A Shoreline Nutrient Pollution Survey on Lake Louise (Thumb Lake), 2007

By Tip of the Mitt Watershed Council

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SUMMARY

During the summer of 2007 the Tip of the Mitt Watershed Council conducted a nutrient pollution shoreline survey on Lake Louise that was funded by the Lake Louise Christian Community. Although nutrients are necessary to sustain a healthy aquatic ecosystem, excess can adversely impact an aquatic ecosystem, and indirectly poses a danger to human health. To determine if nutrient pollution was occurring in Lake Louise, the entire shoreline was surveyed for nutrient pollution indicators and contributing factors.

Data collected during the shoreline survey indicates that little if any nutrient pollution is presently occurring in Lake Louise. Watershed Council staff traveled along the shoreline in kayak, as close to the shore as possible, documenting excessive algae growth and elevated conductivity, which are both indicators of nutrient pollution. After compiling field data and generating maps using GPS information, four areas of the lake appeared to be contributing relatively more nutrient pollution: the embayments in the northeast and southeast corners, the northern part of the west shoreline, and the western side of the southern shoreline. Although parameters surveyed indicate that nutrient pollution is occurring, factors such as wind, wave action, currents, and groundwater paths make it difficult to determine pollution sources with certainty.

To achieve the full value of this survey, it is recommended that the Association engage in follow-up activities aimed at educating riparian property owners about preserving water quality, and to help them rectify any problem situations. Summary information regarding the survey should be provided to all shoreline residents along with information about what each person can do to help, but specific information for individual properties should remain confidential. Individual property owners should be contacted confidentially and encouraged to participate in identifying and rectifying any problems that may exist on their property. Ideally, shoreline surveys should be repeated every 3-5 years as shoreline ownership, management, and conditions change continually.

INTRODUCTION

Background:

A shoreline survey to identify locations of potential nutrient pollution was conducted on Lake Louise by the Tip of the Mitt Watershed Council during the summer of 2007. The entire shoreline was surveyed for *Cladophora* growth and for areas of elevated conductivity. The survey was funded by the Lake Louise Christian Community.

Nutrient pollution can have adverse impacts on an aquatic ecosystem, and indirectly poses a danger to human health. Nutrients are necessary to sustain a healthy aquatic ecosystem, but excess will stimulate unnatural plant growth. Increased abundance of aquatic macrophytes (higher or vascular plants) can become a nuisance to recreation in shallow areas (typically less than 20 feet of depth). An increase in algal blooms also has the potential to become a recreational nuisance when algal mats and scum form on the lake's surface. However, algal blooms can also pose a public health risk as some species produce toxins including hepatotoxins (toxins that cause liver damage) and neurotoxins (toxins that affect the nervous system). Excess growth of both macrophytes and algae has the potential to degrade water quality by depleting the ecosystem's dissolved oxygen stores. Plants respire at night, consuming dissolved oxygen and thus, competing with other organisms and potentially depleting the water's oxygen supply. Furthermore, as vascular plants and algae die, the aerobic activity of decomposers has the potential to deplete dissolved oxygen supplies, particularly in the deeper waters of stratified lakes.

In general, small, shallow lakes are more sensitive to nutrient pollution. Large lakes with greater water volume have a bigger buffer and thus greater resistance to nutrient pollution. The large lakes tend to have greater dissolved oxygen stores and the greater volume allows for greater dilution of nutrients. By contrast, small lakes generally have smaller stores of dissolved oxygen, a lesser ability to dilute nutrients and therefore, are more susceptible to the indirect impacts of nutrient pollution. Small lakes with extensive shallow areas are at even greater risk as there is more habitat to support excessive aquatic macrophyte growth. Lake Louise is relatively small in terms of surface area (~500 Acres), but is one of the deepest inland lakes in the State (maximum depth = ~152 feet). The high water volume as a result of depth makes Lake Louise less susceptible to nutrient pollution due to dilution. Conversely, Lake Louise is a seepage lake with no inflows or outflows, which prevents excess nutrients from flushing out of the system.

Surface waters receive nutrients through a variety of natural and cultural sources. Natural sources of nutrients include stream inflows, groundwater inputs, surface runoff, organic inputs from the riparian (shoreline) area and atmospheric deposition. Springs, streams, and artesian wells are often naturally high in nutrients due to the geologic strata they encounter and wetland seepages may discharge nutrients at certain times of the year. Cultural (human) sources include septic and sewer systems, fertilizer application in riparian areas, and stormwater runoff from roads, driveways, parking lots, roofs, and other impervious surfaces. Poor agricultural practices, soil erosion, and wetland destruction also contribute to nutrient pollution. Additionally, some cultural sources (e.g., malfunctioning septic systems and animal wastes) pose a potential health risk due to bacterial and viral contamination.

Severe nutrient pollution is detectable through chemical analyses of water samples, physical water measurements, and the utilization of biological indicators (a.k.a., bio-indicators). Chemical analyses of water samples to determine nutrient pollution is effective, though costlier and more labor intensive than the other methods. Typically, samples are analyzed to determine nutrient concentrations (usually forms of phosphorus and nitrogen), but other chemical constituent concentrations can be measured, such as chloride, which are related to human activity and often elevated in areas impacted by malfunctioning septic or sewer systems. Physical measurements are primarily used to detect malfunctioning septic and sewer systems, which can cause localized increases in conductivity (i.e., the water's ability to conduct an electric current) and water temperature. Biologically, nutrient pollution is commonly detected by noting the presence of *Cladophora* algae. During the Lake Louise shoreline survey, potential areas of nutrient pollution were identified by noting *Cladophora* growth and collecting conductivity and water temperature data.

Cladophora is a branched, filamentous green algal species that occurs naturally in small amounts in Northern Michigan lakes. Its occurrence is governed by specific environmental requirements for temperature, substrate, nutrients, and other factors. It is found most commonly in the wave splash zone and shallow shoreline areas of lakes, and can also be found in streams. It grows best on stable substrates such as rocks and logs, though artificial substrates such as concrete or wood seawalls are also suitable. *Cladophora* prefers water temperatures in a range of 50 to 70 degrees Fahrenheit, which means that the optimal time for its growth and thus, detection, in Northern Michigan lakes is from late May to early July, and from September and October.

The nutrient requirements for *Cladophora* to achieve large, dense growths are typically greater than the nutrient availability in the lakes of Northern Michigan. Therefore, the presence of *Cladophora* can indicate locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake. Although the size of the growth on an individual basis is important in helping to interpret the cause of the growth, growth features of *Cladophora* are greatly influenced by such factors as current patterns, shoreline topography, size and distribution of substrate, and the amount of wave action the shoreline is subject to. Therefore, the description has limited value when making year to year comparisons at a single location or estimating the relative amount of shoreline nutrient input. Rather, the presence or absence of any significant growth at a single site over several years is the most valuable comparison. It can reveal the existence of chronic nutrient loading problems, and help interpret the cause of the problems and assess the effectiveness of any remedial actions. Comparisons of the total number of algal growths can reveal trends in nutrient input due to changing land use.

Physical water measurements provide additional information to pinpoint areas of nutrient pollution caused by malfunctioning septic/sewer systems, but are particularly useful along lakeshore areas that do not have habitat suitable for *Cladophora* growth. If a septic system is malfunctioning due to mechanical failure or if a drainfield's capacity has been exhausted due to age, shallow groundwater is often contaminated and invariably migrates to adjacent surface water. Septic leachate tends to have high ion content due to dissolved substances in the waste water, such as salts. Increasing the number of ions in the water increases the conductivity and therefore, measuring conductivity in near-shore areas provides a feasible method for detecting septic leachate pollution. In addition, septic leachate pollution can be detected in areas of strong groundwater inputs by measuring water temperature, which may be elevated where contaminated by septic leachate.

The Watershed Council employs a system dubbed the "septic leachate detector" (SLD), whereby near-shore areas are monitored using a continuous flow pump system and a portable conductivity meter. This system has proven to work well for identifying shoreline areas polluted by septic leachate, but there are naturally occurring phenomena that can confuse the signal. For example, streams often have higher conductivity levels than lakes and therefore, strong differences in conductivity may be due to stream inlets on the lake shore. SLD surveys are usually conducted in the fall as septic contamination in shoreline areas is typically at its peak after heavy seasonal use.

According to Tip of the Mitt Watershed Council records, this survey provides the third comprehensive data set documenting shoreline nutrient pollution on Lake Louise; a valuable data set that can be used as a lake management tool. Coupled with follow-up questionnaires and on-site visits, controllable sources of nutrients to the lake can be identified. Subsequently, a reduction in nutrient loading can often be achieved by working with homeowners to solve problems. These solutions are often simple and low cost, such as regular septic system maintenance, proper lawn care practices, and wise land use along the shoreline. Prevention of problem situations can also be achieved through the publicity and education associated with the survey. Periodic repetition of shoreline surveys is important for identifying chronic problem sites as well as recent occurrences. They are also valuable for determining long-term trends of near-shore nutrient inputs associated with land use changes, and for assessing the success of remedial actions.

