Low-dose copper for zebra mussel suppression

Angelique Dahlberg, Nicholas Phelps
UMN Minnesota Aquatic Invasive Species Research Center
*edge0023@umn.edu

Diane Waller, Jim Luoma, Matt Barbour
USGS Upper Midwest Environmental Sciences Center
*dwaller@usgs.gov

Copper-based control:
zebra mussel settlement & non-target impacts

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Agenda

- Brief copper overview
- Our research
- Study design
- Preliminary results
- Future

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A HISTORY OF COPPER USE

for aquatic management

Historically, copper plating was used on boats as an antifouling agent to prevent the attachment of barnacles

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Researchers and communities begin using copper sulfate to control algae in the Madison, WI area (1918) and Fairmont Lakes, MN area (1921)[1]

Copper is used as an aquatic algaecide, herbicide, molluscicide, and for macroinvertebrate control[2].

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Copper is used to control aquatic invasive species, including zebra and quagga mussels[3,4,5,6], faucet snails[7], invasive plants[8], and nuisance algae[9]

Recent research in the lab and field suggests that veligers are more susceptible than adults to copper products[10]

Minnesota's zebra mussel copper treatments

Year	Lake	County
2019	Bone Lake*	Washington
2017	Lake Marion*	Dakota
2016	Lake Minnewashta*	Carver
2015	Ruth Lake*	Crow Wing
2014	Christmas Lake+* Lake Independence+*	Hennepin
2011	Rose Lake Lake Irene	Douglas Otter Tail

*Treated with EarthTec QZ

+ Copper treatment part of larger multi-toxicant treatment series

Other treatments:
Offut Airbase, NE (2008-2009), Billmeyer Quarry, PA* (2017)

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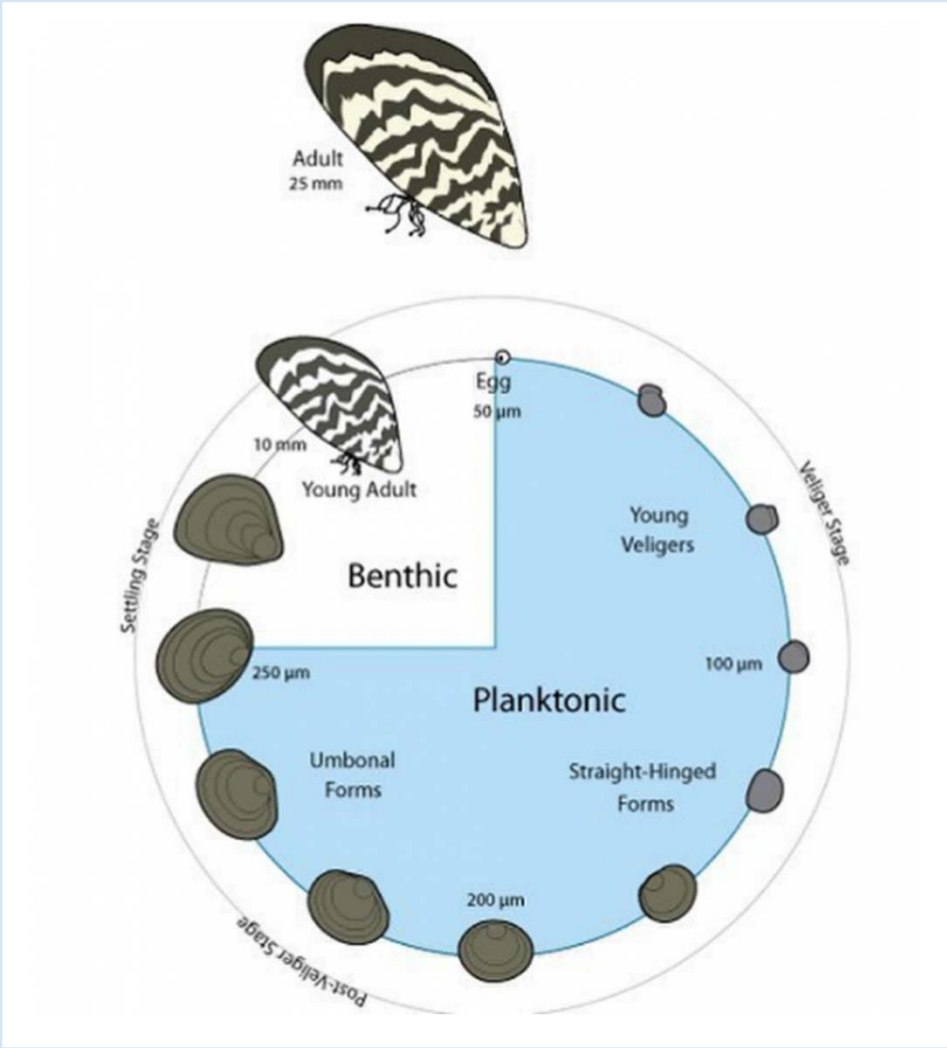
Copper-based control:

zebra mussel settlement & non-target impacts

RESEARCH QUESTIONS

- Can we prevent settling and/or control veligers with a low-dose of copper?
- Does a low-dose decrease ecological risks?
- What is the long-term effect on zebra mussel recruitment and nontarget populations?



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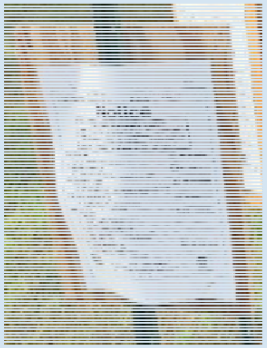
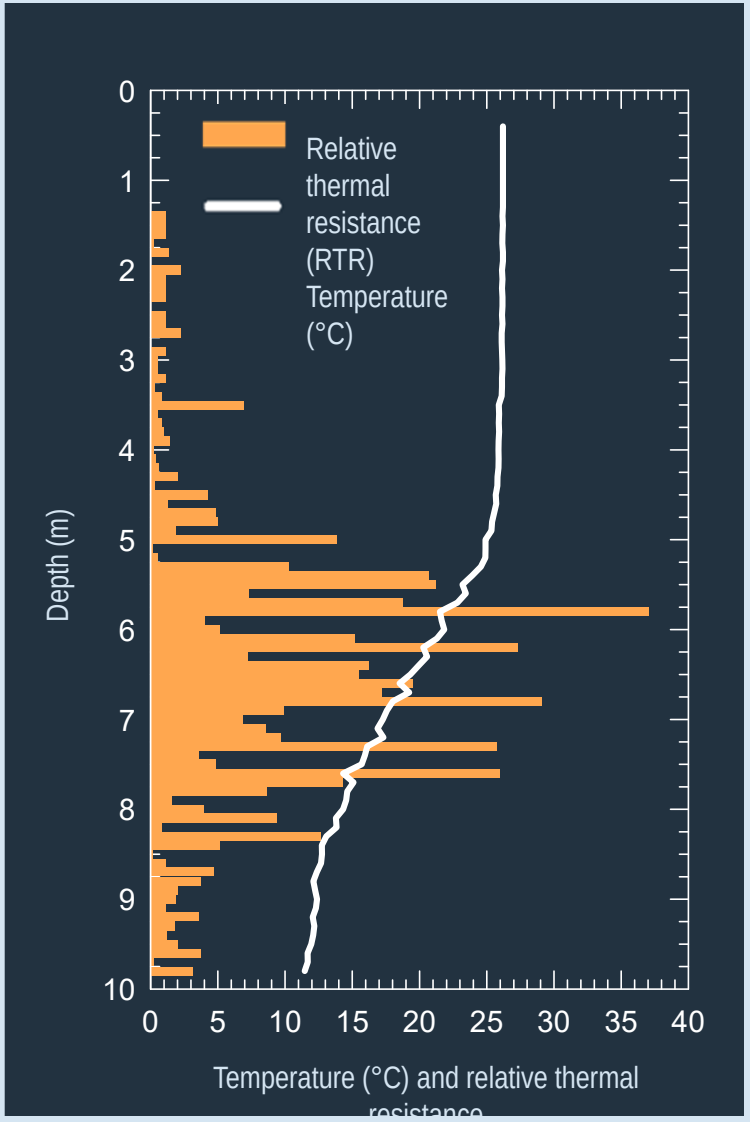


