Mortality responses of Quagga Mussels to KCl Solutions in Different Source Waters

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19th International Conference on Aquatic Invasive Species 2016

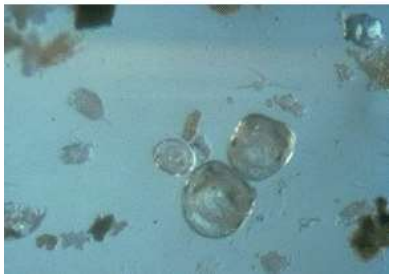
KCL as a Control Tool?

- 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 (Potash) to control Z/Q Mussels

- Veliger zebra mussels - KCl (~ 750 mg/L) + chemical
  - 100% mortality in Great Lakes region
  - Short exposure times (2-3 hrs)
  - Showed little harm to fish with short term exposure



- Byssal zebra mussels - ~100 mg/L for 30 days
  - Milbrook Quarry, VA
  - Lake Winnipeg and Christmas Lake, MN

- Veliger quagga mussels - >2,000 mg/L
  - Colorado River at WBNFH by Sykes showed no veliger mortality
  - Colorado River at LMFH by Pucherelli et al. no veliger mortality

Uncertainty in Data and Efficacy

- Few studies addressed quagga mussels
- Water quality criteria not addressed in studies of efficacy
- Temperature and time of year effects?

Objectives

- Test efficacy of KCl as a toxicant on byssal and veliger quagga mussels
- Compare responses in different water sources
- Explore response with water quality criteria such as conductivity and metals

Studies at WBNFH

- May – June, & August – Sept

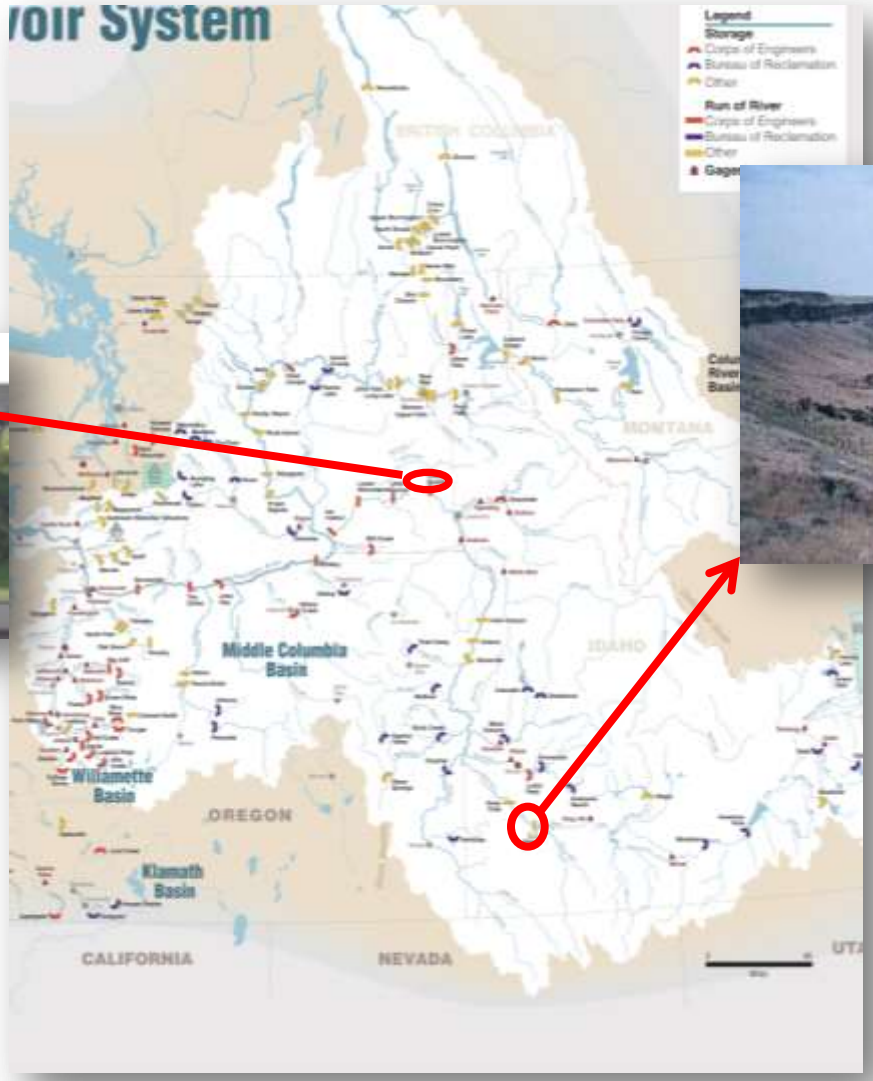
- Static exposure to KCl
  - Byssal stage: 100 and 200 mg/L with renewals every 48 h
  - Veligers: 960 mg/L

