Updates on KCL Toxicity Testing of Dreissenid Mussels

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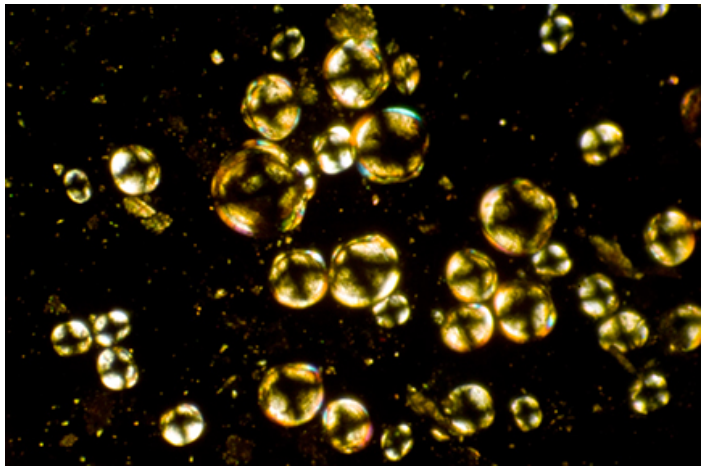
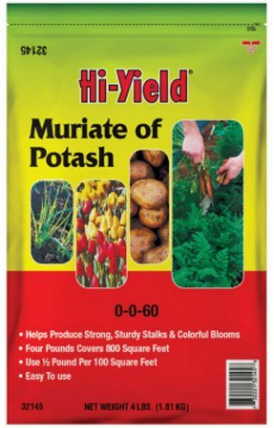
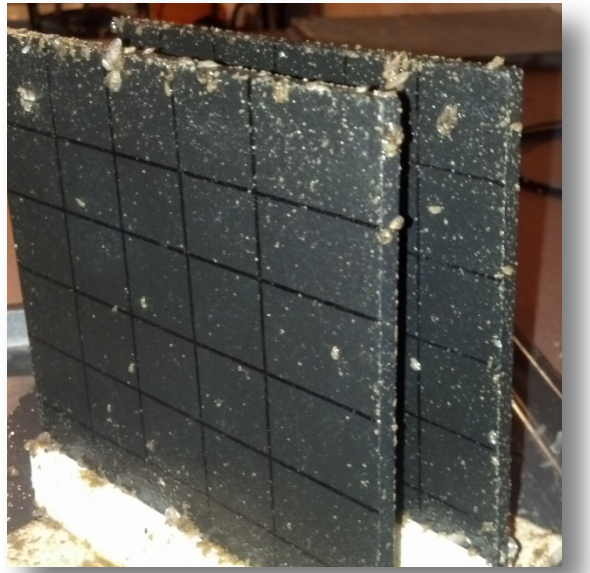


Report to Columbia Basin Team
December 2016

Muriate of Potash (KCl) as a RR Control Tool?





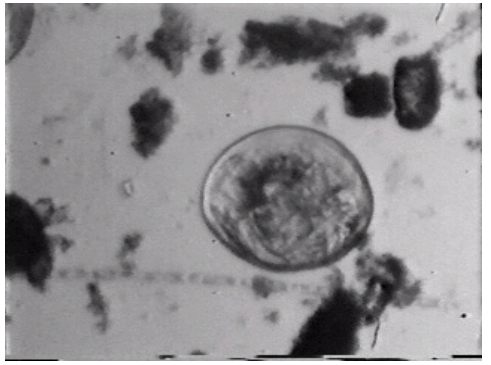
- Disinfection of equipment, boats, or fish hauling trucks
- Prevention of settlement or establishment
- Response to introduction in open or contained waters

- *Low risk to non-molluscan species, fish, vegetation, or human exposure*

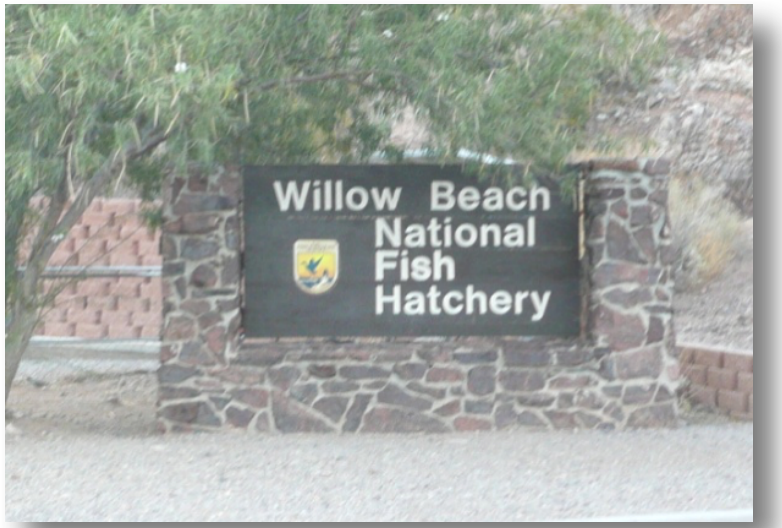
KCl Efficacy – Zebra mussels

- Veliger zebra mussels - KCl (~ 750 mg/L) tested in fish hauling followed by low dose of formalin to reduce risk of veliger transport showed no harm to fish with short term exposure (Edwards et al. 2000)

- Byssal zebra mussels - ~100 mg/L for 30 days in contained field trials.
  - Millbrook Quarry, Virginia (Fernald and Watson 2014).
  - Lake Winnipeg, Manitoba and Christmas Lake, MN (not completely successful)



U of I Studies at WBNFH 2015



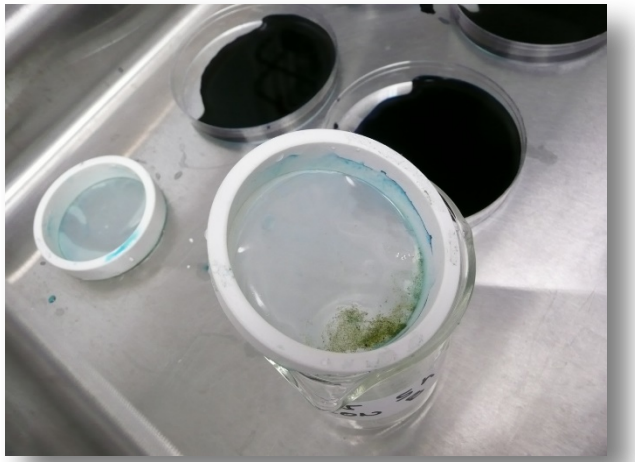
- May – June, & August – Sept
- Static exposure to KCl of veligers and byssal stage
  - Byssal stage 100 and 200 mg/L
  - Veligers 960 mg/L – no formalin (approx 10X byssal treatment.
- Tests with Colorado River water
  U of I groundwater
  & Snake River water

