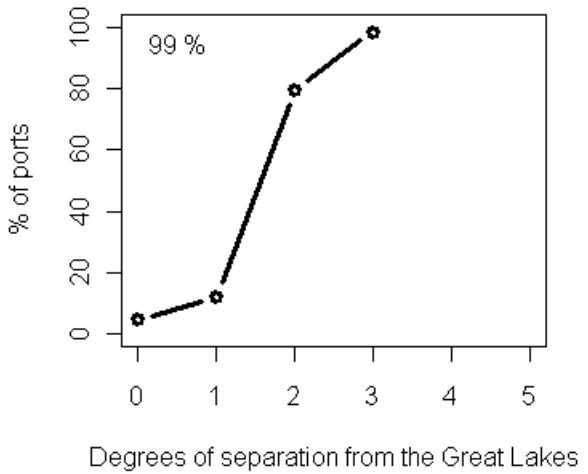
99% of Global Ports connected by 3 degrees of separation



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Great Lakes Connections to Global Shipping Network

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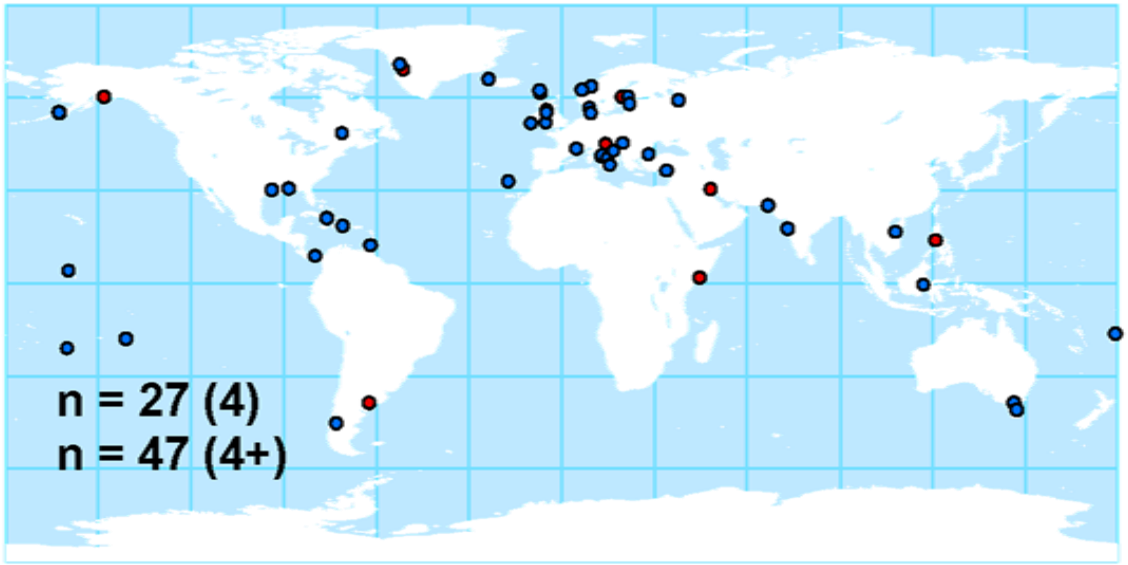
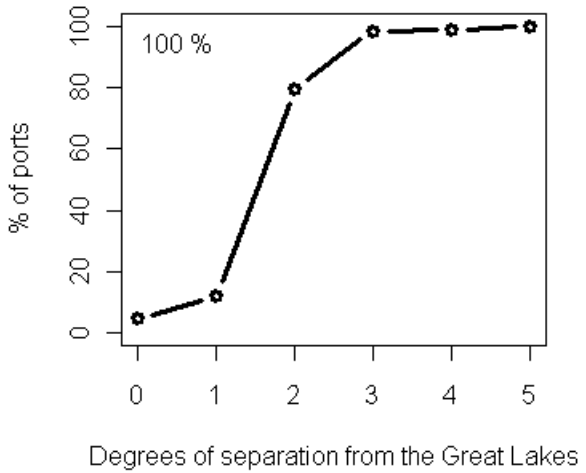
100% of Global Ports connected by 5 degrees of separation





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Conclusions from Network Thinking

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- Great Lakes are connected to the rest of the world's ports with a few degrees of separation
- Temperate freshwater or estuarine species from any port in the world are potential invaders into the Great Lakes
- Through the Great Lakes, the global shipping network connects to the recreational boater network
- So what? What are the impacts?

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Zebra and Quagga Mussels

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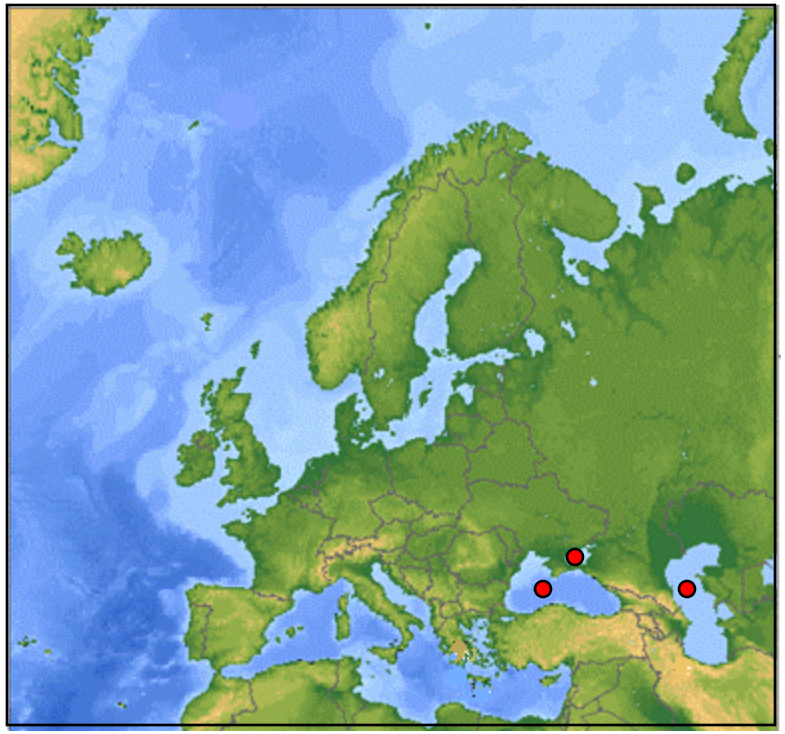
- native to Black & Caspian Seas
- ballast water & hull
- first reported 1986



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Limited Information available on Impacts

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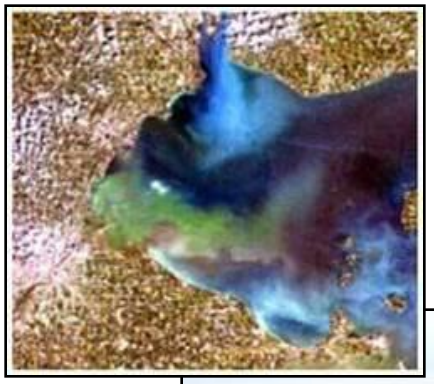

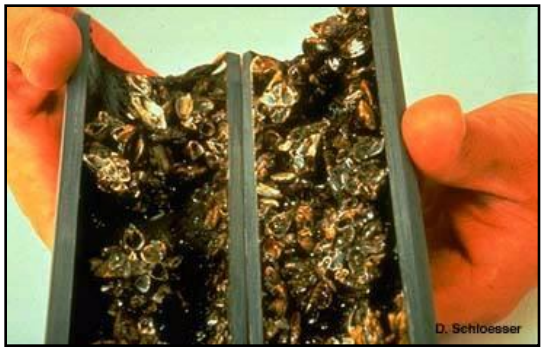

Non-market costs: loss of native clams

Market costs: clog water intake pipes

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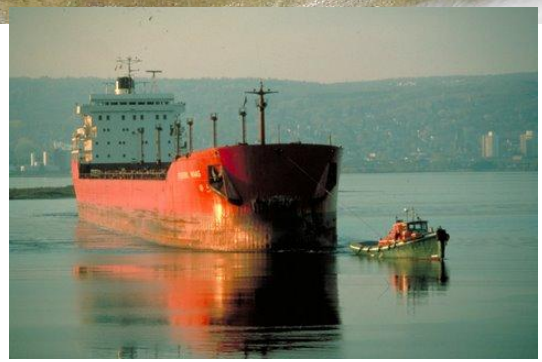
Assessing Species Impacts from Shipping in the GL



Ecosystem Services

Images courtesy US EPA Visualizing the Great Lakes collection

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Determining Impacts: Structured Expert Judgment (SEJ)

European Commission

Community research

Project report

Nuclear science and technolo

Sector

- Nuclear Applications
- Chemical & Gas Industry
- Water pollution (ground and surface)
- Aerospace sector/space debris
- Health: Campylobacter & SARS
- Volcanoes & Dams

Procedures guide for structured expert judgment

"Expert judgment is sought when substantial scientific uncertainty impacts on a decision process."
(Cooke and Goosens 2005)

EURATOM

Types of Elicitation Variables

- Commercial fish landings
- Sport fishing effort
- Biofouling—raw water uses
- Wildlife watching

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What Sort of Experts?

- Fishery biologists
- Industry reps (e.g., power, shipping, angling)
- Environmental economists
- Leisure studies researchers
- GL food web ecologists

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Who are *our* Experts?

