Larks Lake Shoreline Survey 2022

Tip of the Mitt Watershed Council

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SUMMARY

Larks Lake is a small inland lake, covering 600 acres, located in northern Emmet County. Larks Lake is located within the larger Burt Lake watershed. In 2022, Tip of the Mitt Watershed Council conducted a shoreline survey on Larks Lake, which was funded by the Larks Lake Association. The shoreline survey was completed to document the shoreline conditions and their impact on the water quality of the lake. The survey recorded the following along the shoreline: algae density, erosion severity, shoreline alterations, greenbelt scores and parcel development. The shoreline survey created a comprehensive data set that can be used as a lake management tool, and help determine next steps to maintain lake health and the water quality of Larks Lake.

INTRODUCTION

Background

During the summer of 2022, a shoreline survey was conducted on Larks Lake by the Tip of the Mitt Watershed Council to document shoreline conditions that potentially impact water quality. The entire shoreline was surveyed to document the following: algae as a nutrient pollution indicator, erosion, shoreline alterations, greenbelts, and tributary inlets and outlets. The survey was funded by Larks Lake Association.

The 2022 survey provides a comprehensive data set documenting shoreline conditions on Larks Lake; a valuable data set that can be used as a lake management tool. Combined with follow-up activities, such as questionnaires and on-site visits, problems in shoreline areas that threaten the lake's water quality can be identified and corrected. 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 publicity and education associated with the survey. Periodic repetition of shoreline surveys is important for identifying new and chronic problem sites, determining long-term trends of near-shore nutrient inputs and shoreline alterations associated with land-use changes, and for assessing the success of remedial actions.

Shoreline Development Impacts

Lake shorelines are the critical interface between land and water; where human activity has the greatest potential for degrading water quality. Developing shoreline properties for residential, commercial or other uses invariably has impacts on the aquatic ecosystem. During the development process, the natural landscape is altered in a variety of ways; vegetation is removed, the terrain is graded, utilities installed, structures are built, and areas are paved. These changes to the landscape and subsequent human activity in the shoreline area have consequences on the aquatic ecosystem. Nutrients from wastes, contaminants from cars and roads, and soils from eroded areas are among some of the pollutants that end up in and impact the lake following shoreline development.

Nutrient pollution can have adverse impacts on aquatic ecosystems 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 in depth). An increase in algal blooms also has the potential to become a recreational nuisance when algal mats and scum are

formed on the lake's surface. Additionally, algal blooms 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. During nighttime respiration, plants compete with other organisms for a limited oxygen supply. Furthermore, the decomposition of dead algae and plant material has the potential to deplete dissolved oxygen supplies due to the aerobic activity of decomposers, particularly in the deeper waters of stratified lakes.

In general, large, deep lakes are less 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 are more habitats to support excessive aquatic macrophyte growth. Larks Lake is a shallow lake, with its deepest point reaching 9 feet, which means it can be more susceptible to nutrient pollution. Additionally, Larks Lake is fed by springs, but has an outflow, which provides a mechanism to flush excess nutrients out of the system. Surface waters receive nutrients through a variety of natural and cultural (human) 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 sources include septic and sewer systems, fertilizer application, 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. Furthermore, 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 check for nutrient pollution can be effective, though costlier and more labor intensive than 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 water temperature and conductivity (i.e., the water's ability to conduct an electric current). Biologically, nutrient pollution can be detected along the lake shore by noting the presence of *Cladophora* algae.

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 to 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, 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 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 inputs. 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, 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.

Erosion along the shoreline has the potential to degrade the lake's water quality. Stormwater runoff through eroded areas carries sediments into the lake and impacts the lake ecosystem in a variety of ways. Sediments clog the gills of fish, aquatic insects and other aquatic organisms. Excessive sediments smother fish spawning beds and fill interstitial spaces that provide habitat for a variety of aquatic organisms. While moving through the water column, sediments absorb sunlight energy and increase

water temperatures. In addition, nutrients adhere to sediments that wash in from eroded areas, which can lead to nuisance aquatic plant growth and large algae blooms.

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 terrestrial animals. Greenbelts function as erosion control devices, stabilizing the shoreline with plant root structures that protect against wave action and ice. The canopy of the greenbelt provides shade to near-shore areas, which is particularly important for lakes with cold-water fisheries. In addition, greenbelts provide a mechanism to reduce overland surface flow and absorb pollutants carried by stormwater from rain events and snowmelt.

Tributaries have great potential for influencing a lake's water quality as they are one of the primary conduits through which water is delivered to a lake from its watershed. Inlet streams may provide exceptionally high-quality waters that benefit the lake ecosystem, but conversely have the potential to deliver polluted waters that degrade the lake's water quality. Outlet streams flush water out of the lake, providing the means to remove contaminants that have accumulated in the lake ecosystem. With regard to shore surveys, noting the location of inlet tributaries is very helpful when evaluating shoreline algae 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 algae growth along the shoreline.

Responsible, low-impact, lake shoreline property management is paramount for protecting water quality. Maintaining a healthy greenbelt, regular septic tank pumping, treating stormwater with rain gardens, addressing erosion sites, and eliminating fertilizer, herbicide, and pesticide application are among many low-cost best management practices that minimize the impact of shoreline properties on lake water quality. Responsible stewardship on the part of shoreline property owners and living in harmony with the lake is vitally important for sustaining a healthy and thriving lake ecosystem.

Study Area

Larks Lake is located in northern Emmet County. The surface area of the lake is 600 acres and the shoreline measures 4 miles long around the perimeter of the lake. Larks lake is a shallow lake, depths only reaching a few feet throughout the majority of the lake, with its deepest point measuring 9 feet deep. Note that points of deeper/shallower depths are quite small on the map below, and the deepest point is within the larger polygon (Figure 1).

