Life at the Bottom of Torch Lake and Lake Bellaire

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Three Lakes Association

2022 Summer High School Internship

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Introduction

Our Michigan lakes are changing at a rapid pace. There are a number of new foreign species that have invaded our lakes. These species have had consequences on the native species, Diporeia.

Diporeia are shrimp-like, energy-dense creatures. They are an essential part of the diets of slimy sculpin, burbot, lake whitefish, yellow perch, bloater, alewife, and rainbow smelt. They live at the bottom of deep lakes where very little lives. The Diporia have been at the bottom of Michigan's Lakes since the last ice age.

The disappearance of Diporeia, as seen in a study in Lake Michigan (Mehler et al 2020), could be an early warning sign that our lake's ecosystems are going to change, which is likely to have an effect on whitefish. On the other hand, quagga mussels (*Dreissena rostriformis bugensis*) and zebra mussels(*Dreissena polymorpha*) are freshwater mussels originally native to southern Russia and Ukraine, but have been introduced to many locations around the world. They both live 3-5 years and the basic difference is that quagga mussels can live to very extreme depths while zebra mussels can only live 40-50 feet of depth. The mussels have very few predators in Michigan's lakes and so thrive here. They live in the same habitat as Diporeia and are thought to compete against each other.

The primary focus of the study was to sample the amount of Diporeia on the lake bottom to see if there is a decrease or increase in the population as compared to the 2007 study conducted by Three Lakes Association interns (Platte et al 2007). We also were looking for the invasive species quagga mussels and zebra mussels. The abundance of quagga mussels and zebra mussels in other lakes has caused a severe decrease in the Diporeia population. We are looking here to see if the same applies to Torch Lake and Lake Bellaire.

This study was conducted on Torch Lake and Lake Bellaire between June 27th and July 29th of 2022. The study focused on the bottom of these two lakes, where quagga mussels, zebra mussels, and Diporeia reside.

This study is modeled after a study conducted by the interns with Three Lakes Association in 2007 (Platte et al 2007). The 2007 study confirmed the existence of Diporeia in Torch Lake and Lake Bellaire and a small number of zebra mussels in Torch lake. By making a comparison to the initial study we can gain an understanding of the increase or decrease in the Diporeia population. As well, we looked for quagga mussels which may allow us to draw a hypothesis on the causes of any new change we may see in Diporeia population numbers. Quagga mussels are a new factor to consider. This is the first study to look for quagga mussels since 2015. A study in 2015 by the DNR found Quagga Mussels in a few locations on Torch Lake (EGLE 2022, unpublished). Tip of the Mit also searched for them all around the lake in 2015 and never found any (Tip of the Mitt Watershed Council 2017).

We have looked to see if the number of Diporia has dropped in inland lakes the same way as in Lake Michigan (Mehler et al 2020). If the Diporeia have decreased at a similar rate as in Lake Michigan, perhaps we can draw a conclusion that quagga mussels result in the loss of Diporeia numbers. However, if there is no decrease in the native Diporeia population perhaps we can look into the topic of the study more to understand how Torch Lake is different from Lake Michigan, since in Torch Lake it might be that quagga mussels have no effect on the Diporeia.

Methods

On Wednesdays throughout the months of June and July, we went onto Torch Lake and Lake Bellaire to collect the samples for this study. The samples were collected between 9 A.M. and noon on a variety of boats provided by TLA members. When choosing the locations to collect the samples, we followed the previous 2007 Diporeia studies' GPS coordinates, and a

few new locations, chosen by convenience. The samples were collected by using either a PONAR dredge or a plankton net.

The PONAR dredge[7] is a sampling device used to collect sediment on the bottom of lakes. We used a “petite” PONAR grab sampler which collects an area of 6” x 6”. Some creatures in the water are good swimmers, which allows them to avoid the PONAR, so not every creature (e.g. possum shrimp or sculpins) are collected. Before we lowered the PONAR into deep water, we anchored the pontoon. The anchor kept the boat stationary, which made it easier to lower the device without triggering it, and collect the sample at the bottom. When lowering the dredge, we kept tension on the rope until it reached the lake bottom. Once it reached the bottom, we released the tension on the rope and let out slack. This caused the spring pin to release from the PONAR, allowing the device to close and collect the sediment on the lake bottom. When the PONAR was lifted back into the boat, the sediment inside was emptied into a mesh screen to separate the organisms and mussels from the sediment. We placed a larger mesh screen with 0.02 inch square openings on top of a smaller mesh screen with 0.057 inch square opening. By having the two screens stacked, it allowed the smaller organisms that filtered out of the larger sized screen to go into the smaller sized screen, making it easier to extract the organisms from each sample. Visible organisms and mussels were collected by hand or tweezers and placed into a labeled sample bottle, later filled with alcohol to preserve them. On Torch Lake, samples were taken from depths between 41-205 feet. Each trip we were able to successfully collect around 4 different sample pulls. On Lake Bellaire, samples were taken from depths between 47-85 feet. The fraction of Torch Lake that we sampled was 2 x 10^-9, which is very small.

