Methods for Preventing the Spread of Aquatic Invasive Species

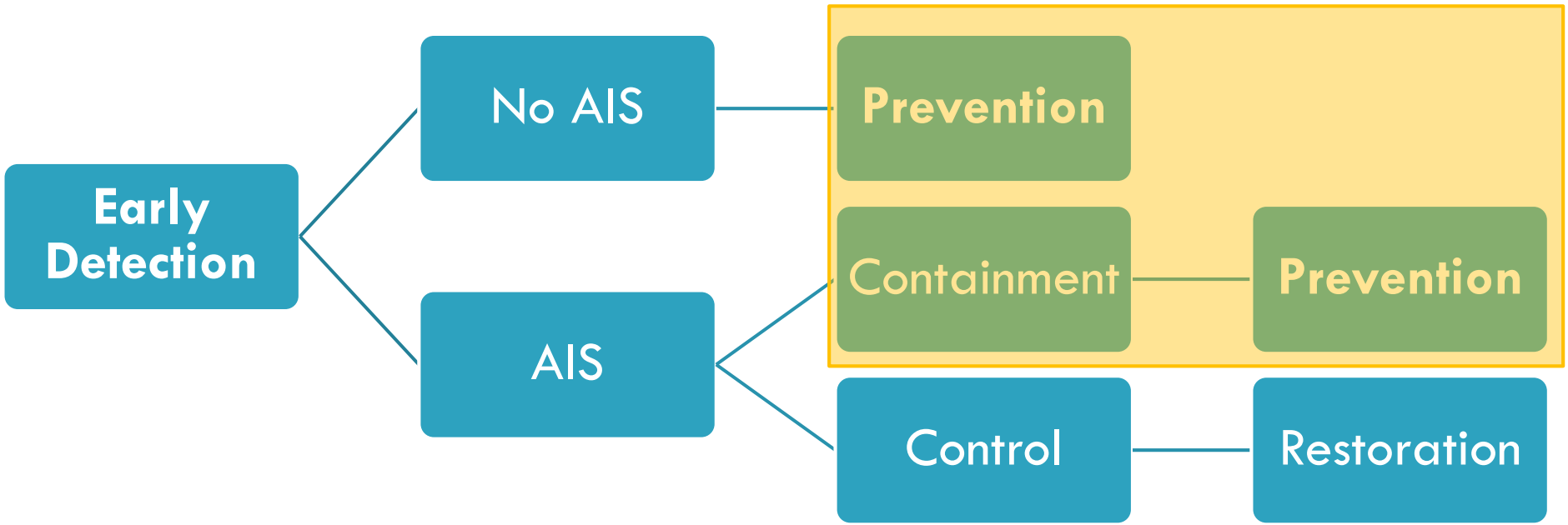
David Wong

Wetlands and Wastewater Program

Bureau of Water Resources

Massachusetts Department of Environmental Protection

Integrated Pest Management



Public Awareness/Outreach/Education

NISAW
National Invasive Species Awareness Week

National Invasive Species Awareness Week

February 26 - March 2, 2018

PARTICIPATE IN EVENTS ACROSS THE NATION to raise awareness and identify solutions to invasive species issues at local, state, tribal, regional, international and national scales. Locate an invasive species event in your state or county. Plan your own event using the NISAW Toolkit – where and when it works for you!

Capitol Hill Lunch Seminars

Monday February 26 - Noon

Invasive Species and Infrastructure, Cannon House Office Building Room 421
Michael Vrabchek representing NISC and the US Army Corps of Engineers

Tuesday February 27 - Noon

Unmanned Aerial Vehicles (UAV), Cannon House Office Building Room 421
Dr. Sinan Abood representing USDA Forest Service

Wednesday February 28 - Noon

Gene Drives 101: Perspectives on Potential Invasive Species Management, Cannon House Office Building Room 421
Heath Packard, Island Conservation

Thursday March 1 - Noon

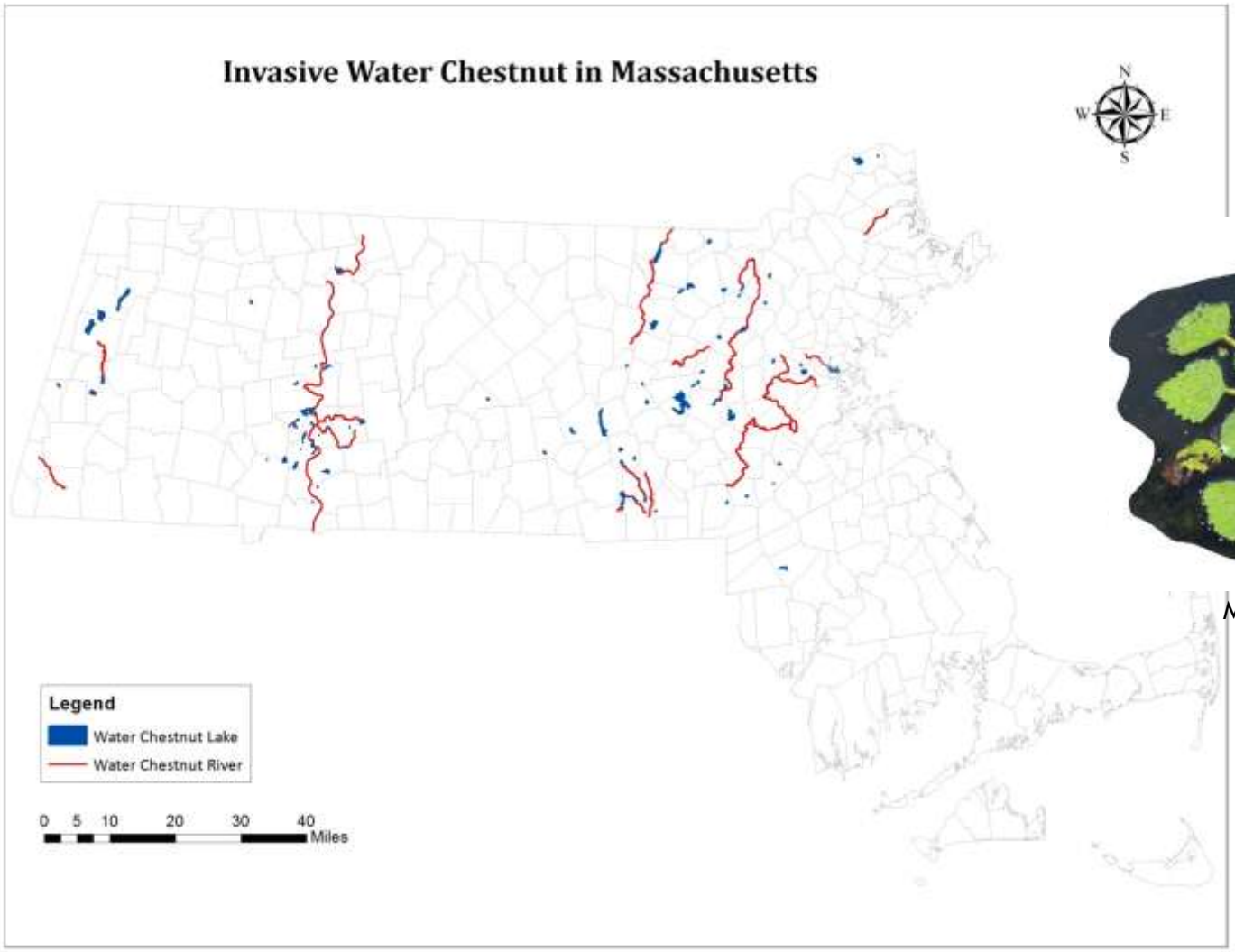
Early Detection and Rapid Response, National Museum of the American Indian, 4th Floor Conference Center
Stas Burgiel representing Department of Interior, National Invasive Species Council (NISC) Secretariat, will moderate the panel. Panelists will include: Chuck Bargeron, Jhoset Burgos, Alex Dehgan, Marshall Meyers and Scott Miller

