Black Lake Shoreline Survey 2017

By Tip of the Mitt Watershed Council

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February 2018

Data collected by Watershed Protection Team 2017

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SUMMARY

During the summer of 2017, the Black Lake Association (BLA) contracted with Tip of the Mitt Watershed Council to conduct a shoreline survey of Black Lake. The survey was designed to replicate and add parameters not reported in a similar 2005 survey. Conditions that can impact water quality were documented in categories representative of 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 Black Lake. Survey results indicate that human activity around Black Lake shoreline is likely impacting the lake ecosystem and water quality to some degree.

Development and Shoreline Vegetation

Of all shoreline parcels (805) surveyed in 2017, 88% (705) were considered developed. Developed was defined as the parcel containing some building structure. This was similar to the 2005 survey when 702 of the 805 parcels (87%) surveyed were developed. At water's edge, 42% (338) of parcels had little to no vegetation (beyond manicured lawn). Lack of vegetation on shoreline property is variable around the lake. However, poor greenbelts were concentrated along the northern and southeastern shoreline. Healthy greenbelts are also variable around the lake, and are partially concentrated along the south – south western shoreline.

Erosion and Shoreline Alterations

Erosion was documented along 45% (361) of properties on the shoreline. A majority of these erosion areas (295 shoreline properties) were identified as "minor" erosion. Meaning, exposed soils were present or contained a gully up to 1" deep. Erosion was not reported in 2005, therefore we are unable to compare 2017 data to previous surveys. Shoreline alterations were similar when compared to a 2005 survey. In 2017, 81% of shoreline properties showed some form of alteration. A majority of this alteration was in the form of cobble and boulder rip-rap at water's edge. In 2005 and 2017, 80% and 81% shoreline properties showed some type of alteration, respectively.

Nutrients and *Cladophora*

The number of shoreline areas with signs of nutrient pollution in 2017 lightly decreased relative to the 2005 survey. *Cladophora*, an algal indicator of nutrient pollution, was documented at 27% of all properties in 2017, down from 33% in 2005. However, areas of concern in 2005 remained in 2018. Interestingly, all surveys (1991, 2001, 2005, and 2017) documented *Cladophora* in similar locations around Black Lake. This could indicate consistent nutrient inputs from year to year via groundwater or tributary input.

In conclusion, data collected during 2017 indicate small shoreline changes from 2005. Areas of concern remain concentrated along the northern and southwestern shoreline. These areas have poor greenbelts and documented *Cladophora* growth. Solutions exist for areas of concern and these are often simple and low cost, such as regular septic system maintenance, proper lawn care practices, and wise land use along the shoreline. Erosion sites can be repaired through greenbelt enhancement by allowing vegetation to regrow on the shoreline, providing improved nutrient filtration and erosion resistance. 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.

INTRODUCTION

Background

During the late spring and early summer of 2017, a shoreline survey was conducted on Black Lake by the Tip of the Mitt Watershed Council to document shoreline conditions that impact water quality. The entire shoreline was surveyed to document the following: algae (*Cladophora*) presence as a nutrient pollution indicator, erosion, shoreline alterations, greenbelts, and tributary inlets and outlets.

According to Watershed Council records, Black Lake has had three shoreline surveys conducted prior to 2017. The first in 1991 and the second in 2001, were limited surveys only covering certain areas of Black Lake shoreline. Additionally, these surveys focused on areas for the presence and relative density of algal (*Cladophora*) growth. The third in 2005 was a bit more comprehensive by noting shoreline alterations, substrate conditions, property developments, and aquatic plants. The 2005 survey also encompassed the entire Black Lake shoreline. The report from 2005, focused on *Cladophora* presence and relative nutrient input. During the summer of 2017, the Black Lake Association contracted with the Tip of the Mitt Watershed Council to conduct the most comprehensive assessment to date of Black Lake shoreline conditions. The following 2017 survey results provide a comprehensive dataset documenting shoreline conditions on Black Lake that can be used as a lake management tool. Where possible, the Watershed Council has compared 2017 survey results with previous survey results.

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. Lake shorelines vary based on shape, size, and vegetation. Accordingly, human activities along shorelines have high potential for degrading water quality of Black Lake. Development of shoreline properties for residential, commercial, or other use have an impact on Black Lake 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 Black Lake increases. Additionally, as the Black Lake Watershed terrain is altered, nutrients and sediment from soils from eroded areas can often end up in Black Lake.

Nutrient pollution can have adverse impacts on aquatic ecosystems and pose a danger to human health. While nutrients are necessary to sustain a healthy aquatic ecosystem, excess nutrients will stimulate nuisance aquatic plant 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. blue green algae) produce toxins, including hepatotoxins (toxins that cause liver damage) and neurotoxins (toxins that affect the nervous system). Excess plant and algae growth can degrade water quality by depleting the ecosystem's dissolved oxygen. During nighttime respiration, plants compete with other organisms for a limited oxygen supply. Furthermore, the decomposition of algae and plants has the potential to deplete dissolved oxygen due to the aerobic activity of decomposers, particularly in the deeper waters of stratified lakes.

In general, large lakes such as Black Lake are less sensitive to nutrient pollution. With the increased volume, large lakes tend to have greater dissolved oxygen and increased dilution of nutrients. By contrast, small lakes generally have a lesser ability to dilute nutrients. Nutrient pollution can be more problematic in small lakes due to extensive shallow areas that can support more aquatic plant growth. However, even large lakes can develop problematic nutrient levels and algae issues.

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 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 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 results in soil erosion, and wetland destruction also contribute to nutrient pollution. Furthermore, 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 costlier than other methods. Typically, water samples are analyzed to determine nutrient concentrations (usually forms of phosphorus and nitrogen), but other chemical constituents, such as chloride, can be measured. Physical measurements, such as water temperature and conductivity (i.e., the water's ability to conduct an electric current), are primarily used to detect malfunctioning septic systems. Biologically, nutrient pollution can be detected along the lake shore by noting the presence of *Cladophora* algae, a bio-indicator.

Cladophora is a branched, filamentous green algal species that occurs naturally in small amounts in Northern Michigan lakes. *Cladophora* occurrence is governed by specific environmental requirements for temperature, substrate, nutrients, and other factors. This algae 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 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 growth and detection in Northern Michigan lakes is from mid-May to early July, and September to October.

The nutrient availability in Northern Michigan lakes is typically less than what is needed for *Cladophora* to achieve large, dense areas/growths. 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 current patterns, shoreline topography, substrate composition, and wave action, the presence or absence of any significant growth is a powerful lake-wide screening tool. The existence of chronic nutrient loading problems can be revealed and *Cladophora* presence can assess the effectiveness of any remedial actions. Comparing the number the total number of algal growths areas along the shoreline can reveal trends in nutrient inputs due to changing land use. 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 and impacts the lake ecosystem in a variety of ways. Sediments reduce organism respiration by clogging the gills of fish, insects, and other aquatic organisms. Excessive sediments smother fish spawning beds and fill interstitial spaces 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 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. They also help stabilize shorelines against wave and ice action with their extensive network of deep, fibrous roots. Greenbelts provide shade to nearshore areas, which is particularly important for lakes with cold water fisheries. Lastly, and perhaps most importantly, greenbelts provide a mechanism to filter pollutants carried by stormwater from rain events and snowmelt. Another pollutant and nutrient delivery mechanism is a tributary.

The primary function of a tributary is to drain the landscape. Therefore, tributaries have a significant 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. 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 the means to remove contaminants that have accumulated in the lake ecosystem. While conducting shore surveys, noting inlet tributary locations 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 algal growth in nearby shoreline areas.

Study Area

Located in the north eastern tip of the Lower Peninsula, Black Lake resides in Grant, Waverly, North Allis, and Bearinger Townships of Cheboygan and Presque Isle Counties. By surface area, Black Lake is the eighth largest inland Lake in the State of Michigan. While the Lake contains a surface area of 10,143 acres, it has a Watershed surface area of 357,000 acres (547 square miles). A ratio of the watershed size to the lake surface area can provide a descriptive measure of how susceptible a lake and its tributaries are to nutrient enrichment. A high ratio can suggest lakes are more susceptible to nutrient enrichment because of the increased opportunity for precipitation to contact soils and leach mineral before discharging into the lake. Black Lake's Watershed ratio is 35.04 (357,000/10,143 acres). Meaning, Black Lake has 1 acre of Lake surface for every 35.04 acres of its Watershed surface. This measurement does not consider water volume, but a watershed-to-lake-area ratio of 35.04 is relatively high for Northern Michigan Lakes. For comparison, Mullett, Charlevoix, and Burt Lakes contain watershed ratios of 9.74, 12.84, and 12.47, respectively. However, Black Lake is not as deep or large as either Lake. As a drainage lake, Black Lake contains some groundwater input, many important inflows, and one main outflow. The important inflows and outflow provide a mechanism to flush excess nutrients out of the system.

According to digitized bathymetry maps acquired from the Michigan Geographic Data Library, the deepest area of Black Lake is located directly in the southern basin with a maximum depth of ~50 feet. Relatively shallow areas are found in the northern shore, toward the Lower Black River outflow (Figure 1).