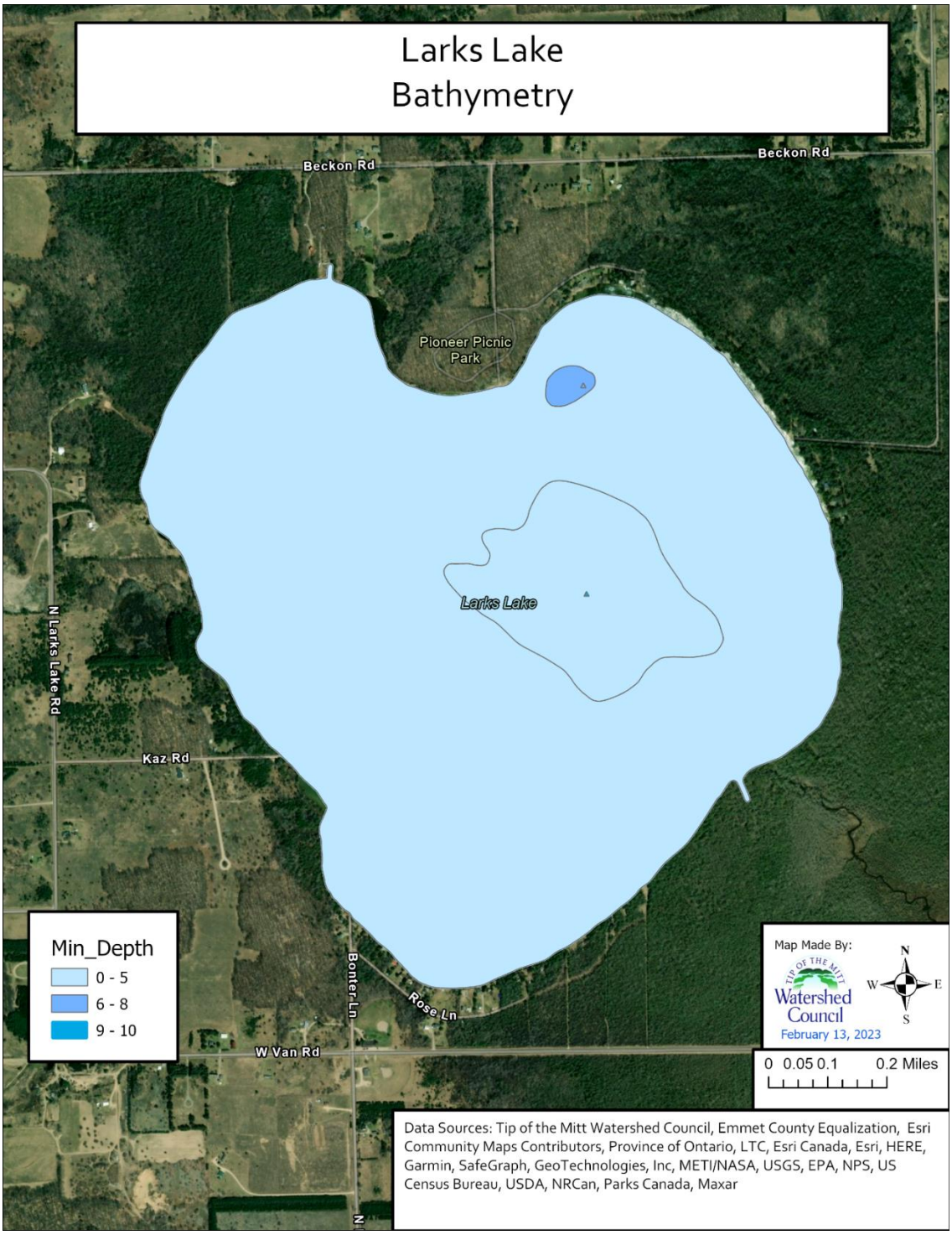


Figure 1. Map of Larks Lake depths.

The Larks Lake watershed and is fed by springs and its primary outflow is Brush Creek on the southwest shore of the lake. Brush Creek flows into the Maple River, which flows to Burt Lake, the Cheboygan River, and the ends up in Lake Huron.

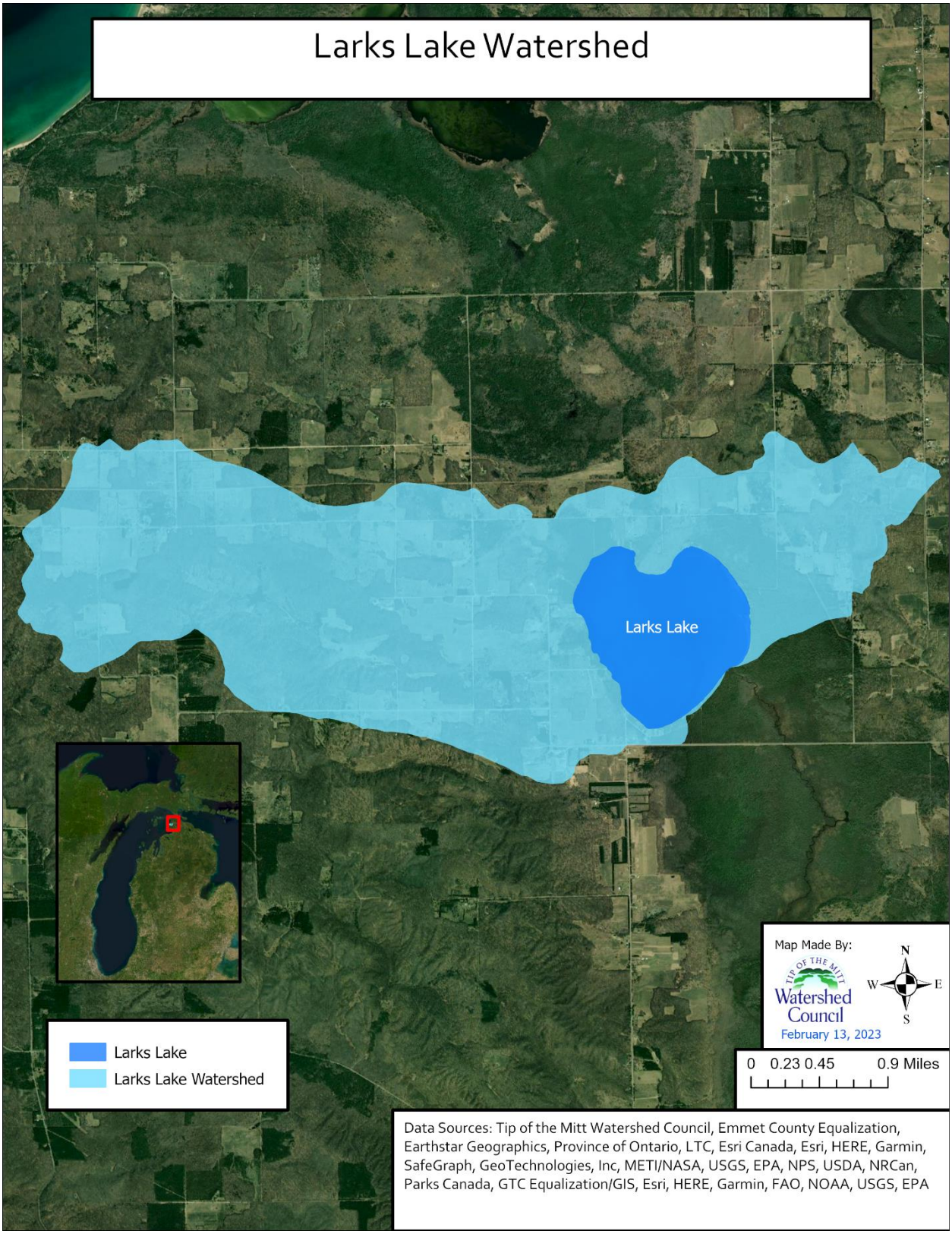


Figure 2. Larks Lake watershed map.

Many recreate on Larks Lake- activities including fishing, boating and swimming. Larks Lake is important not only because of the recreational activities it provides, but it is also a large source of water to the Pleasantview Swamp, which is one of the largest uninterrupted wetlands in northern Lower Michigan. It is at the headwaters of the Western Branch of the Maple River, which makes it important for protecting the water quality of the renowned trout stream. The Pleasantview Swamp is also important habitat for a wide variety of plant and animal life, including but not limited to bobcats, black bear, otters, bald eagles, and osprey.

Table 1. Land Cover in Larks Lake Watershed

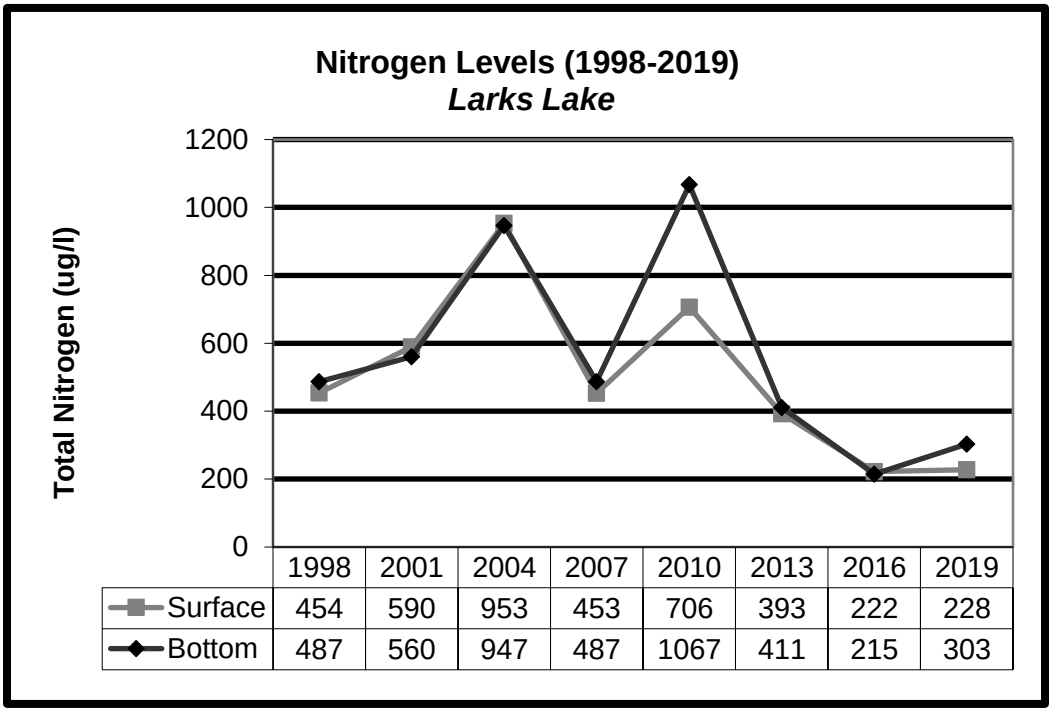
Land Cover Type	**Acreage**	**Percentage**
Forest	829851.3	43.9%
Grassland	166395.9	8.8%
Agriculture	199065.2	10.5%
Wetland	380226.5	20.1%
Scrub/Shrub	108417.9	5.7%
Urban/residential	69621.43	3.7%
Barren	7866.683	0.4%
Water	128439.4	6.8%

Pre-settlement land cover (or vegetation present in about 1800) in the Larks Lake watershed was primarily Beech-Sugar Maple-Hemlock forest in the upland areas and cedar swamp in wetland areas. Present day land cover within the Larks Lake watershed consists largely of forest, grassland, and agriculture, with minor areas of barren and urban/residential land (Table 1). Table 1 was created using the 2016 National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) land cover data.

