



Trial applications of Earth Tec QZ molluscicide for the control of zebra mussel populations in ambient waterways.



Valley Lo 2021



Third Lake 2016



Highland Lake 2019

An estimated 300 trillion invasive mussels blanket Lake Michigan. Eradication may be impossible, but small-scale removal efforts could be the answer.

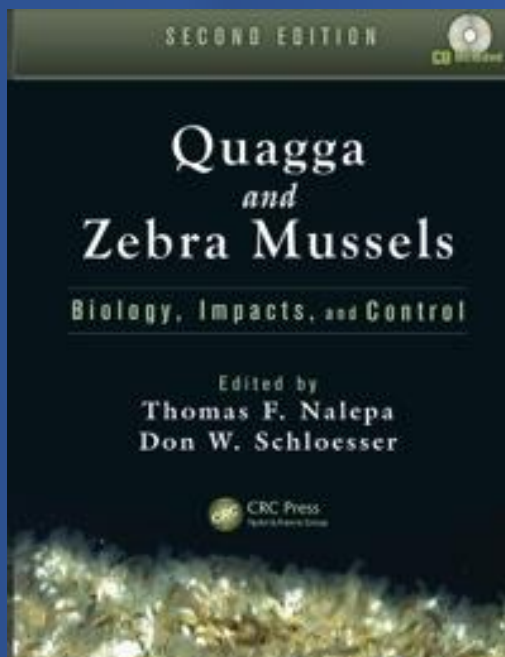
By MORGAN GREENE
CHICAGO TRIBUNE | AUG 01, 2021

**Before any application check with DNR
Ecological Compliance Database EcoCat**



Impacts

- > 30 lakes in Lake County have been infested; numerous detention ponds
- Fouling of submerged substrates including piers and watercraft
- Increased water clarity at the expense of phytoplankton and zooplankton communities
- Benthification of aquatic communities and shifts in trophic structure
- Shifts in species distributions + amphipod crustaceans - freshwater mussels + blue-green algae including hazardous forms



Intensely studied on the Great Lakes

more limited data on inland lakes

limited data on whole lake control measures

in general applications unsuccessful





Goals and Methods

EarthTec QZ new molluscicide; acid stabilized copper sulfate pentahydrate
Separate patent for the product

Will it have efficacy to control both adult and juvenile (veliger) zebra mussels?

Can it be used for spatial and/or partial control of ZMs?

Can it be used to control zebra mussels and/or quagga mussels with limited adverse impact on other aquatic fauna and flora ?

Can a regimen of treatment be determined?

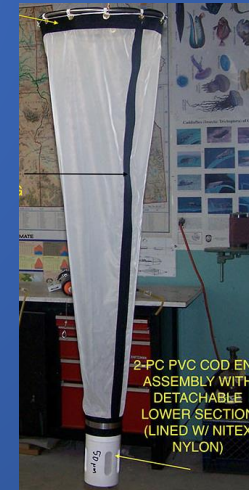
What is the intensity of colonization on other Lake County Lakes?





