Lake Bellaire Shoreline Survey 2017

By Tip of the Mitt Watershed Council

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SUMMARY

During the summer of 2017, Tip of the Mitt Watershed Council conducted a shoreline survey of Lake Bellaire. The survey was a part of a comprehensive shoreline survey for the entire Elk River Chain of Lakes. Surveys were designed to document conditions that can impact water quality, including the three biggest threats to inland lakes: nutrient pollution, habitat loss, and shoreline erosion. The shoreline assessment was conducted on a parcel by parcel basis around the entirety of Lake Bellaire. Survey results indicate that large portions of Lake Bellaire shoreline contains natural and native vegetation growth. However, some human activity around Lake Bellaire shoreline may be impacting the lake ecosystem and water quality. Improving areas with poor greenbelts will help the character and quality of Lake Bellaire by reducing nutrient pollution and sediment input from erosion along the shoreline.

INTRODUCTION

Background

During the summer of 2017, a shoreline survey was conducted on Lake Bellaire by the Tip of the Mitt Watershed Council to document shoreline conditions that impact water quality. Lake Bellaire was one of 15 lakes surveyed during 2016 and 2017 as a part of a broader effort to document shoreline conditions within the entire Elk River Chain of Lakes. The entire shoreline was surveyed to document the following: algal (*Cladophora*) growth as a nutrient pollution indicator, erosion, shoreline alterations (including drain pipes), and greenbelts.

The following 2017 survey results provide a comprehensive dataset documenting shoreline conditions on Lake Bellaire that can be used as a lake management tool.

Shoreline Development Impacts

Lake shorelines are an important interface linking the landscape to water within a watershed. A shoreline is the area in which a transfer of water and nutrients occurs from land to water. This transitional zone does not necessarily have an exact line between the landscape and water as Lake Shorelines vary based on shape, size, and vegetation. Accordingly, human activities along shorelines will have varying potential for degrading water quality of Lake Bellaire. Development of shoreline properties for residential, commercial, or other use have an impact on Lake Bellaire in a variety of ways and in various degrees. For example, as more shoreline vegetation is removed, the potential for nutrients and pollutants to run off the landscape and enter Lake Bellaire increases. Additionally, as the Lake Bellaire Watershed terrain is altered, sediments and nutrients from eroded areas can often end up in Lake Bellaire.

While nutrients are necessary to sustain a healthy aquatic ecosystem, excess nutrients will stimulate nuisance growth of both macrophytes (aquatic plants that grow in or near water and are either emergent, submergent, or floating) and algae. Additionally, algal blooms pose a public health risk as some species (i.e. Cyanobacteria - blue green algae) produce toxins, including hepatotoxins (toxins that cause liver damage) and neurotoxins (toxins that affect the nervous system). Excess plant and algal growth can degrade water quality by depleting the ecosystem's dissolved oxygen. As algal and plant growth increases and individuals begin to die, the aerobic activity of decomposers deplete dissolved oxygen, particularly in the deeper waters of stratified lakes. In general, small lakes are more prone to nutrient pollution than large lakes. With the increased volume, large lakes tend to have greater stores of dissolved oxygen and increased dilution of nutrients. By contrast, small lakes generally have a lesser ability to dilute nutrients and extensive shallow areas that can support aquatic plant growth. Excess nutrients enter surface waters through a variety of natural and cultural (human) sources.

Natural sources of nutrients include stream inflows, groundwater inputs, surface runoff, organic inputs from riparian (shoreline) areas, and atmospheric deposition. Springs and seeps, streams, and artesian wells are often naturally high in nutrients due to the geologic strata they encounter. Nearby wetland seepages may also discharge nutrients at certain times of the year. Cultural (human) sources include septic systems, fertilizers, and stormwater runoff from roads, driveways, parking lots, roofs, and other impervious surfaces. Poor agricultural and forestry practices, which oftentimes result in soil erosion, and wetland destruction also contribute to nutrient pollution. Moreover, some cultural sources (e.g., malfunctioning septic systems) 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.

Although chemical analyses of water samples to check for nutrient pollution can be effective, they are oftentimes more labor intensive and cost prohibitive than other methods. Typically, water samples are analyzed to determine nutrient concentrations (usually the forms of phosphorus and nitrogen), but other chemical constituents, such as chloride, can be measured. Physical measurements, such as water temperature and conductivity (the ability for water to conduct an electrical current), are primarily used to detect excess nutrients entering a water body. Biologically, nutrient pollution can be detected along the lake shore by noting and observing the presence of *Cladophora* algae, a biological indicator. Observed increases of

Cladophora presence can be an indicator of elevated nutrients along the shoreline.

Cladophora is a branched, filamentous green algal species that occurs naturally in relatively small amounts in Northern Michigan lakes. *Cladophora* occurrence is governed by specific environmental requirements for temperature, substrate, sunlight, and nutrients. This algal bio-indicator is found most commonly in the wave splash zone and shallow shoreline areas of lakes and grows best on stable substrates such as rocks and logs. Artificial substrates such as concrete or wooden seawalls are also suitable growth areas. *Cladophora* prefers water temperatures in a range of 50 to 70 degrees Fahrenheit, which means that the optimal time for growth and detection in Northern Michigan lakes is usually from middle of May to early July, and again in early to middle of September. The nutrient availability in Northern Michigan lakes is typically less than what is needed for *Cladophora* to achieve large, dense growth. Therefore, shoreline locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake can be identified by noting the presence of *Cladophora*.

Although the growth of *Cladophora* can be influenced by factors such as water current patterns, shoreline topography, substrate composition, and wave action, the presence or absence of any significant growth can be a powerful lake-wide screening tool. The existence of chronic nutrient availability along the shoreline can be revealed and chronic observance of dense *Cladophora* presence can assess the effectiveness of any remedial actions. Comparing the total number of algal growth areas along the shoreline over time can reveal trends in nutrient inputs to a lake. One factor contributing to nutrient input is bank erosion.

Erosion along the shoreline can degrade the lake's water quality. Stormwater runoff carries sediments into the lake that can reduce organism respiration by clogging the gills of fish, insects, and other aquatic organisms. Excessive sediments can smother fish spawning beds and fill interstitial spaces along the lake bottom that provide habitat for a variety of aquatic organisms. Suspended sediments absorb sunlight energy and increase water temperatures. In addition, nutrients (particularly phosphorus) adhere to sediments that wash in from eroded areas, which can lead to nuisance aquatic plant growth and algal blooms. To help prevent erosion and runoff of sediments and nutrients, healthy shoreline greenbelts are essential.

Shoreline greenbelts are essential for maintaining a healthy aquatic ecosystem. A greenbelt consisting of a variety of native woody and herbaceous plant species provides habitat for near-shore aquatic organisms as well as other shoreline-dependent wildlife. Natural greenbelts can help deter geese as these shoreline guests tend to prefer well-manicured lawns with easy access to the water. Greenbelts also help stabilize shorelines against wave and ice action with their extensive network of deep, fibrous roots. Overhanging vegetation provides shade to nearshore areas, which is particularly important for many fisheries and insects the fish consume. Lastly, and perhaps most importantly, greenbelts provide a mechanism to filter pollutants carried by stormwater from rain events and snowmelt. Vegetation will utilize nutrients (nitrogen and phosphorus) for growth and filter them out of runoff before entering a lake. Another pollutant and nutrient delivery mechanism to a lake is a tributary.

The primary function of a tributary is to drain the landscape (lake watershed). Therefore, tributaries have a very high potential for influencing a lake's water quality as they are one of the primary conduits through which water is delivered to a lake within a watershed. Inlet streams may provide exceptionally high-quality waters that benefit the lake ecosystem. Conversely, they have the potential to deliver polluted waters that degrade the lake's water quality. Outlet streams flush water out of the lake, providing a way to remove contaminants in the lake ecosystem. While conducting shore surveys, noting inlet tributary locations is very helpful when evaluating shoreline algal conditions because nutrient concentrations are generally higher in streams than in lakes. The relatively higher nutrient levels delivered from streams often lead to naturally heavier *Cladophora* and other algal growth in nearby shoreline areas.