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Richard Aiken (recreation economist, USFWS)
Renata Claudi (industry damages, Ontario Hydro)
Mark Ebener (fisheries, CORA, GLFC)
Leroy Hushak (economist, Ohio State U.)
Frank Lupi (economist, Michigan State U.)
Roger Knight (fisheries, Ohio DNR, GLFC)
Lloyd Mohr (fisheries, Ontario MNR, GLFC)
Chuck O'Neill (NY Sea Grant, industry damages)
Don Scavia (ecologist, MI Sea Grant, U. Michigan)
Roy Stein (ecologist, Ohio State U., GLFC)

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Expert Elicitation Background Data

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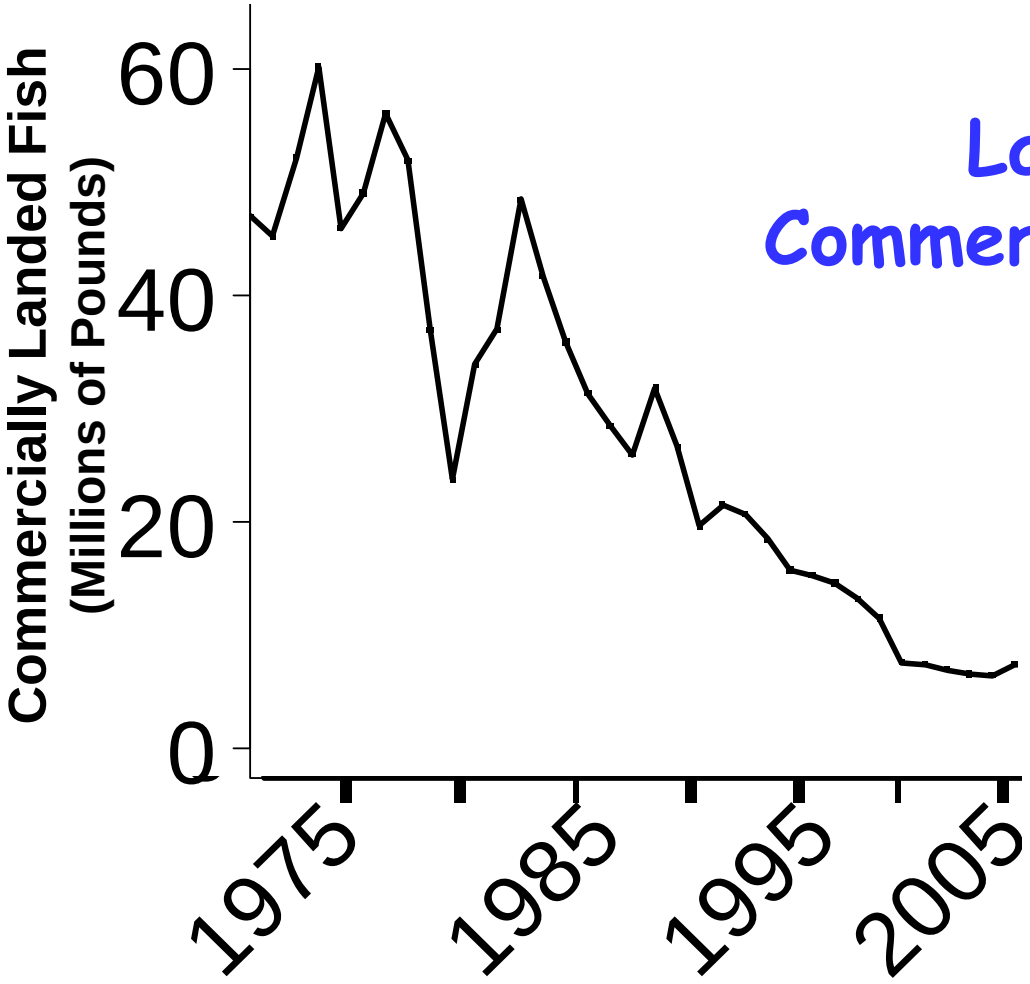

Lake Michigan Commercial Fish Landings

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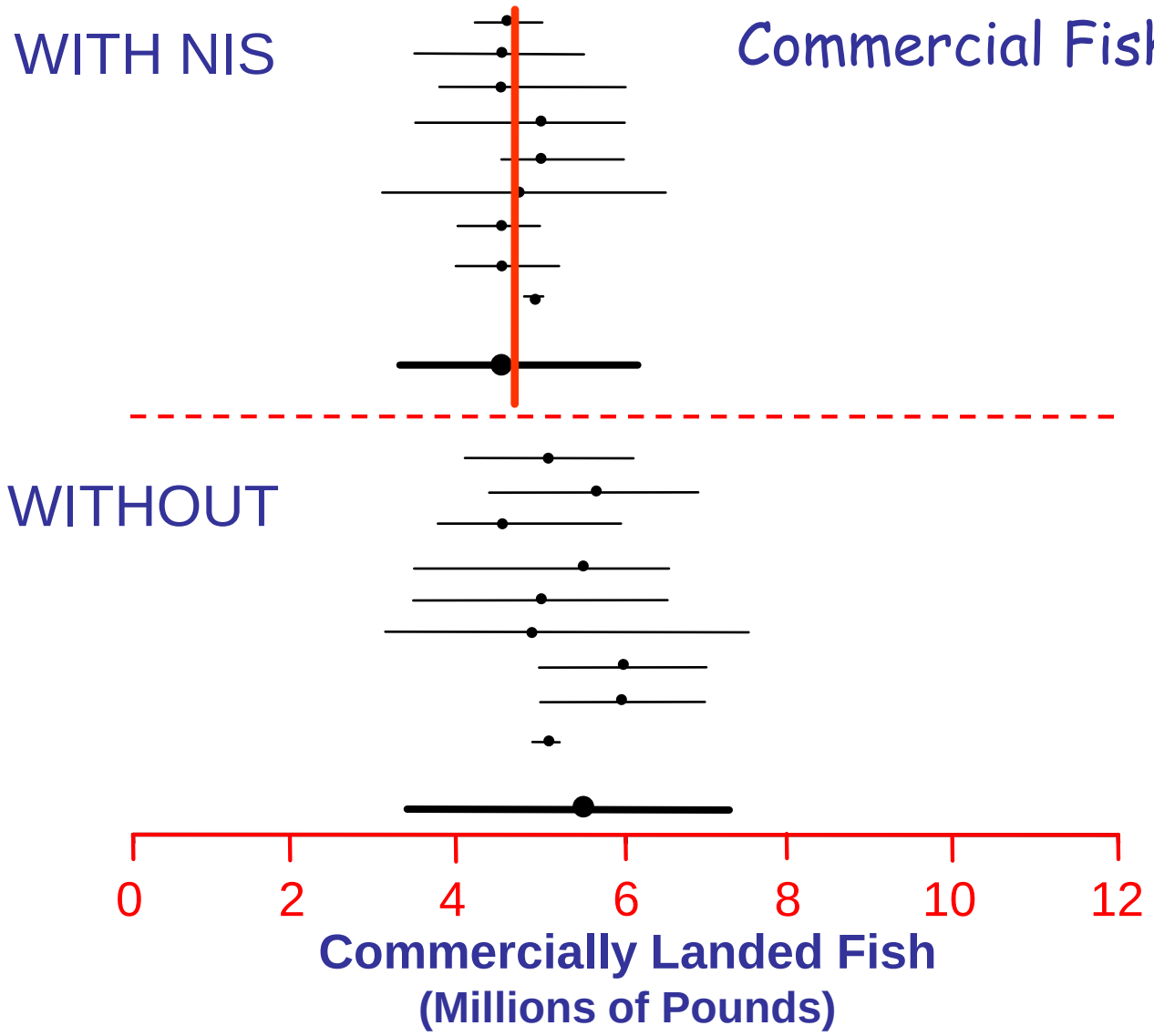
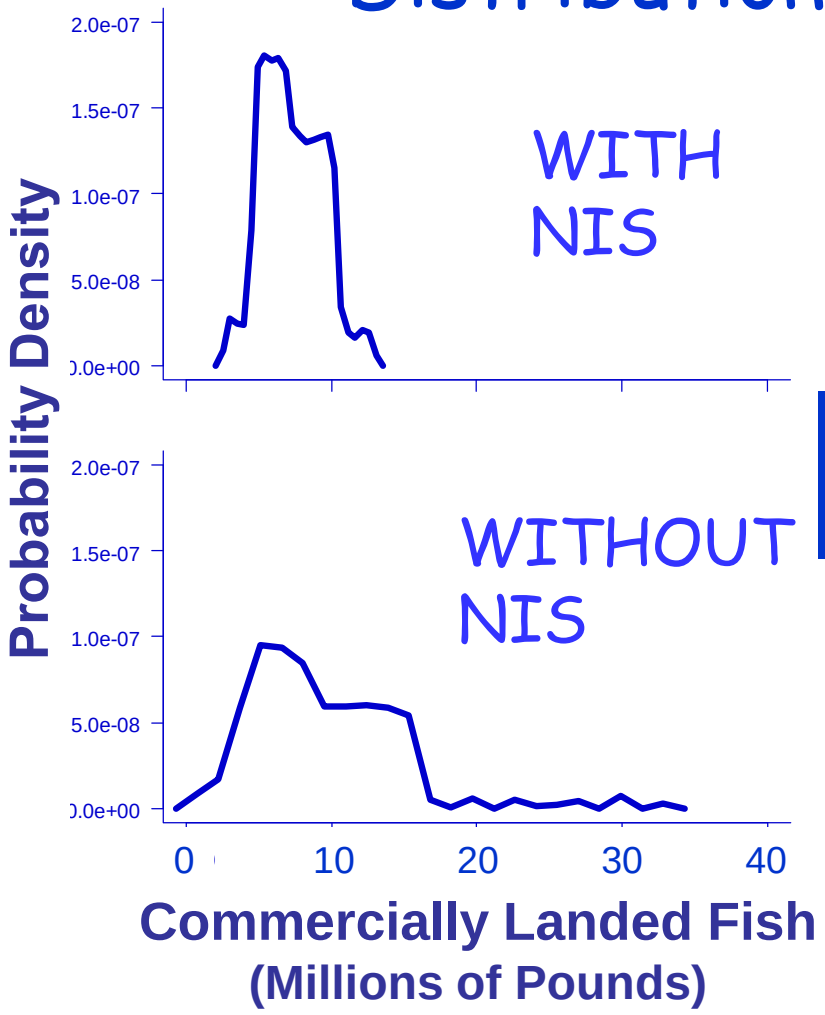
Elicited Data and Calibration



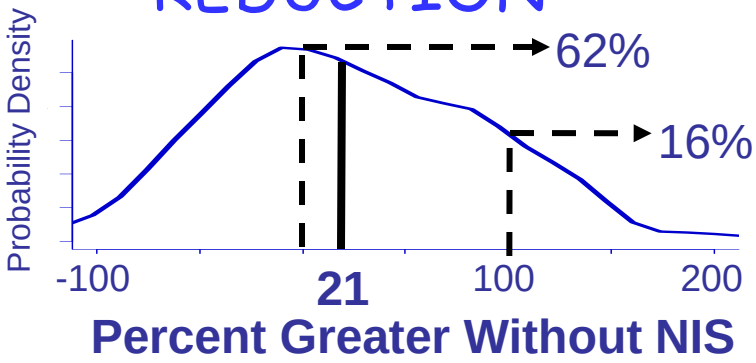
Combined Expert Assessments and Impact Distributions



