OPTIONS FOR WATERCRAFT DECONTAMINATION AFTER ZEBRA MUSSEL EXPOSURE

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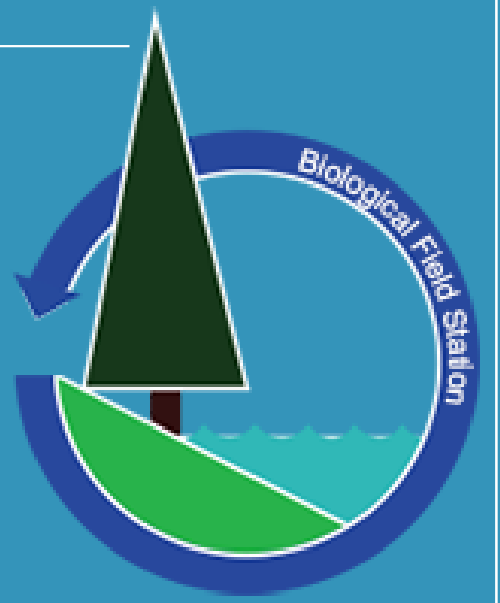


Background

- Zebra mussel- *Dreissena polymorpha*
  - Native to the Black, Caspian, and Azov Seas (Benson et al. 2014)
  - D-shaped shell with sharp margins, concave ventral surface, valves usually symmetrical

Taken from: http://www.fws.gov/midwest/mussel/current_threats.html

Unique Characteristic

- Ability to colonize hard and soft surfaces
  - Byssal threads
    - Protein excreted through muscular foot

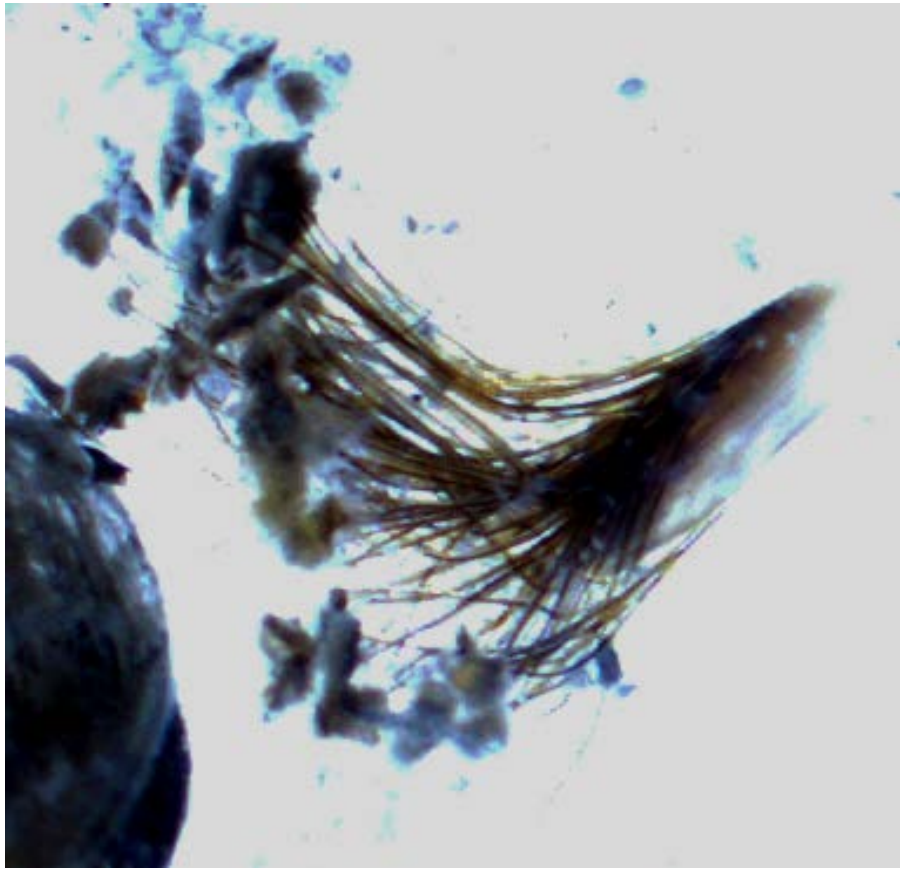
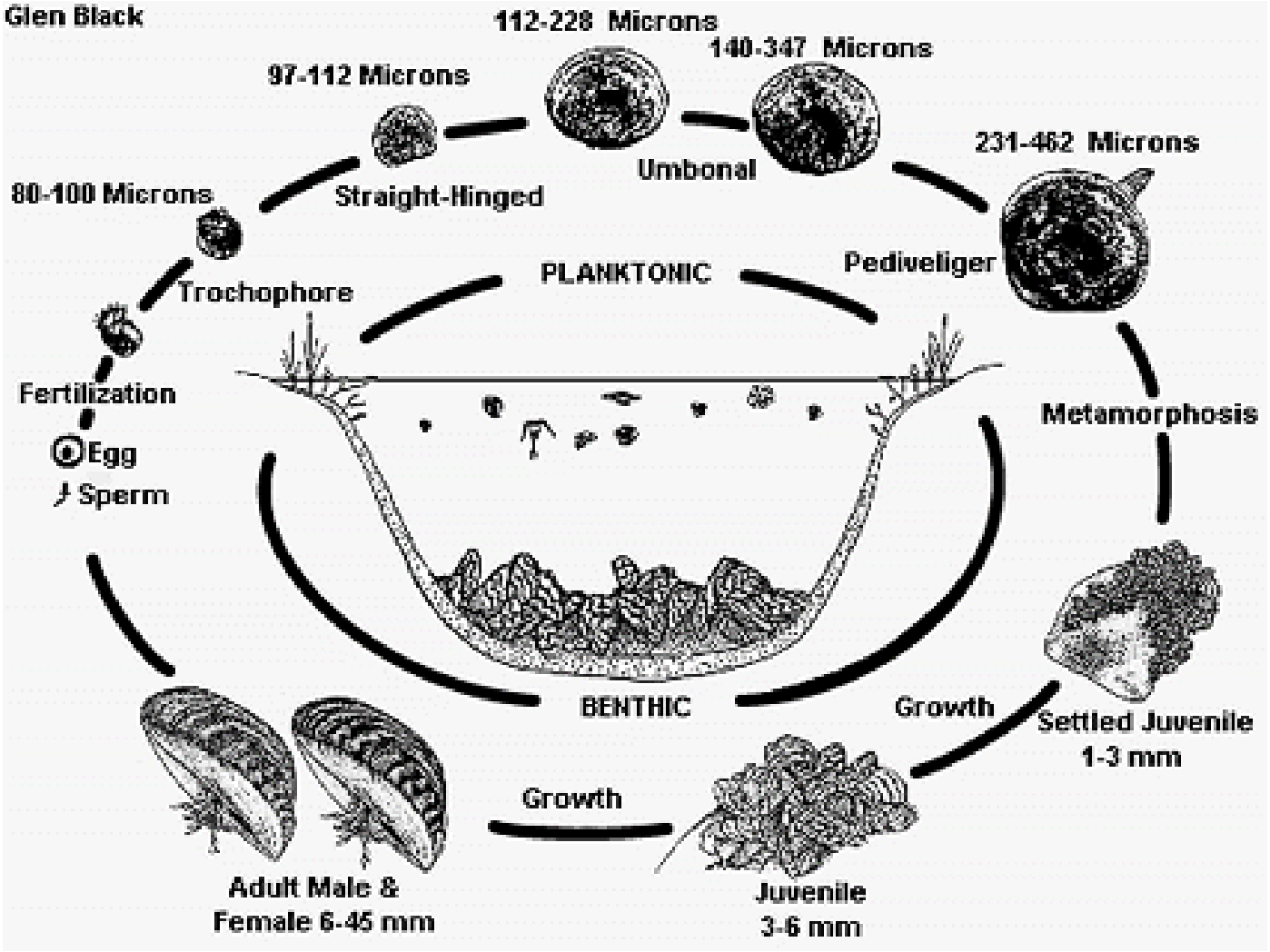


Photo: Eric Davis

Dreissenid mussel lifecycle



Taken from: http://el.erdc.usace.army.mil/zebra/zmis/zmishelp4/life_cycle.htm

Study Goals and Objectives

Determine possible ways to decontaminate recreational watercraft that can be suggested to the public to perform themselves.