Background of Study Area

Located in the northwestern area of the Lower Peninsula, Lake Bellaire resides in Antrim County. Lake Bellaire has a surface area of 1789 acres and a shoreline length of 12 miles. The primary inflow is the Intermediate River from the north (Figure 1). The primary outflow is the Grass River into Clam Lake. According to digitized bathymetry maps acquired from the Michigan Geographic Data Library, the deepest area of Lake Bellaire reaches 95 feet in depth.

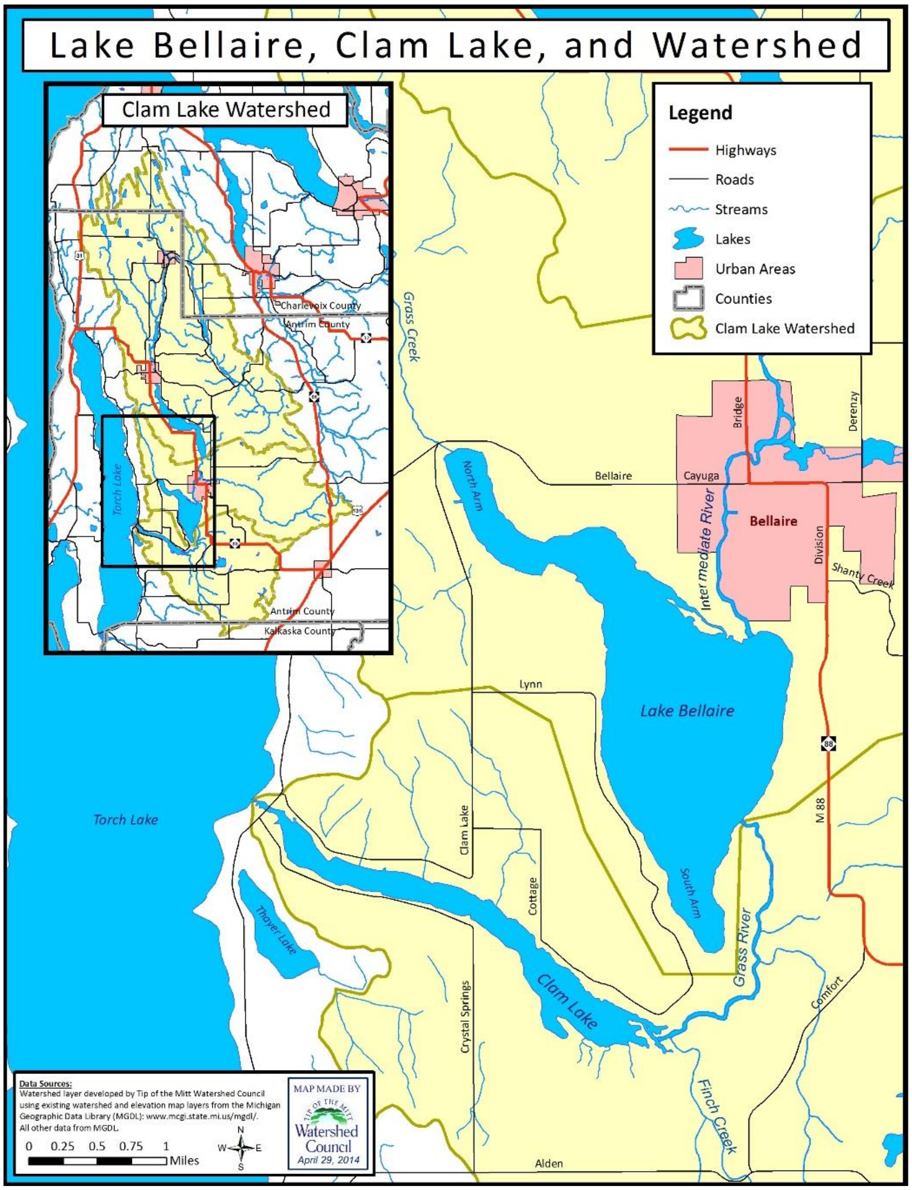


Figure 1 Lake Bellaire Watershed Area

Land cover statistics generated for the surface watershed using data from the NOAA Coastal Great Lakes Land Cover Project reveal much of Lake Bellaire's HUC12 area Watershed land cover is forest (43.87%), wetland (20.10%), and grassland/herbaceous area (8.80%) (Table 1).

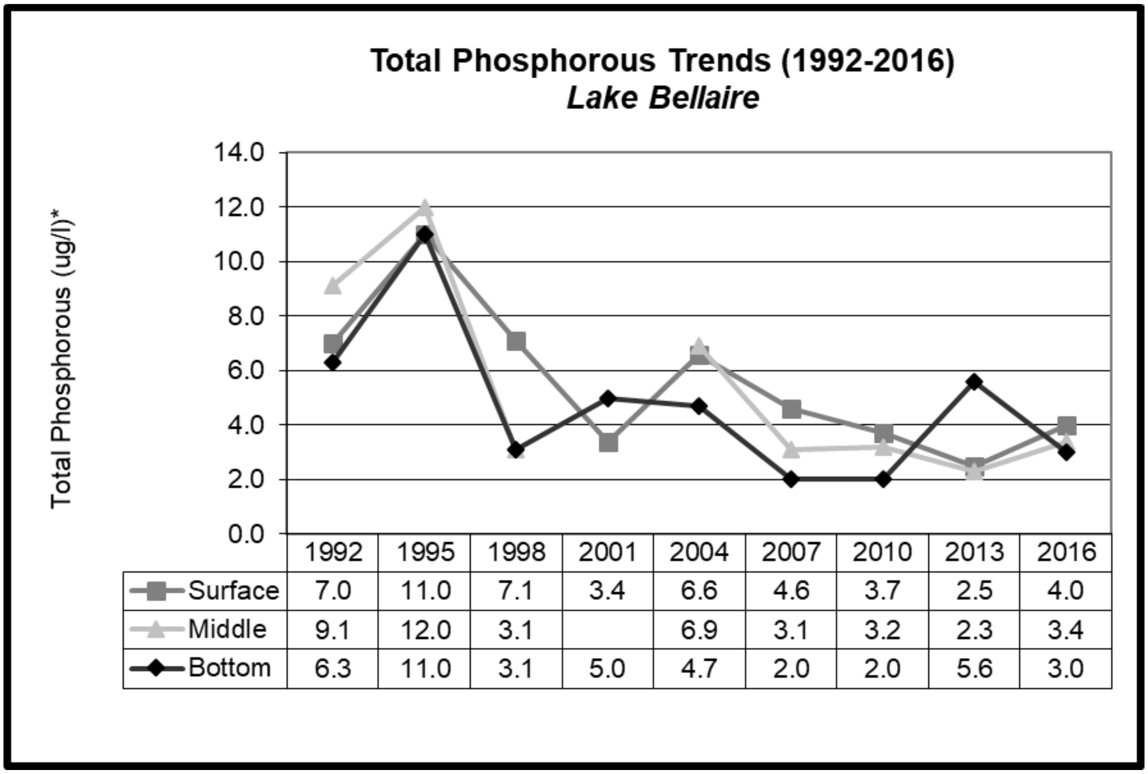
Table 1 Lake Bellaire Surface Watershed Land Cover 2016

Land Cover Type	2016 (% of watershed)
Agriculture	8.64
Bare Land	1.55
Developed	2.63
Forest	43.87
Grassland/Herbaceous	8.80
Open Water	6.79
Pasture/Hay	1.88
Scrub/Shrub	5.73
Wetland	20.10