Public Awareness: Mapping AIS

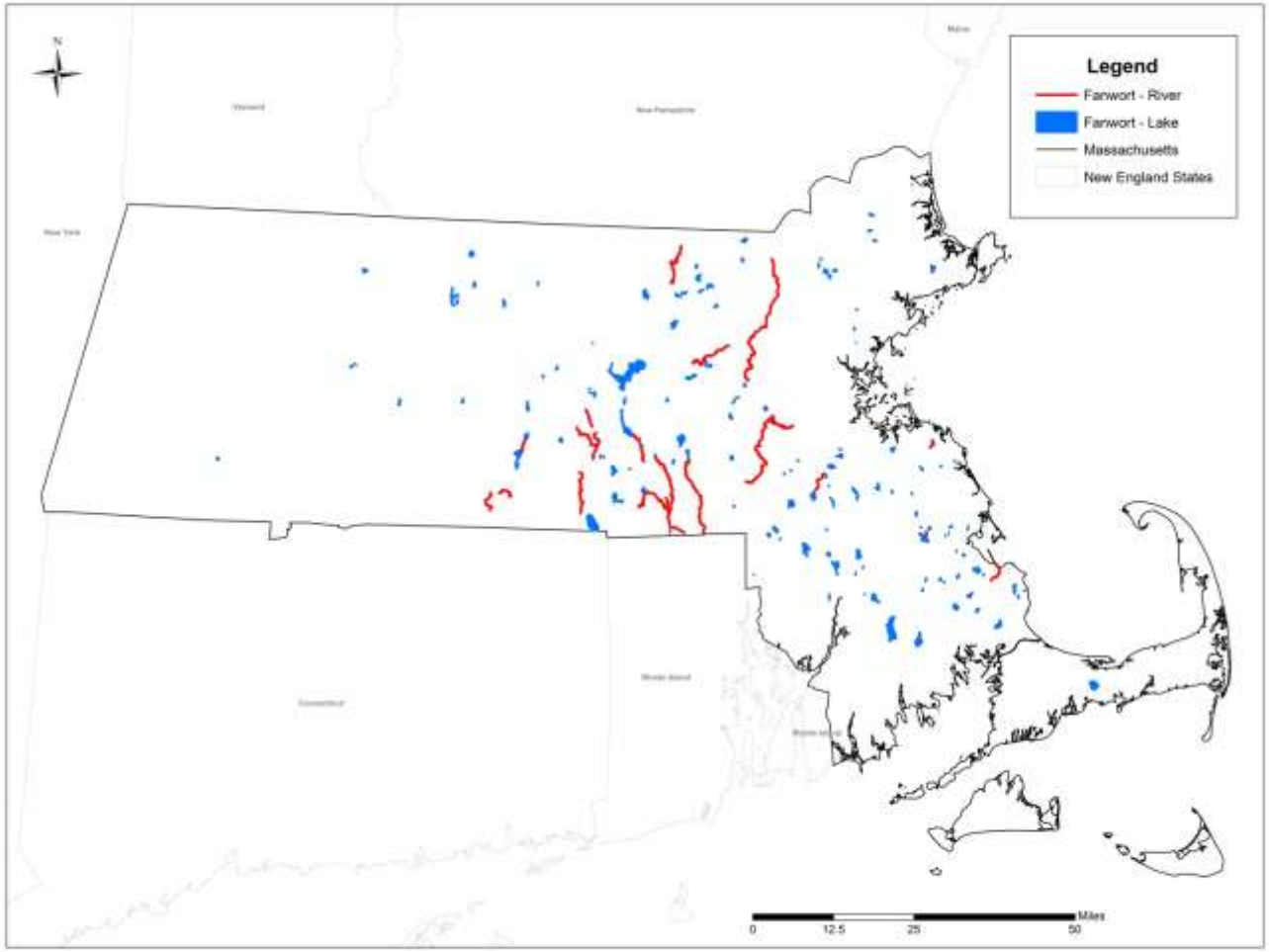
Massachusetts Freshwater AIS List: Aquatic Plants

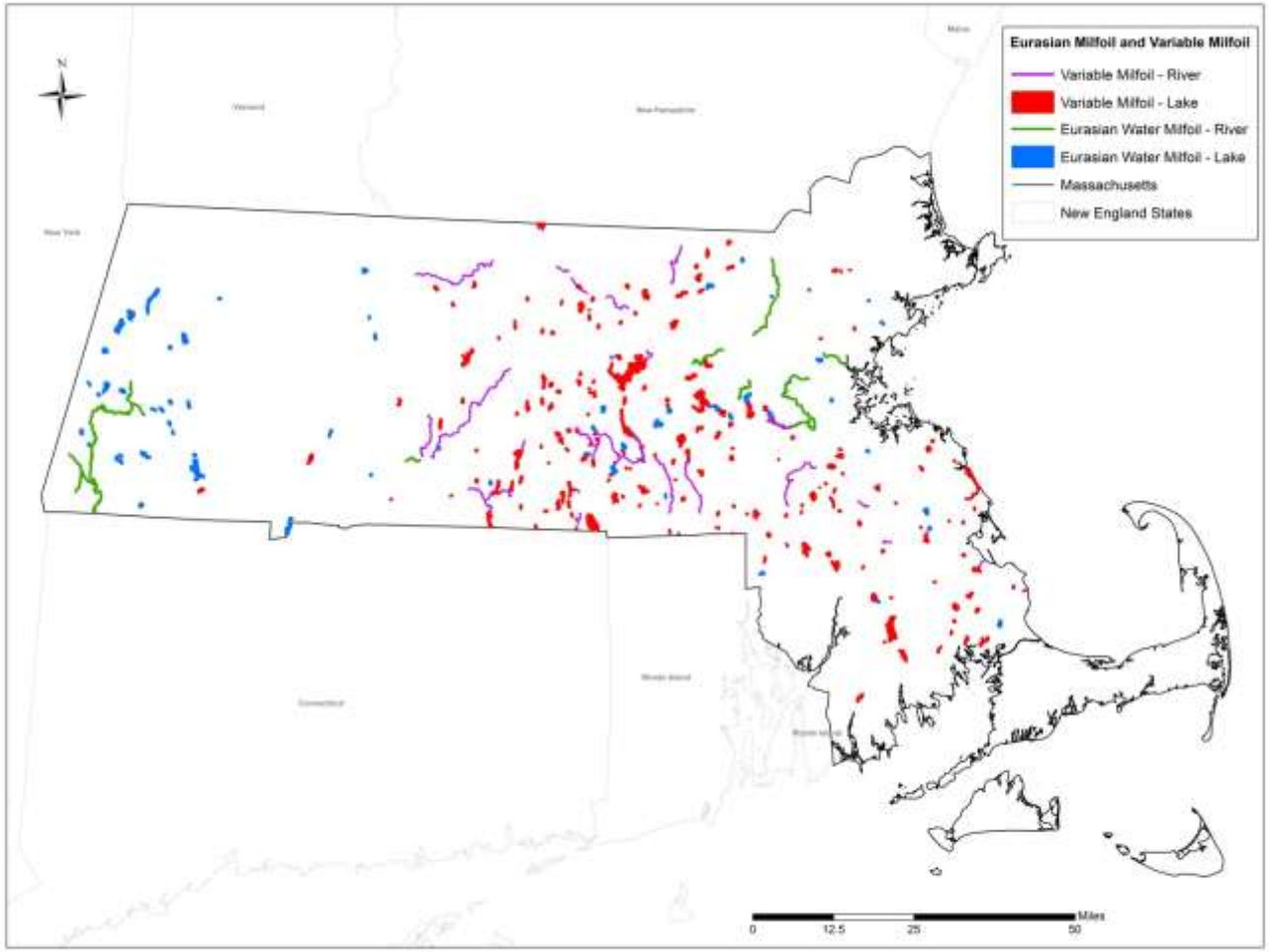
Common Name	Scientific Name	Category
Asian waterwort	*Elatine ambigua*	Vascular plant
Curly pondweed	*Potamogeton crispus*	Vascular plant
Eurasian Water Milfoil	*Myriophyllum spicatum*	Vascular plant
European Naiad	*Najas minor*	Vascular plant
Fanwort	*Cabomba caroliniana*	Vascular plant
Hydrilla	*Hydrilla verticillata*	Vascular plant
Little floating heart	*Nymphoides cordata*	Vascular plant
Mudmat	*Glossostigma cleistanthum*	Vascular plant
Parrot feather	*Myriophyllum aquaticum*	Vascular plant
Purple loosestrife	*Lythrum salicaria*	Vascular plant
Reed grass	*Phragmites australis*	Vascular plant
South American Waterweed	*Egeria densa*	Vascular plant
Swollen Bladderwort	*Utricularia inflata*	Vascular plant
Variable milfoil	*Myriophyllum heterophyllum*	Vascular plant
Water chestnut	*Trapa natans*	Vascular plant
Water fringe	*Nymphoides peltata*	Vascular plant
Water Hyacinth	*Eichornia crassipes*	Vascular plant
Water shamrock or European waterclover	*Marsilea quadrifolia*	Vascular plant
Yellow cress	*Nasturtium sp.*	Vascular plant
Yellow Iris	*Iris pseudacorus*	Vascular plant