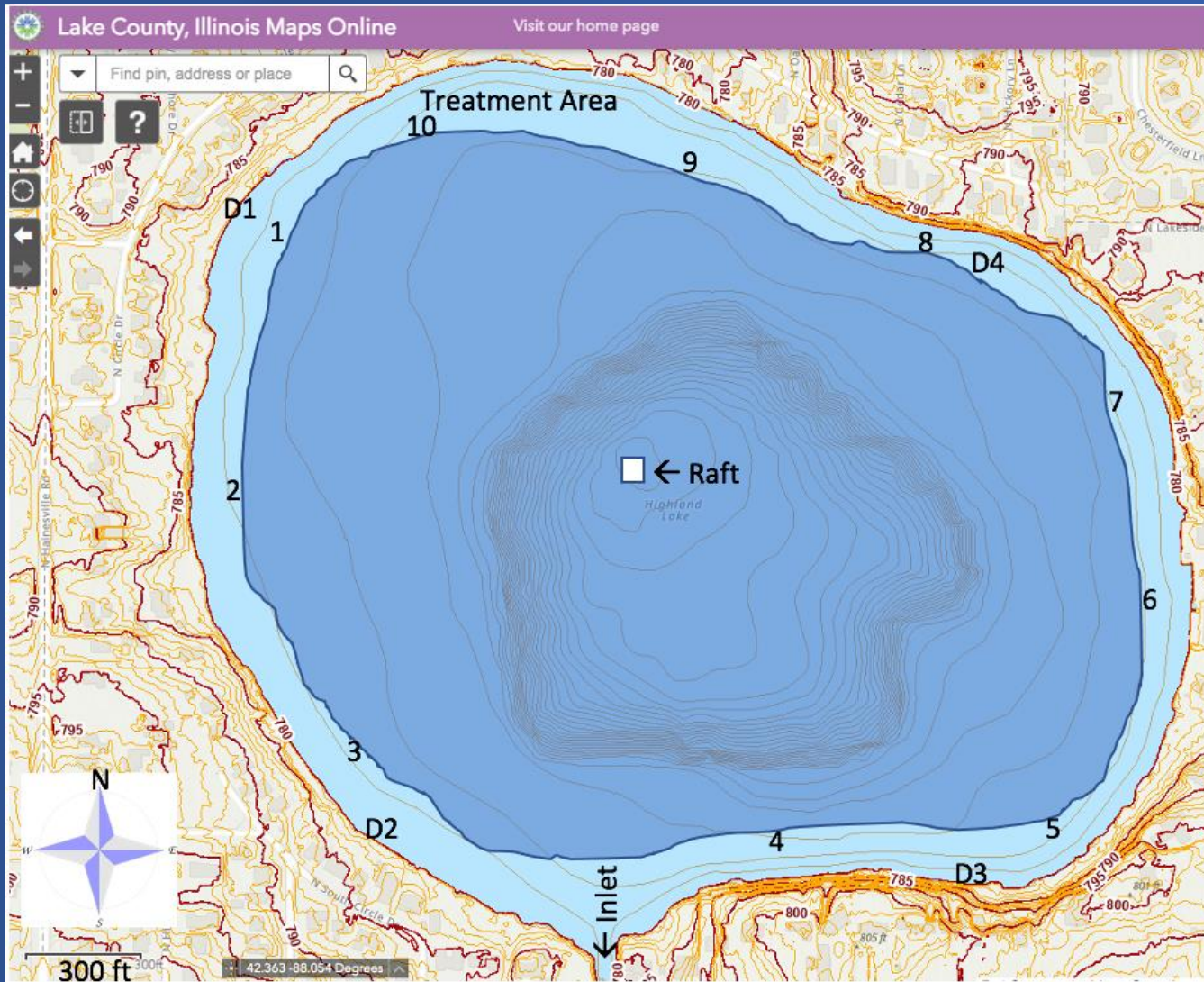
Base Year plus Applications

1. Base Year 2019 : Monitor Lake with Sampling Plates and ZM Cages
2. Application Year 2020: Monitor Lake with Sampling Plates, ZM Cages, and Plankton Tows
3. Application Year 2021: Monitor Lake with Sampling Plates, ZM Cages and Plankton Tows, Copper Assessment and BLM Assessment





2020 Application



TREATMENT 1: .4 mg/L Cu against the zone of treatment (168 gallons)

Followed by

TREATMENT 2: .26 mg/L Cu in treatment zone (109 gallons)

Followed By:

TREATMENT 3: .26 mg/L Cu in treatment zone (109 gallons)

= Low concentration, long duration



Sampling Plate Data

Comparison of Yearly Biomass (grams) on Plate Samplers Values in average grams/ individual plate			
	2019 pretreatment grams (155 days)	2020 w treatment grams (155 days)	2021 w treatment Grams (110 days)
Avg./plate	93.30	40.84	80.11
Std. dev.	52.41	41.96	81.34
n	8	13	9