Water Quality Data

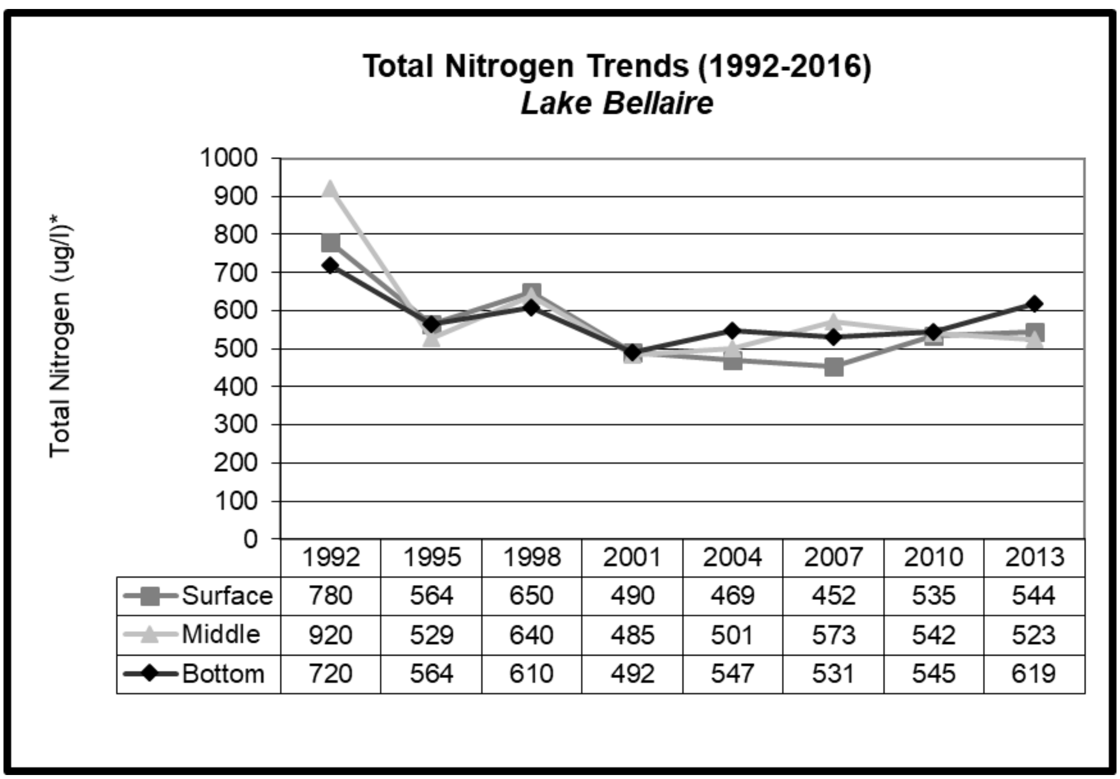
Volunteers have actively engaged with water quality monitoring coordinated by the Watershed Council and as part of the Cooperative Lakes Monitoring Program (CLMP). In addition, Watershed Council staff monitor Lake Bellaire water quality as a part of their Comprehensive Water Quality Monitoring Program (CWQM). Watershed Council staff began monitoring Lake Bellaire in 1992, and has occurred every three years since.

From the CWQM program, data indicate Lake Bellaire water quality is relatively high. Total phosphorous and nitrogen measurements show concentrations have steadily fallen since 1992 (Figure 2, Figure 3). Chloride has increased from around 6.0mg/L to 11 mg/L since 1992 (Figure 4).



	1992	1995	1998	2001	2004	2007	2010	2013	2016
Surface	7.0	11.0	7.1	3.4	6.6	4.6	3.7	2.5	4.0
Middle	9.1	12.0	3.1		6.9	3.1	3.2	2.3	3.4
Bottom	6.3	11.0	3.1	5.0	4.7	2.0	2.0	5.6	3.0

Figure 2 Lake Bellaire Total Phosphorus Trends from 2008 through 2017 as part of the Comprehensive Water Quality Monitoring Program at Tip of the Mitt Watershed Council.



	1992	1995	1998	2001	2004	2007	2010	2013
Surface	780	564	650	490	469	452	535	544
Middle	920	529	640	485	501	573	542	523
Bottom	720	564	610	492	547	531	545	619

Figure 3 Lake Bellaire Nitrogen Trends from 1995 through 2016 as part of the Comprehensive Water Quality Monitoring Program at Tip of the Mitt Watershed Council.

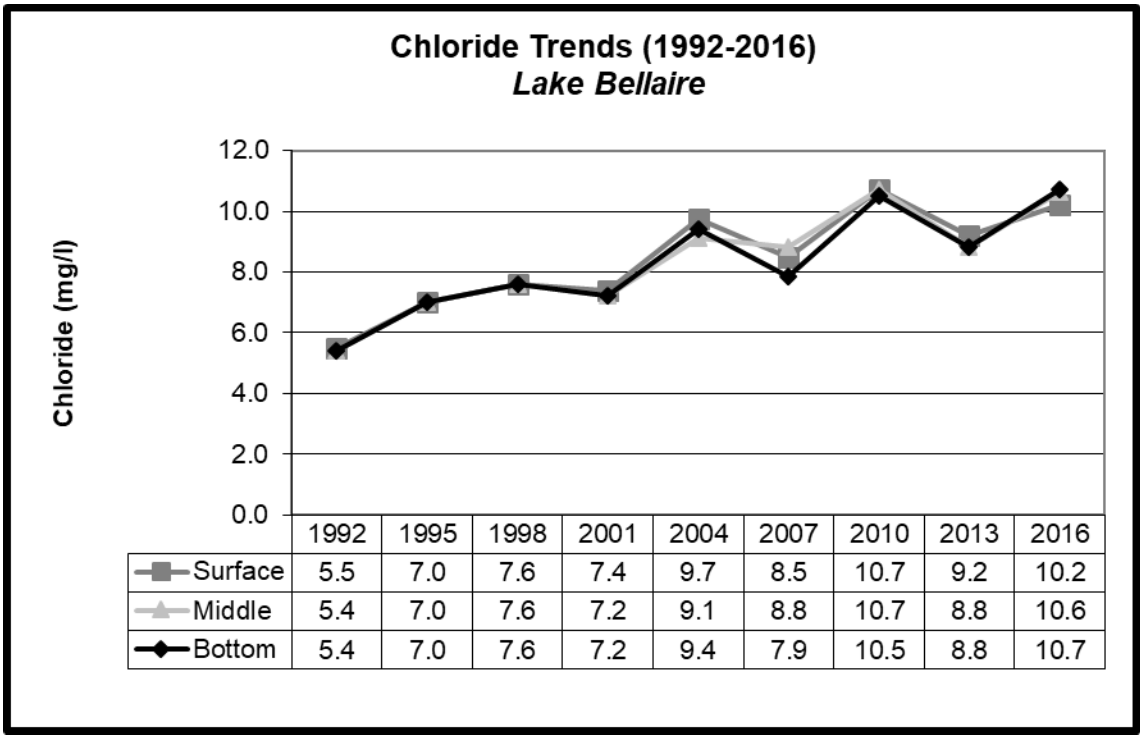


Figure 4 Lake Bellaire Chloride Trends from through 2016 as part of the Comprehensive Water Quality Monitoring Program at Tip of the Mitt Watershed Council.

Since 1991, local volunteers have ventured out to Lake Bellaire to record Secchi disk depth, water temperature, and collect water samples for total phosphorus and *chlorophyll-a* measurements. Lake Bellaire Secchi depth has fluctuated but overall has increased from initial monitoring in 1991 (Figure 5).