In 2006, the Larks Lake Watershed Management Plan was written, which provides a background of the Watershed, along with recommendations to protect water quality. Data from a shoreline survey in 2006 was included in this plan, which was updated in 2022. The lake has been monitored every three years since 1998, for dissolved oxygen, specific conductivity, pH, and total phosphorus levels, through the Watershed Council's Comprehensive Water Quality Monitoring (CWQM) Program. In 1998, total

nitrogen, chloride, and nitrate nitrogen were added to this monitoring program. For 2022 CWQM, total nitrogen, total phosphorus, and chloride levels were not recorded.

Overall, total nitrogen levels have declined since 1998, with the last spike happening in 2010 (Figure 3). Total phosphorus levels have also declined overall. Total phosphorus numbers were significantly higher before 2004, in comparison to recent years (Figure 4). Chloride levels have increased since 1998, but have leveled out in recent years (Figure 5).



	1998	2001	2004	2007	2010	2013	2016	2019
Surface	454	590	953	453	706	393	222	228
Bottom	487	560	947	487	1067	411	215	303

Figure 3. Total nitrogen levels in Larks Lake since 1998.

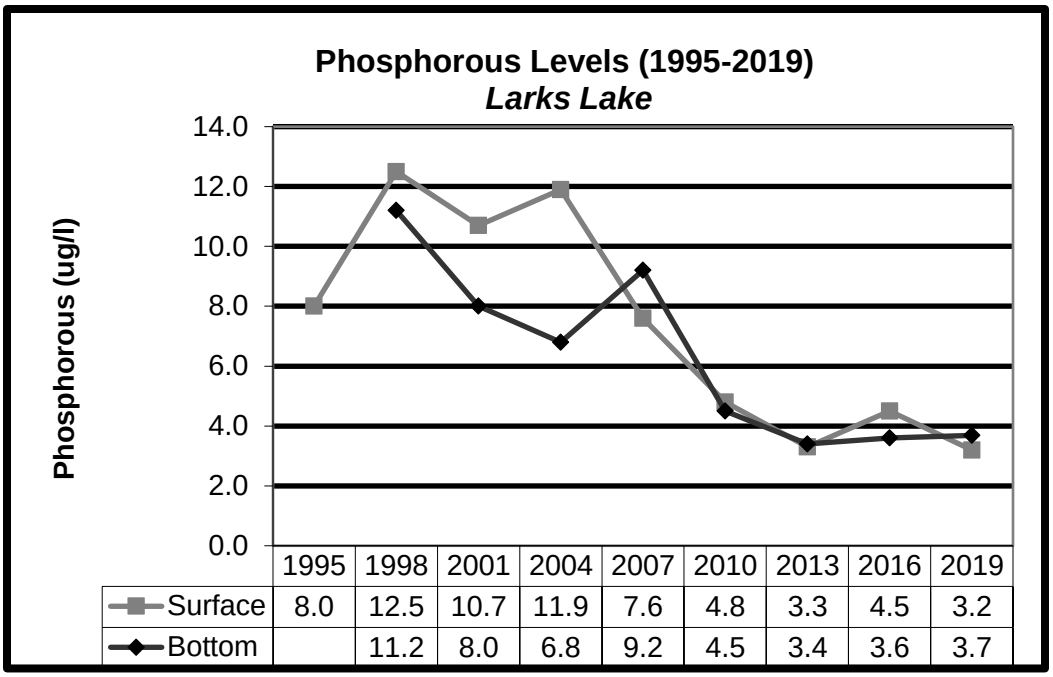


Figure 4. Total phosphorus levels in Larks Lake since 1995.

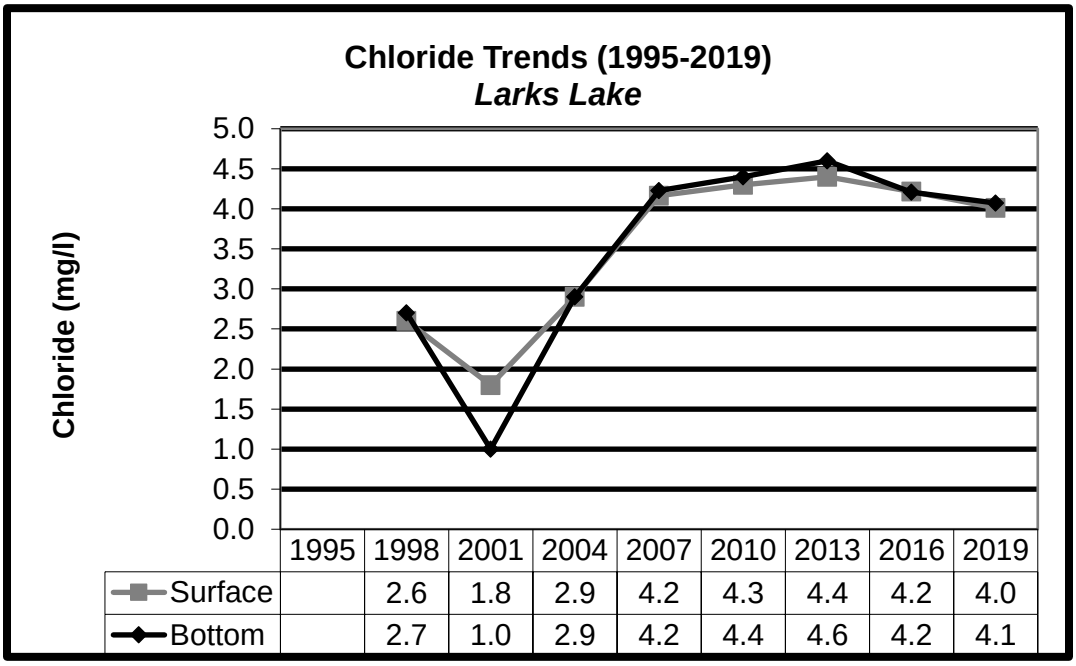


Figure 5. Chloride levels in Larks Lake since 1998.

The lake is also monitored annually through the Watershed Council's Volunteer Lake Monitoring (VLM) Program. This program operates by lake volunteers monitoring water transparency, chlorophyll-a, and water temperature in the deepest point of the lake throughout the summer months. Larks Lake is monitored through the Little Traverse Bay Bands of Odawa Indians Surface Water Protection Program (SWPP). Secchi disk readings and chlorophyll-a samples can be used to assign a Trophic Status Index (TSI) value, which characterizes the lake's productivity level. Larks Lake falls within the mesotrophic category, which indicates intermediate productivity levels. The green on the chart below (Figure 6) indicates the mesotrophic category (40-60 TSI).