[7] https://www.pine-environmental.com/products/ponar_grab_sampler

Figure 1: Petite PONAR grab

We identified the organisms found with the PONAR grab by using microscopes and by using an aquatic macroinvertebrate guide (Figure 2). Samples were placed under microscopes with up to 40x magnification, which allowed us to see small details of the organism and categorize them. To support the interns, a lab assistant was engaged to identify the samples.

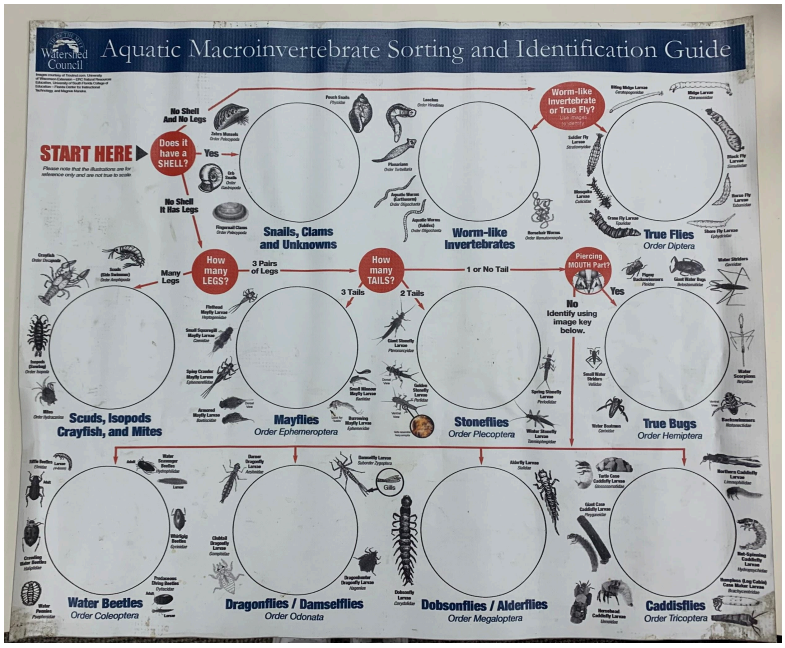

Figure 2: Chart used to help identify organisms

A plankton net is a long mesh net that is used to collect microscopic organisms swimming in the water. The opening of net we used was 50 cm in diameter and the mesh was 380 microns. The plankton net was lowered into the water and as it was pulled up, the water awsfiltered through the net and into a small container attached to the end called a cod end. Once the net was pulled into the boat, we carefully unscrewed the cod end from the bottom of

the net, then we poured the plankton captured in the cod end into a labeled sample bottle that was later filled with alcohol. On both Torch Lake and Lake Bellaire, samples were taken from depths between 30-100 feet. In late June, on both lakes, we were able to collect 3 net pulls. We collected plankton samples only during one of our trips.

We identified the plankton samples by using microscopes and identification cards. The samples were placed under 40x magnification microscopes that allowed us to see the closer body structure of the plankton, which we were then able to compare to identification cards.

At the end of June we were able to use Tip of the Mitt's[8] Hydro Lab[9] on Lake Bellaire. The Hydro Lab is an instrument that is lowered into the water to measure properties of the water column. The Hydro Lab was calibrated 2 days before we used it, and it was able to track the temperature, pH, dissolved oxygen, conductivity, and depth of the lake. For every one meter we lowered the instrument, we would mark the measurements at that depth. We lowered it until it reached the bottom, which was 20 meters.

Results

The most abundant and pertinent species for this study were Diporeia, zebra mussels, and quagga mussels. There were also midge larvae and snails found in the samples. These were noted, but are not described here because they were not central to the research.

Figure 3 shows the relationship between the number of quagga mussels and the number of *Diporeia* found. We expected to find fewer *Diporeia* when there were more quagga mussels, but that wasn't the case. Instead we found no clear relationship between abundances (Figure 3).

