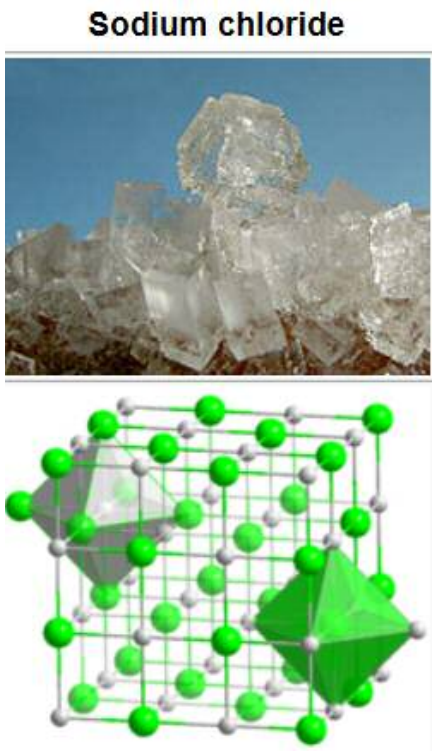
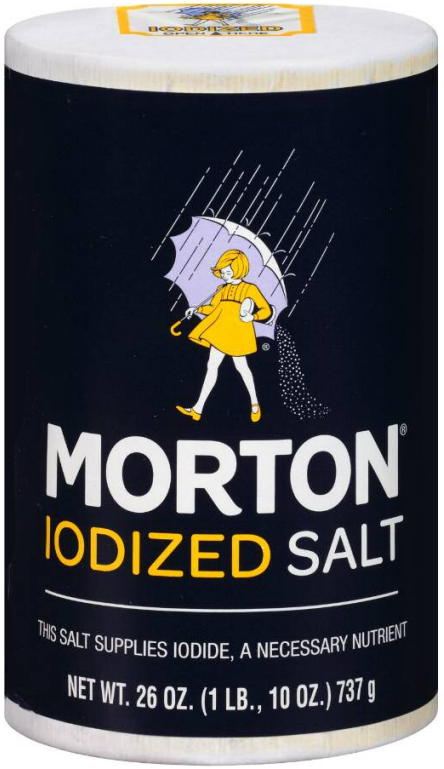
Aquatic Invasive Species Treatment: Is Salt a Terminator or a Facilitator?



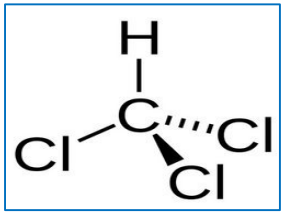


Types	Invasive	Non-Invasive
Physical/Mechanical	High Pressure Wash Hot Water Spray	Garden Hose Flushing Mother Nature
Chemical	Bleach/Chlorine	NaCl
Biological	Zequanox® Redear Sunfish Inspectors working with Microscope in the field	Human Hand Harvest Dogs

Types	Invasive	Non-Invasive
Chemical	Bleach/Chlorine	NaCl

Traditional Approach: Chlorination/Bleach

Water, Facility, and Boat Chlorination



Trihalomethane

Corrosive to pipe
Destructive to biota

Chlorine Residual Regulation by EPA/States

Fish Hatchery Facility

NPDES Discharge Permit

EPA: 19 ppb for freshwater

NaCl Treatment

1) Simple
2) Safe
3) Environmentally Friendly

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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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

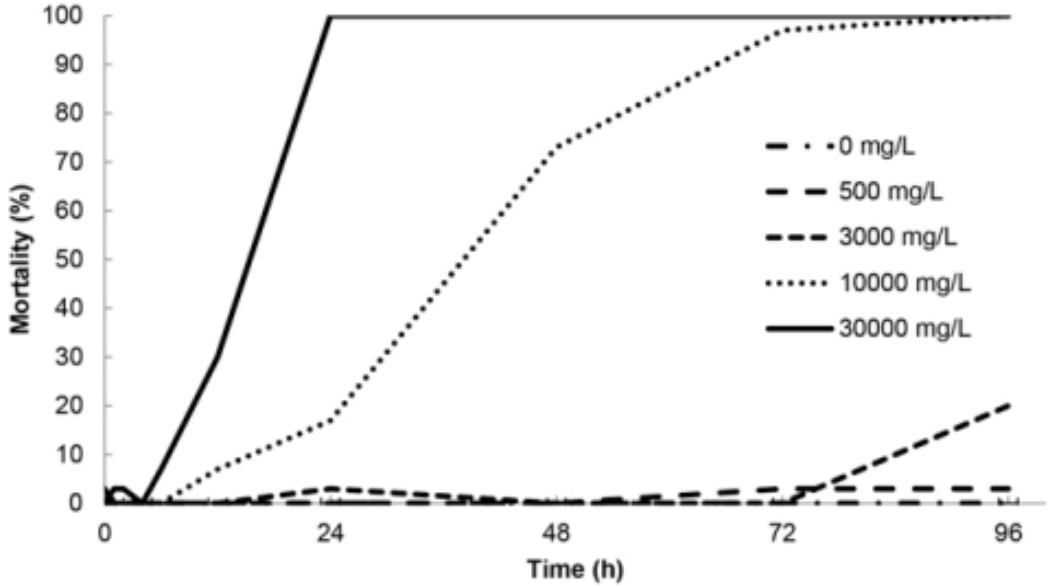
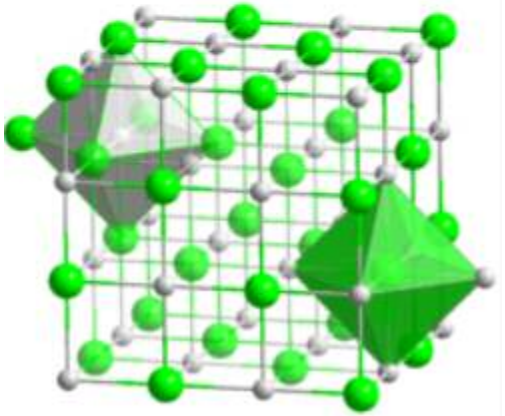


Figure 1. Average mortality (%) of adult zebra mussels (N = 3 groups with 10 mussels in each group) from Otsego Lake after exposure to sodium chloride (NaCl) of varying concentrations in Fall 2014.

Sodium chloride



Iodized Table Salt

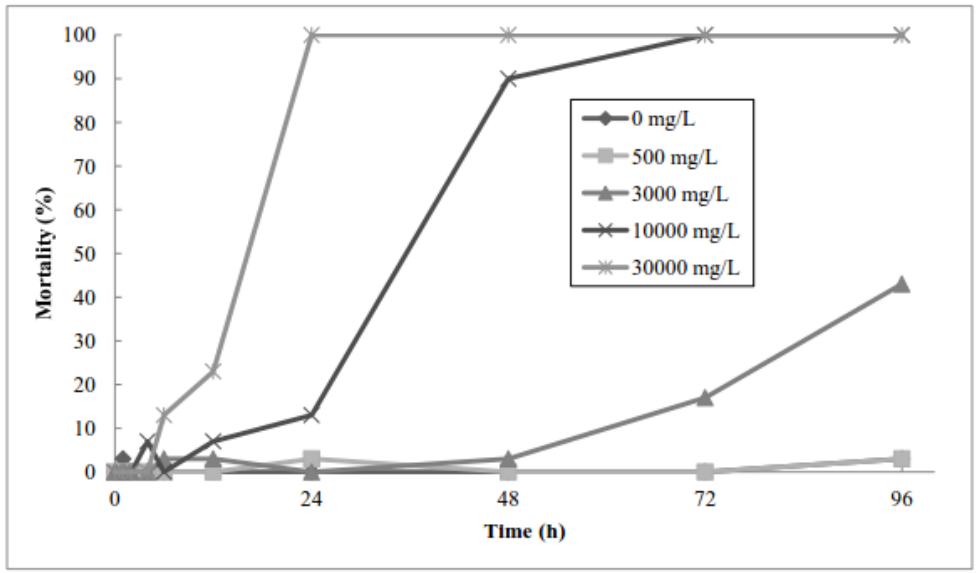
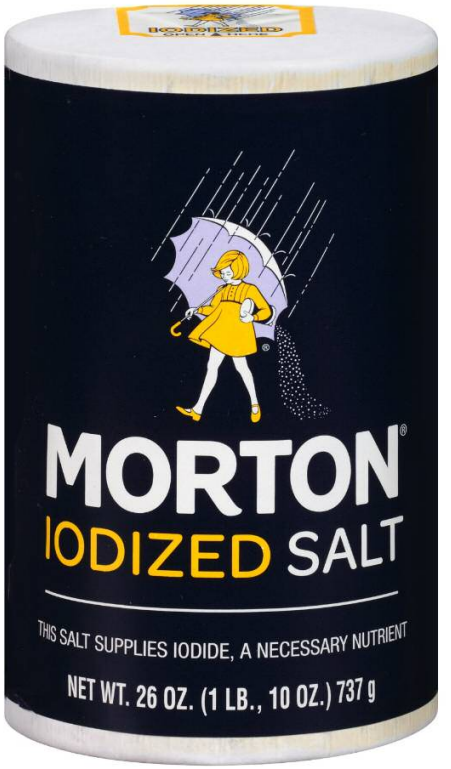


