

Lake County Baseline Calcium Investigation 2019 & 2022

Background

The threat of aquatic invasive species (AIS) infestation presents a real ecological, economic, and recreational impact in Lake County. Invasive zebra mussels and starry stonewort are known to require certain water chemistry to become established and thrive when introduced into a new waterbody. In particular, calcium levels must be high enough to support the growth of starry stonewort and the development of zebra mussel shells. One of the most likely vectors for the introduction of AIS such as zebra mussels are trailered boats. The trailers themselves as well as onboard water compartments in boats are vulnerable to inadvertent transport of plant fragments and small organisms.

Lake calcium data, where it exists, is largely the result of sampling in the 1980s. Based on this historical data, we had reason to believe that few lakes in Lake County would have enough calcium to meet the establishment threshold for starry stonewort and zebra mussels, but sampling and analysis methods have changed over time, and a new dataset could alert us to risks we might not be aware of. Deliberate sampling for the purpose of assessing zebra mussel invasion risk provides baseline data for any future changes, evidence for where to focus education, inspection, and monitoring efforts, as well as inform outside organizations such as the Minnesota Aquatic Invasive Species Research Center (MAISRC) in any future risk modeling. Testing calcium levels also provided an opportunity to take other relevant samples and make field observations on many lakes in Lake County which are infrequently visited by water resources staff.

Method

Because calcium levels do not generally fluctuate a great deal in the arrowhead when there is low human disturbance, we were able to visit a larger number of lakes fewer times. We determined to sample each 2019 site twice during open water season. Birch Lake was sampled at each of its three stations five times throughout the summer of 2019 to observe variability in a more riverine lake. Additional lakes were sampled once during the season in 2022. The effort in accessing the more remote lakes selected in 2022 made it unfeasible to visit each one more than once. Existing Minnesota Pollution Control Agency (MPCA) stations were selected based on historical data, and by weighing representative sampling against proximity to public water access where necessary.

In 2018 MAISRC published results from a zebra mussel and starry stonewort risk assessment model, which included all waterbodies in Minnesota. The model accounted for boater movement, water connectivity, proximity to infested waters, and any known ecological variables, including water chemistry. We used the results of the model as a jumping off point for prioritizing locations to sample, but upon acknowledging some incongruities with what we observed on the ground and in the historical data, we altered our selection accordingly.

The lakes we chose in 2019 have the highest suspected trailered boat traffic. That coupled with ease of access and the number of sampling events supported by our budget, we settled on a selection of 33 sampling sites across 27 lakes in Lake County. We were able to utilize the volunteers in the Citizen Lake Monitoring Program Plus to sample the White Iron Chain, Fall, and Birch Lakes and to rely on their field measurements and lab results for other parameters.

In 2022, we sampled several locations in the heavily visited BWCAW lake of Basswood plus some other nearby or upstream lakes. Basswood was chosen because it was also lacking in historical data, some bays are downstream of Moose Lake which is high in calcium, and despite not technically having a public water access, motorized boats are able to access Basswood by portage through both Moose and Fall Lakes.

This investigation measured elemental calcium by sampling with a two-meter integrated sampler. Any comparison of our findings should take these methods into account.