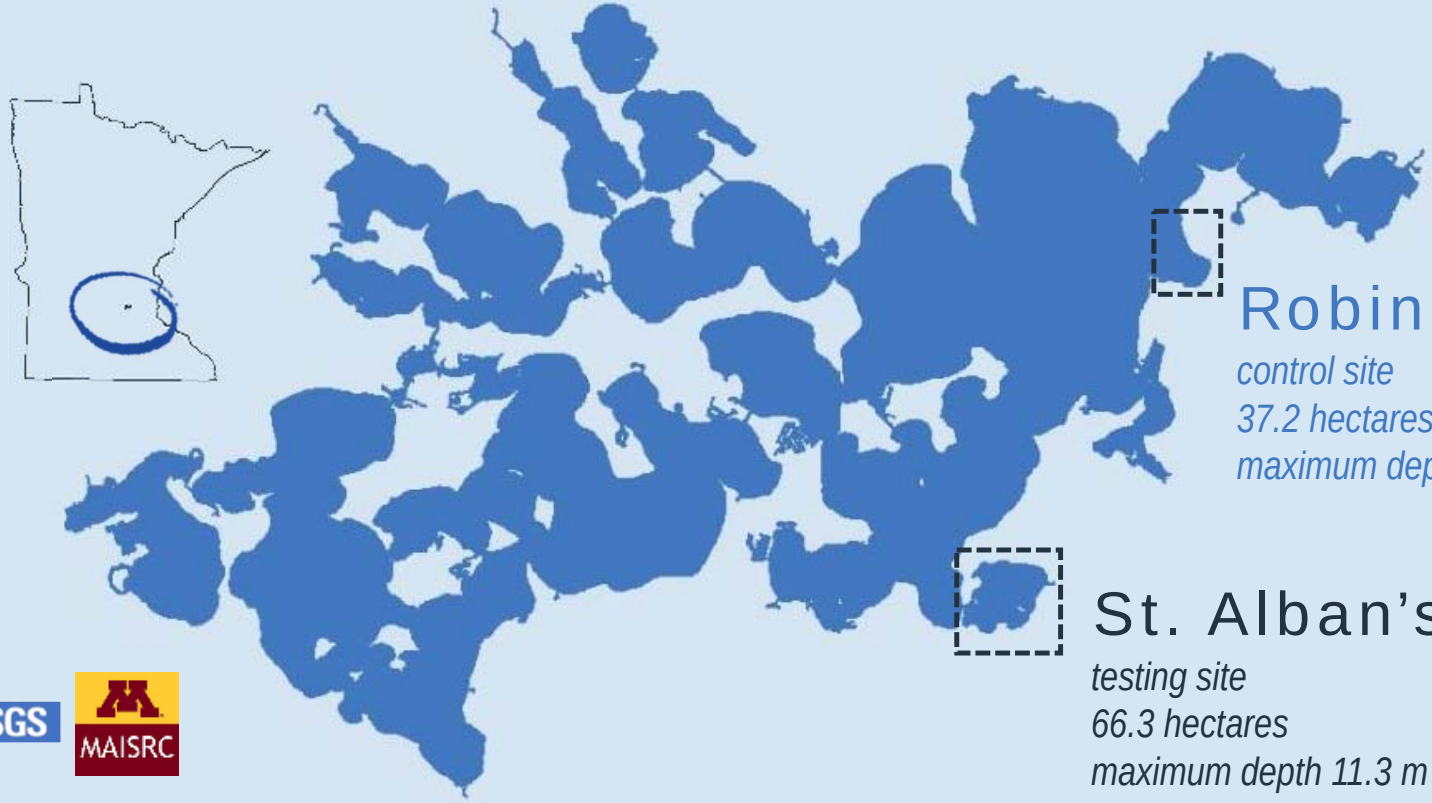
2019 Treatment

- EarthTec QZ
  - Epilimnion only
  - 100 µg/L initial dose
  - 60 µg/L sustained
- Assess ecological impacts
  - Fish species
  - Native mussels
  - Plankton and benthic invertebrates
  - Water quality/chemistry