Figure 2. Average mortality (%) of adult zebra mussels (N=3 groups with 10 mussels in each group) from Otsego Lake after exposure to iodized table salt of varying concentrations in Fall 2014.



Softener Salt

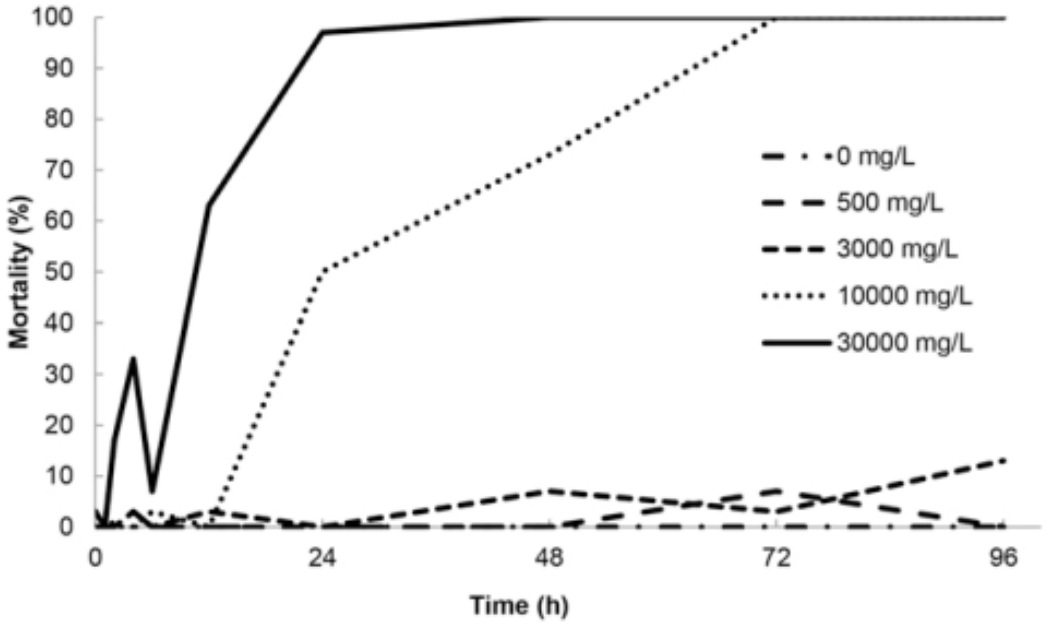
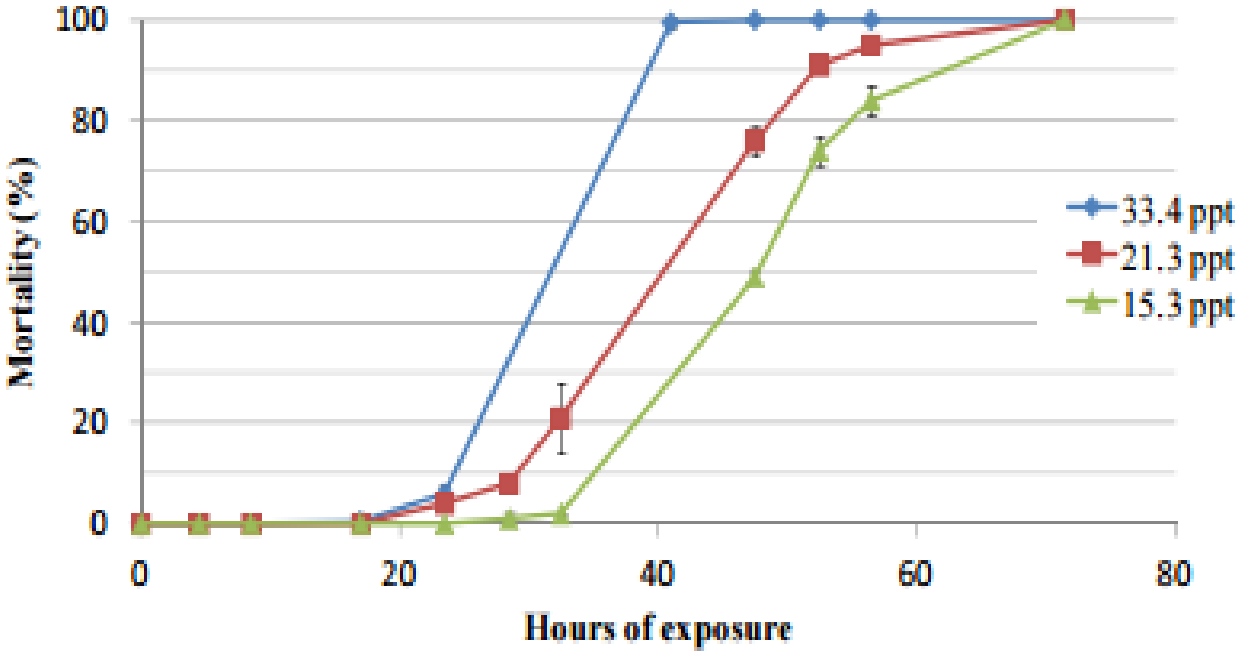


Figure 3. Average mortality (%) of adult zebra mussels (N = 3 groups with 10 mussels in each group) from Otsego Lake after exposure to water softener salt of varying concentrations in Fall 2014.

