

Non-invasive Techniques for Aquatic Invasive Species Prevention and Control



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Non-invasive Techniques:

1) Simple

2) Safe

3) Environmentally Friendly

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

Types	Invasive	Non-Invasive
Physical/Mechanical	High Pressure Wash Hot Water	Garden Hose Flushing Mother Nature

Hot Water Spray Data Collection and Validation



Hot Water Spray: Temperature & Time

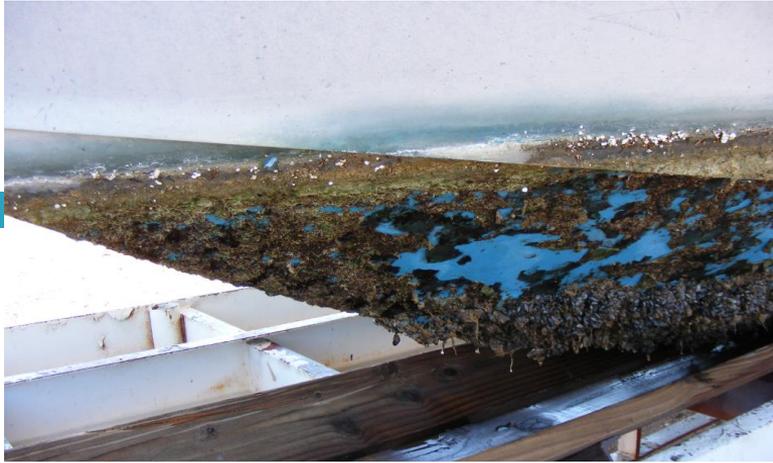
Temperature	Quagga Mussel	Zebra Mussel
68oF	No Mortality	No Mortality
104oF	40 S	40 S
122oF	20 S	40 S
130oF	10 S	10 S
140oF	5 S	10 S
158oF	5 S	5 S
176oF	5 S	5 S

