A WATER QUALITY SAMPLER

The Three Lake Association's

2012 Summer Internship Program

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and

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INTRODUCTION

Every summer since 2003, Three Lakes Association (TLA) has sponsored a student internship program. The purpose of the program is twofold: 1) to enhance TLA's knowledge of Lake Bellaire, Clam Lake and Torch Lake and 2) to deepen the interns' appreciation of the extraordinary water resources of Antrim County. Through a series of activities, the interns learn scientific field procedures and analyses while interacting with several scientists, agency representatives, and TLA volunteers. The interns during 2012 were Sierra Kintigh (16) and Alec Stilwell (16), both students at Bellaire High School, and Zachary Pedersen (14), an incoming first year student at Elk Rapids High School.

Specific activities undertaken by the interns and presented in chronological order included:

- Sampling macroinvertebrate populations in Shanty, Cold, and Finch Creeks as indicators of water quality
- Conducting a time-flow study for Shanty Creek to document storm water flow events
- Conducting aquatic plant surveys of Lake Bellaire, Clam Lake and Torch Lake, especially aimed at determining locations of Eurasian water milfoil (EWM), an invasive species
- Assisting with the installation and initial evaluation of fish shelters in Lake Bellaire, Clam Lake, and Torch Lake
- Participating in an electrofishing survey of Shanty Creek
- Characterizing the plume entering Torch Lake from its main inlet at Clam River, and
- Enhancing public awareness of water quality issues by working at TLA's booth at the Antrim County fair and other educational events.

These activities are documented in further detail in the following pages by the TLA interns. Collectively, these activities provided the interns and TLA with a water quality "sampler", reflecting conditions in the watershed, lakes, and streams during the summer of 2012.

As with the internship program in previous years, many individuals, organizations and agencies supported the 2012 program work in various ways. TLA gratefully acknowledges help from The Watershed Center Grand Traverse Bay (macroinvertebrates), the Antrim County Conservation District (facilities), Tip of the Mitt Watershed Council (flow meter), Friends of Clam Lake (volunteers, boats), the Michigan DNR (electrofishing), and numerous TLA volunteers (time, boats, field guidance). Leah Varga, a recent biological sciences graduate of Connecticut College, served as the intern team's research associate, working with the students on the aquatic plant survey and fish shelters. Thanks to all for their interest and support!

For additional information on this report or the summer intern program, please contact Three Lakes Association at www.3lakes.com or 231.350.7234.

MACROINVERTEBRATES AS INDICATORS OF WATER QUALITY

By Zach Pederson, Elk Rapids High School

Introduction

Macroinvertebrates are a good way to predict the quality of a stream. Macroinvertebrates are small organisms that live in or on water for all or some of their lives and are large enough to be seen without a microscope (e.g. insect larvae, worms, and snails). Some are sensitive to pollution, some are tolerant, and others are in between. In general, the more sensitive macroinvertebrates you find, the better the quality of the stream. When a stream receives pollutants and sediment from the land, more of the less sensitive macroinvertebrates can be found. The pollutants come from different sources such as fertilizer runoff from lawns or storm water runoff from roads.

Methods and Materials

TLA interns sampled Shanty Creek, Finch Creek, and Cold Creek on June15, 2012, following the protocol used in 2011. All three streams are tributaries to the Grass River, which flows into Clam Lake. The three sampling stations were the same as those sampled by the 2011 interns.

At each sampling station, we picked a location downstream, with 100 ft. of space upstream for sampling. Next, we noted the start time of a 30-minute collection interval. To collect, we stood upstream from a D-net (with a D-shaped metal frame designed for macroinvertebrate sampling) and disturbed the bottom of the stream to get the macroinvertebrates to detach and flow into the net (*figure 1*). Then we worked our way upstream, occasionally rinsing out the net into a bin, as we collected. After 30 minutes, we noted the end time and put the contents into a bin and transported the samples to a location for sorting and identification.

Figure 1. Alec and Zach collecting macroinvertebrates

To start the identification process, we used a white tray and a thin mesh to make the dark-colored macroinvertebrates stand out, then we picked them out with tweezers and small pipettes. The organisms were identified using a dichotomous key (which gives two choices of various characteristics) to narrow down the possibilities. We recorded the macroinvertebrates onto a MiCorps datasheet (See appendix) and preserved them in a "kill" jar of ethyl alcohol (figure 2). Typically, no more than 15 specimens of each species should be collected.