- Tests with Colorado River water, U of I groundwater & Snake River water

Columbia River Water Sources

Ground water,
Moscow, ID

Pathogen free,
filtered,
dechlorinated
well water



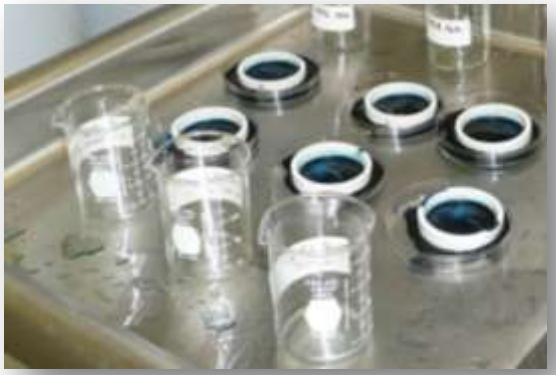
Surface water,
Snake River, ID

Surface water,
filtered 35 µm
plankton net

Studies in Lake Ontario

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

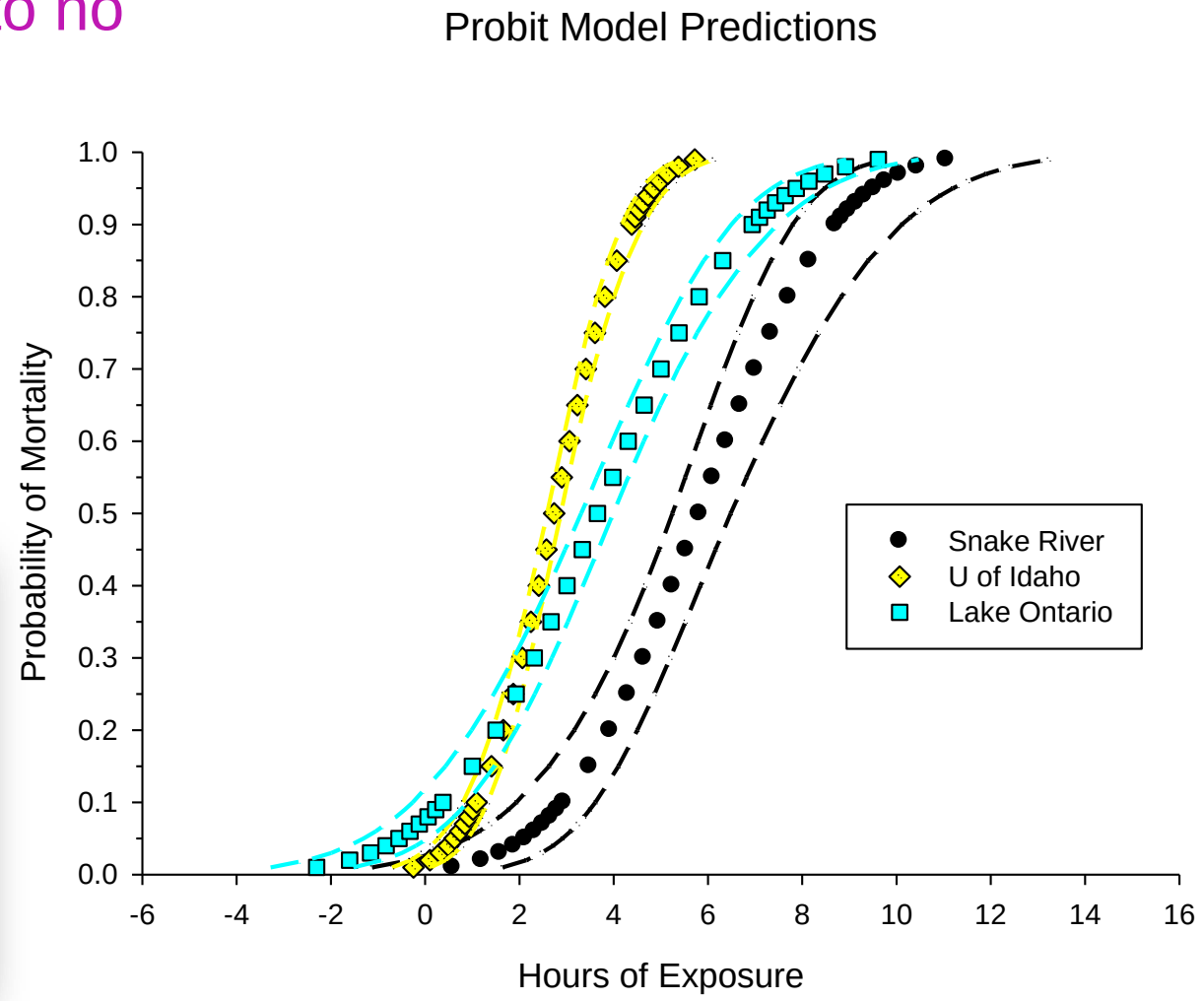
Veliger trials – 960 mg/L



- May – June, August – Sept , October