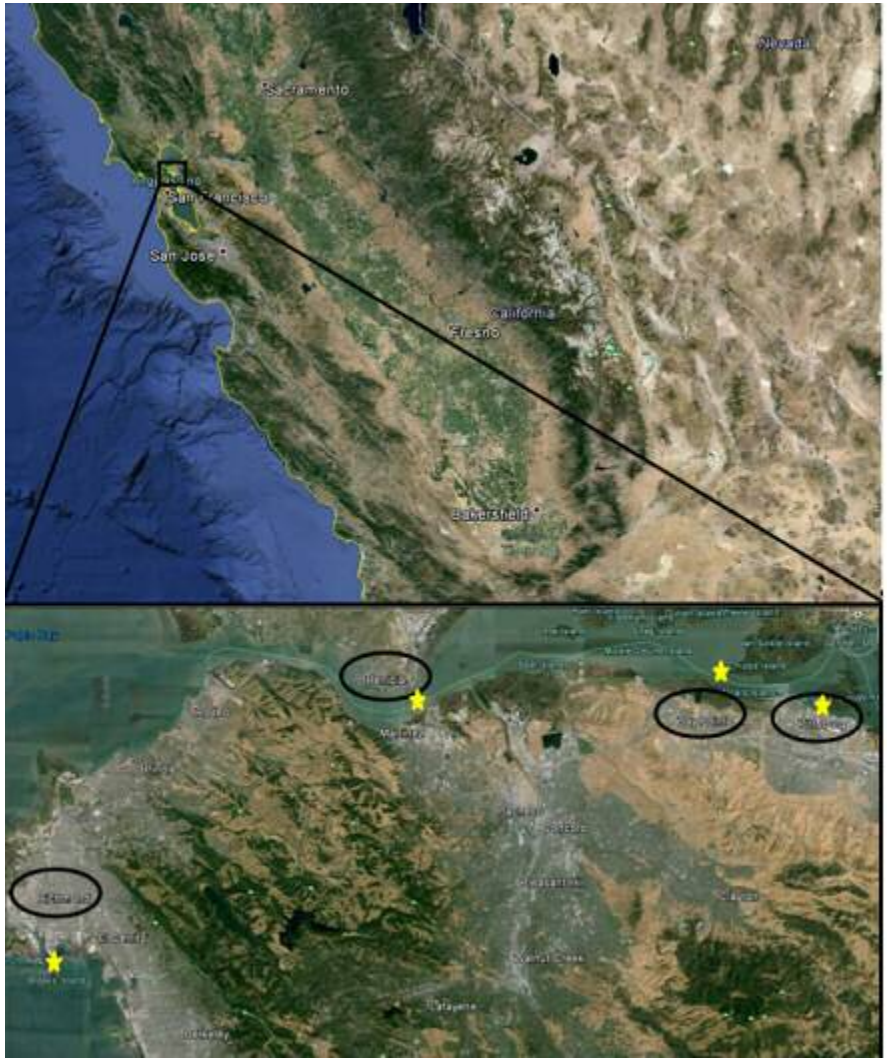
Salt/Brackish Water



Hofius et al. 2015

Saltwater/Brackish Water

- The Bay-Delta, California



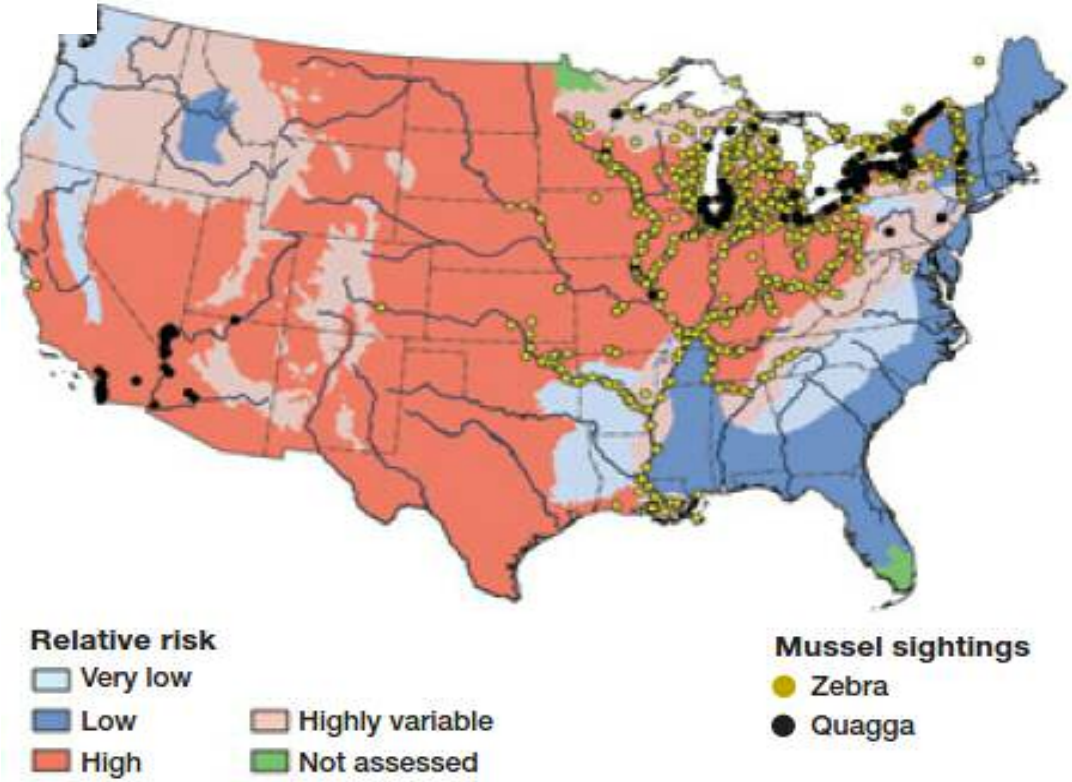
Hofius et al. 2015

THE ECOLOGICAL SOCIETY OF AMERICA
Frontiers in Ecology and the Environment

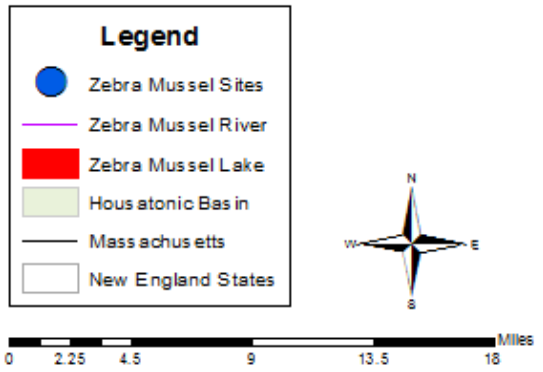
Research Communication

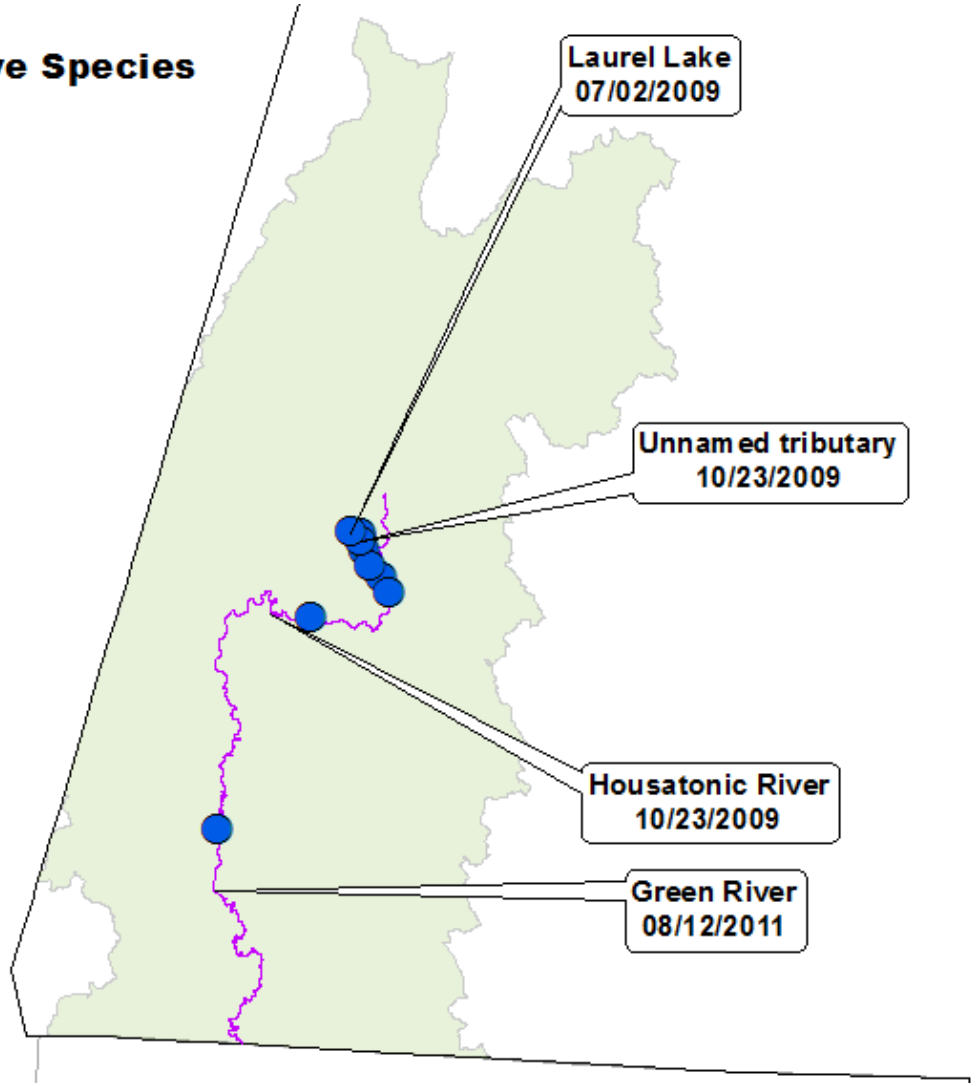
A calcium-based invasion risk assessment for zebra and quagga mussels (Dreissena spp)