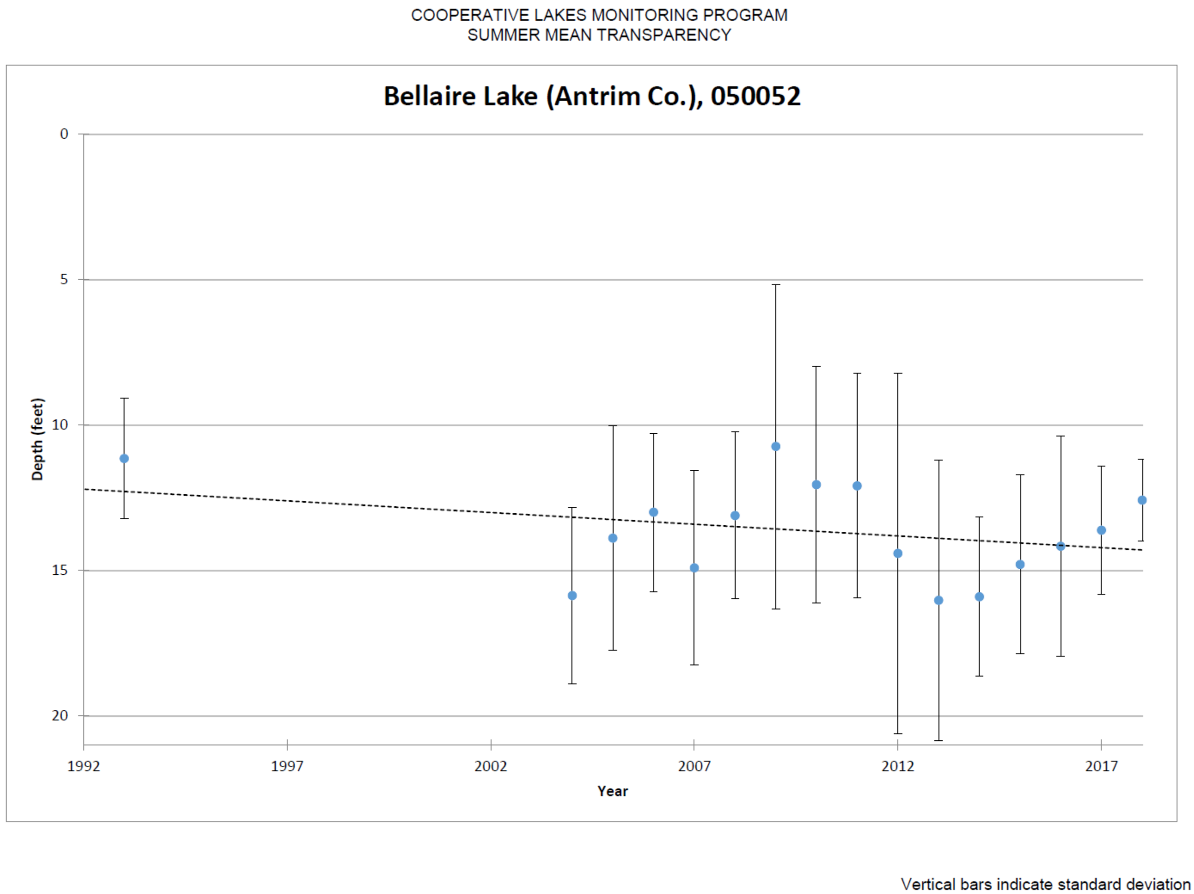


Figure 5 Lake Bellaire Secchi Disk depth, adapted from Cooperative Lakes Monitoring Program (CLMP), 2018 lake report.

At the end of each sampling year, a trophic status index (TSI) is calculated (Figure 6). This value is a measure of biological productivity in a lake at the time of Secchi disk and *chlorophyll-a* sampling. A TSI value ranges from 0 to 100, where a score below 38 describes a lake devoid of nutrients, low biological productivity, and very clear water. A TSI score of 39 – 49 indicates a mesotrophic lake system. Mesotrophic simply means the lake has a moderate amount of nutrients. When nutrients become a problem and productivity becomes too high, a lake is considered “eutrophic” (TSI value above 50). Lake Bellaire has been in the mesotrophic category, with a TSI value ranging between 39 and 45.

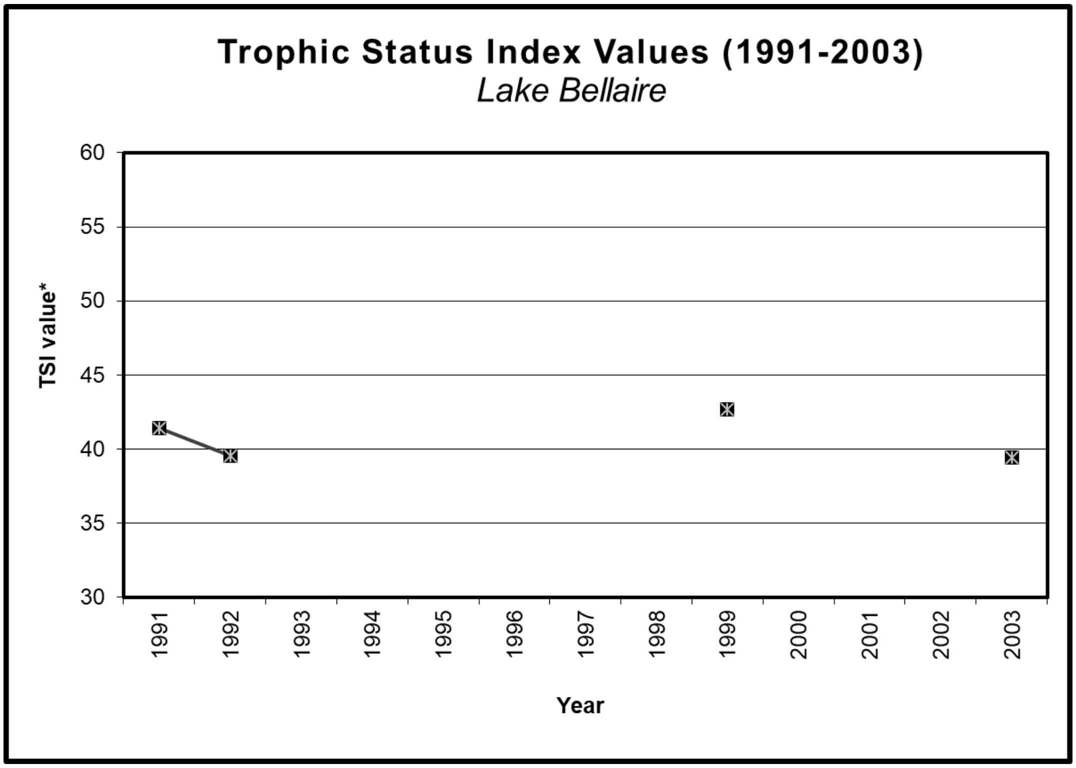


Figure 6 TSI value calculated from volunteer data at Tip of the Mitt Watershed Council

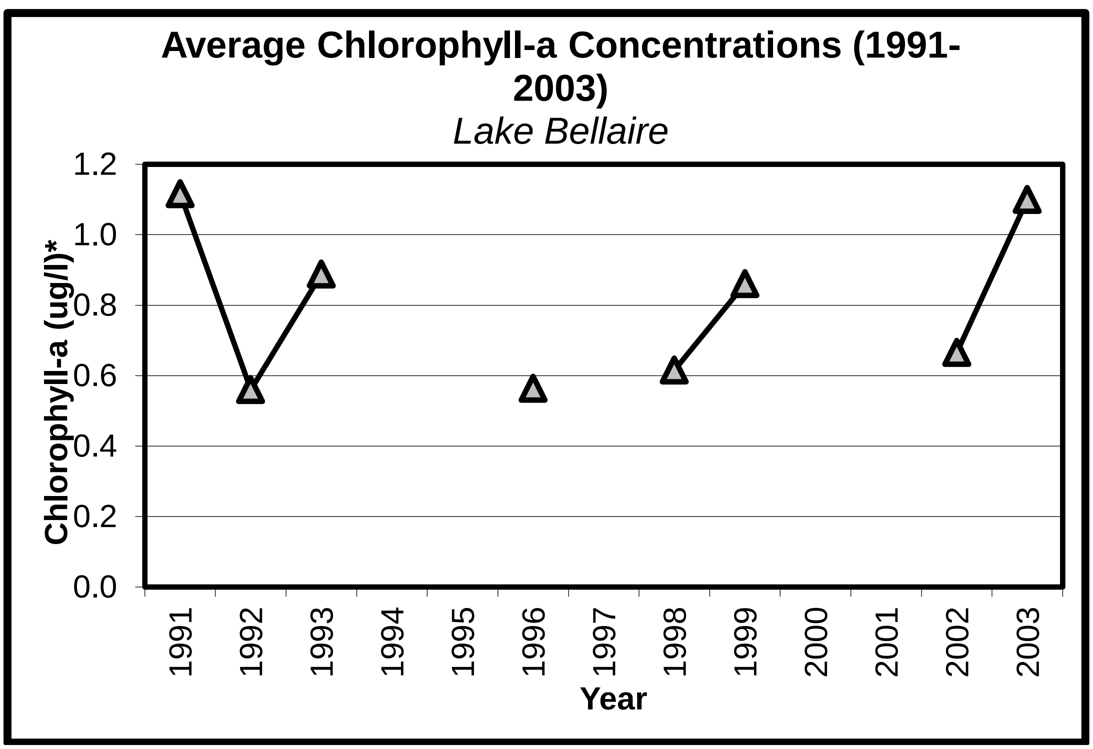


Figure 7 Average Chlorophyll-a concentrations collected by Lake Bellaire Volunteers, Tip of the Mitt Watershed Council