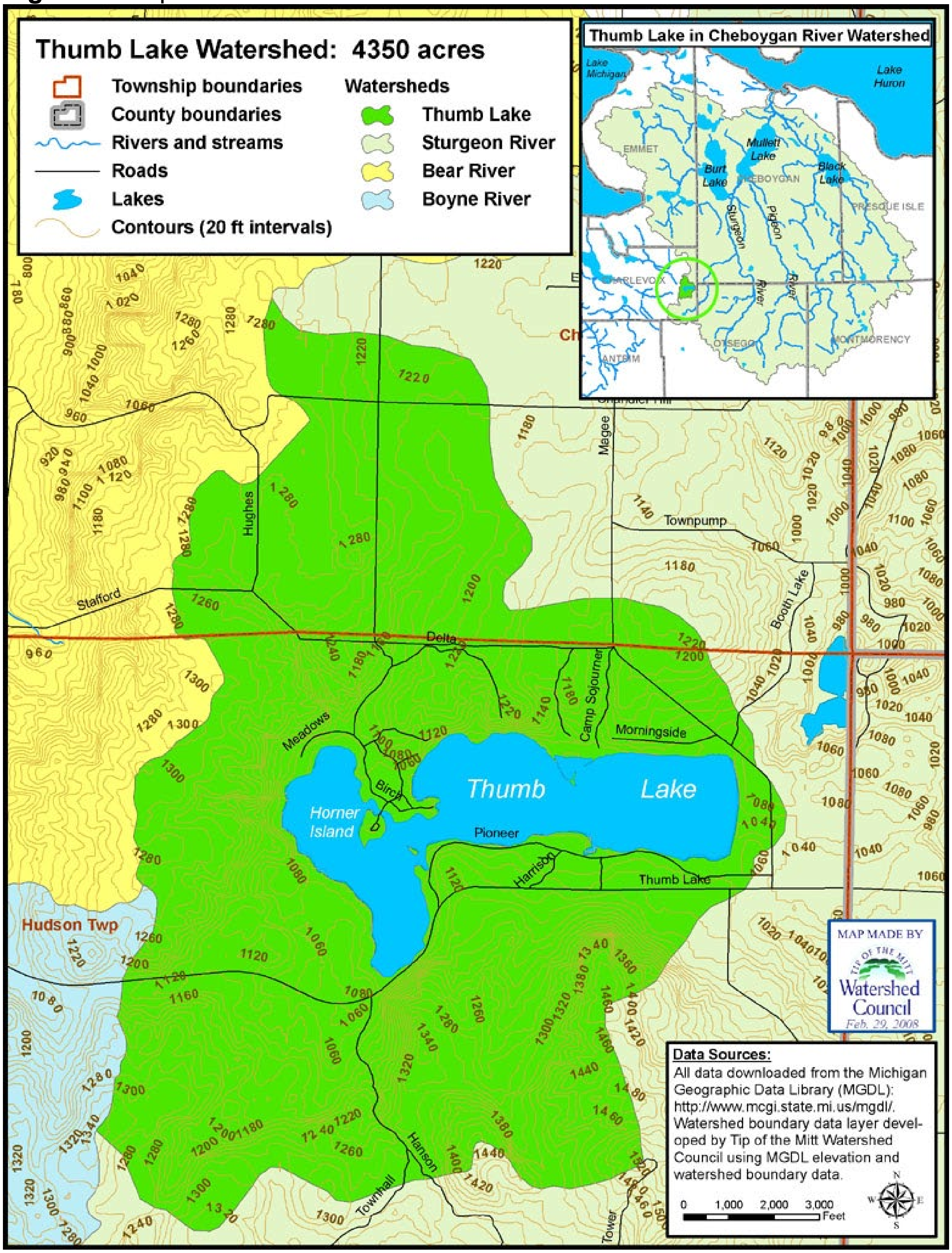
Study area:

Lake Louise is located in the northern Lower Peninsula of Michigan in the southeast corner of Charlevoix County. The entire lake falls within Hudson Township in Charlevoix County. Based upon shoreline digitizing of 2004 aerial photographs, the surface area of Lake Louise is approximately 510 acres and the shoreline distance, including islands, totals roughly 7.5 miles. The deepest point is located in the west end of the lake and is reported to be 152 feet deep.

Lake Louise is a glacially formed kettle lake that sits at the headwaters of the Sturgeon River. There are a few minor inlets and no outlet streams. Due to the lack of an outlet, Lake Louise is considered a seepage lake. Seepage lakes lose water only through evaporation and groundwater channels, which means that lake water has a long residence time in relation to drainage lakes (lakes with outlets). If the water quality of Lake Louise were to seriously deteriorate from pollution in the form of a persistent contaminant, natural recovery would be slow due to being a seepage lake.

The Lake Louise watershed is a sub-watershed of the Sturgeon River watershed, which is, in turn, part of the larger Cheboygan River Watershed. Lake Louise has a small watershed in relation to the lake's surface area, measuring approximately 3,840 acres (does not include lake area). The watershed area to lake surface area ratio is ~8:1, which, compared to other lakes in Michigan, is quite low (e.g., Huffman Lake has a ratio of ~46:1). This ratio provides a statistic for gauging susceptibility of lake water quality to changes in

Figure 1. Map of the Lake Louise watershed.



watershed land cover. Essentially, the ratio indicates that the small size of the Lake Louise watershed provides only limited buffer protection, such that small areas of development in the Lake Louise watershed have the potential to negatively impact water quality.

According to land cover statistics from a 2000 land cover analysis (NOAA, 2003), the majority of the watershed is forested. Of land cover types that typically contribute to water quality degradation, there is little agriculture and even less urban/residential in the watershed (Table 1).

Table 1. Lake Louise watershed land cover, 2000.

Land Cover Type	Acres	Percent
Agriculture	152.13	3.50
Barren	0.67	0.02
Forested	3354.29	77.06
Grassland	140.04	3.22
Scrub/Shrub	30.44	0.70
Urban/residential	54.18	1.24
Wetland	99.97	2.30
Water	520.90	11.97

According to data collected in programs coordinated by the Tip of the Mitt Watershed Council, Lake Louise contains high quality waters that are typical for the region. As part of the Watershed Council's Comprehensive Water Quality Monitoring Program (CWQM), numerous parameters have been monitored in Lake Louise on a triennial basis since 1987. Both dissolved oxygen and pH consistently comply with standards established by the State of Michigan (Table 2). Conductivity and chloride levels have remained low throughout monitoring, which indicates that there is little impact from urbanization and residential development. Typical of high-quality lakes in northern Michigan, nutrient concentrations on Lake Louise have been quite low (total phosphorus, nitrate and total nitrogen).

Table 2. Lake Louise data from the CWQM program.

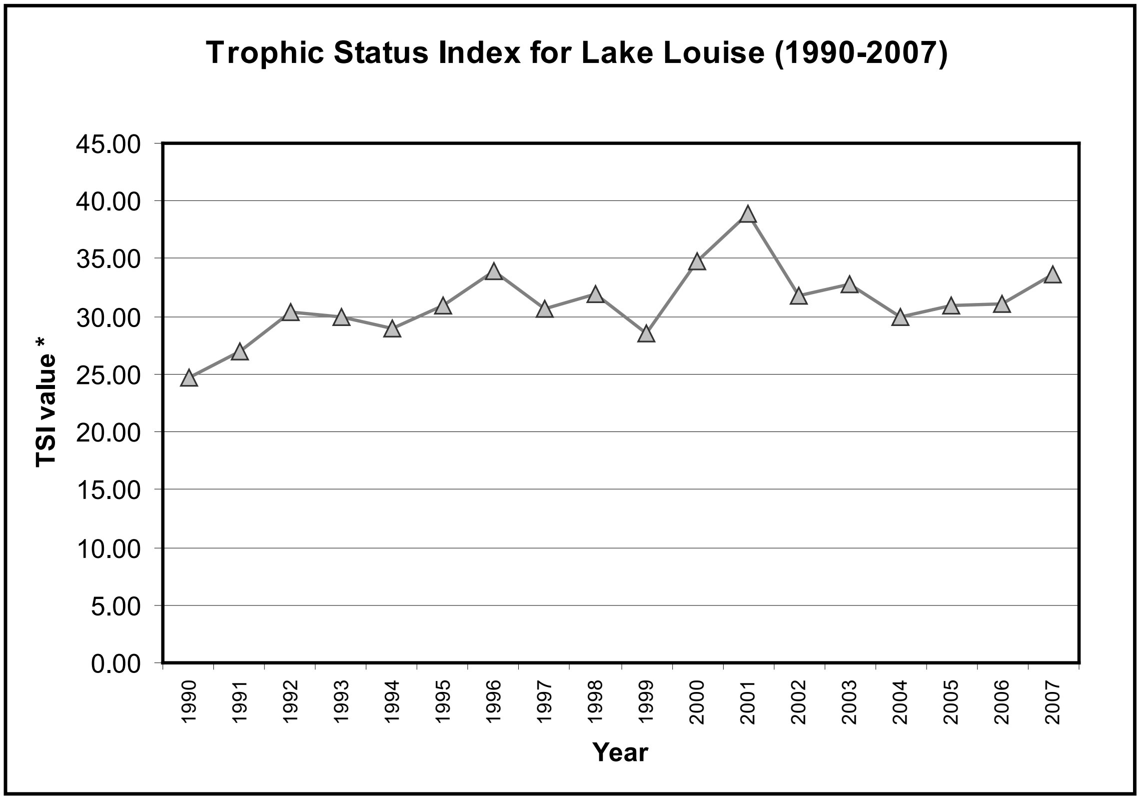
	DO*	pH*	Conductivity	Chloride	Nitrate	TN*	TP*
Units	PPM**	Units	microSiemens	PPM**	PPB**	PPB**	PPB**
Average	10.72	7.90	197.83	3.33	140.00	460.00	10.25
Minimum	8.51	7.28	175.10	1.00	37.00	246.00	2.50
Maximum	12.40	8.60	218.00	10.20	510.00	910.00	35.30

*DO = dissolved oxygen, TN = total nitrogen, TP = total phosphorus
**PPM = parts per million, PPB=parts per billion.

Data from the CWQM program indicate that there is little impact from human development in the watershed. Chloride concentrations and conductivity values tend to increase in areas with strong human population pressure and consequent landscape development. Both of these parameters have remained relatively steady over the two decades that they have been monitored in Lake Louise and are at low levels typical for non-impacted, pristine lakes in this region of Michigan.