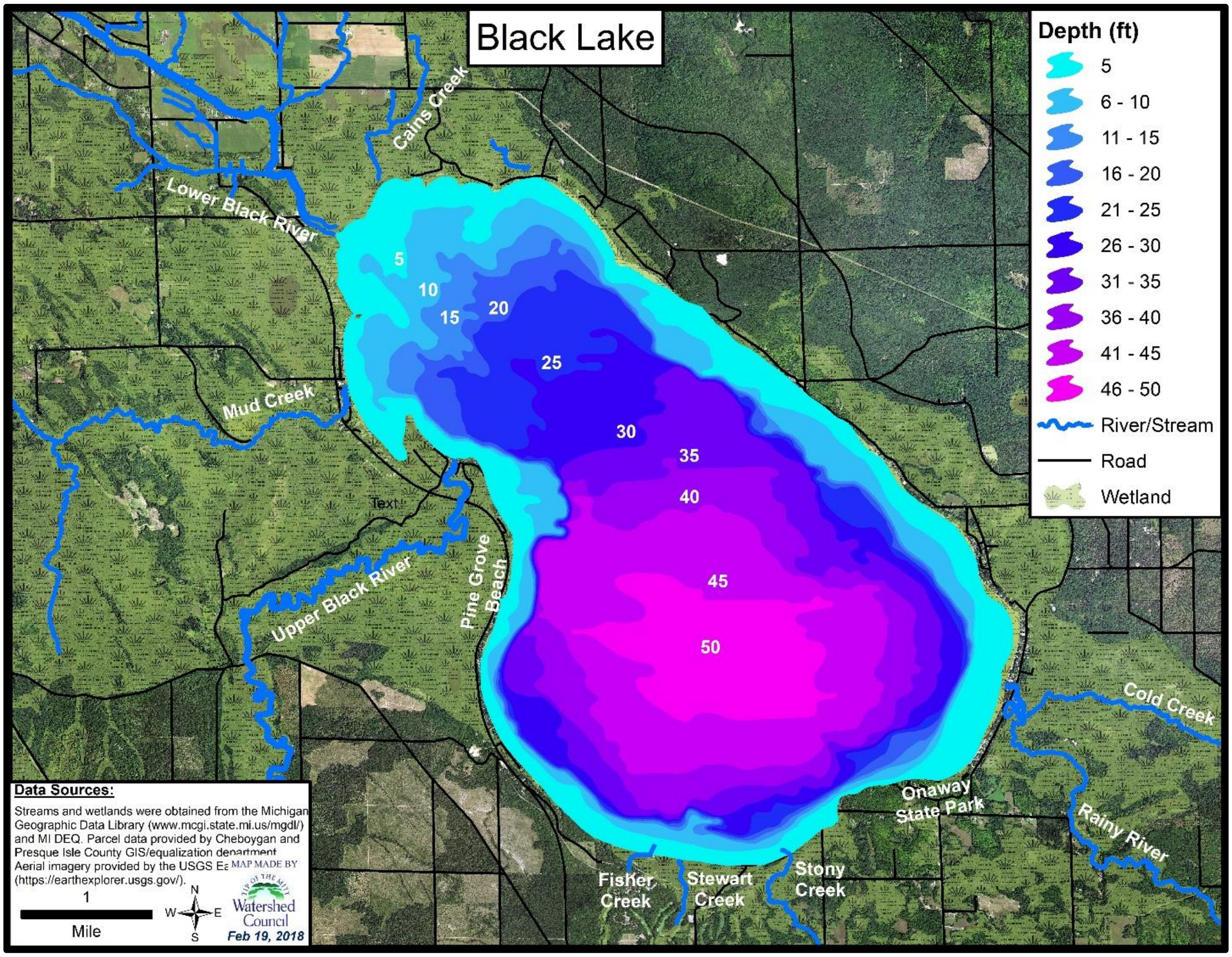


Figure 1 Map of Black Lake Depths (bathymetry) and Features

Black Lake contains eight primary inlets and one primary outlet. The Upper Black River and Mud Creek enter along the western shore. Fisher, Stewart, Stony, and Cold Creeks along with the Rainy River flow into the southern basin. Cains Creek flows in at the northern most basin. The only main outlet from Black Lake is the Lower Black River in the northern shore. The lower Black River then flows into the Cheboygan River and out to Lake Huron.

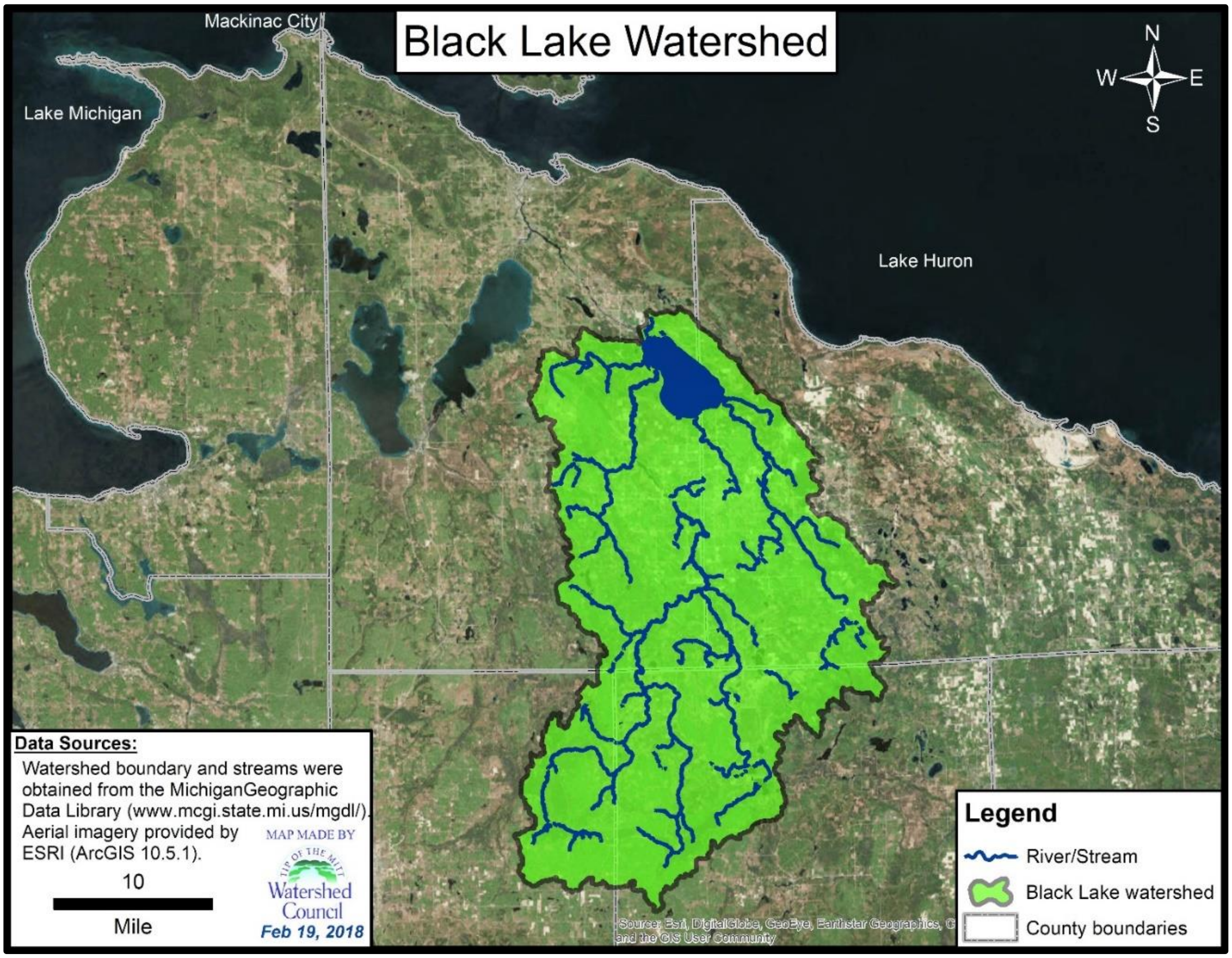


Figure 2 Map of Black Lake Watershed

Land cover statistics were generated for the watershed using data from the NOAA Coastal Great Lakes Land Cover Project (Table 1). Based on 2016 data, much of Black Lake's Watershed land cover is forest and wetlands (combined totaling 71.75%). There is some agricultural land cover (4.2%) and even less urban (1.33%). Since 1975, forested land has decreased about 9.17%, of which 4.13% occurring since the year 2000. Grassland and scrub/shrub land cover collectively have increased around 9.55%, likely as a result of logging. Other land cover categories have remained extremely consistent. Of particular importance is the stability of wetland cover within the Watershed.