High Risk Water Bodies

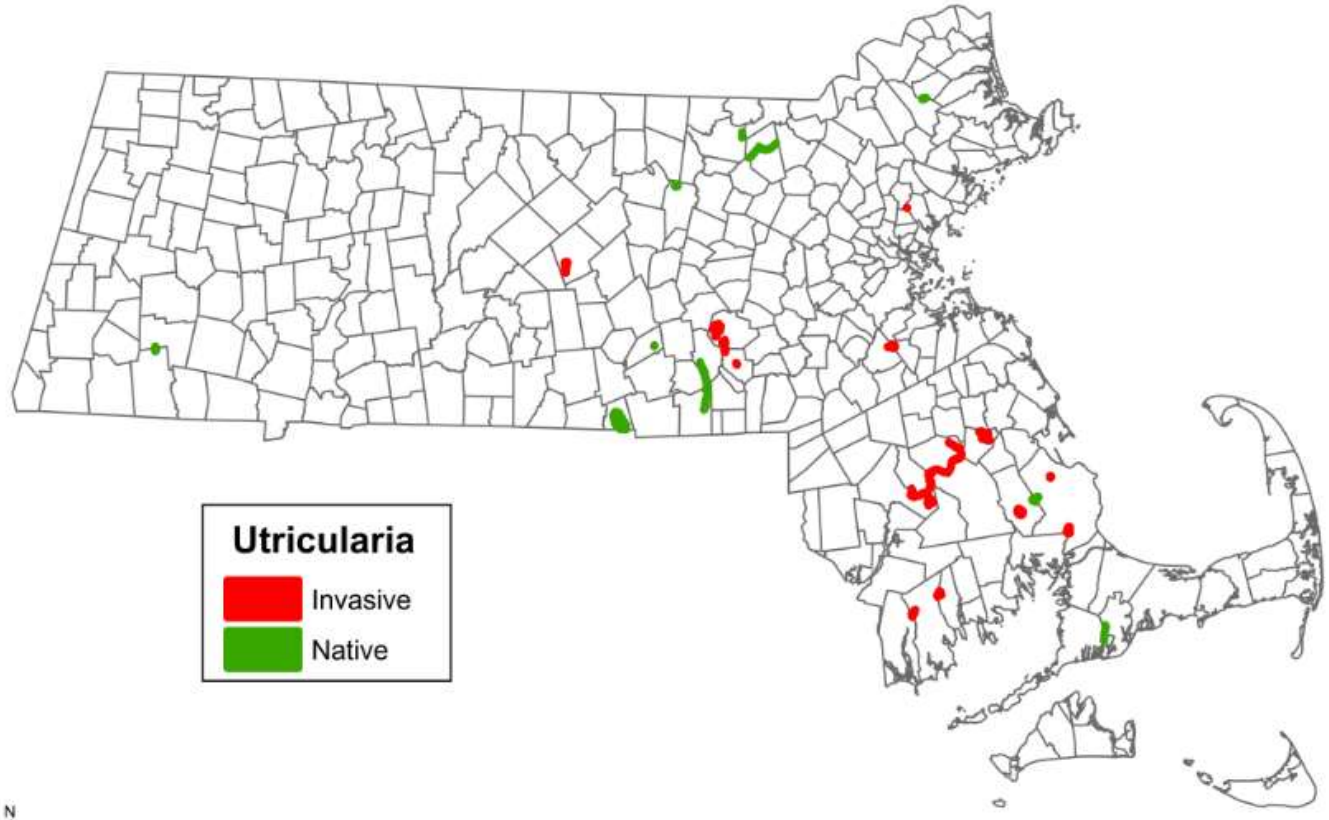


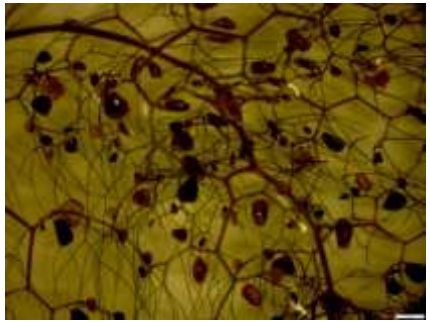
Modified from Susan Wojtowicz


N
Legend
Farwort - River
Farwort - Lake
Massachusetts
New England States
Vermont
New Hampshire
Maine
New York
Connecticut
Rhode Island
0
12.5
25
50
Miles


N
Eurasian Milfoil and Variable Milfoil
Variable Milfoil - River
Variable Milfoil - Lake
Eurasian Water Milfoil - River
Eurasian Water Milfoil - Lake
Massachusetts
New England States
0
12.5
25
50
Miles

Swollen Bladderwort *Utricularia inflata*





Early Detection

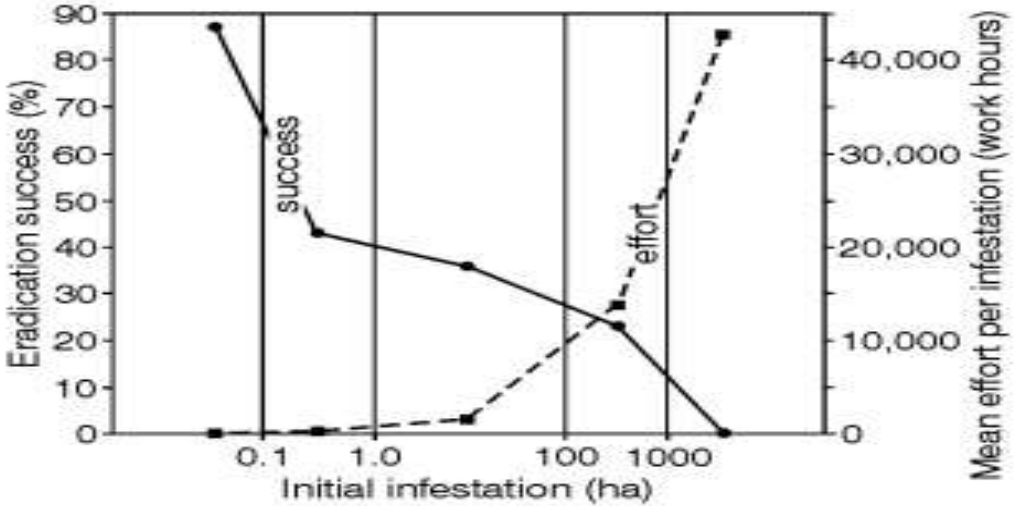


Fig. 1 The dependence of the eradication success (%) and the mean eradication effort per infestation (work hours) on the initial size of infestations. Based on the data for eradication projects of 18 noxious weed species and 53 independent infestations in California (see Table 1). (Rejmanek and Pitcairn 2002)

Field Monitoring/Survey and Identification

Frequency of Invasive Species Establishment

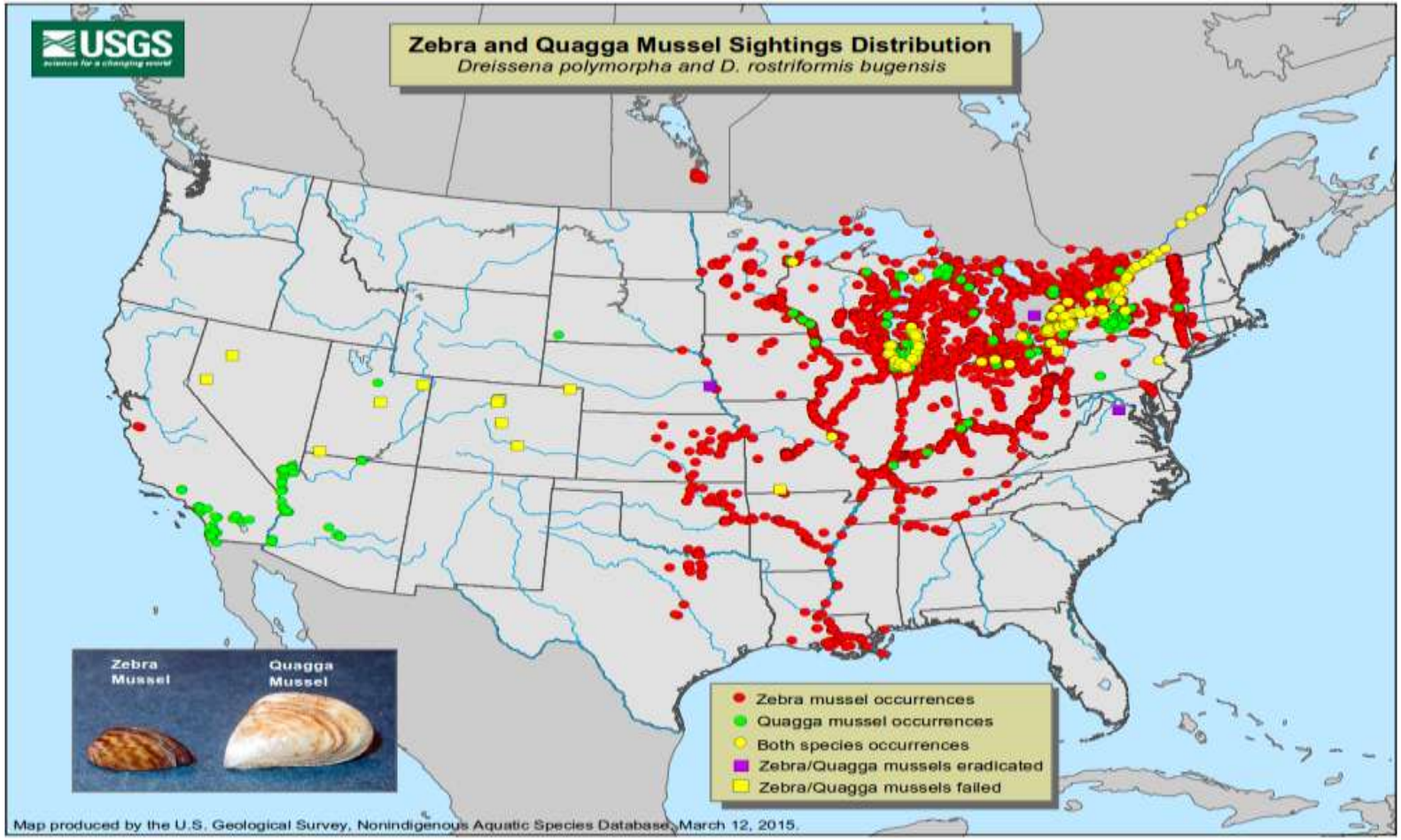
- The Great Lakes: a new species every 6 months
- San Francisco Bay, new species establishment:
  - Since 1850: every 36 weeks
  - Since 1970: every 24 weeks
  - Since 1987: every 12 weeks