  - WBNFH Colorado River, Snake River, UI ground water, and 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
- Water quality analysis
  - Salinity, pH, DO, cond, TDS
  - Metals profile
    - Dissolved and total
    - With and without KCl

Variations in mortality to KCl within different water sources

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



Differences in Water Quality

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

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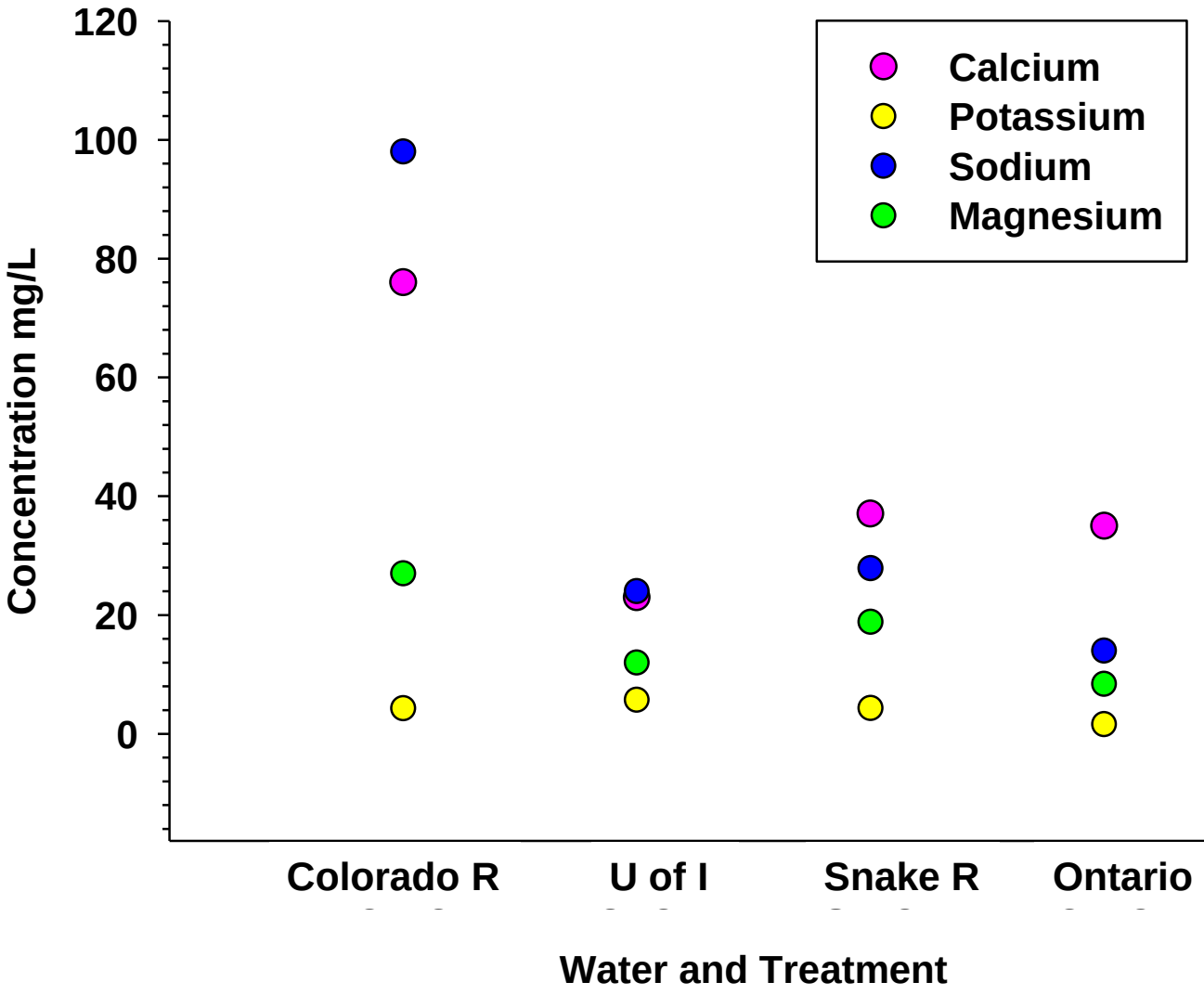
Metals Profile of Water Sources