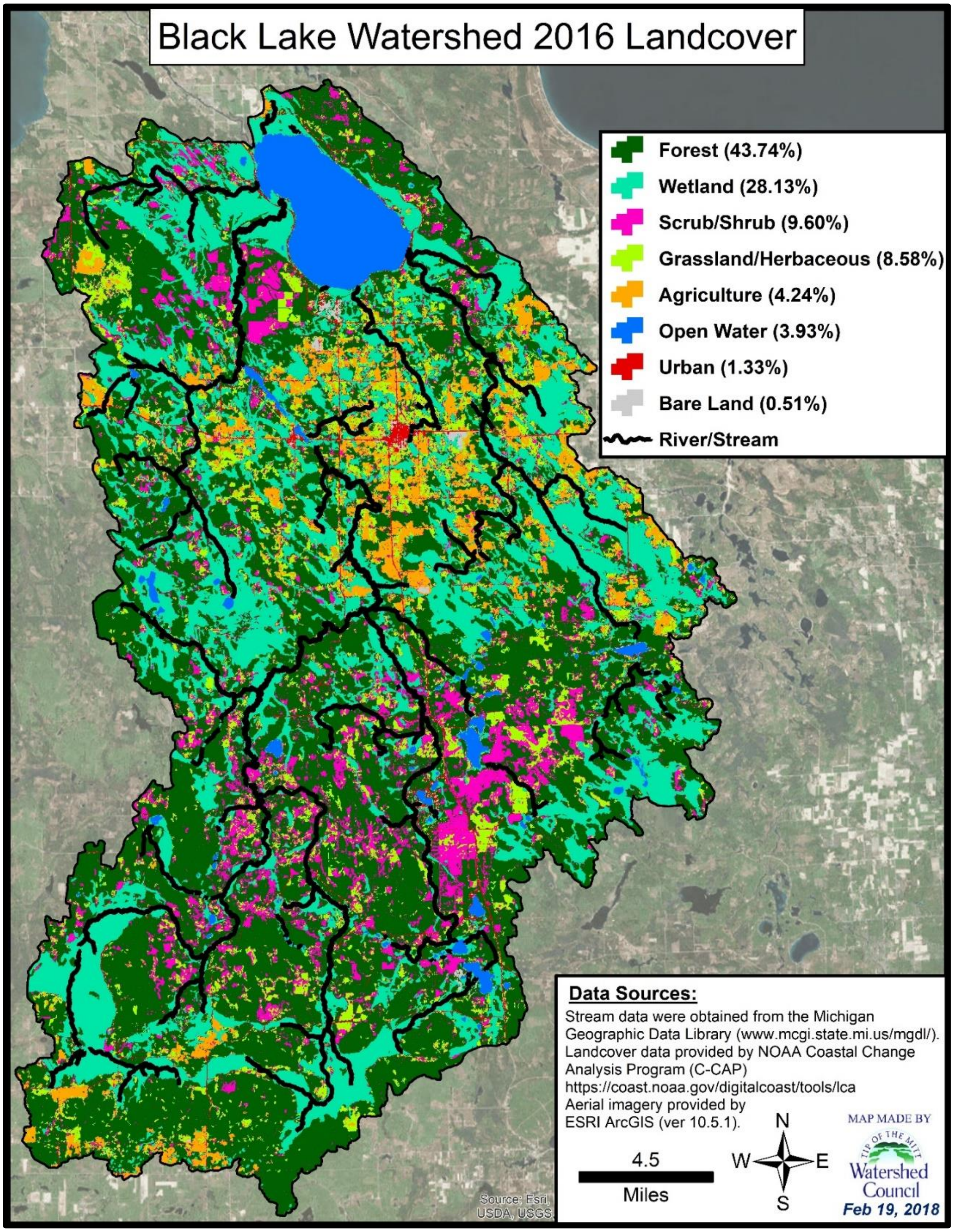


Figure 3 Black Lake Watershed Landcover – 2016

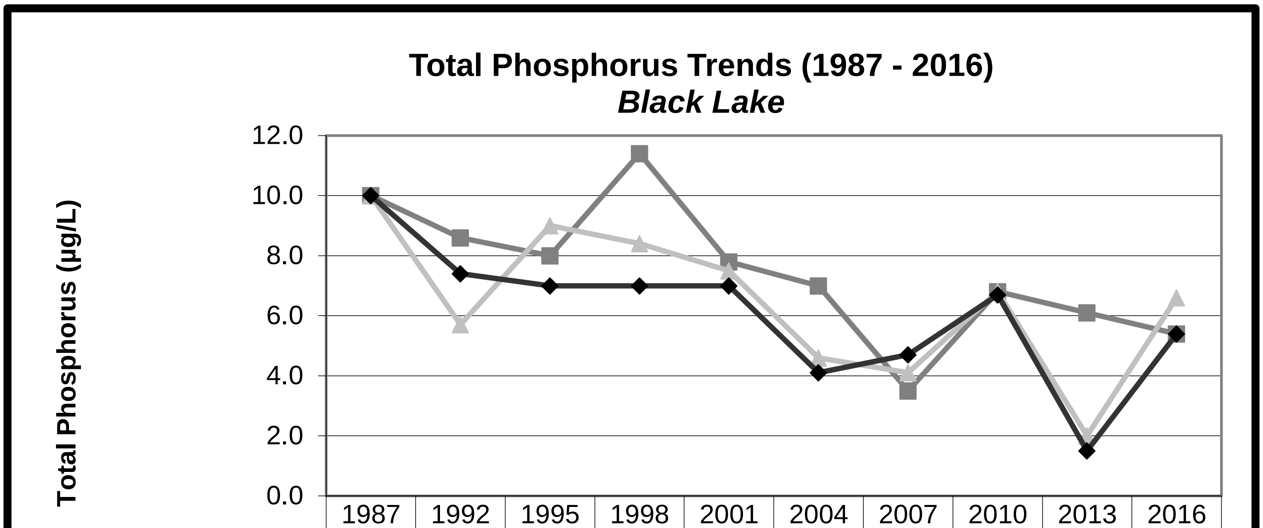
Table 1 Black Lake Watershed landcover change since 1975.

Land Cover Type	1975 (%)	1985 (%)	1996 (%)	2001 (%)	2006 (%)	2010 (%)	2016 (%)	% Change 1975 - 2016	**% Change 2000 – 2016**
Agriculture	4.90	4.93	5.08	4.26	4.25	4.24	4.24	-0.66	**-0.02**
Bare Land	0.39	0.41	0.42	0.49	0.50	0.51	0.51	0.12	**0.03**
Urban	1.18	1.19	1.23	1.33	1.33	1.33	1.33	0.15	**0.00**
Forest	52.91	50.90	48.79	47.87	47.36	45.71	43.74	-9.17	**-4.13**
Grassland	4.91	5.44	7.17	7.89	8.10	7.88	8.58	3.67	**0.69**
Scrub/Shrub	3.72	5.16	5.35	6.17	6.46	8.34	9.60	5.88	**3.44**
Wetland	28.04	28.01	27.99	28.11	28.11	28.12	28.13	0.09	**0.09**

Water Quality Data

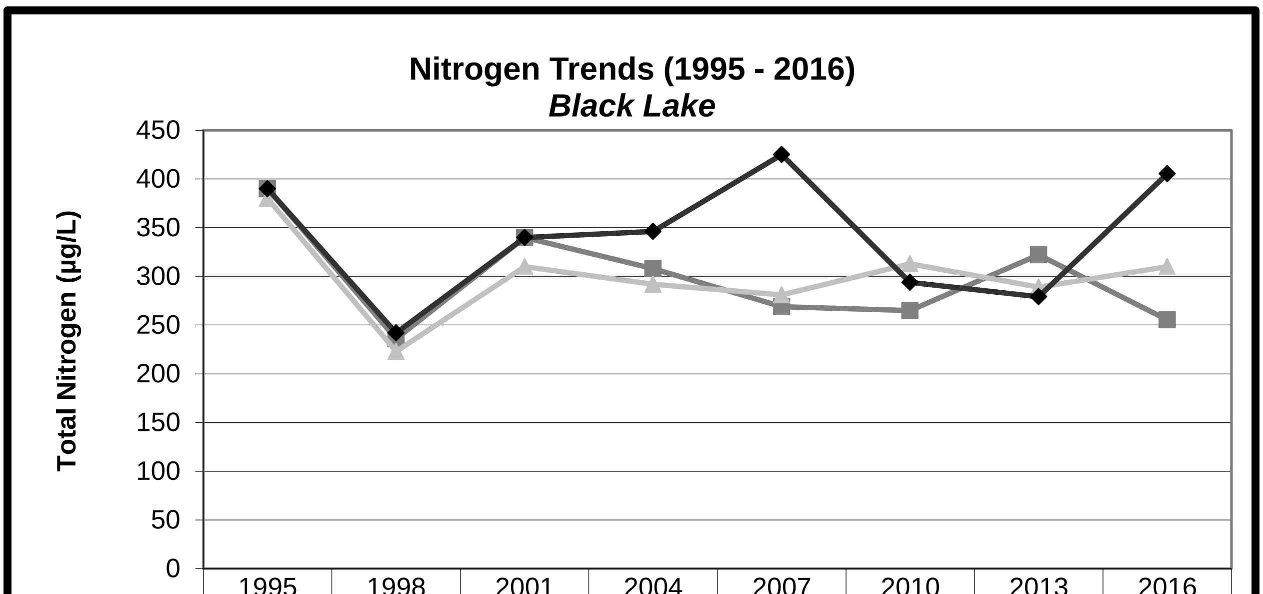
Volunteers have actively engaged with water quality monitoring programs coordinated by Tip of the Mitt Watershed Council. In addition, Watershed Council staff monitor Black Lake water quality as a part of the Comprehensive Water Quality Monitoring Program (CWQM). Volunteer Lake Monitoring and CWQM data began in 1986 and 1987, respectively.

From these programs, data clearly indicate Black Lake water quality remains high. Total phosphorous measurements collected as part of the CWQM program show decreasing concentrations throughout the last 20 years (Figure 4). Nitrogen monitoring began in 1995 and has remained relatively stable, ranging between 250 – 350 μg/L (Figure 5). Chloride measurements have been on the rise in recent years, which could be a result of winter roadside salt application and other nonpoint source pollution within the watershed (Figure 6).