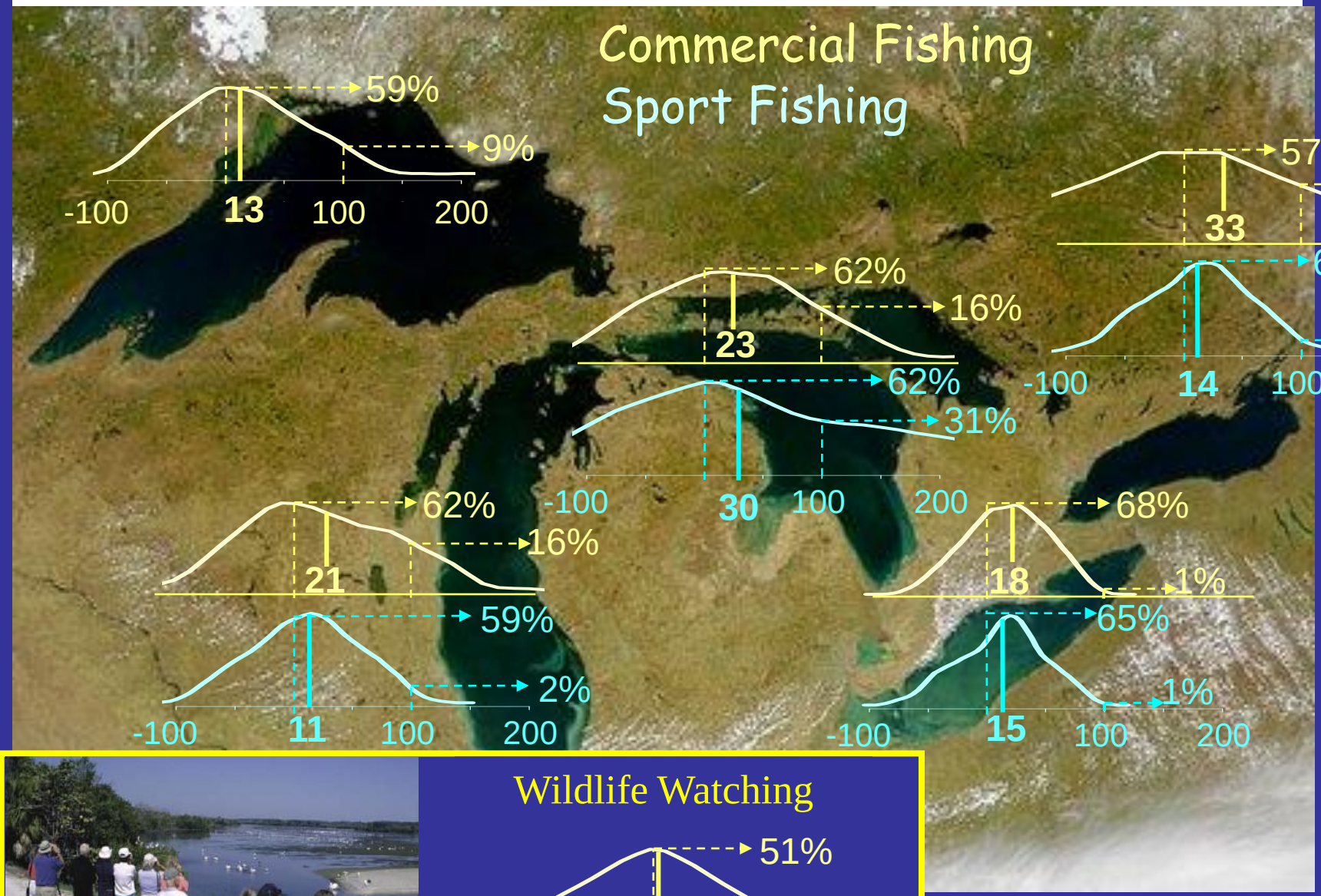
WO-WITH/ WITH

2006 Lake Michigan Commercial Fishing

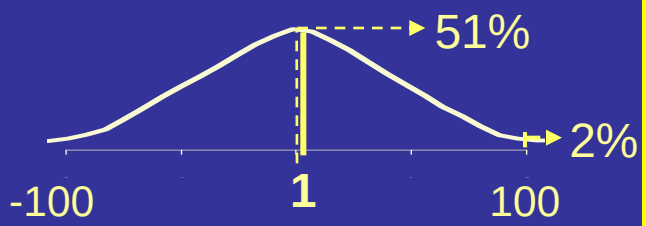
PERCENT REDUCTION



2006 Percent Reduction Distributions



Wildlife Watching



Economic Damages from Ship-borne Invasions

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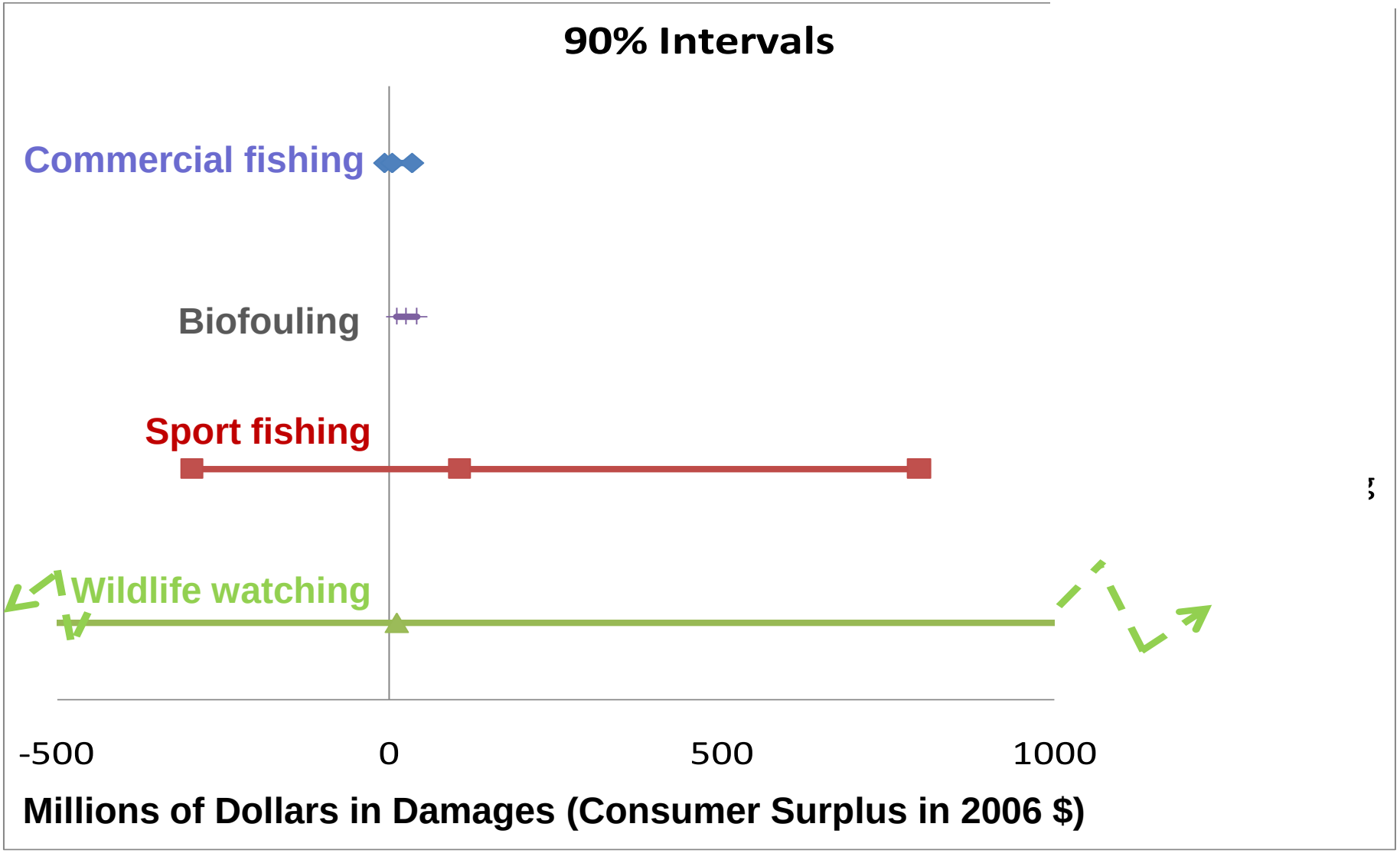

Conclusions on Economic Impact

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- Comprehensive estimates of invasion-induced losses of ecosystem services from shipping
- Substantial reductions in sport and commercial fishing
- Highly uncertain impacts on wildlife watching
- Impacts estimated conservatively:
  - not including beach recreation, recreational boating
  - only US (not including Canada)
  - only impacts in Great Lakes proper

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Great Lakes as the Beachhead

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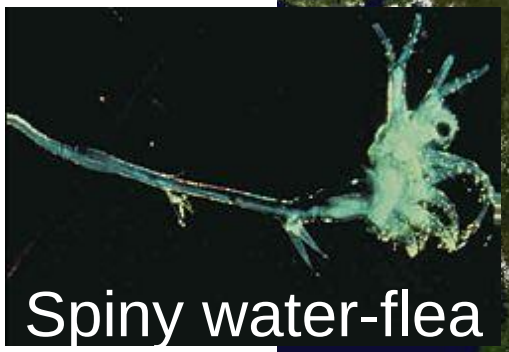