(Cohen and Carlton 1995; Vitousek et al. 1997)

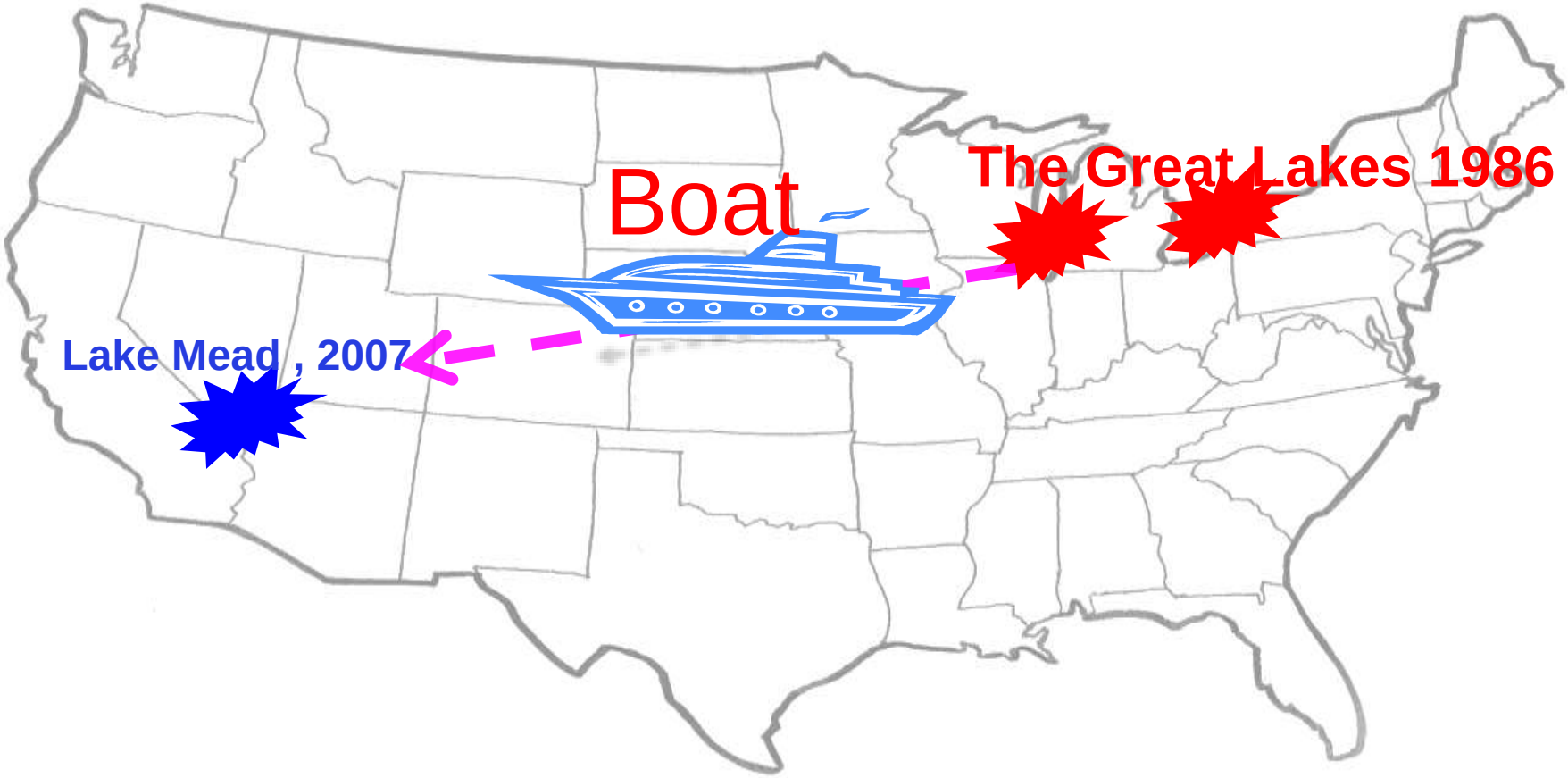
Invasive Species Introduction

- Most invasive species introductions are **accidental** consequences of the global distribution networks that facilitate **international/regional commerce**.
- New species invade new territory attached to the hulls of ships; as stowaways in wooden crates or packing materials; hidden inside unprocessed logs, fruits, or seeds; by aircrafts; **most common of all, species in the ballast water discharged by ships entering ports**

Distribution of zebra/quagga mussels in the U.S.

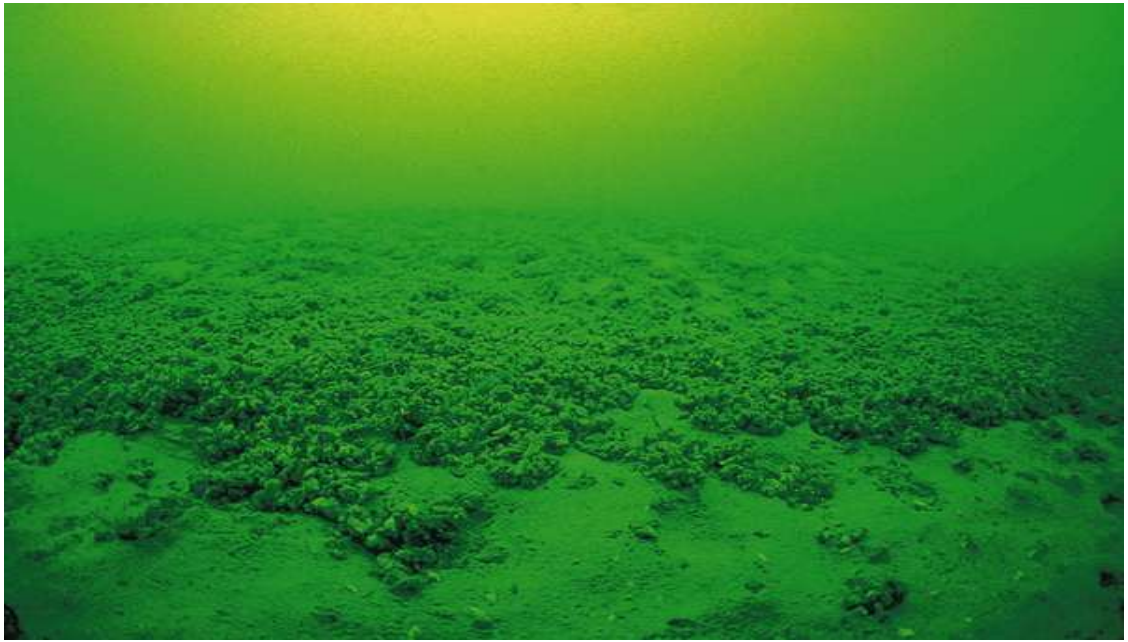



Great Lakes
Lake Mead
Ukraine
Southern Bug River and
Dnieper River tributaries
Atlantic Ocean
Image NASA
© 2008 Europa Technologies
© 2008 Tele Atlas
Map data © 2008 DMapas/El Mercurio
Google
38°05'01.37" N 38°46'14.90" W
Eye alt 9825.10 km


Boat
The Great Lakes 1986
Lake Mead , 2007

Distribution of zebra/quagga mussels in the U.S.