Hot Water Spray Data Collection and Validation



140°F

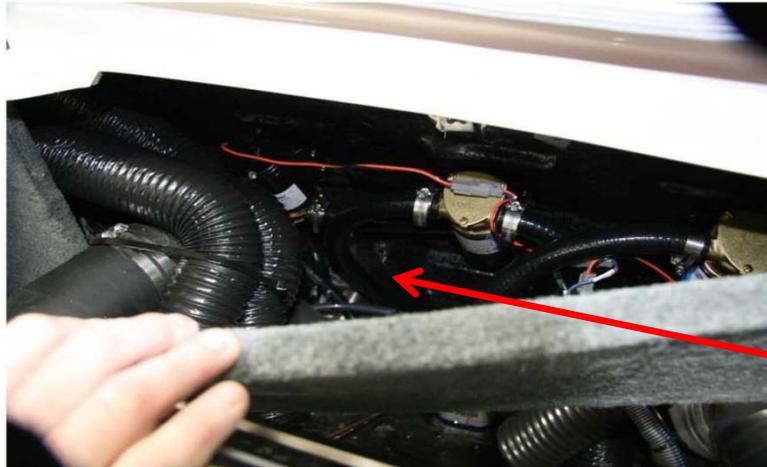
> 140°F



Hull: Easy to access



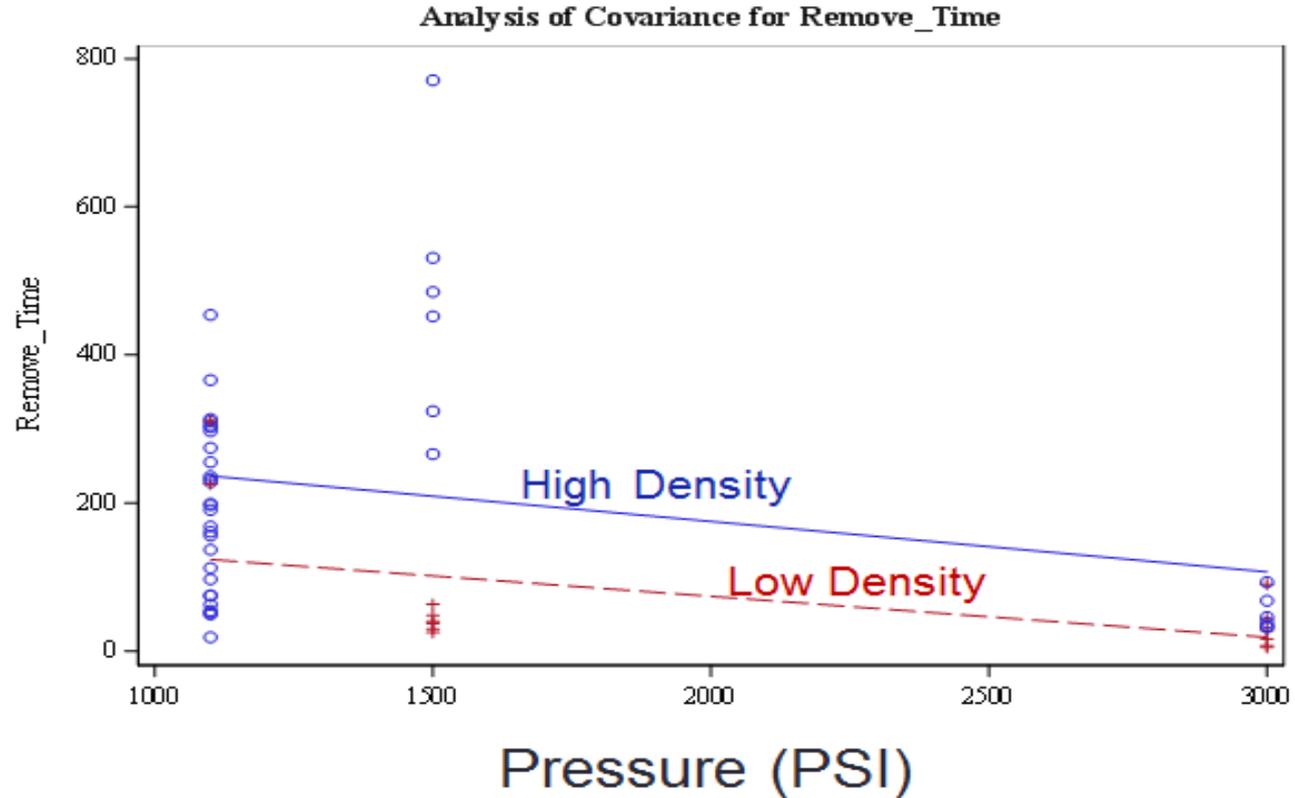
Gimbal area: Hard to access



Ballast system:
Cannot be Accessed

< 130oF

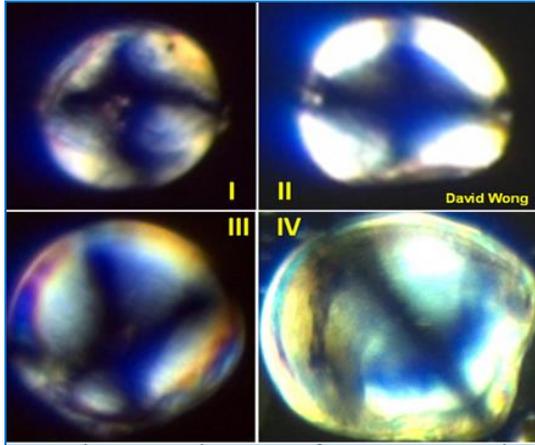
High Pressure Wash



High Pressure Boat Washing Station



Prevent the spread of mussel veligers

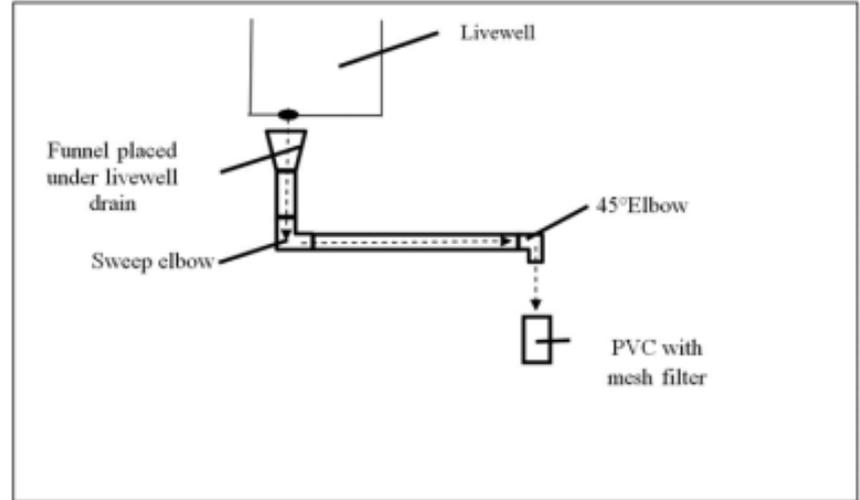
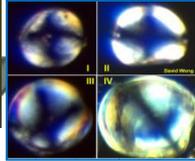