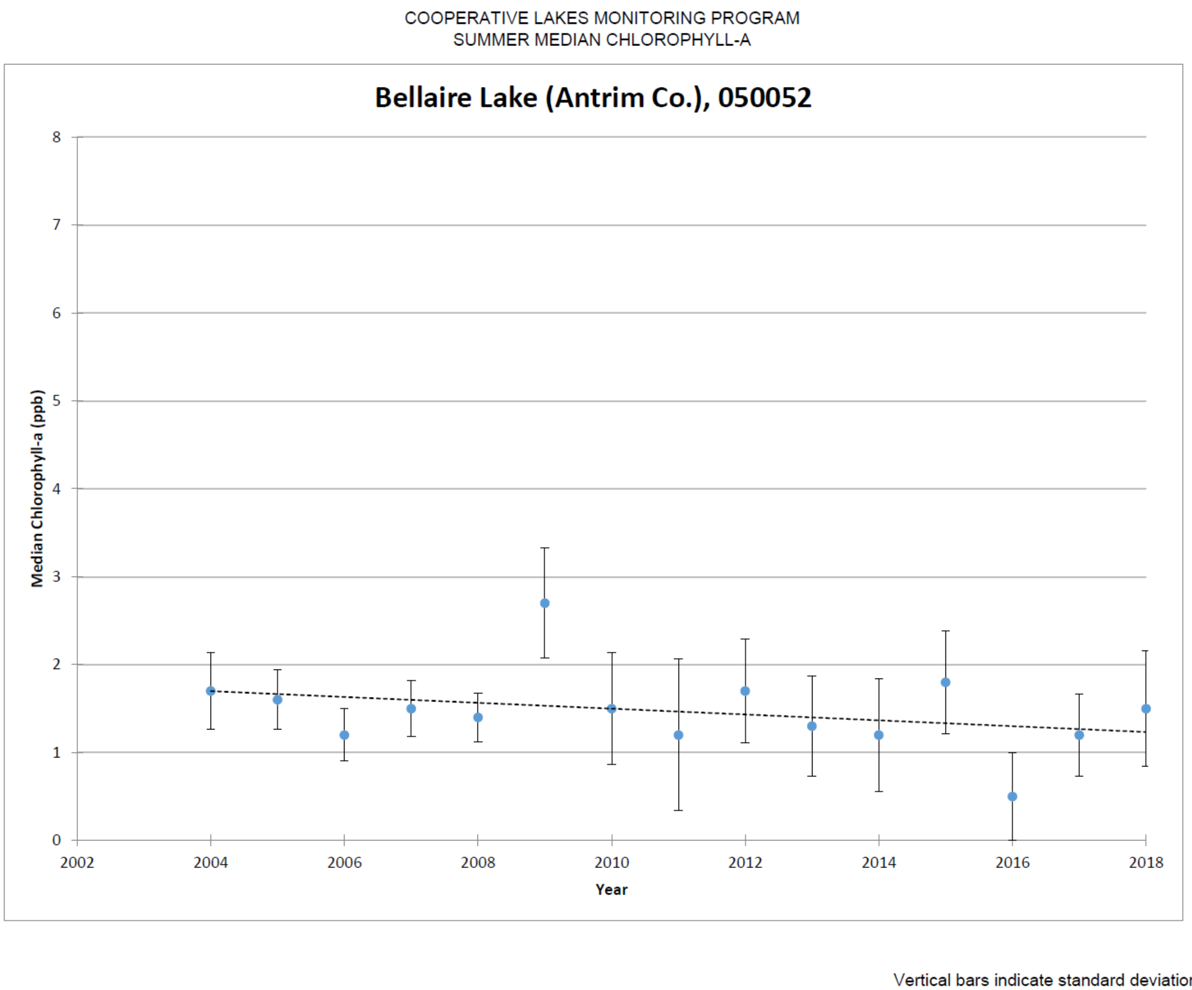


Figure 8 Average Chlorophyll-a in Lake Bellaire, adapted from Cooperative Lakes Monitoring Program (CLMP), 2018 lake report.

SHORELINE SURVEY METHODS

Lake Bellaire was surveyed by kayak during June and July of 2017 to document shoreline conditions. Shoreline conditions were surveyed by traveling as close to the shoreline as possible (usually within 20 feet) and noting *Cladophora* growth, substrate type, erosion conditions, greenbelt length, greenbelt depth, shoreline alterations, and tributaries. All information was recorded on field data sheets and subsequently compiled into a database.

Parameters

Shoreline property features were documented by photographing and noting physical features on a data sheet. 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 permanent structures, including roadways, boat launching sites, and recreational properties (i.e., 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, large parcels that had structures 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. After noting development status, *Cladophora* was identified in the area.

Many species of filamentous green algae are commonly found growing in the nearshore regions of lakes. Positive identification at the species level usually requires the aid of a microscope. However, *Cladophora* genus usually has a unique appearance and texture that is quite distinct to a trained surveyor. Other species of filamentous green algae can respond to an external nutrient source in much the same way as *Cladophora*, though their value as an indicator species is not thought to be as reliable. When other species occurred in especially noticeable, large, dense growths, they were recorded on the data sheets and described the same as those of *Cladophora*.

When *Cladophora* was observed, it was described in terms of the length of shoreline with growth, the relative growth density, and any observed shoreline features potentially contributing to the growth. Both shoreline length and growth density are subjective estimates. Growth density is determined by estimating the percentage of substrate covered with *Cladophora* using the following categorization system:

Table 2 Categorization system 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 high percentage of substrate coverage and long filamentous growth.

Among other things, the distribution and size of each *Cladophora* growth is dependent 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 noted during the survey, using the following abbreviations: m = soft muck or marl, s = sand, g = gravel (0.1” to 2.5” diameter), r = rock (2.5” to 10” diameter), b = boulder (>10” diameter), and w = woody debris. Substrate suitable for *Cladophora* growth include the g, r, b, and w types. However, the extent of suitable substrate along a shoreline parcel in terms of distance was not documented. Erosion conditions were similarly noted along each shoreline.

Erosion was noted based on shoreline areas that exhibited: areas of bare soil, leaning or downed trees, exposed tree roots, undercut banks, slumping hunks of sod, excessive deposits of sediments, or muddy water. Similar to *Cladophora*, shoreline erosion was recorded on field data sheets with extent and relative severity estimates (light, moderate, or heavy/severe). For example “Mx20” indicated 20 feet of shoreline with moderate erosion. Additional information about the nature of the erosion, such as potential causes, were also noted.

Minor: exposed soils, gullies up to 1” deep.

Moderate: exposed soils, gullies > 1” & < 6”, banks undercut by <6”, minor slumping.

Severe: exposed soils, gullies > 6”, banks undercut by > 6”, severe slumping, tree fall

Greenbelts were rated based on the relative length of shoreline with a greenbelt and the average depth of the greenbelt from the shoreline into the property. Ratings ranged from zero to four and were based on the following.

Length	0: None, 1: 1-10%, 2: 10-25%, 3: 25-75%, 4:>75%
Depth	0: None, 1: <10 ft, 2: 10-40 ft, 3: >40 ft

Greenbelt ratings for length and depth were summed to produce an overall greenbelt score.