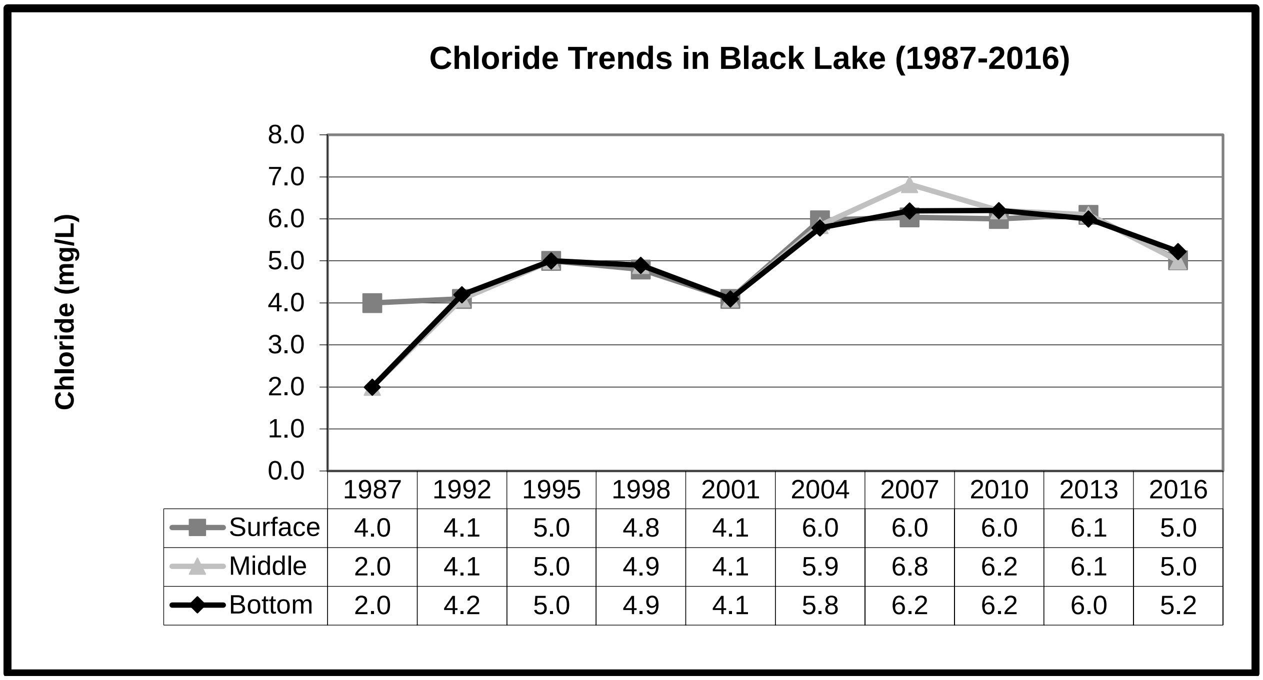
	1987	1992	1995	1998	2001	2004	2007	2010	2013	2016
Surface	10.0	8.6	8.0	11.4	7.8	7.0	3.5	6.8	6.1	5.4
Middle	10.0	5.7	9.0	8.4	7.5	4.6	4.1	6.8	2.0	6.6
Bottom	10.0	7.4	7.0	7.0	7.0	4.1	4.7	6.7	1.5	5.4

Figure 4 Black Lake Phosphorus Trends from 19987 through 2016



	1995	1998	2001	2004	2007	2010	2013	2016
Surface	390	236	340	308	269	265	322	255
Middle	380	223	310	292	281	313	289	310
Bottom	390	242	340	346	425	294	279	405

Figure 5 Black Lake Nitrogen Trends from 1995 through 2016



	1987	1992	1995	1998	2001	2004	2007	2010	2013	2016
Surface	4.0	4.1	5.0	4.8	4.1	6.0	6.0	6.0	6.1	5.0
Middle	2.0	4.1	5.0	4.9	4.1	5.9	6.8	6.2	6.1	5.0
Bottom	2.0	4.2	5.0	4.9	4.1	5.8	6.2	6.2	6.0	5.2

Figure 6 Black Lake Chloride Trends from 1987 through 2016

Since 1987, local volunteers have ventured out to Black Lake to record Secchi disk depth, temperature, and collect a water sample for a *chlorophyll-a* measurement. These data align with above nutrient data, indicating clear and clean water. However, these trends suggest Black Lake has become clearer, with reduced *chlorophyll-a*, and potentially less biological productivity in recent years. Secchi disk records the transparency (turbidity) of Black Lake by measuring the visibility in the water column. As can be seen in Figure 7, Black Lake transparency has slightly increased since volunteers first began recording these data in 1987. This indicates a clearing in the water column. *Chlorophyll-a* provides a measure of available food at the base of the lake ecosystem. Without *chlorophyll-a*, biological life in a lake can be hindered. While variable, *chlorophyll-a* values have decreased but could be rebounding within recent years (Figure 8). At the end of each sampling year, a trophic status index (TSI) is calculated (Figure 9). 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). Black Lake has historically been in the mesotrophic category.

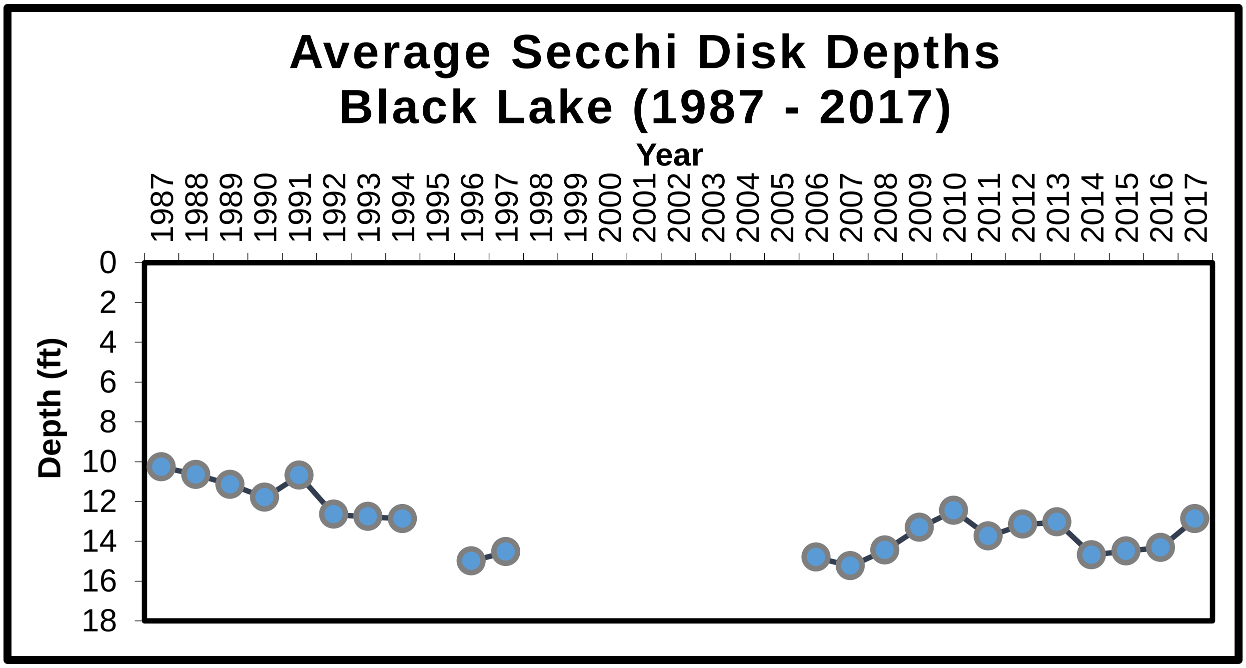


Figure 7 Average Secchi Disk depths collected by Black Lake Volunteers since 1987

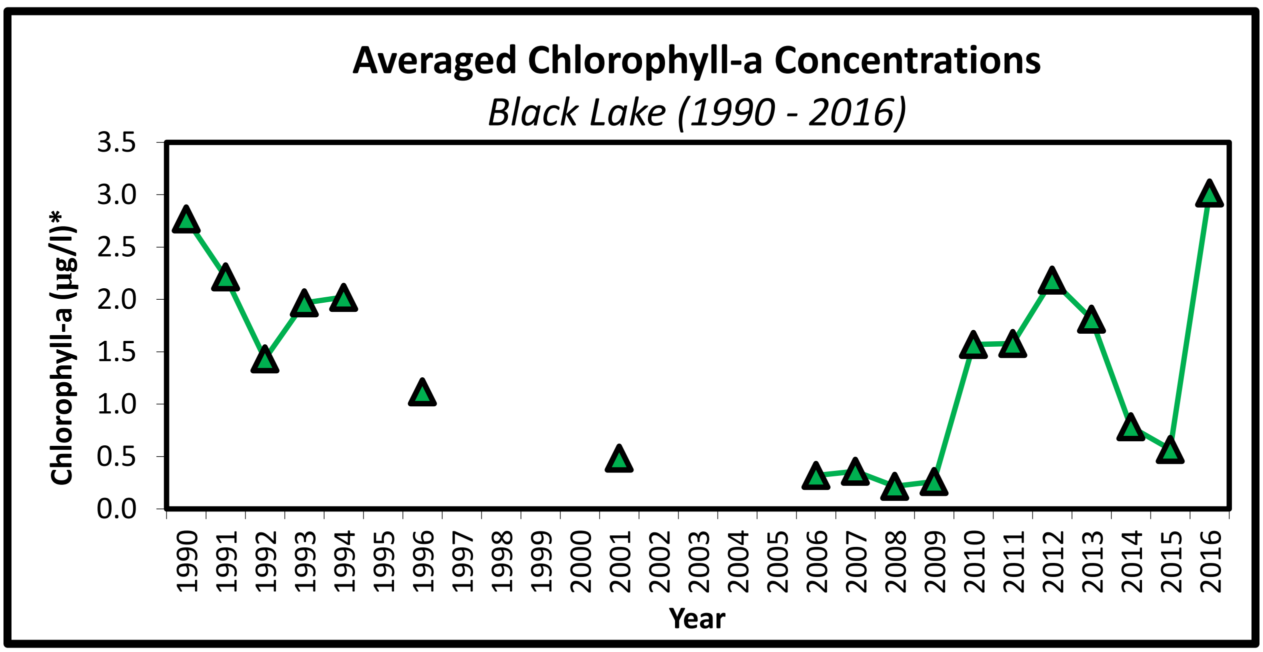


Figure 8 Average Chlorophyll-a concentrations collected by Black Lake Volunteers. Missing values indicate data not available for that particular year