1. Determine the toxicity of numerous common household chemicals to adult mussels and veliger larvae
2. Determine if a commercial carwash without hot water can be used to remove attached adult mussels from the exterior of a watercraft
3. Determine if veligers can be flushed from the livewell and/or the bilge area of watercraft

Chemical Toxicity to Adult Mussels
Methods

- Adult mussels collected from Otsego Lake, put into 800-µm mesh bags in groups of 11
- Placed bags on wooden dowels in groups of 10 and placed bags in large flow-through aquarium with fresh lake water for at least 48 hours to acclimate to bags
- Prior to placing bags into tanks with chemical treatments, mussels within each bag were examined for any mortality. Any dead mussels were removed. If no dead mussels, one mussel removed at random (n=10 mussels per bag)

Photo: Eric Davis

Chemical Toxicity to Adult Mussels
Methods

- Bags of mussels were hung from a wooden dowel in each tank. After all tanks had mussels, one bag was removed from each tank (exposure period o h).
- At the remaining exposure periods, one bag was removed from each tank.
- All removed bags were placed into the large aquarium with a constant flow of lake water.
- After 48 hours in the large aquarium, mussel mortality was assessed.

Photo: Eric Davis

Chemical Toxicity to Adult Mussels
Methods

- Mussels were considered dead if their valves were gaping when removed from the mesh bag and placed on a paper towel.
- Mussels with a slight gape in their valves were probed with a blunt probe. Mussels that did not close their valves after probing were considered dead.

Photo: Eric Davis

Chemical Toxicity to Adult Mussels
Methods

- Shell length of all mussels was measured with digital calipers and entered into Excel along with a mortality assessment (D or A)