Zebra Mussel in Lake Erie



Beckman et al. 1998

Mussel bed at the bottom of Lake Mead

NPS Water Intake

Boat

Photo by David Wong

Hoover Dam Intake

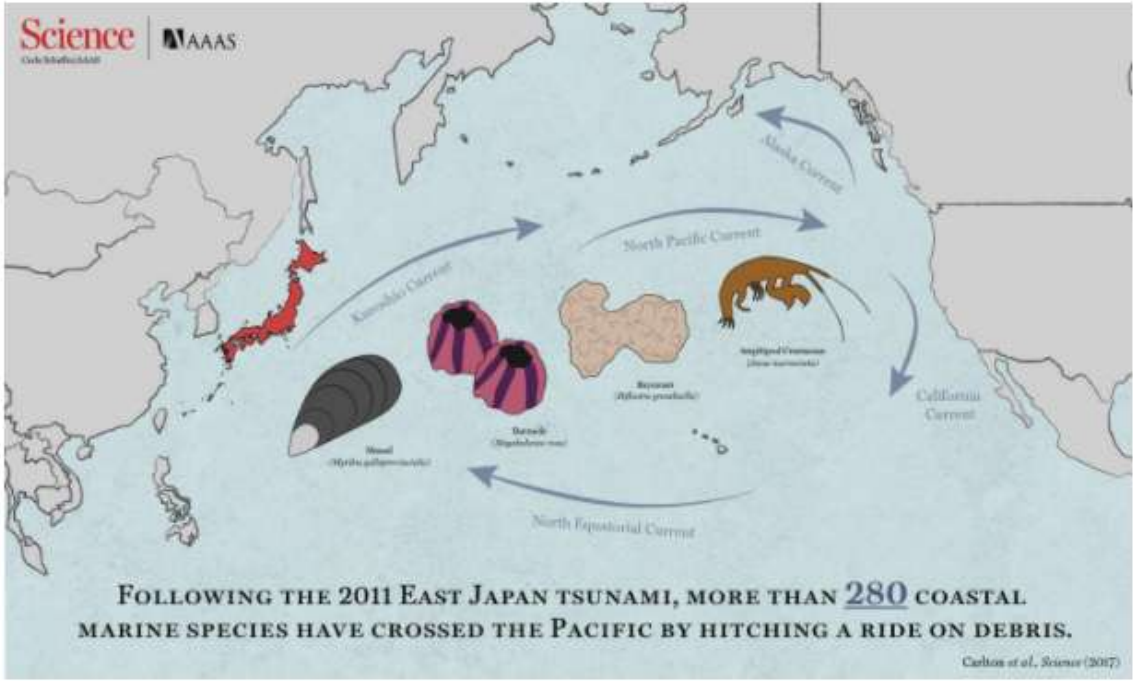
Marine Tsunami: Sendai Japan 2011

The Fukushima Daiichi nuclear disaster

Marine Tsunami: Sendai Japan 2011

How one tsunami and lots of manmade debris are triggering a mass marine migration

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Upper photo, “Misawa 1”, a fisheries dock from the Port of Misawa, Aomori Prefecture, washed away March 11, 2011, and landing on Agate Beach, Newport, Oregon, June 5, 2012.

Lower left, sea anemones (Metridium dianthus) from Japan, along with barnacles (Semibalanus cariosus) and mussels (Mytilus galloprovincialis) on Misawa 1; lower right, S. cariosus, M. galloprovincialis, and the barnacle Megabalanus rosa. Photographs by Jessica A. Miller.

Invasive Species Introduction

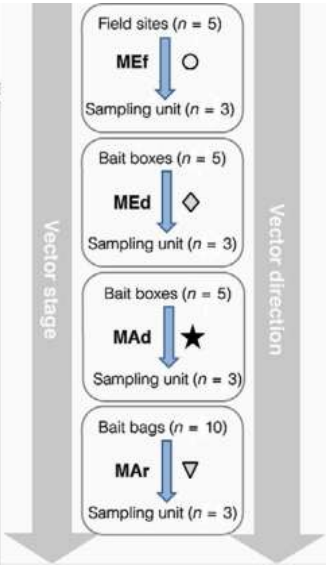
Opening Pandora's bait box: a potent vector for biological invasions of live marine species

Amy E. Fowler[1,2*], April M. H. Blakeslee[1,3], João Canning-Clode[1,4,5], Michele F. Repetto[1], Anne M. Phillip[1], James T. Carlton[6], Fredrika C. Moser[7], Gregory M. Ruiz[1] and A. Whitman Miller[1]

[1]*Marine Invasions Laboratory, Smithsonian Environmental Research Center, Edgewater, MD 21037, USA,* [2]*Marine Resources Research Institute, South Carolina Department of Natural Resources, 217 Fort Johnson Road, Charleston, SC 29422, USA,* [3]*Biology Department, East Carolina University, 1001 East 5th Street, Greenville, NC 27858, USA,* [4]*Marine and*

ABSTRACT

Aim For over 80 years, the Maine baitworm trade has shipped live polychaete worms and packing algae 'wormweed' to distributors world-wide, while also consistently transferring a wide diversity and abundance of hitchhiking organisms of all life stages to numerous recipient communities. Here, we investigate this potent, yet underestimated, invasion vector using an important recipient region (the Mid-Atlantic) to examine the stepwise species transfer and survival along four stages of the vector.



Invasive Species Introduction

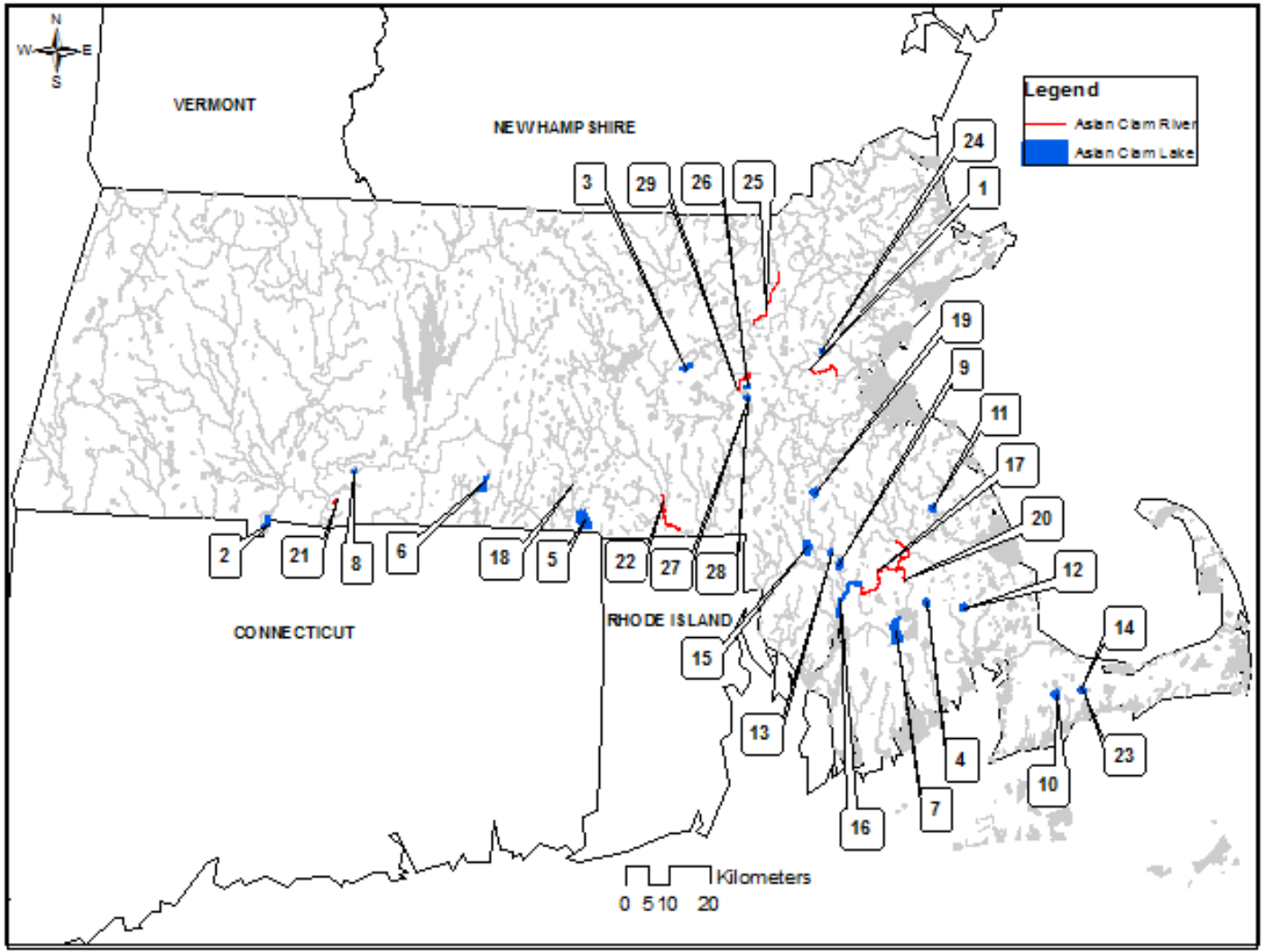
314 CMR 9.00: 401 WATER QUALITY CERTIFICATION FOR DISCHARGE OF DREDGED OR FILL MATERIAL, DREDGING, AND DREDGED MATERIAL DISPOSAL IN WATERS OF THE UNITED STATES WITHIN THE COMMONWEALTH

Dredged sediment from Lake Erie ports has value, U.S. Army Corps of Engineers is discovering

314 CMR 9.07 (2)

9. At the Department's discretion, the project proponent for an aquatic disposal facility may be required to perform a biological assessment of the dredged materials to determine whether there is the potential for the inadvertent transfer of an "invasive species" from the dredging area to the disposal location.