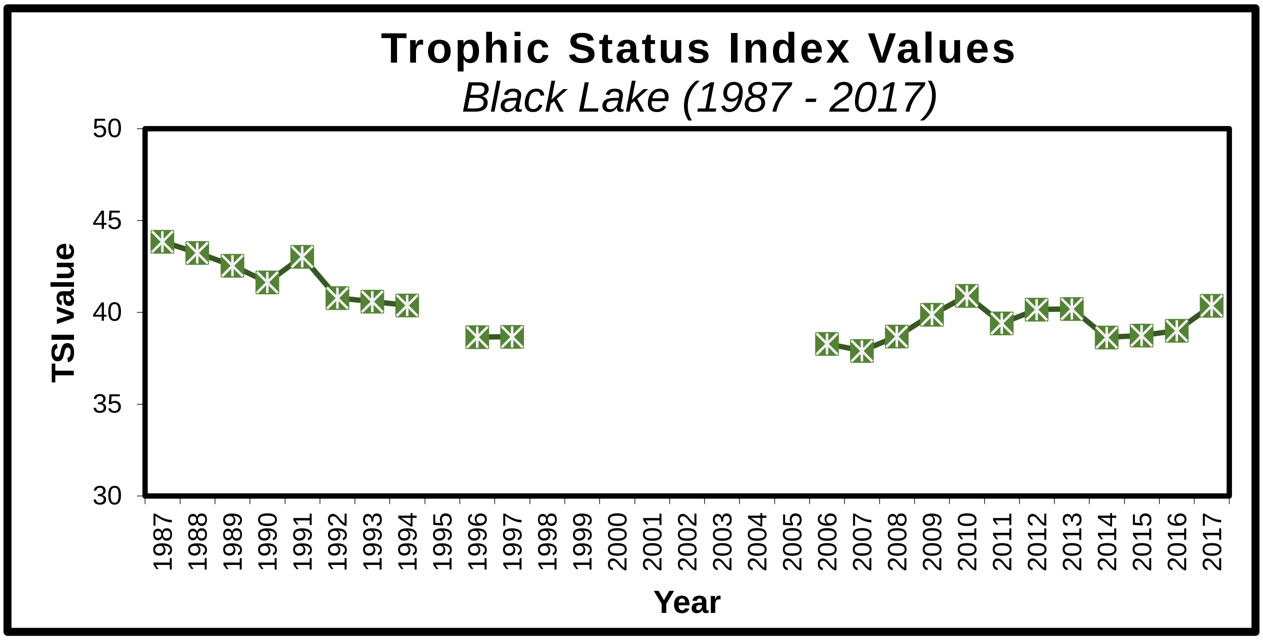


Figure 9 Trophic Status Index (TSI) from data collected by Black Lake Volunteers since 1987

SHORELINE SURVEY METHODS

Black Lake 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. Field photos were geotagged, and recorded field data were linked to spatial data and in ESRI ArcGIS (v10.5.1) for analyses to be conducted to show where good and bad areas exist around Black Lake.

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 of the species usually requires the aid of a microscope. However, *Cladophora* usually has a unique appearance and texture that is quite distinct to a trained surveyor. 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. 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 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 Black Lake 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 Cheboygan and Presque Isle Counties 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 Black Lake 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 805 parcels on Black Lake. Approximately 88% (705) of shoreline properties on Black Lake were considered developed.

Cladophora

Noticeable growths of *Cladophora* or other filamentous green algae were found along the shoreline at 214 parcels (27% of total parcels surveyed; Table 3). At properties where *Cladophora* growth was observed, 70% (150 parcels) consisted of light or very light growth, whereas only 19% (42 parcels) had moderate to heavy growth.

Table 3 Cladophora density results

***Cladophora* Density**	**Parcels**	**Percent (%)**
Very light	92	43
Light	58	27
Light to Moderate	22	10
Moderate	26	12
Moderate to Heavy	11	5
Heavy	4	2
Very Heavy	1	<1

The few moderate to heavy patches of *Cladophora* growth were located along the western and northern shores of Black Lake (Figure 10). A few parcels along the eastern shoreline contained moderate *Cladophora* growth. Properties with little to no *Cladophora* growth were around the lake with large sections along the southern, western, and northern shorelines.

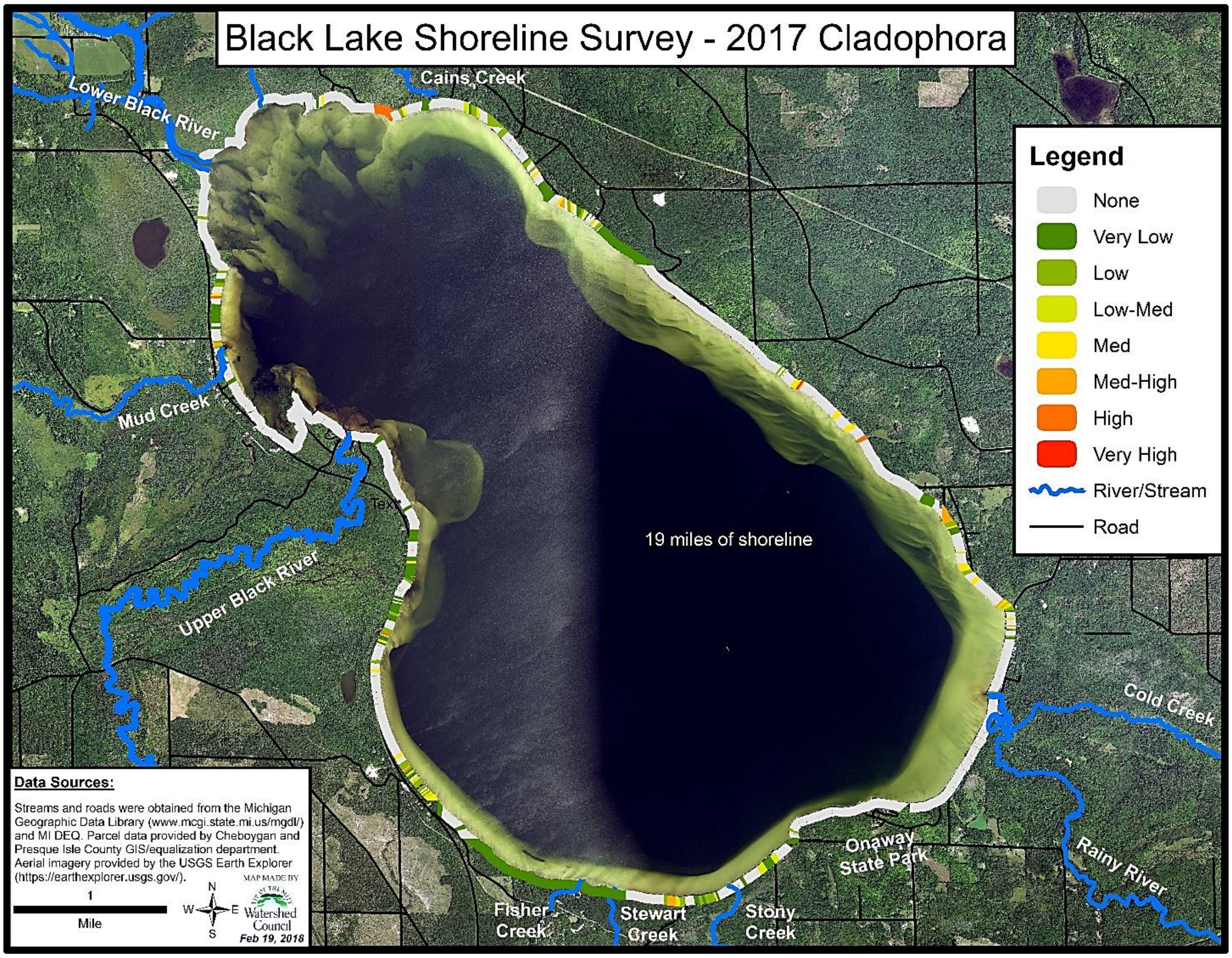


Figure 10 Cladophora density around Black Lake Shoreline

Interestingly, similar areas documenting *Cladophora* in 2018 were identified in the surveys of 1991 and 2001 (Figure 11), as well as 2005. These areas of concern are highlighted along the western shore. However, there appears to be fewer areas towards the south along the western shore.