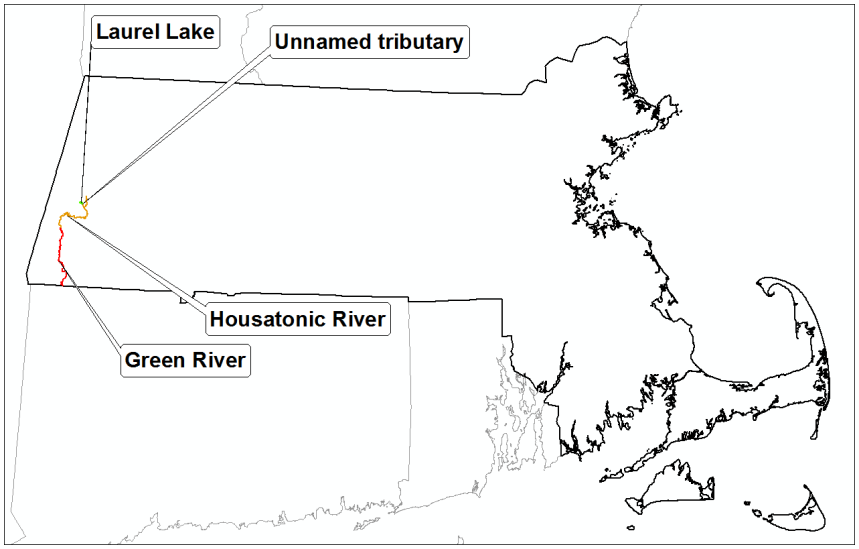
Whittier et al. 2008



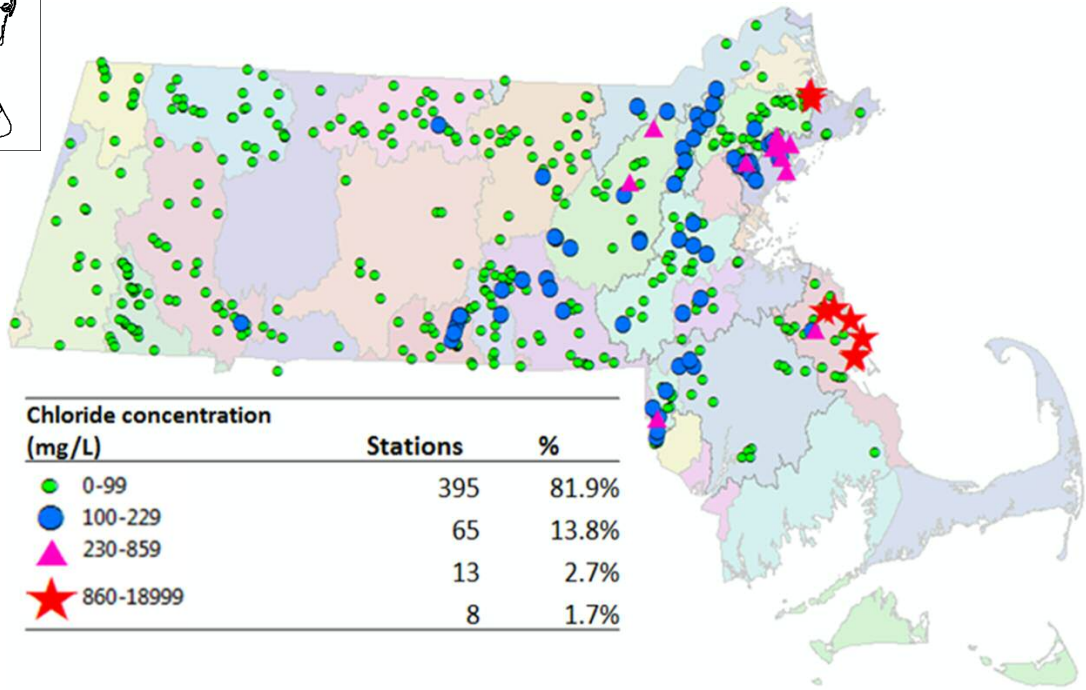
Massachusetts Aquatic Invasive Species
Zebra Mussel
MassDEP