[8] www.watershedcouncil.org
[9] www.hydrolab.com

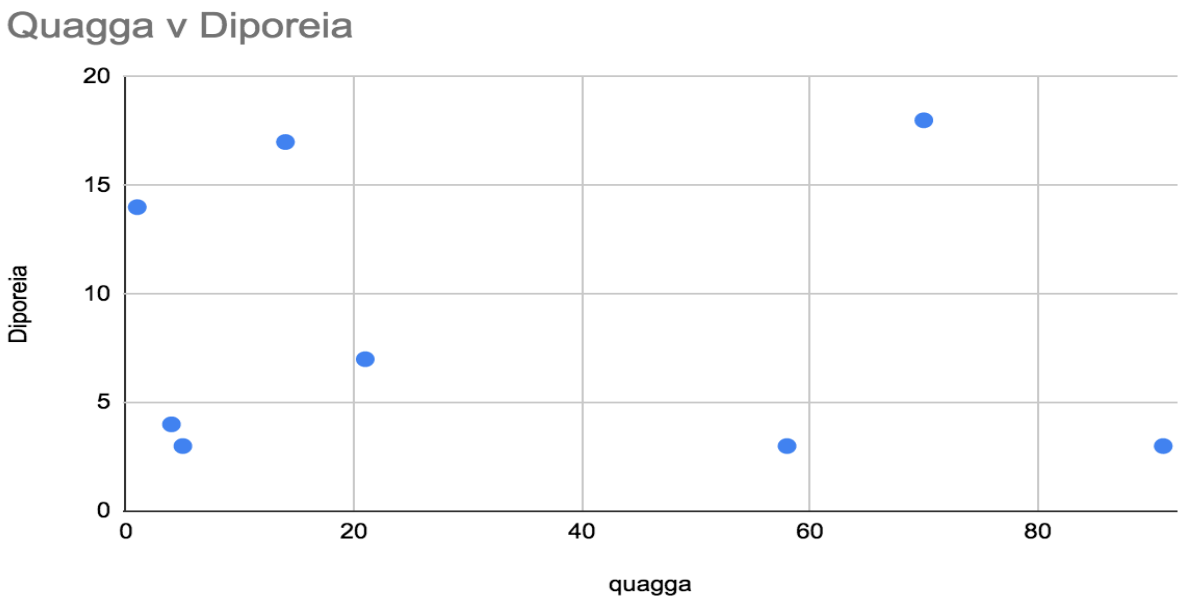

Figure 3: The number of quagga mussels compared to the number of *Diporeia* in Torch Lake per sample.