Tributaries were noted on the field data sheets and included in a separate column in the database. Additional information was included in the database in a "comments" column. The comments column also included notes about shoreline alterations. Shoreline alterations (structures) were noted with the following abbreviated descriptions:

SB = steel bulkhead (i.e., seawall)
CB = concrete bulkhead
WB = wood bulkhead
BB = boulder bulkhead
RR = rock rip-rap
BH = permanent boathouse
DP = discharge pipe

Data Processing

Upon completion of surveying the entire Lake Bellaire shoreline, all field data were transferred to a Microsoft Excel® workbook. Digital photographs and GPS data were uploaded to a computer and processed for use. Linking field and equalization data allows shoreline conditions documented during the survey to be referenced by parcel identification number or parcel owner name. Field data were linked to Antrim County parcel data in a Geographic Information System (GIS) with the aid of GPS and photographs.

In order to display survey results without pinpointing specific parcels, a new map layer was developed using the parcel map data layer acquired from the county equalization department and a Lake Bellaire shoreline layer. The new map layer consists of a narrow band following the shoreline, split into polygons that contain field and equalization data. This data layer was overlaid with other GIS data from the State of Michigan to produce the maps contained in this report.

RESULTS

Following are results of the 2017 survey documenting shoreline conditions at 288 parcels on Lake Bellaire. Approximately 86% (248) of shoreline properties on Lake Bellaire were considered developed.

Cladophora

Noticeable growths of *Cladophora* or other filamentous green algae were found along the shoreline at 101 parcels (42%of total parcels surveyed; Table 3). At properties where *Cladophora* growth was observed, 74 parcels consisted of light or very light growth, while 11 parcels had moderate to heavy growth (Figure 12).

Table 3 Cladophora density results

***Cladophora* Density**	**Parcels**	**Percent of total parcels (%)**
Very light	36	12.5
Light	38	15.3
Light to Moderate	16	10.4
Moderate	3	1.0
Moderate to Heavy	5	1.7
Heavy	3	1.0
Very Heavy	0	0
Total	101	42

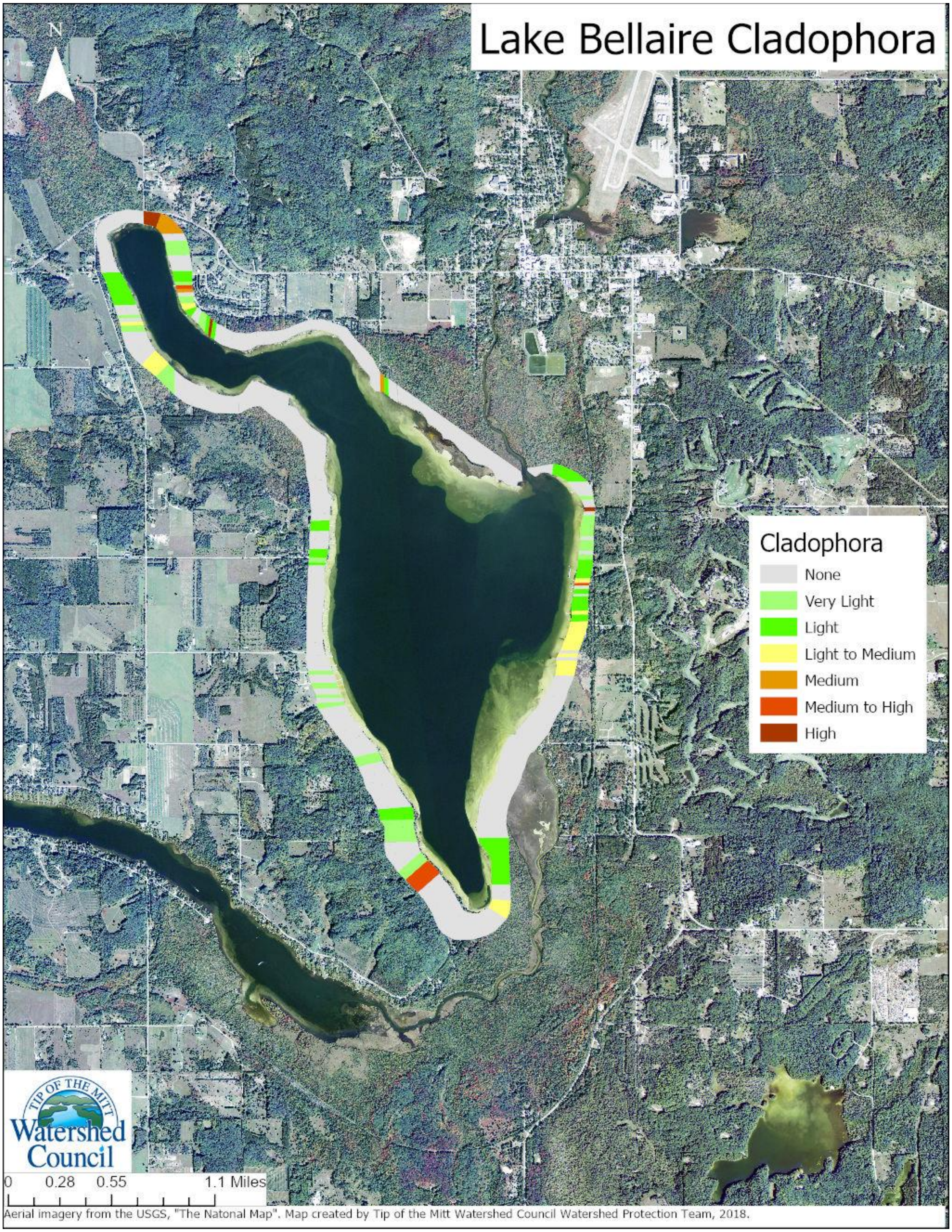


Figure 9 Cladophora density around Lake Bellaire Shoreline

Greenbelt Scores

Greenbelt scores ranged from 0 (little to no greenbelt) to 7 (exemplary greenbelt). Lake Bellaire greenbelts were generally observed to be in poor to fair condition. Of 288 parcels surveyed, 86 parcels (29.9%) received a greenbelt rating in the poor or very poor categories (Table 4).

Table 4 Greenbelt rating results

Greenbelt Rating		Number of Parcels	Percent (%)
0	Very Poor (absent)	35	12.2
1-2	Poor	51	17.7
3-4	Moderate	40	13.9
5-6	Good	79	27.4
7	Excellent	72	25

Clusters of properties along the northern and western shoreline were ranked in the very poor (absent) to poor categories (Figure 13). Large parcels along the eastern shoreline showed excellent, healthy greenbelts. These areas were also largely undeveloped parcels of land.