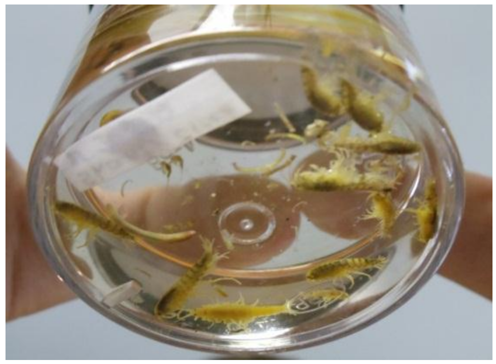
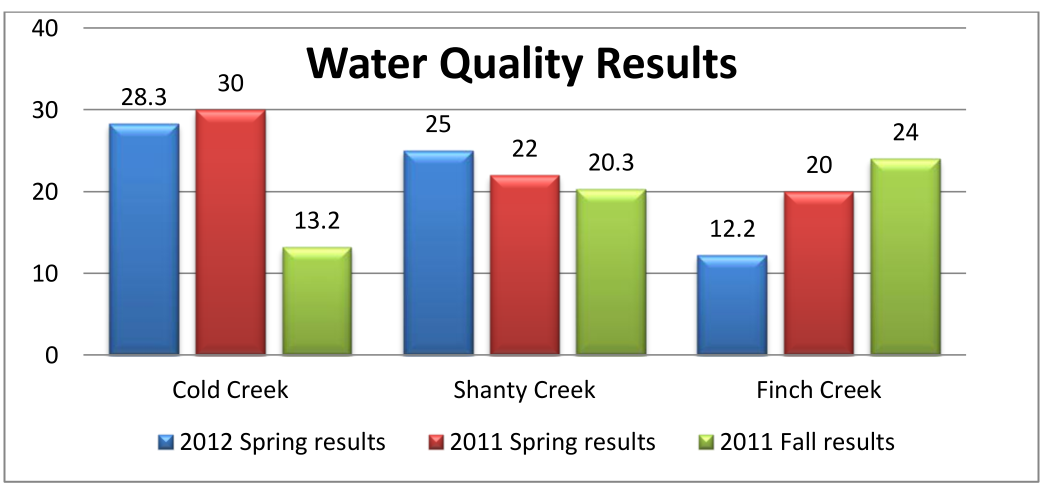


Figure 2. The "kill" jar from the Shanty Creek sample

For this assessment, macroinvertebrates are divided into three categories and two subcategories: Group 1, sensitive; Group 2, somewhat sensitive; and Group 3, tolerant. Within these groups, both rare and common species may occur, which further affects the water quality score determined or each sample. If 1 to 10 specimens of a species are found in a sample, that species is considered rare. If 11 or more specimens of a species are found, that species is considered common. Rare species within Group 1, for example, have a higher score than common species within the same group, and indicate a more hospitable environment for aquatic life. The MiCorps data sheet (see Appendix) interprets the numerical rankings for stream quality as follows: Score >48 = excellent, 34-48 = good, 19-33 = fair, and <19 = poor.

Results

The graph below compares the 2011 and 2012 sampling results for the three streams:



Overall results for June 2012 (shown in blue) indicate that water quality in Cold Creek and Shanty Creek is fair while water quality in Finch Creek is poor It was noted that Shanty Creek had more sediment in 2012 than in 2011 although the numerical value was slightly higher. Finch and Cold Creeks had few physical differences from the previous year.

Future Plans

The data we collected during the single sampling in 2012 provides only a “snapshot” of the streams’ water quality. TLA’s plans are to continue sampling in the spring and fall through 2013 to track water quality trends for each creek. More refined trends in water quality are expected to emerge over a period of years as more data are collected.

TLA is concurrently studying sedimentation and flow within the sampling areas. Further, they are promoting improvements to streambank erosion and native shorelines. It is very probable that these initiatives will assist in the improve water quality of the streams and the overall health of the watershed.

References

Michigan Clean Water Corps (MiCorps) http://www.micorps.net/streamoverview.html

TIME-FLOW STUDY OF SHANTY CREEK

By Sierra Kintigh, Bellaire High School

Introduction

A time-flow study of Shanty Creek was undertaken as a follow-up to the 2011 summer intern Grass River Sedimentation project (Three Lakes Association 2011). During that study of the tributaries to Grass River, Shanty Creek was identified as a possible concern due to extensive development along its banks and observations of excessive tree fall and siltation, potentially due to runoff and erosion from storm water events. Developments in this watershed include a large golf course, a ski slope, and hard surfaces associated with condominiums and other structures.

The purpose of our 2012 study was to quantify brief spikes in storm water from major storm events and to consider measures to decrease runoff and its impacts to Shanty Creek.

