Summary report of the 2024 TLA Aquatic Science High School Internship Program

By Jeanie WIliams



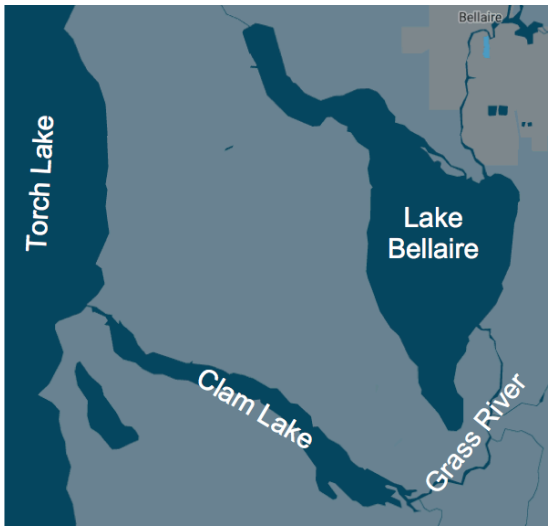

Background

The first[1] quagga mussels on Torch Lake were found in 2022 by high school interns with Three Lakes Association. This was a big and important discovery. Quagga mussels (an invasive species) have caused great change to lakes across the United States and Canada, and once we collected those mussels in 2022, we knew they were impacting Torch Lake too.

Quagga mussels (*Dreissena rostiformis bugensis)* and their close relatives, zebra mussels (*Dreissena polymorpha*) filter food particles and algae out of the water at very high rates. As they become abundant, nutrient availability shifts from the water column to the lake bottom, both clearing the water for greater light penetration, and encouraging extensive plant and algae growth at deeper depths than ever before.

Zebra mussels usually establish themselves in a lake several years before quagga mussels are detected, and in many inland lakes, only zebra mussels are present. But quagga mussels filter more water and can live in deeper areas than zebra mussels. Eventually quagga mussels may become far more common than zebra mussels and consequently exacerbate the ecological impacts. Even though zebra mussels had been known residents of Torch Lake (and the adjacent Lake Bellaire and Clam Lake) for many years, we suspected quagga mussels may have become dominant in Torch Lake, with unknown consequences.

The job of the 2023 TLA interns was to determine how quagga mussels were distributed around Torch Lake and how abundant they really were. The interns were astounded by how many they found. GoPro footage revealed that the bottom of Torch Lake was carpeted with mussels at many depths. Nearly 94% of all mussels sampled were quagga mussels, and they were most abundant around 75 feet. It was clear that there were very likely enough mussels in Torch Lake to influence the nutrient cycling of the lake.



Nutrient distribution is a major regulator of lake ecology and has big impacts on algae, plankton, and fish abundance. Knowing about the influence of mussels can inform our management decisions.

In 2024, we wanted to know if the other water bodies that Three Lakes Association watches over were also home to quagga mussels: Clam Lake, Lake Bellaire, and the connecting Grass River.

These mussels produce tens of thousands of microscopic larvae called veligers that float for several weeks in the water before they find a settling place in the lake. They might settle on a

[1] At the time we didn't think they had been found before. Tip of the Mitt Watershed Council performed a survey for quagga mussels in 2015 and didn't find them anywhere in the Elk River Chain of Lakes. However we later learned that the DNR had found them while performing invasive species surveys in Torch Lake of that same year.

rock, a boat dock, a water intake pipe, or in the case of quagga mussels, in the mud. Where they settle, they grow a shell and begin an adult life. These larvae are spread easily by boats.

We know that boats are constantly moving between the three lakes and the Grass River so it would be nearly unthinkable that quagga mussel veligers had not had the opportunity to grow upstream of Torch Lake. However, a handful of samples by the 2022 interns did not find any quagga mussels in Lake Bellaire (they did find zebra mussels). In the summer of 2024 we looked for quagga mussels to see if these upstream lakes were hospitable to them.