Studies in Lake Ontario

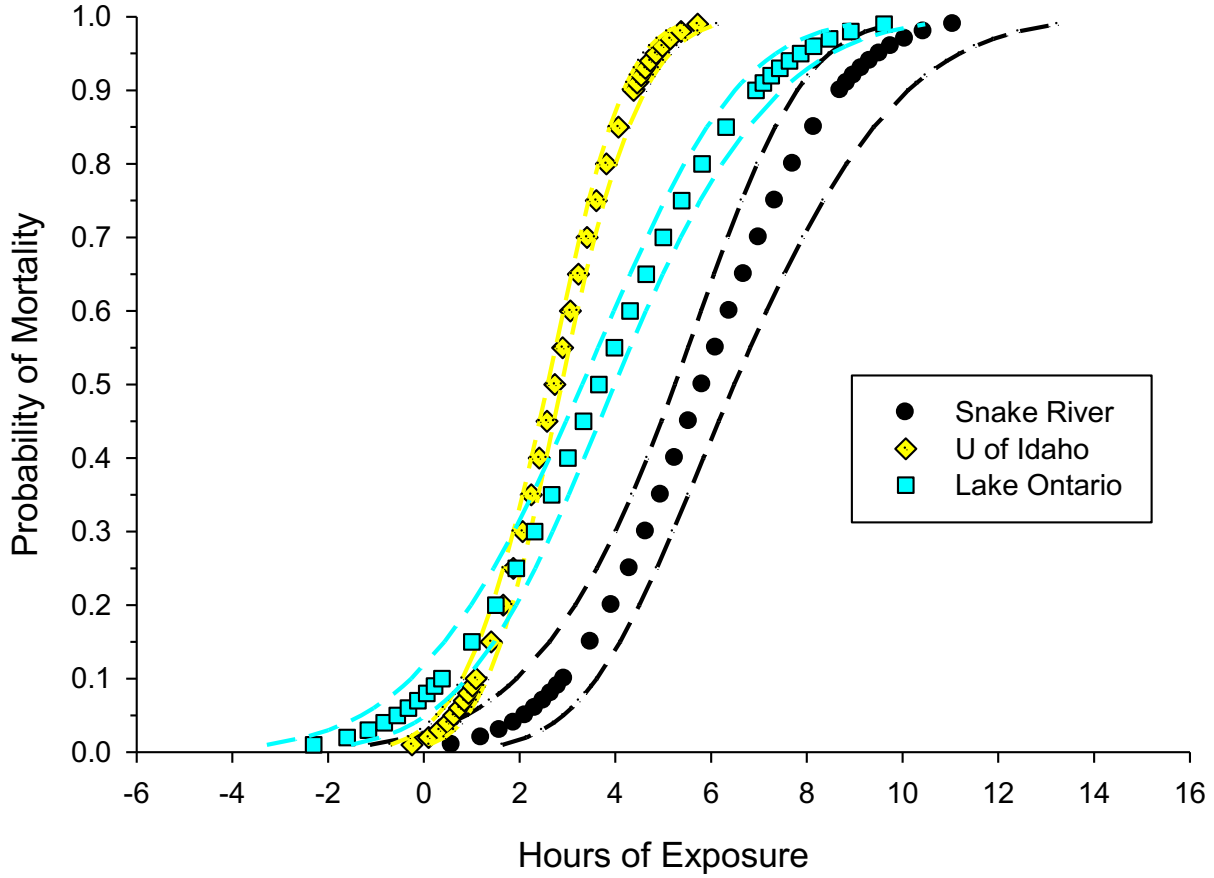
- October – Dec 2015
- Water and mussels from Lake Ontario Woupoos Marina
- Static exposure to KCl with renewal after 48 h
  - Byssal stage 100 mg/L
  - Veligers 960 mg/L

Variations in Mortality to KCl Among Water Sources 2015

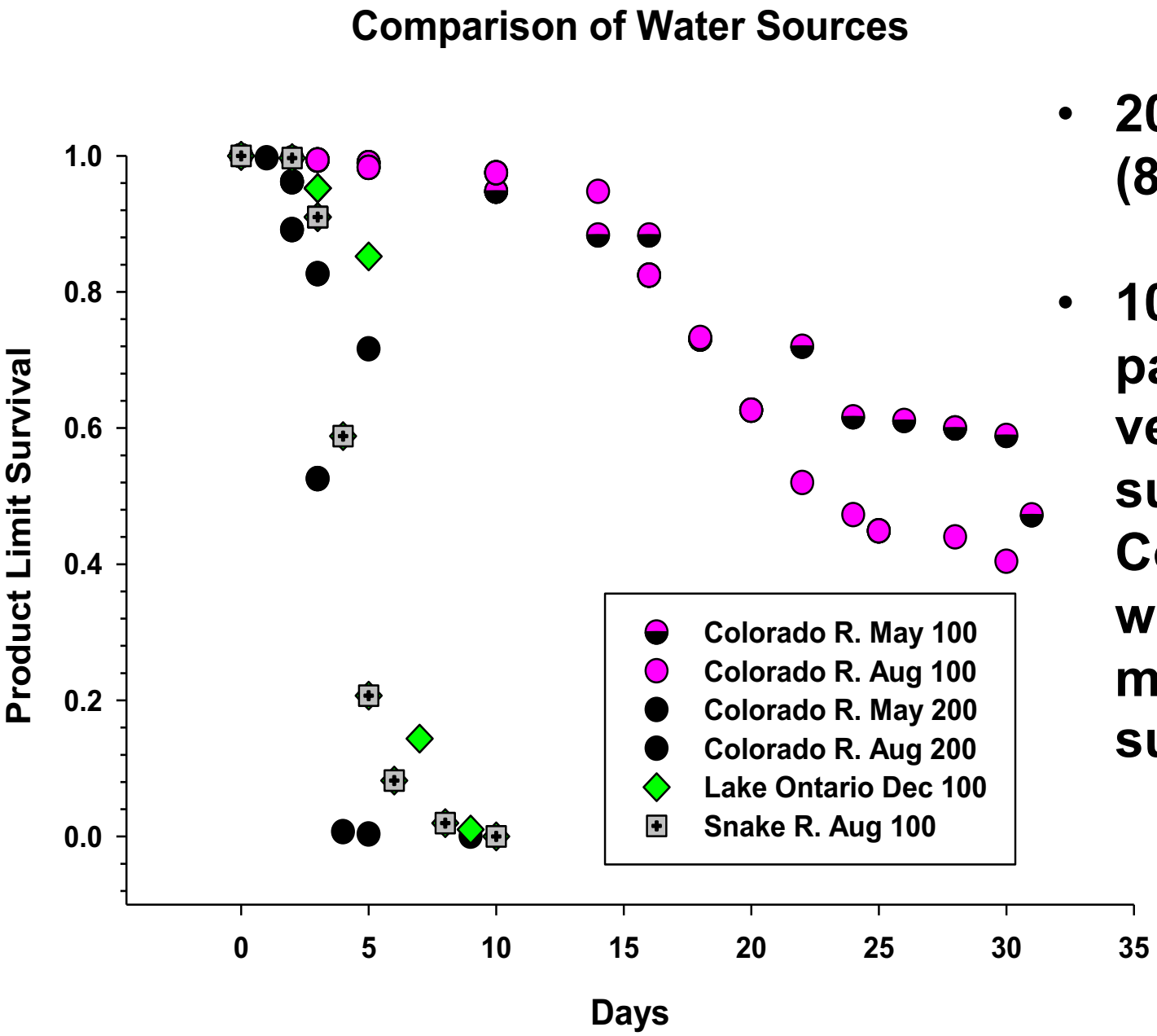
- WB Colorado little to no mortality over 24 h
- Lethal Time 50%
  - UI water = 2.7 h
  - ON water = 3.7 h
  - SR water = 5.8 h