2000-2016


N
W
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VERMONT
NEW HAMPSHIRE
CONNECTICUT
RHODE ISLAND
Legend
Asian Clam River
Asian Clam Lake
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26
25
24
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9
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17
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6
18
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27
28
Kilometers
0 5 10 20

Economic Cost of Invasive Species

- **$138 Billion / Year**
  - **Federal Emergency Management Agency (FEMA) 2015 Budget: $ 10 Billion**

Pimentel et al. 1999

Invasive species triggers a massive loss of ecosystem services through a trophic cascade

Jake R. Walsh[a,1], Stephen R. Carpenter[a,1], and M. Jake Vander Zanden[a]

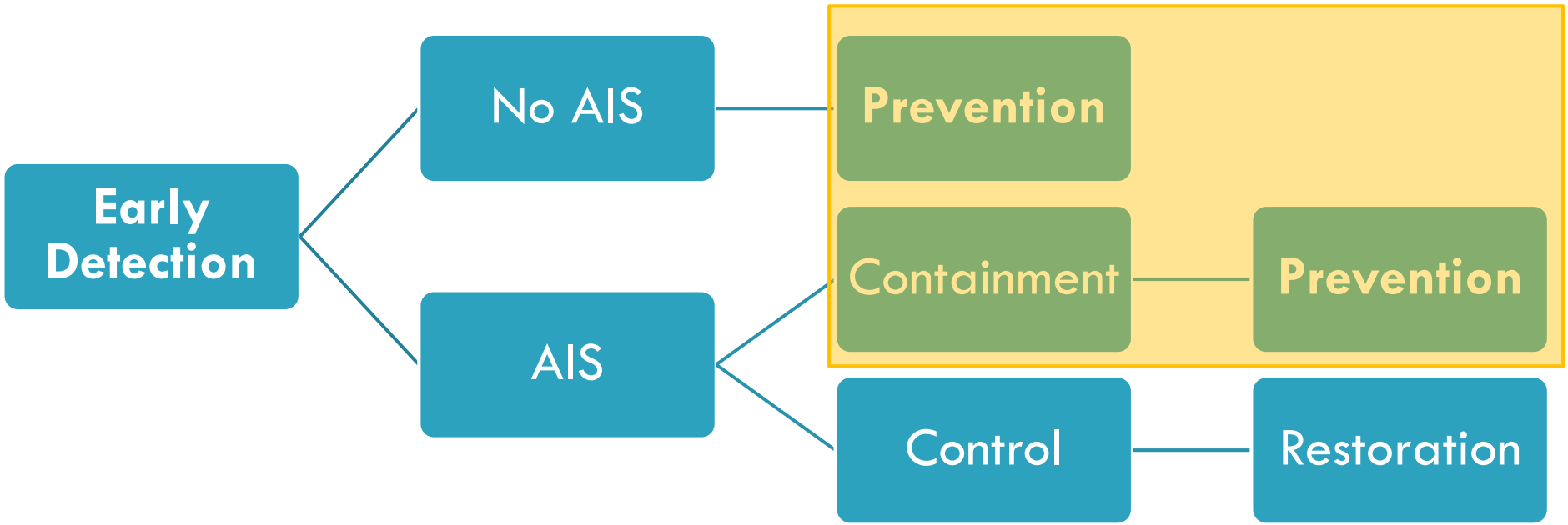
Author Affiliations

Contributed by Stephen R. Carpenter, February 17, 2016 (sent for review January 8, 2016; reviewed by Chris Luecke, David Strayer, and Norman D. Yan)

Significance

Invasive species represent a largely unquantified threat to ecosystem services. Although investment in the prevention of species invasions may sustain ecosystem services, these effects of invasions are rarely measured in monetary terms useful to decision makers. We quantify the economic damages of the degradation of an important ecosystem service, water clarity, caused by invasion by the spiny water flea. We find that the costs of restoring this service, US$86.5 million–US$163 million, are comparable with the willingness to pay for the service itself: US$140 million. This finding highlights the severity of invasive species' impacts when their damages to ecosystem services are considered. Costs of invasive species' secondary spread aggregated across many invasive species and ecosystem services may be large.

Integrated Pest Management



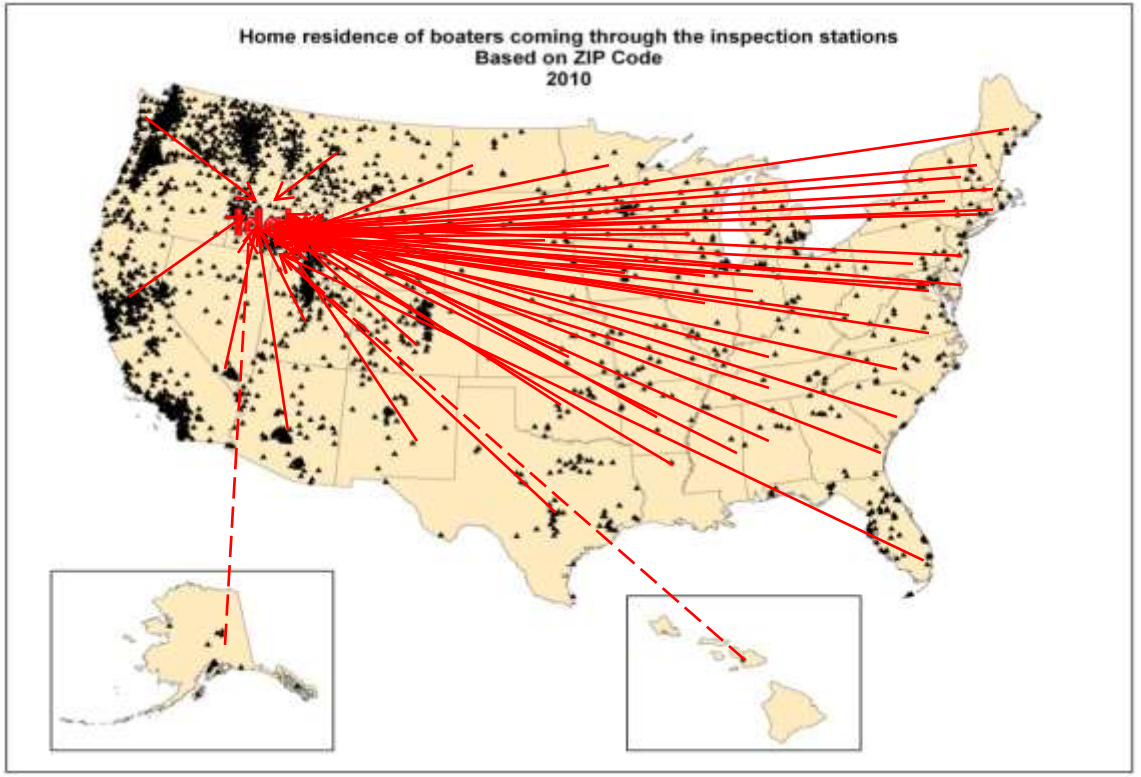
AIS Spread to Inland Waters


B36 KMA

Aquatic Invasive Species Spread to Inland Waters

- The spread of AIS to the inland water bodies of North America is most likely be attributed to the **unintentional overland transport of trailered boats** contaminated with the invasive organisms into an uninfested body of water (Bossenbroek et al. 2001; Johnson et al. 2001; Leung et al. 2006).

Recreational Boating in Idaho



(Ferriter and Anderson 2015)

dcr
Massachusetts

Department of Conservation and Recreation ~ Lakes and Ponds Program

Prevention: **C**heck **C**lean **D**rain **D**ry

Types	Methods
Physical/Mechanical	High Pressure Wash/Hot Water Spray Garden Hose Flushing Mother Nature
Chemical	Bleach/Chlorine NaCl/KCl
Biological	Inspectors Dogs

High Pressure Boat Washing Station

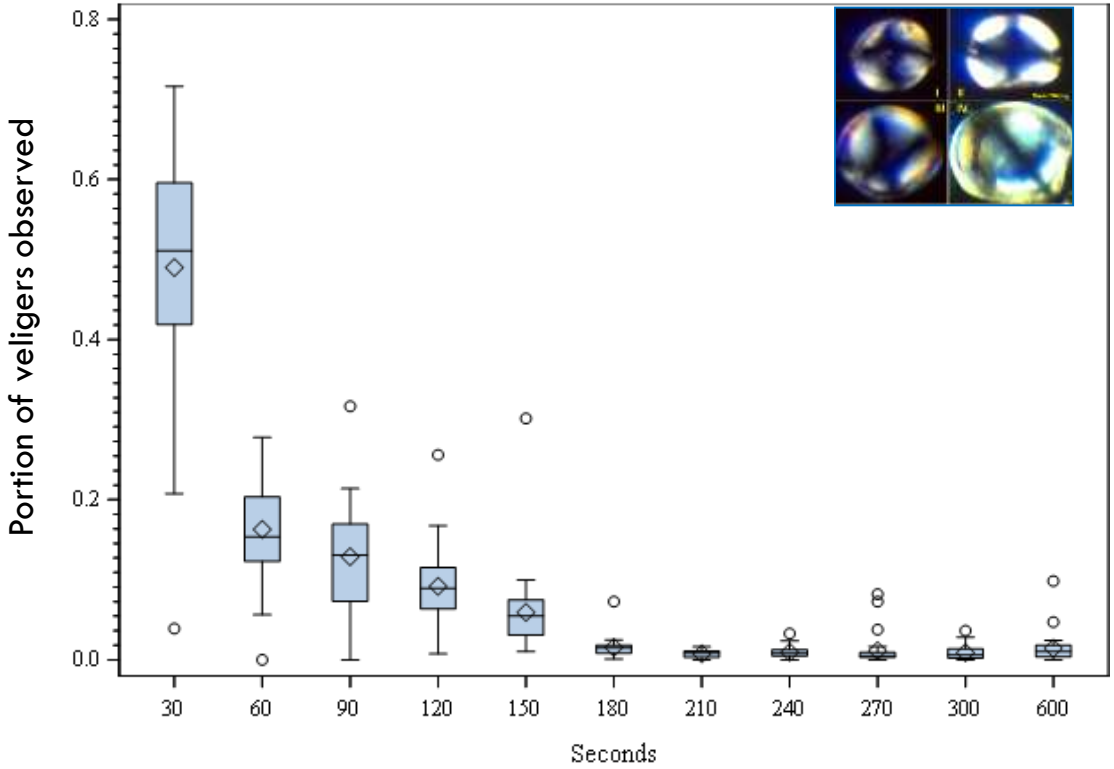
Power Wash: 3000 PSI
Hot Water: 140°F
Time: 10 Seconds