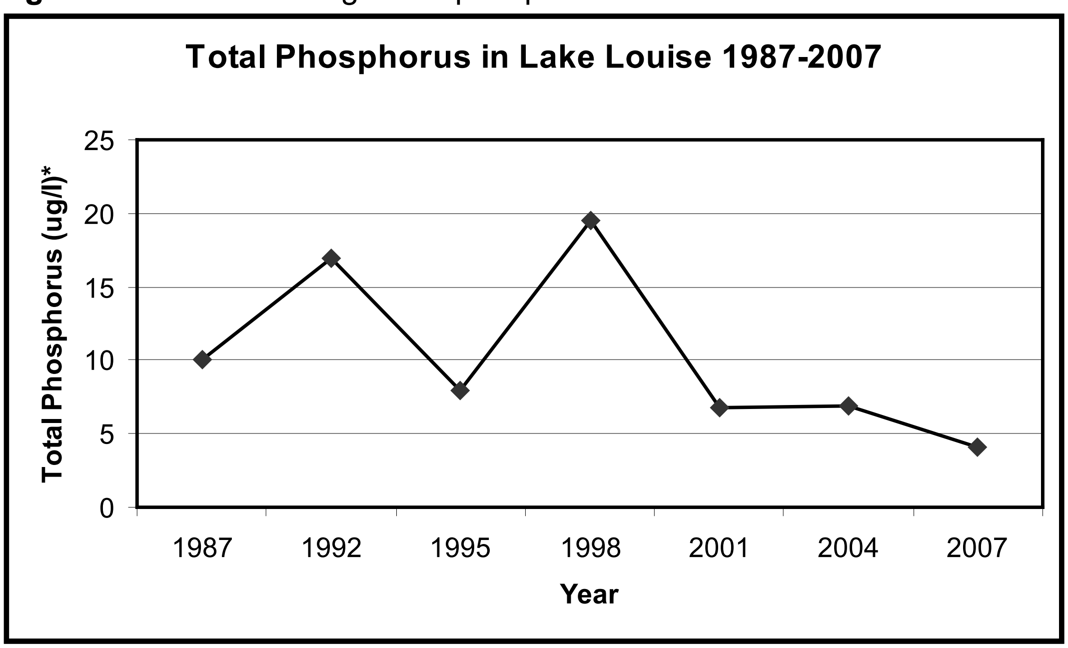
Based on data collected as part of the Watershed Council's Volunteer Lake Monitoring Program, Lake Louise is classified as an oligotrophic lake (Figure 1). Oligotrophic lakes are characteristically deep, clear, nutrient-poor water bodies. Phosphorus data from the CWQM program supports this characterization as concentrations have typically been less than 10 parts per billion and have been decreasing over time (Figure 2). In contrast to phosphorus, Secchi disc depth data show a trend of Lake Louise becoming more productive. Water clarity, as measured with a Secchi disc, shows a decrease over time (Figure 3). Chlorophyll-a data, an indirect measure of algal biomass, appears to have stayed the same or increased slightly over time (Figure 4). Thus, Secchi disc data make it appear that Lake Louise is becoming more productive, possibly as a result of increased algae abundance, and moving away from oligotrophy.

Figure 2. Chart of trophic status index values in Lake Louise.



* Lower values (0-38) indicate an oligotrophic or low productive system, medium values (39-49) indicate a mesotrophic or moderately productive system, and higher values (50+) indicate a Eutrophic or highly productive system.

Figure 3. Chart of average total phosphorus concentrations in Lake Louise.



*ug/l = micrograms/liter = parts per billion.

Figure 4. Chart of average Secchi disc depths in Lake Louise.

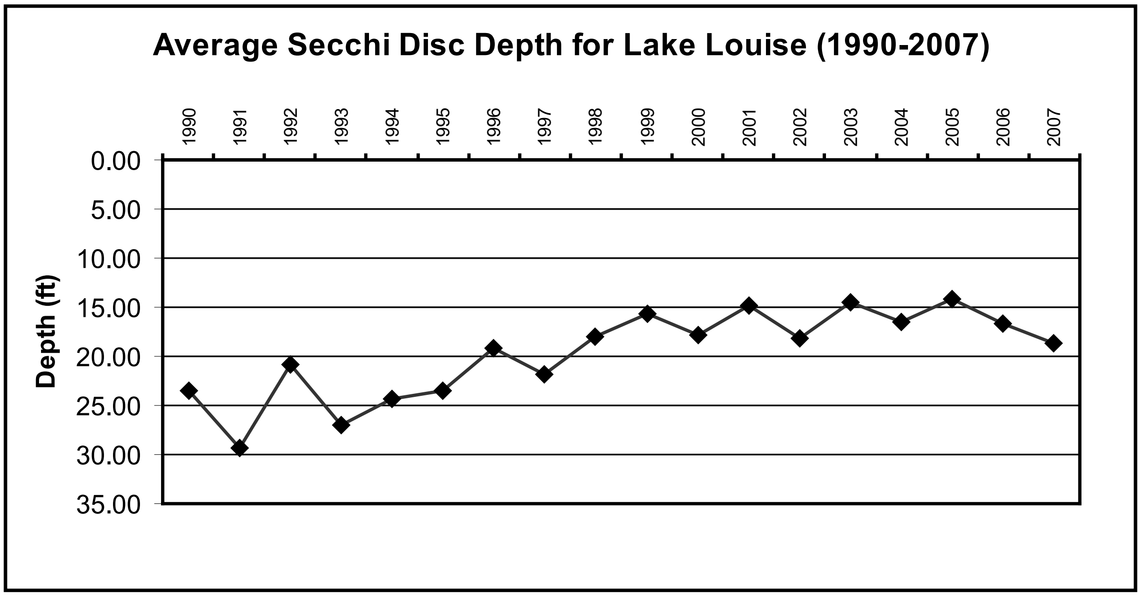
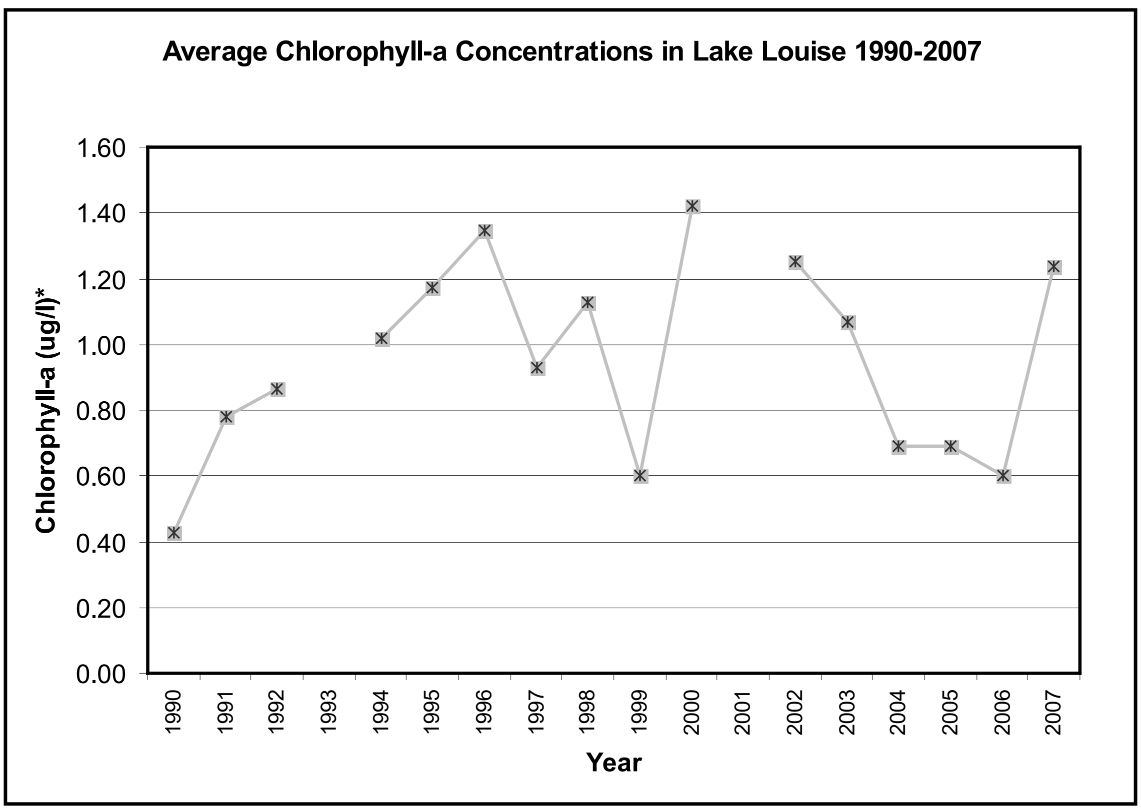


Figure 5. Chart of chlorophyll-a concentrations in Lake Louise.



*ug/l = micrograms/liter = parts per billion.

METHODS

The Lake Louise shoreline was surveyed in a kayak during the summer and early fall of 2007 to document signs of nutrient pollution. On a first pass around the lake on June 11, 2007, all shoreline parcels were photographed with a digital GPS camera and shoreline features were noted for each parcel. Traveling as close to the shoreline as possible (usually within 20 feet), the entire shoreline was examined for the presence of *Cladophora*. During a second pass on September 20-23, 2007, near-shore waters were monitored with the septic leachate detector. All information was recorded on field data sheets, subsequently inputted into a database, and used in conjunction with GPS data to link field data to photographs and to historic shore survey databases.