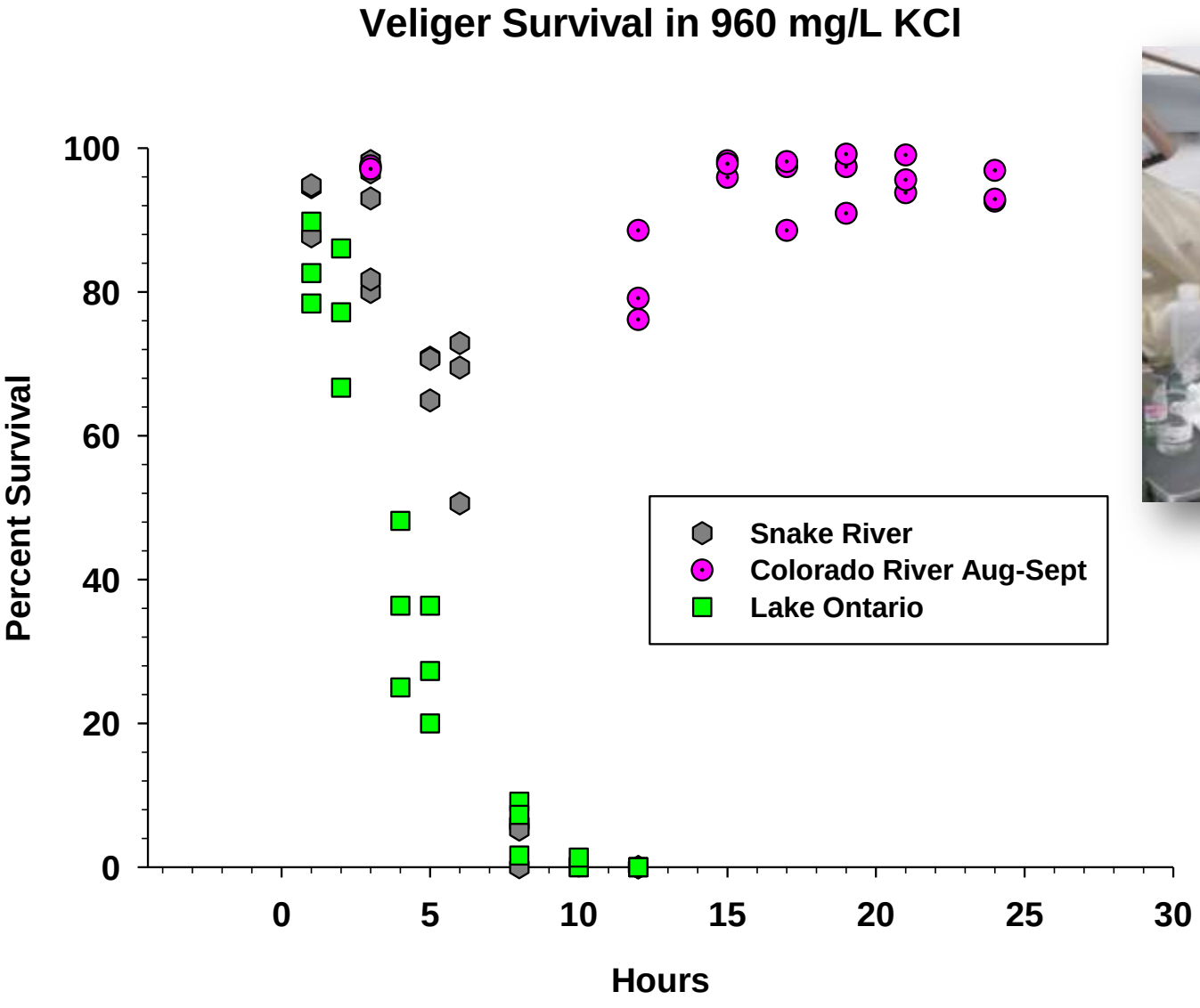


- Na+, Ca++, Mg++ higher in Colorado River water source
- No difference in K+ levels of test waters after KCl addition