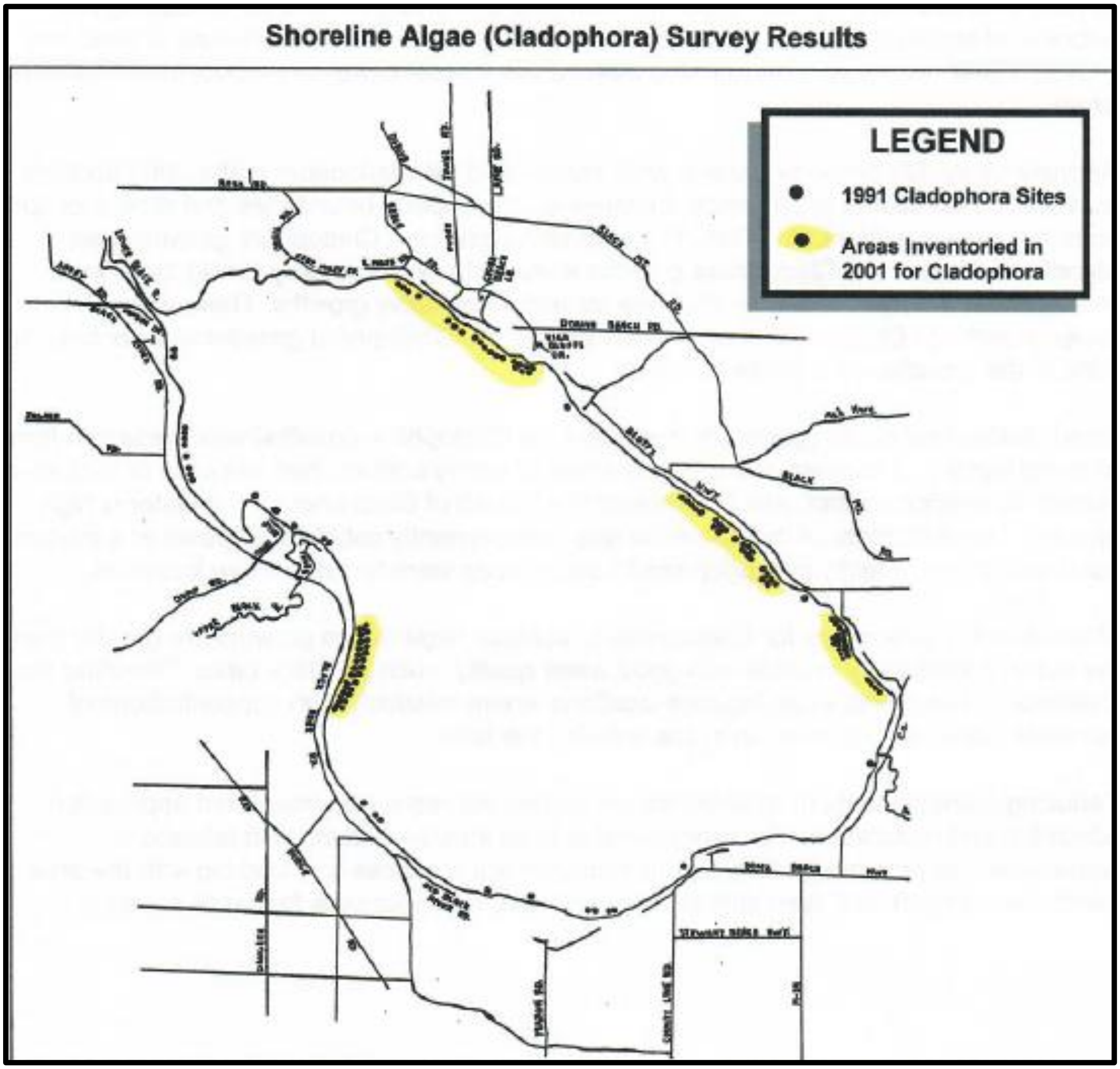


Figure 11 Cladophora from 1991 and 2001 survey

Greenbelt Scores

Greenbelt scores ranged from 0 (little to no greenbelt) to 7 (exemplary greenbelt). Only 30% of shoreline greenbelts along Black Lake were found to be in good or excellent condition (Table 4). Of 805 surveyed, 338 parcels (42%) received a greenbelt rating in the poor or very poor categories.

Table 4 Greenbelt rating results

Greenbelt Rating		Number of Parcels	Percent (%)
0	Very Poor (absent)	139	24
1-2	Poor	145	18
3-4	Moderate	228	28
5-6	Good	153	19
7	Excellent	86	11

Greenbelt status varied around Black Lake. However, many clusters of properties along the northern shoreline were ranked in the very poor (absent) to poor categories (Figure 12). Clusters along the western and southern shoreline were in the moderate to excellent rating.

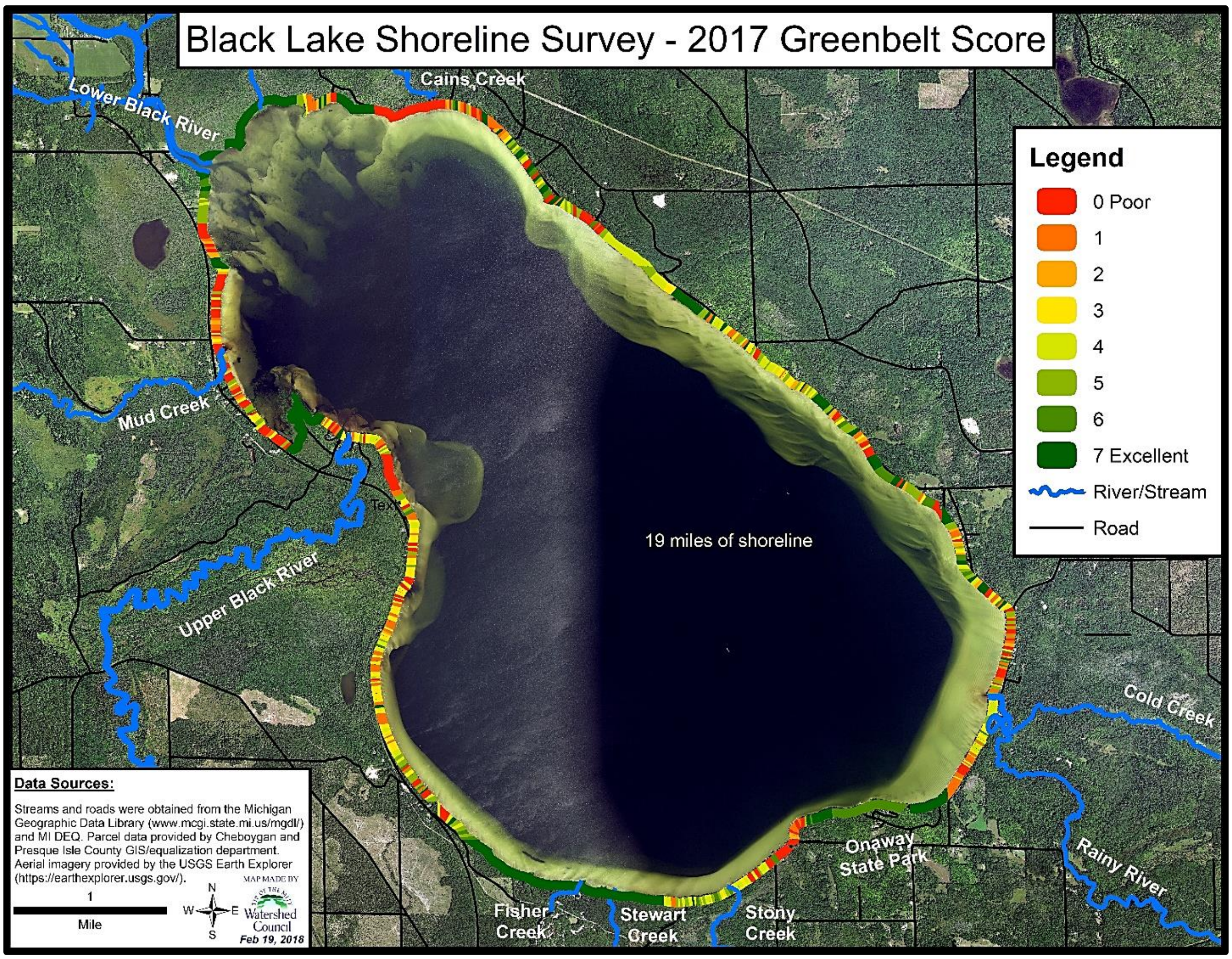


Figure 12 Greenbelt Scores around Black Lake shoreline

Shoreline alterations

Some form of shoreline alteration was noted at 80% of shoreline properties (Table 6). Of the alterations, 30% are rip-rap, while seawalls (wooden, concrete, or metal), account for approximately 28% of all shoreline alterations. Artificial beach sand is also noticeable around the shoreline.

Table 6 Shoreline alteration results

Alteration Type	Number of Parcels*	Percent With Alteration (%)*
Riprap (small)	25	3
Riprap (boulder)	105	13
Mixed riprap	115	14
Seawalls	223	28
'Artificial' Beach Sand	225	28
Discharge Pipes	68	8
Unaltered	164	20

**Numbers and percentages quantify alteration type, many parcels had multiple alterations*

Erosion

Erosion was noted at 361 parcels (45%) on the Black Lake shoreline (Table 6). Most of the erosion (37%) was classified as minor in terms of severity, while less than 1% of properties were considered severe. (Figure 13).