Methodology

Stream flow rates were determined from a combination of water level and velocity measurements through a known cross-sectional area. A Global Water WL16 Data Logger was installed in Shanty Creek for long-term monitoring of the water level at the M-88 road crossing. Water velocities were measured when water levels were distinctly different using a Marsh-Birney meter. From the collected data, a relationship between water level and flow was established to a correlation coefficient of 0.94. The cross-sectional area of Shanty Creek was determined from physical measurements made of the cement rectangle culvert where the data logger was located (Figure 1). Flow rates were then determined from the long-term monitoring data and the stream channel cross-sectional area. These results were compared to historical flow data from nearby Cold Creek which, in contrast, flows through an almost all natural environment.

Figure 1. Determining the cross-sectional area of Shanty Creek

Results and Discussion

Water flow data were collected between March 24, 2012 and June 21, 2012, during which time five major rain storm events greater than 0.5 inches in 24 hours impacted Shanty Creek. During the 13-week monitoring period, the average flow rate of Shanty Creek at this location was determined to be 5.3 cubic feet per second (cfs). Peak flow rates during storm events were in the range of 12.2 to 15.6 cfs, making the average peak flow more than 2.7 times greater than average flow. The duration of these peak flow events ranged from 33 to 83 hours (Figure 2).

For comparison, five major storm events measured over a period of 12 weeks on Cold Creek in 2006 resulted in peak flows being, on average, only 1.9 times greater than the average flow rate (Table 1). The larger influence that storm events had on Shanty Creek suggests that factors beyond the natural environment are influencing the flow rate.

Rapid rises in water level and high peak flows are associated with increased stream bank erosion and sediment transport. A factor known to cause rapid increases in the flow rate is runoff from impervious surfaces, including pavement and rooftops in developments. The results from the study on Shanty Creek indicate that there are opportunities to reduce the influence of storm water events in Shanty Creek by implementing various best management practices. These could include directing runoff from impervious surfaces to detention basins and rain gardens.

Figure 2

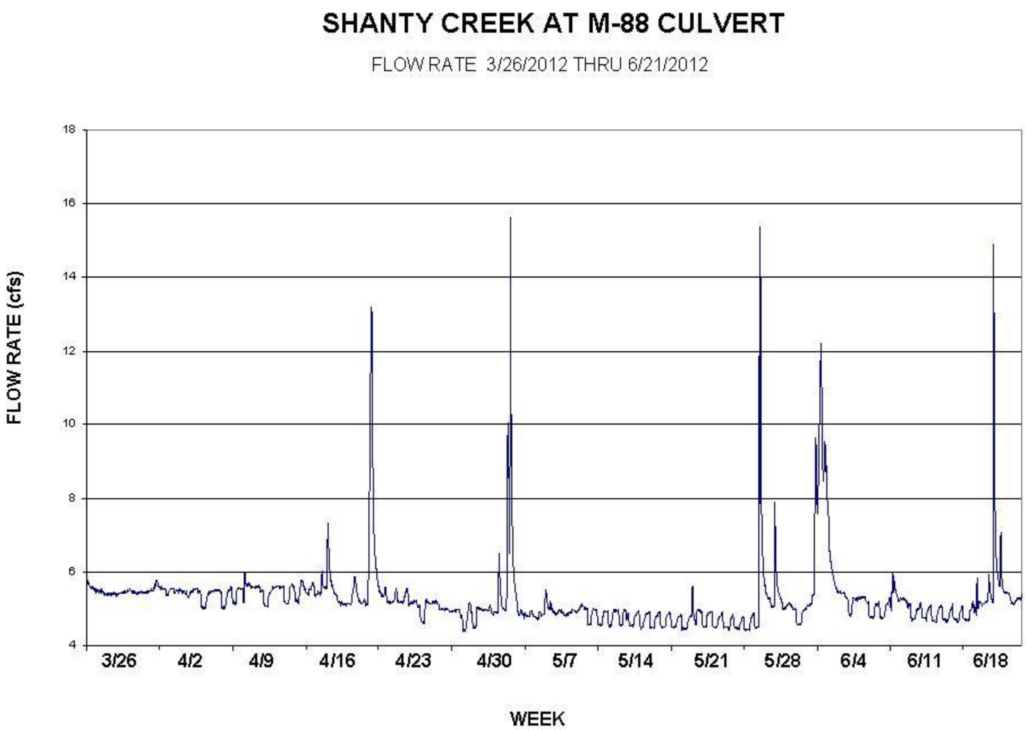


Table 1

A Comparison of Flow Characteristics in Shanty Creek and Cold Creek

Storm water flow characteristics	**Shanty Creek**	**Cold Creek (2006 data)**
Types of development in watershed	Roads, golf, homes	Minimal, fish farm
Average flow, five major spring events	14.3 cfs	54.8 cfs
Average flow (normal & storm events)	5.3 cfs	28.8 cfs
Ratio: avg. storm water flow: avg. flow	**2.7 x**	**1.9 x**
Flow, Largest storm event	15.6 cfs	71.9 cfs
Ratio: Largest event flow: avg. flow	2.9 x	2.5 x