Shoreline Features

Shoreline property features were documented by taking pictures with a Ricoh Caplio Pro G3 GPS camera and by noting physical features on a data sheet, such as building descriptions, public access sites, and county road endings. Due to data sheet space limits, building descriptions were recorded in an abbreviated cryptic style. For example, *Red 2 sty, brn rf, wht trm, fldstn chim, lg pine* means that the property has a red two-story house with a brown roof, white trim, fieldstone chimney, and a large pine tree in the yard. Whenever possible, names of property owners and addresses were included.

Developed parcels were noted on field data sheets and included as a separate column in the database. Properties described as developed indicate the presence of buildings or other significant permanent structures, including roadways, boat launching sites, and recreational properties (such as parks with pavilions and parking lots). Properties with only mowed or cleared areas, seasonal structures (such as docks or travel trailers), or unpaved pathways were not considered developed. Additionally, relatively large parcels that may have development in an area far from the water's edge were not considered developed. The length and area of developed versus undeveloped shoreline was not calculated.

Shoreline alterations were also noted during the field survey and included as a separate column in the database. Examples of alterations include seawalls, rip-rap, rock jetties, and concrete bulkheads. Shoreline alterations were simply noted as present or absent.

Lake bottom types were also noted during the field survey and included as a separate column in the database. Bottom types (substrates) are important because *Cladophora* requires a hard substrate to grow. Soft substrates necessitate use of the Septic Leachate Detector to survey for nutrient pollution. The following abbreviations were used to note bottom types:

R = rock
G = gravel
S = sand
M = muck

If multiple bottom types were present, all were noted.

Tributaries are one of the primary conduits through which water is delivered to a lake or river from its watershed. Tributaries also carry and deliver a variety of materials from throughout the watershed to the receiving water. This can include pollutants such as sediment, nutrients, bacteria, and toxins from human activities far removed from a lake or river. *Cladophora* growths and elevated conductivity levels often occur at the mouth of tributaries. Therefore, tributary streams were documented during the survey, mapped with a Trimble GeoExplorer3 GPS unit, and included in a separate column in the database.

Additional information regarding shoreline property features or nutrient pollution that was written on field data sheets was also inputted into the database. This information was added to a column entitled “comments”.

Nutrient Pollution Indicators

Many species of filamentous green algae are commonly found growing in the nearshore regions of lakes. Positive identification of these species usually requires the aid of a microscope. However, *Cladophora* usually has an appearance and texture that is quite distinct to a trained surveyor, and these were the sole criteria upon which identification was based.

Other species of filamentous green algae can respond to an external nutrient source in much the same way as *Cladophora*, although their value as an indicator species is not thought to be as reliable. When other species occur in especially noticeable, large, dense growths, they are recorded on the survey maps and described the same as those of *Cladophora*.

Among other things, the distribution and size of each *Cladophora* growth is dependant on the amount of suitable substrate present. The extent of suitable substrate should therefore be taken into account when interpreting the occurrence of individual growths, and assessing the overall distribution of *Cladophora* along a particular stretch of shoreline. Substrate types were recorded during the survey, but the extent of different types was not noted.

When *Cladophora* was observed, it was described in terms of the length of growth along the shoreline and relative growth density. In addition, shoreline features that potentially contribute to growth, such as drainpipes and erosion, were noted. Shoreline length and growth density are subjective estimates. Growth density is determined by estimating the percentage of substrate covered with *Cladophora.* The categories and determinations for growth density are as follows:

Table 3. Categories and determinations for *Cladophora* density.

Density Category	**Field Notation**	**Substrate Coverage**
Very Light	(VL)	0% *
Light	(L)	1- 20%
Light to Moderate	(LM)	21-40%
Moderate	(M)	41-60%
Moderate to Heavy	(MH)	61-80%
Heavy	(H)	81-99%
Very Heavy	(VH)	90-100% *

**Very Light is noted when a green shimmer is noticed on hard substrate, but no filamentous growth present. Very Heavy overlaps with heavy and is distinguished by both high percentage of substrate coverage and long filamentous growth.*

A septic leachate detector (SLD) was used during the second pass throughout most of the shoreline, but with particular focus on parcels that had no or partial *Cladophora* habitat. The SLD consists of a water pumping system that provides continuous flow to a chamber to measure the conductivity of the water. Using the SLD, water was pumped from as close to the shoreline as possible (ideally within 1-2 feet) and conductivity levels were continually monitored to note changes. Low lake levels as a result of an extended drought throughout the spring and summer of 2007 made it difficult to approach the shoreline in kayak. Consequently, some shoreline areas were surveyed directly with the meter by walking in shallow shoreline areas and testing conductivity at frequent intervals.

Data Processing

Upon completing field work, all field data was transferred to computer. Information recorded on field data sheets was inputted into a Microsoft Excel® workbook. Digital photographs and GPS data were uploaded to a computer at the Watershed Council office and processed for use. The digital photographs were renamed to match the identification number used for each property in the database.

Field data were linked to GPS points collected during the survey and maps were made using a Geographical Information System (GIS). Both tabular data and digital photographs were linked to GPS points to create a GIS data layer that permits the user to view data and photographs from selected points. This data layer was overlaid with other GIS data from the State of Michigan to produce the maps contained in this report.

Final products include a comprehensive database, digital GPS photographs, and a GIS data layer that includes both database and GPS information. The shoreline survey database contains a sequential listing of properties beginning at the boat ramp in the southwest corner of the lake (the “thumb”) and traveling counter-clockwise around the entire perimeter of the lake. The database contains all field data (Appendix A) with identification numbers that correspond to those in the GIS data layer and on the hard-copy map.

RESULTS

This survey documented conditions along 167 distinguishable shoreline segments on Lake Louise. Some portion of the shoreline was developed at 145 of these shoreline segments (87%). Habitat generally considered suitable for *Cladophora* growth was present along at least part of the shoreline of 130 land segments (78%). During the June 2007 survey, noticeable growths of *Cladophora* or other filamentous green algae were limited to six shoreline segments (4%). The septic leachate detector survey in September of 2007 showed increased conductivity levels at 32 shoreline segments (19%).

Cladophora growths were found in three areas: in the small cove to the southeast of the small island at the channel connecting the east and west basins of the lake; in front of one residence on the south side of the west half of the eastern basin; and near the bridge to Horner Island. Although a few of the growths were classified as “heavy”, field observations indicate that growth at five of the six shoreline areas could have been the result of natural conditions.

Increases in conductivity were recorded with the SLD in shoreline areas scattered along most of the lakeshore. Conductivity levels ranged from 178 to 250 microSiemens/centimeter (µS/cm) and there was quite a bit of variability in the readings from one area of the lake to another and from day to day. For example, conductivity levels were as high as 250 µS/cm at the undeveloped area to the northeast of the boat launch, yet as low as 186 µS/cm at the point to the south of the smaller unnamed island. The second day of data collection with the SLD showed an increase of 10 µS/cm at the same location measured three days earlier. This variability could be due to natural factors, a consequence of the frequent inaccessibility to the shoreline due to low lake levels, or equipment issues.

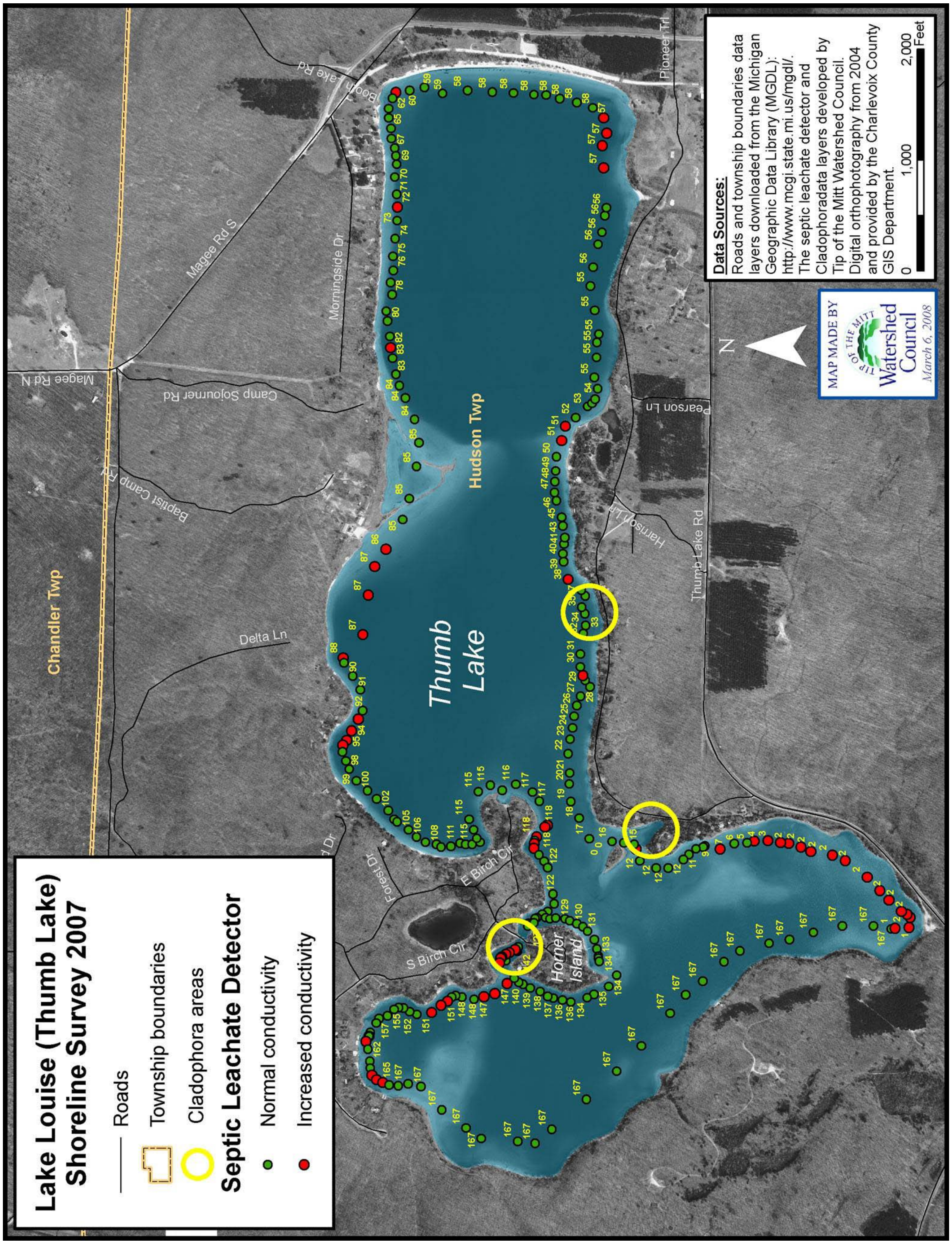
Maps made in a GIS using field notes linked to GPS data were developed to examine the spatial distribution of occurrences of *Cladophora* growth and conductivity increases (Figure 3). There did not seem to be any clear patterns as