Probit Model Predictions



Byssal Quagga in KCl?



- 200 mg/L: 100% (8-10 days)
- 100 mg/L: Similar patterns as veligers, high survival in Colorado River water, but rapid mortality in other surface waters

Conclusions and relevance of trials with veligers to assess vulnerability

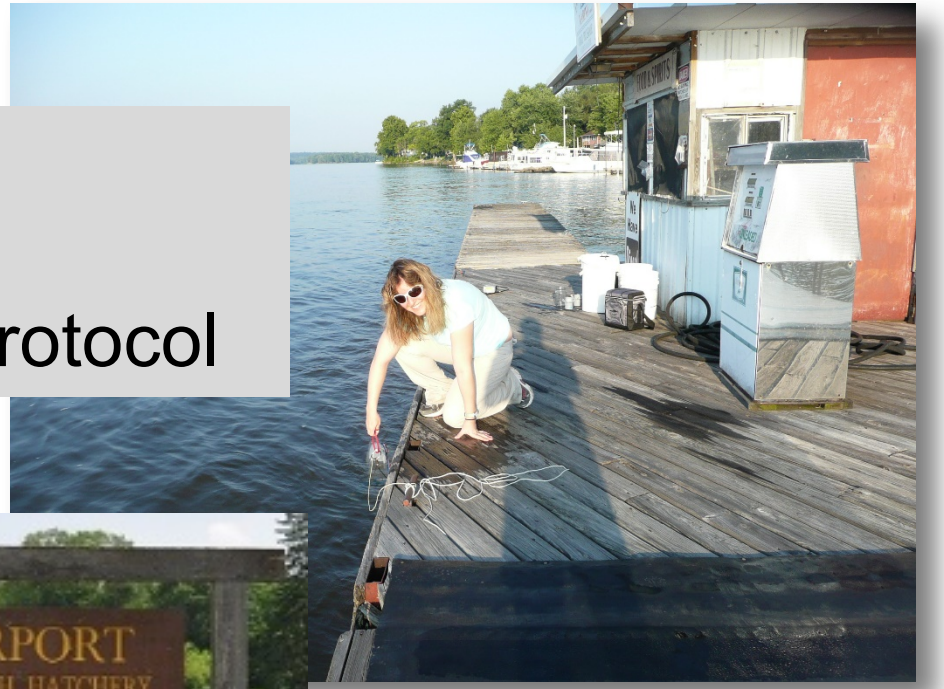
- Response of veligers to ~ 10 X higher concentrations over recommended treatment for byssal for 30 d can be a model for adult response at lower concentrations

- Shorter duration, and easier to monitor

Studies on Mississippi River August 2016

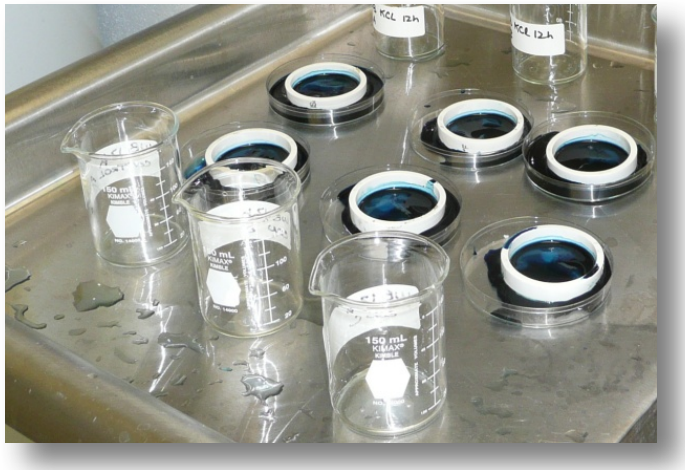
Static exposure to KCl

- Veligers 960 mg/L
- Edwards hauling protocol



Veliger trials – 960 mg/L 2015-2016

- May – June August – Sept , October 2015
  - WBNFH Colorado River, Snake River and UI ground water, Lake Ontario at Picton
  - KCl (analytical grade) @ ~ 20°C
  - Exposure times of 1, 3, 4, 5, 8, 10, 12, 24 hours