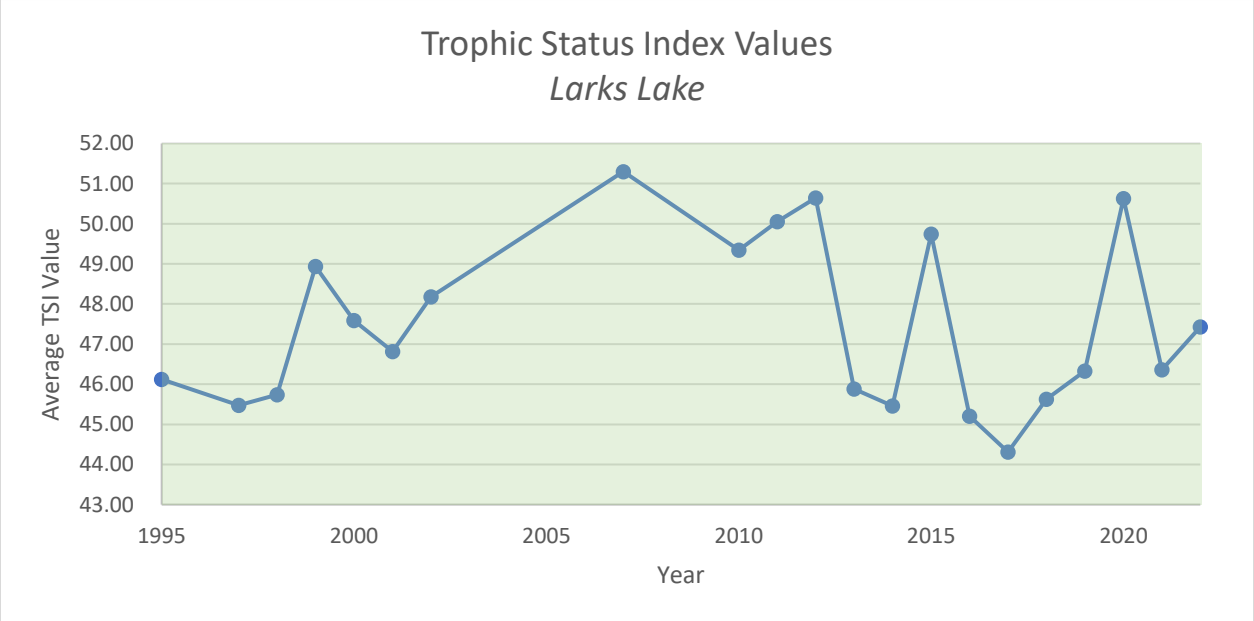


Figure 6. TSI values for Larks Lake; 1995-2020..

METHODS

From June to July, the entire Larks Lake shoreline was surveyed to comprehensively document shoreline conditions. Shoreline conditions were surveyed by traveling in kayak as close to the shoreline as possible (usually within 20 feet) and noting *Cladophora* growth, substrate type, erosion, greenbelt health, shoreline alterations, and tributaries. Information for each property was recorded on iPads using the app ArcGIS FieldMaps, which immediately linked it with property owner data from county equalization records.

Field Survey Parameters

A feature class with shoreline property outlines and ownership information were collected from Emmet and Charlevoix County Equalization in February 2022, and imported into the software program ArcGIS Pro. The parcels from each county were merged into a single feature layer. Only shoreline parcels were selected using a 100-meter buffer around a shapefile of Larks Lake. Fields for each survey parameter were set up in an attribute table with owner, property identification numbers, and address information. Domains were described in each field according to options available under each parameter. The feature layer was uploaded to ArcGIS online and options were set for editing offline in the app ArcGIS FieldMaps. The lake was downloaded on the FieldMaps app in an iPad for data collection.

Shoreline property features were documented by photographing and noting physical features in the FieldMaps app on iPads. Physical features include building descriptions, public access sites, and county road endings. Building descriptions were recorded in an abbreviated style such as, "*Red 2 sty, brn rf, wht trm, fldstn chim, lg pine."* This 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.

Development

Parcels were noted in FieldMaps as developed, non-developed, or partially developed, in 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, large parcels that had structures in an area far from the water's edge were not considered developed. Partially developed parcels included those with a non-livable structure or addition to the

land, including a shed, driveway, gazebo, etc. The length and area of developed versus undeveloped shoreline was not calculated.

Cladophora

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*, 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. For example, "MHx30 – seeps" denotes a moderate to heavy growth that covered 30 feet of the shoreline and with groundwater seeps in the area that may have been 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)	A green shimmer
Light	(L)	Up to 25% coverage
Light to Moderate	(LM)	25-49% coverage
Moderate	(M)	50-59% coverage
Moderate to Heavy	(MH)	60-74% coverage
Heavy	(H)	75-99% coverage
Very Heavy	(VH)	90-100% coverage

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 considered 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), W = woody debris (logs, sticks), and MTL = steel bulkhead, barrels, etc. Suitable habitat for *Cladophora* growth, which is based on the substrate types present and includes the categories: G, R, B, W and MTL. Either Yes (Y), Partial (P), or No (N), was noted to record if habitat for *Cladophora* was present throughout most of the shoreline.

Greenbelts

Greenbelts, i.e. shoreline vegetation, were rated based on the length of shoreline with a greenbelt and the average depth of the greenbelt from the water's edge landward into the property. Ratings for length ranged from zero to four while depth ranged from zero to three and were based on the following:

Table 3. Greenbelt scoring chart.

Score	Length (%)	Depth (feet)
0	Absent	Absent
1	<10%	<10
2	10-25%	10-40
3	25-75%	>40
4	>75%	NA

Greenbelt ratings for length and depth were summed to produce an overall greenbelt score. Greenbelt scores ranged from 0 to 7, representing the greenbelt status or health. Scores of 0 were considered very poor, 1-2: poor, 3-4: moderate, 5-6: good, and 7: excellent.

Shoreline Alterations

Shoreline alterations were surveyed and noted with the following abbreviated descriptions. Bulkheads refer to an erect manmade structure parallel to shoreline, which hardens the shoreline. Rip-rap can be described as a range of individual rocks that harden the shoreline.

SB = steel bulkhead (i.e., seawall) BB = big boulder rip-rap/bulkhead

CB = concrete bulkhead	RR = rock rip-rap
G = groin (rock, concrete in water)	BR = mixed boulder and rock rip-rap
WB = wood bulkhead	BS = beach sand
BH = permanent boathouse	DP = discharge pipe

Erosion

Erosion was noted based on shoreline areas that exhibited areas of bare soil, leaning or downed trees, exposed tree roots, scalloped shoreline shape, rapid rate of recession, vegetation removal for beach sand, slumping hunks of sod, undercut bans and gullies from runoff. Similar to *Cladophora*, shoreline erosion was recorded on field data sheets with estimates of its extent and relative severity (light (L), moderate (M), or heavy (H)). For example, "Mx20' at E. End" indicated 20 feet of shoreline with moderate erosion on the east end. Additional information about the nature of the erosion, such as obvious causes, were also noted.

Comments

Additional information regarding shoreline property features or shoreline conditions recorded on field data sheets was included in the database in a "comments" column.

Data Processing

Data was collected using the app ArcGIS FieldMaps on offline maps. Offline maps were synced daily to a web map on ArcGIS online. Data was downloaded from the ArcGIS shapefile.

Discrepancies were altered when processing the data in order to best represent the data collected. All "Null" values were changed to "None" or "0" depending on the parameter for the specific data. Comments made during field work about parcel development were used to update developed recordings.

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 departments and a Larks Lake shoreline layer. The new map layer consists of a 100-meter band following the shoreline, split into polygons that contain field and equalization data. Parcels were generalized and squared off, so the public data layer does not match actual parcel size and shape.

Final products include a comprehensive database with attached photos, GIS data layers of shoreline parcels that include both county equalization and shore survey data, and a story map displaying results. The database contains all data collected in the field and identification numbers in the database correspond to those in the GIS data layer and on hard-copy maps.

RESULTS

Development

This survey documented shoreline conditions at 76 parcels on Larks Lake. Approximately 54 (71%) of shoreline properties on Larks Lake were considered to be developed or partially developed, the majority (48.7%) being developed (Figure 7). The Larks Lake Developed Parcels map (Figure 8), shows that while developed and partially develped parcels were spread out around the lake, but developed parcels shown in red were often grouped together.