What we did in each lake and why

Our first question was: **Are quagga mussels established upstream of Torch Lake?**

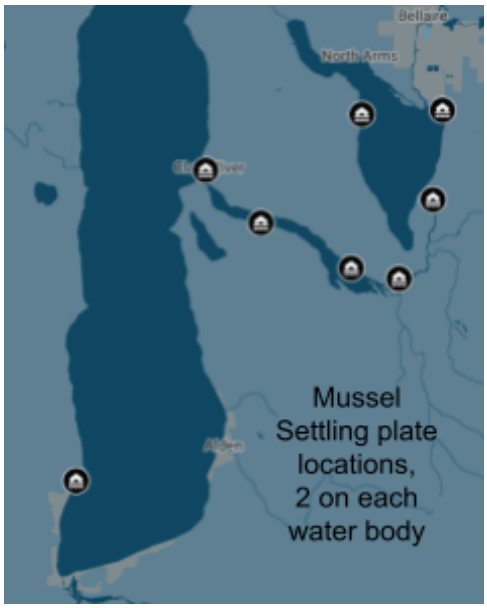
We attempted to answer this question in a variety of ways:

1. In all lakes and the Grass River we installed **mussel settling plates** nearshore to collect settled veligers that grew into adults. The device consisted of 4 light colored ceramic floor tiles, vertically arranged in a milk crate, and held in place by zip ties that created slots for each tile to be placed within. Each crate was placed under a dock.

   Plates were installed on or near May 1, 2024

   Two plates were collected from each crate on August 1, using a random number table to determine which plates to remove. All mussels were counted.

   The remaining plates were collected at the end of September, and mussels counted.



2. In Clam Lake:

   PONAR grabs (with GoPro footage of each drop) were taken in three locations:

   a. **At the west end**, near Torch Lake and where there is a large amount of marina and boat traffic. With high boat traffic and abundant quagga mussels established in Torch Lake near the mouth of Clam Lake, this seemed like a highly likely place to find quaggas if they were in Clam Lake.
   b. **In the middle**, near the DNR boat launch. Mussels are transported by boats, so any place with high boat traffic is more likely to receive mussel veligers and therefore have adult mussels growing nearby.
   c. **At the east end.** This area is completely different from the rest of the lake. It is surrounded by natural shoreline and is quieter overall. It was less likely to harbor mussels, but did help us better understand the lake as a whole.

   Two grabs were taken in each location. The plan was to take a series of grabs in each location, for a total of at least 6 grabs in each place, but the quantity of mussels found in

the west end made this plan impossible. We did not have time to collect, let alone count, that many samples so we only sampled twice in each place.

3. Lake Bellaire:

   PONAR grabs (with GoPro footage of each drop) were taken in many locations:

   a. **An east-west transect across the lake**, crossing the deepest part of the lake. We sampled at 10, 30, 60, 80, and 95 feet, 2 samples at each depth on each side of the lake, and 3 at the 95 foot depth, for a total of 19 samples. The lake drops off quickly near 30 feet, so it didn't make sense to sample again until after the drop off, around 60 feet.
   b. **A north-south transect along the west side**. In our east-west transect we found quagga mussels near 30 feet, so we concentrated our samping near that depth on the west side of the lake. We collected 10 samples in 10 different locations.
   c. **Near the mouth of Intermediate River**: 2 samples
   d. **At the Sunken Island** on the east side of the lake: 2 samples

4. Grass River

   Visual examination of hard surfaces by kayak

   Submerged woody debris and permanent docks were examined for the presence of quagga and zebra mussels. We were looking to see how they were distributed (clusters or individuals) and how abundant they were (<10, 10-100, >100)

   Snorkeling along a transect

   A double observer design was used to do an underwater survey of a stretch of river. Additional available time was used to snorkel casually in search of mussels.

Our second task was to: **Describe <u>the occurrence</u> of zebra and quagga mussels upstream of Torch Lake.** To do that we:

1. Noted presence/absence of quagga and zebra mussels in every observation
2. Counted the number of mussels from each PONAR grab, from which density could be determined.
3. Counted the number of mussels on Mussel Settling Plates, from which density could be determined.
4. Collected video footage of each PONAR grab, for qualitative assessment of mussel density