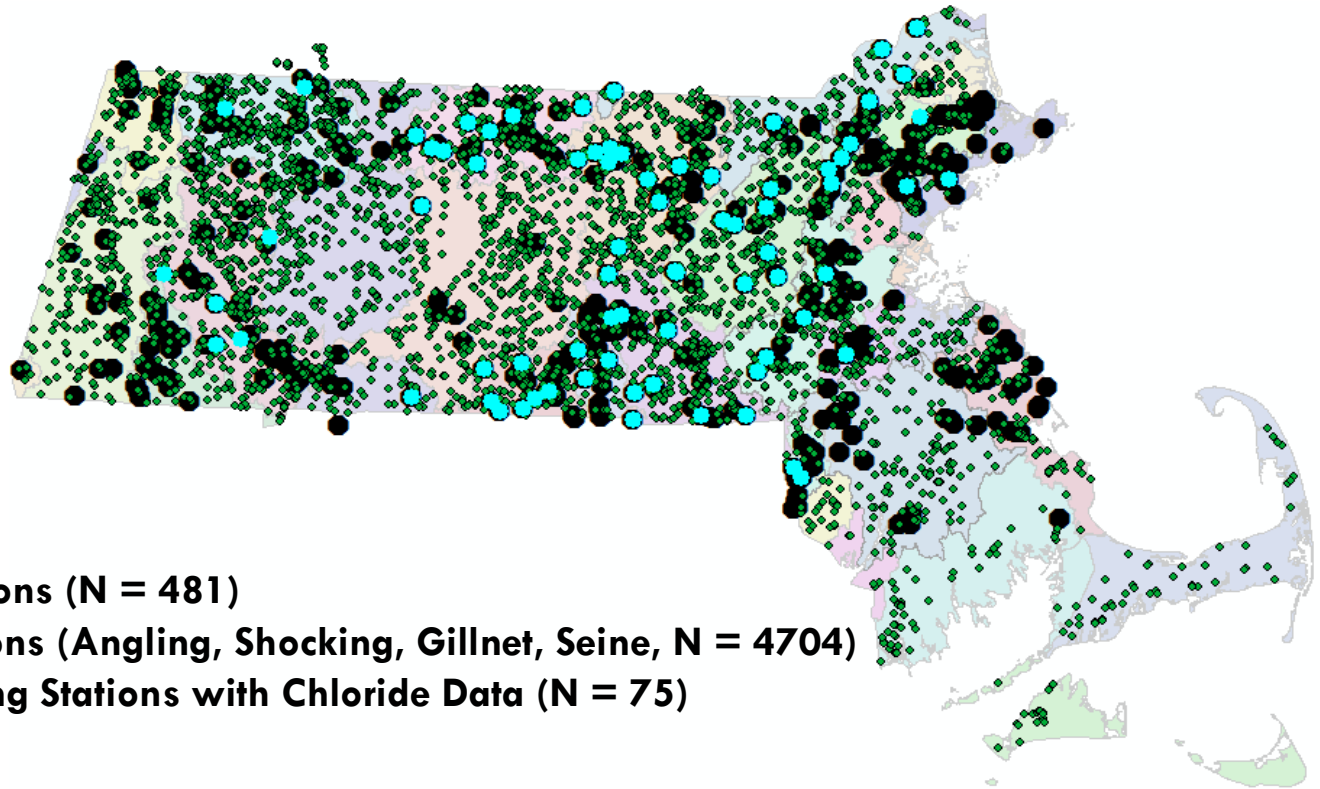


ZM vs. Chloride levels in MA waters



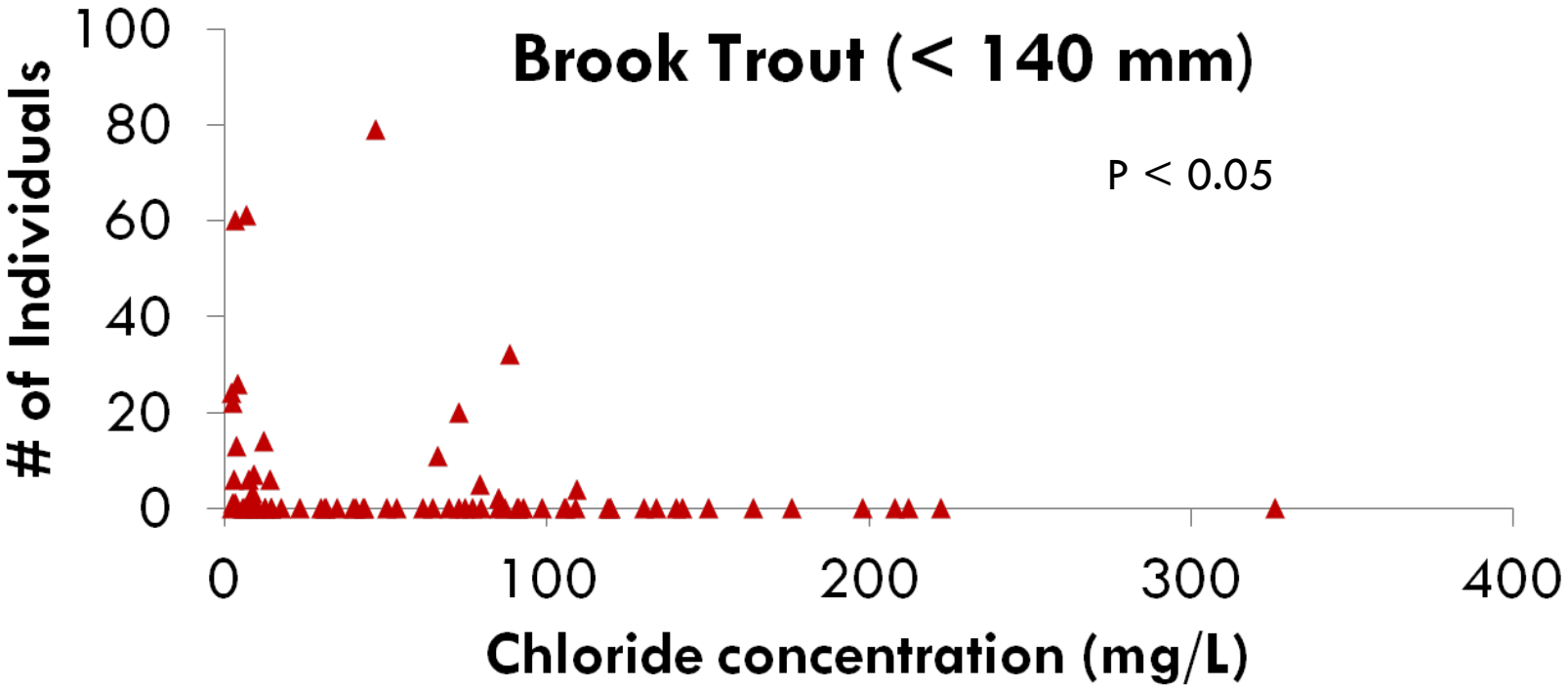
Chloride concentration (mg/L)	Stations	%
0-99	395	81.9%
100-229	65	13.8%
230-859	13	2.7%
860-18999	8	1.7%

Fish Communities and Chloride

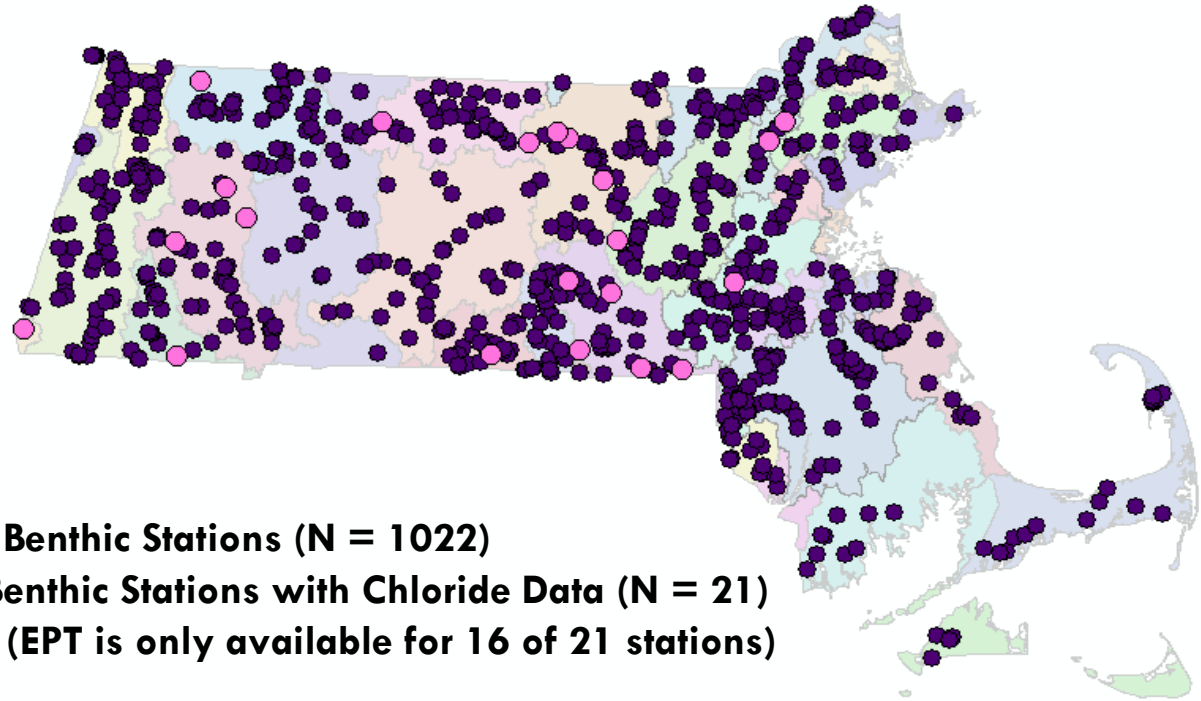


Black Dot: Chloride Stations (N = 481)
Green Dot: Fishing Stations (Angling, Shocking, Gillnet, Seine, N = 4704)
Blue Dot: Electric Shocking Stations with Chloride Data (N = 75)