High Pressure Boat Washing Station

Expensive: > $30,000/Station

Low Pressure Boat Washing/Spray

Low pressure (60 psi) on livewell

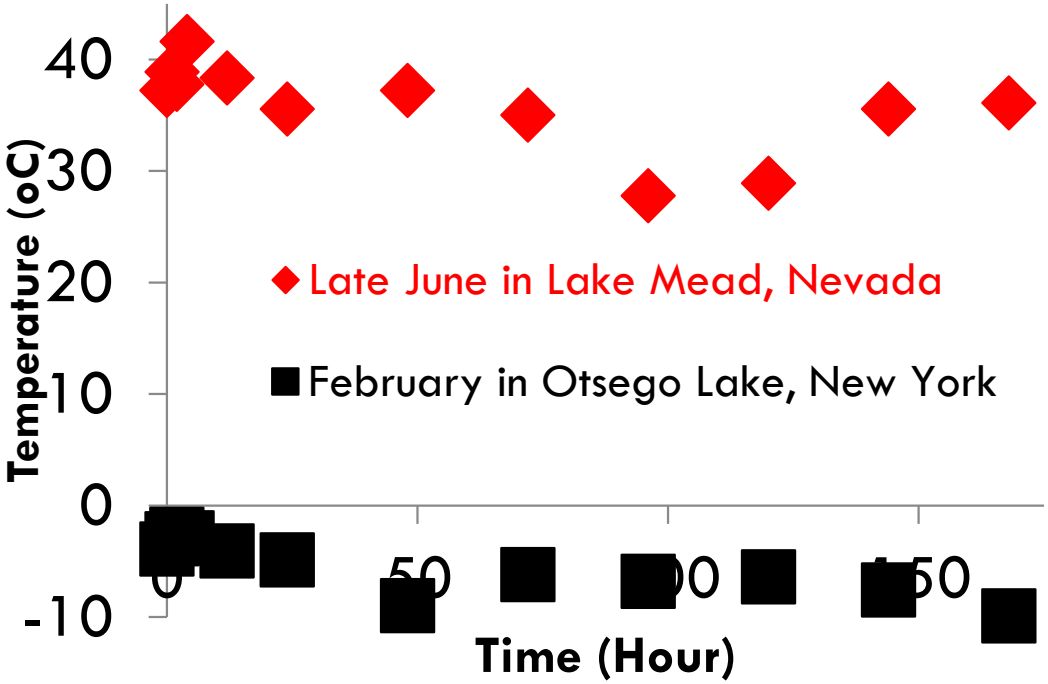


Davis et al. 2016

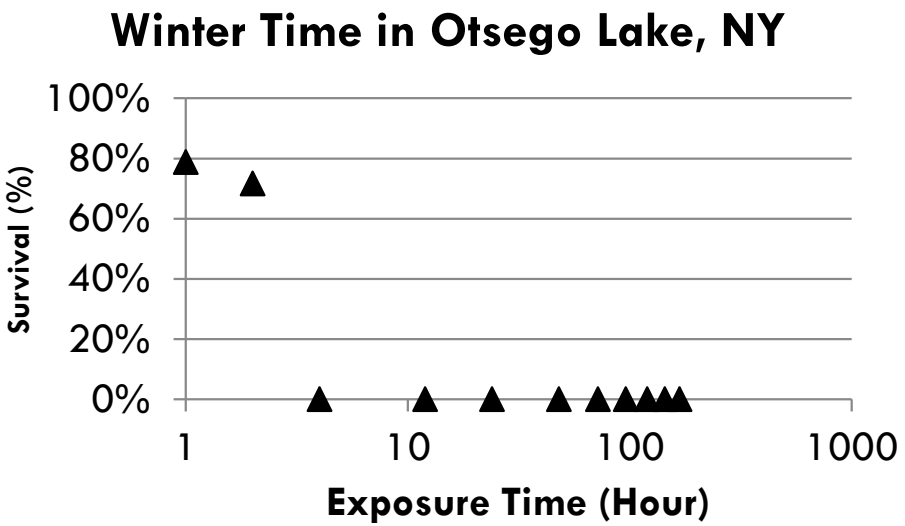
Mother Nature Helps

Mother Nature

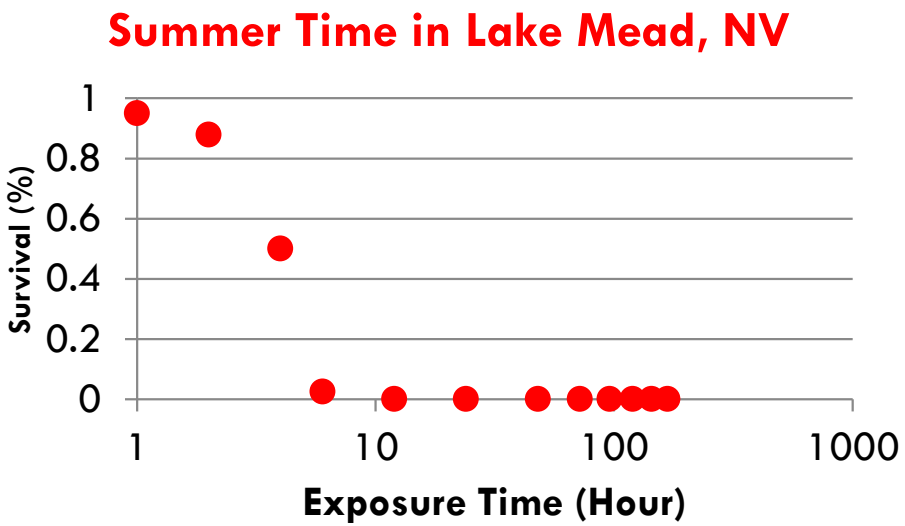
Cold Winter



Mother Nature



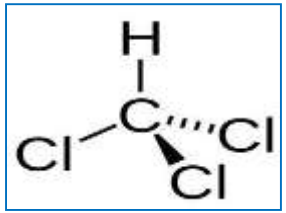
SUNY Oneonta/MassDEP



National Park Service

Chemical: Traditional Chlorination/Bleach

Water, Facility, and Boat Chlorination



Trihalomethane

Corrosive to pipe
Destructive to biota

NaCl

Journal of Shellfish Research, Vol. 34, No. 3, 1029–1036, 2015.

COMPARISON OF THREE SODIUM CHLORIDE CHEMICAL TREATMENTS FOR ADULT ZEBRA MUSSEL DECONTAMINATION

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[1]*Department of Biology, State University of New York College at Oneonta, 108 Ravine Parkway, Oneonta, NY 13820;* [2]*Massachusetts Department of Environmental Protection, 8 New Bond Street, Worcester, MA 01606;* [3]*Biological Field Station, State University of New York College at Oneonta, 5838 State Highway 80, Cooperstown, NY 13326*

ABSTRACT Chemical treatment for the control of the spread of zebra mussels in watercraft is typically focused on the early life stages of the mussel. Adult mussels may be spread via attachment or entangling to gear that is brought on board. Sodium chloride is a chemical that has been recommended for use during some aquacultural practices as a mussel disinfectant. The effectiveness of three sodium chloride–based salts (high-grade sodium chloride, iodized table salt, and water softener salt) was examined for their use as an adult zebra mussel decontamination solution. High-grade sodium chloride and iodized table salt both caused complete mortality at 30,000 mg/l in 24 h. Water softener salt caused complete mortality at the same concentration at 48 h. Iodized table salt caused complete mortality at a lower concentration faster than the laboratory-grade sodium chloride. On the basis of the results of this study, iodized table salt may be an acceptable alternative to high-grade sodium chloride for decontamination of zebra mussels, costing much less and leading to an increase in spread-prevention effectiveness.