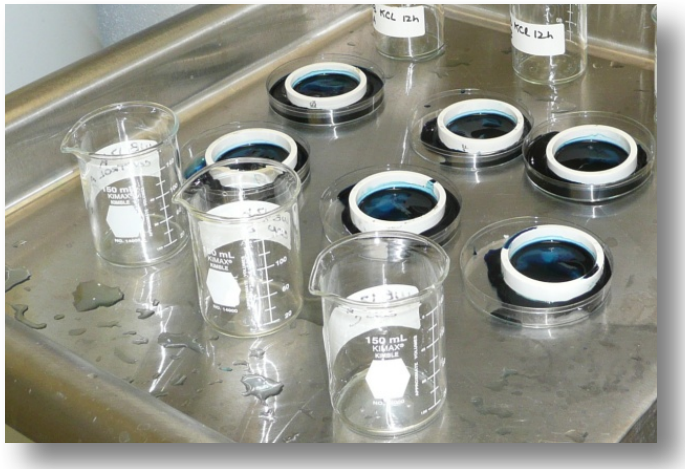


  - Fast green dye used to assist assessment of mortality

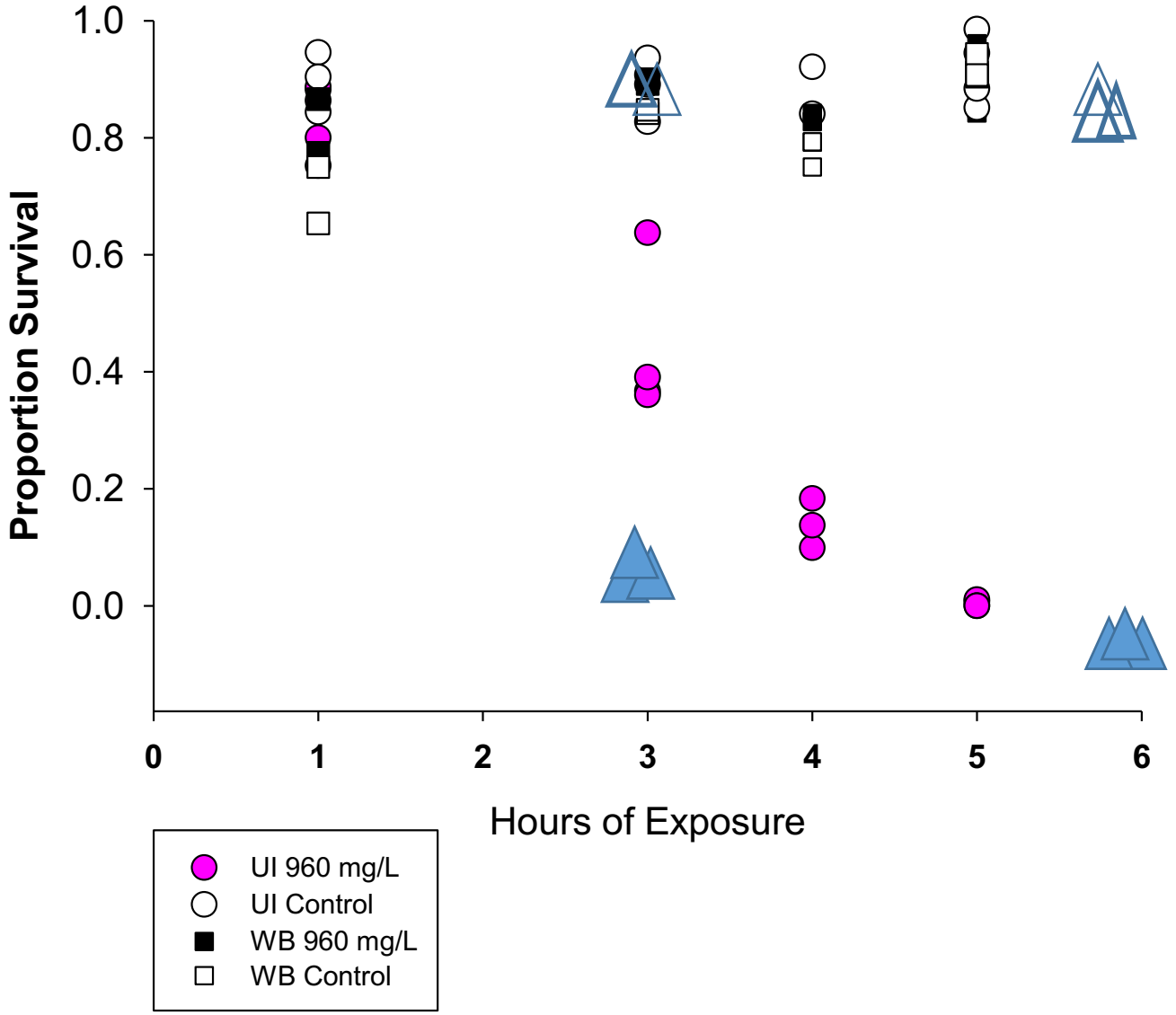
Veliger trials – 960 mg/L 2016

- Fairport Hatchery, Mississippi River, August 2016
  - KCl (analytical grade) @ ~ 20°C
  - Exposure times 3, 6, 12, 24 h

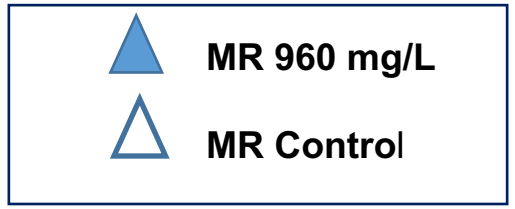
  - Fast green dye used to assist assessment of mortality



U of Idaho and Colorado River 2015 with Mississippi River, 2016



Mississippi River conductivity equal to U of Idaho groundwater had even lower survival at 3 h than U of Idaho



Water Quality Parameters Considered

- Water quality differences across the range of water sources
  - Salinity, pH, DO, Specific conductivity, TDS
  - Metals profile - ICP
    - Dissolved and total
    - With and without KCl

Summary of WQ Measures all Locations Tested

Source	Temp (°C)	pH	Specific conductivity (mS/cm)	TDS (mg/L)	Salinity ppt
U Idaho	22.2	8.1	0.37	0.25	0.18
Snake River	22.8	8.1	0.47	0.31	0.23
Colorado River	22.2	7.9 - 8.2	1.08 – 1.02	0.67	0.51
Lake Ontario	20.0	8.3	0.33	0.21	0.15
Mississippi River	20.4	8.2	0.37	.24	0.18