Very high variability

No statistical difference between means

Loss of plate samplers

Substantial differences between localities

Liquid application results in rapid dilution

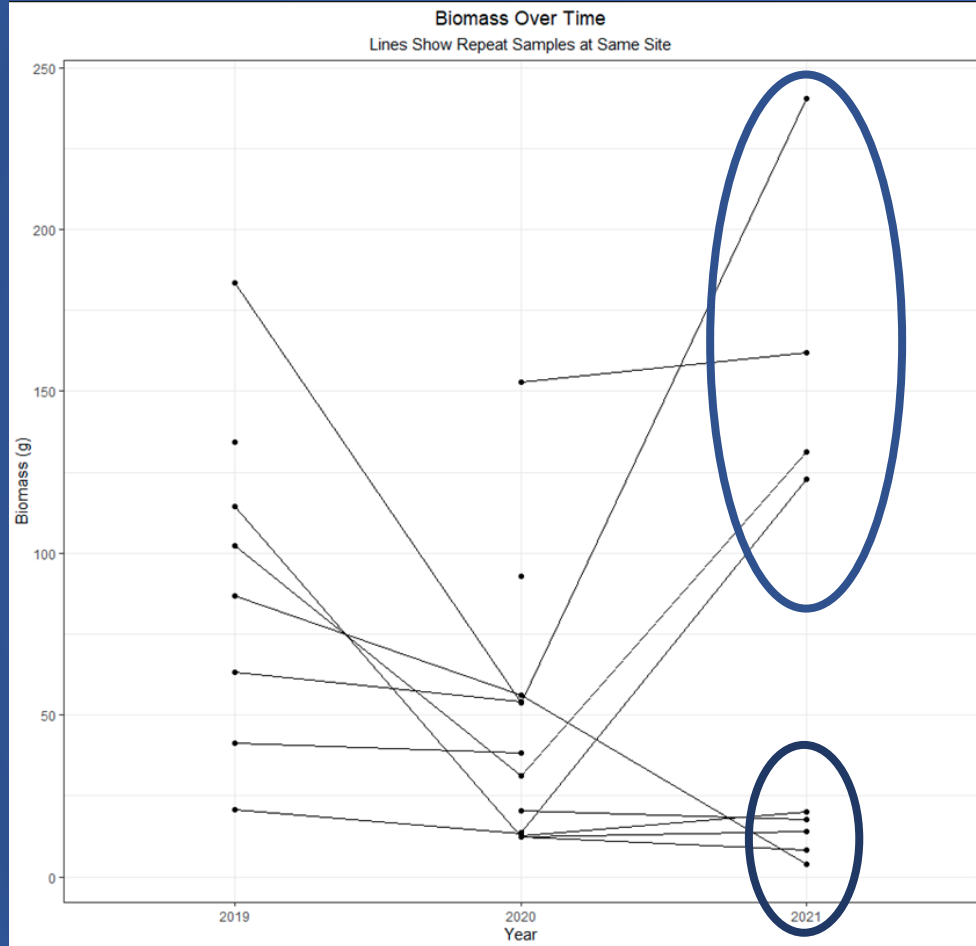


Do we think it worked ? ...yes, with qualifications



Sampling Plate Data

Y axis=
biomass /
plate for
individual
site
locations



2019

2020

2021

Data from individual plate sites. Apparent control from 2019 to 2020, do not however, have validated significance because of high variability.

Variability for 2021 is substantial with 2 clusters of results.





Adult ZM Cages



Post Treatment (2020 and 2021) Zebra Mussel Mortality in Mussel Cages

Each cage was initially loaded with 30 live adult zebra mussels

2020 Cage Mortality	1	2	3	4	5	6	7	8	9	10	Avg 1-10	Std Dev 1-10
RED	100%	100%	57%	100%	100%	63%	83%	70%	97%	100%	87%	17%
YELLOW	100%	90%	70%	60%	100%	57%	63%	50%	60%	90%	74%	19%
BIOMASS% (BIOMASS/RAFT)	98%	90%	98%	74%	97%	98%	91%	91%	95%	84%	91%	

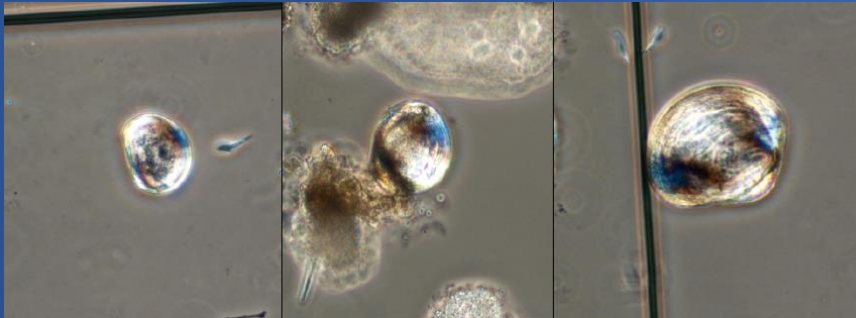
2021 Cage Mortality	1	2	3	4	5	6	7	8	9	10	Avg 1-10	Std Dev 1-10
RED	100%	100%	53%	40%	97%	80%	73%	43%	87%	63%	74%	23%
YELLOW		100%		47%		60%		50%		13%	54%	31%
BIOMASS% (BIOMASS/RAFT)	99%	99%	79%	72%	97%	97%		59%	78%		85%	