MassEEA

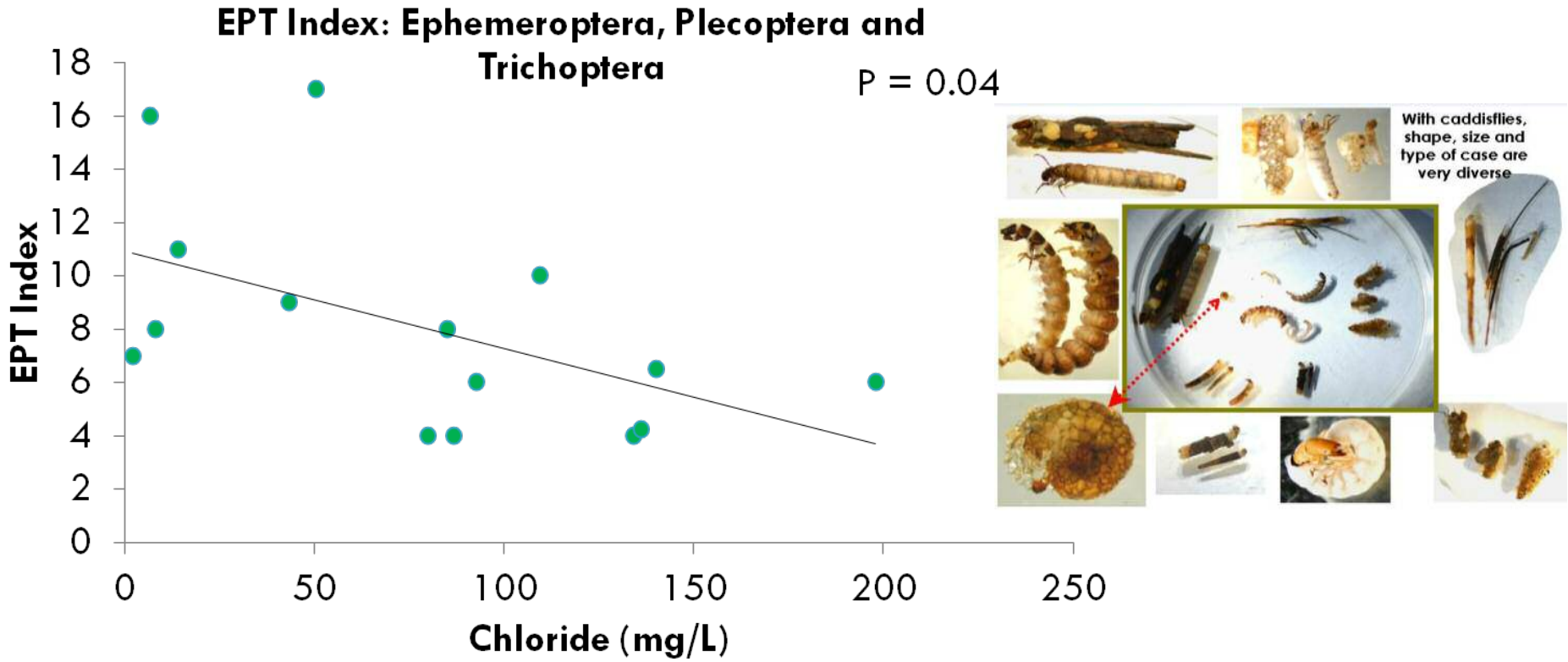

Brook Trout (< 140 mm)
P < 0.05
# of Individuals
100
80
60
40
20
0
0
100
200
300
400
Chloride concentration (mg/L)

Benthic Community and Chloride (Year 2010 or earlier)

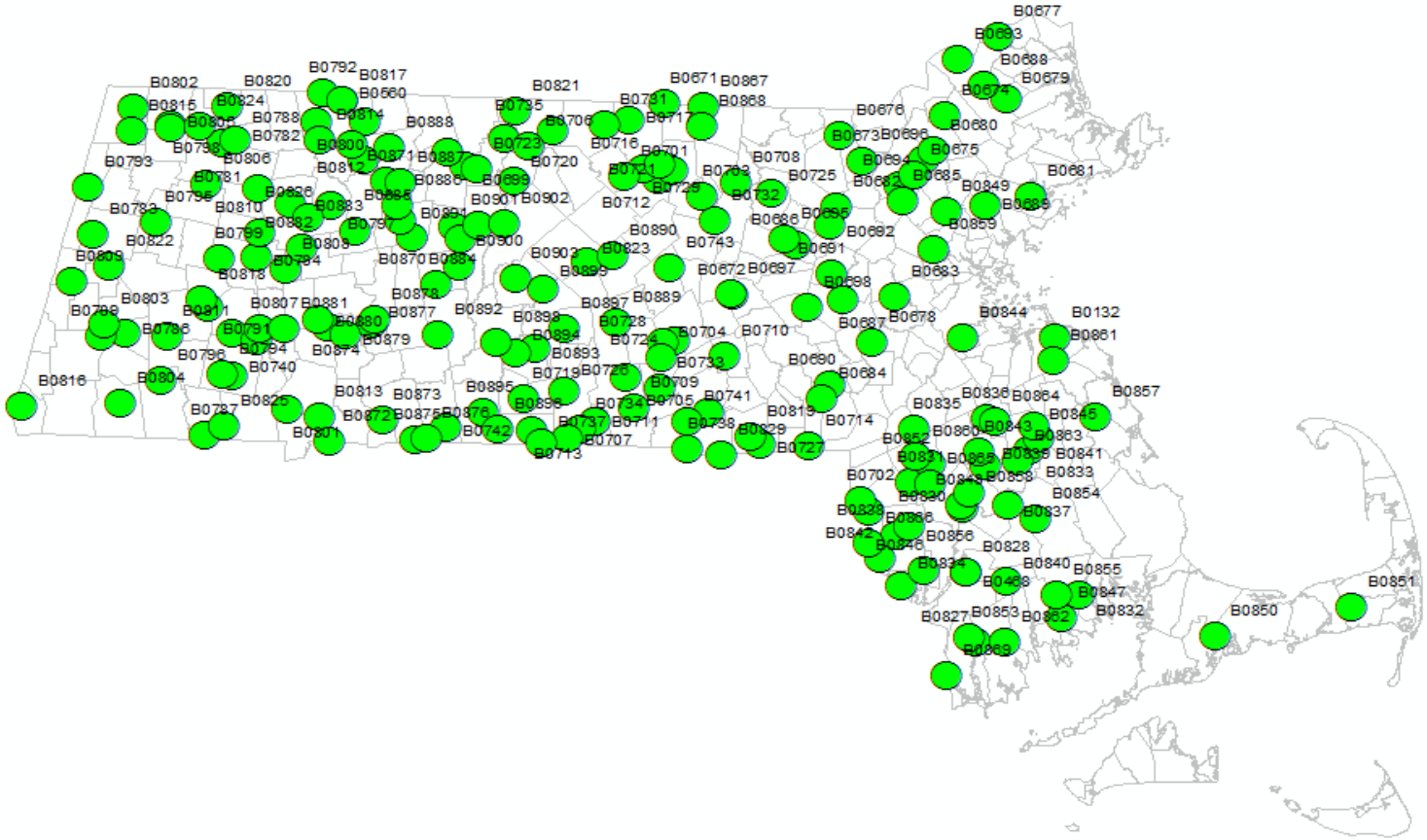


Black Dot: Benthic Stations (N = 1022)
Pink dot: Benthic Stations with Chloride Data (N = 21)
(EPT is only available for 16 of 21 stations)