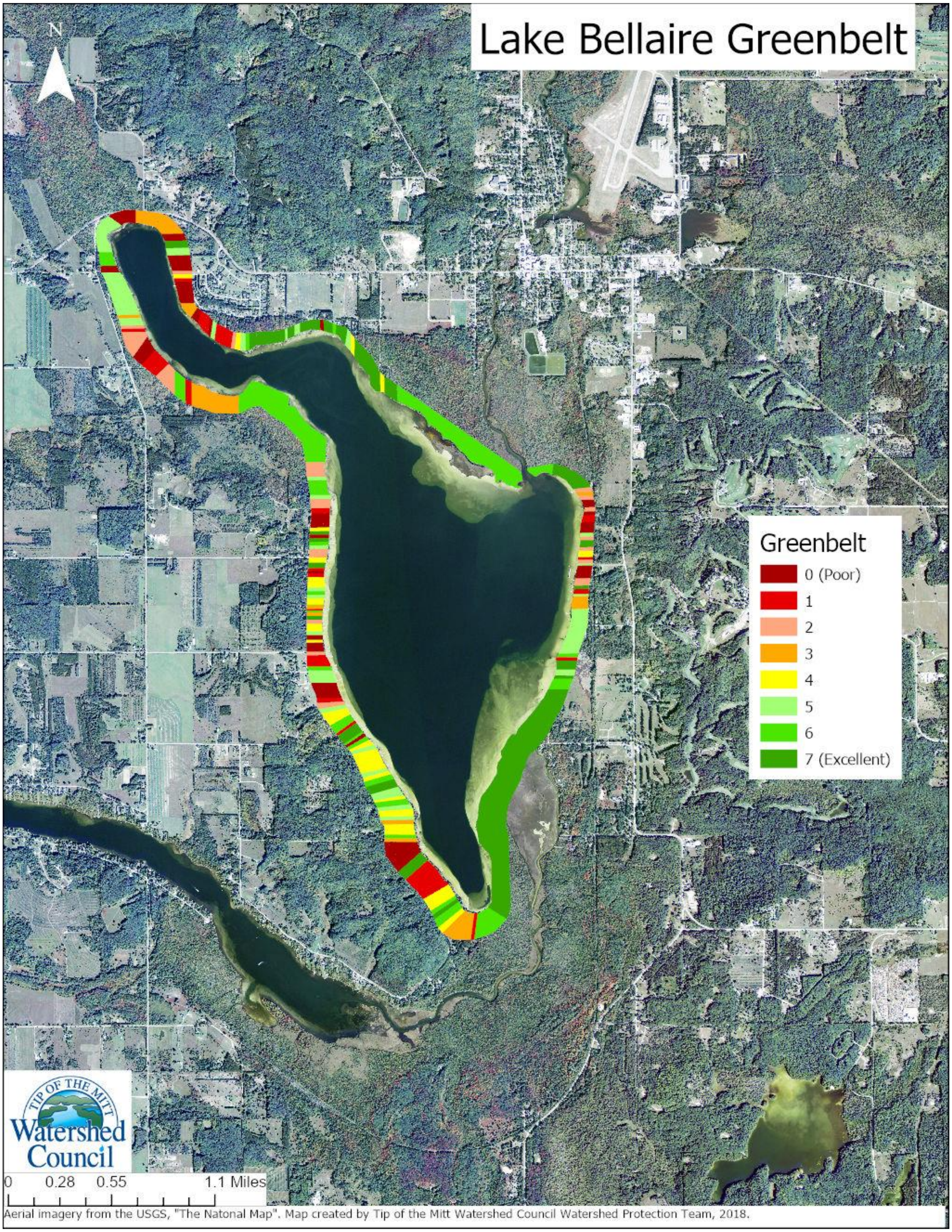


Figure 10 Greenbelt Scores around Lake Bellaire shoreline

Shoreline alterations

Some form of shoreline alteration was noted at 45% (131 parcels) of shoreline properties (Table 5). Of the alterations, 49 parcels contained a seawall barrier.

Table 5 Shoreline alteration results

Alteration Type	Number of Parcels*	Percent With Alteration (%)*
Riprap (cobble)	34	11.8
Riprap (boulder)	10	3.5
Mixed riprap	33	11.5
Seawalls	49	17
'Artificial' Beach Sand	23	8
Discharge Pipes	14	5
Unaltered	157	55

**Numbers and percentages quantify alteration type, some parcels could have multiple alterations*

Erosion

Erosion was noted at 78 parcels (27.1%) on the Lake Bellaire shoreline (Table 6). Much of the erosion (22.6%) was classified as minor in terms of severity, while no properties considered severe (Figure 11).

Table 6 Shoreline erosion severity results

Erosion Category	Number of Properties	Percent of Properties (%)
Light	65	22.6
Medium	13	4.5
Heavy	0	0

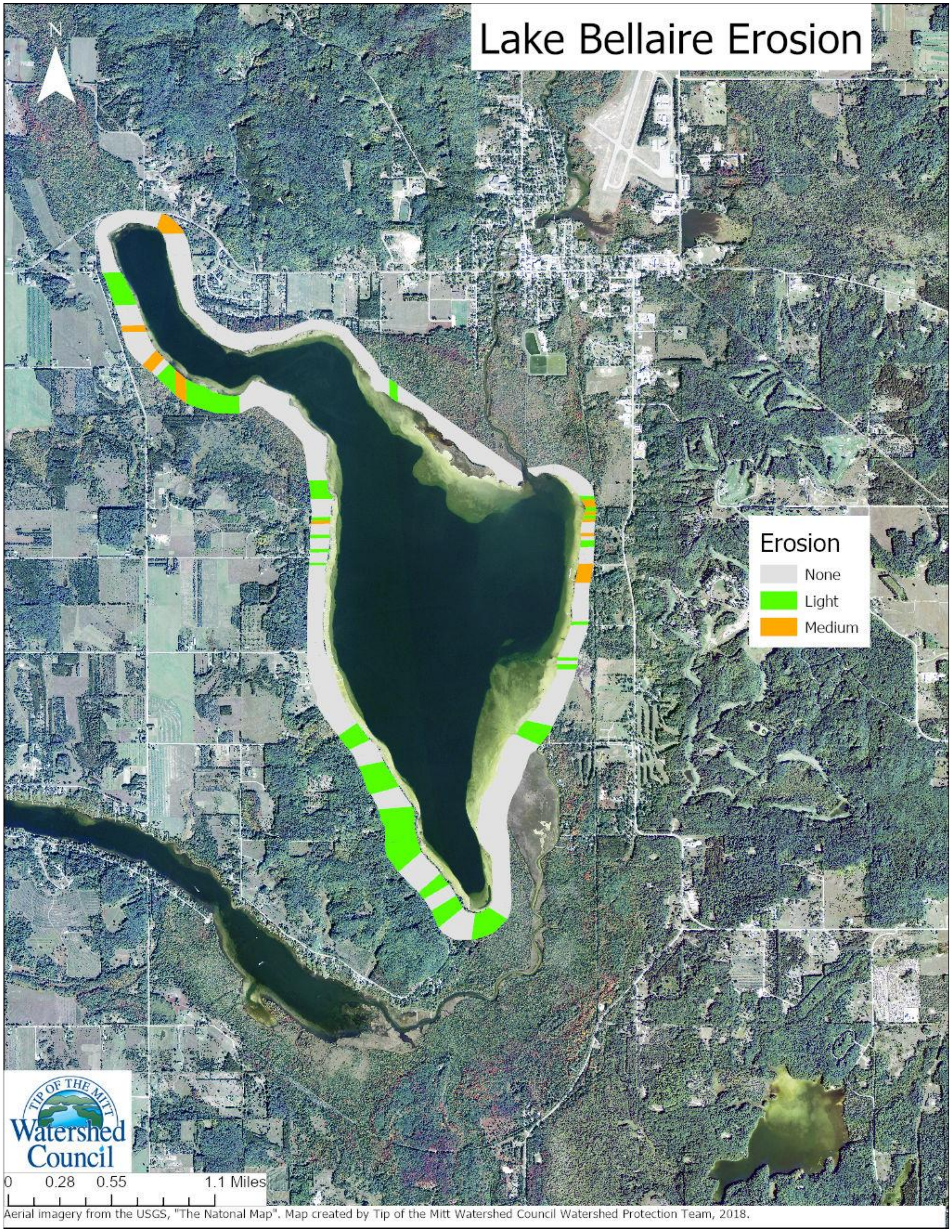


Figure 11 Erosion severity around Lake Bellaire shoreline

DISCUSSION

In general, development of shoreline parcels can negatively impact a lake's water quality due to a multitude of factors. Among the most serious impacts to water quality include:

1) Loss of vegetation that would otherwise absorb and filter pollutants in stormwater runoff as well as stabilize shoreline areas and prevent erosion.
2) Increased impervious surface area such as roofs, driveways and roads, which leads to greater inputs of stormwater runoff and associated pollutants.
3) Waste and byproducts of human activity such as septic leachate, fertilizers and decomposing yard waste that potentially reach and contaminate the lake water.