From year to year some of the same localities behave in similar fashion

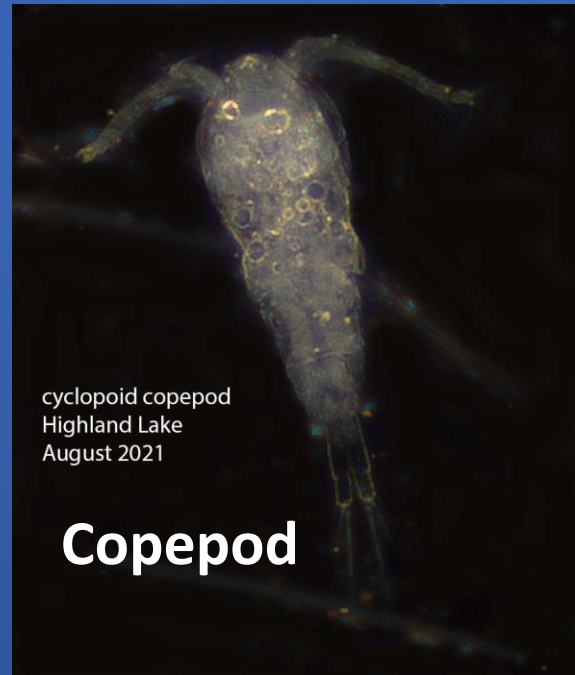


Plankton Tows

Intent: Validate veliger mortality and thus chemical efficacy
Cross polarization
Compare near-shore versus raft for mortality
Validate zooplankton rebound
30 cm horizontal tow is done through 1000 liters volume