Veligers: 80-350 μm

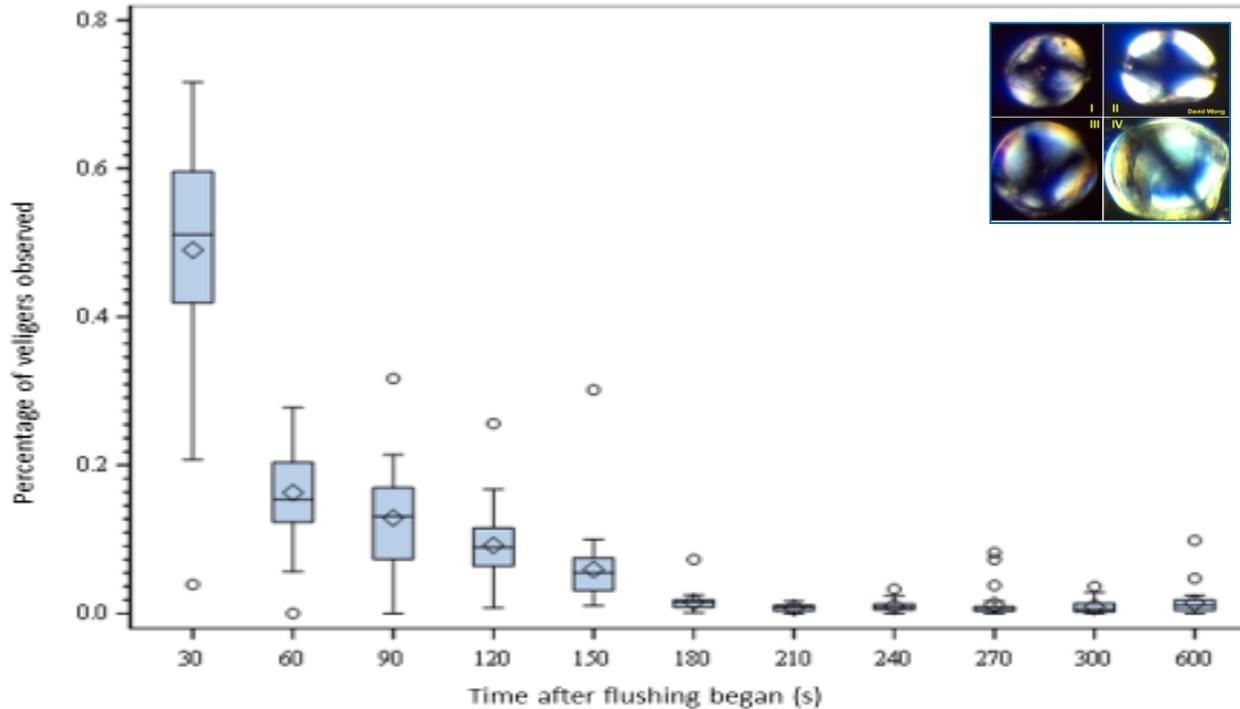


Adults: 8000-40000 μm

Low pressure (60 psi) on livewell

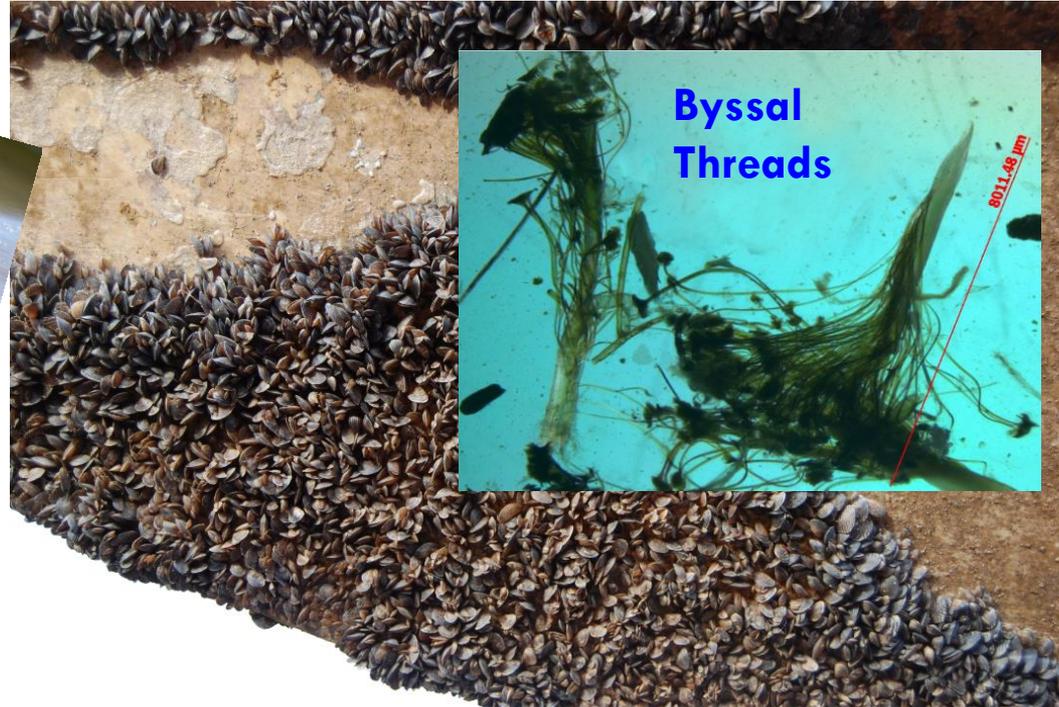


Low pressure (60 psi) on livewell

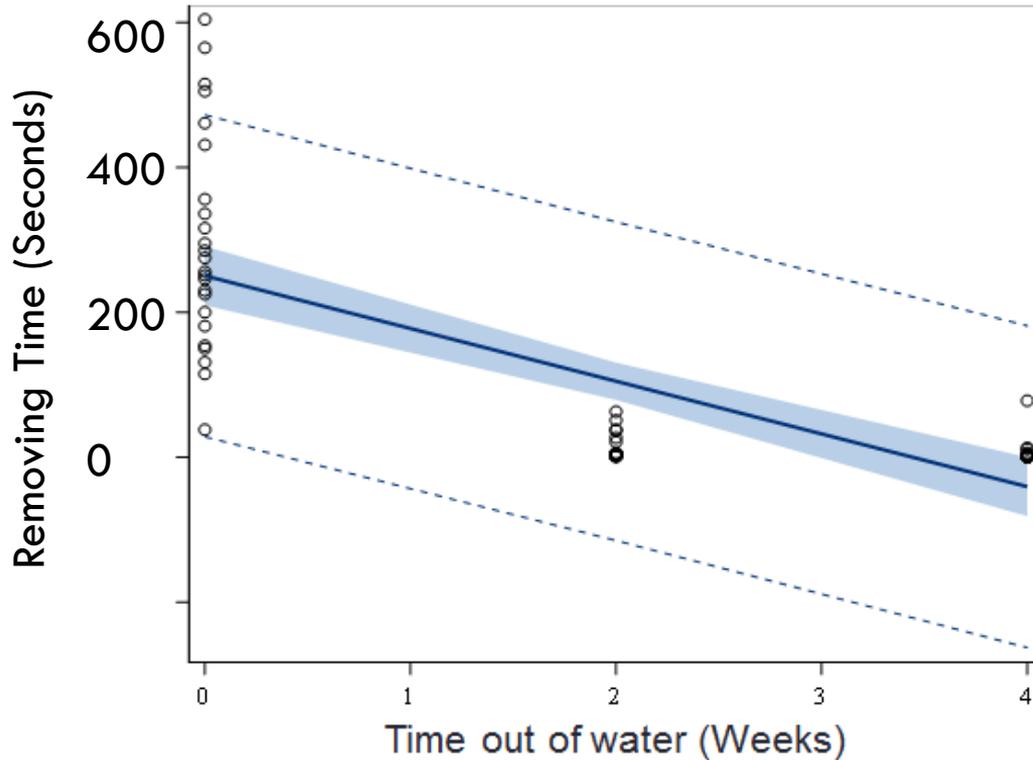


Davis et al. 2016

Prevent the spread of adult mussels



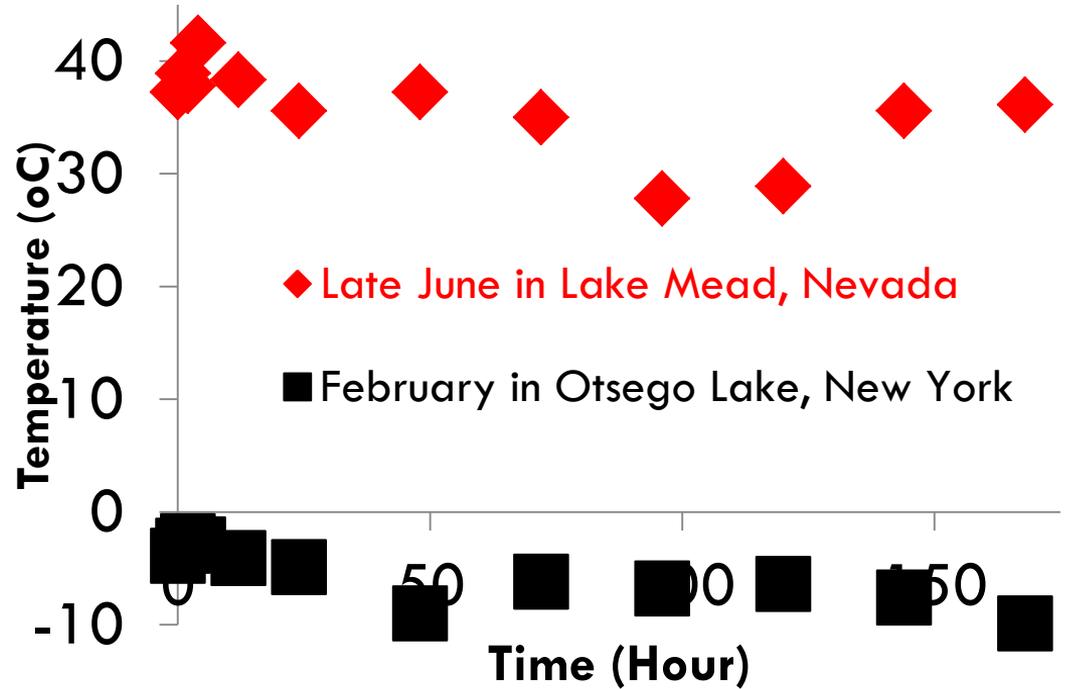
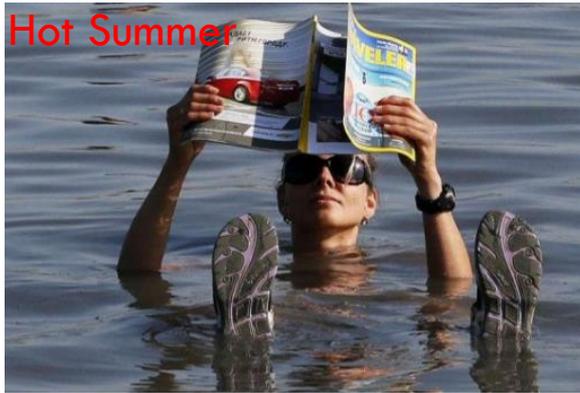
Prevent the spread of adult mussels