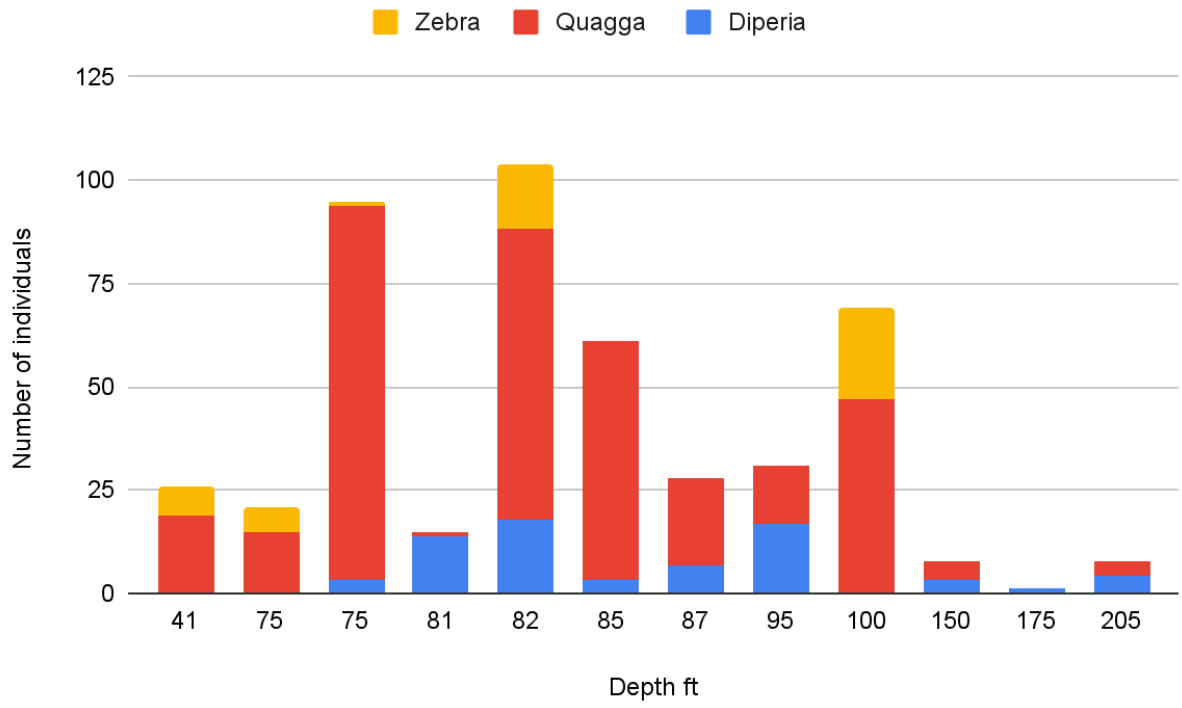

Figure 4: The ratio of individuals per PONAR sample on Torch Lake. Each bar is a

separate sample. Yellow represents zebra mussels, red represents quagga mussels, and blue represents Diporeia.

We collected a variety of organisms in each sample, and quagga mussels made up the majority of individuals nearly every time, and were often present in large numbers (Figure 4). Zebra mussels were present in four of our samples and found in shallow depths (~40 ft) as well as deeper depths (80-100 ft). *Diporeia* were also present in nearly every sample, particularly in the deeper depths (>75 ft)

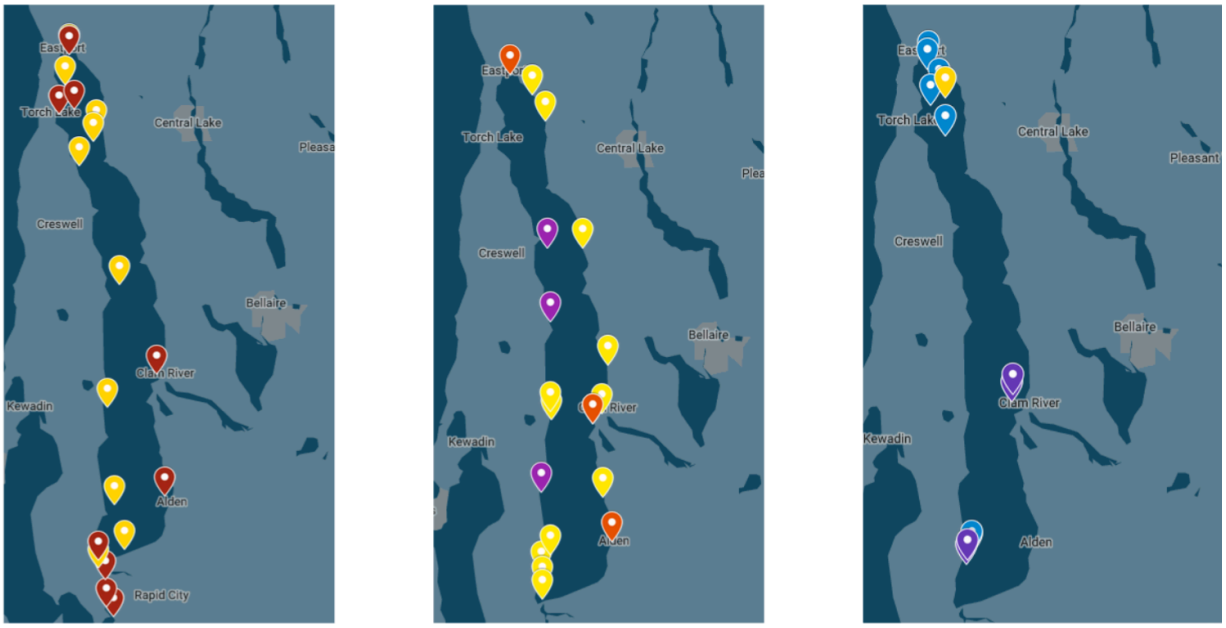

Figure 5: Map of Zebra and Quagga Collection Sites. Yellow points represent no mussels collected. Red/orange points represent only zebra mussels collected. Blue points represent only quagga mussels collected. Purple points represent both zebra and quagga mussels collected.