Results

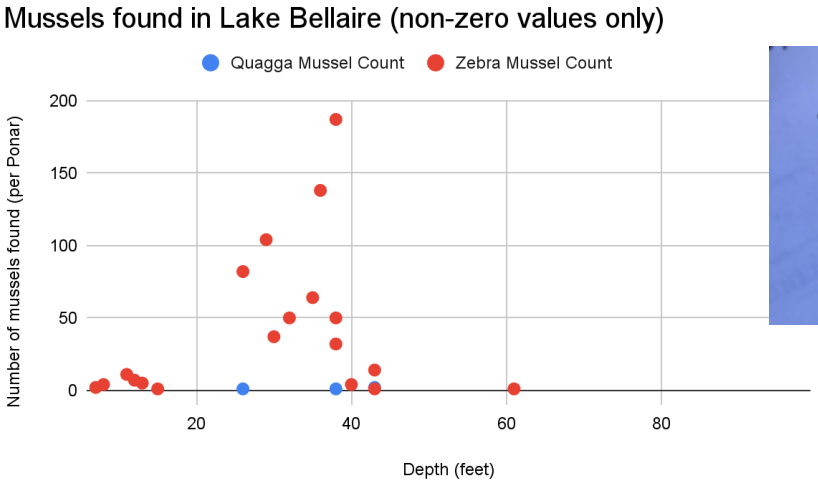
This map shows all of our sampling locations. Link to map. The symbol in each location indicates what we found there: zebra mussels only, zebra mussels and quagga mussels, or no mussels. This map indicates presence/absence only. For quantities, see the graphs that follow.

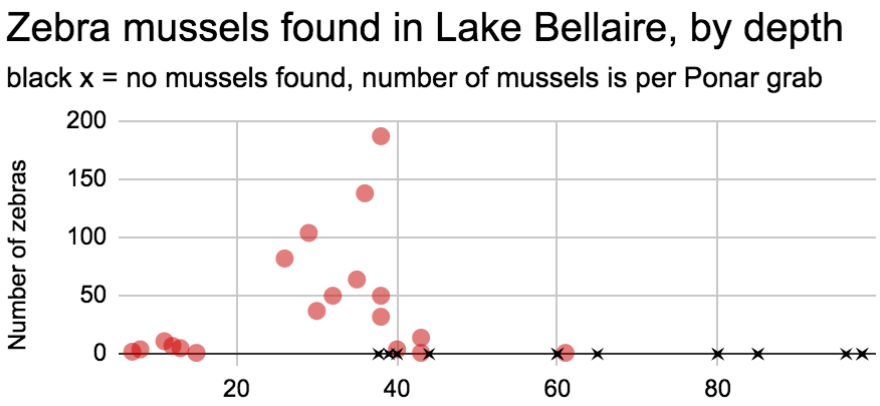
- Zebra mussels were found abundantly in all bodies of water.
- Quagga mussels, four total in three separate samples, were found in Lake Bellaire. All were found on the west side of the lake. Two of the samples were in nearly the same spot, but collected three weeks apart. The other sample was south of there.
- We did not find quagga mussels in the Grass River or Clam Lake.

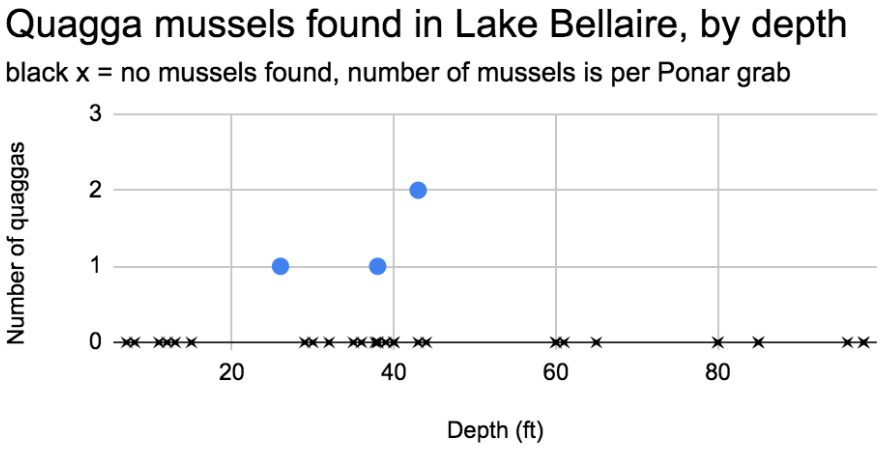
Are quagga mussels established upstream of Torch Lake?