Lake Minnetonka

zebra mussels first appeared in 2010



Robinson Bay

control site
37.2 hectares
maximum depth 19.1 m

= ROB

St. Alban's Bay

testing site
66.3 hectares
maximum depth 11.3 m

= SAB

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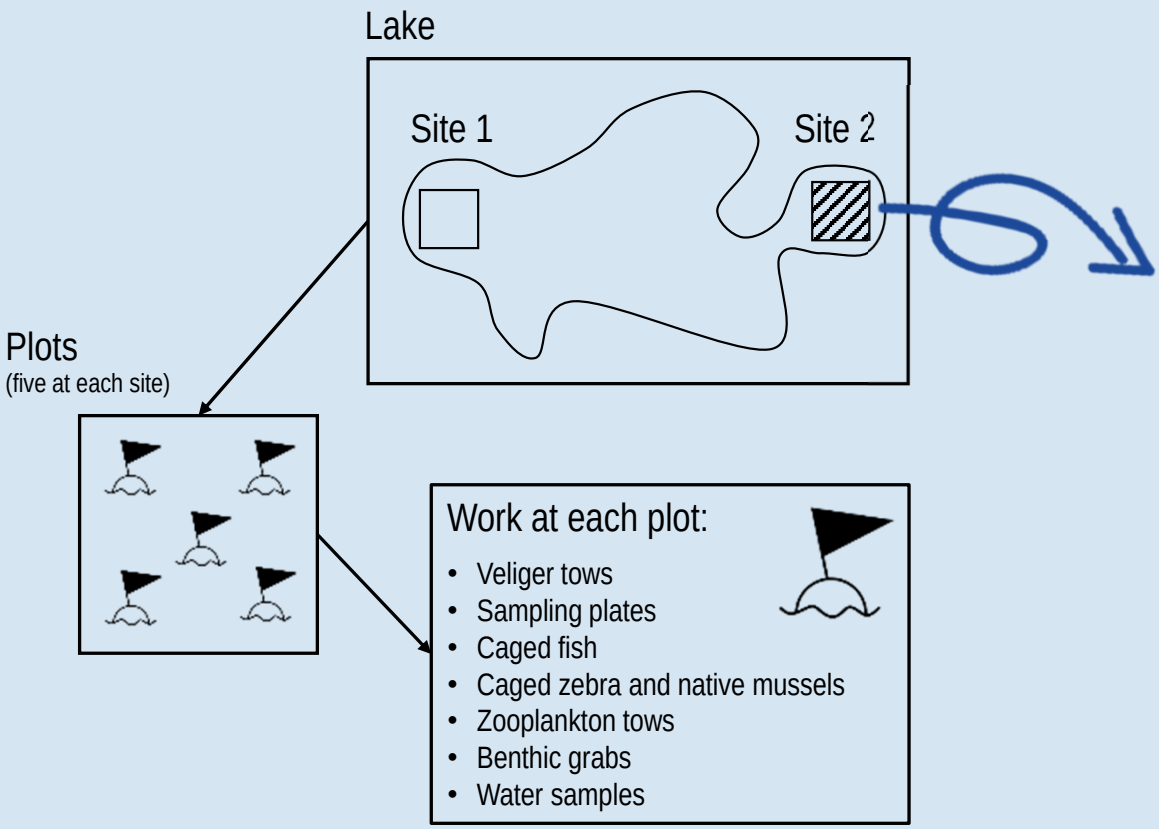
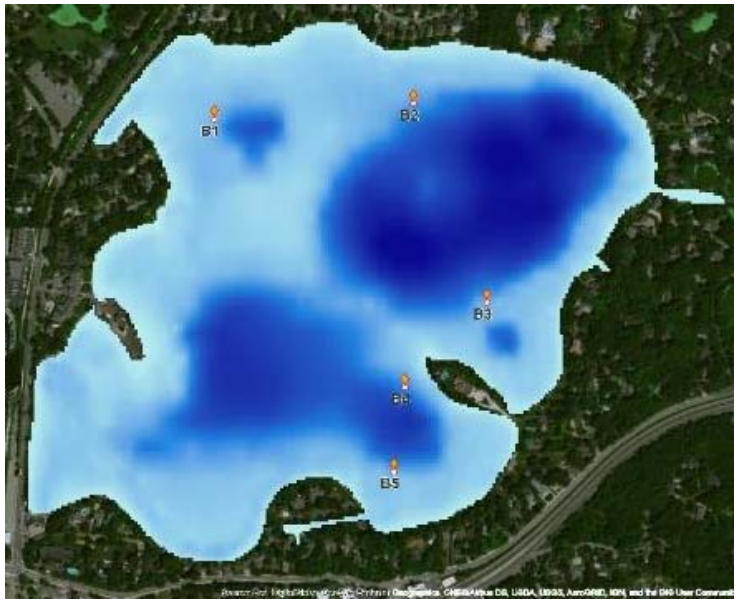
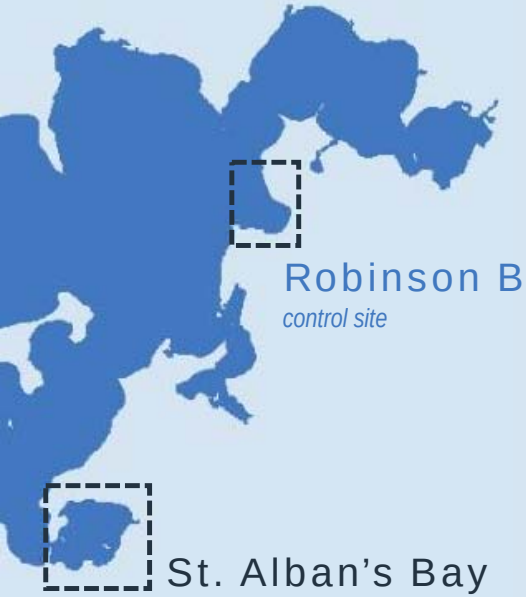




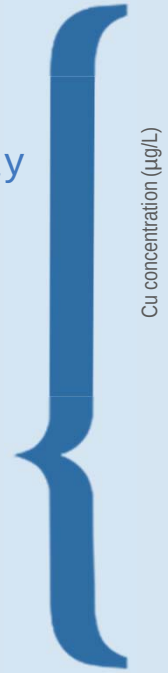
Saint Alban's Bay, Lake Minnetonka, was used as the treatment bay in 2019. Red markers indicate plots (marked by buoys).

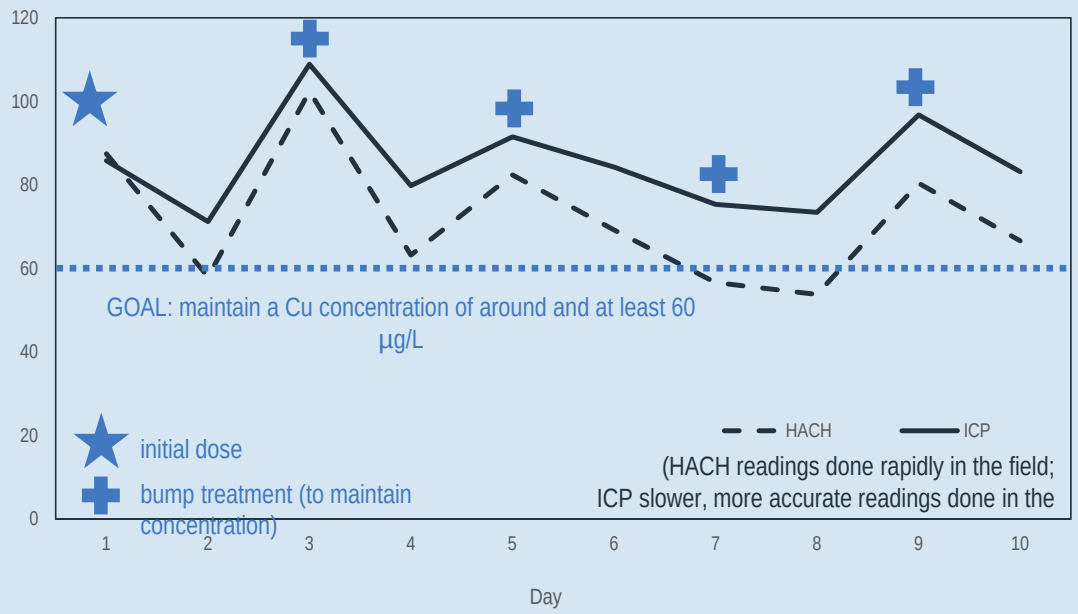
COPPER TREATMENT



Robinson Bay
control site

St. Alban's Bay
testing site





Daily means:

ICP = 83.0

Hach = 67.3

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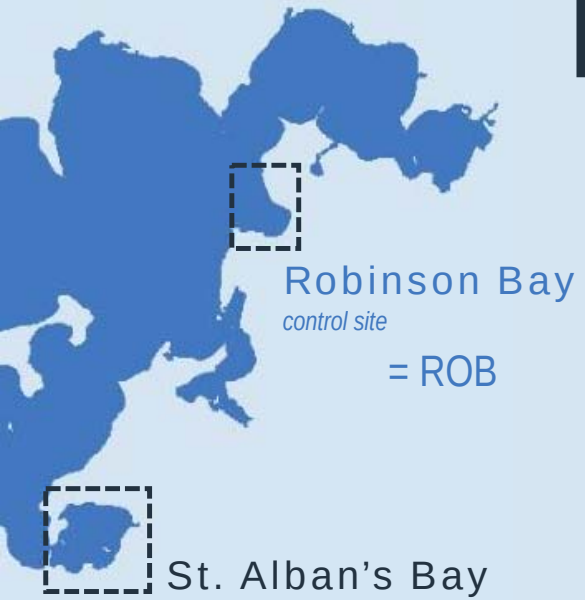
TARGET IMPACTS

Zebra mussel veligers



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control site

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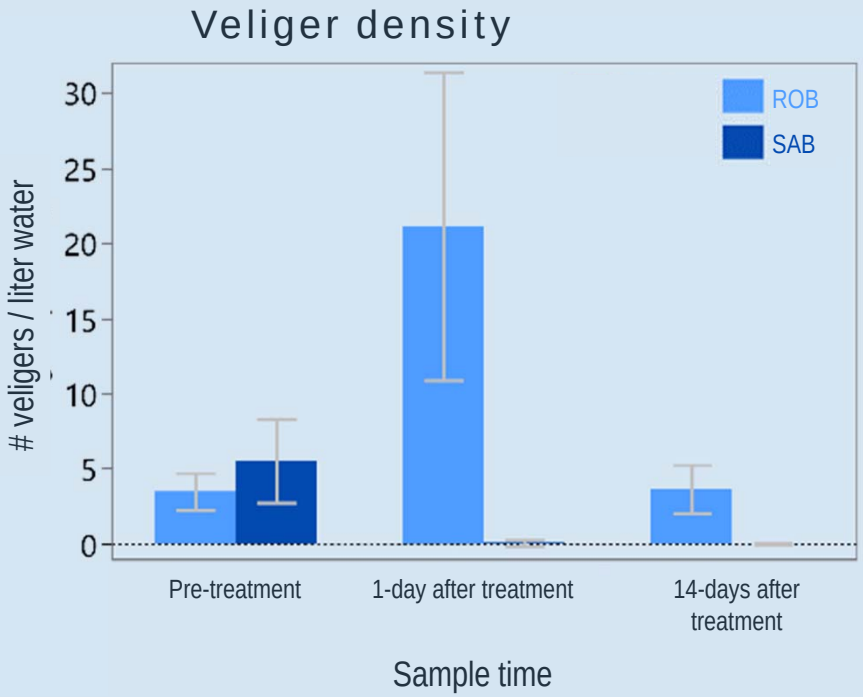
St. Alban's Bay

testing site

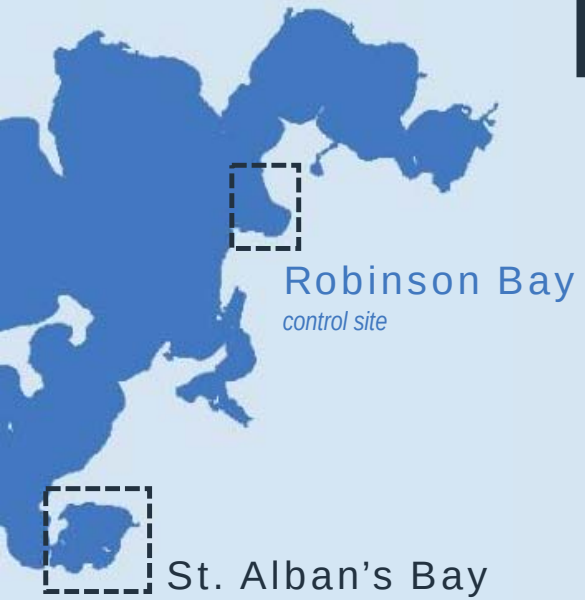
= SAB

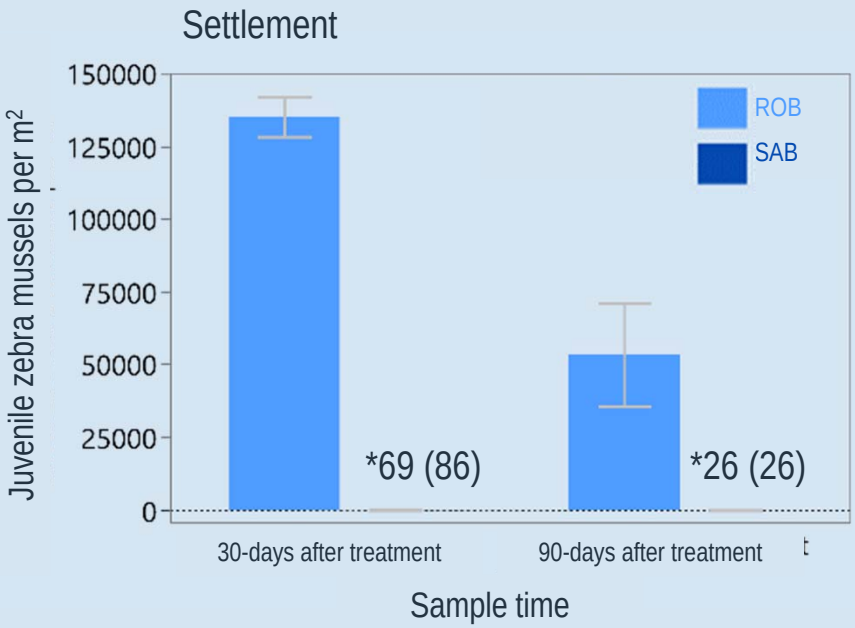


Treatments effectively reduced zebra mussel veliger density

TARGET IMPACTS

Zebra mussel juveniles





Treatments effectively reduced zebra mussel settlement (August & October)