Veligers fluorescing under scope



Copepod



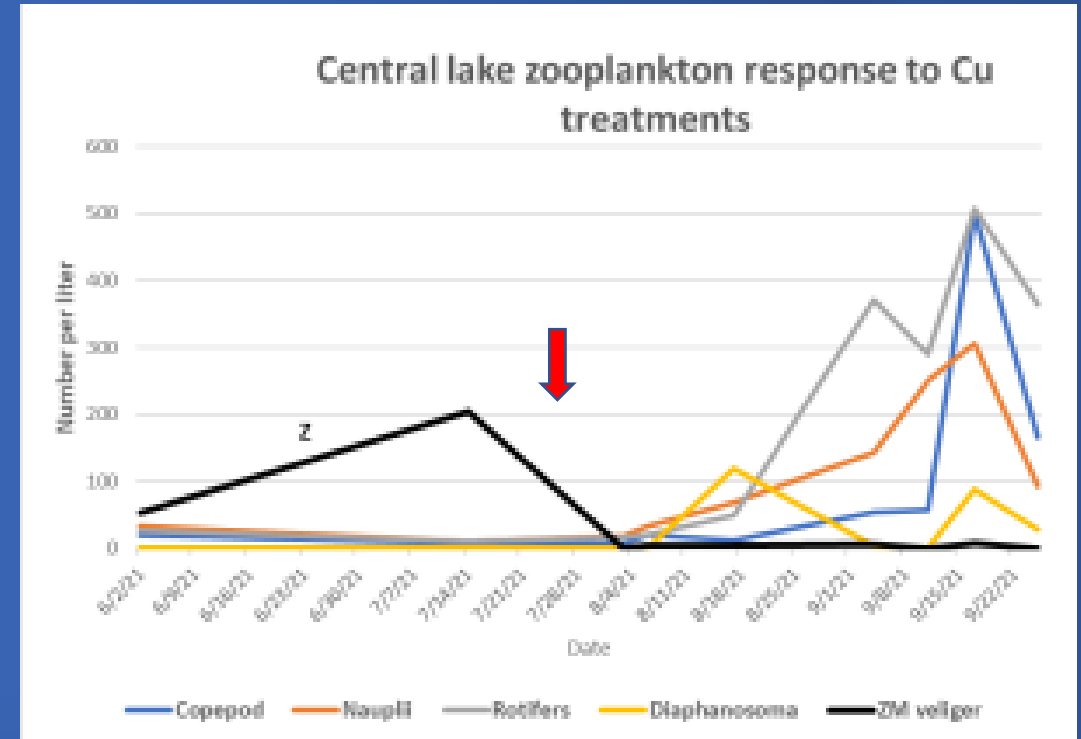
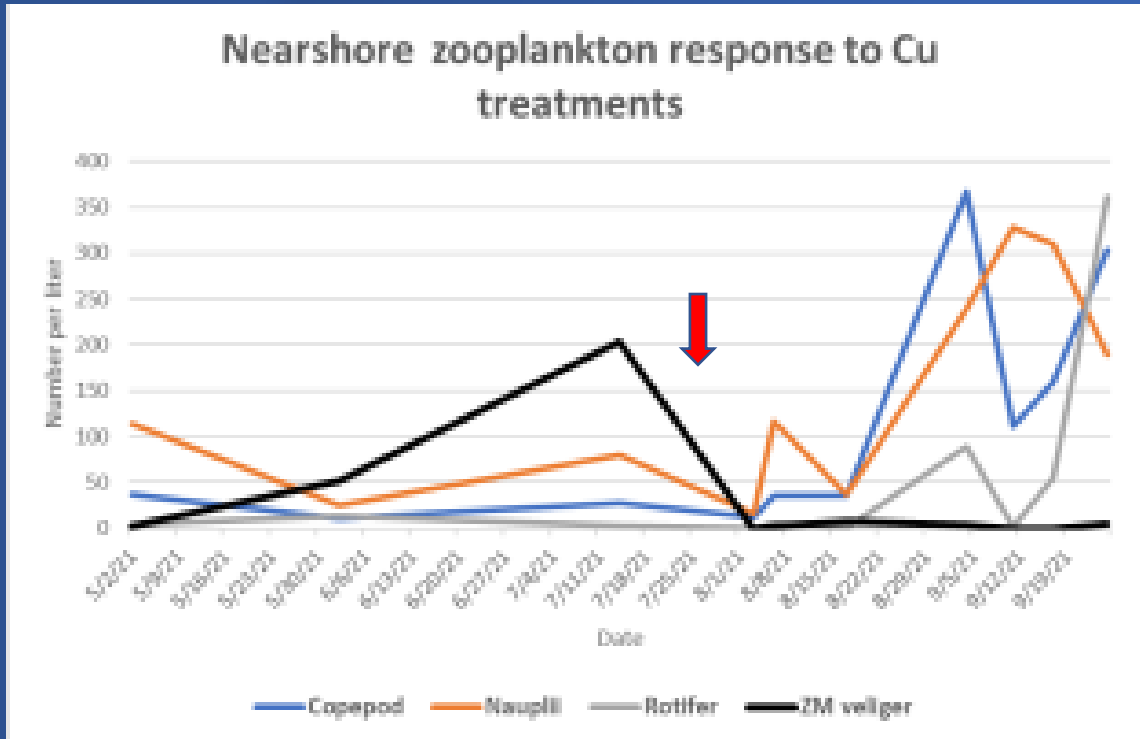
Rotifer





Plankton Tows

Numbers/ liter of veligers and zooplankton for 2021



Both 2020 and 2021 showed dramatic response to treatment with EarthTec QZ



Copper Monitoring 2021

State and Federal Regulations

Label limit for Cu= 1mg/L

Ambient Illinois Guideline= Title 35, Section 302

Illinois Acute: 21.8 ug/L at 130 mg/L hardness

Illinois Chronic: 14.2 ug/L at 130 mg/L hardness

4 samples over 4 consecutive days

In the future we belong measuring Cu concentration daily across the entire application duration