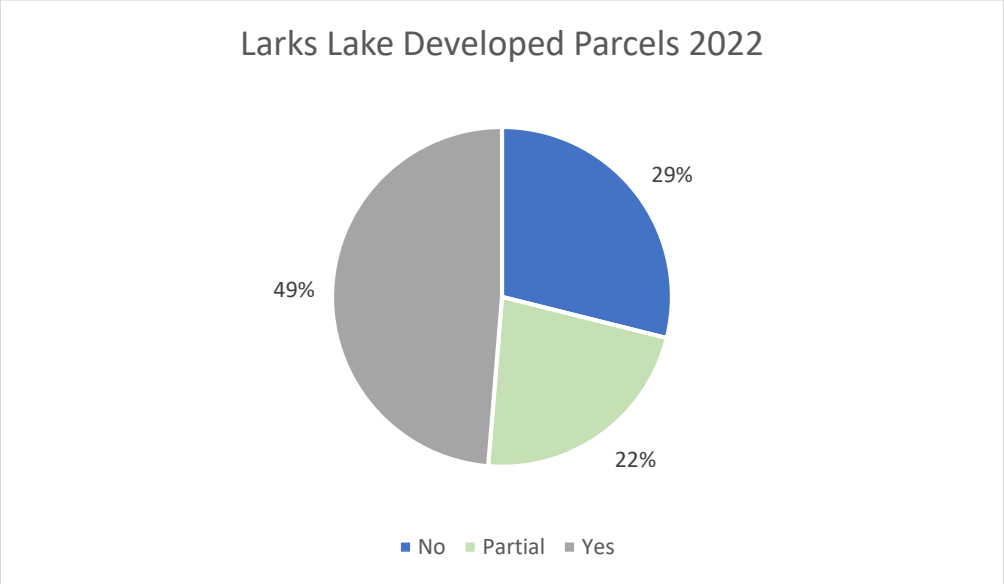


Figure 7. Developed parcels percentages.

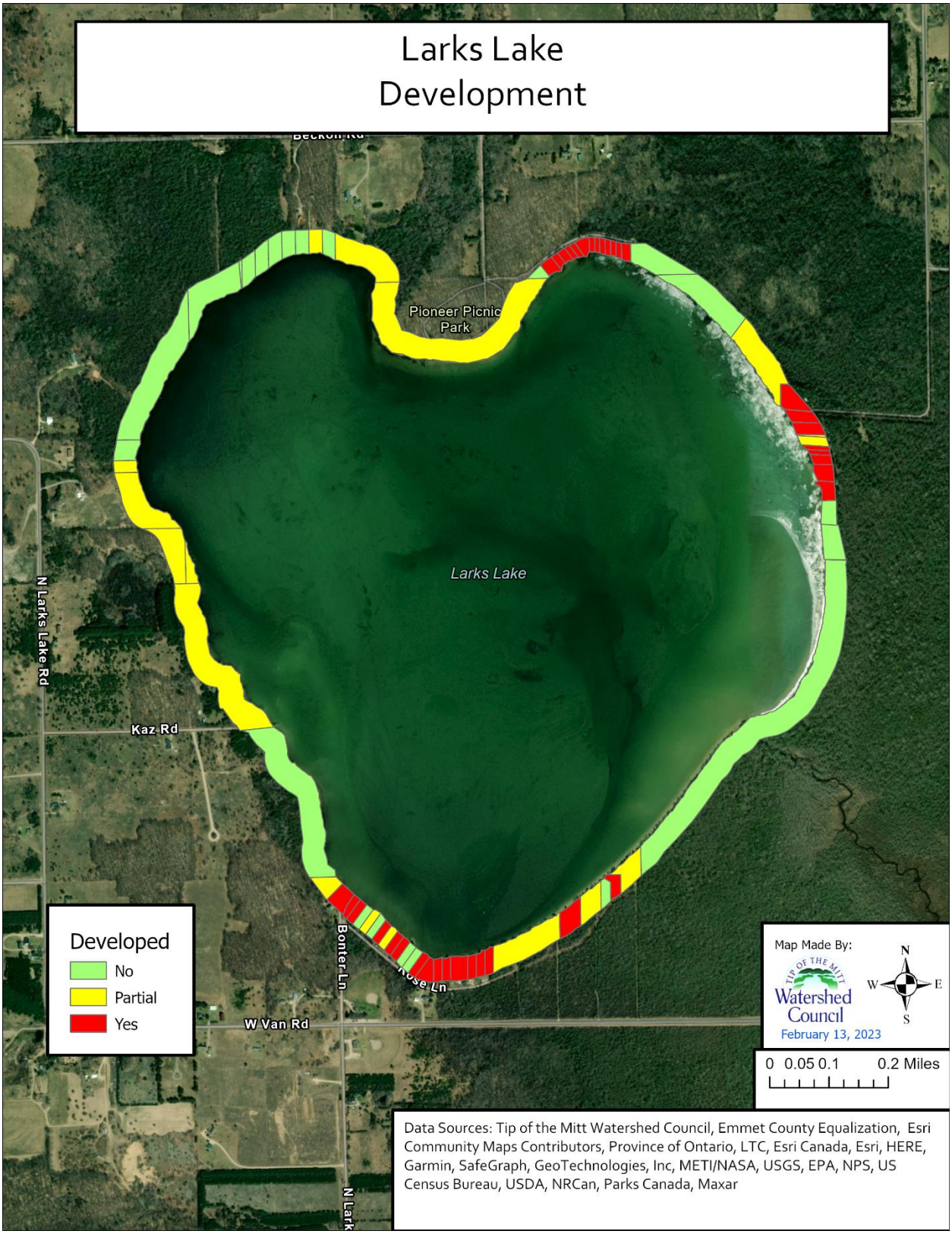


Figure 8. Larks Lake developed parcels map 2022.

Cladophora

Cladophora growth was not present along any section of the Larks Lake Shoreline (Figure 9).

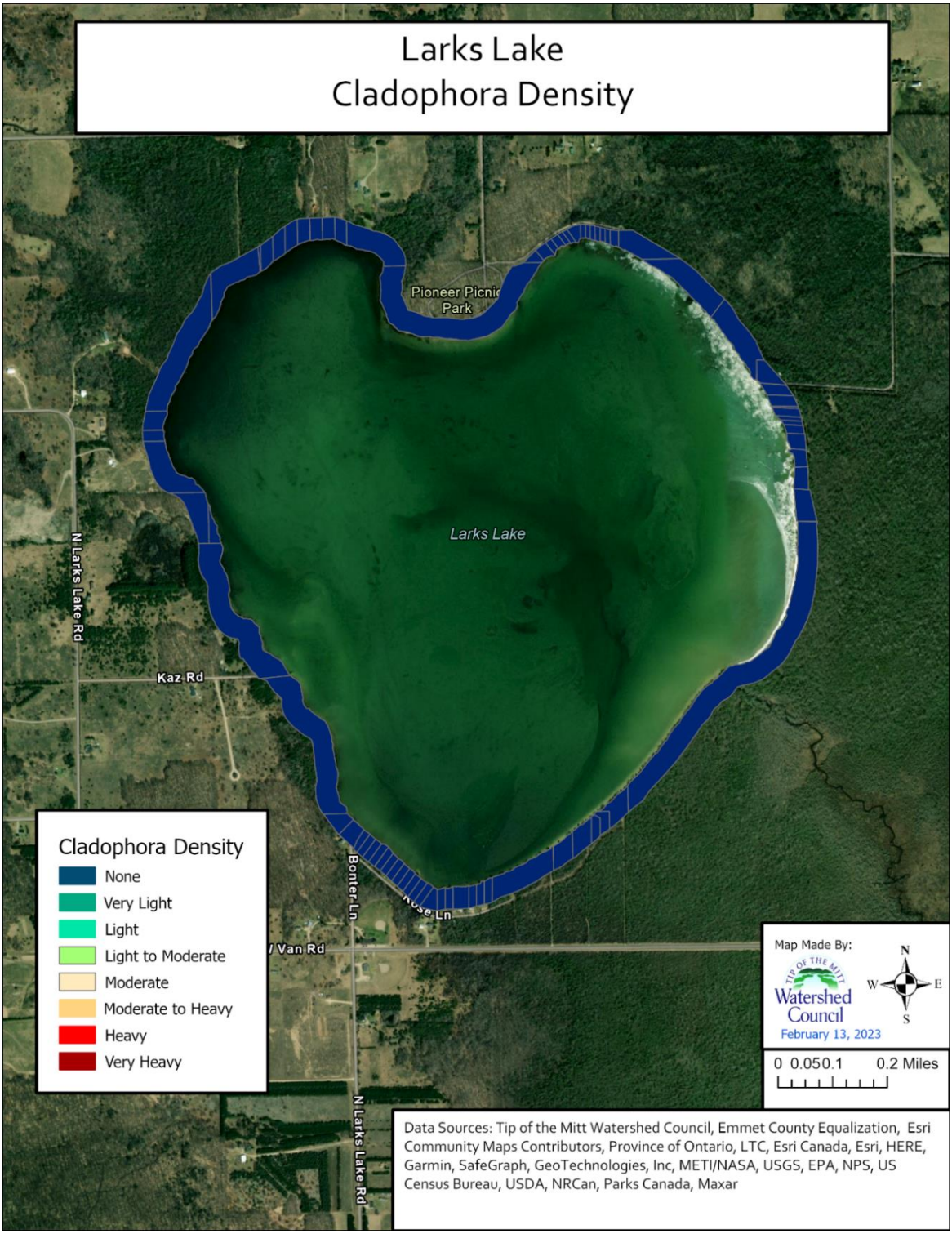


Figure 9. Cladophora density for Larks Lake 2022.