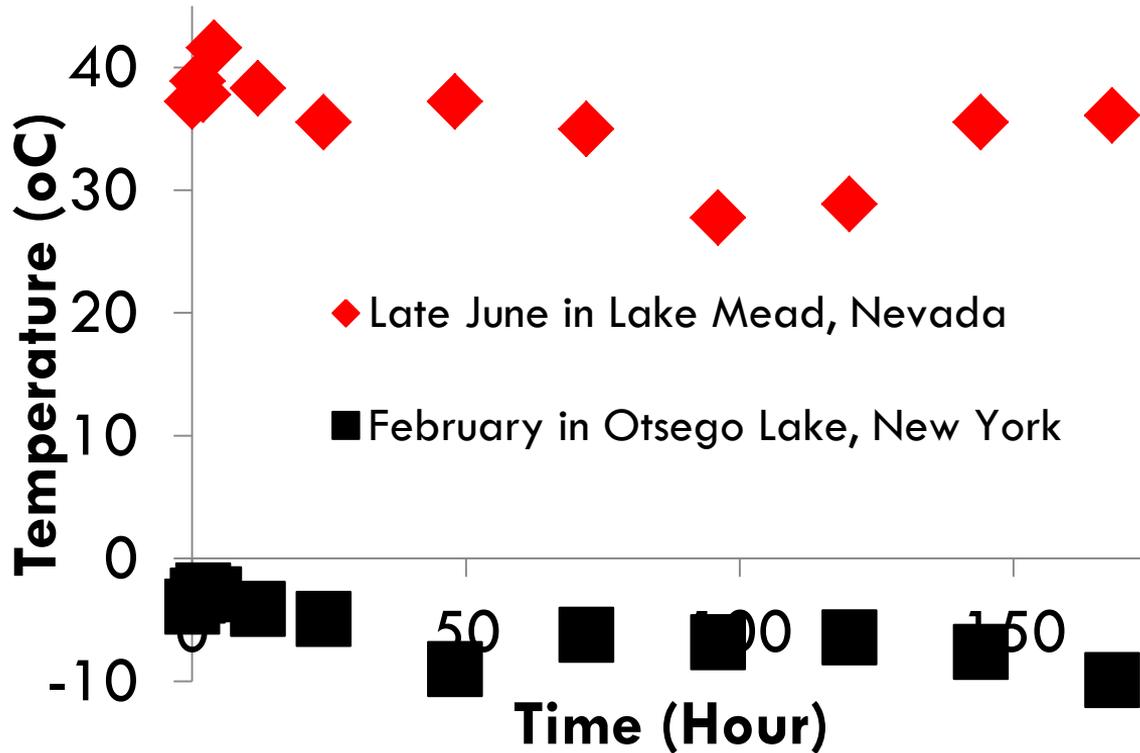
Prevent the spread of adult mussels



Mother Nature

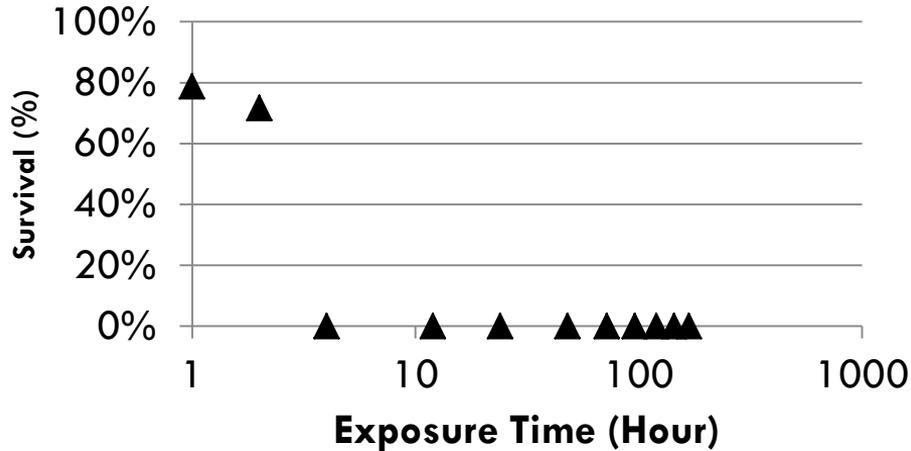


Mother Nature



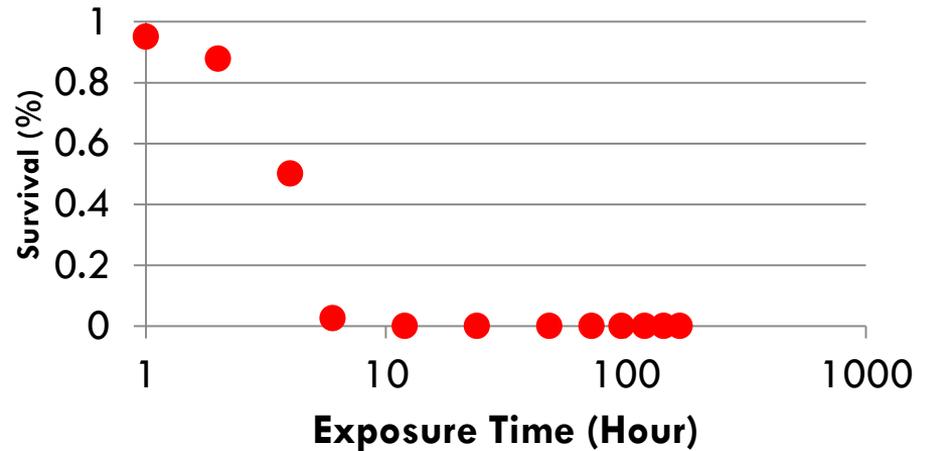
Mother Nature

Winter Time in Otsego Lake, NY



SUNY Oneonta/MassDEP

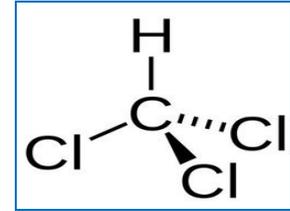
Summer Time in Lake Mead, NV



NPS

Types	Invasive	Non-Invasive
Chemical	Bleach/Chlorine EarthtecQZ®	NaCl KCl

Traditional Approach: Chlorination/Bleach



Trihalomethane



Corrosive to pipe
Destructive to biota

Water, Facility, and Boat Chlorination

Control of Mussels with EarthTec QZ in the Open Waters of Lakes
Rapid Response, Independence Lake, MN



EarthTec Chemistry

EPA Registered as an Algaecide/Bactericide

Registered in All 50 States as Algaecide/Bactericide, in
26+ States as Molluscicide