Clearly, there are many problems associated with development, but there are also many solutions for reducing or even eliminating impacts. Numerous best management practices have been developed that help minimize negative impacts to water quality and can be utilized during or after the development of shoreline parcels. A buffer of diverse, native plants can be planted/maintained along the shoreline to filter pollutants and reduce erosion. Impacts from stormwater generated from roofs, roads, and driveways can be reduced using rain barrels, rain gardens, grassy swales, and many other techniques. Leachate reaching the lake from septic systems can be minimized by pumping the septic tank regularly, having all components of the septic system inspected regularly and replacing the septic system when necessary. Mulch can be composted far from the shoreline and fertilizers applied sparingly, if at all.

A quick comparison with prior shoreline survey shows changes in these measurements over time. The total number of properties with documented *Cladophora* growth increased since 1998 (Table 6). This points towards a potential increasing trend of near-shore nutrient pollution. Outreach regarding septic system maintenance, phasing out of old systems, and properly siting new systems may help play a role in reduction in nutrient pollution related to septic systems. Where human-caused nutrient pollution is occurring, the source has to be identified in order to address the problem. Although impeded by factors such as wind, wave action, currents, and groundwater paths, efforts by trained personnel to identify specific nutrient input sources on individual properties are often successful.

Table 7 Critical shoreline survey parameter comparisons: 1998 to 2016.

Survey Parameter	**1998 Survey Results**		**2008 Survey Results**		**2017 Survey Results**	
	Properties	%	Properties	%	Properties	%
Cladophora Algae Presence	36	14.2%	ND	ND	121	42%
Poor Greenbelts (score 0-2)	ND	ND	93	32%	86	29.9%
Erosion	7	2.5%	8	3	47	16.3%
Shoreline Alterations	ND	ND	ND	ND	45	15.6%

Results from the 2017 shoreline survey indicate that some of the aforementioned issues may pose a threat to the water quality and overall health of Lake Bellaire. The lack of native vegetation at water's edge with potential septic leakage for some parcels might be the greatest threat to Lake Bellaire. Removal of shoreline vegetation and *Cladophora* presence are highlights as the main concerns. Erosion was less of a concern around the lake. Fortunately, wetland areas surrounding Lake Bellaire have remained intact. The easiest, and perhaps most beneficial way to improve Lake Bellaire shoreline to defend water quality would be to have native vegetation at water's edge.

A lack of vegetation on the lake's shoreline, which provides habitat and acts as a food source, can impact the abundance and diversity of aquatic organisms, ranging from minute crustaceans to top tier predator fish. Furthermore, the absence of vegetation can lead to increased shoreline erosion and less filtration of pollutants. Properties with healthy, intact greenbelts provide a model for improvement for other shoreline properties.

Table 8 Shore survey statistics from Northern Michigan lakes

Lake Name	Survey Date	*Cladophora**	Heavy Algae*	Erosion*	Poor Greenbelts*	Alterations*
Beals Lake	2016	0%	0%	0%	17%	0%
Ben-Way Lake	2016	3%	0%	84%	47%	40%
Burt Lake	2009	47%	29%	4%	36%	46%
Bellaire Lake	2017	35%	1%	27%	30%	55%
Charlevoix, Lake	2012	22%	19%	14%	34%	79%
Clam Lake	2017	48%	5%	30%	51%	55%
Crooked Lake	2012	29%	26%	14%	51%	65%
Douglas Lake	2015	27%	6%	17%	53%	60%
Elk Lake	2017	84%	2%	52%	30%	87%
Ellsworth Lake	2016	40%	14%	38%	24%	23%
Hanley Lake	2016	11%	0%	33%	19%	23%
Huffman Lake	2015	14%	0%	7%	57%	70%
Huron, Duncan Bay	2013	41%	2%	19%	45%	63%
Huron, Grass Bay	2013	0%	0%	4%	0%	8%
Intermediate Lake	2016	19%	9%	53%	63%	77%
Lance Lake	2014	19%	0%	12%	35%	31%
Larks Lake	2006	4%	0%	ND	12%	29%
Mullett Lake	2016	44%	6%	36%	59%	76%
Pickerel Lake	2012	27%	33%	15%	52%	64%
Round Lake	2014	21%	0%	27%	44%	44%
Scotts Lake	2016	0%	0%	2%	18%	7%
Silver Lake	2014	3%	0%	70%	53%	65%
Skegemog Lake	2017	52%	5%	40%	46%	76%
St. Clair Lake	2016	4%	0%	13%	34%	21%
Six Mile Lake	2016	10%	24%	13%	41%	37%
Thayer Lake	2017	11%	1%	32%	16%	22%
Thumb Lake	2007	4%	0%	ND	ND	39%
Torch Lake	2017	39%	5%	26%	20%	ND
Walloon Lake	2016	62%	2%	17%	39%	80%
Wildwood Lake	2014	5%	0%	22%	45%	50%
Wilson	2016	27%	5%	29%	11%	14%
AVERAGE	NA	24%	6%	26%	36%	47%

**Percentages are in relation to number of parcels on the lake shore, except for "heavy algae", which is the percent of only parcels that had Cladophora growth. Erosion is the percentage of parcels with moderate to severe erosion and poor greenbelts include those in the poor or very poor categories. ND=no data.*

Many properties with patches of lawn at water's edge experience a minor undercutting caused by waves and ice shove. Properties with artificial beach sand usually experience some loss of sand into the Lake, evidenced by small erosional rills leading into the Lake. Although not catastrophic, these types of minor erosion do have the ability to degrade the water and habitat quality of Lake Bellaire. To prevent changes to the lake ecosystem, changes should be made in shoreline property management. Mismanagement of shoreline properties can degrade the lake's water quality, diminish fisheries, and even create an environment that poses threats to human health. Therefore, Tip of the Mitt Watershed Council offers a number of recommendations.

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, and to help them rectify any problem situations. The following are recommended follow-up actions:

1. Keep the specific results of the survey confidential (e.g., do not publish a list of sites where *Cladophora* algae were found) as some property owners may be sensitive to publicizing information regarding their property.
2. Send a <u>general</u> summary of the survey results to all shoreline residents.
3. Organize and sponsor an informational session to present findings of the survey to shoreline residents and provide ideas and options for improving shoreline management practices that would help protect and improve the Lake's water quality.
4. Inform owners of properties with heavy *Cladophora* growths of specific results for their property, ask them to fill out a questionnaire in an attempt to interpret causes of the growth, and offer individualized recommendations for water quality protection.
5. Inform owners of properties with poor greenbelt scores and those with severely eroded shorelines of specific results for their property. Supply these property owners with information (e.g., brochures) regarding the benefits of greenbelts and/or the problems

associated with erosion. Encourage property owners to improve greenbelts using a mix of native plants and to correct erosion problems. Property owners can contact the Watershed Council for more information on how to improve greenbelts and/or correct erosion problems.

6. Utilize the Internet and other organizations' websites to share survey information. A general summary report and this detailed report can be posted on websites because they do not contain any property-specific information. Property-specific information can be shared by randomizing and encrypting the shoreline survey database and providing property owners with a code number that refers specifically to survey results from their property. The Watershed Council is available to assist with this approach.
7. Continue to support the Tip of the Mitt Watershed Council Volunteer Lake and Stream Monitoring programs by providing volunteer support. The information collected by volunteers is extremely valuable for evaluating water quality and determining trends. These data are also provided to State agencies (EGLE, EPA). Lake residents are encouraged to continue supplying volunteer help and volunteers should attend training sessions held by the Watershed Council to ensure that a complete set of quality data is being collected each year.
8. Repeat some version of the survey periodically (ideally every 5 - 10 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 details about shoreline features are added to the database, which can be utilized for other water resource management applications.
9. The Michigan Natural Shoreline Partnership has developed a new educational tool called the Michigan Shoreland Stewards Program, which is a voluntary web-based survey designed to educate shoreline property owners on the importance of lake-friendly management practices. The survey asks questions related to management practices in each of the four sections of a shoreland property: upland, buffer, shoreline and lake. Responses to the questions are rated to determine the shoreland steward recognition level. A gold, silver, bronze or starter level rating can be achieved.

Encourage Lake Bellaire residents to visit www.mishorelandstewards.org to take the survey.

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