Cladophora growths appeared to occur independently of increases in conductivity. There is an apparent overlap between nutrient pollution indicators on the map near the Horner Island Bridge. However, Cladophora was documented on the south side of this embayment and conductivity increases occurred on the north side.

Only one tributary stream was documented during the survey. An inlet stream was noted flowing into the lake on the undeveloped parcel to the northwest of the boat launch. GIS data layers from the State of Michigan indicate that another stream flows into Lake Louise on the west shoreline along the undeveloped parcel to the north of Camp Kinawind.

Shoreline alterations were noted along 65 of shoreline areas surveyed (39%). Most shoreline alterations consisted of riprap, though there were also a number of areas with wood seawalls or added beach sand.

Figure 6. Map of Lake Louise Shore Survey 2007 results.



DISCUSSION

The Lake Louise shoreline showed little to no evidence of nutrient pollution during the 2007 shoreline survey. Although some of the algae growth and conductivity increases might be caused by septic system leachate or other factors associated with development and human activities, the majority is probably due to natural ecosystem processes. The lack of biological and physical nutrient pollution indicators exemplifies the success of efforts by the Lake Louise Christian Community to monitor and protect the lake's water quality.

Conductivity data collected with the SLD showed increases at many points along the lake shoreline, but these increases were probably not caused by nutrient pollution. Streams, springs and seeps flow into Lake Louise at different points along the shoreline, delivering water that could potentially increase or decrease conductivity depending on the ion content. If factors such as failing septic systems or stormwater outlets were causing increases in conductivity levels, then nutrients from the same sources would stimulate algae growth. However, very little algae growth was observed during this survey and there was little overlap between increased conductivity levels and *Cladophora* growths. Therefore, the variability in conductivity numbers along the lakeshore is believed to be, for the most part, natural.

Water quality monitoring data from Lake Louise are ambiguous; both supporting and refuting the results of this survey. Nutrient pollution in Northern Michigan lakes is typically caused by increases in phosphorus concentrations, which causes algae blooms that then, decrease water clarity. Data collected in the Watershed Council's CWQM program show a decrease in phosphorus concentrations over time, which supports results of this survey. However, results from the Watershed Council's Volunteer Lake Monitoring Program show a decrease in water clarity and slight increase in chlorophyll-a (algae abundance) since the early 1990s. Thus, results of these two monitoring programs run contrary to one another.

Recommendations

The full value of a shoreline survey is only achieved when the information is used to educate riparian property owners about preserving water quality, promote stewardship of the resource, and help them rectify any problems. The following are recommended follow-up actions:

1. Keep the specific results of the survey confidential (i.e., do not publish a list of sites where filamentous algae or high SLD readings were found) as some property owners may be sensitive to publicizing information regarding their property.

2. Send a general summary of the survey results to all shoreline residents and emphasize the success of the Lake Louise Christian Community's efforts to protect and improve water quality. Optionally, a packet of informational brochures produced by the Watershed Council and others can be sent out with the summary to provide information about dangers to the lake ecosystem and public health as a result of nutrient pollution as well as practical, feasible, and effective actions to protect water quality. This would cost approximately $5 to $25 per household, depending on the complexity and type of materials distributed.

3. Inform owners of properties with *Cladophora* growths or SLD signals of the specific results for their property, ask them to fill out a questionnaire in an attempt to interpret causes of the growth/signals, and offer individualized recommendations for water quality protection. Although we believe that little nutrient pollution is occurring in Lake Louise, taking this action may uncover problems that were not obvious during the survey. Following the questionnaire survey, property owners have the option to contract the Watershed Council to perform site visits and even conduct ground water testing in an effort to gain more insight into the nature of the

findings. Again, it should be stressed that all information regarding names, specific locations, and findings be kept confidential to encourage property owner participation in this project.

4. Repeat some version of the survey periodically (ideally every 3-5 years), coupled with the follow-up activities described previously, in order to promote water quality awareness and good management practices on an ongoing basis. During each subsequent survey, more information about shoreline features could be added to the database. The database will also facilitate future surveys, resulting in a reduction of staff hours needed for repeating the survey, and can be utilized for other water resource management applications.

5. Continue to support the Tip of the Mitt Watershed Council Volunteer Lake Monitoring program by providing volunteer support. The information collected by volunteers is extremely valuable for evaluating long-term trends and determining causes of change in water clarity. The Community is encouraged to continue supplying volunteer help. Volunteers should attend training sessions held by the Watershed Council to ensure that a complete set of quality data is being collected each year. In addition, the Association should consider funding the collection of phosphorus data by the volunteer monitor (generally less than $50 per year for water chemistry analyses).

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Appendix A. Lake Louise 2007 shoreline survey database.

ID	Property Description 2007	Last Name	First Name	Summer Address
1	MDNR public access site			
2	Undeveloped stretch along highway			
3	Red brick & red stained wood siding, obscr	Compton	Lewis and Jean	10155 Pioneer Trail, Boyne Falls, MI 49713
4	Brown, wht trm, red rf, fldstn found, log blkhd, brn boaths	Compton	Asa and Warda	10161 Pioneer Trail, Boyne Falls, MI 49713
5	Grey 2 sty, grey rf	Baldwin	Maryanna	10167 Pioneer Trail, Boyne Falls, MI 49713
6	2 sty log home, natural finish, grey rf, block terraces & chimn	Renton	Don and Barbara	10173 Pioneer Trail, Boyne Falls, MI 49713
7	Log cabin, gry-grn rf, fldstn chim, rock terrace, porch, log boaths	Cieslak	Ronald and Joyce	10179 Pioneer Trail, Boyne Falls, MI 49713
8	Sm brn log cabin, wht trm, fldstn chimn, obscr	Pankey	Janet Tuuri	10185 Pioneer Trail, Boyne Falls, MI 49713
9	Green log cabn, brn rf, large windows	Beers	Birt and Helen	10191 Pioneer Trail, Boyne Falls, MI 49713
10	Grn 2 sty log cabn, brn & wht trm, brn rf, obscr	Salow	Patrick and Karen	10199 Pioneer Trail, Boyne Falls, MI 49713
11	Brn log cabn, wht trm, brn wd beach shed, metl rail, obscr	Joranko	Joyce	10205 Pioneer Trail, Boyne Falls, MI 49713
12	Yellow 2 sty, blk trm, fldstn chim, on bluff at point	Harrison	Robert and Rona	10211 Pioneer Trail, Boyne Falls, MI 49713
13	Undeveloped wetland cove			
14	2 sty, tan vinyl siding over old log cabin, fldstn chim	McGuire	Donald and Mary	10217 Pioneer Trail, Boyne Falls, MI 49713
15	Sm wht cottage, blk rf	Ward	Thomas and Carol	10223 Pioneer Trail, Boyne Falls, MI 49713
16	Grn horizontal log cabn, wht trm, grey rf, porch	Harrington	Phyllis	10229 Pioneer Trail, Boyne Falls, MI 49713
17	Brn log cabn, lg scrn porch, block found, fldstn chim, at bend	Schaub	Paul	10235 Pioneer Trail, Boyne Falls, MI 49713
18	Varn knotty pine chalet, grn trm, lg deck	Cotton	J. Kingsley	10241 Pioneer Trail, Boyne Falls, MI 49713
19	Yellow & fldstn 2 sty, lg fldstn terraces,	O'Hara	Thomas & Eleanor	10247 Pioneer Trail, Boyne Falls, MI 49713
20	Brn log cabn, wht trm, fldstn found & chim	Moore	Robert and Betty	10253 Pioneer Trail, Boyne Falls, MI 49713
21	Cement block 2 sty, flat-sloped rf, red trm, balcony	Yinger	H. Vincent	10334 Pioneer Trail, Boyne Falls, MI 49713
22	4-way stone A-frame, red trm, lg deck, red beach shed	Sharp	A. Jefferson	10360 Pioneer Trail, Boyne Falls, MI 49713
23	Lg blue 2 sty, wht trm, blk rf, 2 decks	Clapp	Jon and Karen	10382 Pioneer Trail, Boyne Falls, MI 49713
24	Vacant lot			
25	Obsc brn log cabn, fldstn chim, A-frame boathse	Mulder	David & Elizabeth	10492 Pioneer Trail, Boyne Falls, MI 49713
26	Fldstn siding & chim, rd-brn rf, red beachhs, obscr	Ainsworth	Elizabeth	10500 Pioneer Trail, Boyne Falls, MI 49713
27	2 sty brn log cabn, brn rf, timber seawall, mtch boathse	Adan	Al and Nancy	10512 Pioneer Trail, Boyne Falls, MI 49713
28	Varnish log, grn rf & trm, lg shore deck, obscr, mtchg log beach shed	Kapnick	Catherine	10540 Pioneer Trail, Boyne Falls, MI 49713
29	2 sty brn log cabn, bm rf, fldstn & red brk chims	Routhieaux	Thomas and Else	10547 Pioneer Trail, Boyne Falls, MI 49713
30	Yellow log cabin, blk rf, fldstn found & chim	Pirie	Alex & Marilyn	10569 Pioneer Trail, Boyne Falls, MI 49713
31	Brn log cabn, fldstn found & chim, yell trm, red boathse, setback	Janke	Kenneth and Daisy	10608 Pioneer Trail, Boyne Falls, MI 49713
32	Blue red wht trim, red rf,wht block chimm, near shore	Lyndon	Richard and Karen	10626 Pioneer Trail, Boyne Falls, MI 49713
33	Tan brk, blue & yell trm, reddish rf	Meyer	Dan and Kay	10634 Pioneer Trail, Boyne Falls, MI 49713
34	Obsc log cabn, fldstn found, wood seawall	Niles	Harold and Mary	10650 Pioneer Trail, Boyne Falls, MI 49713
35	Grn-stained vert log cabn, brn rf, fldstn chim, mtch bchshed, obscr	Niles	Philip & Virginia	10676 Pioneer Trail, Boyne Falls, MI 49713