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Spread of Mussels

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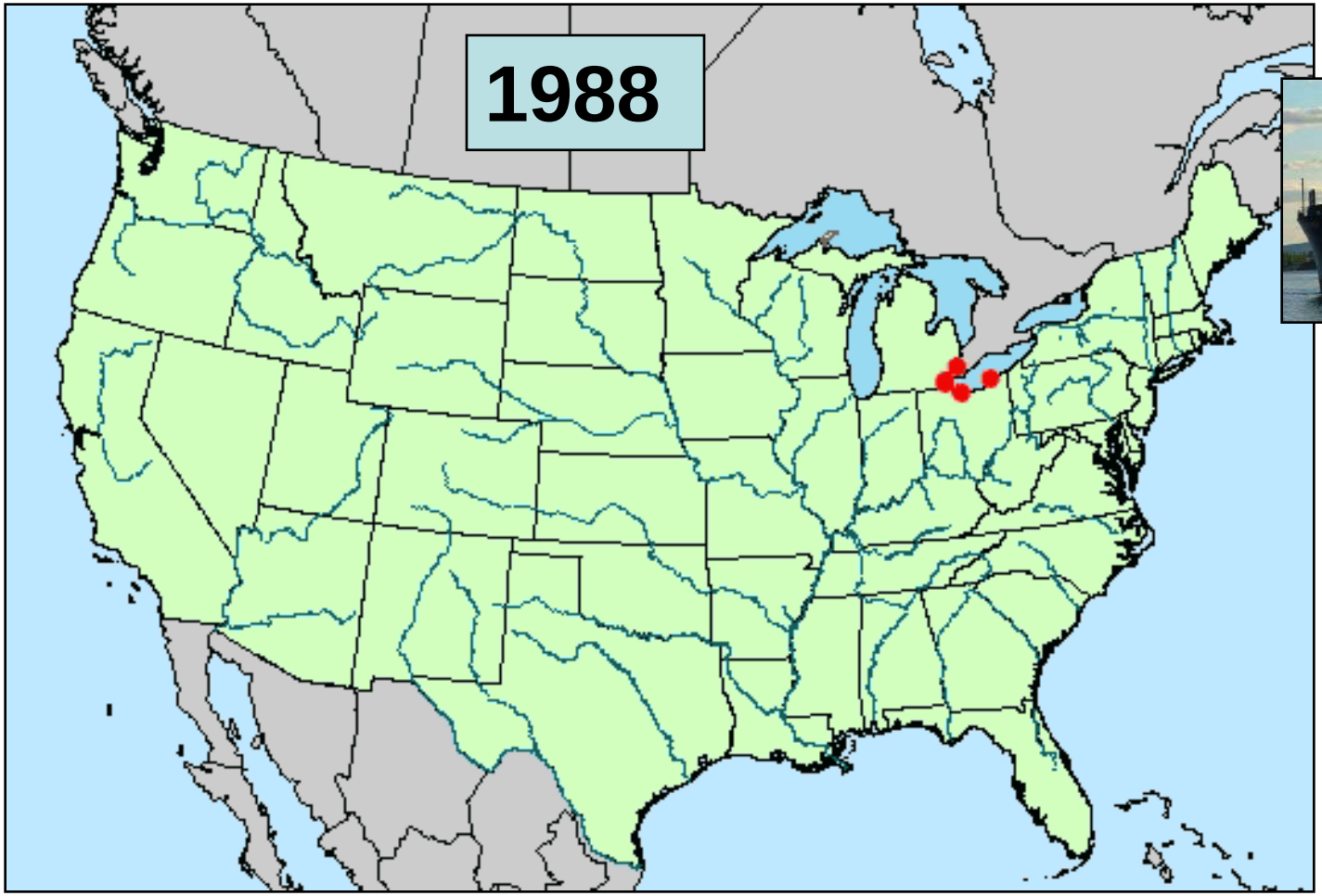

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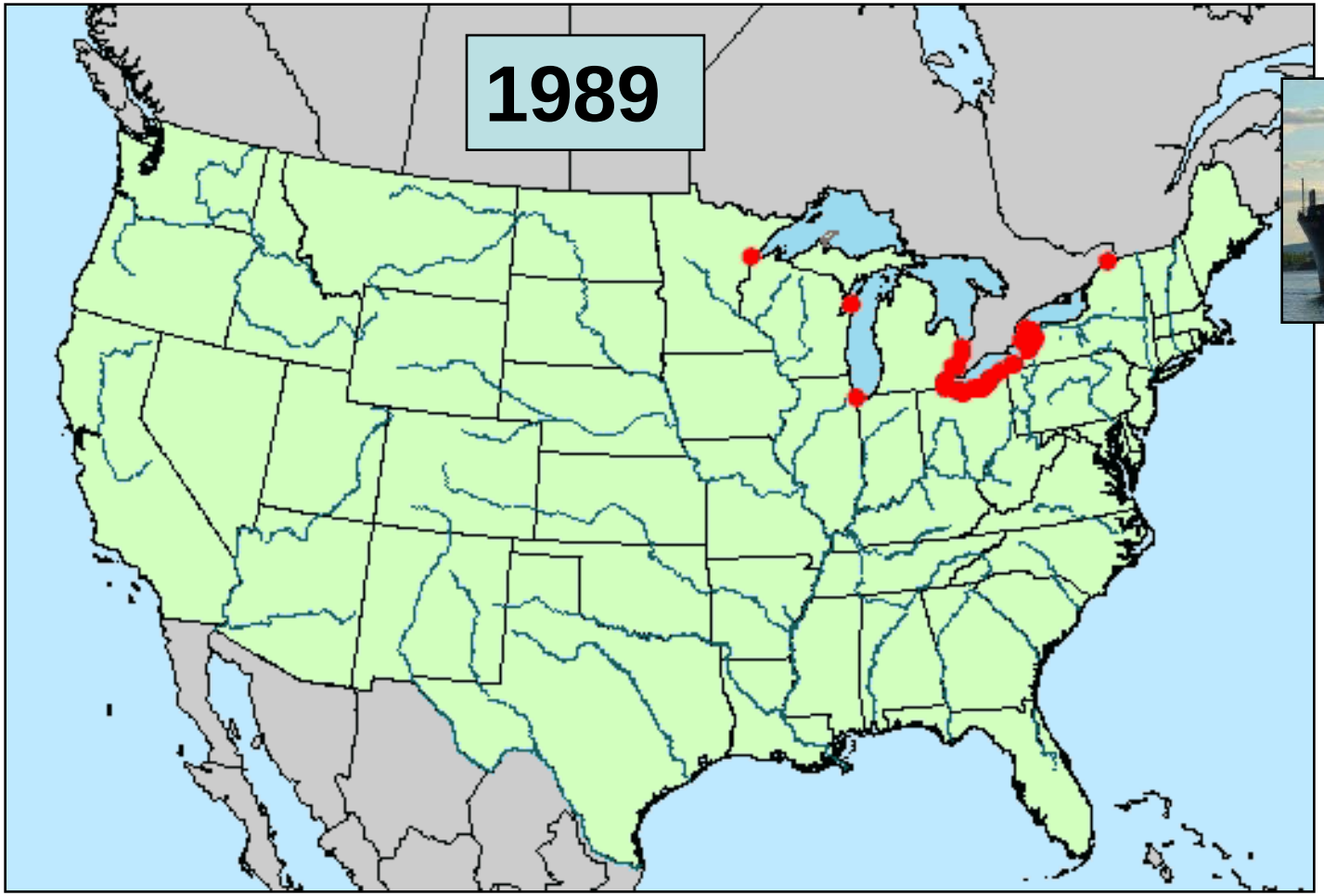
Spread of Mussels

CENTER FOR AQUATIC CONSERVATION



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Spread of Mussels

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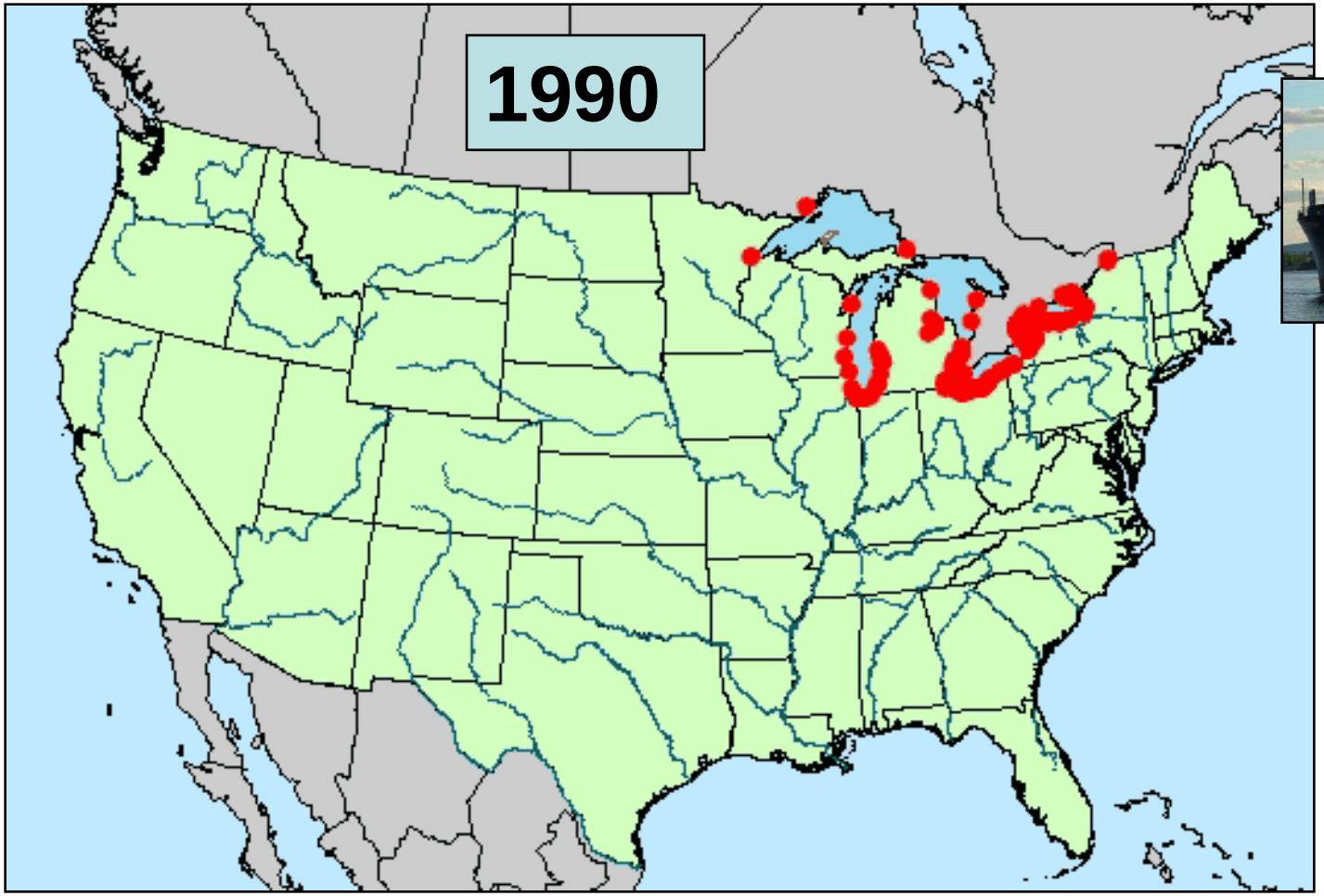