On the far left of Figure 5, the 2015 Tip of the Mitt Invasive Species Study shows that only zebra mussels were collected, however they were found all over Torch Lake. In the same

year, the DNR did another invasive species survey, although their results were slightly different than the Tip of the Mitt study, with zebra mussels being found along with quagga mussels. In our 2022 TLA Intern Study our results are vastly different, with no pulls bringing up just zebra mussels and most pulls bringing up quagga mussels. Only one pull had neither, in contrast to previous studies that frequently had samples with neither and were performed in similar locations.

Plankton Samples-

Table 1: Location and species found in plankton net samples taken at the south end of Torch Lake, June 22, 2022.

Depth (ft)	GPS	Type
30	44.87 -85.32	Calanoid Copepod
60	44.87 -85.32	Calanoid Copepod
100	44.87 -85.32	Calanoid Copepod

On June 22, 2022, at the south end of Torch Lake, the only species collected by the plankton net were Calanoid Copepods.

Table 2: Plankton Net Samples taken near the center of Lake Bellaire, June 29, 2022.

Depth	GPS	Species
66 ft	44.95 -85.21	Colonial Rotifer, Diaphanosoma Birgei
68 ft	44.95 -85.23	Keratella, Mysis Relicta
90 ft	44.95 -85.22	Calanoid copepod, Daphnia sp., Bosmina sp., Colonial Rotifer

On June 29, 2022, near the center of Lake Bellaire, a variety of species were collected with the plankton net. It is also interesting that there is almost no overlap of species in the three samples. This suggests there is quite a lot of diversity in this lake.

Between the two lakes, the biodiversity and quantities of plankton collected varied greatly. In Lake Bellaire, eight individual species were recorded, while in Torch Lake only one species of plankton was found in our samples.

PONAR Dredge Samples-

Table 3: Location and number of individuals found in PONAR dredge samples taken in Torch Lake between June 29, 2022 and July 29, 2022.

Date	Depth	GPS	Diporeia	Quagga	Zebra	Amphipods	Snails	Misc
6-29-22	75	44.95 -85.29		15	6	3		2
6-29-22	41	44.95 -85.29		19	7			
6-29-22	45	44.95 -85.29		yes	yes	yes		
7-13-22	81	45.10 -85.35	14	1				1
7-13-22	87	45.10 -85.35	7	21				
7-20-22	100	44.88 -85.32		47	22			
7-20-22	85	44.88 -85.32	3	58			4	
7-20-22	82	44.87 -85.32	18	70	16			
7-20-22	75	44.87 -85.32	3	91	1			
7-29-22	150	45.09 -85.34	3	5				
7-29-22	95	45.08 -85.34	17	14				
7-29-22	205	45.07 -85.34	4	4				
7-29-22	175	45.086 -85.34	1					

Between June 29, 2022 and July 29, 2022 we collected over 300 quagga mussels in Torch Lake, which showed up in 92% of the PONAR dredge pulls. Zebra mussels were collected in 46% of pulls, while diporeia were collected in 69% of the pulls.

Table 4: Dredge Samples taken near the center of Lake Bellaire July 7, 2022.

Date	Depth	GPS	Diporeia	Quagga	Zebra	Amphipods	Snails	Misc
7-6-22	95	44.95 -85.22			2			

7-6-22	82	44.95 -85.22						
7-6-22	53	44.96 -85.23						
7-6-22	60	44.95 -85.21			9	14	3	1
7-6-22	85	44.95 -85.22				1		1
7-6-22	68	44.95 -85.23				15		
7-6-22	47	44.95 -85.23				12		

On July 7, 2022 mostly amphipods were collected, in 57% of pulls, along with small amounts of zebra mussels, which appeared in 2 out of 7 pulls at individual locations.

Conclusion

Our main objective in this study was to find out if the Diporeia population was declining in Torch Lake and Lake Bellaire. Instead, we found that the population of Diporeia in Torch Lake increased. In Torch Lake, there were around 2.5 in one pull in 2007, as compared to 6 Diporeia per pull in 2022. There were more steady numbers in Lake Bellaire. In 2007 the numbers of Diporeia in Lake Bellaire were, on average, around 5 Diporeia per pull compared to around 6 per pull in 2022. In Torch Lake and Lake Bellaire, the Diporeia seem to be holding strong in favorable conditions.

Our second objective was to survey for zebra and quagga mussels. We found zebra mussels in both Lake Bellaire and Torch Lake in 2022 with around eight encounters every ten pulls. In 2007 the group didn't find any zebra mussels in Lake Bellaire. In Torch during the 2007 study, they were only found in two out of the ten pulls. In 2015 both Tip of the Mitt and the DNR found Zebra mussels in Torch Lake, with around seven encounters per ten locations.