Certified to NSF Standard 60

Reduces Labor Costs

EarthTec Is the Easiest, Safest and Most Efficient Method
to Deliver Copper



NaCl

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

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

ERIC A. DAVIS,¹ WAI HING WONG^{2*} AND WILLARD N. HARMAN³

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

Sodium chloride

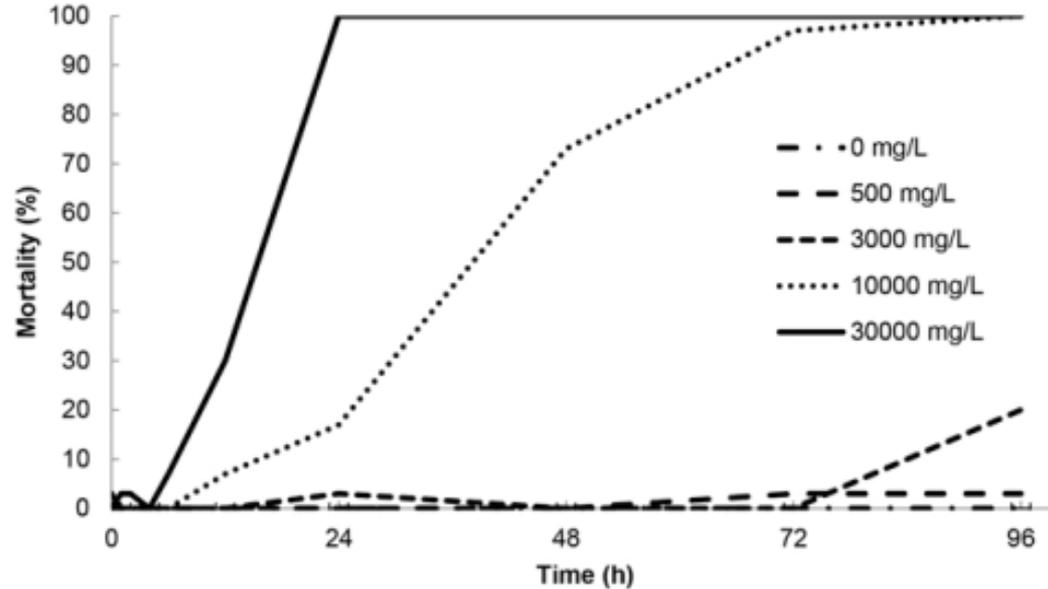
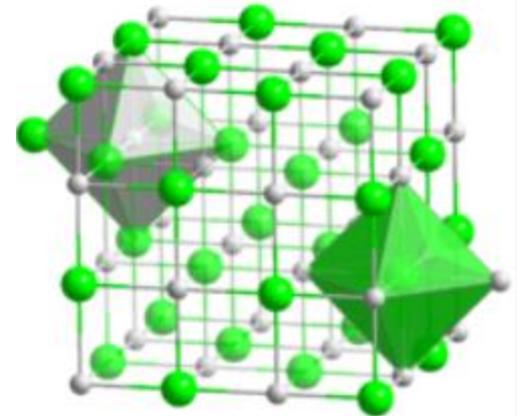


Figure 1. Average mortality (%) of adult zebra mussels (N = 3 groups with 10 mussels in each group) from Otsego Lake after exposure to sodium chloride (NaCl) of varying concentrations in Fall 2014.



Iodized Table Salt

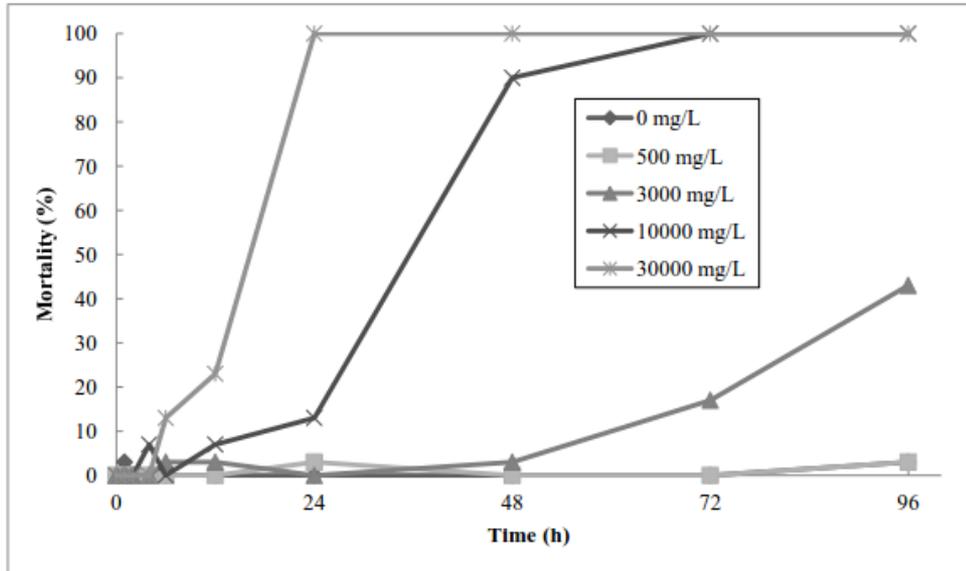


Figure 2. Average mortality (%) of adult zebra mussels (N=3 groups with 10 mussels in each group) from Otsego Lake after exposure to iodized table salt of varying concentrations in Fall 2014.