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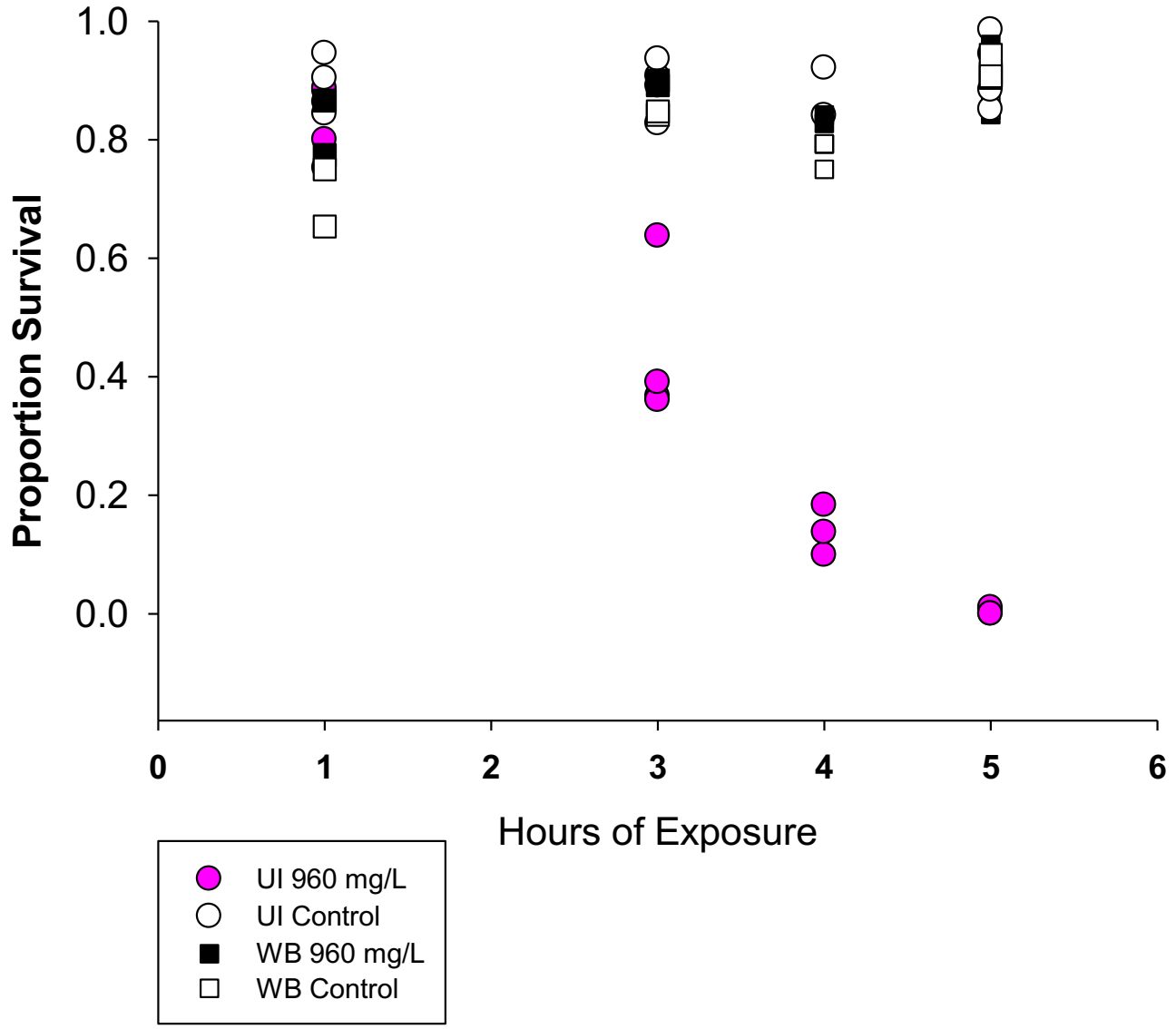
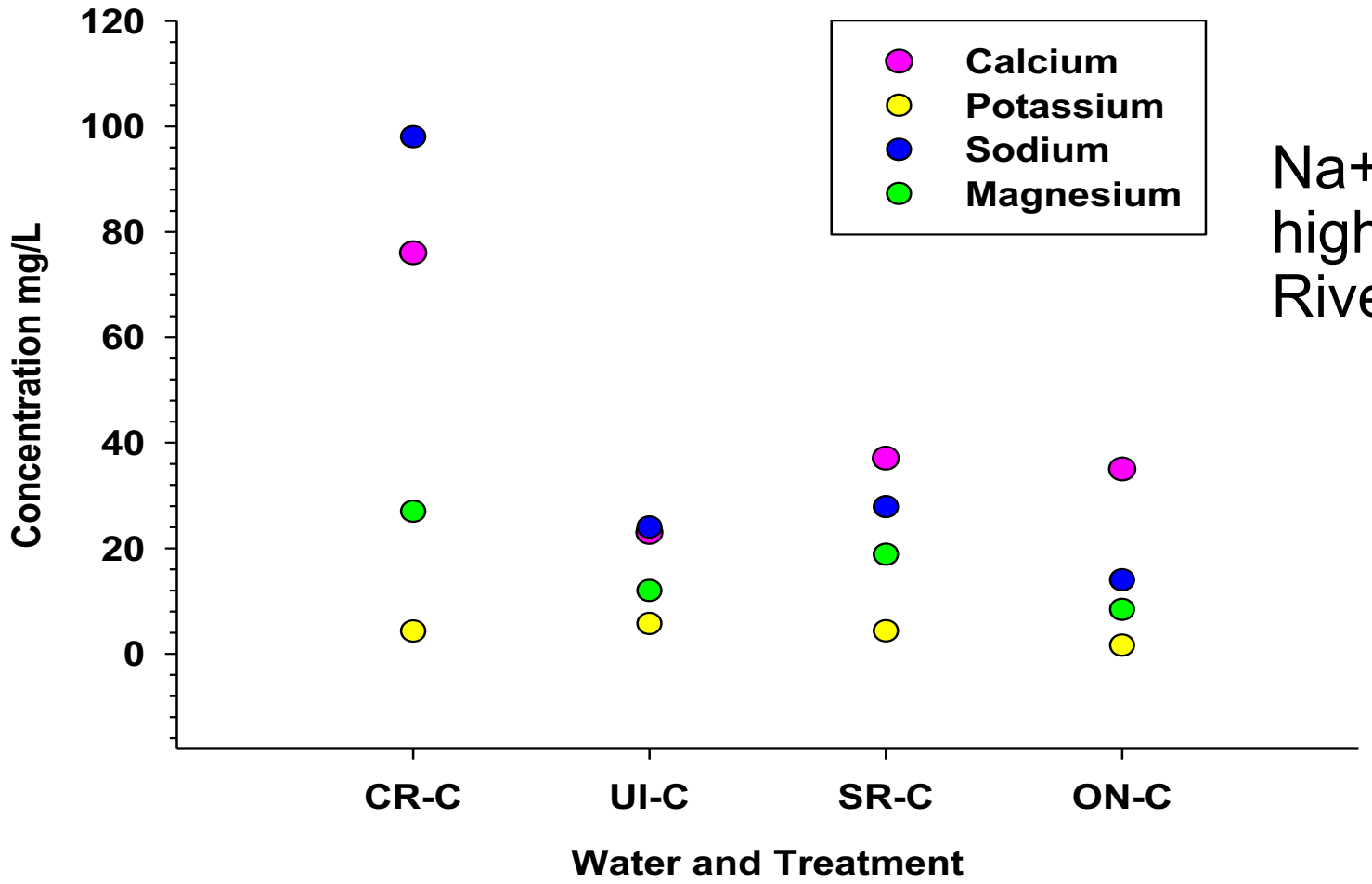
Comparison Survival in U of Idaho (Conductivity = 0.37) and Colorado River (Conductivity ~ 1.0) 2015