Reference

Three Lakes Association. 2011 Summer Intern's Report, "*Grass River and its Tributaries Restoration Assessment: 2011 Findings".*

Three Lakes Association, 2007 "Predictive Water Quality Model for Lake Bellaire and Clam Lake.

AQUATIC PLANT SURVEYS OF LAKE BELLAIRE, CLAM LAKE, AND TORCH LAKE

By Zach Pederson, Elk Rapids High School

Introduction

Aquatic plants are an important part of a lake's ecology. Plant growth occurs primarily in the littoral zone or area in the water where the sunlight hits bottom. This area is perfect for fish to seek shelter from land birds and other predators. Some plants are beneficial to the lake's ecosystem, for example, Northern milfoil. Others, such as nonnative Eurasian milfoil, are not beneficial because they can outcompete the native plants and eventually dominate a lake's vegetation. During July 2012, we surveyed our three lakes to determine where invasive plants occurred so that future actions could be planned to prevent spreading.

Methods and Materials

First, we constructed a double-sided rake with no handles and attached a long, strong rope to it (Figure 1). Also, we acquired a net with a handle, zip-lock bags, labels, marker, and a storage bin approximately 2 feet x 1 foot x 6 inches and a trash bucket. In each lake, we boated out to a water depth of 10 to 15 feet and lowered the rake until it hit bottom, then we firmly pulled, keeping constant tension on the rope. The rake and its contents were brought to the surface and placed in the storage bin to obtain a good specimen of each plant represented in the sample. Each sampling location was labeled on our map and, when possible, GPS coordinates were taken. We then moved to the next location looking for vegetation on the bottom of the lake at a depth of about 10-15 feet. When vegetation was spotted, we lowered the rake and repeated the process. If nothing was retrieved, we placed the rake on the bottom of the lake, put about 2 ft. of slack in the line and trolled a short distance and pulled the line in. This was sometimes difficult when the rake was full. After collecting about 20 to 25 samples in each lake, we returned to shore for identification.

A dichotomous key works great to identify the samples. *A Citizen's Guide for the Identification, Mapping and Management of the Common Rooted Aquatic Plants of Michigan Lakes* includes a good key that we used. This key can be found online at the URL provided under References.

Figure 1. Two-sided harvesting rake

Results

Three Lakes Association's interns collected samples from Lake Bellaire, Clam Lake, and Torch Lake and found 12, 11 and 9 plant species, respectively, as listed in Table 1. A digitized map of our sampling locations is included in the appendix.

Table 1
Scientific and Common Names of Aquatic Plants Found in Lake Bellaire, Clam, Lake, and Torch Lake
July 2012

			Lake	
Scientific Name	**Common Name**	**Bellaire**	**Clam**	**Torch**
Ceratophyllum demersum	Coontail		x	
Cladophora spp.	A filamentous green alga	x		
Chara spp.	Stonewort	x	x	x
Elodea canadensis	Waterweed	x		
Myriophyllum spicatum	Eurasian milfoil		x	x
Myrioplyllum spp.	Native milfoil	x	x	
Najas spp.	Bushy pondweed		x	x
Nuphar spp.	Yellow water lily	x	x	
Potamogeton amplifoilus	Large-leaf pondweed	x	x	x
Potamogeton gramineus	Variable pondweed	x		
Potamogeton illinoensis	Illinois pondweed			x
Potamogeton nodosus	American pondweed	x		x
Potamogeton richardsonii	Clasping-leaf pondweed	x		x
Potamogeton zosteriformis	Flat-stemmed pondweed	x	x	x
Potamogeton spp.	Thin-leaf pondweed	x	x	x
Scirpus spp.	Bulrush	x	x	
Utricularia spp.	Bladderwort		x	
Vallisneria americana	Wild celery	x	x	
Number species found		**12**	**11**	**9**

Eurasian milfoil has been of special concern in the lakes we studied. During our survey, we found this invasive species in Clam River near Butch's Marina as it flows into Torch Lake and in Torch Lake at the Alden Marina and between Stony Point and Lone Tree Point. These are sites where remediation efforts have occurred in the past.