KEY WORDS: sodium chloride, zebra mussel, *Dreissena*, decontamination, iodized table salt, water softener salt

NaCl

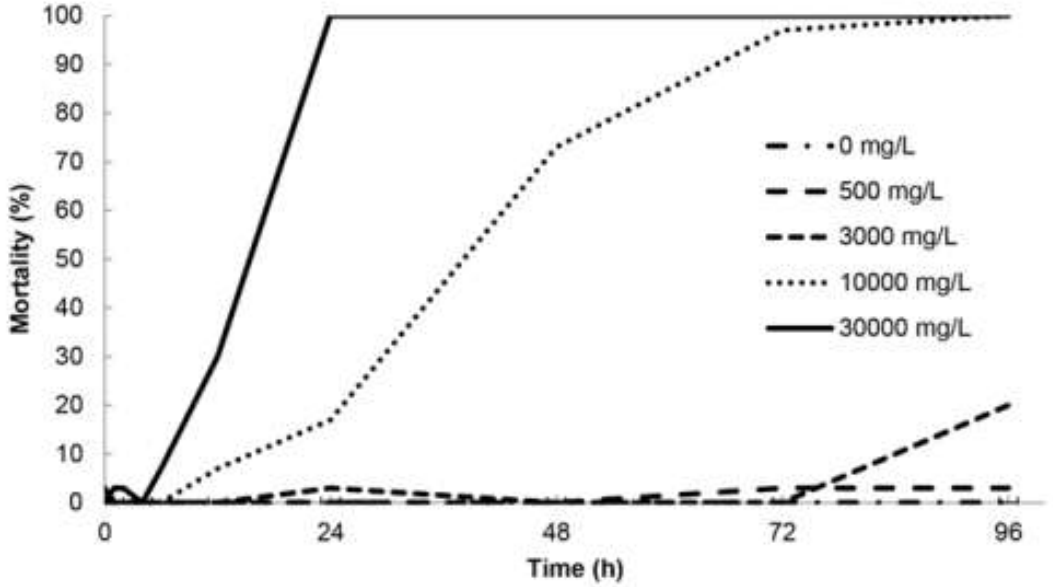
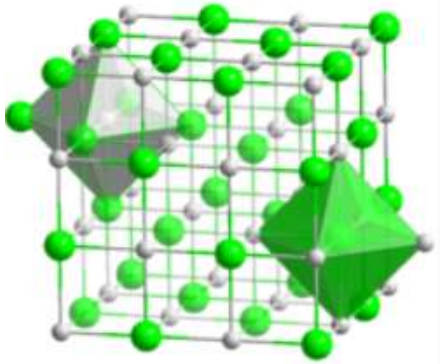


Figure 1. Average mortality (%) of adult zebra mussels (N = 3 groups with 10 mussels in each group) from Otsego Lake after exposure to sodium chloride (NaCl) of varying concentrations in Fall 2014.

Sodium chloride



Softener Salt

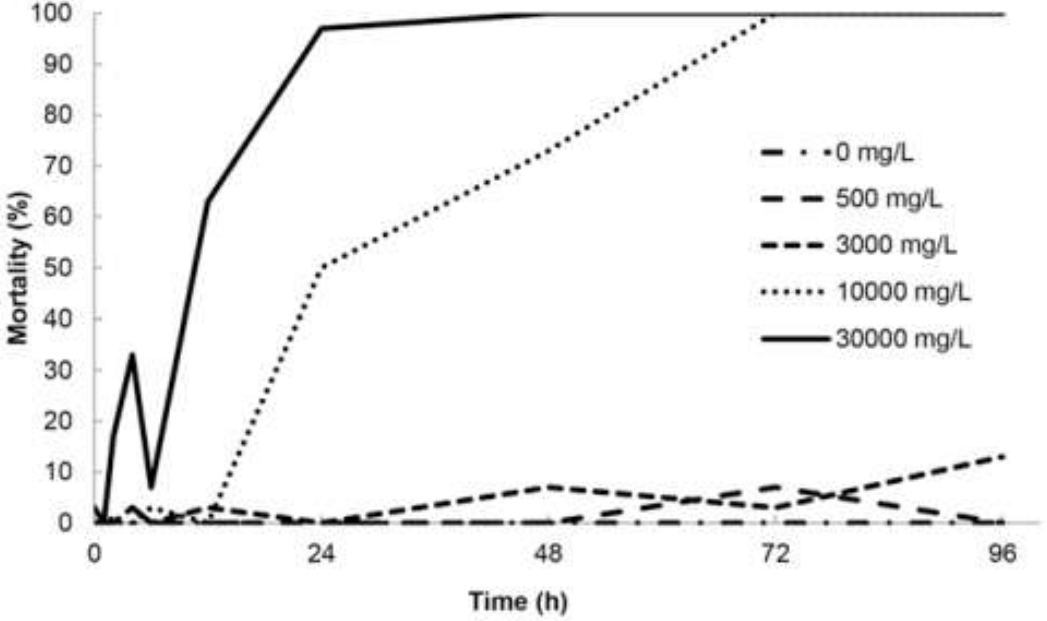
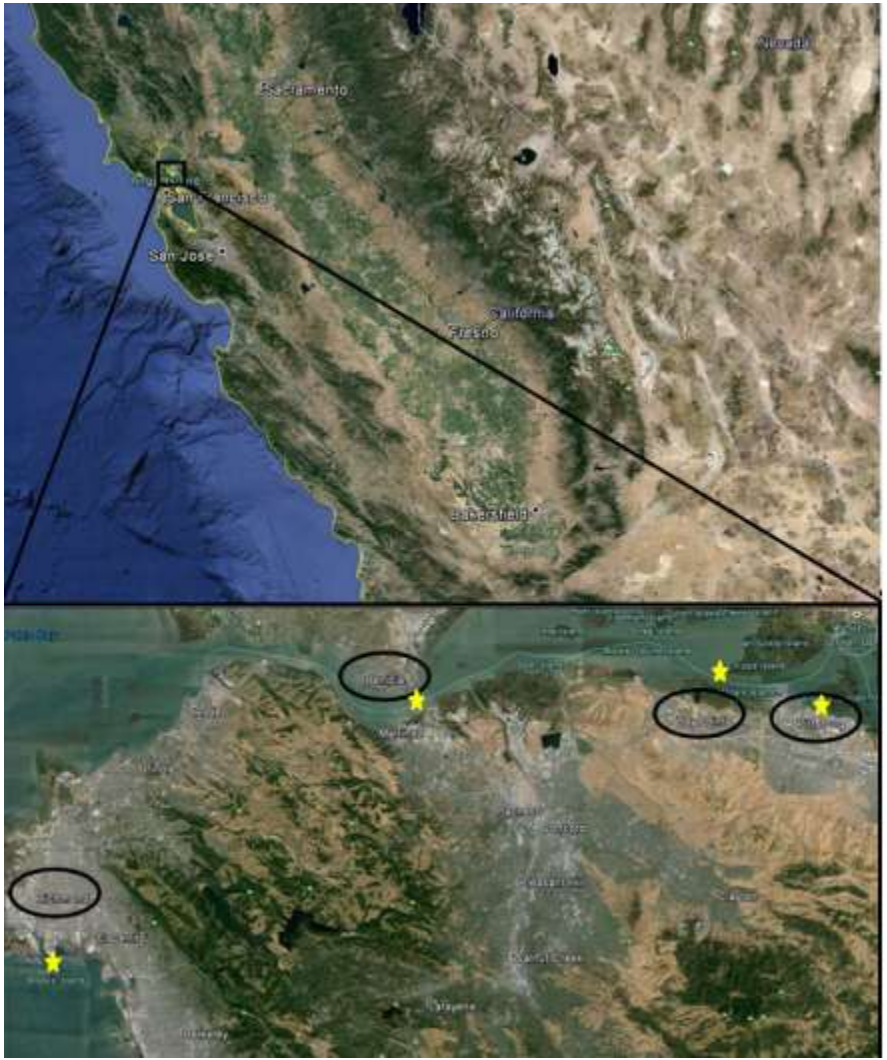


Figure 3. Average mortality (%) of adult zebra mussels (N = 3 groups with 10 mussels in each group) from Otsego Lake after exposure to water softener salt of varying concentrations in Fall 2014.

Saltwater/Brackish Water

- The Bay-Delta, California

Hofius et al. 2015



Massachusetts

Biological: Inspector

Detector Popeye

CAN THE DOGS FIND INVASIVE MUSSEL VELIGERS?

MassDEP Field Operation Stand Operating Procedures

MassDEP

Massachusetts Department of Environmental Protection
Division of Watershed Management

STANDARD OPERATING PROCEDURE

Field Equipment Decontamination
to Prevent the Spread of Invasive Aquatic Organisms

CN 59.6
August, 2015

Acknowledgements

Massachusetts Department of Environmental Protection
Massachusetts Department of Fish and Game
Massachusetts Department of Conservation and Recreation
U.S. Fish and Wildlife Service
New York Department of Environmental Conservation
SUNY Oneonta Biological Field Station
National Science Foundation
National Park Service
Kansas Department of Wildlife, Parks, and Tourism
Lake Mead Marina/Las Vegas Boat Harbor
Colleagues, Students and Interns