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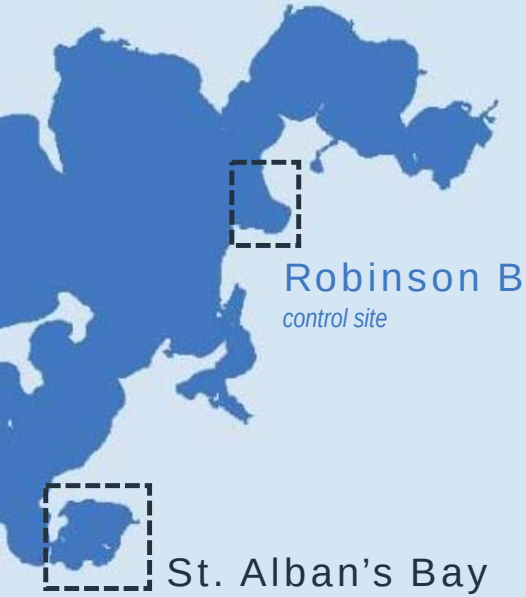
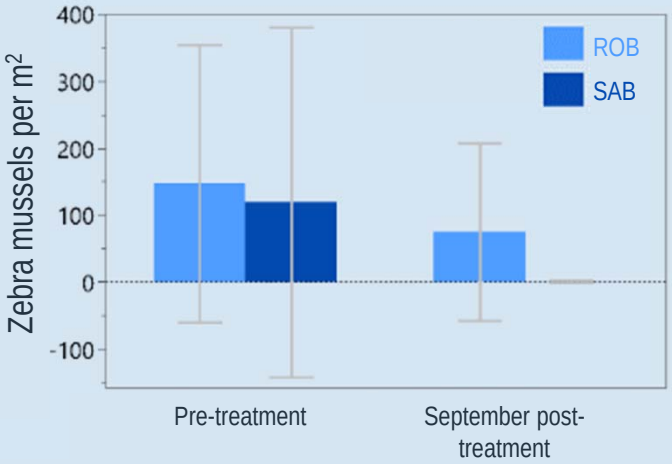
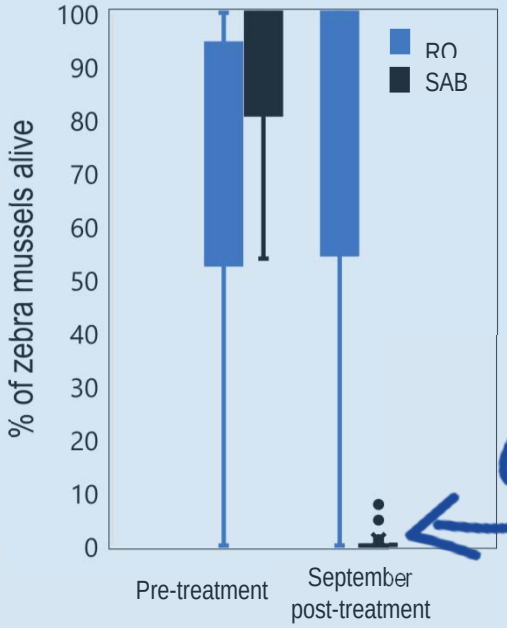
TARGET IMPACTS

Adult zebra mussels



Resident adult survival





Few live adult zebra mussels in SCUBA survey at 2-months post-treatment

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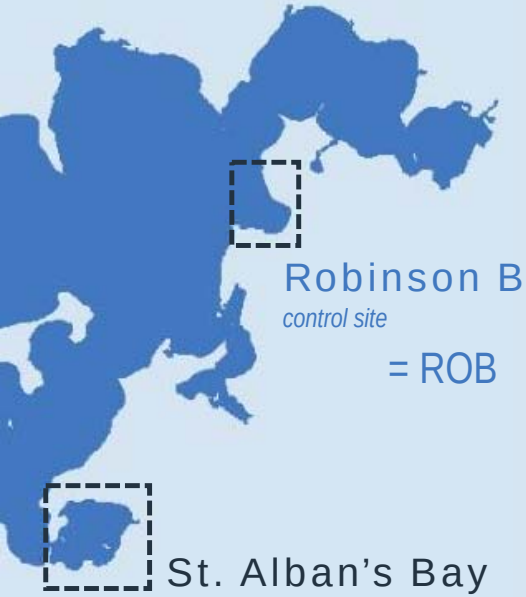
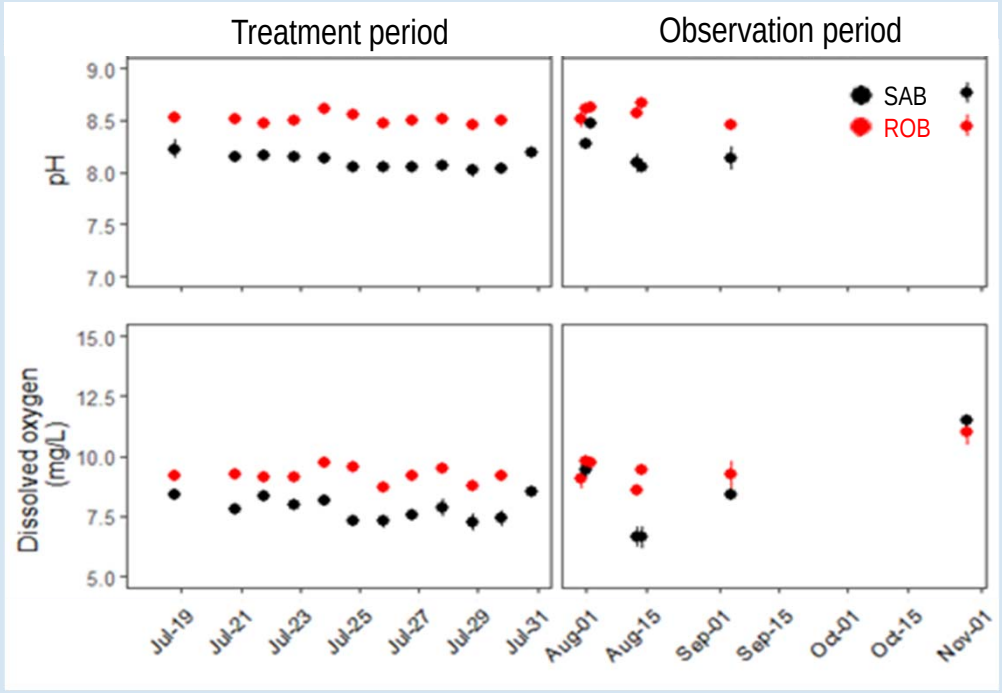
NON-TARGET IMPACTS