<u>Yes. We found 4 quagga mussels in Lake Bellaire</u>

in three different samples, all along the west shore, in the dropoff zone. The photo shows the first quagga we collected on June 18.
Surprisingly, we found no mussels at deeper depths (>60 foot depth)







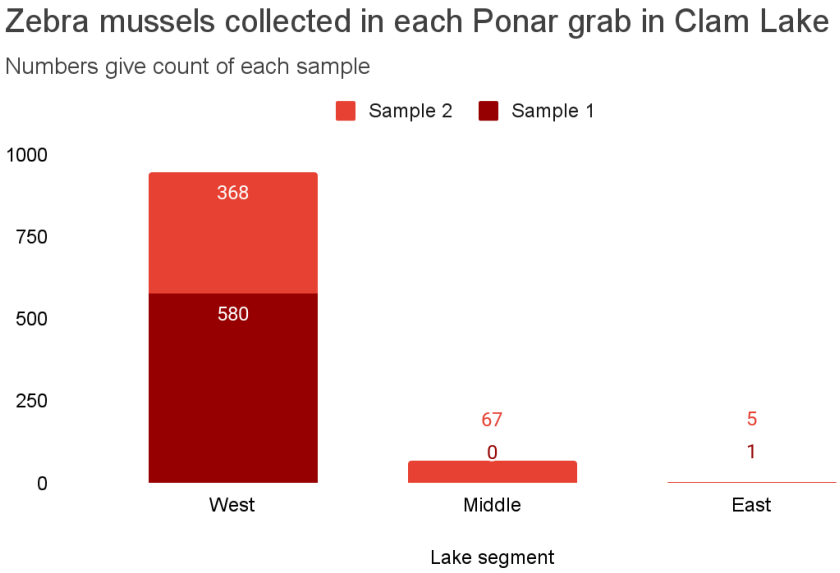
We did not find any quagga mussels in Clam Lake,

although our sampling effort was small (we only took six samples). We did enough examination to understand the character of the lake in different regions, but not enough to say with any confidence how mussels are distributed.

Huge numbers of tiny mussels were found in the west end. They were clinging to muskgrass (aka Chara) so were hard to count. In the case of the 580 mussels sample, we counted 25% of the sample and estimated 580 mussels from there. Abundant plant life obscured our ability to assess mussel occurrence.

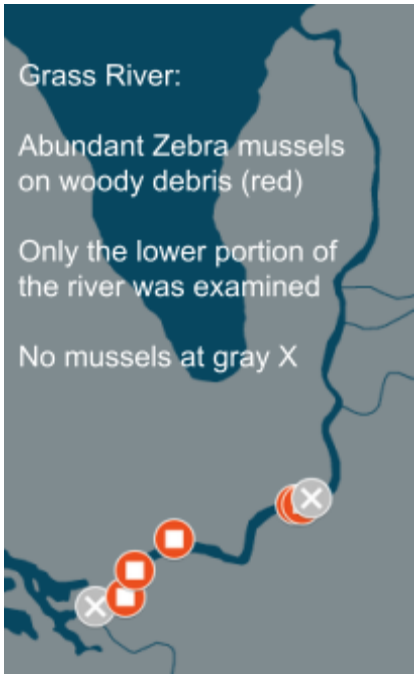
In the middle of the lake, one sample came up with zero mussels despite the other sample having an abundant number (67). This variation suggests that more sampling is needed to understand the nature of this area. There was plentiful vegetation here, although markedly less than in the west end.

Few mussels were found in the east, which was consistent between samples. Plant life was present in these samples.