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Spread of Mussels

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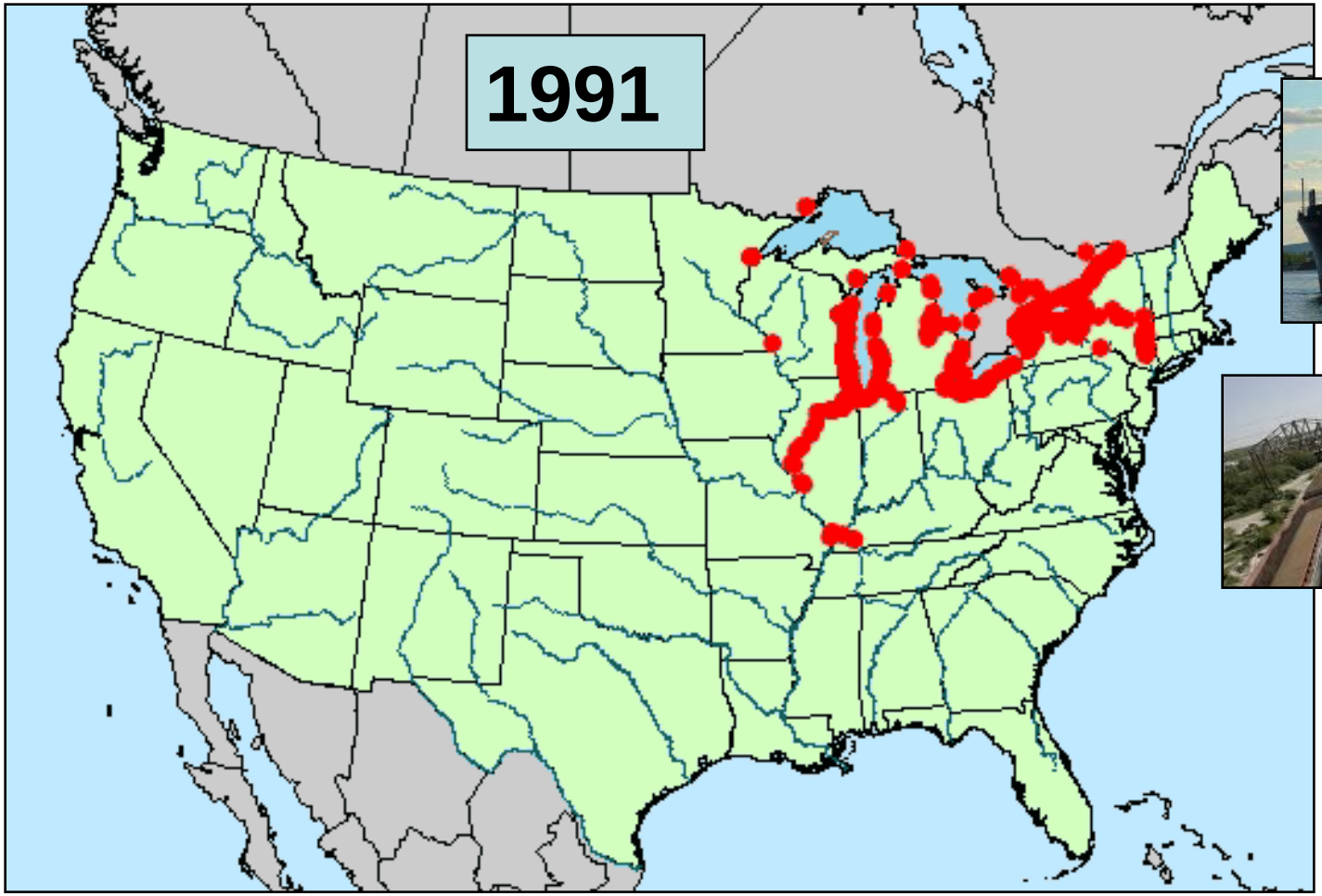

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Spread of Mussels

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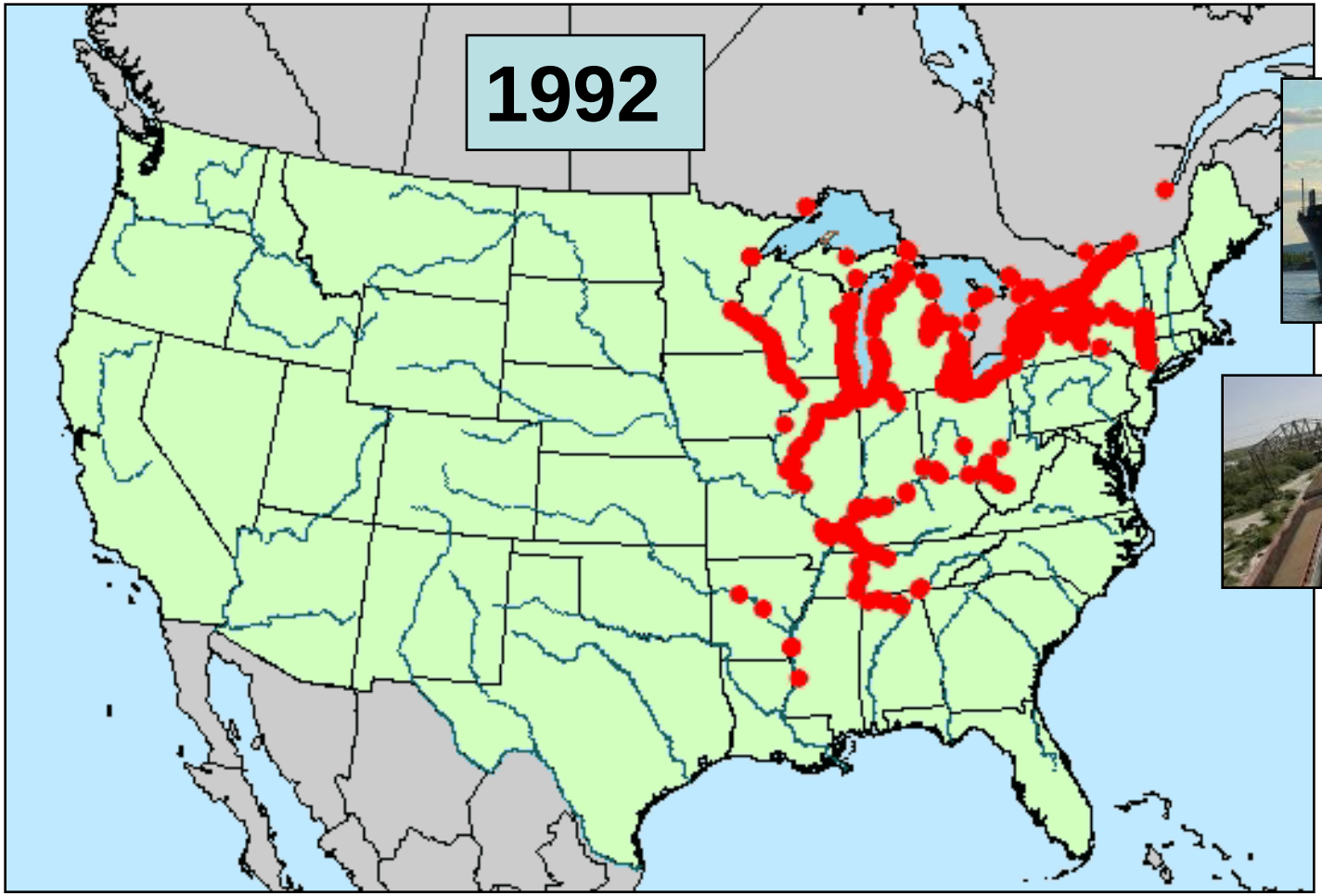

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Spread of Mussels

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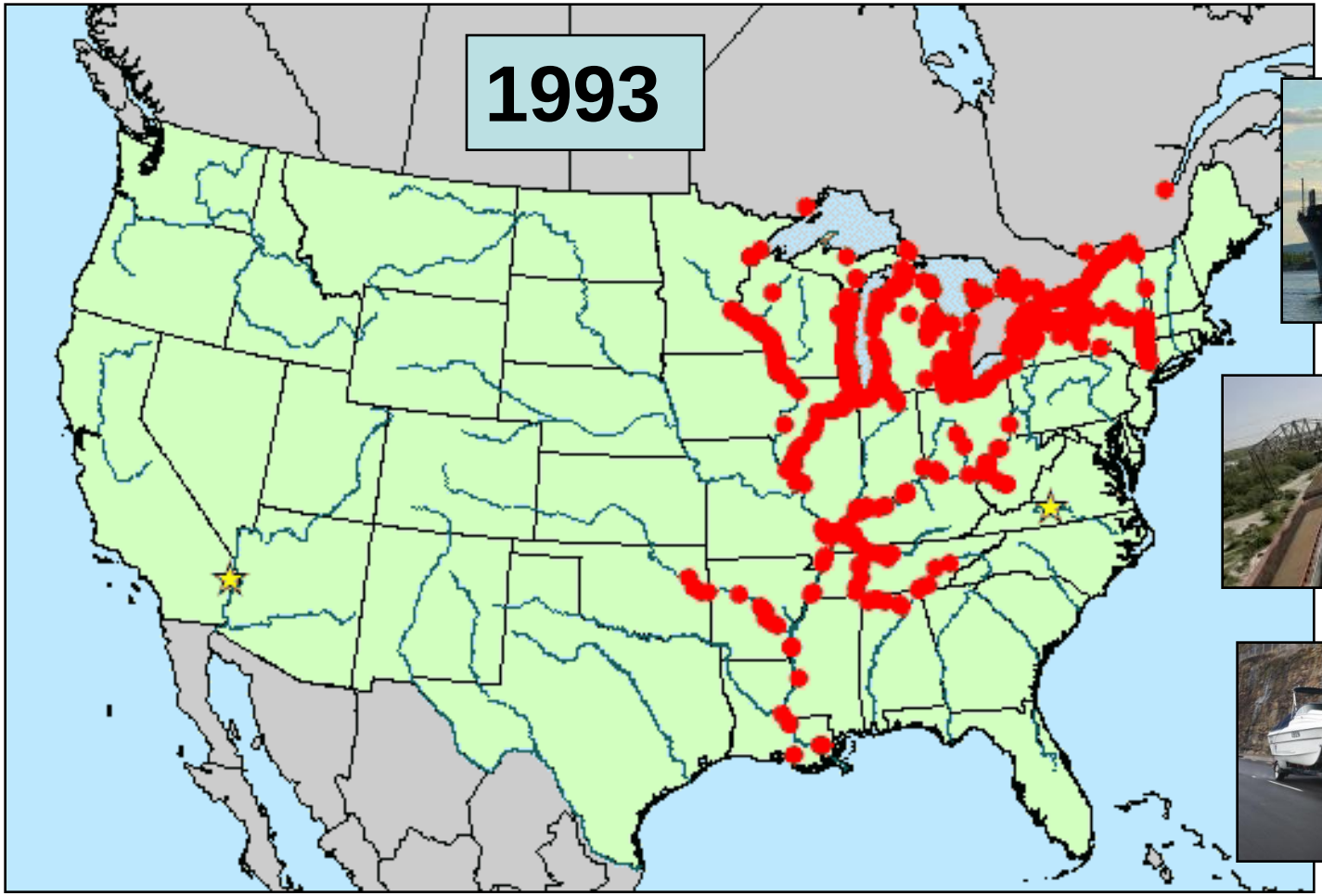