Softener Salt

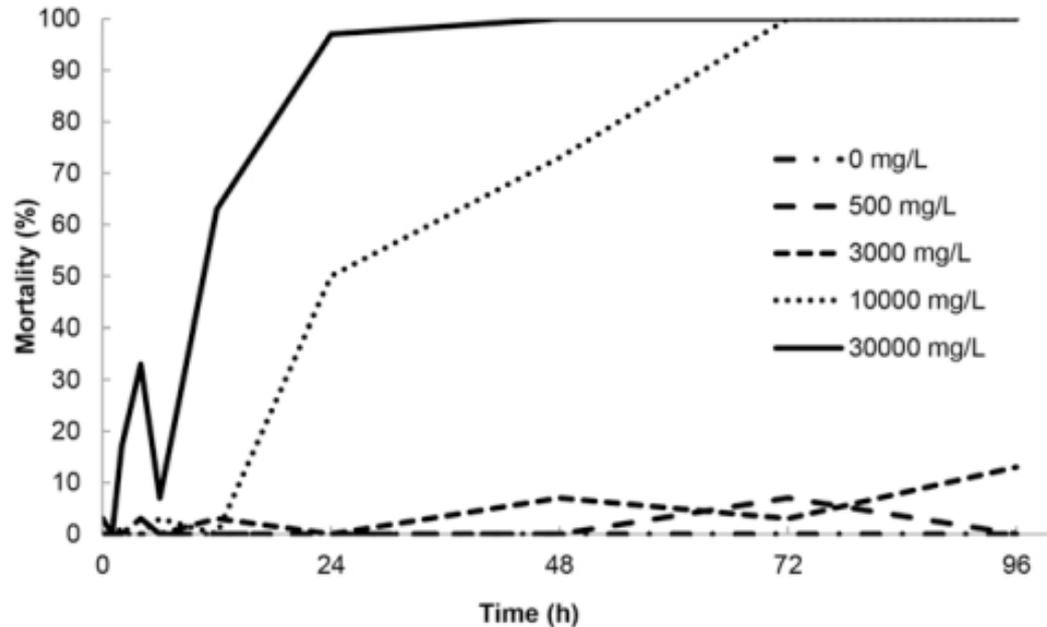
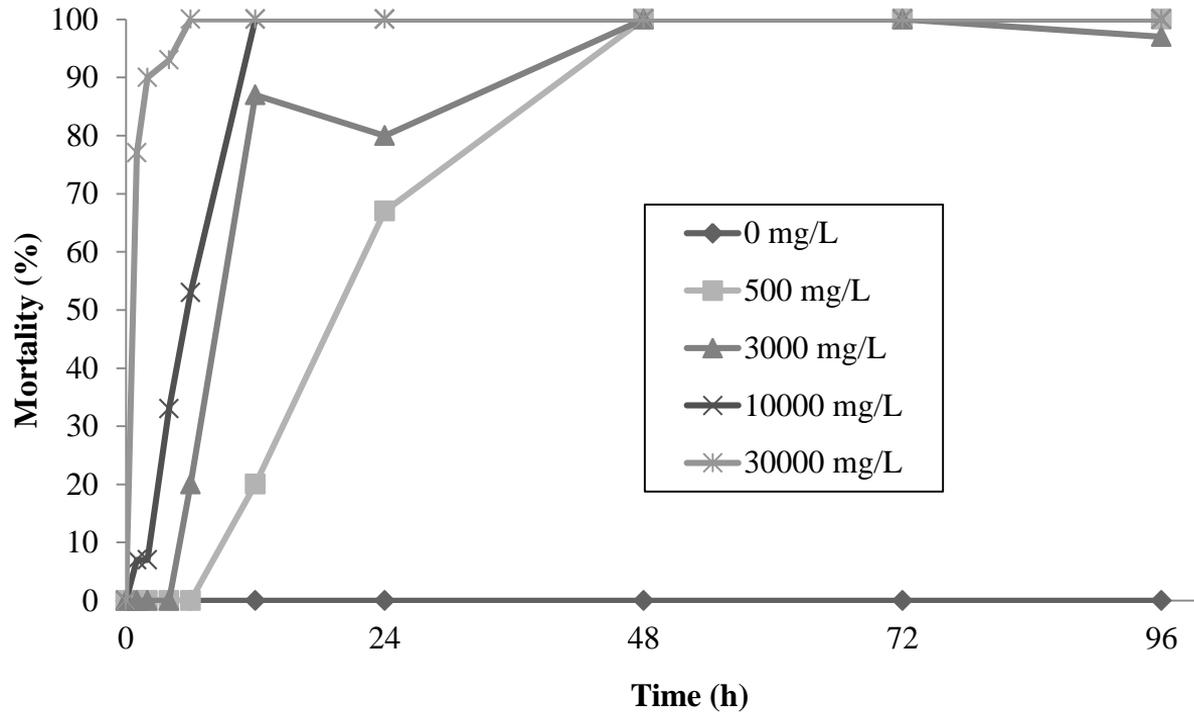
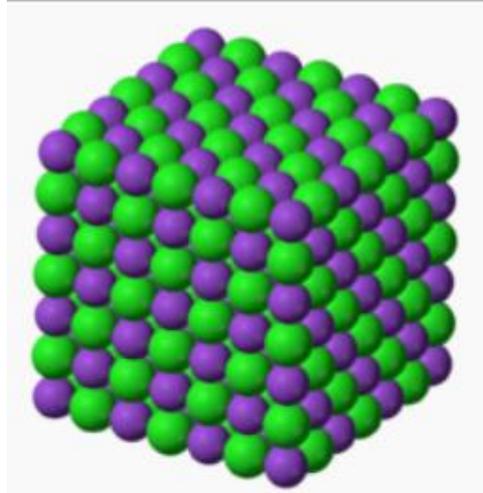


Figure 3. Average mortality (%) of adult zebra mussels (N = 3 groups with 10 mussels in each group) from Otsego Lake after exposure to water softener salt of varying concentrations in Fall 2014.