<u>We did not find quagga mussels in Grass River,</u>

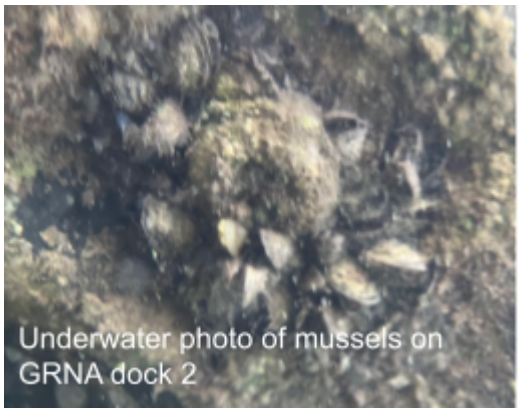
despite there being many mussels In the river. We looked at docks and woody debris and searched for anything that didn't look like a zebra mussel, however we did not identify or count every mussel we saw. By this time in the summer we had identified many mussels, so our search image was honed, but we could have missed a quagga mussel had it been there.

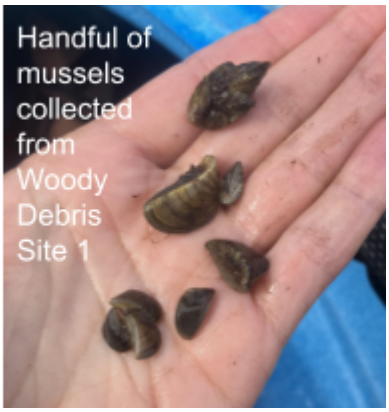


at

The only locations without mussels (gray x on the map) were the Main GRNA dock, where there was also no woody debris, and the snorkel transect site, which had a sandy bottom and no woody debris.

At the underwater transect, the bottom substrate was loose sand, which is not a reliable substrate for mussel attachment, so it is not surprising that we didn't find any mussels. A casual snorkel search of the area also did not reveal any mussels. However, nearby, in the emergent vegetation, there were many small mussels attached to mats of Chara, just like we saw in the west end of Clam Lake.


Underwater photo of mussels on GRNA dock 2


Handful of mussels collected from Woody Debris Site 1

	Dock	Woody debris
GRNA Dock 1	None	
GRNA Dock 2	Zebra	Zebra
Private Dock 1	Zebra	None
Private Dock 2	None	Zebra
LWD1		Zebra
LWD2		Zebra

This table shows the mussel species found on each substrate (docks or woody debris)

- Four of the sites had docks; zebra mussels were found on half of them.
- Five of the sites had woody debris; zebra mussels were found at four of them.
- No quagga mussels were found.

This table shows how mussels were growing as a percentage of all substrates: in clusters, or individually.

Mussels more often grow in clusters and seem to prefer woody debris.

	Dock	Woody Debris
Individuals	25%	60%
Clusters	50%	80%

Go Pro Footage

All times mussels were seen in GoPro Footage: Comparison to Ponar collection (Lake Bellaire) Sorted by number of mussels in Ponar for ease of interpretation.

# Zebras in Ponar	Distribution type	Density
0	Clusters	Sparse
0	Clusters	Sparse
0	Clusters	Sparse
4	Clusters	Sparse
14	Random	Sparse
31	Clusters	Sparse
37	Clusters	Sparse
50	Clusters	Dense
64	Random	Dense
76	Even	Medium
104	Random	Dense
138	Even	Dense
187	Even	Dense

These data were analyzed to understand the correlation between GoPro footage and Ponar Collections. Do they give us the same understanding about mussel density? Does the Ponar data match what we see in GoPro footage? Do we need to use the Ponar if the GoPro is just as effective?

Each small table below summarizes what we see in this larger table. Overall, the correlation between the two is very good. This is particularly true when it is "Dense" in the GoPro; we always find high numbers of mussels in the Ponar. However they seem to work best in tandem.

When mussels are sparse in the GoPro we nearly always get low densities of mussels in the Ponar. However when mussels are distributed in clusters, we will sometimes see higher densities with the Ponar and sometimes we will find nothing with the Ponar.

FInally, when mussels are not seen in the GoPro footage, surprisingly 50% of the time the Ponar collects them.