The survey provided a good opportunity to learn aquatic plant identification. Some plants are easy to identify while others require looking more carefully. Figures 2 and 3 show the similarity between the native milfoil and nonnative Eurasian milfoil. In general, the number of tiny leaflets is higher in the nonnative species, but identification can be complicated if two species hybridize.

Figure 2. Native Northern milfoil

Figure 3. Nonnative Eurasian milfoil

Future Plans

Future plans are to sample aquatic plants in the north end of Torch Lake. Also, TLA will continue to consider possible remediation efforts for Eurasian milfoil, including possible new approaches.

References

http://www.micorps.net/documents/CommonRootedAqPlants-MSUE-WQ-55.pdf

TLA's FISH SHELTER PROJECT

By Alec Stilwell, Bellaire High School

The goal of the Fish Shelter Project, begun just this year by TLA and two other lake associations, is to deploy fish shelters in the five target lakes of Torch, Clam, Bellaire, Intermediate, and Elk. The reasons for this project are threefold: 1) to improve fishing in the five lakes, 2) to improve habitat for all species of fish and all life stages, and 3) to increase the population of fish-food organisms. These shelters are anticipated to improve the lakes' fish populations because fish gravitate to more complex habitats that offer places to hide from predators. TLA received an installation permit from the Michigan DEQ on June 1, 2012. We also obtained permission from all riparian property owners.

Types of Fish Shelters

To date, the project has focused on three types of shelters:

- Crate
- Split log
- Stump

Crate shelters consist of cubical frames with wood slats and are filled with sticks to simulate natural habitat. The split log shelters are made of half-logs attached to a central rod in a helical pattern on a wooden base, similar to a small tree. The relatively large stumps used to improve fish habitat are retrieved from local forests.

Figure 1. Construction of split log shelter

Figure 2. Construction of crate shelter

Figure 3. Finished shelters ready for deployment

Deployment

The three types of shelters have been deployed in eight locations in four lakes as the date of this writing. The five-year plan is to deploy fish shelters in up to 80 locations. Observations made by divers at the deployment locations are promising. The fish have colonized shelters in less than a week, as seen in Figure 4 on the following page.

Figure 4. Early colonization of fish shelters deployed in 2012

Future Plans

In partnership with the other lake associations, twelve more deployments are scheduled for 2012, with an additional twenty in 2013 and each subsequent year until all eighty shelter sites have been placed. With the help of Leah Varga, TLA 2012 TLA Research Associate, observations of the deployed shelters showed colonization at a rapid rate.

ELECTROFISHING SURVEY OF SHANTY CREEK

By Heather Hettinger, Michigan DNR Biologist, with notes in *italics* by Sierra Kintigh, Bellaire High School

Introduction

Shanty Creek is a tributary to the Grass River located in Antrim County, in the northwest lower peninsula of Michigan. Shanty Creek originates to the west of Schuss Mountain in section 4 of Custer Township. Shanty Creek flows to the west and crosses under highway M-88 before joining the Grass River. Shanty Creek is the first tributary to the Grass River downstream of Lake Bellaire.

Shanty Creek has a mainly sand and gravel bottom and flows through areas of upland hardwoods down to lowland conifer swamps as it approaches the Grass River. The stream itself has good overhanging cover, and the surrounding landscape is well vegetated, *(Figure 1).*

Figure 1. Electrofishing in Shanty Creek.

Shanty Creek is regulated by the state as a Type 1 stream, open to all tackle types. The daily possession for Type 1 streams is five fish, with an 8 inch minimum size limit (msl) for brown and brook trout and a 10 inch msl for Rainbow Trout, Coho and Chinook salmon.

Methods & Materials

On July 26, 2012 Shanty Creek was shocked with a backpack electrofishing unit. The goal of this study was to collect fisheries information around the site of a small dam that could potentially be removed in the near future and to collect data from a site downstream for comparison. Three locations along Shanty Creek were shocked: 1) upstream of highway M-88 in the Pinebrook development above a small dam, 2) in the Pinebrook development below the small dam and 3) downstream of highway M-88 at an old railroad grade crossing bridge.

Alec Stilwell and I met Heather at the Conservation District Office in Bellaire, MI. She introduced herself, and explained the backpack electrofishing unit. Heather would be carrying a large sack on her back with a shocker connected to it; a button on the pole would cause an electric field in the water, which would stun the fish once they swam into it. The fish were caught with the assistance of Alec and me and then were later measured and identified,
as shown below.