Water quality



Robinson Bay
control site
= ROB

St. Alban's Bay
testing site
= SAB

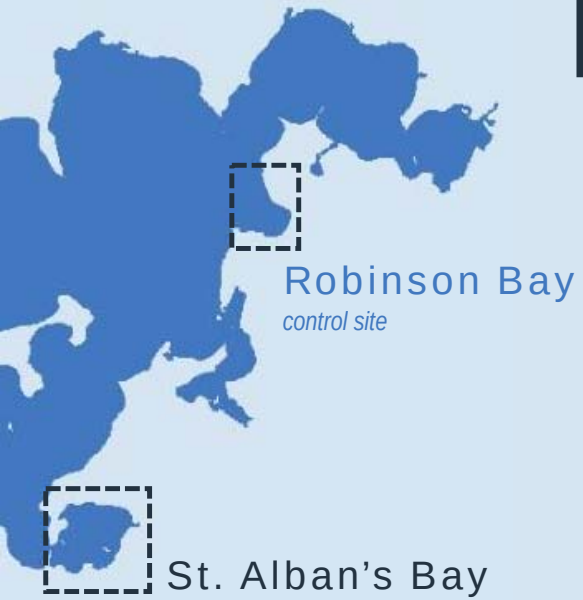


Also monitored:

- Temperature
- Conductivity
- Chloride
- Dissolved organic carbon
- Sulfate
- Calcium
- Magnesium
- Sodium
- Potassium

NON-TARGET IMPACTS

Algae



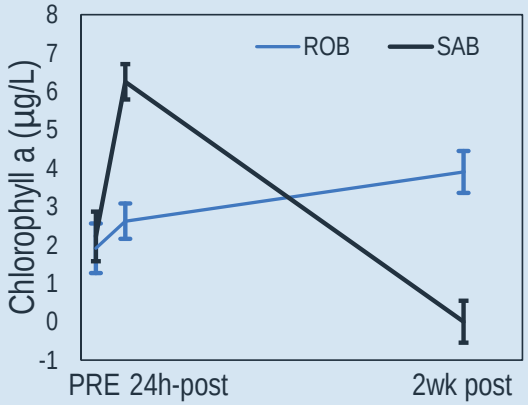
Robinson Bay

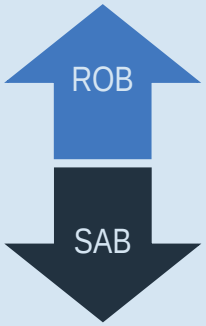
control site

St. Alban's Bay

testing site

ALGAL PRODUCTIVITY





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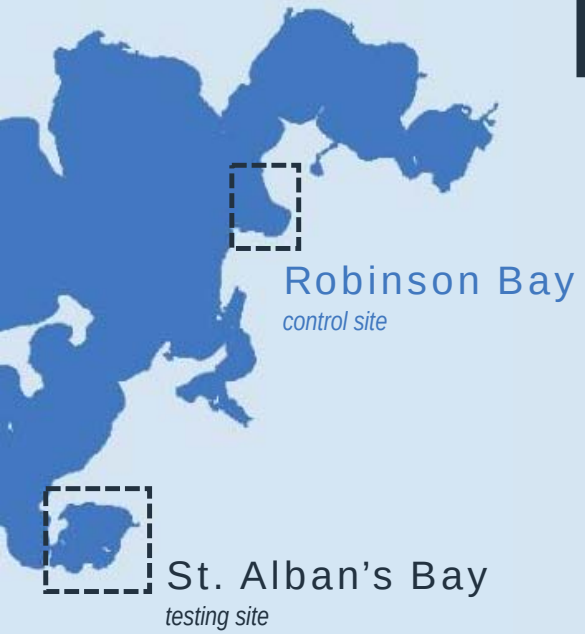
NON-TARGET IMPACTS

Benthic invertebrates & Zooplankton



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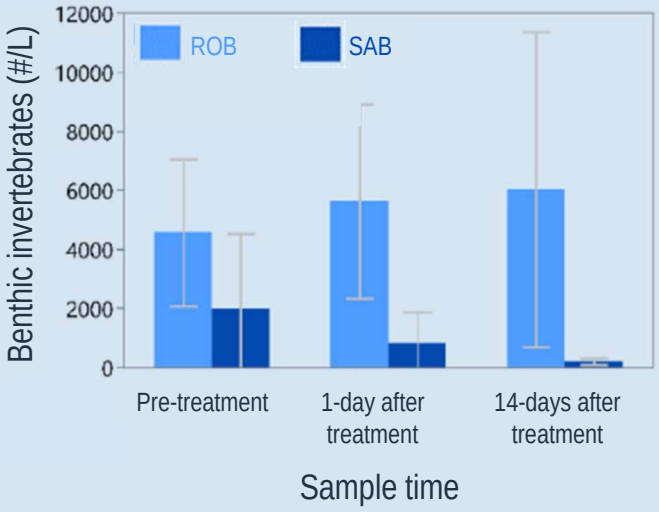