Table 5 Shoreline erosion severity results

Erosion Category	Number of Properties	Percent of Properties (%)
Minor	295	37
Moderate	56	7
Severe	10	<1
TOTAL	361	45

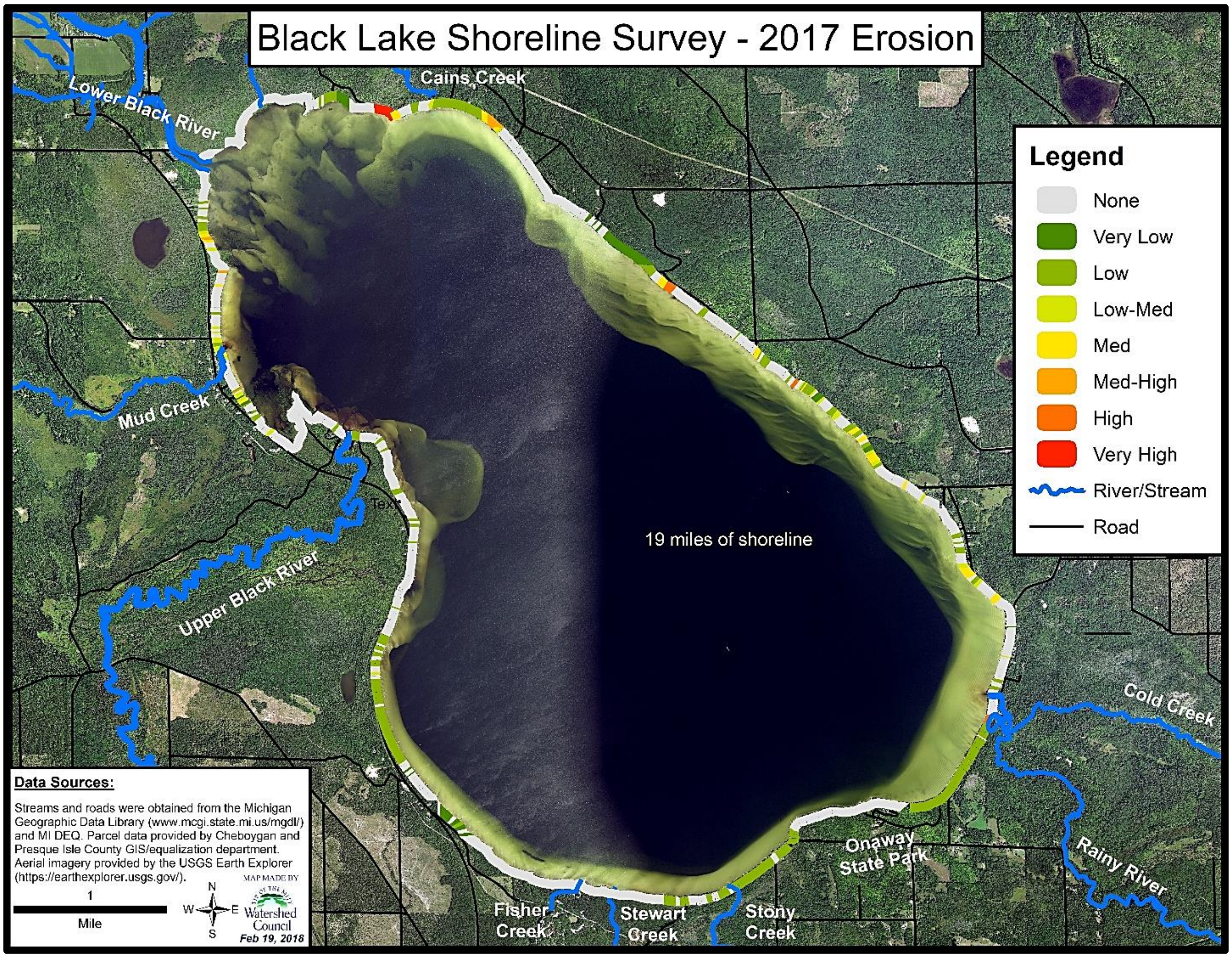


Figure 13 Erosion severity around Black Lake shoreline

DISCUSSION

In general, development of shoreline parcels can negatively impact a lake's water quality due to a multitude of factors. For Black Lake, the lack of native vegetation at water's edge is likely the greatest threat. 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.

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 Black Lake. Widespread removal of shoreline vegetation is the paramount concern. Over half (70%) of all shorelines exhibited greenbelts that were in poor, very poor, or moderate condition. Erosion is also a concern, with light to moderate erosion commonly occurring throughout the same areas most heavily impacted by vegetation removal. Algal indicators of nutrient pollution are far less extensive than the above issues. Although interestingly, the areas with documented *Cladophora* growth were similar to previous surveys, indicating potential for groundwater input or small changes to nutrient inputs. Future work should document what the nutrient load is to Black Lake as this information is relatively unknown. Fortunately, wetland areas surrounding Black Lake have remained intact.

Wetlands are incredibly important as they provide habitat for insects and other macroinvertebrates, amphibians and reptiles, waterfowl, and fish. Fish use wetlands as sources of food, protection from predators, and as spawning grounds. Waterfowl rely heavily on wetland areas during times of migration, to find food, and as protection. Wetland areas essentially act as a “nutrient sponge” and significantly help filter nutrients such as phosphorus and nitrogen before water enters Black Lake. Resiliency of Black Lake water quality could very well depend on the wetland areas immediately surrounding the lake. Another issue to consider are septic system maintenance.

Outreach regarding septic system maintenance, phasing out of old systems, and properly siting new systems may be playing 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 from septic systems on individual properties are often successful.

Further improvements would benefit the lake's ecosystem and reduce impacts associated with increasing lakeshore development. The easiest, and perhaps most beneficial way 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. Although a large number of greenbelts are in poor condition, 11% of properties received a perfect score, indicating exemplary greenbelt health. Properties with healthy, intact greenbelts provide a model for improvement for other shoreline properties. Compared to other lakes in the region, Black Lake has a relatively high number of parcels exhibiting shoreline alterations, poor greenbelts, and a moderate level of *Cladophora* growth (Table 7).

Table 6 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%
Black Lake	2017	27%	2%	45%	42%	80%
Burt Lake	2009	47%	29%	4%	36%	46%
Charlevoix, Lake	2012	22%	19%	14%	34%	79%
Crooked Lake	2012	29%	26%	14%	51%	65%
Douglas Lake	2015	27%	6%	17%	53%	60%
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%
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%
Six Mile Lake	2016	10%	24%	13%	41%	37%
Thumb Lake	2007	4%	0%	ND	ND	39%
Walloon Lake	2016	62%	2%	17%	39%	80%
Wildwood Lake	2014	5%	0%	22%	45%	50%
AVERAGE	NA	23%	11%	18%	41%	52%

**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.*

Although many properties on Black Lake are experiencing some form of erosion, the majority (82% of all erosion sites) are considered minor and less than 3% of all erosion is considered to be severe. 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 Black Lake. 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 general 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. 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 Black Lake residents to visit www.mishorelandstewards.org to take the survey.

LITERATURE AND DATA REFERENCED

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Appendix A:

Watershed landcover change based on NOAA Coastal Change Analysis Program (C-CAP).