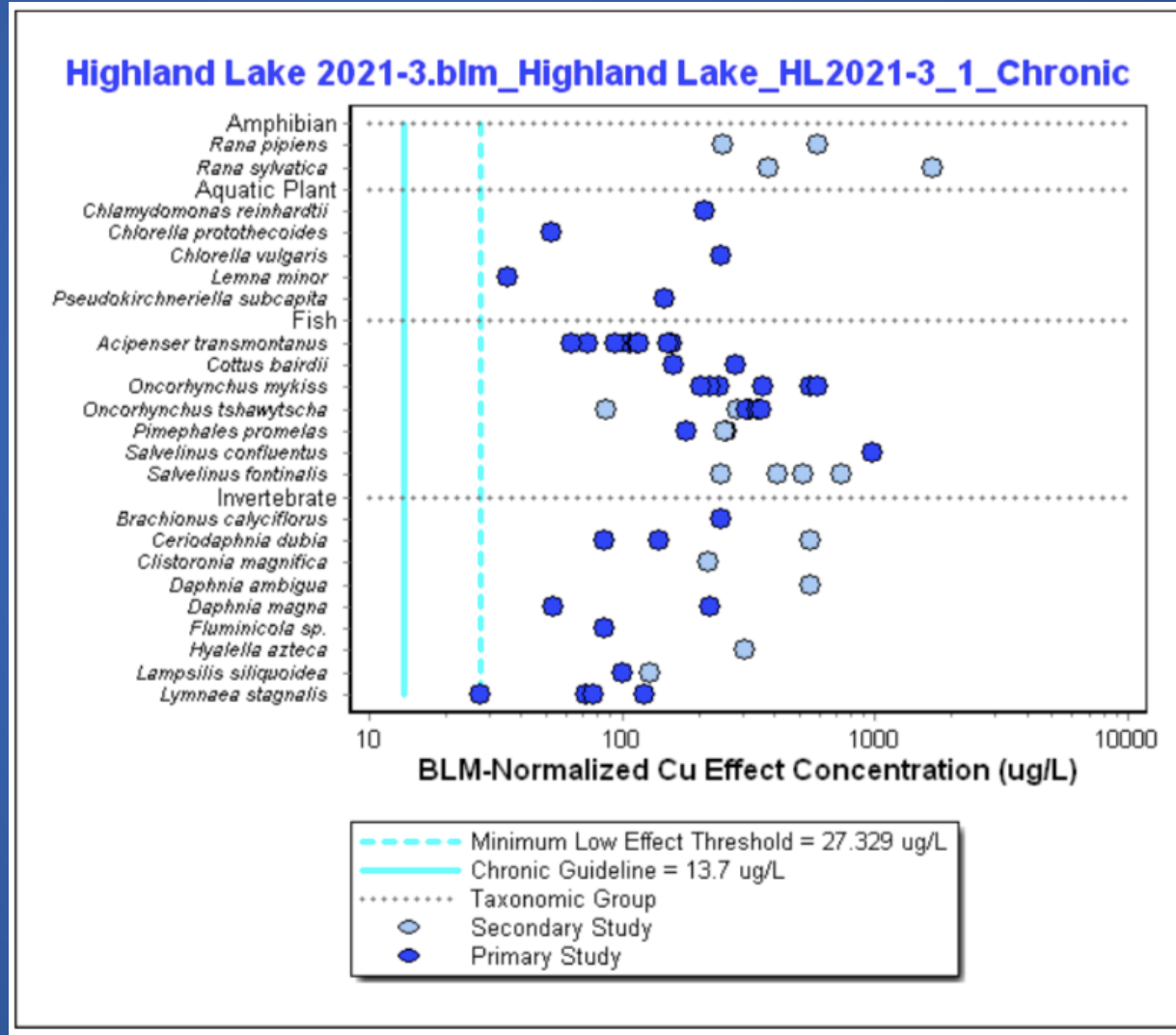




Copper Monitoring 2021



Significance
of Biotic
Ligand Model
(BLM) for
expressed
biological
toxicity





Copper Monitoring 2021

2021 Values for soluble Cu	
Non detect	7/2/2021
3.9 ppb	7/29/2021
Treatment	7/31/2021
4.0 ppb	8/11/2021
Treatment	8/13/2021
8.5 ppb	8/17/2021
Treatment	8/20/2021
9.0 ppb	8/20/2021
18.0 ppb	8/31/2021
5.4 ppb	9/3/2021
Treatment	9/10/2021
6.1 ppb	9/18/2021
4.0 ppb	9/21/2021

- Dilution very prominent in Cu values
- BLM generated :
 - FAV of 198 ppb **Acute**
 - CMC of 99 ppb **Acute for Reg.**
 - Chronic of 62 ppb
 - Graded against multiple species and 95% coverage per USEPA**