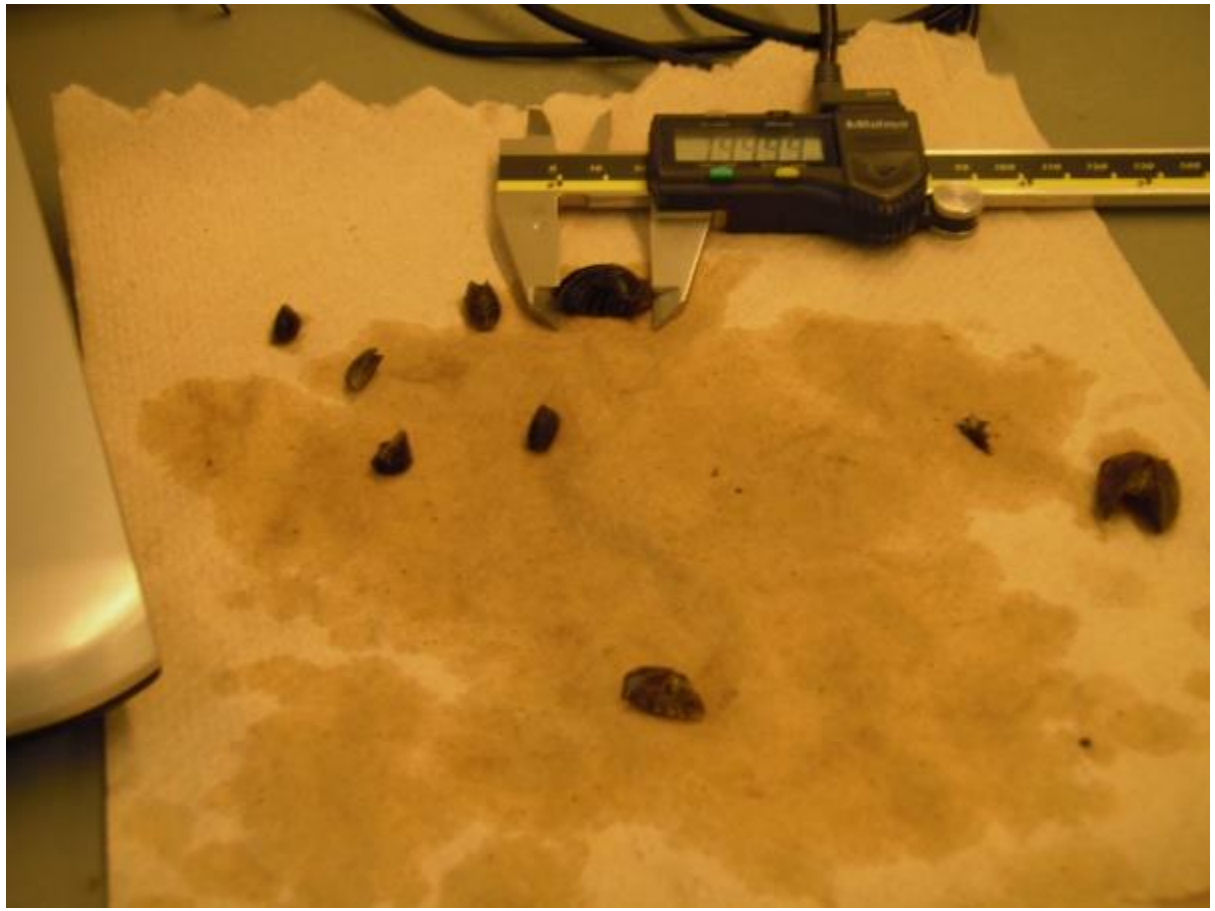


Photo: Eric Davis

Chemical Toxicity to Adult Mussels

Methods

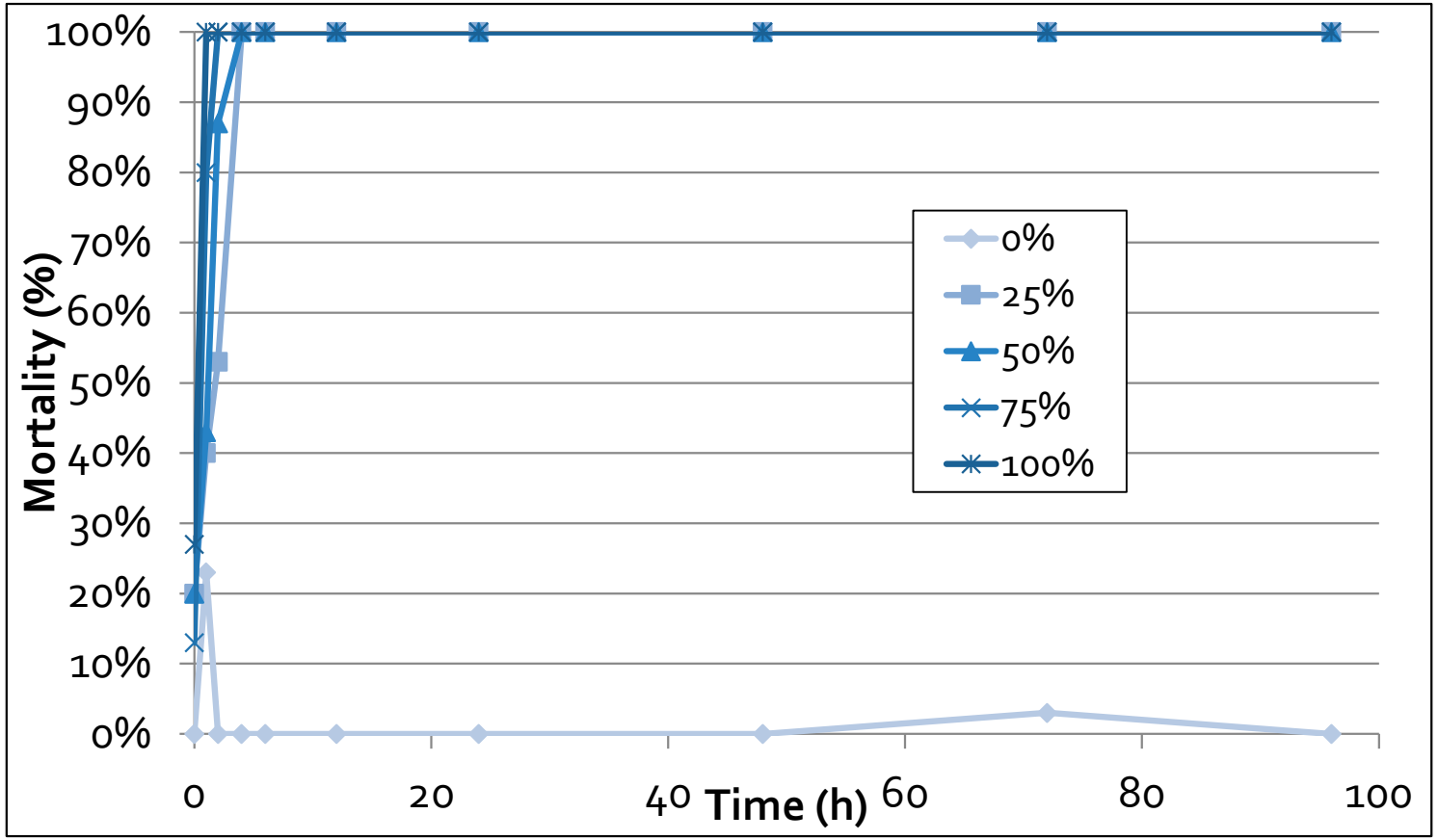
Chemical	Concentration
Distilled white vinegar (5%)	0, 25, 50, 75, 100% (vinegar out of the jug)
Potassium chloride	0, 500, 3000, 10000, 30000 mg/L
High grade sodium chloride	0, 500, 3000, 10000, 30000 mg/L
Iodized table salt	0, 500, 3000, 10000, 30000 mg/L
Water softener salt	0, 500, 3000, 10000, 30000 mg/L

Chemical Toxicity to Adult Mussels

Results

Distilled White Vinegar

- Undiluted vinegar caused complete mortality in 1h
- Most diluted vinegar (25%) caused 100% mortality in 4h

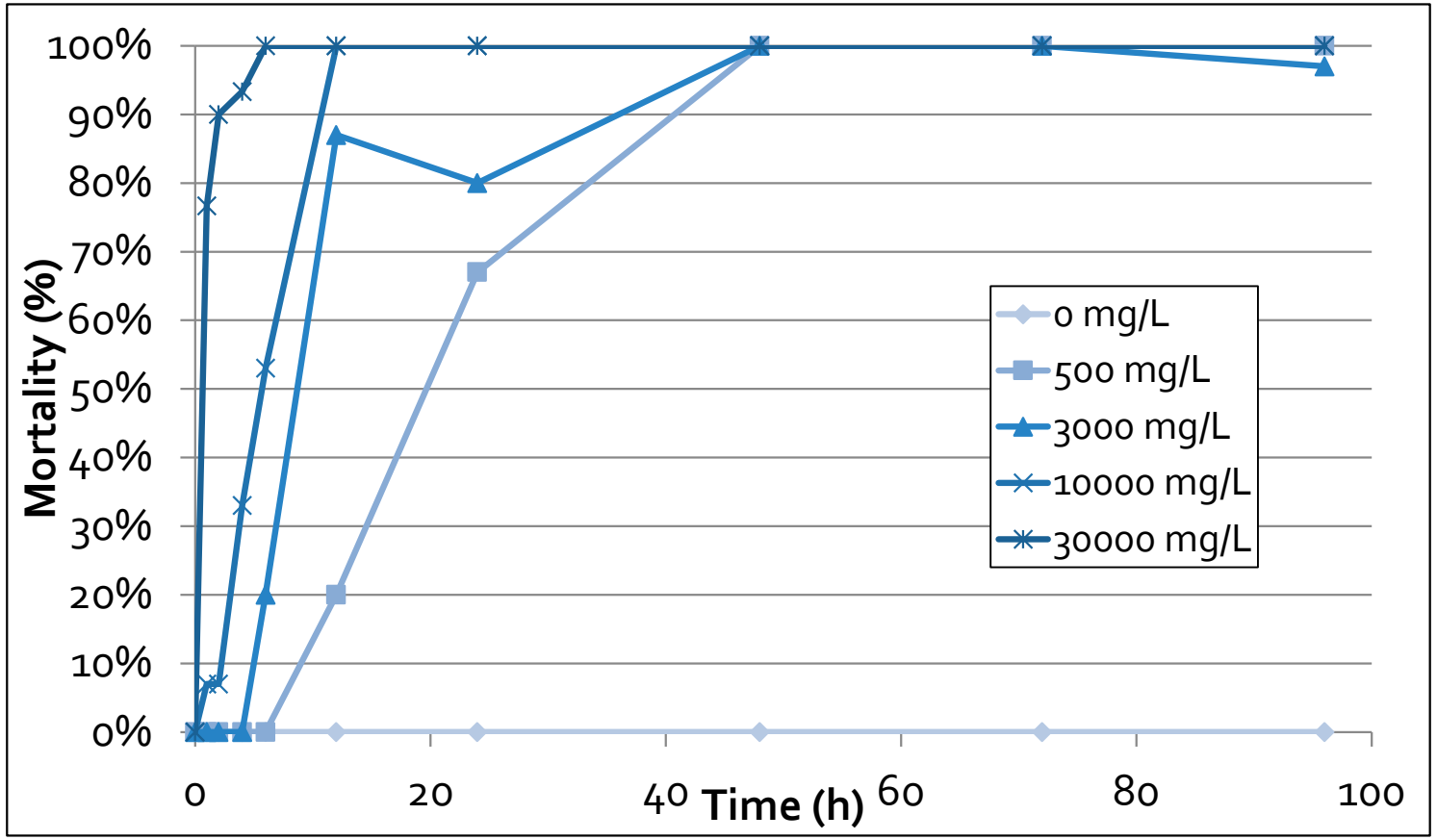


Chemical Toxicity to Adult Mussels

Results

Potassium chloride

- 30000 mg/L caused complete mortality at 6 h
- 10000 mg/L caused 100% mortality at 12h