Figure 2. Measuring fish captured in Shanty Creek.

Results

Table 1
Fish Collected in Shanty Creek using a Backpack Shocker on July 26, 2012

Location	Brook Trout	Rainbow Trout	Brown Trout	*Mottled* Sculpins	Total Number of Fish By Site
Below the Dam at Pinebrook	23	2	0	2	27
Above the Dam at Pinebrook	19	2	0	6	27
Old Railroad Grade Bridge	14	0	8	17	39
Total Number of Fish by Species	56	4	8	25	

Table 2
Water Temperatures in Shanty Creek on July 26, 2012

Location	Time	Temperature
Below the Dam At Pinebrook	9:30 AM	62 °F
Above the Dam at Pinebrook	10:15 AM	60 °F
Old Railroad Grade Bridge	11:15 AM	55 °F

Discussion

Shanty Creek downstream of the dam on the Pinebrook property had a good gravel bottom and a good quantity of large woody debris. The stream is very shallow with exposed gravel bars and sand bars in the center. Very few holes or deep water cover are present. Shanty Creek upstream of the dam on the Pinebrook property is very sandy and the first 100 feet of stream above the dam was so filled in with soft sand that we were unable to wade through the sand effectively to shock. Near the top of the station by the footbridge, the bottom was predominately gravel. There was a good amount of large woody debris in this stretch as well, and deeper pools were more prevalent. Brook trout, rainbow trout, and mottled sculpins were collected both above and below the dam in pretty equal numbers and at relatively equal sizes (Table 1). Most of the fish collected below the dam were collected from the two deeper holes (~ 12 to 18 inches deep) at the log jam and in the plunge pool. The fish collected above the dam were well distributed through the station. The dam does appear to be impacting water temperatures, as the temperature above the dam was 2 °F cooler than the temperature below.

Shanty Creek at the old railroad grade crossing had a predominately sandy bottom, with good undercut banks, deeper water on average, and a good quantity of large woody debris. The deepest hole in the station produced two brook trout over 10 inches in length. The water temperature at this shocking location was 55 °F.

Recommendations

1) Since Shanty Creek is a naturally reproducing trout stream, it should be protected from uncontrolled development and poor land-use practices by working with MDEQ Water Resources Division to evaluate permit applications.

2) The dam on the Pinebrook property is a barrier for fish movement and is potentially causing a disruption of the thermal regime on Shanty Creek. If the property owners are willing, dam removal should be pursued.

3) The Three Lakes Association has been collecting temperature data on Shanty Creek for the past couple of summers; if dam removal does occur theses temperature loggers should remain in place to document the expected temperature benefits of this dam removal.

4) Continue to work with the Three Lakes Association and the Antrim Conservation District to protect Shanty Creek.

CHARACTERIZING THE CLAM RIVER OUTFLOW INTO TORCH LAKE

By Alec Stilwell, Bellaire High School

Introduction and Background

Many people have wondered why the water flowing out of Clam River into Torch Lake is a greenish-brown color. As can be seen in Figure 1, there is a distinct difference in the color of water flowing from Clam River into Torch Lake. Concerns about the Clam Lake plume arose during the fall of 2011 when Three Lakes Association (TLA) was reviewing a permit application submitted by Dewitt Marine to fill a small portion of wetland on the shoreline of Clam Lake.

Figure 1. Aerial view of Clam River as it discharges into Torch Lake on August 13, 2012.

The dark color of the Clam River water is not a new phenomenon. Postcards of this area from the 1960s captured this color mixing in aerial views. In both historic and recent aerial photos, Clam Lake's darker color is very visible as it mixes with the turquoise waters of Torch Lake near the Dockside restaurant. An increase in the size of the this color plume in recent years also has been observed by at least one long time summer resident in the bay immediately south of the mouth of Clam River. Following rain events and strong winds from the north-northwest, the plume now extends toward the bay between Stony Point and Lone Tree Point.

There were three likely hypotheses for the greenish brown color of the water:

1. Small photosynthesizing organisms called phytoplankton
2. Tannins and humic acids extracted from the banks of the river
3. A combination of the two

A concern with the filling of wetlands in the area near the mouth of the Clam River was that such action could increase nutrients in the water that otherwise would be filtered and adsorbed by the wetlands. These released nutrients in turn could contribute to increased algal and other phytoplankton growth in Clam River.

Materials and Methods

To characterize the Clam River outflow and the factors affecting its coloration, we sampled and analyzed water quality and organic composition. Sampling occurred not only at the outflow, but also in three other locations within the same hydrological and ecological system, as shown in Table 1. A sampling site location map can be found in the appendix.