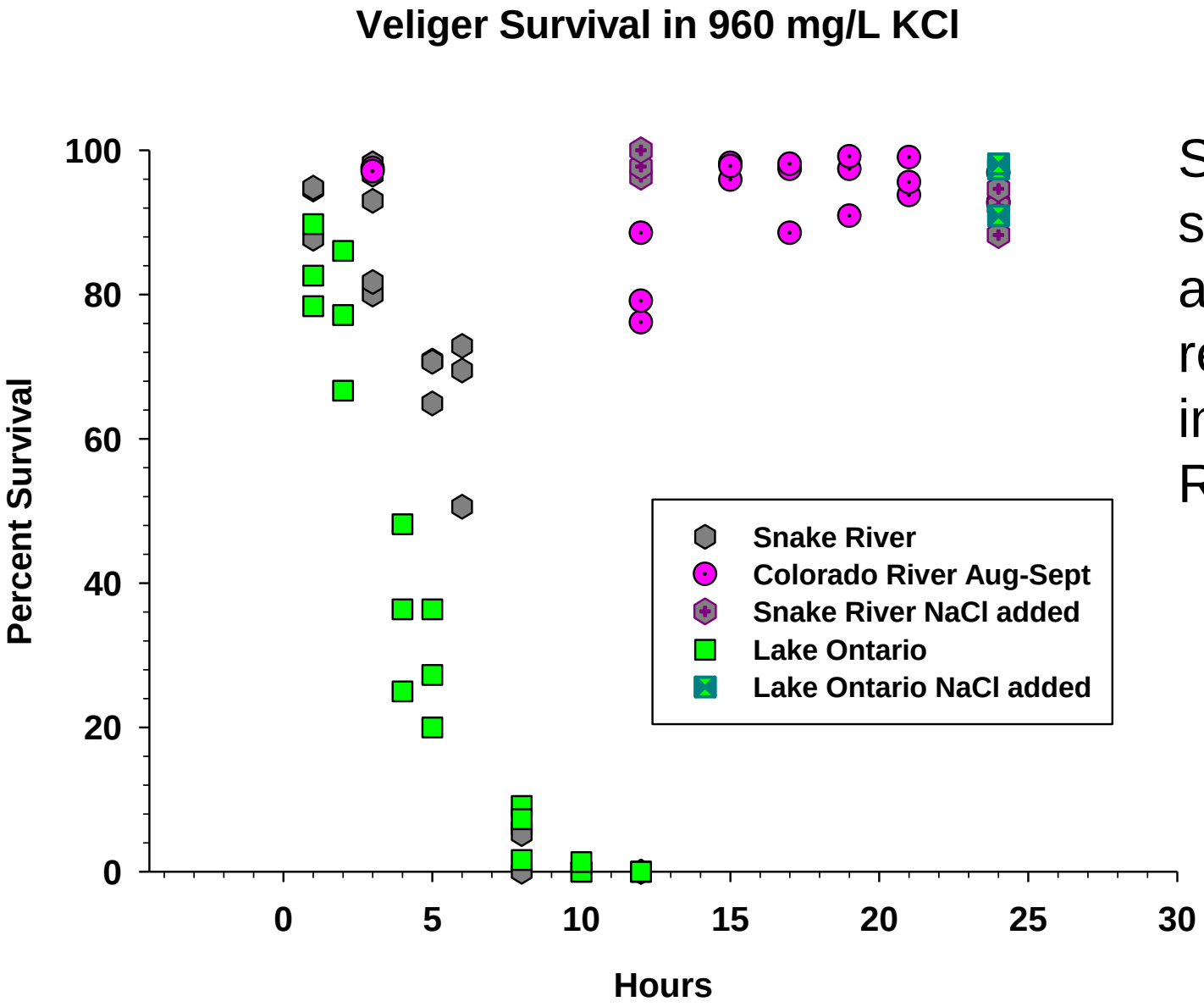
Adjusted Conductivity of Snake River and Lake Ontario with NaCl Addition

Source	Sp. Cond (ms/cm) unadjusted	Adjusted conductivity	Adjusted TDS	Adjusted salinity
Colorado River Not adjusted	1.02 – 1.08	1.02 - 1.08	0.67	0.51
Snake River	0.47	1.04	0.68	0.52
Lake Ontario	0.33	0.91	0.59	0.45