Greenbelts

Greenbelt scores in this shoreline survey ranged from 0 (absent or little greenbelt) to 7 (exemplary greenbelt). More than half of greenbelts (62%) along the Larks Lake shoreline were found to be in good or excellent condition, while 31% of properties were rated poor or very poor. Table 2. The parcel greenbelt scores chart (Figure 10) visually expressed the high number of greenbelt scores 7 and 0. The greenbelt score map (Figure 11) shows where parcels with good and poor greenbelt scores were located around the lake.

Table 4. Greenbelt scores 2022.

Greenbelt Score		2022 Parcels	2022 % Parcels
0	Very Poor (absent)	18	23.68
1-2	Poor	6	7.89
3-4	Moderate	5	6.58
5-6	Good	20	26.32
7	Excellent	27	35.53

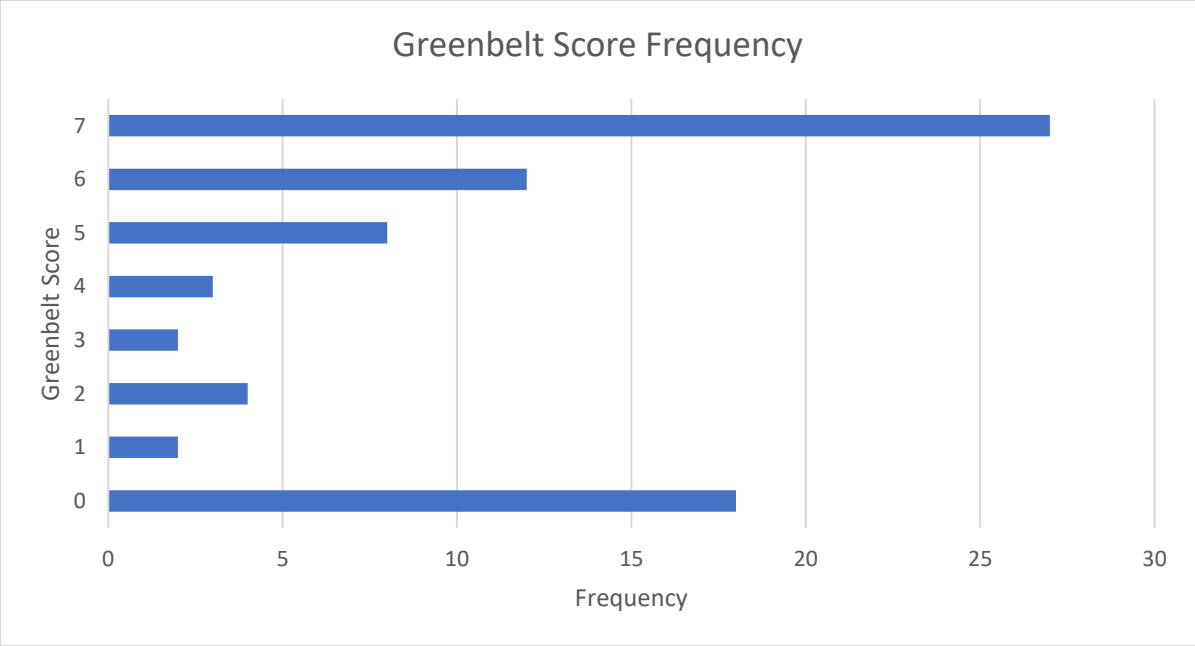


Figure 10. Greenbelt score chart for Larks Lake 2022.

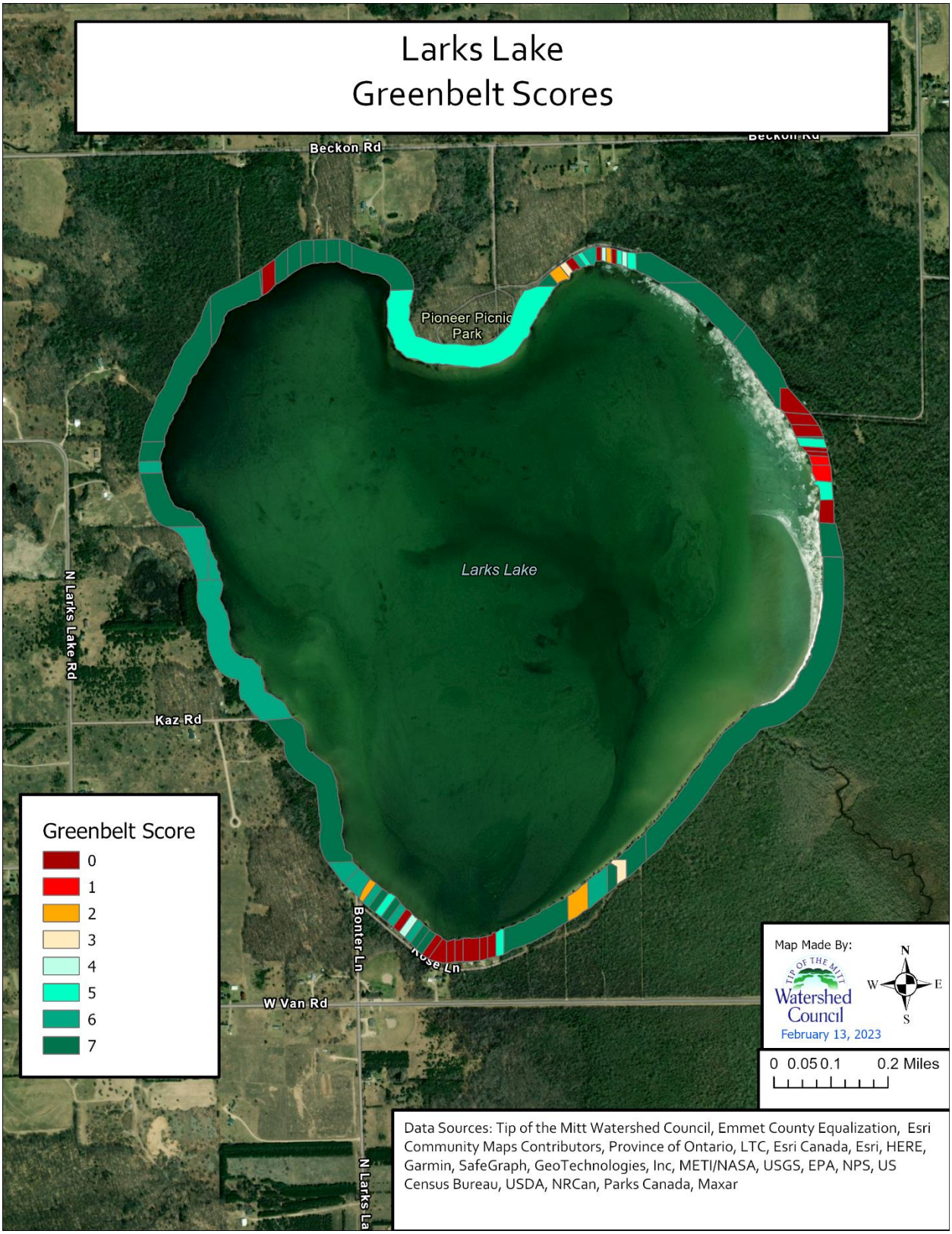


Figure 11. Map of greenbelt scores on Larks Lake 2022.

Shoreline Alterations

The majority of Larks Lake's shorelines (86%) were recorded as having no shoreline alterations. Some form of shoreline alteration was noted at 13% of shoreline properties (Table 6). The largest number of alterations on one parcel was 2 alterations (Table 6). For shorelines that were recorded as altered, the most common alteration (9%) was composed of a variation of riprap. (Table 5 and Figure 12). The rip-rap category includes boulders that were tallied as rock riprap (2.5" to 10" rocks), big boulder riprap (greater than 10" diameter), or mixed boulder and rock riprap. Table 5 refers to the total number of parcel alterations, while Table 6 refers to the number of alterations found per parcel. Note that the frequency totals are different for this reason.