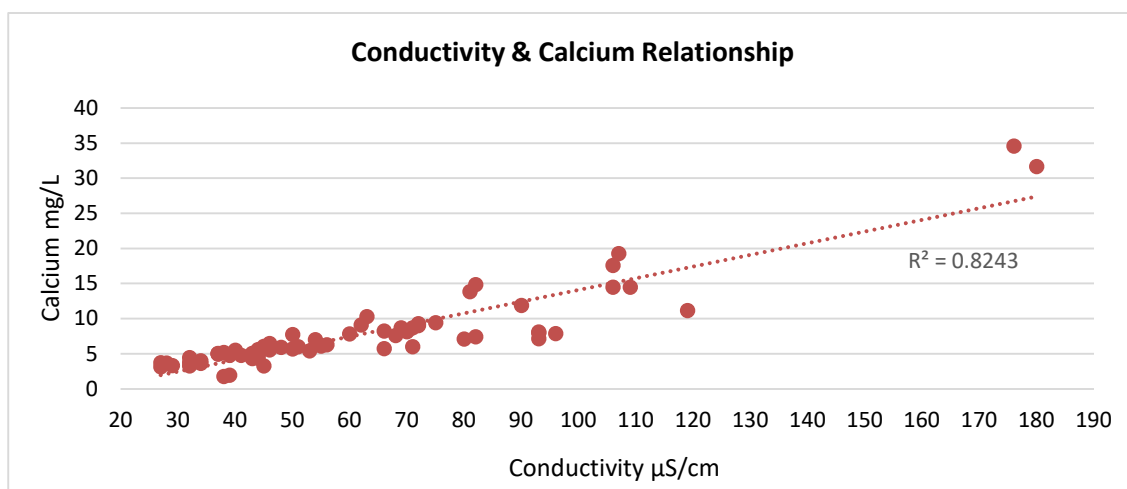
Results

The largest difference in calcium levels between two sampling events at the same location is 2.9 mg/L (measured at Tofte Lake). The average difference in calcium levels at the same location is about 1.1 mg/L. This confirms that calcium variability is low in the lakes we sampled, and that even lakes near threshold levels could be monitored on an infrequent basis. The table below shows the calcium requirements for zebra mussels.

Calcium Requirements for zebra mussels	Ca mg/L
Required for veliger shell development	>8.5
Some adult survival, but potential shell loss	8-15
Adults likely to survive, and embryonic, larval, and juvenile individuals may have good growth rates	15-28
Thriving, reproducing populations, infestation level	>28

Data summarized by MAISRC suggest that starry stonewort needs 28 mg/L of calcium to thrive in its invaded range (North America). The only lake that measured high enough calcium levels to support starry stonewort was Tofte Lake. Calcium levels are high in Tofte Lake due to the local bedrock and geological features. Starry stonewort has been observed in a wide range of habitats in North America, including mesotrophic – eutrophic lakes and a variety of substrates, indicating a potential for infestation in Tofte if introduced.

As conductivity is a useful analog for calcium levels and is a relatively easy and inexpensive field measurement to take, larger fluctuations in calcium could be detected by taking sonde readings on site. The chart below illustrates the relationship between calcium and conductivity readings at the sites sampled in 2019.



In addition to calcium, pH plays a role in zebra mussel survival, as indicated in the following table. The locations with elevated calcium which also had an inhospitable pH on at least one occasion were Gegoka, Sullivan, and Bob Bay in Birch Lake. It's possible that the low pH at these sites would help prevent any zebra mussels from becoming established.

pH effects on zebra mussels	pH
Lethal to velligers	<7.4
Optimal for adult growth	7.4-8.0
Needed for infestation levels	8.0
Optimal velliger survival	8.4+

The following table shows the individual calcium results for the sampling events in 2019. Further detail is available by contacting Lake SWCD and through the [MPCA's online Surface Water Data Access](#). The cells are shaded according to the zebra mussel risk levels from the table on the previous page.

2019 Samples

Project Station	Calcium 1 st Sample mg/L	Calcium 2 nd Sample mg/L	Calcium 3 rd Sample mg/L	Calcium 4 th Sample mg/L	Calcium 5 th Sample mg/L
Birch - Center	7.79				
Birch - Bob Bay	11.2				
Birch - Dunka	8.14	7.2	7.92	8.02	8.81
Birch - Narrows	5.75	6.06	7.11	7.44	8.04
Birch - Rapids	3.31	3.69	4.9	5.05	5.59
Cedar	9.16	10.3			
Crooked	5.62	6.51			
Dumbbell - North	8.22	9.06			
Dumbbell - South	8.16	8.73			
East Chub	1.78	1.96			
Fall - East	3.31	5.71			
Fall - West	7.63	6.12			
Farm - South Kawishiwi	4.44	5.73			
Farm - North Kawishiwi	3.33	3.97			
Farm - Middle	4.04	4.31			
Garden - Middle	4.34	5.23			
Garden	4.76				
Gegoka	5.43	8.29			
Greenwood	3.73	4.48			
Harriet	6.03	7.04			

Hogback	5	4.81			
Lax	8.73	9.3			
Little Wilson	5.1	5.94			
Moose	17.6	19.3			
Ninemile	6.33	7.87			
North McDougal	5.09	7.76			
Ojibway	13.9	14.9			
Section 29	4.83	6.08			
Silver Island	3.8	5.05			
Snowbank	5.21	5.52			
Stewart	14.5	14.5			
Sullivan	9.44	11.9			
Tofte	31.7	34.6			
White Iron*	4.42	5.24	5.83		
Wilson	5.22	5.59			