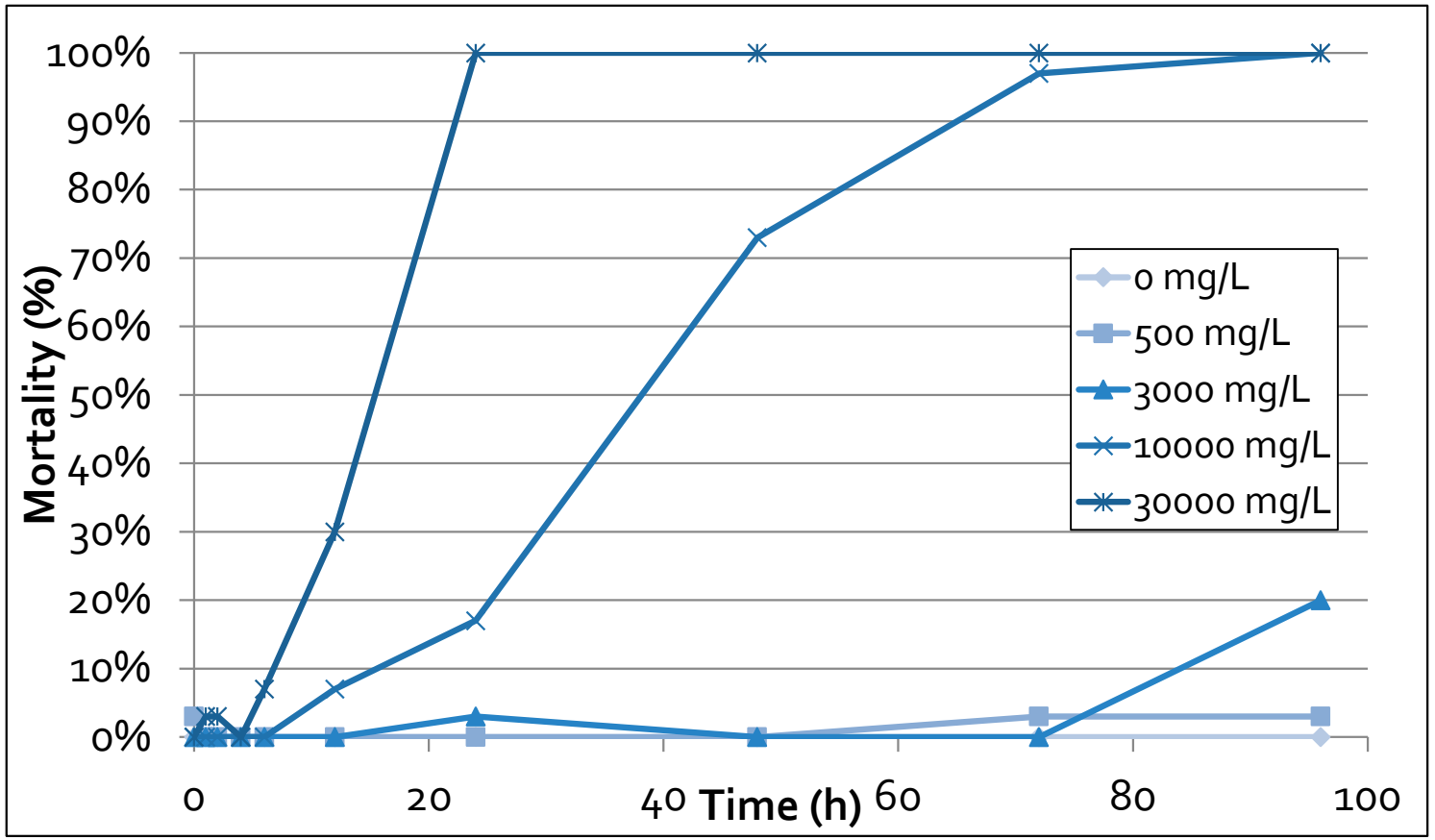


Chemical Toxicity to Adult Mussels

Results

High grade sodium chloride

- 30000 mg/L caused complete mortality at 24h
- 10000 mg/L caused 100% mortality at 96h

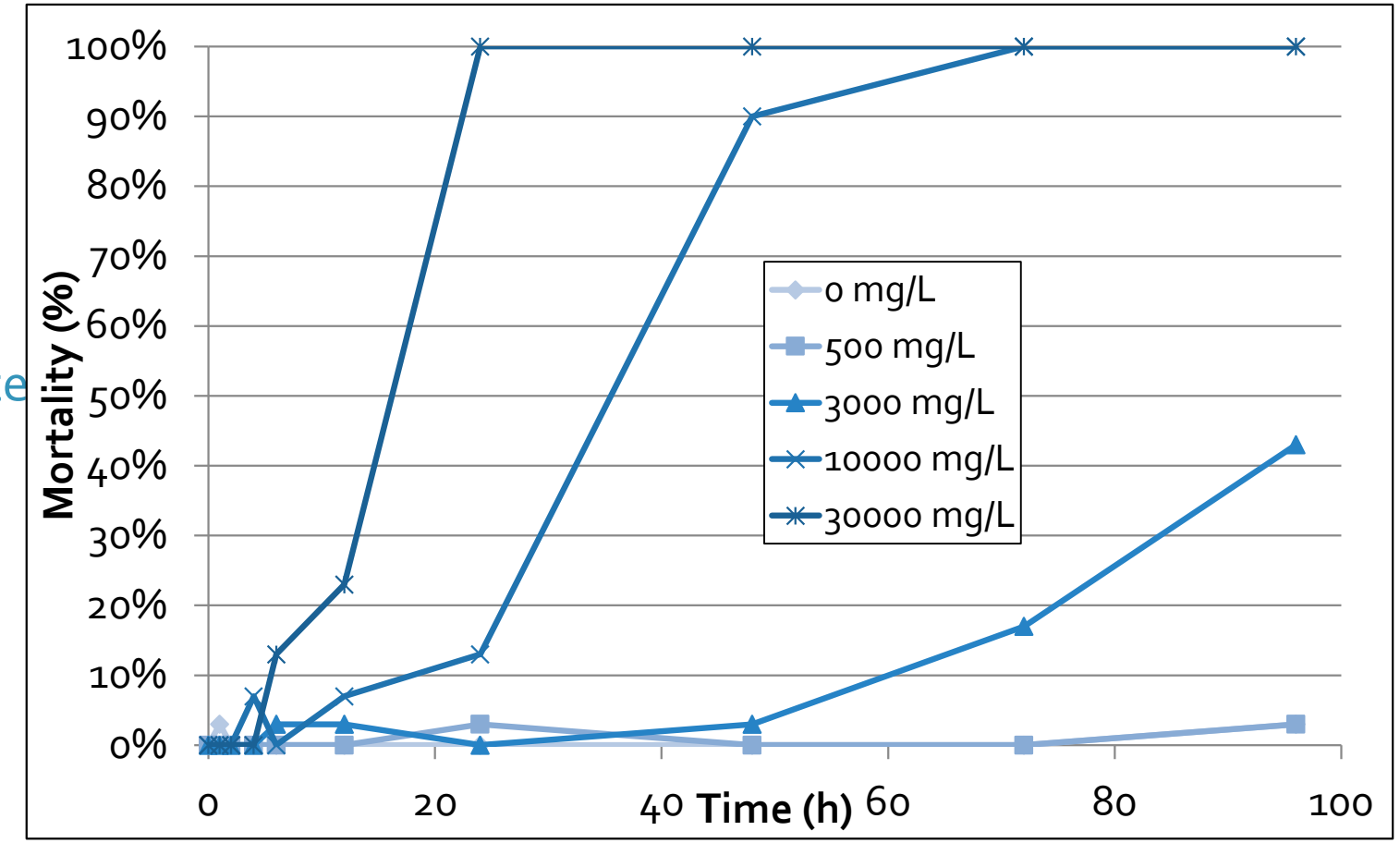


Chemical Toxicity to Adult Mussels

Results

Iodized Table Salt

- 30000 mg/L caused 100% mortality at 24h
- 10000 mg/L caused complete mortality at 72h