Table 5. Shoreline alterations 2022.

Alterations		Frequency	Percent
None		66	85.7
Beach Sand		2	2.6
Boat Launch		1	1.3
Rip-rap		7	9.1
Wooden Bulkhead		1	1.3
Total		77	100.0

Table 6. Number of alterations per parcel 2022.

Number of Alterations	Frequency	Percent
0	66	86.8
1	9	11.8
2	1	1.3
Total	76	100.0

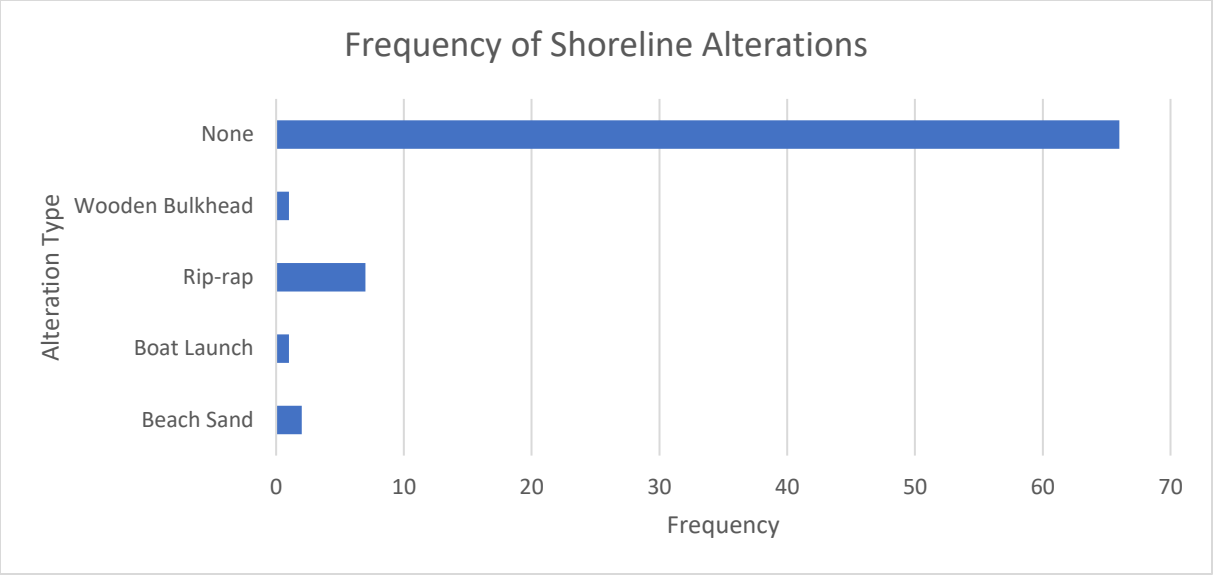


Figure 12. Frequency of alterations chart Larks Lake 2022.

Erosion

Erosion was noted at a low number of shorelines on Larks Lake; 6 out of the 76 parcels (9%) in 2022 were recorded as experiencing erosion (Table 7). Only erosion that was observed to be caused by human practices was recorded. The vast majority of shoreline properties (91%) did not have eroding shorelines. Locations of heavy erosion were recorded in two areas, the largest area being north west of Pioneer Picnic Park. (Figure 13). Note that this same section of shoreline was partially developed and had a poor greenbelt score.

Table 7. Erosion severity 2022.

Erosion Severity	Frequency	Percent
None	69	90.79
Low	4	5.26
Medium	1	1.32
Heavy	2	2.63
Total	76	100.00

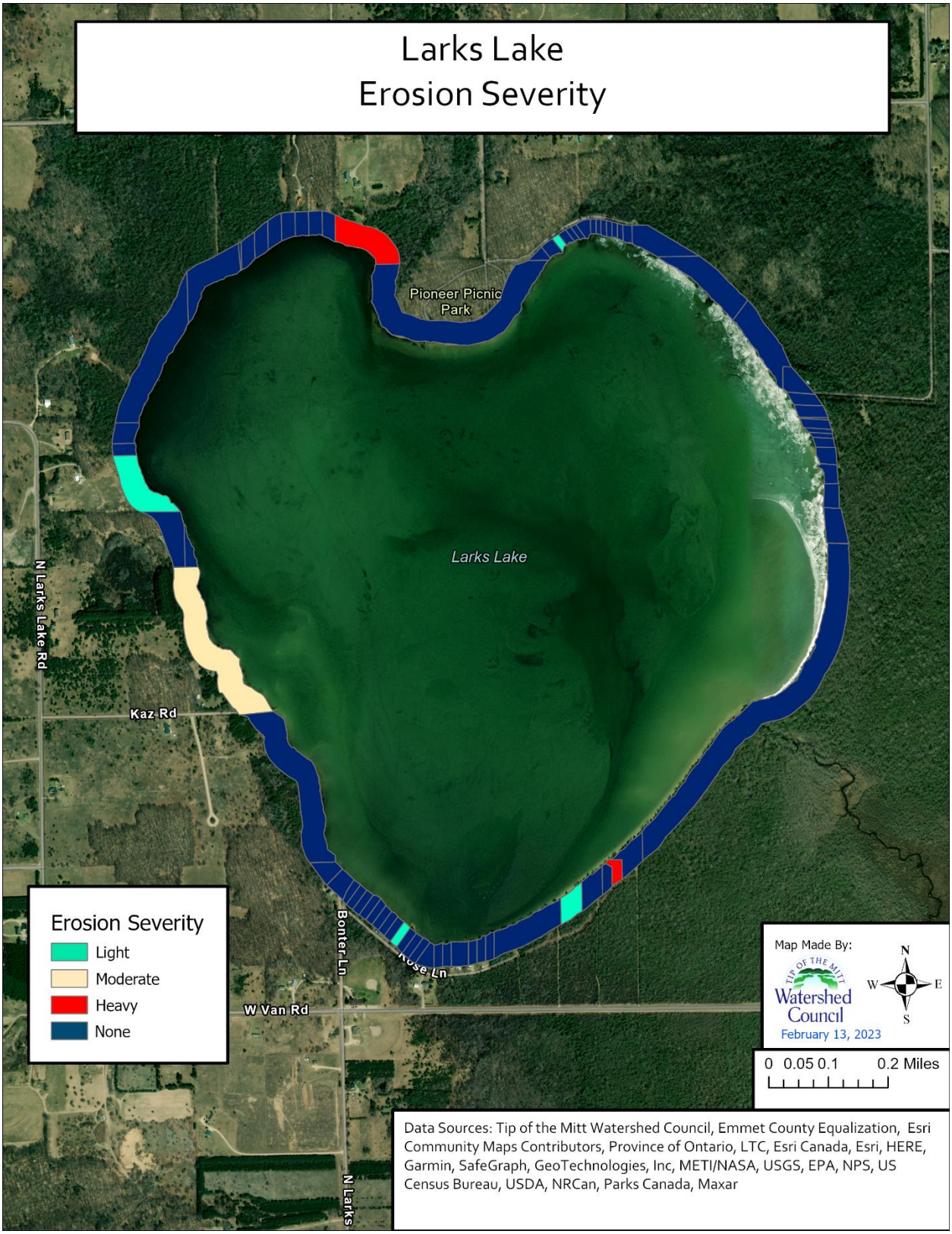


Figure 13. Map of erosion severity for Larks Lake 2022.

DISCUSSION

Development of shoreline parcels negatively impacts a lake's water quality due to a multitude of factors. Among the most serious impacts are: 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, and 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 entirely eliminating impacts.

Numerous best management practices have been developed that help minimize negative impacts to water quality and can be utilized during, or retroactively after, the development of shoreline parcels. A buffer of diverse, native plants can be 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.

Comparison to 2006 Shoreline Survey

Prior to the 2022 shoreline survey, a shoreline survey on Larks Lake was last conducted in 2006. This shoreline survey did not capture as much data as the 2022 survey, and parameters were slightly different, but it is still relevant to compare data and analyze parcel changes over the years.