Benthic Community



196 New Benthic Stations: 2011 - 2015

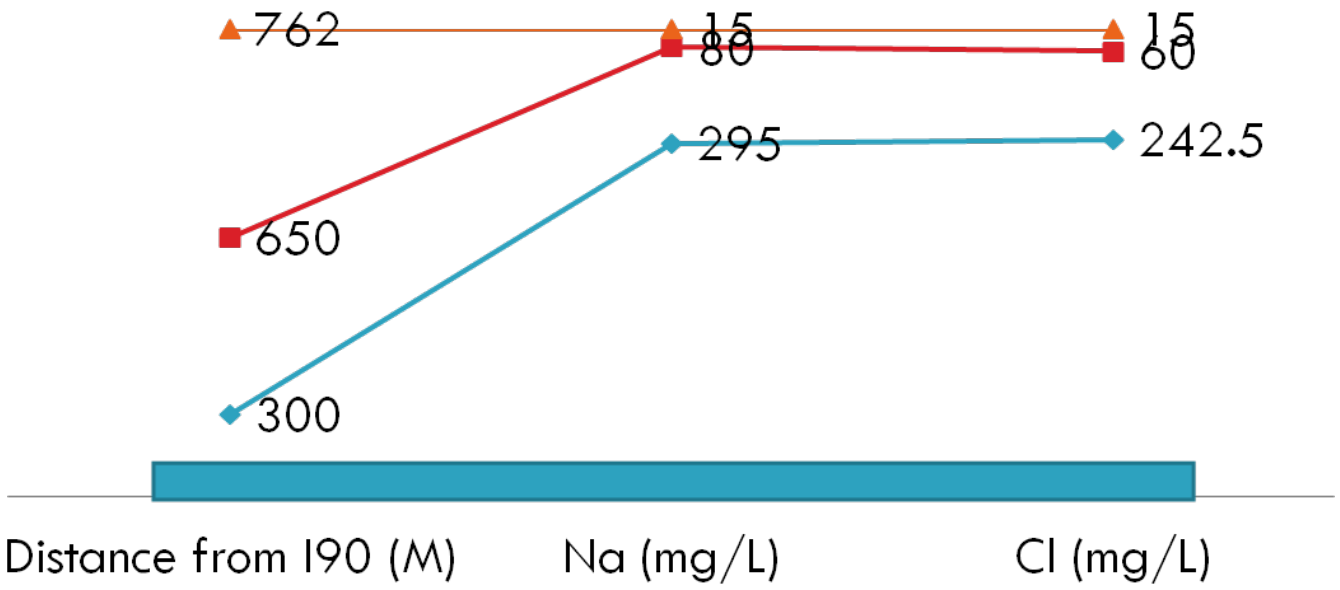


Stepwise regression results showing chloride negatively affects Species Richness

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	3108.58341	444.08334	12.07	<.0001
Error	131	4818.13801	36.77968		
Corrected Total	138	7926.72142			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	42.14199	5.56172	2111.63752	57.41	<.0001
Calcium	-0.32599	0.12855	236.50155	6.43	0.0124
Magnesium	1.48210	0.42579	445.63330	12.12	0.0007
TN	-12.10744	2.72187	727.74168	19.79	<.0001
Chloride	-0.03772	0.01580	209.64653	5.70	0.0184
Ammonia	-30.92140	14.21947	173.92401	4.73	0.0315
Antimony	-39.15340	22.02076	116.27388	3.16	0.0777
NO3_NO2	17.36426	3.63868	837.59236	22.77	<.0001

Salt Concentrations in waters along Interstate 90



Modified from Richburg et al., 2001

Invasive Common Reed Grass *Phragmites*

Effects of Road Salt and *Phragmites australis* Invasion on the Vegetation of a Western Massachusetts Bog (Richburg et al., 2001)

Mass Pike

Assabet River at Route 9

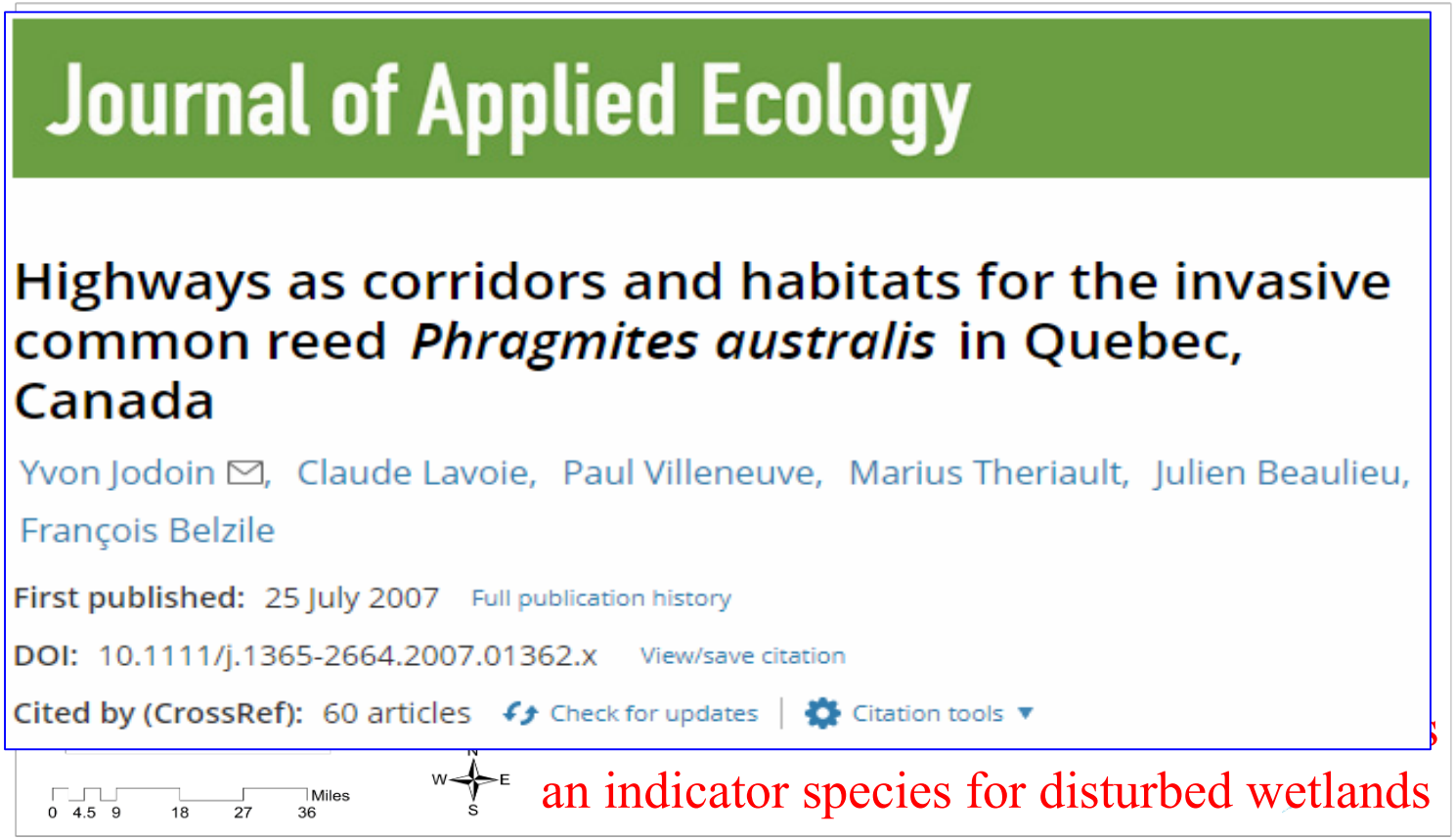
Invasive Common Reed Grass

Photo by Jeffrey Carter

Parking Lot

Phragmites (Common Reed Grass)

Coastal Wetland Species in **Inland lakes/rivers**



Journal of Applied Ecology

Highways as corridors and habitats for the invasive common reed *Phragmites australis* in Quebec, Canada

Yvon Jodoin, Claude Lavoie, Paul Villeneuve, Marius Theriault, Julien Beaulieu, François Belzile