All times mussels were <u>NOT seen</u> in GoPro Footage: Comparison to Ponar collection (Lk Bellaire)

	% of time no mussels in Ponar	% of time mussels collected in Ponar
No Mussels Visible	50%	50%*

**All of these Ponar collections were small (1-11 mussels found)*

All times mussels were <u>seen</u> in GoPro Footage: Comparison to Ponar collection (Lk Bellaire)

	% of time found with Ponar	% of time not found with Ponar
Mussels visible	69.23%	23.08%*

**All of the times not found with Ponar were also "sparse" density on GoPro*

All times mussels were "<u>Sparse</u>" in GoPro Footage: Comparison to Ponar collection (Lk Bellaire)

	% of time below 50th percentile	% of time at or above 50th percentile
Sparse	71.4%	28.6%*

**All "sparse" cases at or above 50th percentile were in clusters or random*
All of the smallest collections with the Ponar were categorized as "sparse" density on GoPro footage

Only one categorized as "<u>medium</u>" density, and this was a bit above the 50th percentile, and less than half of the highest quantity

All times mussels were "<u>Dense</u>" in GoPro Footage: Comparison to Ponar collection (Lk Bellaire)

	% of time above 50th percentile	% of time at or below 50th percentile
Dense	100%	0%

The lowest "dense" case was distributed in clusters, the rest were distributed randomly or evenly

Invertebrates

Although this study didn't intend to study invertebrates in the lakes, we did collect presence/absence information on these creatures. In every sample we noted the species that we found, so there are basic data on species found and depth, which would be interesting to analyze. For now, here are word clouds, with word size determined by frequency of appearance.

Clam Lake: 6 Samples

Lake Bellaire: 33 Samples

Mussel Settling Plates

Click here for a slideshow of our experience collecting the plates. We had a lot of fun!

We collected 2 plates from each crate using a random number table on August 1, 3 months after installation, for a total of 16 plates. Three of the plates were 16 cm x 16 cm; ten were 20 cm x 25 cm. In most cases, there were few mussels found on the plates, despite mussels being relatively common on the crates themselves. Three of the plates had a large number of miniscule mussels on them (Bellaire East (2) and Grass River North (1)), perhaps 50-100 mussels, and given time constraints on collection day, we stored them in the freezer for later examination. Unfortunately, the freezer damaged the tissues so extensively that it was impossible to determine how many mussels were present. The homeowner at Bellaire East reports having a pump that is regularly clogged by mussels.

The remaining plates were collected by Fred Sittel on September 29, 2024, 5 months after installation and counted by intern Carter Massey. Many of the crates had an abundance of mussels on them, they seemed to find all of the nooks and crannies of a milk crate quite desirable! From Fred Sittel:

> *"Once again, the number of mussels on the tiles was low and most were small. Both Clam Lake crates, however, were covered with mussels (maybe more than a thousand) and most were in the protective recesses on the outside faces of the crates. One of the tiles from Art's location also had many small mussels along a straight line lying under where the zip tie was in contact with the tile.*
>
> *"Carter speculated that the attributes of the hard surface they choose to colonize appear to be much less important than the protection from predation the location provides. Which begs the questions, is predation a significant factor controlling their population and what is eating zebra mussels in Clam Lake and at which stages of their lifecycle?"*

Crate collected from Clam Lake. Note the abundance of mussels nestled in the crevices.

Recommendations

This was a very basic survey, conducted in order to get a beginning understanding of the occurrence of quagga and zebra mussels upstream of Torch Lake.

It is very clear that quagga mussels are in Lake Bellaire. However, there are many places in the lake we didn't look. For a better picture of their distribution, an examination of these places is recommended: The eastern shore and the north arm, in particular.

Clam Lake was the least well examined. It is very difficult to say much about mussel distribution in Clam Lake except that there is a well established zebra mussel population there. More sampling in the middle and eastern end would be particularly useful for understanding zebra mussel distribution.

Only the lower portion of Grass River was examined, so a similar survey in the upper portion is advised. We were all surprised at the ubiquity of zebra mussels in the water and it would be interesting to know more about their habits in this ecosystem.

There were so few quagga mussels in Lake Bellaire that we only knew we had collected them when we examined and counted each individual back on shore. This illustrates that the kind of survey we conducted in Grass River is insufficient for detecting the sparse distribution that we suspect might be occurring with quagga mussels. The same is true of Clam Lake. Our tiny sampling effort could have easily overlooked quagga mussels even if they are established.

At minimum, nothing further needs to be done regarding zebra and quagga mussels in the next year or two. We have a decent understanding of what is occurring in all three locations, including Torch Lake, which was studied in 2023. If quagga mussels are there, their numbers will increase and they will be easier to find in a few years.