In both 2006 and 2022, parcel development was recorded. The percentage of parcels that are partially/fully developed has decreased by 8% since 2006 (Table 8). This statistical change is abnormal and could be due to survey parameters changing since 2006, human error, or parcels defined in the surveys changing, such as being grouped together.

Table 8. Parcel development comparison; 2006 and 2022.

Parcel Development	2006 Frequency	2006 Percentage	2022 Frequency	2022 Percentage
Yes/Partial	65	79%	54	71%
No	17	21%	22	29%
Total	83	100%	76	100%

In the 2006 survey, 3 parcels (4%) were found to have light *Cladophora* density. In 2022, no parcels were found to have signs of *Cladophora* growth. This shows improvement since 2006.

The percentage of parcels with altered shorelines decreased from 29% in 2009, to 13% in 2022 (Table 9). This percentage decrease could be due to similar reasons as those mentioned about development previously, or shoreline improvements like removing seawalls, could have been made between 2006 and 2022.

Table 9. Shoreline alterations comparison; 2006 and 2022.

Shoreline Alterations	2006 Frequency	2006 Percentage	2022 Frequency	2022 Percentage
Yes	24	29%	10	13%
No	58	71%	66	87%
Total	82	100%	76	100%

Lake Comparison

Long Lake is an inland lake, similar in size to Larks Lake and located in northern Cheboygan County. A shoreline survey was conducted on Long Lake in 2021, and results from the 2021 survey will be compared to the 2022 Larks Lake shoreline survey data in this section.

In 2021, 24% of Long Lake's parcels showed signs of algae growth, most of these parcels were recorded as having light or very light *Cladophora* density. On Larks Lake in 2022, not a single parcel was recorded as having *Cladophora* present (Figure 14).

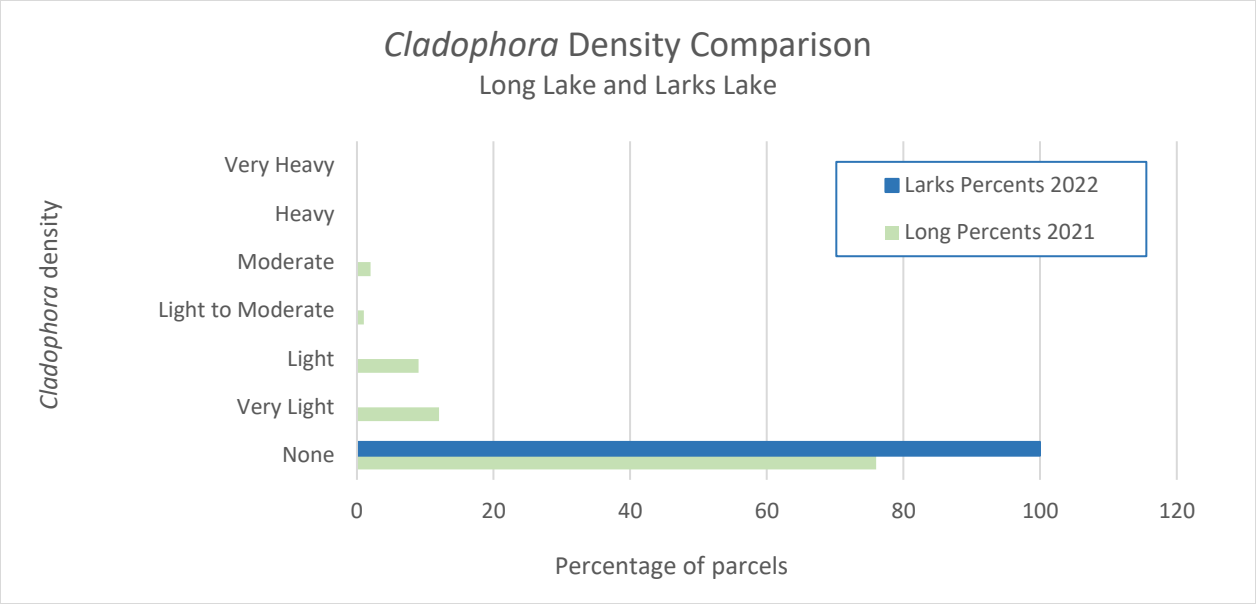


Figure 14. Cladophora density comparison for Long and Larks Lakes.

Long Lake (2021) and Larks Lake (2022) recorded similar percentages in the shoreline surveys that were conducted. Larks Lake did have a higher percentage of parcels recorded with good and excellent greenbelts, while long lake had a slightly higher percentage of parcels with very poor greenbelts, and a significantly higher percentage of parcels with poor greenbelts. From the graph (Figure 15), we can infer that Larks Lake overall had better greenbelt scores in 2022 than Long Lake had in 2021.

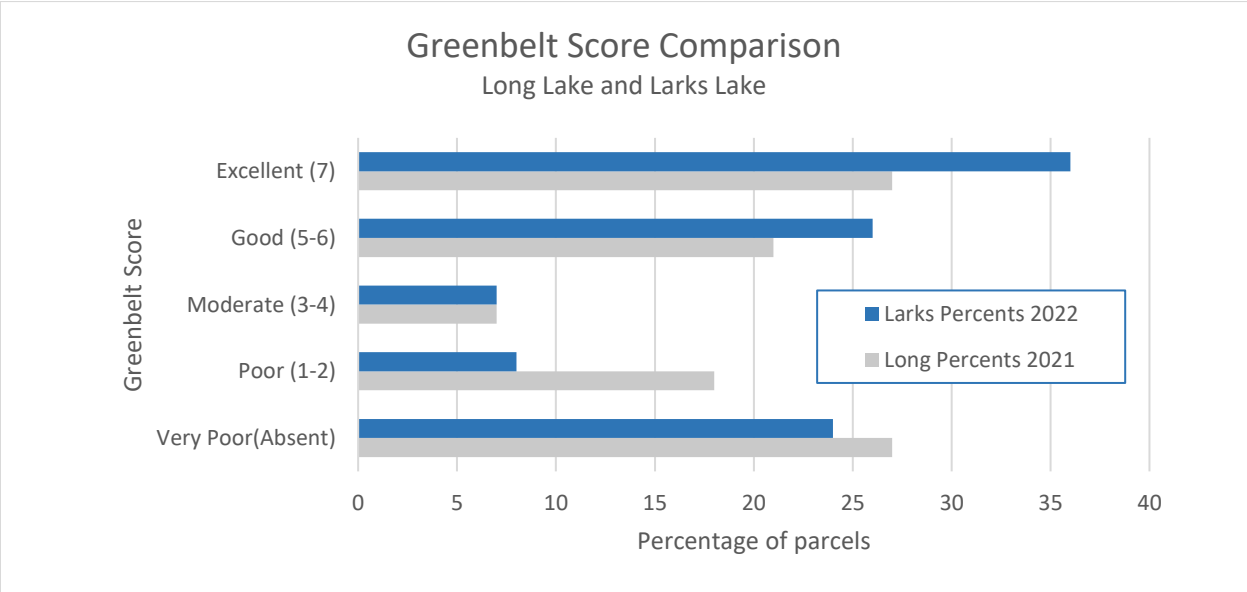


Figure 15. Greenbelt score comparison for Long and Larks Lakes.

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 *general* summary of the survey results to all shoreline residents.
3. Make results available online through an ESRI StoryMap or WebApp, so individual property owners can get their specific shoreline results.
4. Share results and a summary in the Larks Lake Association and Watershed Council newsletters.
5. Present findings to the Larks Lake Association at their annual meeting.
6. Encourage land owners to sign up and take a self-assessment for MI Shoreland Stewards.
7. Promote and encourage landscape contractors and designers to attend bioengineering workshops held by the Watershed Council.
8. Repeat some version of the survey periodically (ideally every 5-10 years).
9. Have property owners check their septic systems, some tanks might need to be pumped out or replaced. Septic tanks should be pumped every 3-5 years.
10. 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. Larks Lake is 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.
11. Advertise a sign-up for individual site visits with a Watershed Council shoreline expert to address concerns and recommend shoreline improvements.
12. Work with the Watershed Council to develop a cost-share program for property owners to participate in – projected for 2024.
13. Use this shoreline survey to target priority parcels for cost-share funds.

REFERENCES

"Larks Lake Watershed." Tip of the Mitt Watershed Council. https://www.watershedcouncil.org/larks-lake-watershed.html Accessed on January 28, 2023.