A significant difference between the 2007 study and the present study is the overwhelming presence of quagga mussels in Torch Lake. Quagga mussels were prominent in

almost every pull, with up to 91 mussels within a single pull. During the study of 2007, there were no quaggas in Torch Lake, and when the DNR studied Torch Lake in 2015, they were found, but only in three out of twenty locations. Now, they have spread and are abundant in Torch Lake, meaning extra competition for plankton and other microorganisms. Quagga mussels thrive in lakes like Torch Lake and Lake Michigan, because they can survive on the soft, sandy, and deep lake bottoms.

Torch Lake has experienced a massive change in species composition, while Lake Bellaire has not. The appearance of quagga mussels in Torch Lake could mean harder times for the lake's benthic organisms. Yet, for now, in both lakes Diporeia seem to have steady or increasing numbers which is positive for the species that rely on them.

Discussion

We initially conducted this study to identify any changes in the population of Diporeia compared to a 2007 study (Platte et al 2007) conducted on Torch Lake and Lake Bellaire. Any changes in the population and location of Diporea would indicate a shift in the aquatic ecosystem of our lakes. These changes could also signal that our lakes have started taking a turn for the worse. For example, many native fish species, including whitefish, would experience a decrease in one of their most vital food sources.

We found that Diporeia populations have stayed almost unchanged since this study was performed in 2007 on Torch Lake (Table 3). This is a good sign for Torch Lake. In Lake Bellaire, we found higher numbers of amphipods in our samples than what was found in the 2007 study. We suspect that many of these amphipods were Diporeia, but because these samples degraded before they were identified, we were unable to determine the exact species of these amphipods.

Although Diporeia numbers have appeared to remain steady over the years, we believe that their numbers will be decreased by their competition with the newly arrived quagga

mussels. A similar pattern happened in Lake Michigan, a much larger, but very similar lake to Torch Lake. This would be devastating for many fish species that are dependent on the soft-bodied Dipporeia. Our native fish species are unable to consume the hard-bodied mussels.

We found unsettlingly large amounts of invasive quagga mussels on Torch Lake. In 2015, very few quagga mussels were found, whereas in 2022, we found up to 91 quagga mussels in a 6'' by 6'' sample. In addition, we found quagga mussels in all but one sample in Torch Lake (Figure 5). No quagga mussels were found in Lake Bellaire, but zebra mussels were present. The abundance of zebra and quagga mussels alone could lead to declining water quality in our inland lakes. These mussels filter nutrients out of the water column, and bring all of the nutrients down to the bottom. This makes the water appear clearer. It is also very difficult to reverse this rapid spike in quagga mussels on such a large scale because of their competitive nature.

While we hypothesize that the quagga mussels will drive down Diporeia populations. We are not exactly sure what these changes in Diporeia and mussels populations in Lake Bellare and Torch Lake mean for the future of the lower chain of lakes.

In order to track and act on these changes we recommend some next steps. The first step would be to have a fish study on Torch Lake and Lake Bellaire, giving us a baseline number to compare with later, as well as to compare with our current Diporeia and quagga mussel numbers. Next we recommend redoing our study, along with the proposed fish study in three or five year intervals. This will allow us to see what is happening to the fish in our lakes in relation to the changes in quagga mussels and Diporeia. Having this as an ongoing study will allow us to observe any negative changes over time, and to contact conservation organizations, such as the Michigan DNR, or Tip Of The Mitt, if conservation efforts are needed in the lakes.

Acknowledgments

The 2022 Three Lakes Association interns would like to give thanks to multiple people and associations for their help this past summer. Thank you to our volunteers and coordinators; Jeanie Williams, Gary Bart, Norton Bretz, David Yuhas, Fred Sittel, Zac Roth, and Katie Kraft; who helped keep us all working and safe. Thank you to Mitchell Pietryga for counting and identifying many of our samples. Thank you to Greg Fredericksen, Dean Branson, John Curtis, Gary Bart, and Norton Bretz for letting us use their boats! Alden Train Depot, Elk Rapids Harbor, Grass River Natural Area, Barnes Park, Bellaire High School, Antrim County Building, Greg Fredericksen and Christian and Anja Stoldt, thank you for meeting and working spaces. Thank you to Norton Bretz, Fred Sittel, David Clapp, Tip of the Mitt, and Great Lakes Environmental Center for equipment and technical support. Thank you to the Garritt Lee Wierda Memorial Internship Fund.

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