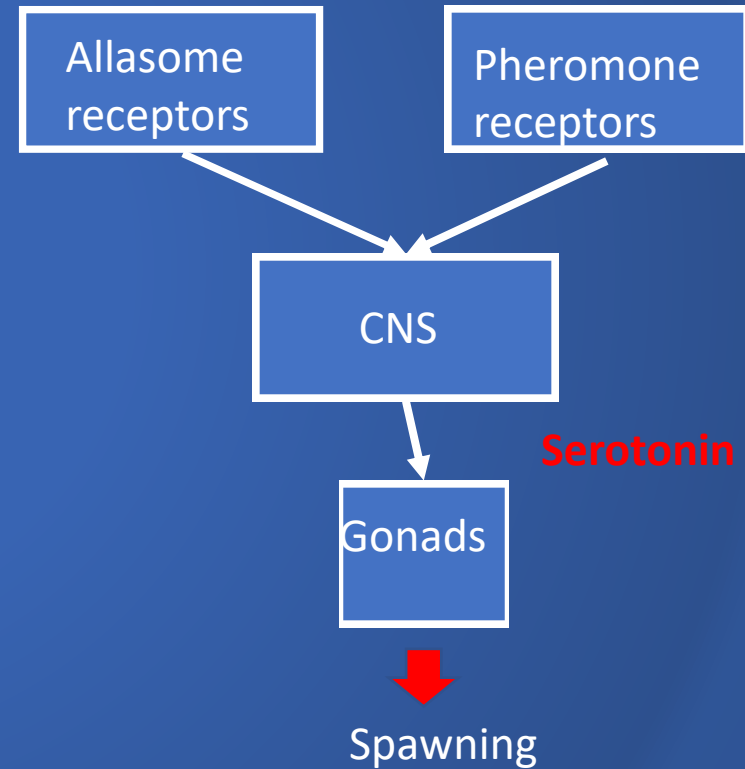
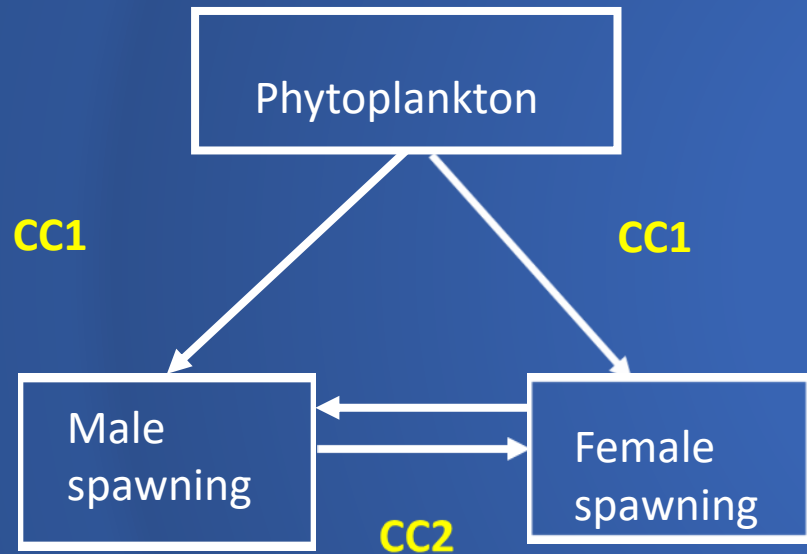
Conclusion:

Values at Highland Lake far below rated toxicity yet sufficient to generate adult and juvenile ZM dieback



Intervention on Reproductive Timing and Physiology

For ZM > 15 C temp
Reproductive synchrony



CC1= chemical cues from Allomones (i.e. *Chlorella*)
CC2= chemical cues from pheromones

From *Chemical Regulation of Dreissenid Reproduction* Kashian and Ram



Preliminary Conclusions

Will it have efficacy to control both adult and juvenile (veliger) zebra mussels?
Bench trials and ambient applications verify efficacy

Can it be used for spatial and/or partial control of ZMs? **We have conflicting results but feel that it is possible with modified treatment regimes**

Can it be used to control zebra mussels and/or quagga mussels with limited adverse impact on other aquatic fauna and flora ? **Low application concentrations and robust rebound of zooplankton are positive; BLM model and literature suggests it can be done**

Can a regimen of treatment be determined? **Look to experiment with zooplankton quick tows and reproductive timing. Synchrony and serotonin**

What is the intensity of colonization on other Lake County Lakes? **Ongoing expansion of lake monitoring**



Internships and Limnological Education

- Interns
- High School Limnological Units/Course
- Hudson Bay 718 miles, Chesapeake Bay 638 Miles, Lake Pontchartrain 835 miles

	2022	2023	2024
Interns	24	72	240
Hours	960	2,880	9,600





Internships and Limnological Education

- **Jim Bland**
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