ID	Property Description 2007	Last Name	First Name	Summer Address
36	Blu-grey siding, rd-brn trm, lg windows, brn log boaths, obscr	Huber	Milton and Ruth	10690 Pioneer Trail, Boyne Falls, MI 49713
37	Brn log cabn, wht chinking, fldstn found, brn boatshed	White	Gloria	10707 Pioneer Trail, Boyne Falls, MI 49713
38	Yell 2 sty, fldstn chim, grn-grey rf, block seawall, boathse	Simons	John	10715Pioneer Trail, Boyne Falls, MI 49713
39	Brn log, cedr-shngl front, lattice lower, fldstn chim, brn rf, wht trm	Brubaker	Ellen	10727 Pioneer Trail, Boyne Falls, MI 49713
40	Brn log cabn, wht chinking, fldstn chim, grn boathse	Brubaker	Dale	10739 Pioneer Trail, Boyne Falls, MI 49713
41	Orange 2 sty log cabn, grn trm, scrn porch	Gschwind	Thomas and Betsy	10745 Pioneer Trail, Boyne Falls, MI 49713
42	Red log cabn, wht trm & chinking, red block boathse	Isakson	Larry and Vicky	10759 Pioneer Trail, Boyne Falls, MI 49713
43	Brn log cabn, wht trm, unpainted block boathse	Nichols	Yulonne	10771 Pioneer Trail, Boyne Falls, MI 49713
44	Vacant lot			
45	Brn-stained 2 sty, balcony deck, lg side porch	Mauch	Eugene & Sherlee	10795 Pioneer Trail, Boyne Falls, MI 49713
46	Grn 2 sty log cabn, wood seawall	Marshall	John and Barbara	10801 Pioneer Trail, Boyne Falls, MI 49713
47	Natural log cabn, fldstn chim, grn rf	Cotton	John and Lois	10819 Pioneer Trail, Boyne Falls, MI 49713
48	Flagstn & nat wd front, flgstn chimn, angular front, lg windows	McKay	Orville	10835 Pioneer Trail, Boyne Falls, MI 49713
49	Gray cottage, orange logs in back, brn rf & trm, skylights	Strong	David and Marcia	10857 Pioneer Trail, Boyne Falls, MI 49713
50	Red log cabn, wht chinking, brn rf, wht & mtl trim, obscr	Vosburg	Marvin and Sharon	10879 Pioneer Trail, Boyne Falls, MI 49713
51	Yellow & brown 2 sty, porch w/ vert log, obscr	Yinger-Quinlan	Yvonne	10891 Pioneer Trail, Boyne Falls, MI 49713
52	Blue vinyl siding, wht trm, blk rf, fldstn chim, gable	Burgess	Ray and Martha	10915 Pioneer Trail, Boyne Falls, MI 49713
53	Undeveloped wetland cove			
54	Brown-stained wood, red-brn rf, metal chimney--part of camp?			
55	Undeveloped wooded stretch			
56	United Methodist Camp - chapel, cabins and beach			
57	Undeveloped stretch			
58	Magee Road Beach			
59	Brn beachse, main house setback across Magee Road	Riley	James and Lisa	00600 South Magee Road, Boyne Falls, MI 49713
60	McMansion, 3 stry, blk rf, fldstn chimns, wht trim, brn panel	Weiss	William and Jean	11444 Morning Side Drive, Boyne Falls, MI 49713
61	Vacant lot?			
62	Sm brn cottage, brn rf, willow tree, wht trim, wht fenced deck			
63	Sm wht cottage, gry rf, willow tree	Bowden	Helen and John	11428 Morning Side Drive, Boyne Falls, MI 49713
64	Yellow/fldstn siding, wht trm, brn rf	Beekley	Jeanne	11410 Morning Side Drive, Boyne Falls, MI 49713
65	Lg 3 str, gray vinyl, wht trim no sediment control	Higdon	Charles	11394 Morning Side Drive, Boyne Falls, MI 49713
66	Lg 3 stry nat log, grn rf, 2 gables, fldstn chimn	Sursaw	Margaret	11378 Morning Side Drive, Boyne Falls, MI 49713
67	Splitstone siding, grn trm, matching boathse, #55	Westcott	Donald	11366 Morning Side Drive, Boyne Falls, MI 49713
68	Fldstn & tan panel siding, fldstn base & stairs, lightpost	Hamlin	Edward	11354 Morning Side Drive, Boyne Falls, MI 49713
69	2 sty fldstn, grn trm, grey rf, fldstn steps, rock jetty	Graag	Donald	11338 Morning Side Drive, Boyne Falls, MI 49713
70	Red & white, blue trm, grey rf, fldstn steps	Jameson	Edward and Ruth	11326 Morning Side Drive, Boyne Falls, MI 49713
71	Tan brk & fishscale shingle siding, brn rf, deck	Vogel	Douglas & Cheryl	11310 Morning Side Drive, Boyne Falls, MI 49713

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72	Brown 2 sty chalet, angled front, large lot?	Benson	Howard & Shirley	11296 Morning Side Drive, Boyne Falls, MI 49713
73	Lrg brn log, brn rf, shore shed, wood seawall	Smith	Gary and Sandy	11288 Morning Side Drive, Boyne Falls, MI 49713
74	Tan brick, red-brn panel, fldstn & red brik chim, red beachshd	Buege	John and Barbara	11276 Morning Side Drive, Boyne Falls, MI 49713
75	Natural, angular, 2 sty log, grn trim, lg deck, block boathse	Manning	Larry and Shirley	11262 Morning Side Drive, Boyne Falls, MI 49713
76	Tan vinyl-sided chalet, brn rf, deck	Luchenbill	Al and Donna	11230 Morning Side Drive, Boyne Falls, MI 49713
77	Red, wht trm, fldstn chim & foundation	Synwolt	Royal and Connie	11214 Morning Side Drive, Boyne Falls, MI 49713
78	Lg brn 2 sty, blk rf, beachshd, obscr	Davey	Edward	11198 Morning Side Drive, Boyne Falls, MI 49713
79	Yellow log cabn, wht trm, grey rf	Lindland	Kenneth & Agnes	11182 Morning Side Drive, Boyne Falls, MI 49713
80	Red wood & red brick siding, wht trm, metl rf, red boaths	Wilson	Ruth	11166 Morning Side Drive, Boyne Falls, MI 49713
81	Vacant lot?			
82	Brn, wht trm, wht blok found, grn mtl rf, stone jetty, blok boaths	Vandenberg	Sally and Curtis	11150 Morning Side Drive, Boyne Falls, MI 49713
83	Undeveloped stretch - Baptist Camp property?			
84	Clearing with sheds, signs, picnic tables Baptist Camp			
85	Undeveloped stretch--sandbar points enclosing lagoon			
86	Baptist Camp - cabins and mess hall			
87	Undeveloped upland forested land			
88	Fieldstone siding, brn trm & rf, 1 gable	Breining	Austin	00308 Delta Lane, Boyne Falls, MI 49713
89	Red-brown stain, grey rf, block chim	Mate	William and Mary	00320 Delta Lane, Boyne Falls, MI 49713
90	2 sty blue-grey vert log cabn, wht trm, mtch beach shed	Morrill	Charles & Donna	00332 Delta Lane, Boyne Falls, MI 49713
91	3 sty A-frame, grn rf, red brk chim, glass front	Brown	Ronald	00340 Delta Lane, Boyne Falls, MI 49713
92	Vert brn log cabn, grn rf, fldstn chim	Seaton	Jane and Hal	00356 Delta Lane, Boyne Falls, MI 49713
93	Cottage with grey siding & rf, screened porch	Brubaker	Bette Jo	00368 Delta Lane, Boyne Falls, MI 49713
94	Red, red-brn rf, deck in front & to side	Marvin	Charles and Carol	00374 Delta Lane, Boyne Falls, MI 49713
95	Cement brick & red-stained wood, red trm, grey rf	Way	Lura and Steve	00380 Delta Lane, Boyne Falls, MI 49713
96	Blue-grey 2 sty high on hill, long steps	Sabin	Jan and Fred	00392 Delta Lane, Boyne Falls, MI 49713
97	300 foot undeveloped stretch			
98	Brn 2 sty, bubble skylights, high on hillside	Morgan	Kermit and Nancy	00400 Halsted Drive, Boyne Falls, MI 49713
99	Grey, mtching beachse, deck W/glass railing, wood terrace	Pankratz	Paul	00412 Halsted Drive, Boyne Falls, MI 49713
100	Brn log cabn, wht chinking, 2 sty A-frame beach shed	Englund	Stan and Marge	00426 Halsted Drive, Boyne Falls, MI 49713
101	2 sty brn log cabn, wht chinking, grn rf, grn block pumphse	Halsted	A. Theodore	00444 Halsted Drive, Boyne Falls, MI 49713
102	200 foot undeveloped stretch			
103	Sm log cabn, fldstn chim, obscure	Carpenter	Jane	00460 Halsted Drive, Boyne Falls, MI 49713
104	Tan 2 sty chalet, many windows, tan beachse, timber seawall	Holder	Scott and Patty	00488 Forest Drive, Boyne Falls, MI 49713
105	Nat vert log cabn, fldstn chim, sm 2nd sty, fldstn stairway	Gregg	Lois	00530 Forest Drive, Boyne Falls, MI 49713
106	Brn-stained wood, brn rf, 2 flat skylights, deck	Montgomery	Sharon & Richard	00546 Forest Drive, Boyne Falls, MI 49713
107	Brn cottage, red-brn rf, red trm, block boathse, fldstn chim	Persons	Nancy & Donald	00558 East Birch Circle, Boyne Falls, MI 49713