However, this survey could reasonably be continued to include the missing portions from this year: Clam Lake, the upper reach of Grass River, and the eastern shore and north arm of Lake Bellaire. It would also be useful to identify more individuals in Grass River, as quagga mussels could be present amidst the zebra mussels. This would fill out the survey and provide a more complete picture of what is happening in these lakes.

The veliger settling plates provided a surprising observation, which could also be studied next year. Does predation influence mussel settling rates? In combination with this, an understanding of the round goby population in our lakes could also be illuminating.

No matter what happens next year, it is advisable to repeat surveys on Torch Lake, Lake Bellaire, Clam Lake and the Grass River on some regular frequency to keep tabs on the development of quaggas and zebras in these lakes. This could be done every five to ten years. A survey to examine benthic fauna would also be meaningful, and could give an opportunity to find quagga mussels should they be present.

APPENDIX 1: About this study

This study was designed by Jeanie Williams with the guidance of Sean Callahan, Conservation Director of Grass River Natural Area, and the TLA Water Quality Team. Equipment was designed and built, when necessary, by Rick Doornbos, Fred Sittel and Gary Bart. The work was performed by three high school students Carter Massey, Anabelle England, and Addison Novath (two rising juniors and one rising Sophomore), Gary Bart (Internship Lead for TLA), Jeanie Williams (Internship Coordinator), and our boat captains (Brian Hayes, Heath Meeder and John Curtis). Settling plates were located under docks provided by Art Hoadley, Fred Sittlel, Ed Gorley, Greg Fredericksen, Jim Fisher, Bill Owen, Gary Knapp and the Grass River Natural Area. Lois McLean (TLA Executive Director), Steve Laurenz (TLA Education Chair), and the TLA Water Quality Team also provided support from time to time.

The three students did the Ponar hauling, sieving, measuring, and counting. They also guided our direction daily and were instrumental in designing our activities for the sampling in Lake Bellaire. The data analysis was performed by Jeanie, with assistance from the interns. The students created a slideshow of their work; Beth LaVasseur (Volunteer), Gary Bart, and Jeanie supported the development of their presentation. The students presented to the TLA Board of Directors and their respective school boards. Jeanie wrote the report you see here.

The TLA internship program is intended to introduce young people to the field of aquatic science and help them build a foundation of skill and experience, as well as a deeper personal connection to the waters that they live among. We hope that through this experience, these young people will be better equipped for whatever they choose to do next. For some it will be a career in conservation or environmental science. For others, they learn that their interests lie elsewhere. We mostly discover what we like to do by doing lots of different things, and this experience is distinctive and clarifying. No matter what the students pursue next, for all of them, they learned many things about how aquatic systems work, and what it really means to protect water bodies, which is knowledge all citizens need. Importantly, they left with an experience that will always mark their lives and connect them to the place where they grew up.

We also aim to focus the TLA internship around a real question that would be helpful to answer. In an ideal world, the students learn a lot *and* TLA gets useful data that it can use to better educate the community and protect the lakes. In this case, the question at the heart of the study was particularly interesting to TLA and the community at large. We learned a whole lot about quagga and zebra mussels, but largely in a qualitative way. Yes, we are reporting numbers and counts, but we didn't run statistical analyses on them, and our sample sizes were small, so citing numbers to make arguments and such could be misleading to the general public.

We discovered something very important, and we made hard decisions all along the way to make sure the project could be completed in the time we had (six mornings on the lake), and the capabilities available (three typical teens, who are smart, ambitious and wonderful in marvelous and excellent ways).

We hope you take this work seriously, as it is a well designed and robustly implemented study, but like all studies, there are limits to how far it can be applied.

APPENDIX 2: Presentation

The students presented their work to the TLA Board of Directors as a team. They also presented individually to their school's Board of Education.

Click here to see the presentation slides

APPENDIX 3: Data

Link to spreadsheet with the data

For additional data analysis and graphics, Please contact Jeanie Williams: jeanie@wayfinderfacilitation.com

Click here to explore the map of the 2024 data. To the right is a screen shot of the map you will find.

A map of the data from the 2023 interns and the 2022 interns can be found at this link. Below is a screenshot of the map you will find.