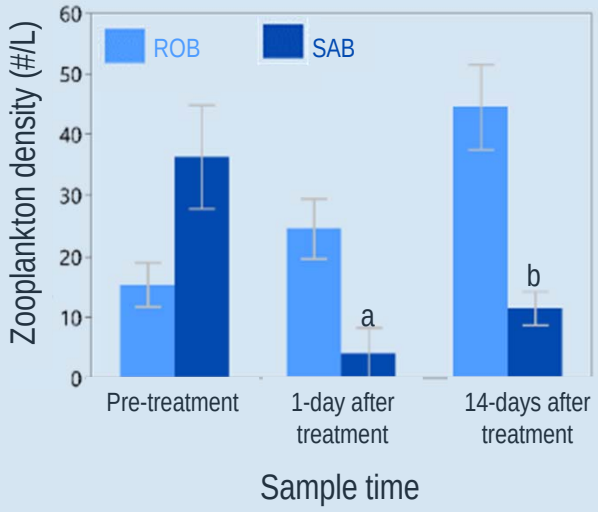

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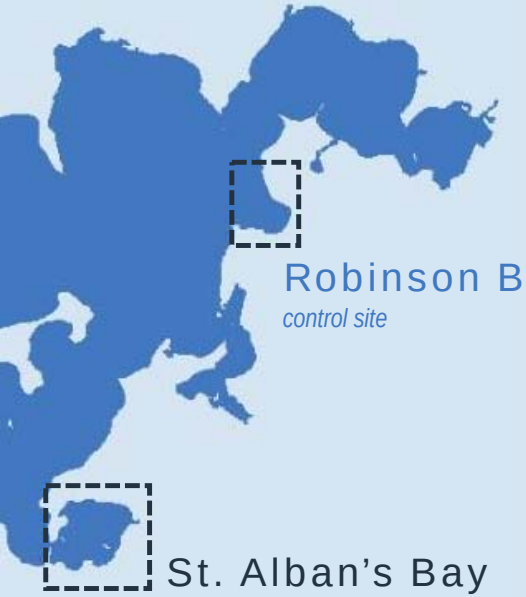
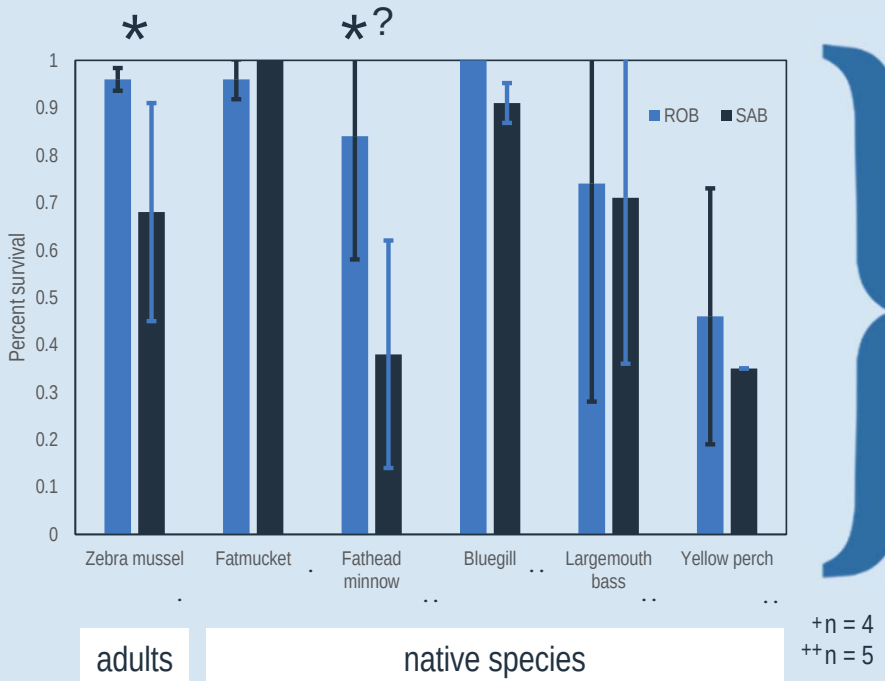
NON-TARGET IMPACTS

Fish, native mussels, & adult zebra mussels





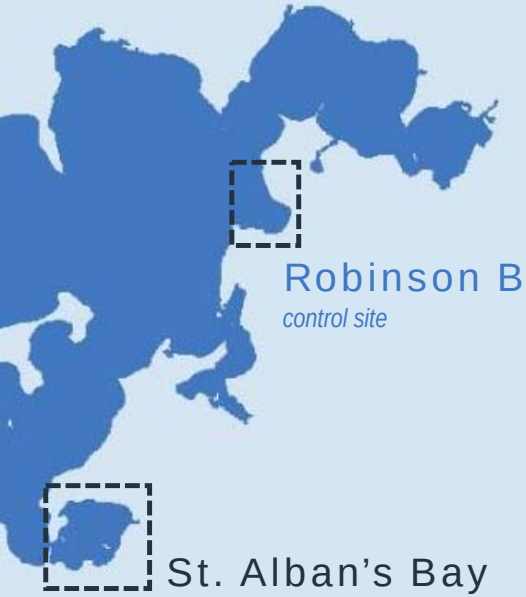
From the fish & mussels in cages, we found:

Reduced survival of adult zebra mussels and fathead minnow in the treated site.

More research is needed to understand the response of fathead minnows.

NON-TARGET IMPACTS

Fish, native mussels, & adult zebra mussels



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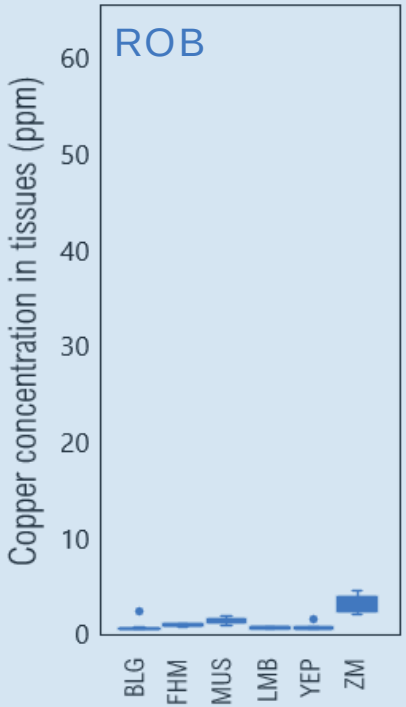

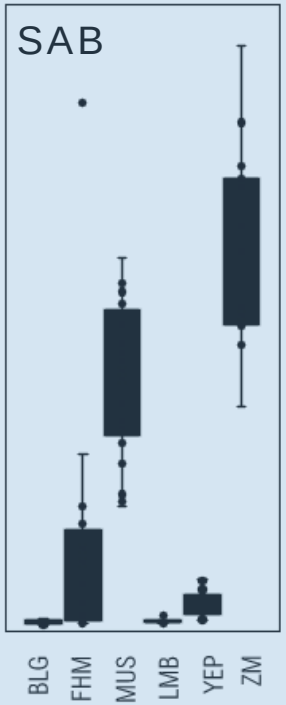

From the fish & mussels in cages, we found:

Fathead minnows, fatmuckets, & zebra mussels had higher copper concentrations in their tissues after copper treatments

KEY

BLG – bluegill
FHM – fathead minnow
MUS – fatmucket
LMB – largemouth bass
YEP – yellow perch
ZM – adult zebra mussel

In summary,

- Treatments effectively reduced zebra mussel veliger density, juvenile zebra mussel recruitment, and live zebra mussel density in quadrat samples.

- Non-target impacts varied:
  - Relative zooplankton mean density was reduced at immediately after treatment and showed some recovery at 2 weeks
  - Chlorophyll a concentration increased after treatment
  - Survival and copper residue in fathead minnow suggest sensitivity in this species