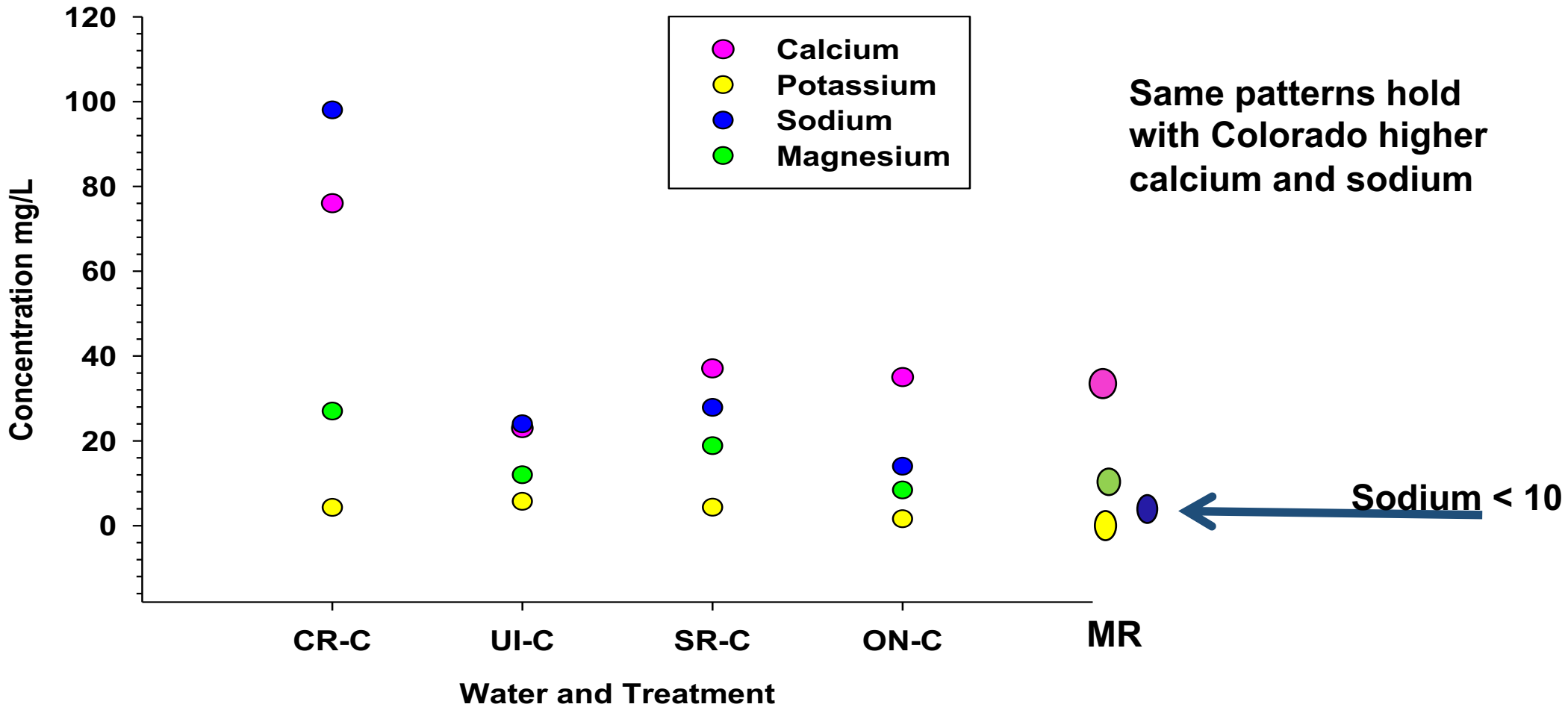
ICP Metals Profile of Water Sources



Na+, Ca++, Mg++ higher in Colorado River water source

- No difference in K+ levels of test waters after KCl addition

ICP Metals Profile of Water Sources All Locations

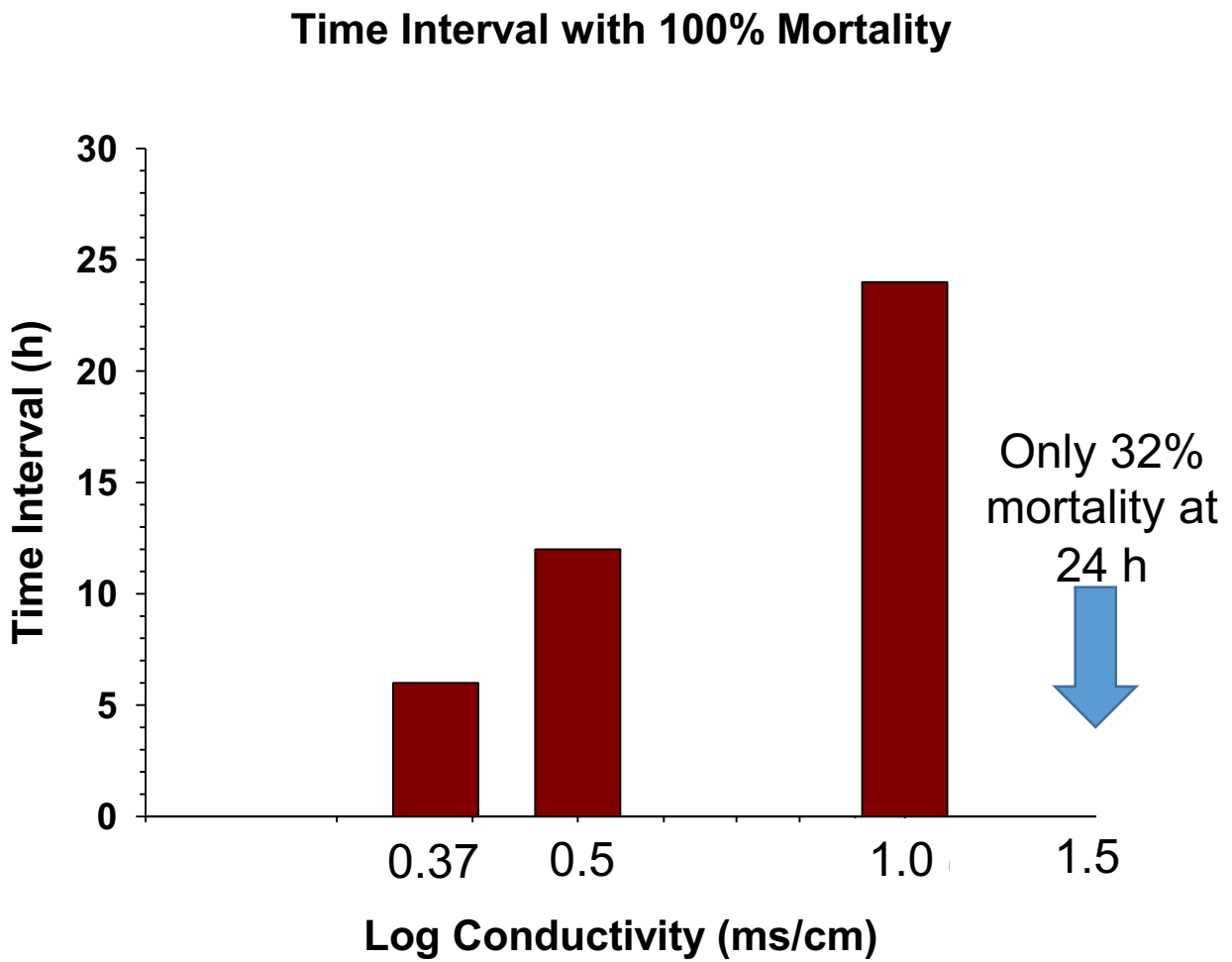