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Spread of Mussels

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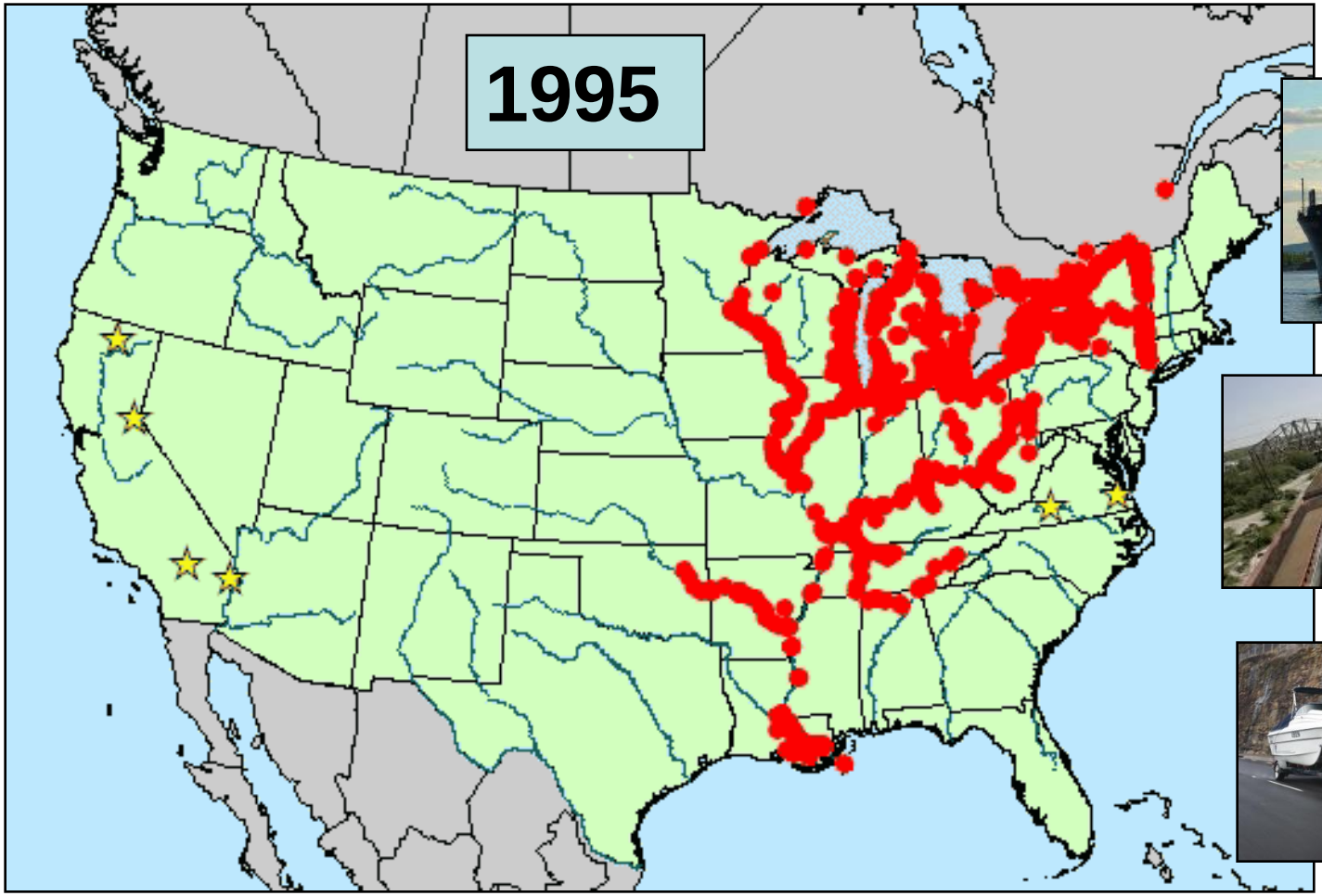

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Spread of Mussels

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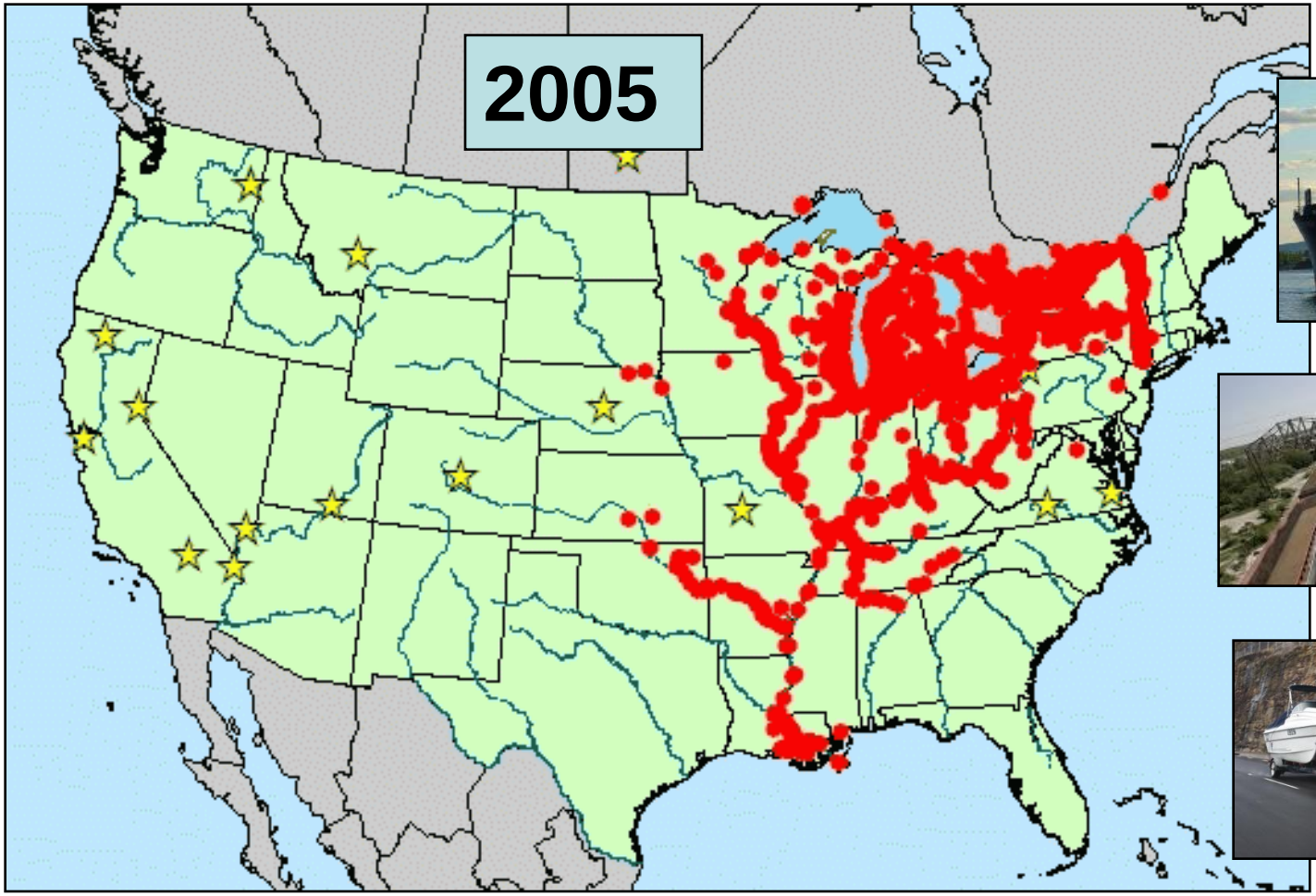