Survival of Veligers in Lake Ontario and Snake River Water Compared with Colorado River

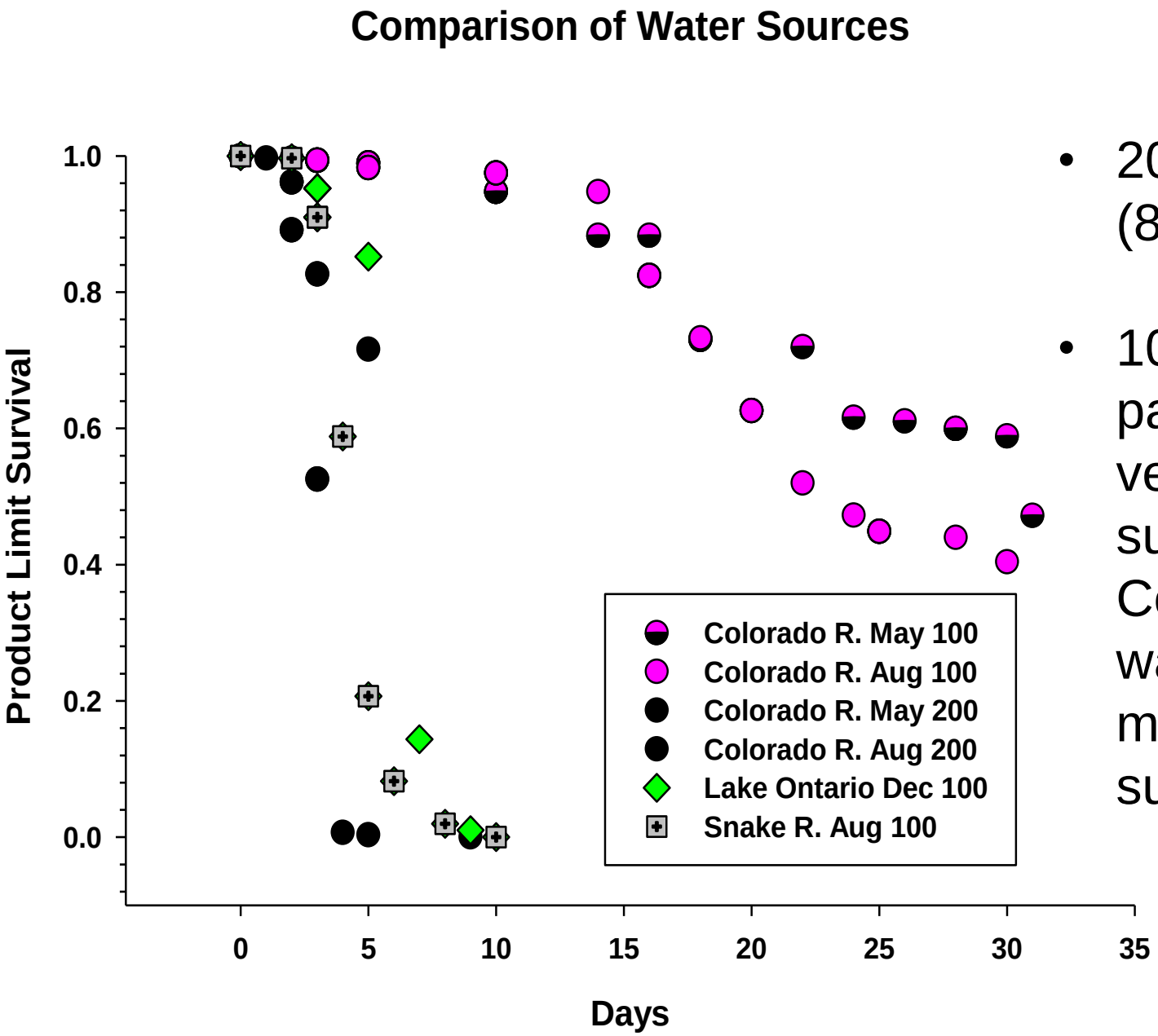


Survival Comparisons with NaCl addition