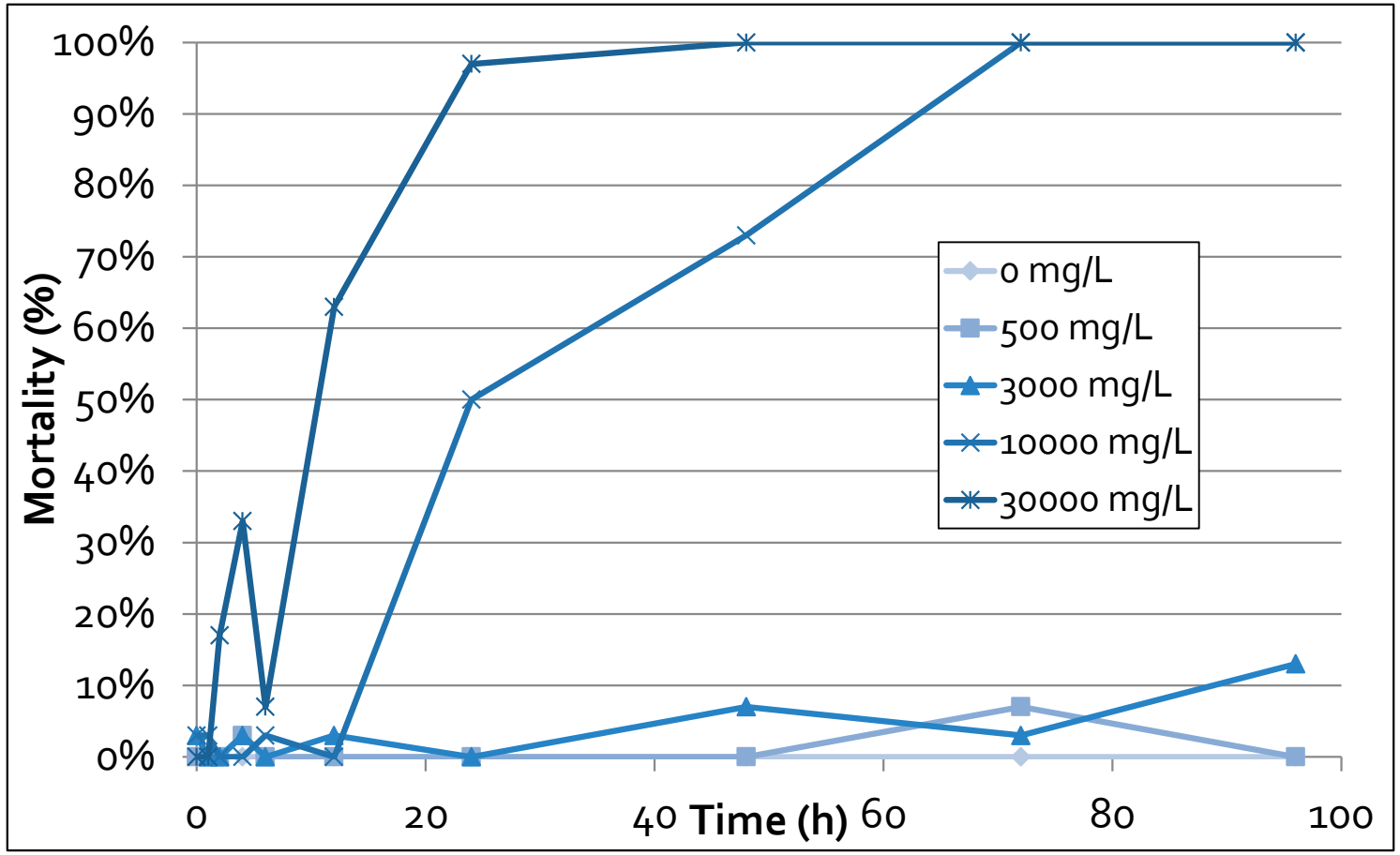


Chemical Toxicity to Adult Mussels

Results

Water softener salt

- 30000 mg/L caused complete mortality at 48h
- 10000 mg/L caused 100% mortality at 72h



Chemical Toxicity to Mussel Veligers

Methods

- Mussel veligers collected from Otsego Lake using 63-µm plankton nets and placed into 1L bottles and brought to BFS
- Water containing veligers concentrated down to about 100mL, three 1mL samples placed onto Sedgewick-Rafter counting cells and analyzed using cross-polarized light (CPL) microscopy to get an average number of veligers per mL