*Historic data shows that White Iron has had higher calcium levels in the recent past

2022 Samples

Project Station	Calcium mg/L
Basswood Hoist Bay	10.0
Basswood Jackfish Bay	5.3
Basswood Norway Point	6.1
Basswood Pipestone Bay	5.7
Basswood Wind Bay	10.5
Birch Lake BWCAW	13.6
Moose Lake	18.1
Newton Lake	6.1
Sucker Lake	10.9

Implications/Recommendations

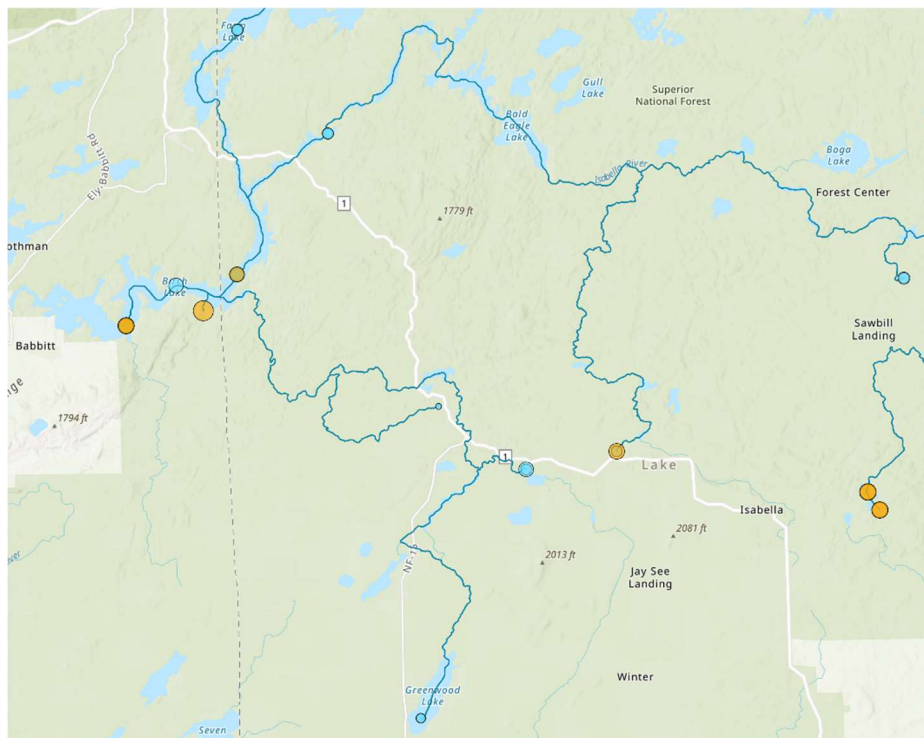
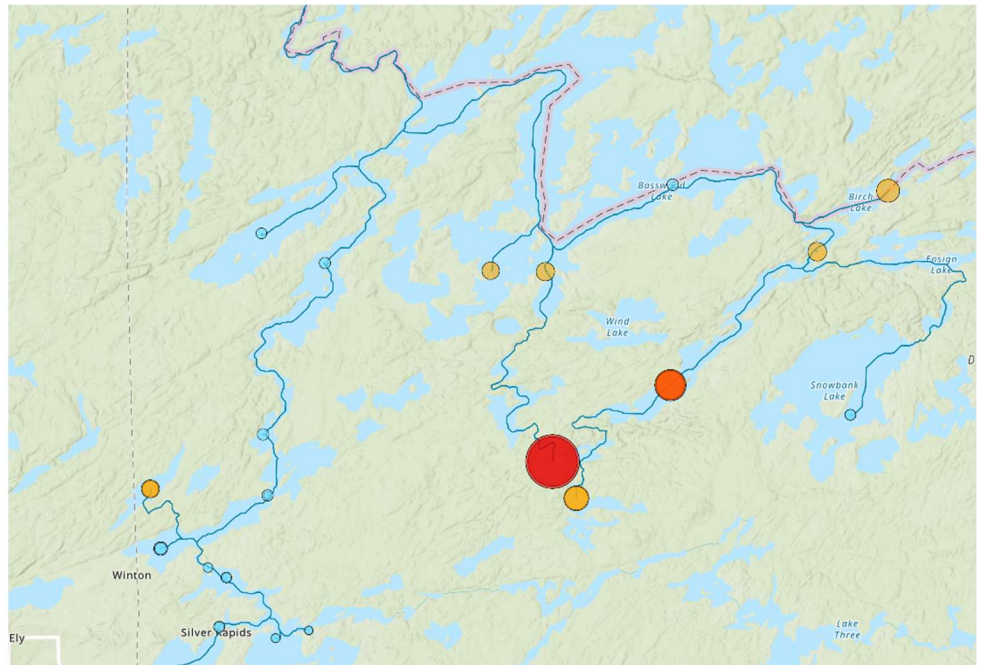
In the event of zebra mussel or starry stonewort introduction, most lakes in Lake County are at a low risk of establishing a reproducing population. However, there are several lakes with high enough calcium levels to support zebra mussel survival, as well as several that are on the cusp. Just because a lake has low levels of calcium does not mean that we should let our guard down. There is still the potential that introduced AIS can be carried downstream or that they hitch a ride to a different water body. The following maps illustrate calcium results from 2019 in conjunction with downstream pathways of connected waters.