Table 1
Location and Depths of Sampling Stations

Site Name	Site No.	Longitude	Latitude	Depth (ft.)
Lower Grass River near mouth	CL-001	44.55.03	85.13.31	5.00
Clam Lake Basin	CL-002	44.56.08	85.16.21	24.00
Clam River near Dockside	CL-003	44.56.33	85.17.02	3.35
Torch Lake west of plume	CL-004	44.56.42	85.17.56	245.00

Bottles provided by Great Lakes Environmental Center (GLEC) in Traverse City were used to collect water samples that were then returned to the GLEC lab for analyses of several parameters, including:

- Chlorophyll A
- Total Dissolved Organic Carbon
- Dry Weight Phytoplankton
- Total Phosphorus
- Nitrogen

We also used a Hydro-Lab that measured conductivity, pH, dissolved oxygen and temperature. The Hydro-Lab has underwater sensors that can send data back to a small screen (Figure 2).

Figure 2. Hydro-Lab with receiving apparatus

Plankton was collected in a conically-shaped tow net that concentrates algae, including diatoms, and other small organisms into a small metal trap, which is removable to retrieve a sample. The net is slowly towed behind a boat and the tow rate during collection is determined, therefore, making it possible to determine the dry weight of plankton captured per sample. (See Table 2 notes for additional details.) Before sending the plankton samples to the lab, we viewed them under a microscope and observed a variety or organisms (Figure 3). All samples were analyzed by August 31, 2012

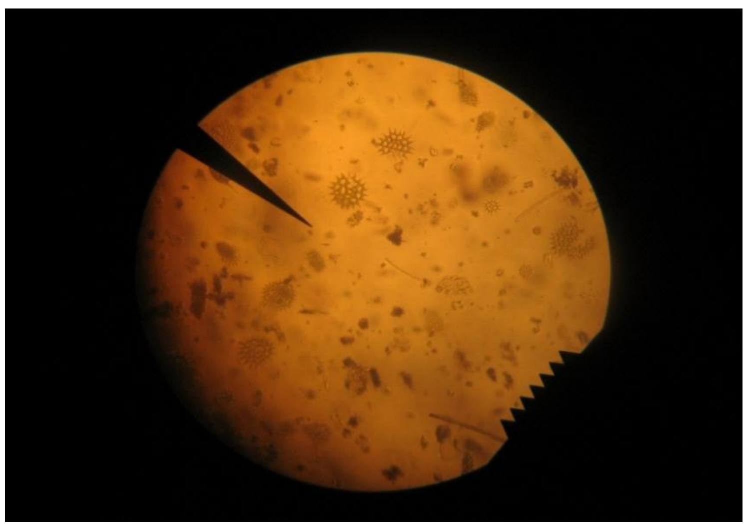


Figure 3. Microscopic view of phytoplankton collected from Clam River on August 3, 2012.

Results and Discussion

Table 2 summarizes the sampling results.

Table 2
Water Quality Parameters –
(From samples collected on August 3, 2012)

Sampling Stations	**Chlorophyll A (mg/L)**	**Phytoplankton Dry Weight* (mg)**	**Dissolved Organic Carbon (mg/L)**	**Total Phosphorus (ug/L)**	**Nitrogen (mg/L)**
Grass River Lower reach	0.57	64.5	5.2	Not sampled	Not sampled
Clam Lake Deep basin	2.73	58.0	5.7	3.3 – 6.9 ug/L**	Not sampled
Clam River At Dockside	2.38	79.5	6.2	8.6 ug/L	0.25 mg/L
Torch Lake Beyond visible plume	0.44	59.2	4.1	avg. 2.5 ug/L***	0.12 mg/L

* Phytoplankton tow volume = approximately 2,482 L based on a one-foot diameter net towed horizontally for two minutes at about 55.8 ft. per minute, which corresponds to 87.65 cubic feet or 2,482 L.
** Typical values for Total Phosphorus in Clam Lake range from 3.3 to 6.9 ug/L . (TLA CLMP)
*** Total Phosphorus concentration in Torch Lake based on hundreds of samples analyzed in 2006

Table 1 indicates that Chlorophyll A values on August 3, 2012 were markedly higher in both of the Clam Lake water samples compared to the Grass River or Torch Lake water samples. Dissolved organic carbon incrementally increased by 0.5mg/L in the three water samples along the flow route from Grass River to Clam Lake to Clam River, but sharply decreased in the Torch Lake water sample. Only one sample (at Clam River) was collected for total phosphorus analysis, but that result, 8.6 ug/L, was 2ug/L higher than historical values. Nitrogen in the water sample from Clam River was twice as high as nitrogen in the Torch Lake water sample. The historical values for nitrogen and phosphorus confirmed that phosphorus is the limiting nutrient. The dry weight plankton value for the water sample collected from Clam River was at least 15 mg higher than samples collected at the other sites.