KCl

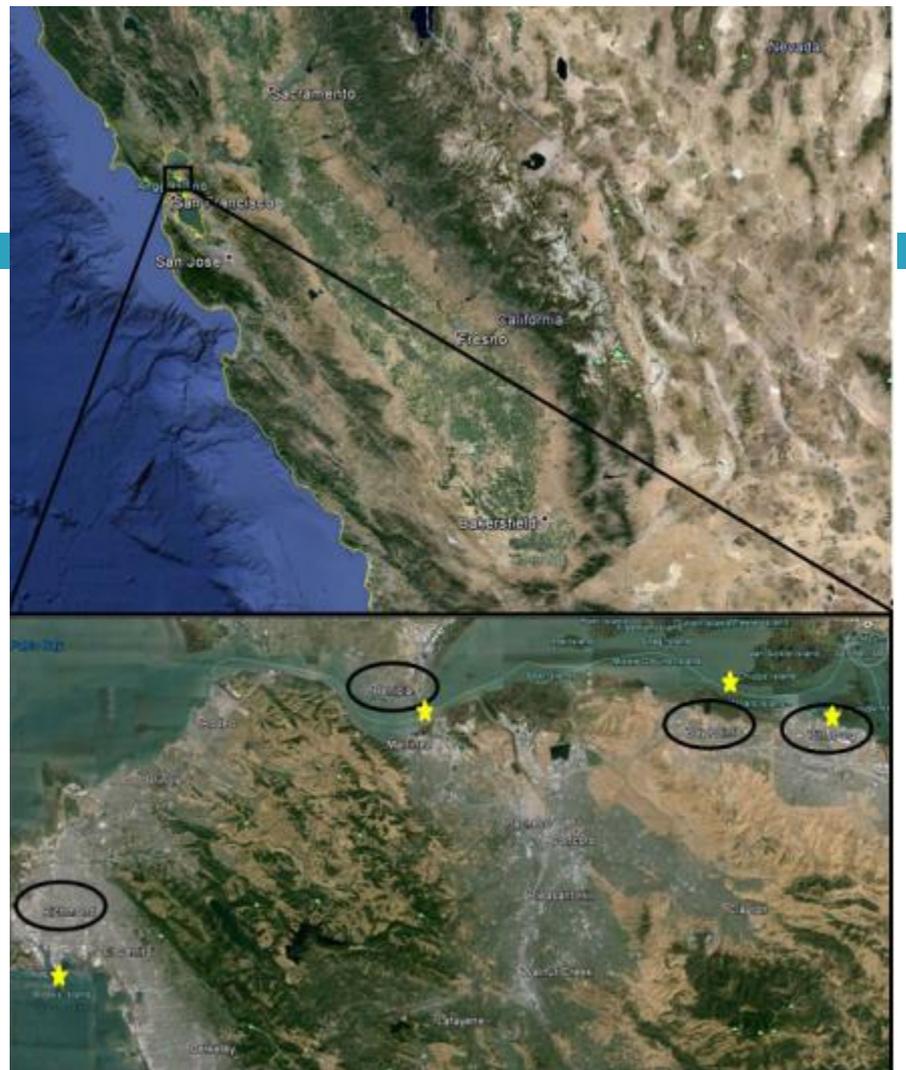
Potassium chloride



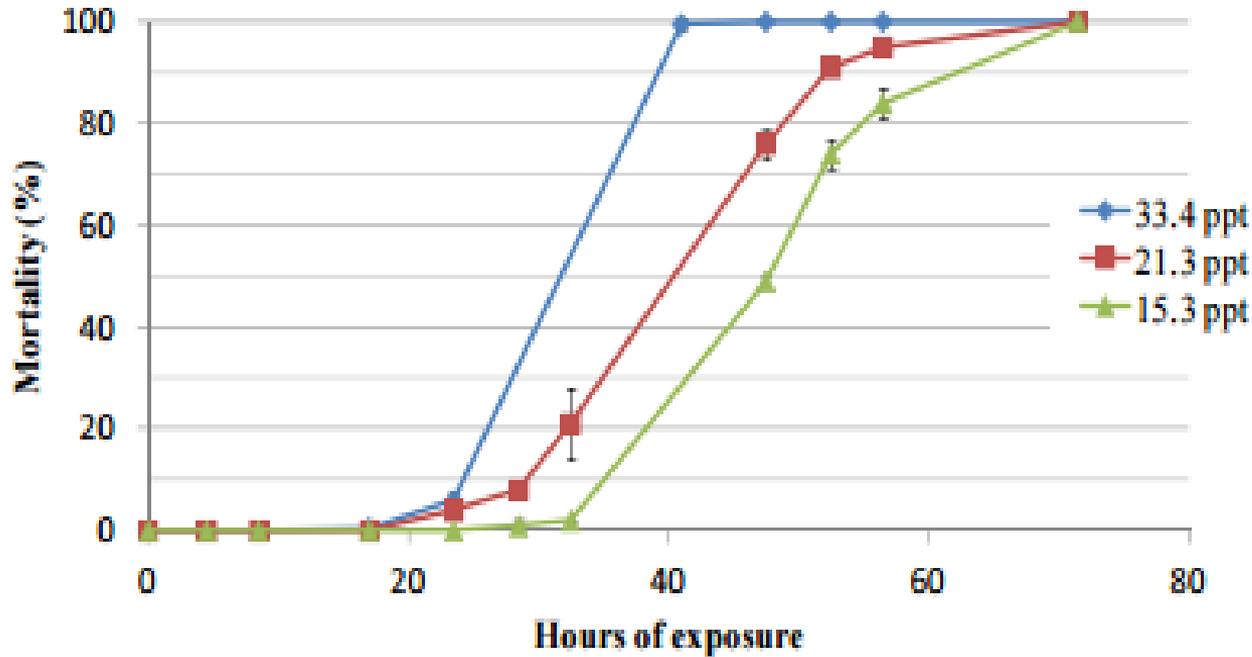
Saltwater/Brackish Water

□ The Bay-Delta, California

Hofius et al. 2015



Salt/Brackish Water



Types	Invasive	Non-Invasive
Biological	Zequanox® Redear Sunfish Microscope in the field	Dogs

ZEQUANOX[®]

□ Non-Chemical Control of Invasive Zebra and Quagga Mussels



Pseudomonas fluorescens

No evidence of mortality among:

The ciliate *Colpidium colpoda*

The cladoceran *Daphnia magna*

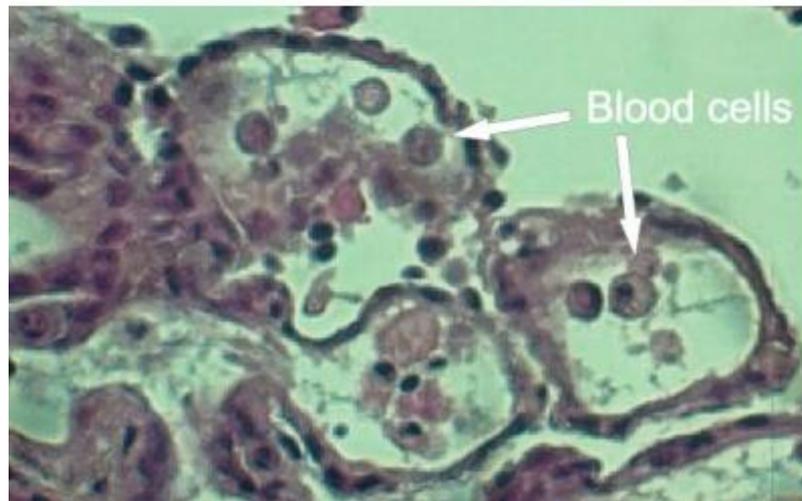
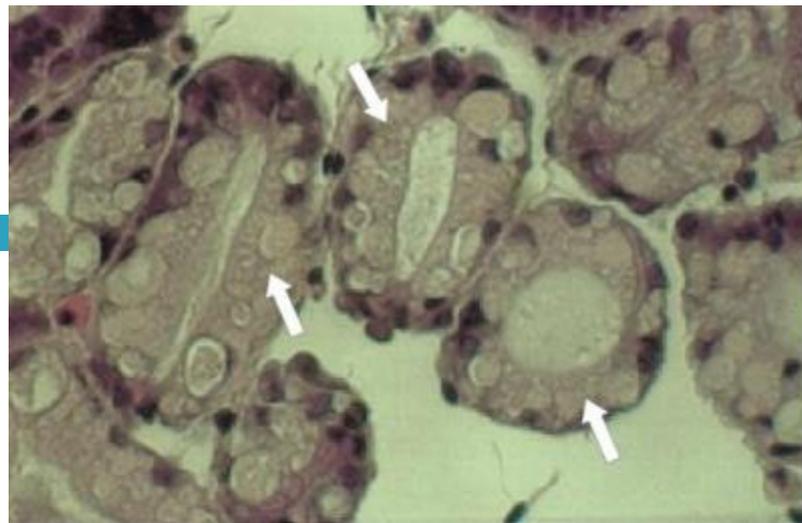
Three fish species (*Pimephales promelas*, *Salmo trutta*, and *Lepomis macrochirus*)

Seven bivalve species (*Mytilus edulis*, *Pyganodon grandis*, *Pyganodon cataracta*, *Lasmigona compressa*, *Strophitus undulatus*, *Lampsilis radiata*, and *Elliptio complanata*)