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108	Sm yellow, vertical, log cabn, red trm, brn rf	Matson	Max	00### East Birch Circle, Boyne Falls, MI 49713
109	Vacant lot?			
110	2 sty chalet, gry vinyl siding, tan trm, block foundation	Magsig	Judy and George	00600 East Birch Circle, Boyne Falls, MI 49713
111	Red upper, wht trm, dk. grey rf, block found	Rupe	Meredith	00620 East Birch Circle, Boyne Falls, MI 49713
112	Fldstn siding, wht & varnished trm, blue-grey rf	Bank	James	00646 East Birch Circle, Boyne Falls, MI 49713
113	Bright red, wht trm, flat rf, grn block beach garage	Carson	Merry	00662 East Birch Circle, Boyne Falls, MI 49713
114	Dk brn 2 sty, nook of bay, mtch gar w/red door	Mahan	Chester & Dorothy	00674 Cove Drive, Boyne Falls, MI 49713
115	Blue vinyl siding, wht trm, brn garage, on point	Mayo	James and Judith	00686 Cove Drive, Boyne Falls, MI 49713
116	Sm blue cottage, black rf, red brk chim, in small cove	McConnell	Judy	00698 Cove Drive, Boyne Falls, MI 49713
117	Vert brn log & brn slab wood siding, 2 sty, grn shed #96	Lyons	Paul Julie	00719 Cove Drive, Boyne Falls, MI 49713
118	Dk brn 2 sty, lime grn trm, deck	Branstner	Virginia	00755 Cove Drive, Boyne Falls, MI 49713
119	Undeveloped lot			
120	Tan 2 sty log cabn, porch, mtch outbuilding/garage	Burgess	Linda	00777 Cove Drive, Boyne Falls, MI 49713
121	Blue 2 sty chalet, brn trm, scalloped deck railing	McKee	William & Dolores	00895 South Birch Circle, Boyne Falls, MI 49713
122	3 sty, grn-stained siding, brn rf, lg bi-level deck	Melvin	Kay and Inez	00883 South Birch Circle, Boyne Falls, MI 49713
123	Varnished log cabin, red rf, fldstn chim, high rock RR	Knopf	Stanley	00871 South Birch Circle, Boyne Falls, MI 49713
124	Brn tri-level, grey rf, balcony deck, wht blok chimn	Sayre	Jean	00859 South Birch Circle, Boyne Falls, MI 49713
125	Grey, grn rf, metl chim, 3 skylights, deck	Finley	Dwight and Gloria	00847 South Birch Circle, Boyne Falls, MI 49713
126	Grey 2 stry, wht trm, mtch garage	May	Robert and Eva	00835 South Birch Circle, Boyne Falls, MI 49713
127	Bridge to Horner Island-south side			
128	2 sty chalet, brn upper & wht lower, block foundation	Armstrong	Donald and Gloria	00696 Circle Drive, Boyne Falls, MI 49713
129	Varnished log cabin (obscured) , grn mtl rf.	Robinson	Edward & Patricia	00704 Circle Drive, Boyne Falls, MI 49713
130	Grey A-frame, blk rf, boulder rip-rap, rock jetties.	Getts	Robert & Margaret	00710 Circle Drive, Boyne Falls, MI 49713
131	Grn cottage, red brk foundation, boulder rip-rap	Hilborn	Kriss	00718 Circle Drive, Boyne Falls, MI 49713
132	Tan chalet, grn trim, wht fenced deck	Delaney	Robert & Shirley	00730 Circle Drive, Boyne Falls, MI 49713
133	Red-stained cottage, wht trm, red brk chim, mtch shed	Korthase	Edward and Arlene	00742 Circle Drive, Boyne Falls, MI 49713
134	2 sty, on peninsula, drk brn trim	Swift	Elizabeth	00755 Circle Drive, Boyne Falls, MI 49713
135	Undeveloped lot?			
136	Wht & brn chalet, Turquoise trm, 3 stry	Noftz	Mearl and May	00747 Circle Drive, Boyne Falls, MI 49713
137	Grey 2 sty, dk grey rf, mtch shed	Yund	Gaylord	00735 Circle Drive, Boyne Falls, MI 49713
138	Red 2 sty, wht trm	Davis	Carl and Rebecca	00723 Circle Drive, Boyne Falls, MI 49713
139	Tan 2 sty, wht trm	Brown	Harold and Hilda	00711 Circle Drive, Boyne Falls, MI 49713
140	Grey 2 sty, wht trm	Sternberg	Louise	00699 Circle Drive, Boyne Falls, MI 49713
141	Grn 2 sty chalet, wht trm, deck, mtch garage	Gunkler	Albert & Caroline	00687 Circle Drive, Boyne Falls, MI 49713
142	Undeveloped stretch			
143	Bridge crossing to Horner Island - north side			

ID	Property Description 2007	Last Name	First Name	Summer Address
144	Brown & wht chalet, brn rf, shore platform	Marvin	John	00663 South Birch Circle, Boyne Falls, MI 49713
145	Blue 2 stry, wht trm, grey rf, red brk chim, lattice lower.	Welton	Floyd and Bernice	00659 South Birch Circle, Boyne Falls, MI 49713
146	Brown & wht 2 sty, flat rf.	Neely	W. Brock and Mary	00635 South Birch Circle, Boyne Falls, MI 49713
147	Red vert log cabn, grn rf, fldstn chim, at point	Sherman	Eber and Jeanne	00575 South Birch Circle, Boyne Falls, MI 49713
148	Lg log cabn, spltstn chim, 2 gables, grey rf.	Babbitt	Judith	00563 South Birch Circle, Boyne Falls, MI 49713
149	Dk brn cottage, lt brn rf, wht trm, lg deck, 2 outbuildings	Laginess	Ed and Rose Marie	00551 South Birch Circle, Boyne Falls, MI 49713
150	Red, grey rf, deck, stone terrace	Vessells	Russell and Irene	00539 South Birch Circle, Boyne Falls, MI 49713
151	Wht stucco 2 sty, 2 modules, gray trm, close to shore, BBRR	Merrill	John and Jan	00527 South Birch Circle, Boyne Falls, MI 49713
152	Undeveloped lots?			
153	Yellow concrete block, red trm	Bristah	James and Jo	00515 South Birch Circle, Boyne Falls, MI 49713
154	Nat-stn log cabn, brn rf, 2 porches, lg windows	Babbitt	W. Eric	00503 South Birch Circle, Boyne Falls, MI 49713
155	Tan vinyl chalet, wht trm	Selberg	Robert and Linda	09940 Meadows Trail, Boyne Falls, MI 49713
156	Brn 2 sty, brn rf, mtl chimn	Turner	Arthur and Molly	09900 Meadows Trail, Boyne Falls, MI 49713
157	Nat, angular wood chalet, fancy round windows, obser.	DeMoss	Lynn and Kay	09888 Meadows Trail, Boyne Falls, MI 49713
158	Brown siding, 3-tiered rf, deck, obscr	Shipley	Anthony and Barba	09850 Meadows Trail, Boyne Falls, MI 49713
159	Brn 2 sty chalet, red brk chim, hot tub on wrap-around deck	Davis	Robert and Linda	09844 Meadows Trail, Boyne Falls, MI 49713
160	Yellow, unusual brn rf, wht trm	Laird	Marsha and Jim	09830 Meadows Trail, Boyne Falls, MI 49713
161	Brown & wht chalet, brn rf, white stucco chim	Fettig	Kim and Rhonda	09818 Meadows Trail, Boyne Falls, MI 49713
162	Tall, brn A-frame, brn rf, lg deck, garage behind, obsrc	Janka	Ralph and Millie	09780 Meadows Trail, Boyne Falls, MI 49713
163	Brown, white trim, brick lower, obscr	Dickins	Clive and Sally	09770 Meadows Trail, Boyne Falls, MI 49713
164	Brown 2 sty chalet, block foundation, deck, beach shed, obscr	Andrews	J. Leon	09752 Meadows Trail, Boyne Falls, MI 49713
165	2 sty brn barn-style chalet, red brk chim	Moerland	Helen and Lee	09744 Meadows Trail, Boyne Falls, MI 49713
166	grn, grey rf, lg wht brk chim, stonework	Herrington	James & Meredith	09720 Meadows Trail, Boyne Falls, MI 49713
167	Western shore--undeveloped except for Camp Kinawind			