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Spread of Mussels

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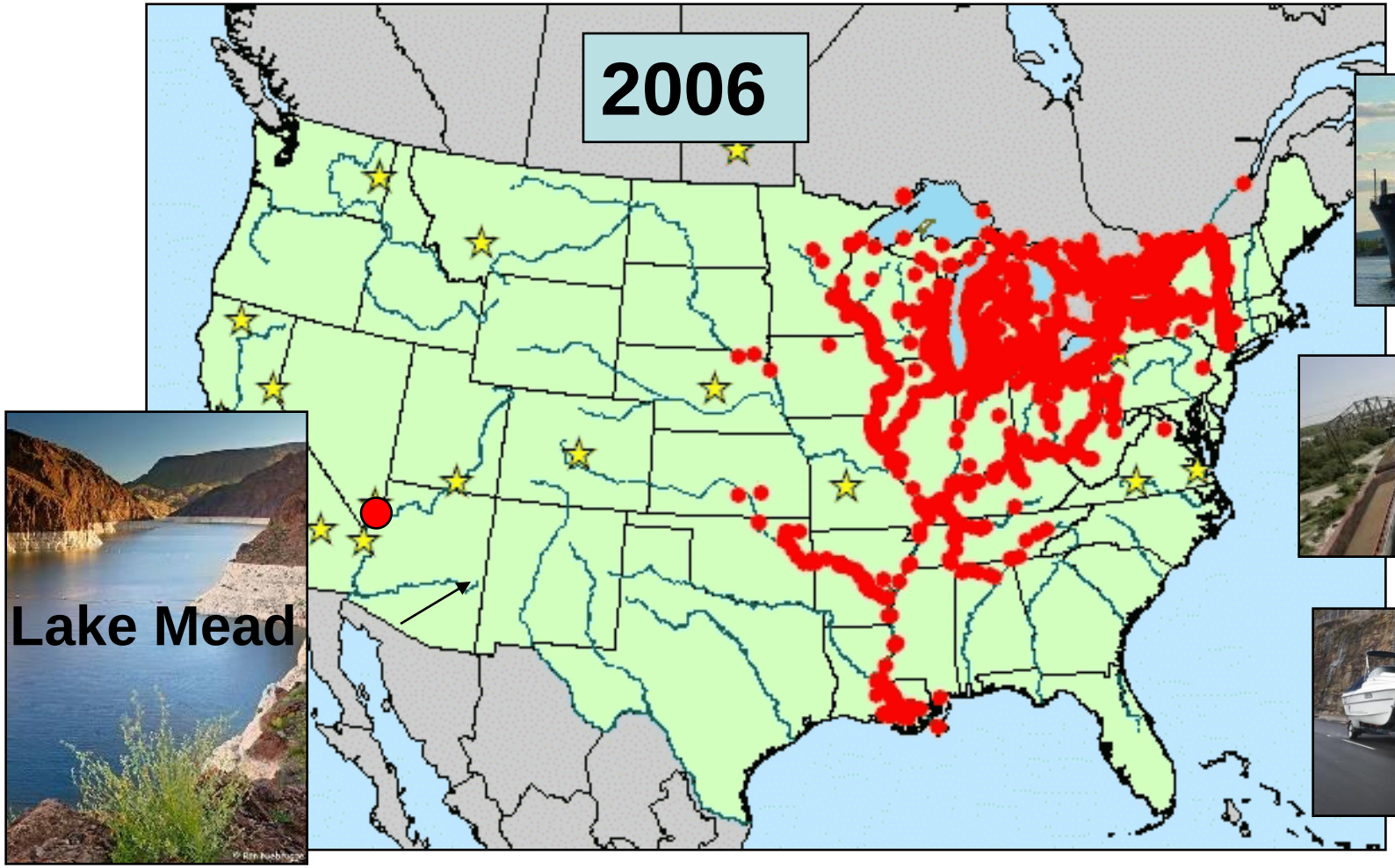

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Spread of Mussels

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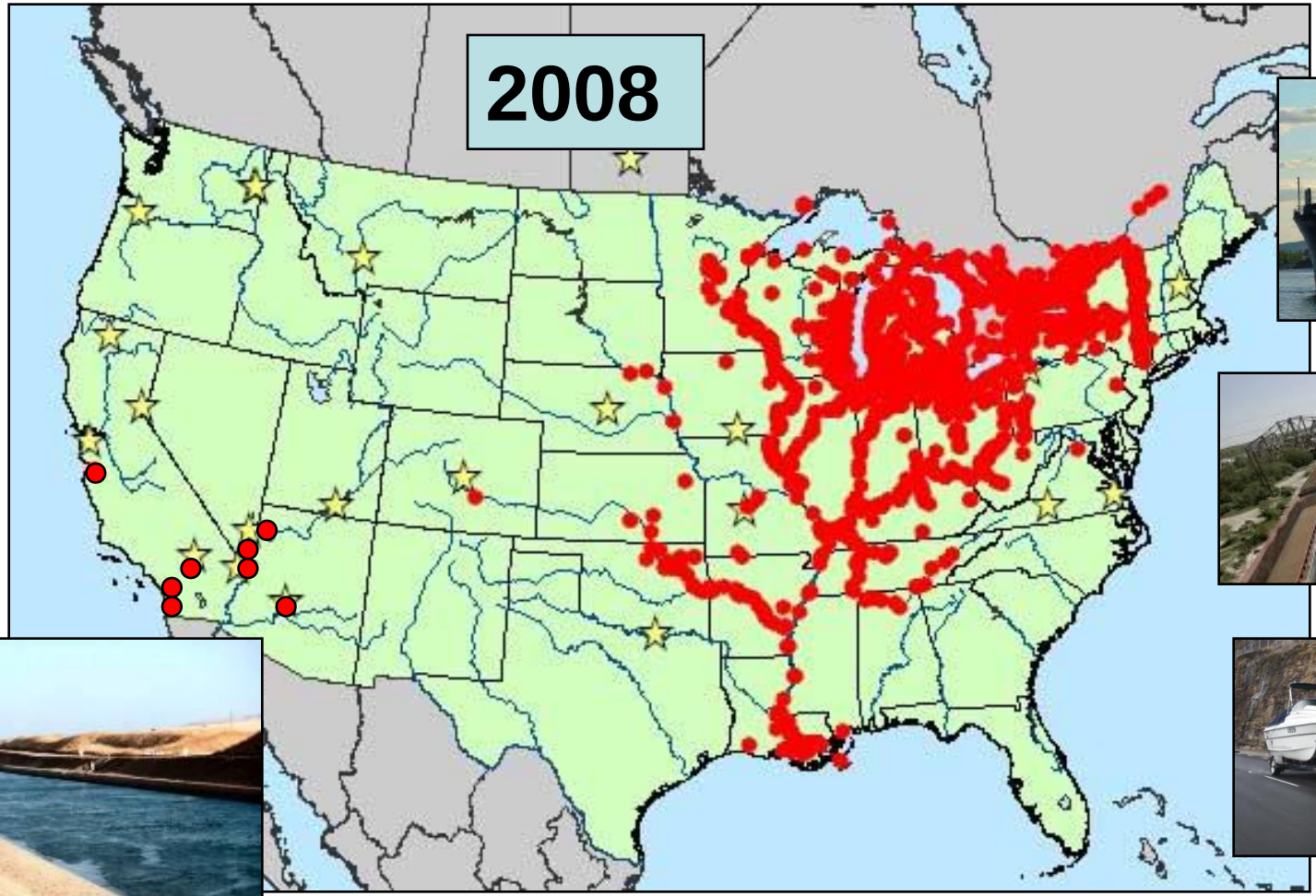

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Great Lakes as the Beachhead

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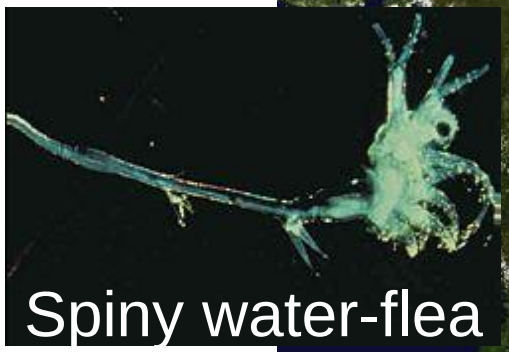
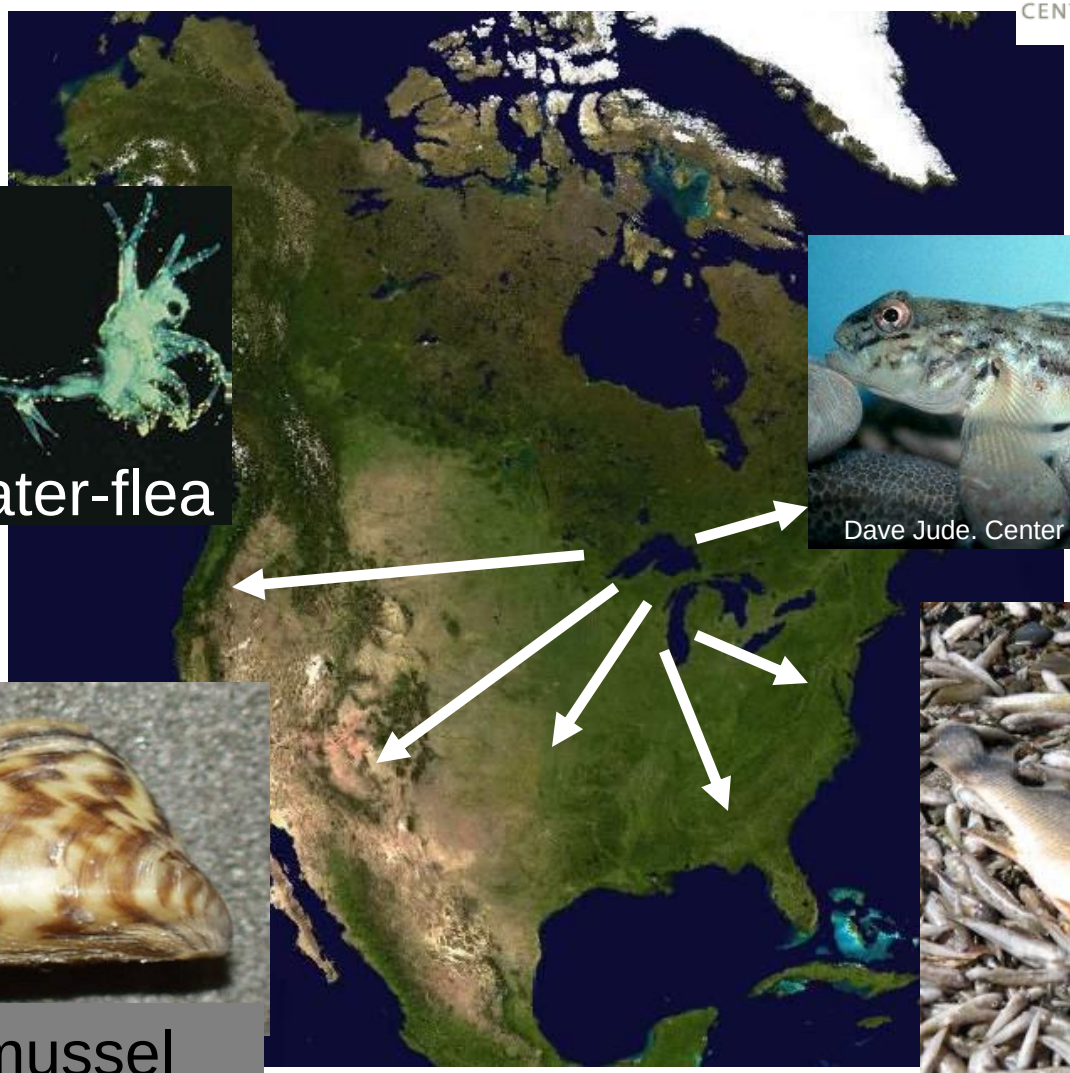


Spiny water-flea

Round goby

Dave Jude. Center for Great Lakes Aquatic Sciences.