- No difference in K+ levels of test waters after KCl addition

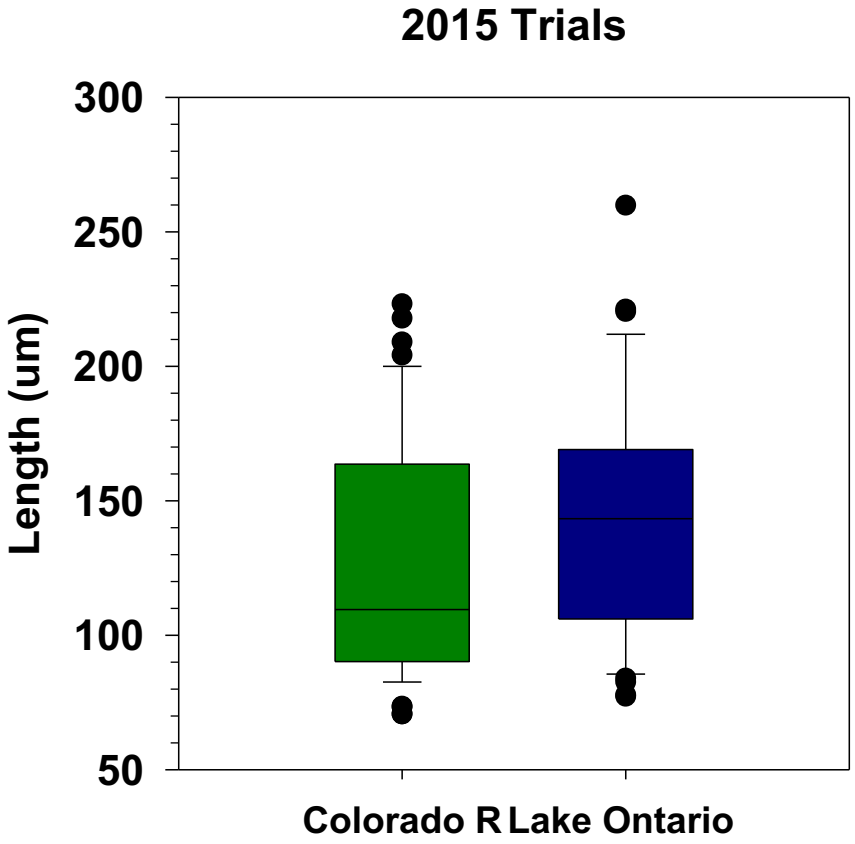
As with studies in 2015, NaCl added to base water to reach conductivity of Colorado River

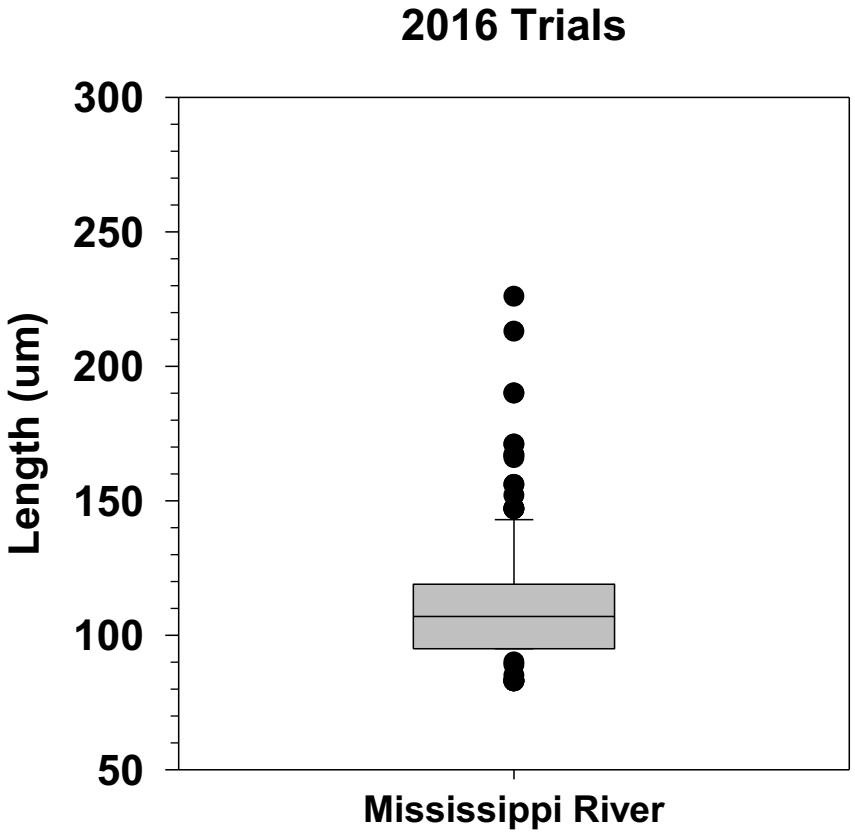
- Baseline 0.37 mS/cm
- Added NaCl to achieve: 0.5, 1.0, and 1.5