While drawing many conclusions from a single day's study of the Clam River outflow is not scientifically valid, the results we obtained indicate differences in water samples from Clam River compared to other areas sampled. The dissolved organic carbon values in Clam River compared to Grass River are consistent with the brownish-green color of Clam River being partially attributable to naturally occurring chemicals such as tannins and humic acids extracted from the wetlands surrounding Clam Lake, but it also may be related to human activities, which have increased near Clam River.

The higher dry weight plankton values also indicate that algae and plankton organisms are responding to increased concentrations of nutrients in the water; these higher algal concentrations most likely influence the water's color. More detailed analyses of the algal composition of Clam River could provide more useful clues for interpreting water color. It also is important to note that the morphology of a waterway, including depth and width, can affect concentrations of water quality parameters. Clam River receives a large volume of water in a relatively narrow channel that becomes diluted after entering Torch Lake.

The assemblage of factors affecting the coloration and chemical composition of the Clam River outflow presents several opportunities for further investigation, as outlined below.

Recommendations

The following recommendations for a more comprehensive study are based on the results from the one-day screening of water quality parameters:

1) Conduct a similar study of Clam River next summer using a more comprehensive sampling strategy to address the following question:
   - ✓ Are the results reproducible?
   - ✓ Are there differences in water quality values (dry weight phytoplankton, dissolved organic carbon, chlorophyll A, and total phosphorus before the eastern no wake sign and the western no wake sign in the river narrows?
2) Review TLA’s historical *E. coli* test results from the Clam River site in search of possible sources of septic waste to explain the elevated phosphorus values.
3) Increase sampling frequency to once a month during the ice free months of Clam Lake- May, June, July, August and September
4) Apply TLA’s predictive Water-Quality Model for Clam Lake to forecast the Chlorophyll A values based on the elevated total phosphorus values.

References

Three Lakes Association, 2006, Predictive Water Quality Model for Torch Lake
Three Lakes Association 2003 - 2012 Cooperative Lake Monitoring Program

ENHANCING PUBLIC AWARENESS OF WATER QUALITY ISSUES

By Leslie Meyers, TLA Executive Director and 2012 Intern Coordinator

During the summer of 2012, Three Lakes Association (TLA) was involved in various public events to heighten public awareness of the organization's activities and also to highlight the work of the summer interns.

In conjunction with TLA's standard summer educational events, staff, volunteers and interns set up a booth at each session. The first event, "Got Fish," attracted not only 120+ attendees but also featured fish shelters awaiting deployment. The second event, "Antrim County Underground," boasted similar attendance and focused on the TCE groundwater plume near Mancelona. Because of the manned booth at each event, TLA attracted several new members, collected over $120 in donations to the Fish Shelter Project, and encouraged a few members to become more active as volunteers.

A "first" this summer was setting up a working booth at the Antrim County Fair. The three-day event drew a crowd of over 2000! Thanks to our interns and many volunteers, TLA provided education and information to most. Scaled-down models of the fish shelters were built and set up in a fish tank, complete with minnows served as our main draw. Once visitors to the booth were engaged by our Fish Shelter Program partnership, they became educated about Eurasian water milfoil (EWM), the importance of macroinvertebrate populations in our streams (Figure 1), the Science Education Outreach Program, and our high school internship program. As an added bonus, Governor Snyder stopped by the booth on Thursday while it was manned by the Interns (Figure 2). He expressed concern over the EWM issue, as it is affecting the lake at his summer home.

We hope that visitors to our booth got a better understanding and deeper appreciation of the streams and lakes in Antrim County. According to one Fair Director, "If there had been a Blue Ribbon for educational booths, TLA would have won hands down."

Additionally, this summer TLA's website (www.3lakes.com) got an update and "makeover" to make it fresher and more user-friendly. TLA expanded the use of our Facebook page, too. By regularly posting updates, we have tripled our "likes." These new "friends" represent a mixture of all generations. Check us out at www.Facebook.com/3lakes

(See photos on following page)

Future Goals

TLA will continue to promote its educational mission and expand as resources allow.

Figure 1. Kids learn about macroinvertebrates in our simulated “stream” at the county fair.

Figure 2. Interns Zach Pederson, Alec Stilwell, and Sierra Kintigh meet Governor Snyder!