First published: 25 July 2007 Full publication history

DOI: 10.1111/j.1365-2664.2007.01362.x View/save citation

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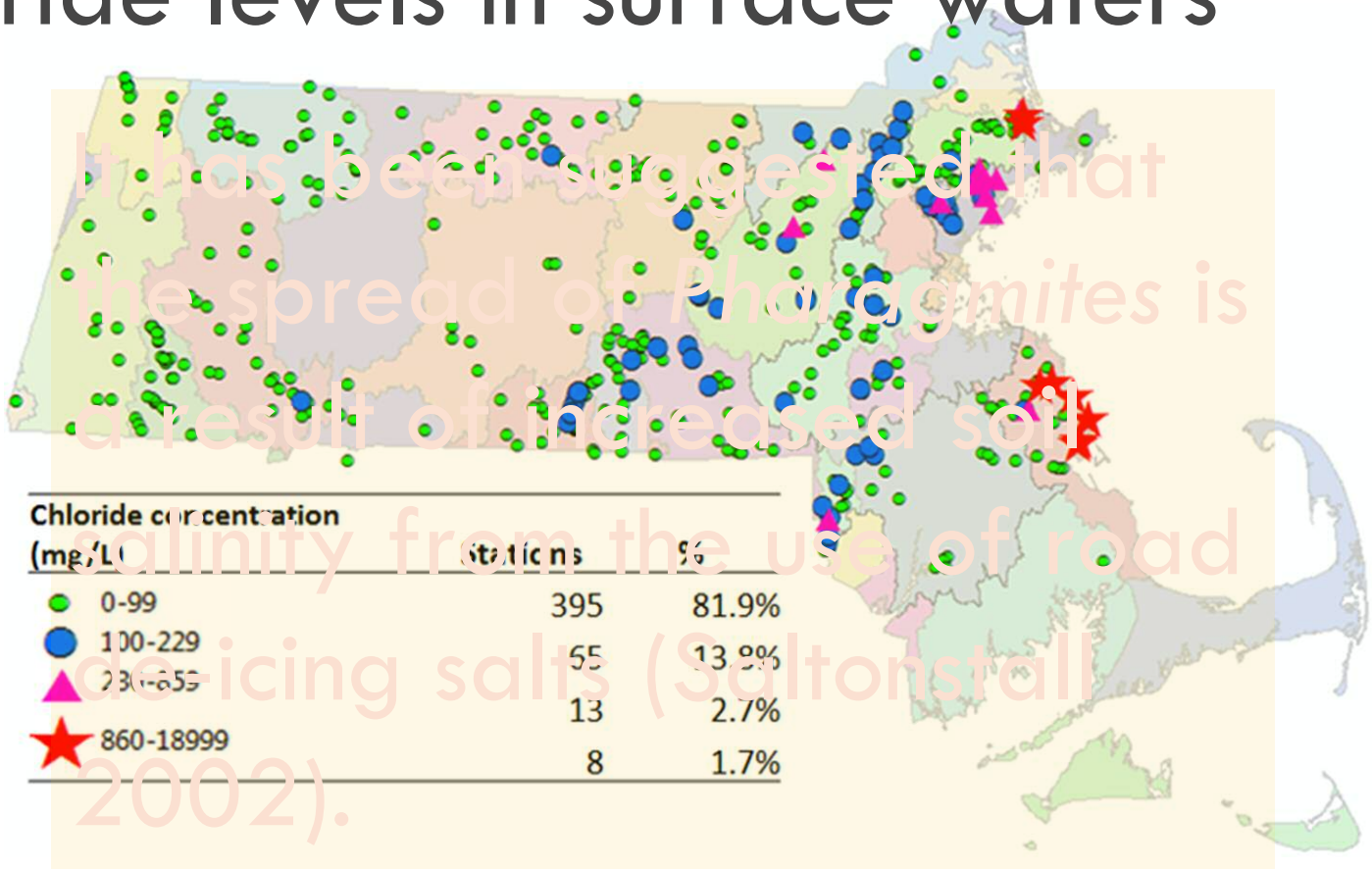
Miles
0 4.5 9 18 27 36

N W E S

an indicator species for disturbed wetlands

Chloride levels in surface waters



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It has been suggested that the spread of *Phragmites* is a result of increased soil salinity from the use of road de-icing salts (Saltonstall 2002).

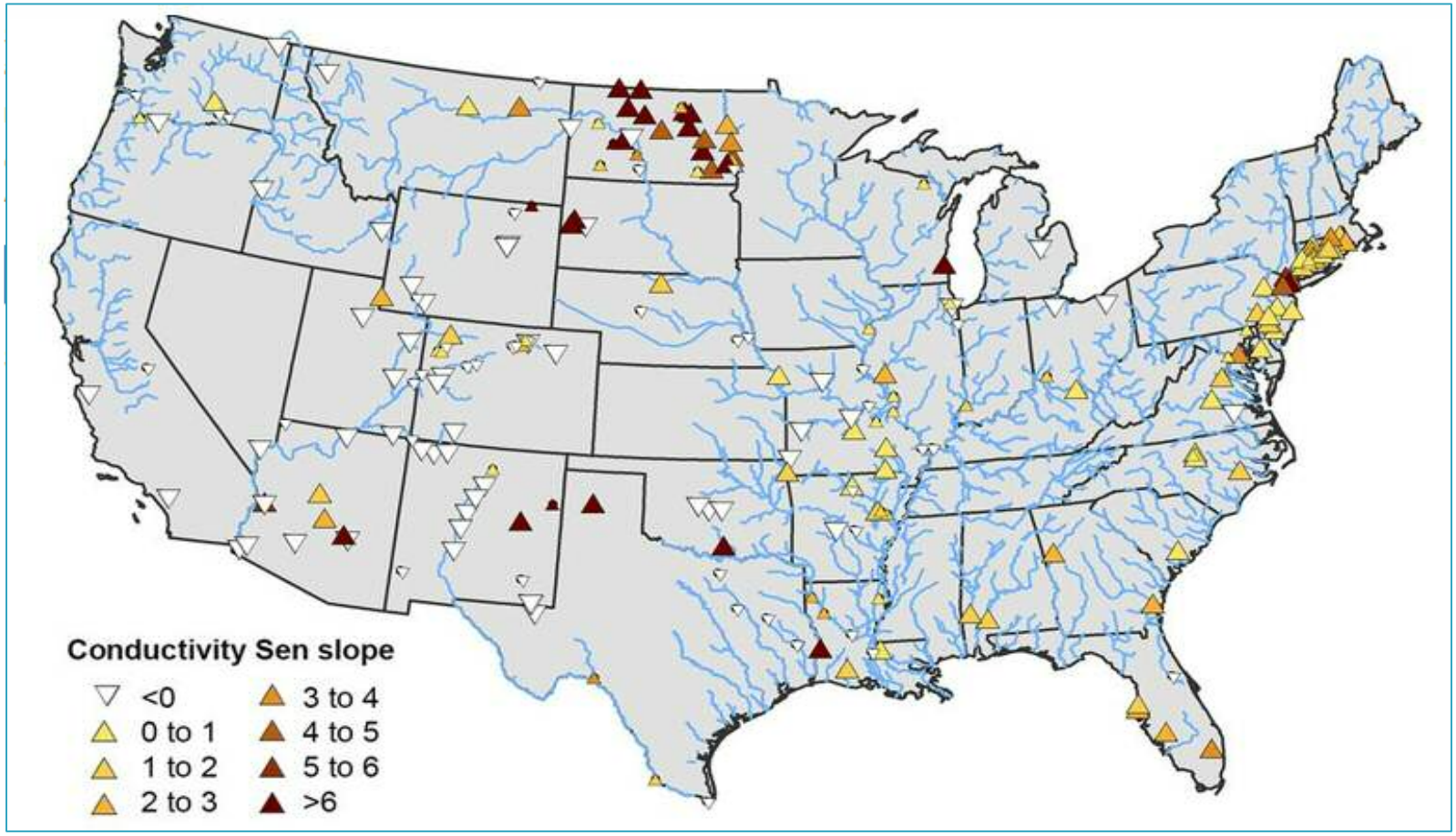
Invasive *Phragmites*

- Martin and Blossey (2013): more than four billion dollars is spent per year by different municipal, federal, land trusts, state and private organizations to manage reed grass. Despite the large fund dedicated to eradicating and managing reed grass, significant improvement has not been achieved.

Storm JUNO: 35,000 Tons of salt for Boston (Jan 28, 2015)

(www.weather.com)

Freshwater salinization syndrome on a continental scale



- Salinization is facilitating the invasion of *Phragmites* and directly harming native species and degrading water quality in freshwater ecosystems

Acknowledgements

U.S. Fish and Wildlife Service
New York Department of Environmental Conservation
SUNY Oneonta Biological Field Station
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National Park Service
Kansas Department of Wildlife, Parks, and Tourism
Massachusetts Department of Environmental Protection
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Colleagues and Students