Time to Mortality vs Log Conductivity



Sizes of Veliger Tested in Trials



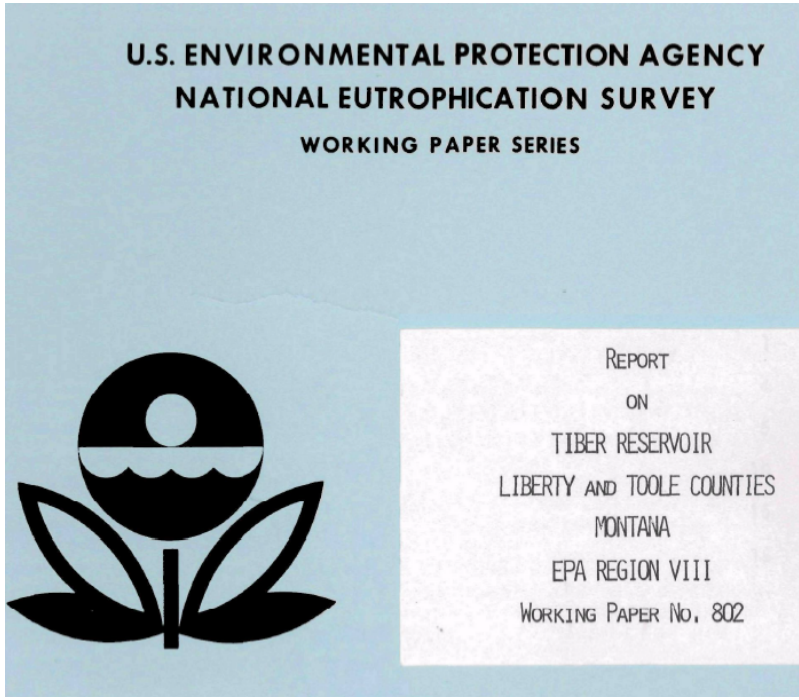


Conclusions

- Osmotic balance in membranes involved active exchange of Na and K
- If higher Na+ is in source water, mortality from KCl is reduced.
- Models held with zebra mussels, but size and acclimation to elevated temperatures of Mississippi River likely affect rate of mortality, and zebra mussels were more vulnerable.
- Additional analysis of tests of Edwards protocol with bench and lab studies not yet completed.

Montana RR Treatment Options

- Conductivity range of Tiber Reservoir from water quality reports appears to be mean from 0.3 – 0.45 mS/cm
- Thus treatment looks plausible with KCl
- Recommend metals profile sampling



Acknowledgements

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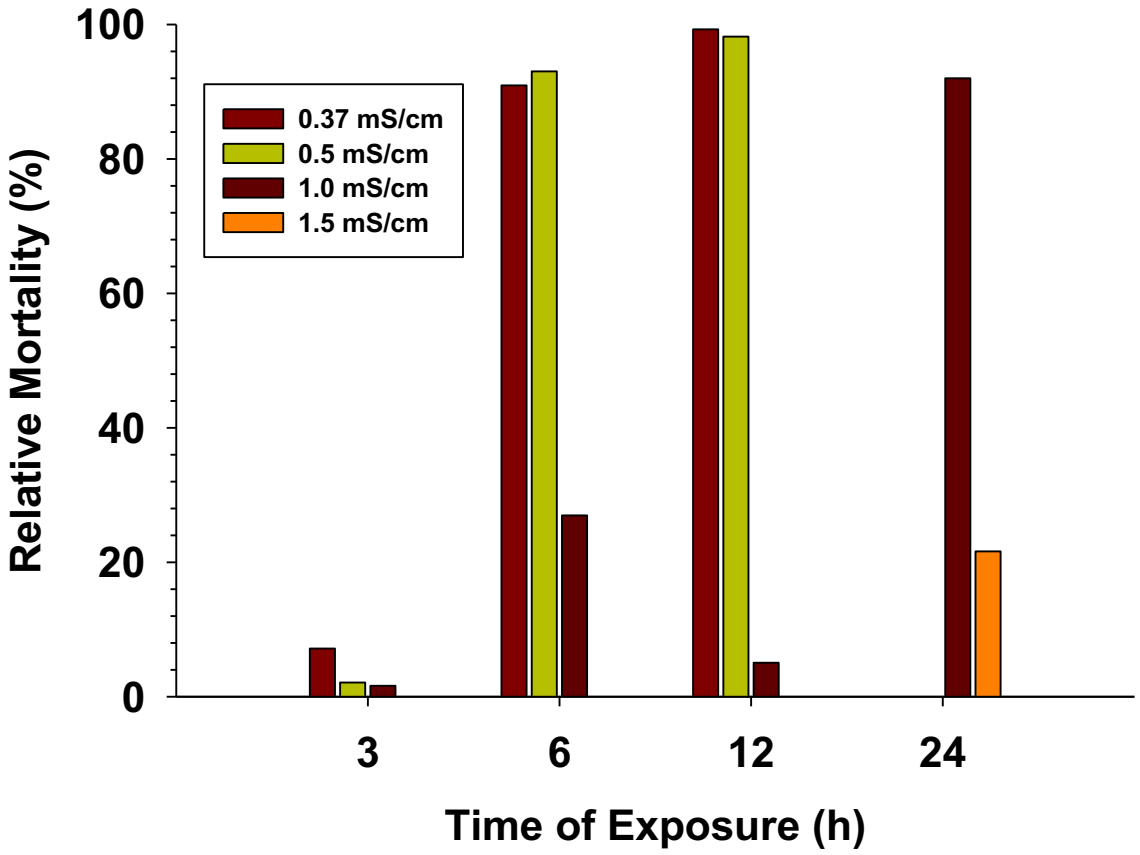
- Staff of Fairport State Fish Hatchery, Iowa DNR
- Dave Parrish IDFG
- Bob Kibler FWS


100
80
60
40
20
0
Relative Mortality (%)
0.37 mS/cm
0.5 mS/cm
1.0 mS/cm
1.5 mS/cm
3
6
12
24
Time of Exposure (h)