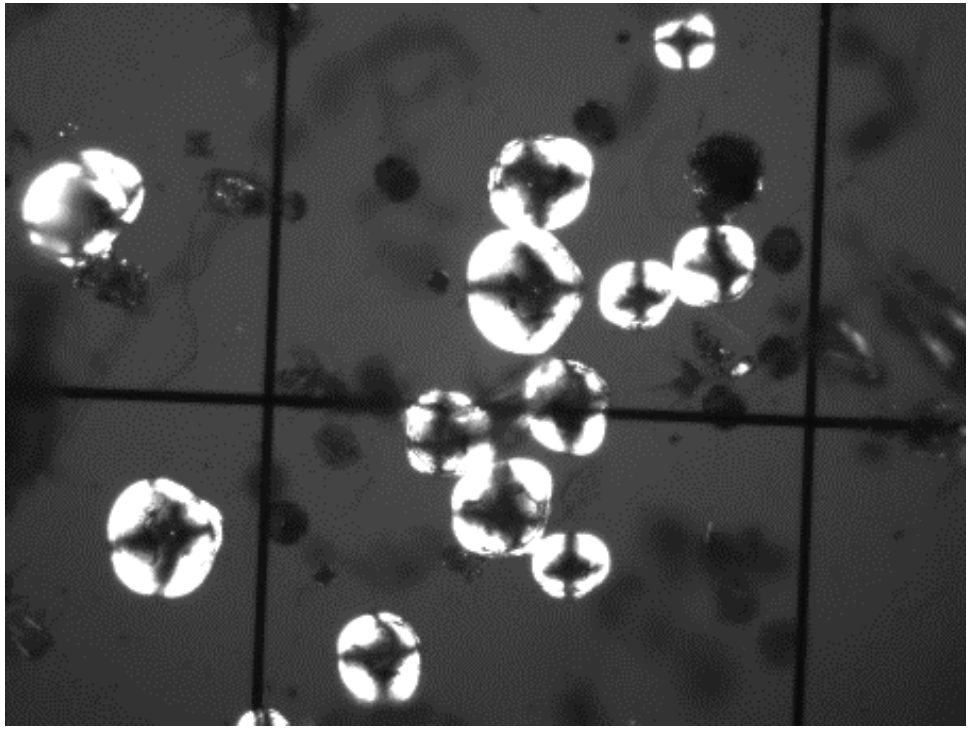


Photo: Eric Davis

Chemical Toxicity to Mussel Veligers

Methods

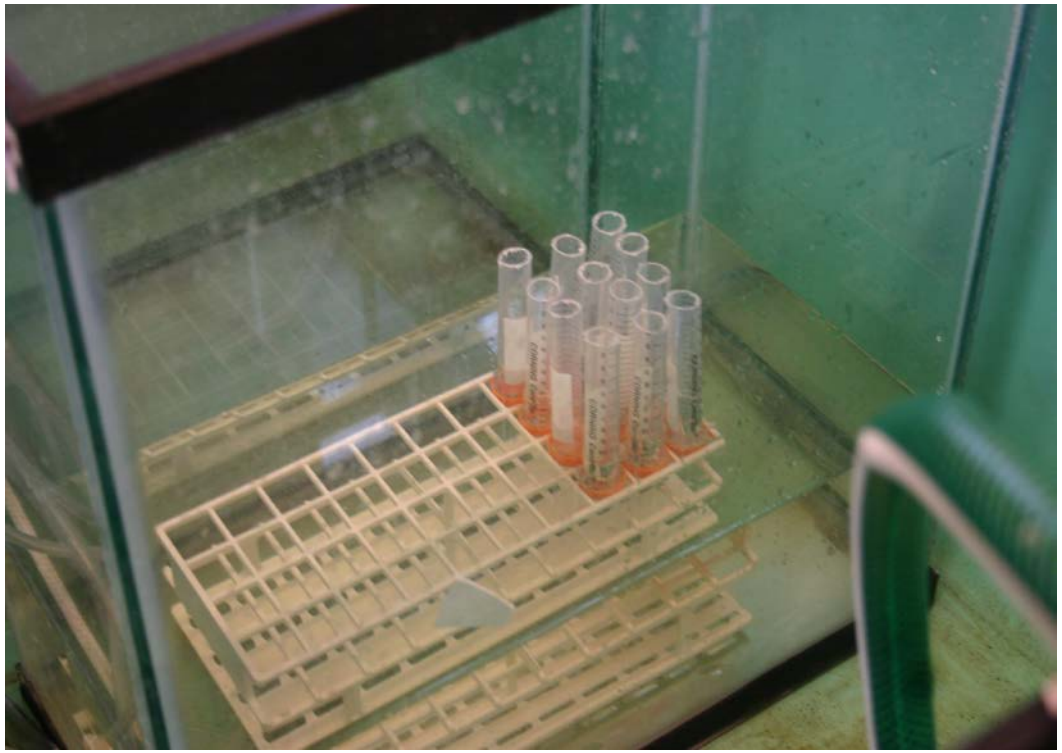
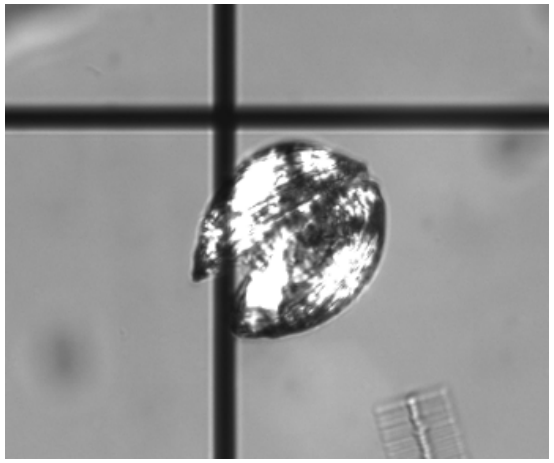


Photo: Eric Davis

- One mL of concentrated veliger water was added to 24mL of chemical solution in a 50mL beaker
- After the exposure period ended, beaker contents were rinsed into a veliger holding device with filtered lake water
- Veligers were examined with CPL after removal and every 24h after for 3 days for mortality assessment

Chemical Toxicity to Mussel Veligers

Chemicals	Concentrations	Exposure
Distilled white vinegar	0, 25, 50, 75, 100%	10, 20, 30 min
Potassium chloride	0, 1250, 2500, 5000 mg/L	12, 18, 24 h
Sodium chloride	0, 5000, 10000, 15000 mg/L	18, 24 h
Iodized table salt	0, 5000, 10000, 15000 mg/L	18, 24 h



Potassium chloride 12 h at 2500 mg/L

Chemical Toxicity to Mussel Veligers

Results

Chemical	Concentration	Exposure Period
Distilled white vinegar	25, 50, 75, 100% vinegar	10 min, 20 min, 30 min
Potassium chloride	1250, 2500, 5000 mg/L	12 h, 18 h, 24 h
Sodium chloride	10000, 15000 mg/L	18 h, 24 h
Iodized Table Sale	10000, 15000 mg/L	18 h (15000 only), 24 h

Direct comparison of sodium chloride and iodized table salt did not indicate difference in mortality based on chemical ($p = 0.2130$)

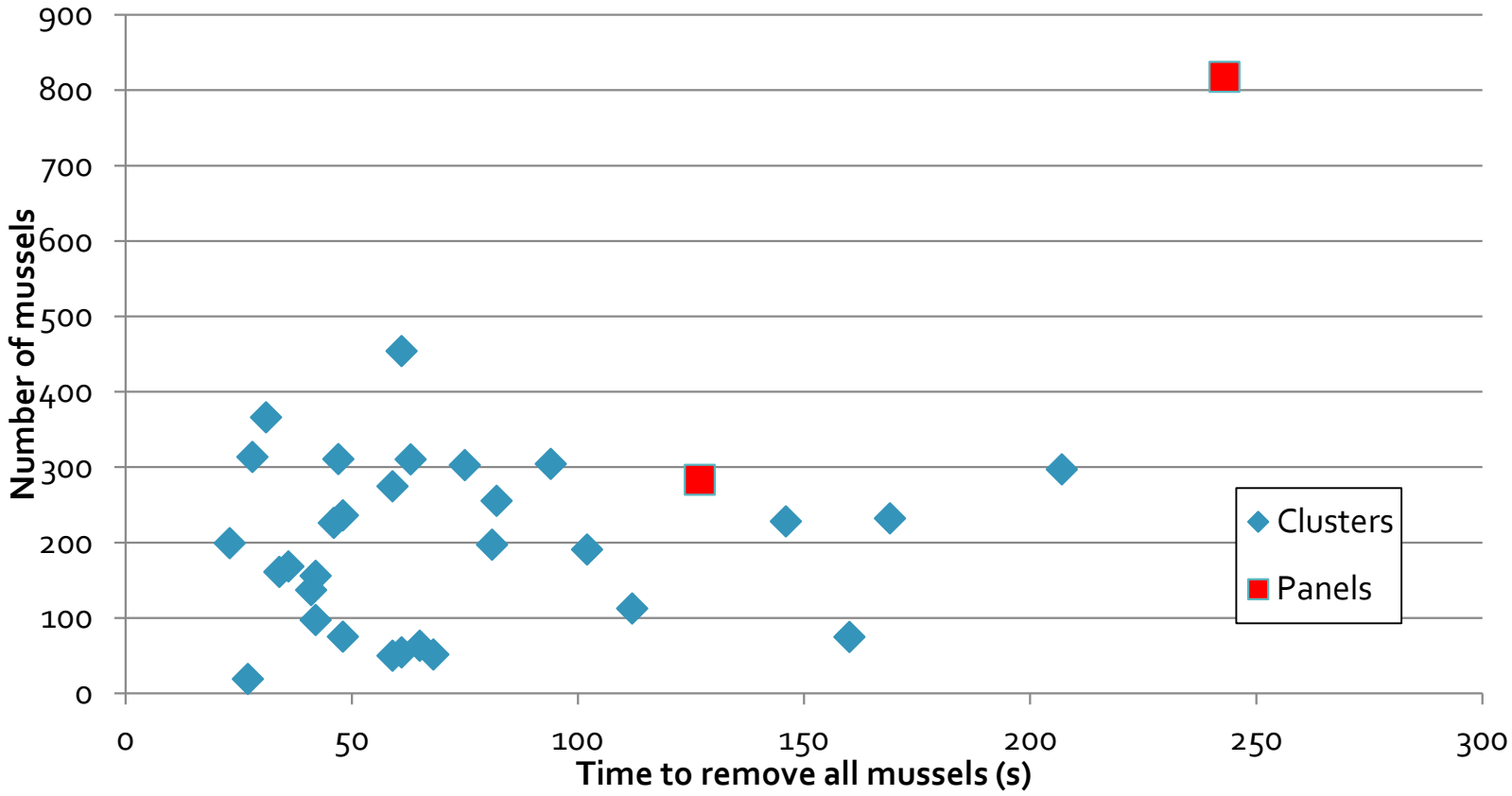
Potassium chloride was significantly more effective than sodium chloride when compared at 5000 mg/L ($p = 0.0476$)