Equivalent to Colorado River



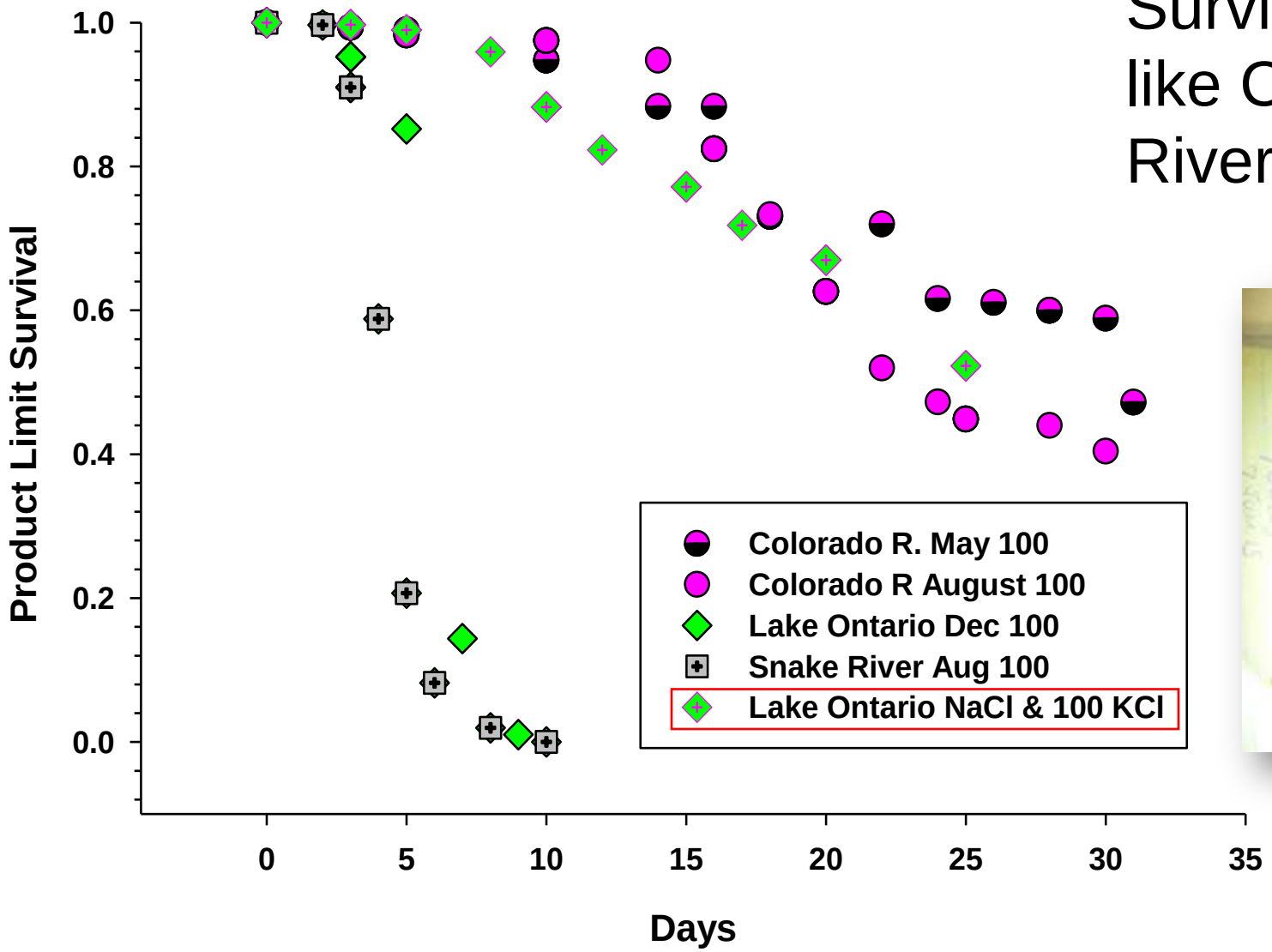
Survival in salinity adjusted water resembled that in Colorado River water

Byssal Quagga in KCl?