Zebra mussel

VHS

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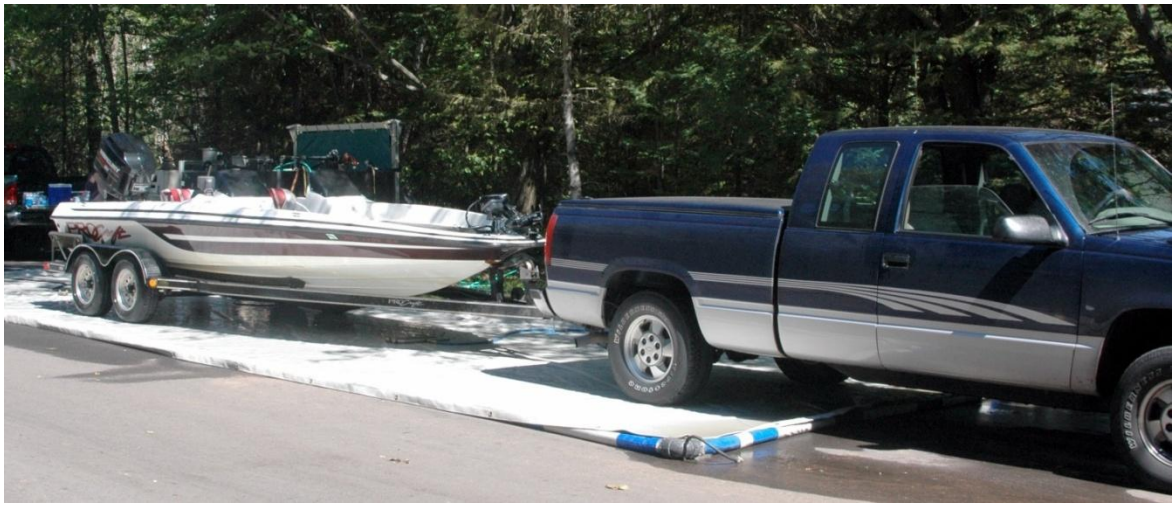
The Recreational Boating Network

Recreational boating nationwide

- $37 B/year Industry
- 71 million participants in 2006
- 18 million boats in use (large proportion in WI)

Our work on species spread by recreational boaters

- Surveys of boater behavior regarding boat hygiene
- Modeling of boater network (trips between lakes)
- Experiments on effectiveness and costs of different interventions



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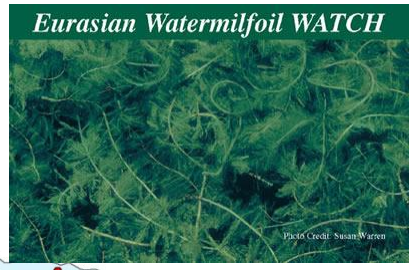
WI Recreational Boater Network: Milfoil



Predicted Risk

Estimated Risk
0.1%
1%
10%
WI Counties

Invaded = Sources

Conclusions: Boater Network

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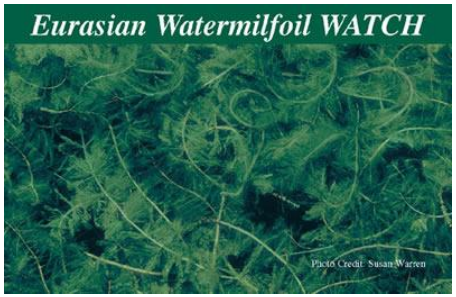
- Models have low ability to predict which lakes will become invaded



- Containment more effective than shielding at landscape scale

- But what affects risk at individual boater scale?

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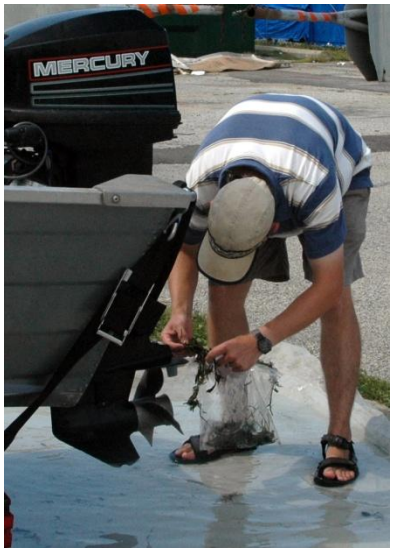
Different Methods of Intervention

Voluntary → Mandatory

Experiments on Different Methods of Hand Removal and Boat Cleaning



Cost Effectiveness of Intervention Strategies

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Intervention	Implementation	Effectiveness	Cost/launch
Inspection & hand removal	signage only	11%-79% Macrophytes 12%-63% Small	$200
Inspection & hand removal	paid labor (peak hrs) @ 7 weeks	4%-79% M 5%-70% S	$2,240
Inspection & hand removal	paid labor full time	(100%)(88%) =88% M (100%)(70%)=70% S	$10,240
HP wash **containment**	paid labor full time	(100%)(88%)=88% M (100%)(92%)=92% S	$15,000-$20,000
HP wash **shield**	paid labor full time	88% M 92% S	$15,000-$50,000

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Conclusions for Experiments

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1. High removal rates are possible, but appropriate technique depends on organism type
    - Visual inspection sufficient for macrophytes
    - Power washing significantly better for small-bodied organisms (e.g., plankton, seeds)

2. Voluntary interventions may be cost-effective but compliance rates are not well documented.

3. Containment, rather than shielding, is a more-cost effective intervention strategy.

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Overall Conclusion

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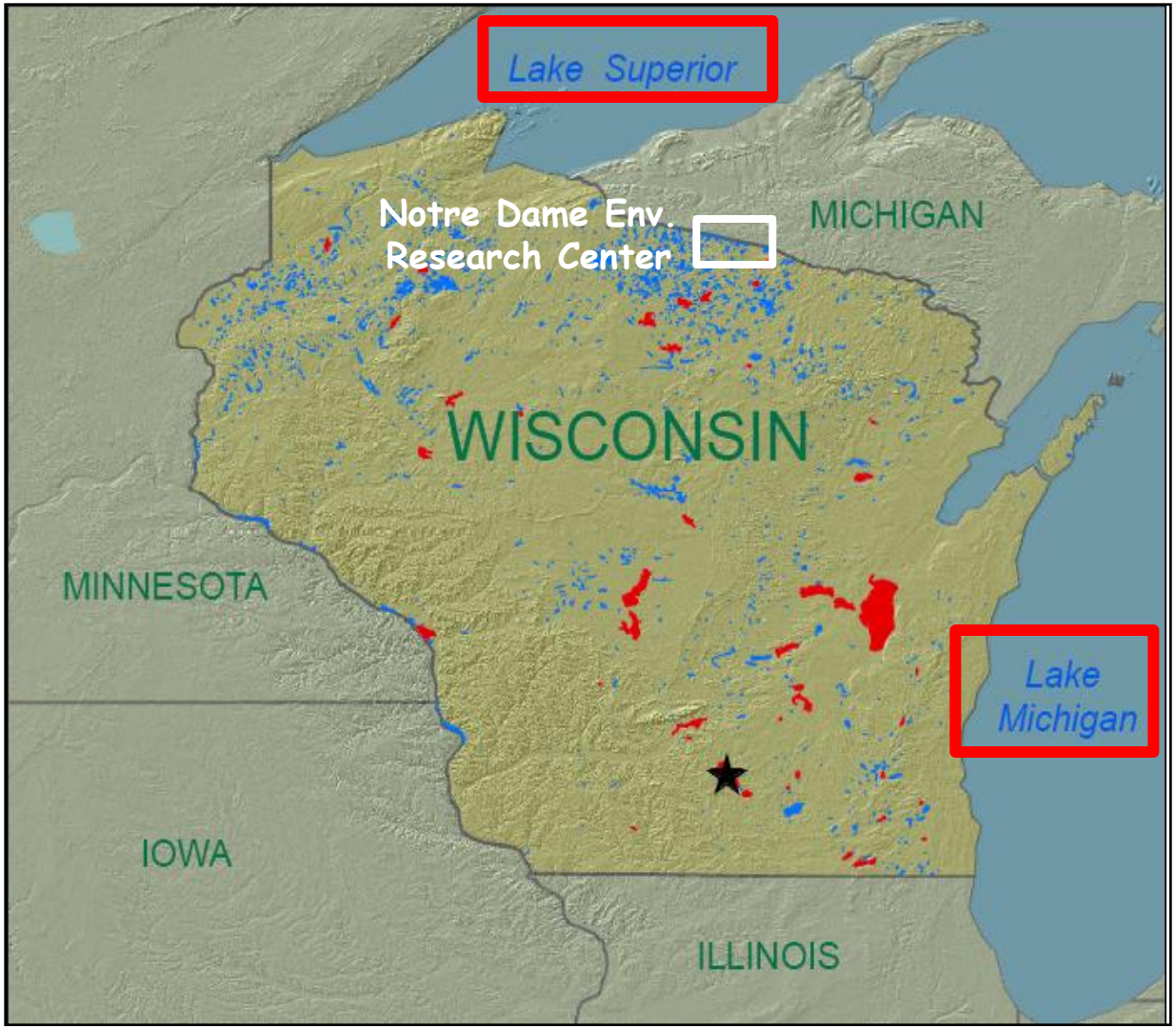
Most cost-effective regional strategy would be to contain lakes that are superspreaders:

- Heavily invaded
- Heavily visited



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Future Directions

Geographic analyses combining ecology and economics will lead to more cost effective management.

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