ID	Cladophora 2007	Conductivity	High*	Alt*	Substr*	Hab*	Comments
1		200-250	T	F	GS	y	cond highest at ramp and E of cleared area
2		200-250	T	F	RGSWD	y	high cond from stream flowing in??
3		205-215	T	F	GS	y	Low lake levels from drought - hard to access shore
4		205-210	T	T	GS	y	WD Seawall
5		196-205	F	F	S	n	Open water cond = 197, temp = 17 C
6		196	F	T	S	n	
7		200-208	T	F	GS	y	
8		195-200	F	F	GS	y	
9		198	F	F	GS	y	
10		196	F	F	S	n	
11		194	F	F	GS	y	
12	Lx10 (30' SW of dock)	186-196	F	T	RGS	y	
13	MHx30 on SE side & Hx25' on NE end (Tunard's cove?)	186-220	T	F	M	n	Cladophora natural from wetland & sun exposure?
14	Hx50' south of dock (mixed w/ brush)-wetland?	190	F	F	GS	y	Cladophora natural from wetland & sun exposure?
15		187	F	F	GS	y	
16		188	F	F	GS	y	
17		185	F	F	S	n	channel open water cond=197, temp=19.8C
18		185	F	F	S	n	
19		185	F	T	GS	y	
20		183-189	F	F	RGS	y	
21		184	F	F	RGS	y	
22		184-186	F	T	RGS	y	SLD survey dnr ramp to here on 9-17-7
23		193-194	F	T	RGS	y	SLD survey here onward on 9-20-7
24		193-194	F	F	S	n	Cond changed from 180s to 190s in 3-day period
25		193-194	F	F	S	n	
26		193-194	F	T	GSR	y	fall periphyton Mx5 groin E
27		193-194	F	T	SR	y	fall periphyton Mx5 groin W & MX2 groin E
28		192-193	F	F	S	n	fall periphyton Mx2 groin W
29		197-200	T	T	GS	y	suspicious cond readings
30		194	F	T	RGS	y	
31		192-194	F	T	RGS	y	
32		193-194	F	T	RGS	y	
33		193-194	F	F	GS	y	
34	Mx 5 on veg-west of dock-veg?	194-196	F	T	RGS	y	
35		194-195	F	T	RGS	y	

**High=relatively high conductivity reading, Alt=shoreline alteration, Substr=substrate (bottom type), Hab=Cladophora habitat.*

ID	Cladophora 2007	Conductivity	High*	Alt*	Substr*	Hab*	Comments
36		193-195	F	T	RGS	y	fall periphyton LMx50 entire shore
37		194-197	F	F	RGS	y	fall periphyton Mx40 west end
38		193-199	T	T	RGS	y	fall periphyton Lx30 east of dock
39		192-193	F	T	GS	y	
40		193-194	F	T	RGS	y	
41		194	F	T	GS	y	
42		194	F	T	RGS	y	
43		194	F	F	RGS	y	
44		192-193	F	F	RGS	y	
45		193-197	F	T	RGS	y	
46		193-194	F	T	RGS	y	fall periphyton Mx100 entire shore
47		192-194	F	T	RGS	y	
48		194-202	F	T	RGS	y	
49		202-205	F	T	RGS	y	suspicious cond readings, fall periphyton LMx20
50		204-207	F	F	GS	y	suspicious cond readings
51		206-210	T	F	GS	y	suspicious cond readings
52		203-206	F	F	S	n	suspicious cond readings
53		198-204	F	F	RSG	y	
54		200-203	F	T	RGS	y	
55		196-200	F	F	RGS	y	
56		189-192	F	T	SG	y	changed methods as battery died
57		178-211	T	F	S	n	& directly measure w/ meter (no pump)
58		202-208	F	F	S	n	open water cond = 195
59		202-204	F	F	S	n	
60		204-208	F	F	S	n	
61		208-209	T	F	S	n	
62		206-208	F	F	GS	y	
63		206-208	F	T	RGS	y	
64		201-207	F	T	GS	y	
65		204-205	F	F	GS	y	
66		200-203	F	T	GS	y	
67		200-204	F	F	GS	y	
68		204	F	F	GS	y	
69		203	F	F	GS	y	
70		207	F	T	RGS	y	

**High=relatively high conductivity reading, Alt=shoreline alteration, Substr=substrate (bottom type), Hab=Cladophora habitat.*

ID	Cladophora 2007	Conductivity	High*	Alt*	Substr*	Hab*	Comments
71		202-206	F	T	RGS	y	
72		207-208	T	T	RGS	y	
73		200-208	F	T	RGS	y	
74		198-203	F	T	RGS	y	
75		200-202	F	F	RGS	y	
76		200-204	F	T	RGS	y	
77		200-202	F	T	RGS	y	
78		198-199	F	T	RGS	y	
79		199-202	F	T	RGS	y	
80		202-204	F	T	RGS	y	fall periphyton Hx20
81		202-204	F	F	GS	y	
82		203-210	T	T	RGS	y	eroded shore, patchy fall periphyton
83		204	F	F	S	n	
84		200-204	F	F	RGS	y	
85		?	F	F	S	n	
86		211	T	F	GS	y	
87		211	T	F	RGS	y	
88		204-209	T	T	GS	y	
89		201-206	F	F	RGS	y	
90		199-201	F	T	RGS	y	
91		199-205	F	F	RGS	y	
92		202-206	F	T	RGS	y	
93		206-209	T	F	RGS	y	
94		209-214	T	T	GS	y	
95		211-214	T	T	GS	y	
96		208-214	T	F	GS	y	
97		203-207	F	F	RGS	y	
98		205-207	F	T	RGS	y	
99		200-203	F	T	RGS	y	
100		198-200	F	F	RGS	y	high cond in front of hs
101		197-200	F	T	RGS	y	high cond in front of hs
102		195-197	F	F	RGS	y	
103		195-197	F	F	RGS	y	
104		197-200	F	T	RGS	y	high cond in front of hs
105		197-198	F	F	GS	y	

High=relatively high conductivity reading, Alt=shoreline alteration, Substr=substrate (bottom type), Hab=Cladophora habitat*.**

ID	Cladophora 2007	Conductivity	High*	Alt*	Substr*	Hab*	Comments
106		197-201	F	F	GS	y	high cond in front of hs
107		199-200	F	F	GS	y	
108		192-197	F	F	S	n	
109		191-196	F	F	S	n	
110		194-196	F	F	S	n	
111		194	F	F	S	n	
112		193-197	F	F	S	n	high cond in front of hs
113		194-196	F	F	S	n	
114		194	F	F	S	n	
115		191-198	F	F	RGS	y	cond 198 to NW end
116		189-194	F	F	RGS	y	
117		193-195	F	F	RGS	y	
118		193-202	T	F	GS	y	
119		?	F	F	GS	y	In channel at end of day: cond=198, temp = 19.9C
120		199-200	T	F	RGS	y	
121		194-196	F	T	RGS	y	
122		194-195	F	T	RG	y	
123		194-195	F	T	RGS	y	
124		193	F	F	RGS	y	
125		197	F	F	RGS	y	
126		200	T	F	SM	n	
127		?	F	T	RGS	y	
128		196-197	F	F	RGSM	y	
129		196	F	T	GR	y	
130		196	F	T	RGS	y	
131		194-198	F	T	RGS	y	
132		196-197	F	T	RGS	y	
133		194-198	F	T	S	n	EWM at dock
134		195-197	F	T	RGS	y	cond open water off point = 193, temp 17.8 C
135		193-195	F	F	RGS	y	fall periphyton LMx50 N. end
136		185-193	F	T	RGS	y	fall periphyton LMx100 front to S
137		188	F	F	RGS	y	fall periphyton LMx70 entire shore
138		187	F	F	RGS	y	fall periphyton LMx30 S. end
139		188	F	T	RGS	y	
140		191	F	F	GS	y	fall periphyton Mx5 N. end

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ID	Cladophora 2007	Conductivity	High*	Alt*	Substr*	Hab*	Comments
141	LMx40'-probably partially natural (south of dock)	190-194	F	F	RGS	y	
142		188-192	F	F	SM	n	
143	Hx20, SW side of bridge rd.	188	F	F	RGS	y	
144		190-198	T	T	RGS	y	cond higher in front of hs
145		196-203	T	F	S	n	SLD higher on west end
146		202	T	F	SM	n	
147		195-197	T	T	RGS	y	fall periphyton Mx5 on point
148		189-196	F	F	RGS	y	
149		190-192	F	F	SG	y	
150		192-199	T	F	S	n	
151		196-200	T	T	RGS	y	
152		190	F	F	GS	y	cond open water west bay = 193, temp 18.5 C
153		190	F	F	RGS	y	fall periphyton Mx5 front to S
154		202	F	F	RGS	y	cond higher in front of hs
155		195-203	F	F	GS	y	cond higher in front of hs
156		204	F	F	RGS	y	
157		205-206	F	F	RGS	y	fall periphyton Lx10 on logs
158		201-202	F	F	RGS	y	EWM off shore, fall periphyton Mx5 on jetty
159		204-209	T	F	GS	y	
160		204-210	T	F	S	n	
161		203-205	F	F	SM	n	cond low to high = east to west
162		203-205	F	F	SM	n	cond low to high = east to west
163		202	F	F	SM	n	
164		207-208	T	F	M	n	
165		210	T	F	M	n	
166		202	F	F	M	n	
167		192-195	F	F	RGS	y	

**High=relatively high conductivity reading, Alt=shoreline alteration, Substr=substrate (bottom type), Hab=Cladophora habitat*.