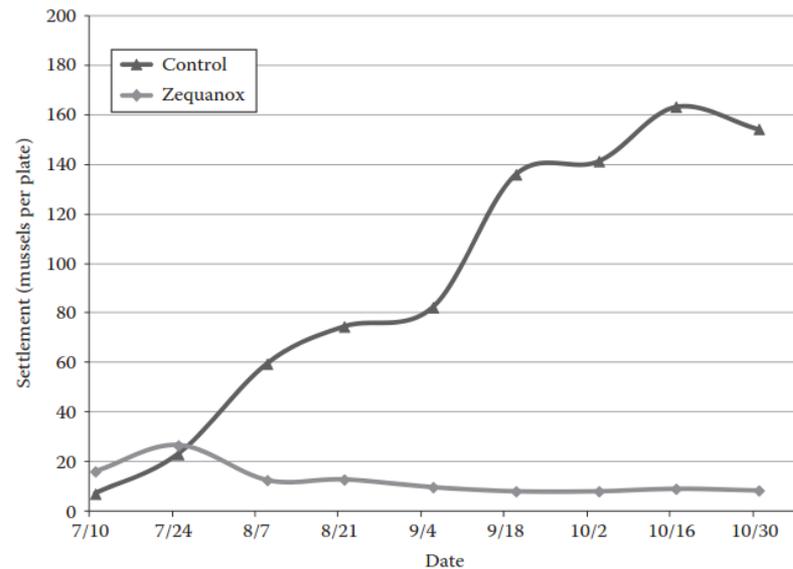
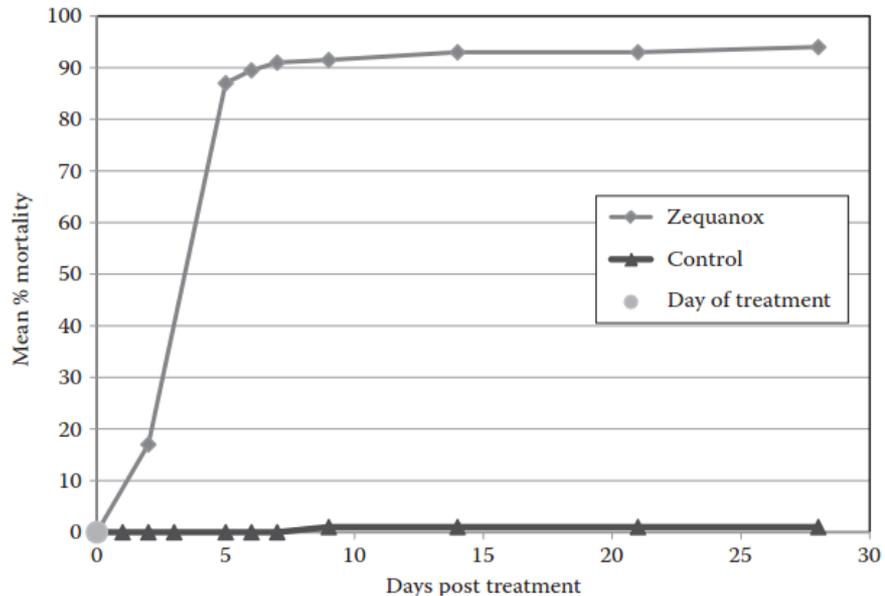
Low mortality (3-27%) was recorded:

The amphipod *Hyaella azteca*

ZEQUANOX[®]



ZEQUANOX[®]



Rackl and Link 2015

ZEQUANOX®



Meehan et al. 2013



Holt 2014

Biological Control

- What species:

Redear sunfish

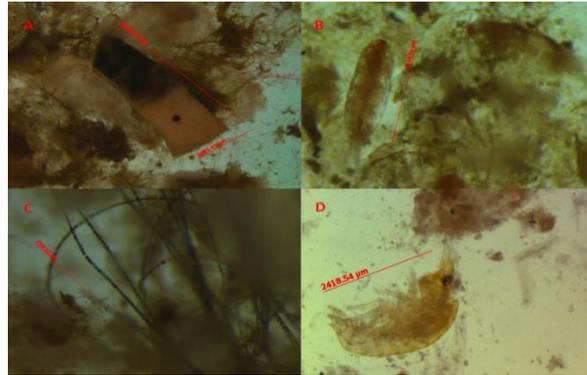
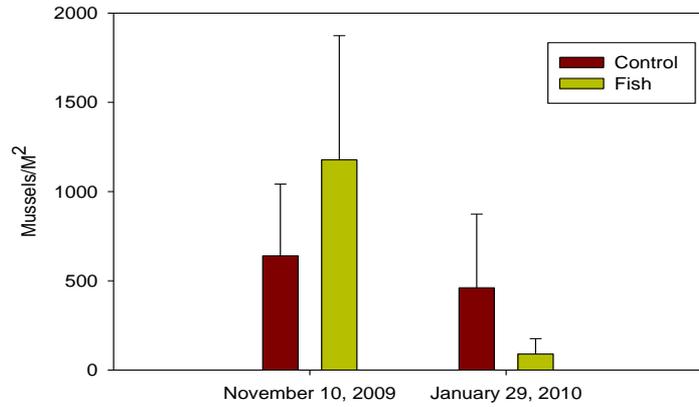
Pumpkinseed

Freshwater drum

(French 1993)



Sweetwater Reservoir, CA



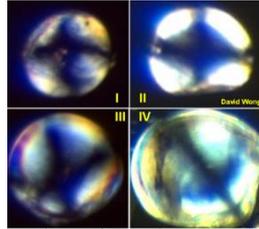
Wong et al. 2013

Biological Control

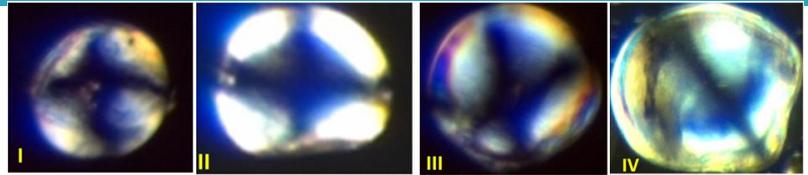


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Boat Inspection: Aquatic Plant Seeds and Microorganisms



Detector Popeye



▶ CAN THE DOGS FIND VELIGERS?



- ❑ CAN THE DOGS FIND VELIGERS?
- ❑ Yes – Four dogs, each tried four times
- ❑ Accuracy – 100%
- ❑ DeShon et al. 2016

Future Research

- 1. Optimal combination of warm water/low pressure to remove adult mussels in the surface area and/or veligers in the livewells/baitwells
- 2. Livewell flushing: density of veligers and the species of veligers; Effectiveness of flushing veligers in different configurations of livewells, as well as the bilge area of a watercraft needs to be investigated in the future
- 3. Out-of-water boats: Pressure/Temperature
- 4. Develop more species-specific and environmental-friendly inspection and decontamination methods

Acknowledgements



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Colleagues and Students

Thank you !



MassDEP Field Crew