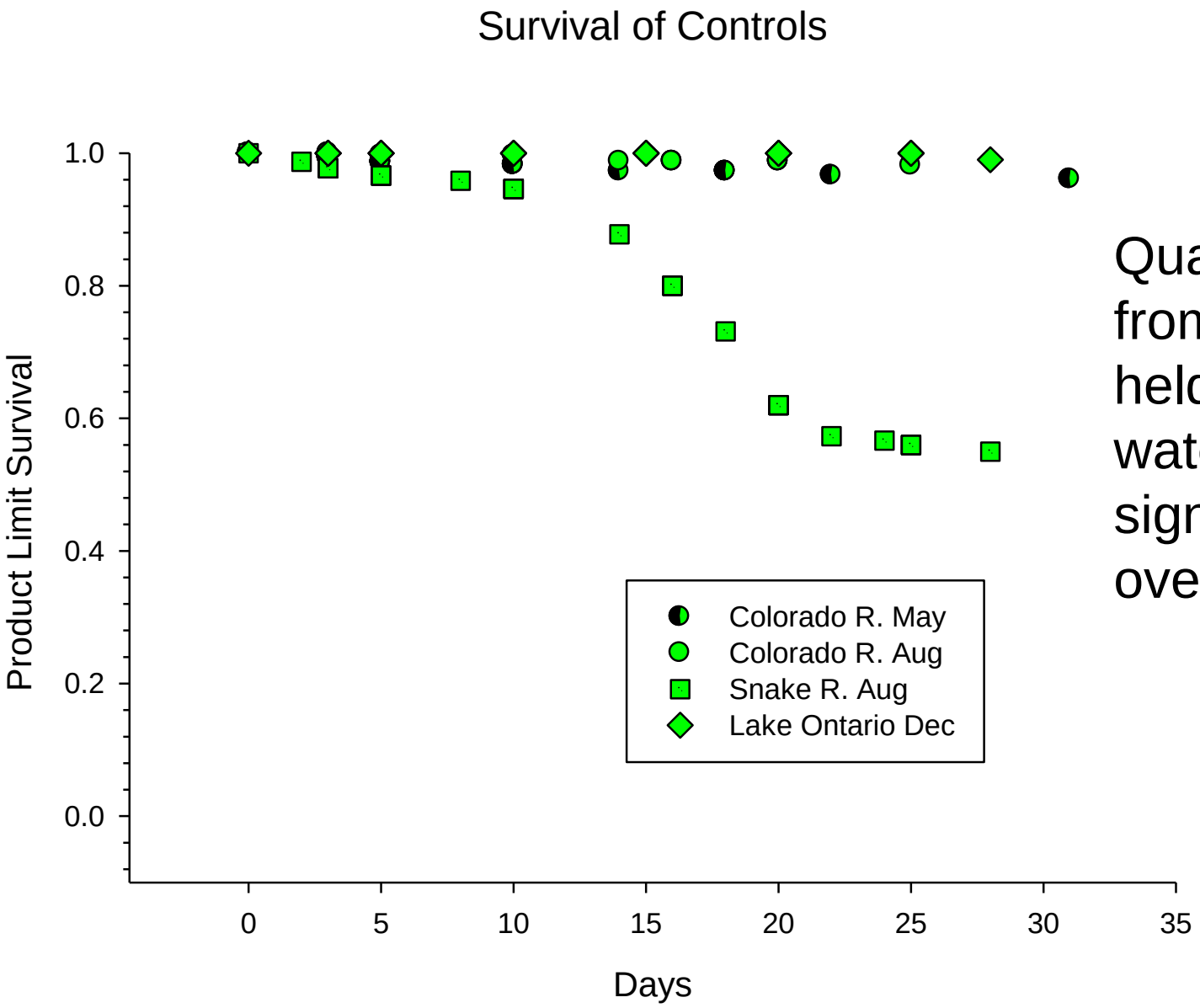
- 200 mg/L: 100% (8-10 days)
- 100 mg/L: Similar patterns as veligers, high survival in Colorado River water, but rapid mortality in other surface waters

What Happens with Addition of NaCl?



Survival looks like Colorado River !

Survival in Controls – no KCl?



Quagga mussels from Colorado R held in Snake R water showed significant mortality over the 30 d

Discussion

- Confirmed Sykes and Pucherelli et al. results
- Metal ion analysis and conductivity, TDS, and salinity are important water quality parameters to include in chemical toxicity trials
- Not a large seasonality effect at WBNFH

Conclusions

- Na+ content of source waters may be key factor determining mortality in KCl treatments

- Na+/K+ ion exchange membrane in quagga and zebra mussels functions similar to that of fish and other organisms
  - Though Na+/K+ exchange in Z/Q mussels is particularly active (over other mollusks)
- Probability of survival of Colorado River mussels may be reduced if transported into areas of lower conductivity/salinity. Higher risk may be associated with quagga/zebra mussels adapted to low conductivity!

Acknowledgements

- Funding Utah Division Wildlife Resources, USFWS, USGS, PSMFC
- Staff and facilities at WBNFH, manager Mark Olson and Asst Mgr. Tom Frew
- Dave Parrish IDFG, and Bob Kibler USFWS for help with water collection and shipping