Calcium Results

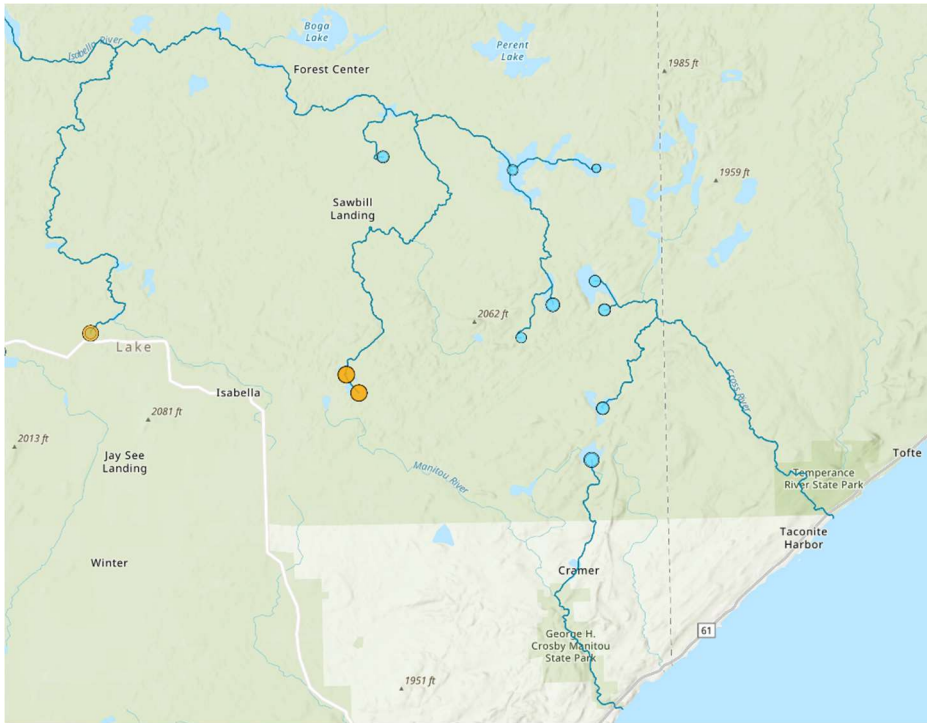
mg/L

-  2 - 8
-  9 - 15
-  16 - 28
-  29 - 35

— Downstream of calcium sampled lakes



These maps illustrate the sampling locations in Lake County, the calcium levels detected, and the downstream flow from each of the sampled lakes.



Based on sampling results, boater traffic, and common misconceptions of zebra mussel risk, here are some recommendations to consider in the future:

- Increase watercraft inspections at Tofte Lake (implemented in 2020).
- Install zebra mussel sampling plates and conduct veliger tows at Tofte and Moose lakes and conduct more frequent public access monitoring at other high-risk lakes for early detection.
- Complete a thorough littoral vegetation survey of Tofte Lake (completed in 2020).
- Collect sonde profiles while conducting early detection surveys. Monitor conductivity numbers for any significant increases from previous results.
- Communicate through lake associations, Ely Area Invasives Team, written materials, social media, festivals, farmers markets, and other outreach events to convey these findings and their implications for AIS risk. When communicating with the public, increase emphasis on the threat of zebra mussels to Lake County.

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