Pressure Washer to Remove Attached Mussels

- Panels of fiberglass canoe were hung in Otsego Lake in late August 2014 to allow mussel colonization
- Panels were removed 10 October 2015 for testing
- A cluster of mussels that was isolated on the panel was selected and pictures were taken with rulers for calculating mussel density
- The amount of time (in seconds) required to remove all mussels in the cluster was recorded

Photos: Eric Davis

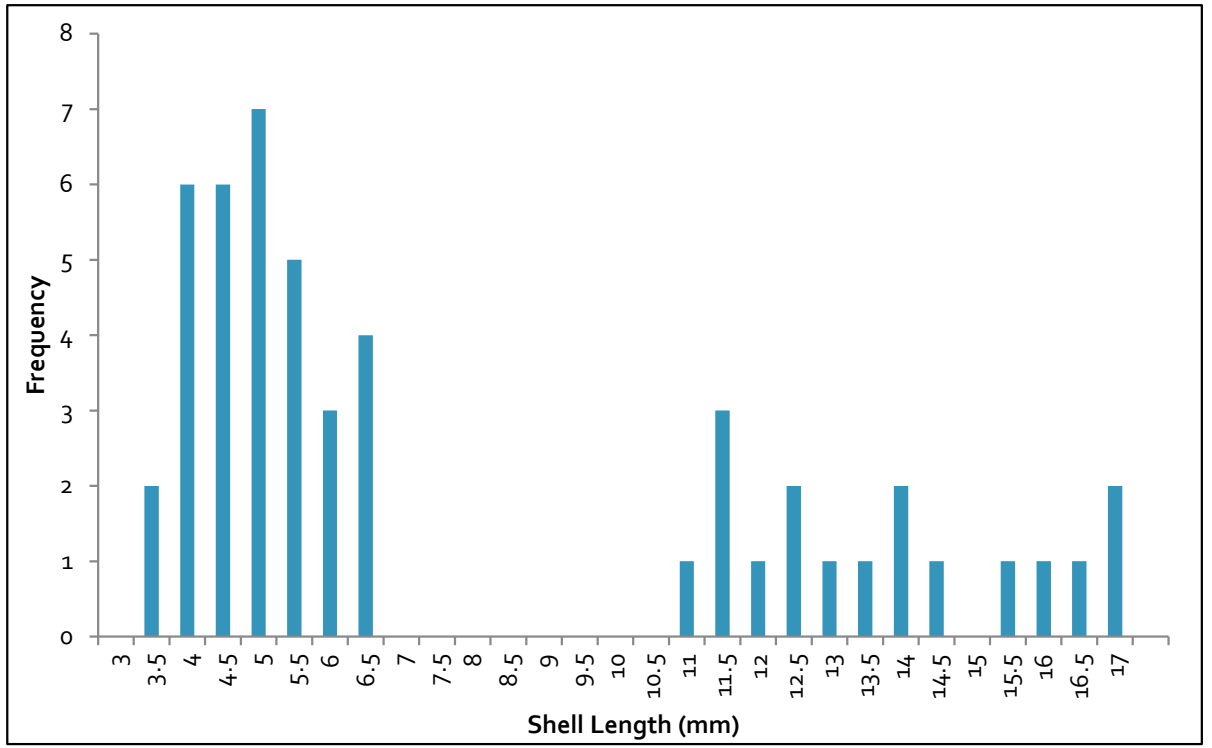
Pressure Washer to Remove Attached Mussels



No linear correlation between removal time and number of mussels ($r = -0.12$, $p = 0.52$) or between removal time and density of mussels ($r = 0.08$, $p = 0.69$)

Pressure Washer to Remove Attached Mussels

- Mussels attached to fouling plates had distinct size differences (2 age classes)
- Boats arriving with attached mussels is an unlikely scenario in NY due to winter ice and time needed for mussel settlement
- Use of commercial carwash is possible to remove attached mussels if the situation does occur



Livewell Flushing to Remove Veligers

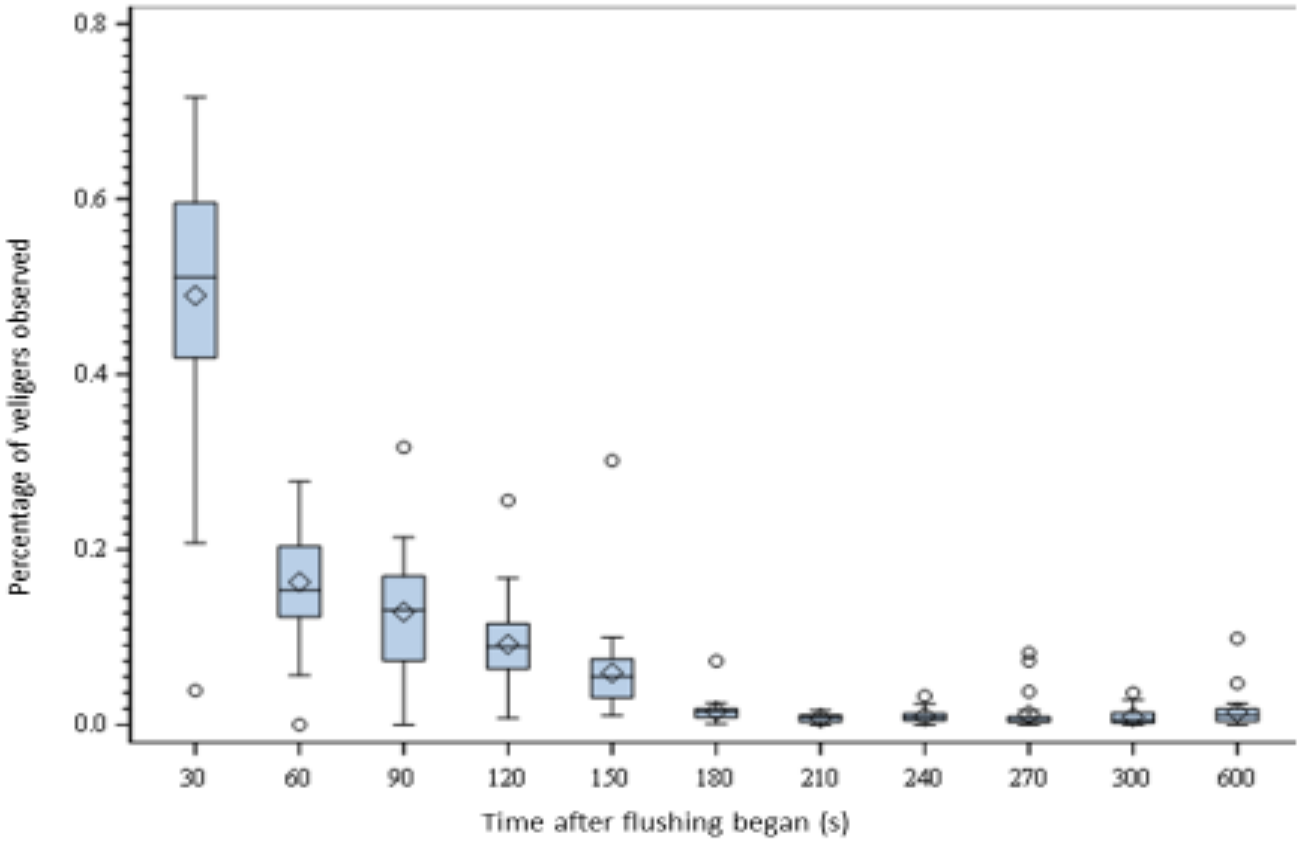
- Livewell filled with ~22L of veliger-rich water, then drained
- After draining, livewell flushed for 7 minutes
  - Contents leaving livewell filtered with plankton net material and filter changed every 30 s for first 5 minutes then 2 minute extra flush
- Filter contents backflushed into beakers and filtered down to 5 mL for every interval
- Final 5 mL preserved in ethanol for sample analysis
  - Veligers enumerated in preserved samples using CPL