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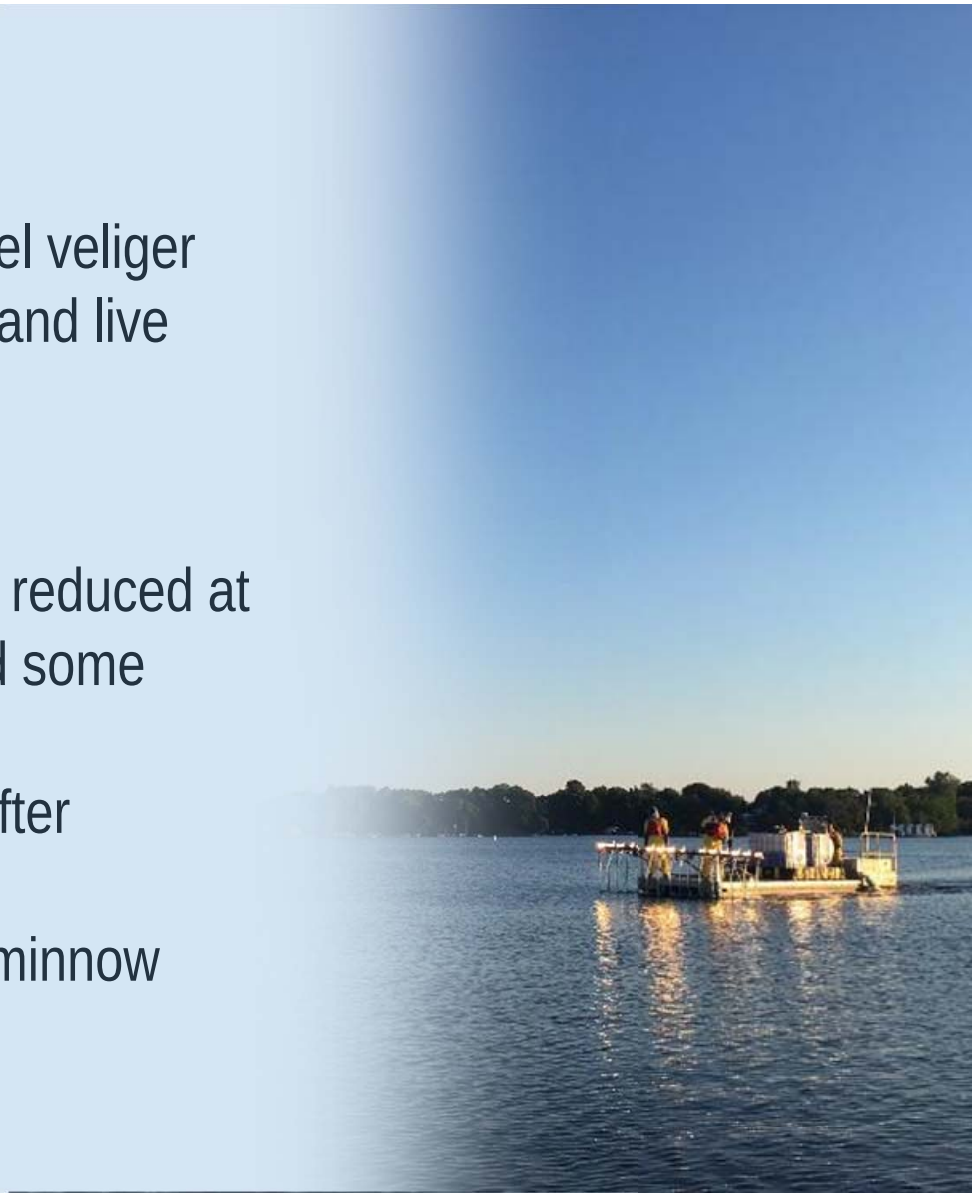
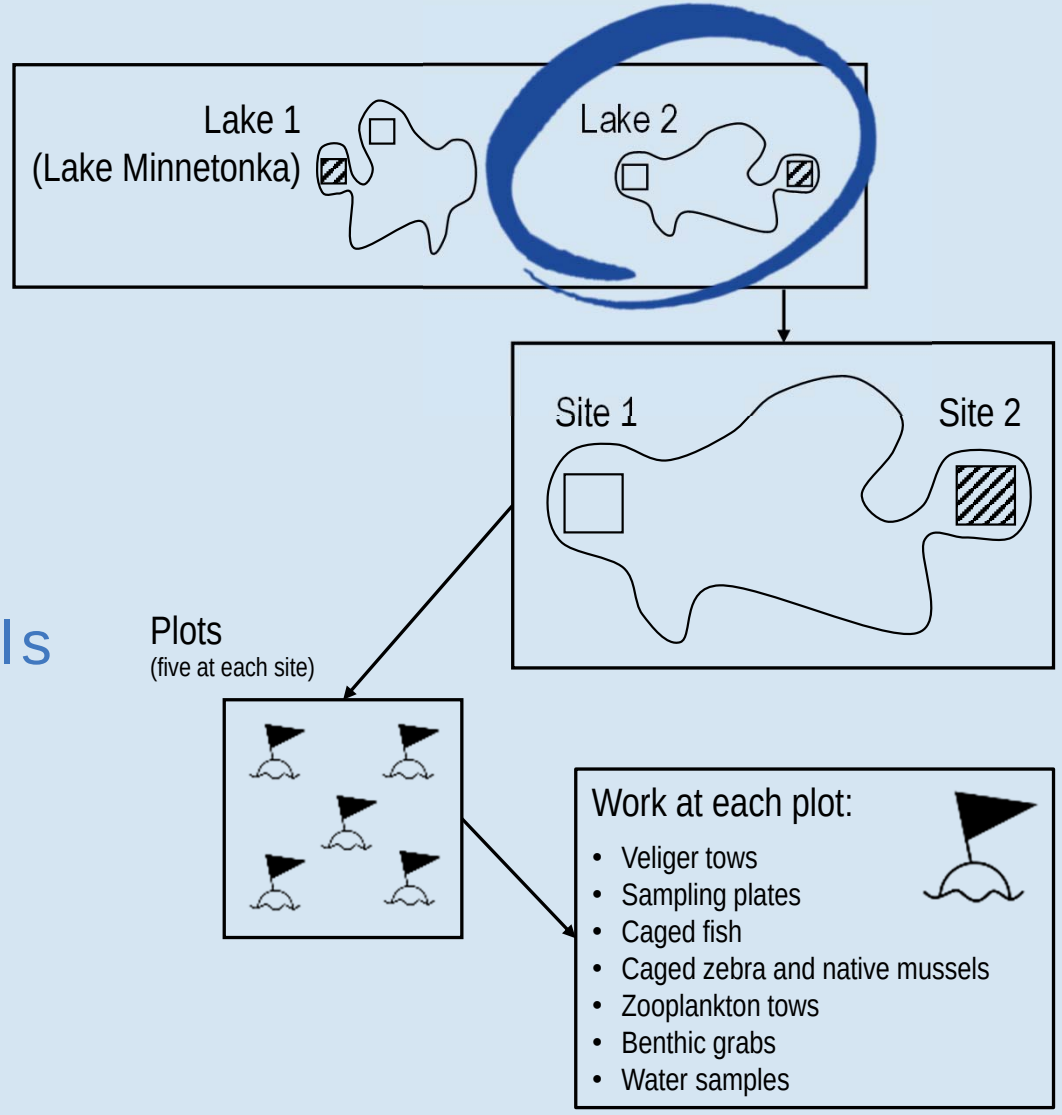


NEXT STEPS

- What is the long-term response of zebra mussels and nontarget?
- Can we effectively apply less copper?



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for more information, visit:
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