Photo: Eric Davis

Livewell Flushing to Remove Veligers

- Livewell flushing of 5 minutes was not effective at removing all veligers
  - Average of 4.8 veligers in final sample

- Over 90% of all veligers counted in a replicate were in samples taken during the first 150 s (2.5 mins) of flushing



Kendall's tau correlation coefficient = -0.632, $p < 0.0001$, N=330

Things to Consider

Practical use of the decontamination methods tested

1. Chemical treatments
   - Limited applications
     - External decontamination unlikely, gear immersion and water-holding areas possible
   - What do you do with the solution after you're done?
     - Depending on what chemical is used, chemical reuse is possible but recapture pads can be use similar to those at wash stations
   - Converting to usable terms
     - 30000 mg/L converts to 0.42 cups/gallon
   - The hardness and conductivity of water can influence NaCl and KCl effectiveness
     - High conductivity water had decreased efficiency (Sykes 2009)
   - Zebra mussels can have greater salt tolerance based on salinity where they live

Things to Consider

2. Commercial carwash

- Ability to decontaminate entire boats
  - Based on results, the time required to wash a 16-foot boat could exceed 7 hours

3. Livewell flushing

- Effectiveness
  - Only 1 of 30 replicates had no veligers after 5 minutes of flushing, but >90% removal in 3 mins

Image from: https://www.emaze.com/@ALLTTFFO/Zebra-Mussles

Things to Consider

Cost of decontamination methods

Chemical	Cost of chemical → Cost per unit of treatment
Potassium chloride	$42/kg → $5.83/gallon of 30000 mg/l
Sodium chloride	$39/kg → $5.42/gallon of 30000 mg/l
Iodized Table Salt	$1.17/kg → $0.17/gallon of 30000 mg/l
Distilled white vinegar	$2.49/gallon → $0.63/gallon of 25% solution
KCl water softener salt*	$1.64/kg → $0.23/gallon of 30000 mg/l

*testing to confirm effectiveness is required before recommending this chemical

Things to Consider

Cost of decontamination methods

Commercial carwash

-$1.50-$3.00 for limited spray times

- Gas Motor Pressure Washer- $750-$1000

Livewell flushing

- To build cart-based sprayer
  - Cart- $60
  - Pump- $60-$100
  - Tank- $50
  - Hose and Nozzle- $50
  - Battery- $100

  Total cost: $320-$360

Acknowledgements

- Funding for this research was provided by the Environmental Protection Fund, administered by the New York State Department of Environmental Conservation
- Brittney Rogers and Catherine McGylnn for the invitation to speak today

References

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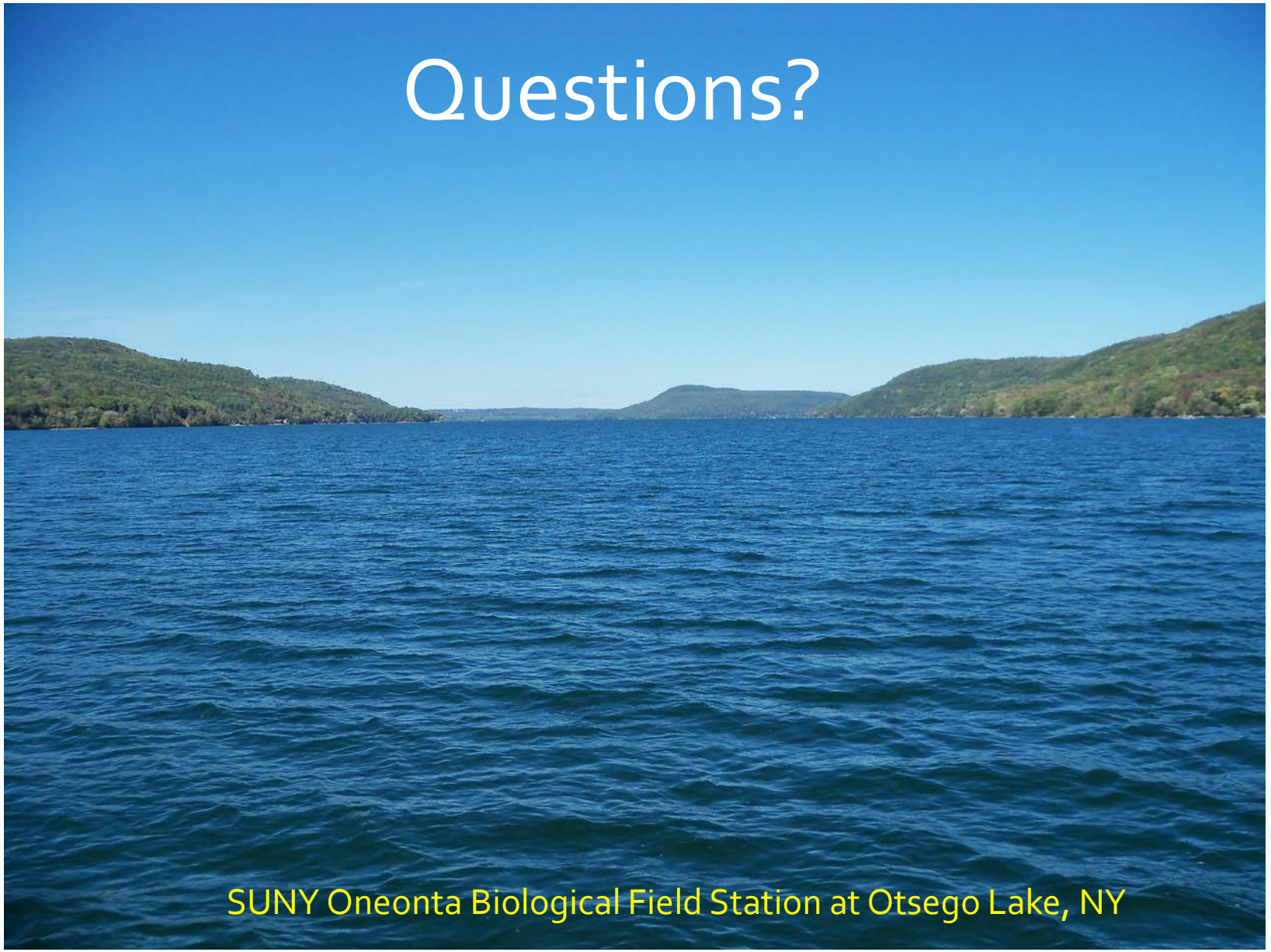
Questions?



SUNY Oneonta Biological Field Station at Otsego Lake, NY