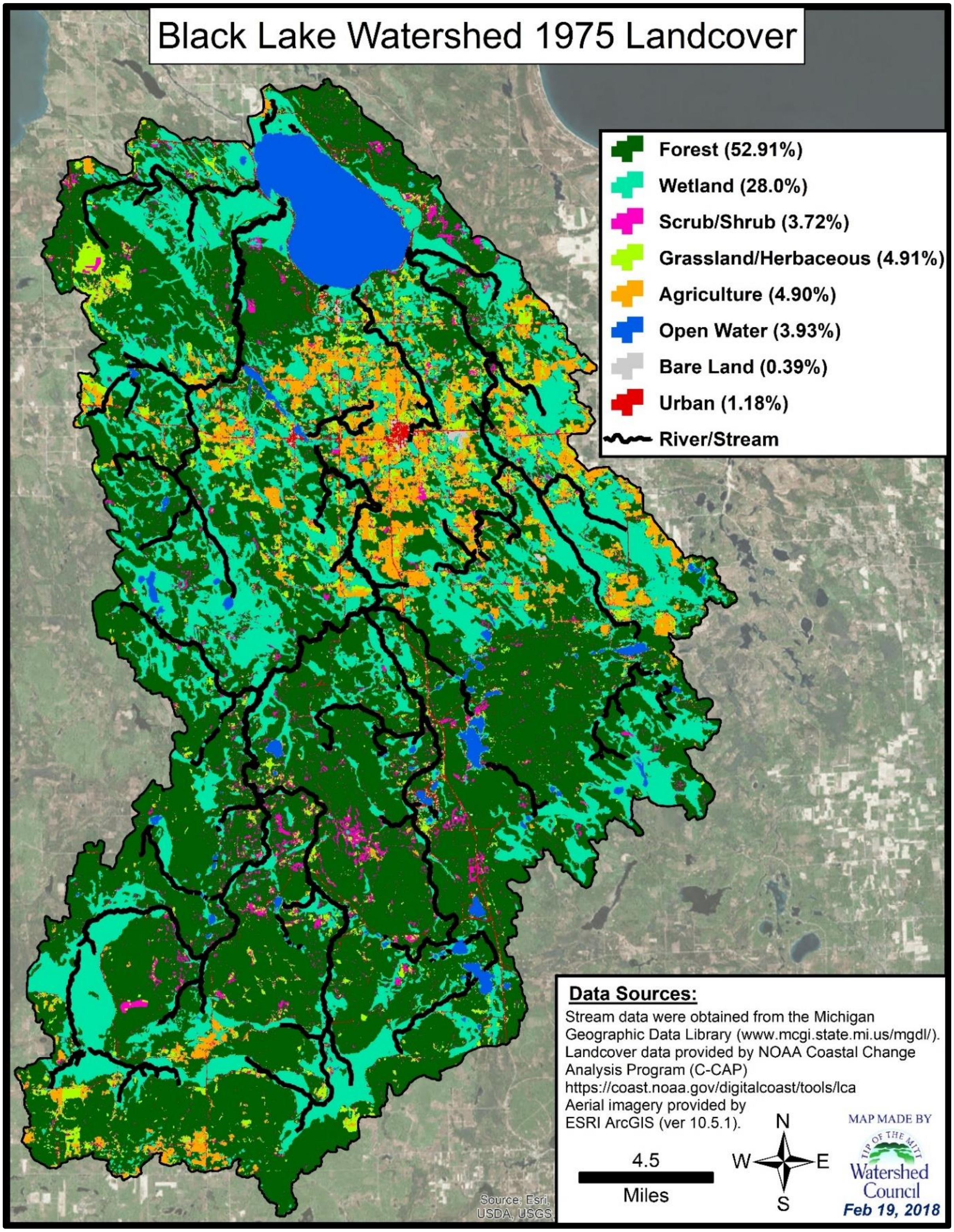

Figure 14 Watershed Land Cover Statistics, 1975

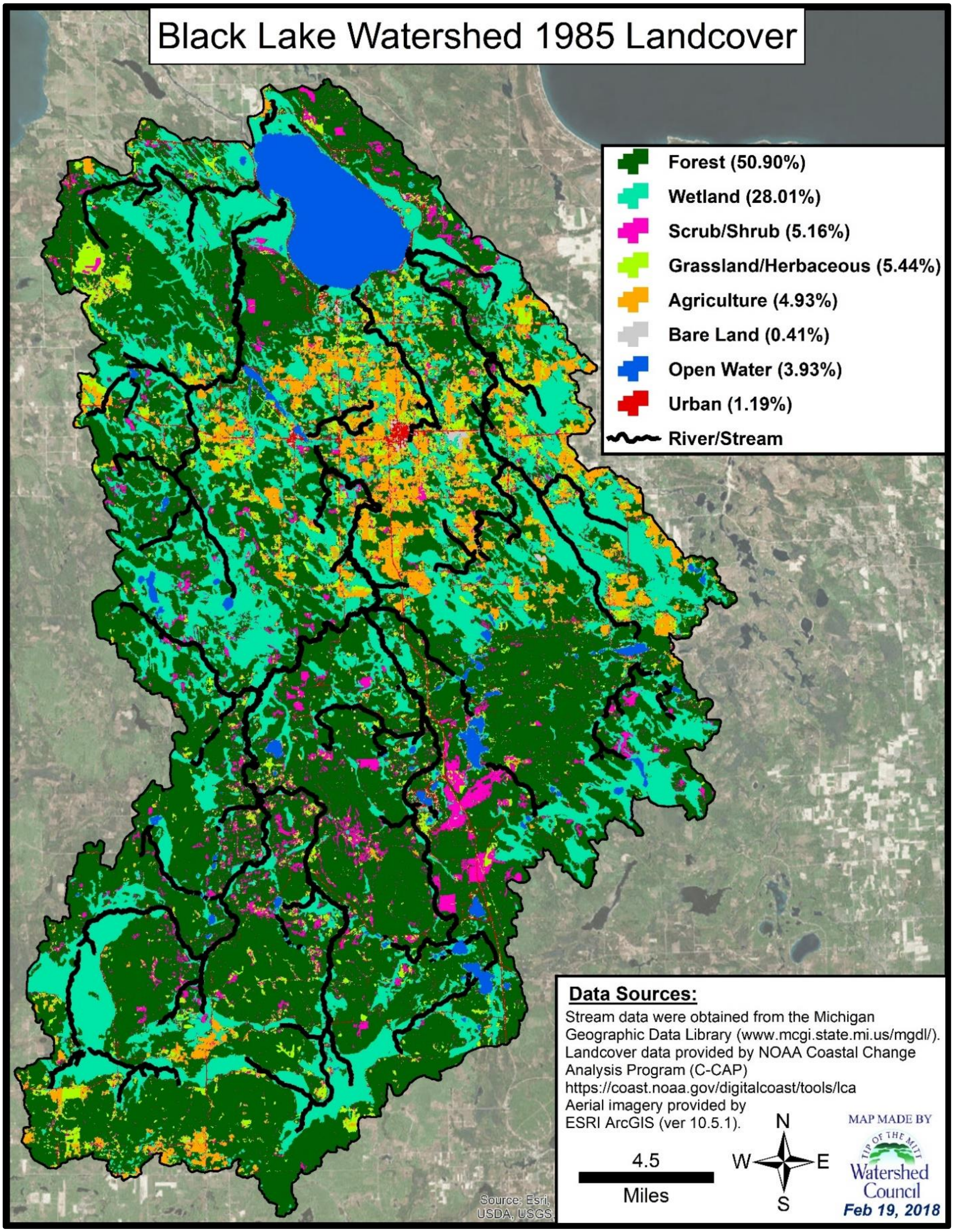

Figure 15 Watershed Land Cover statistics, 1985

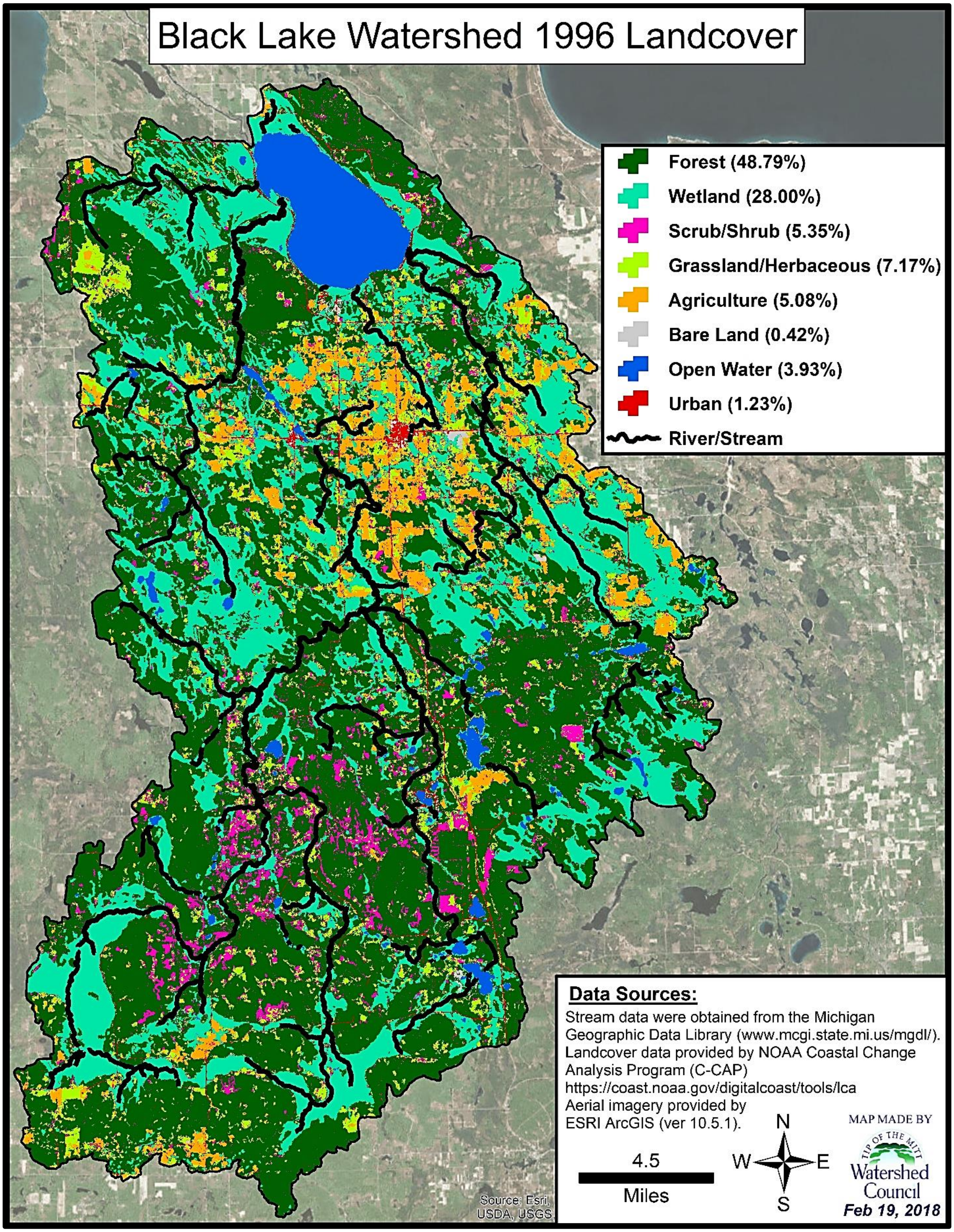

Figure 16 Watershed Land Cover Statistics, 1996

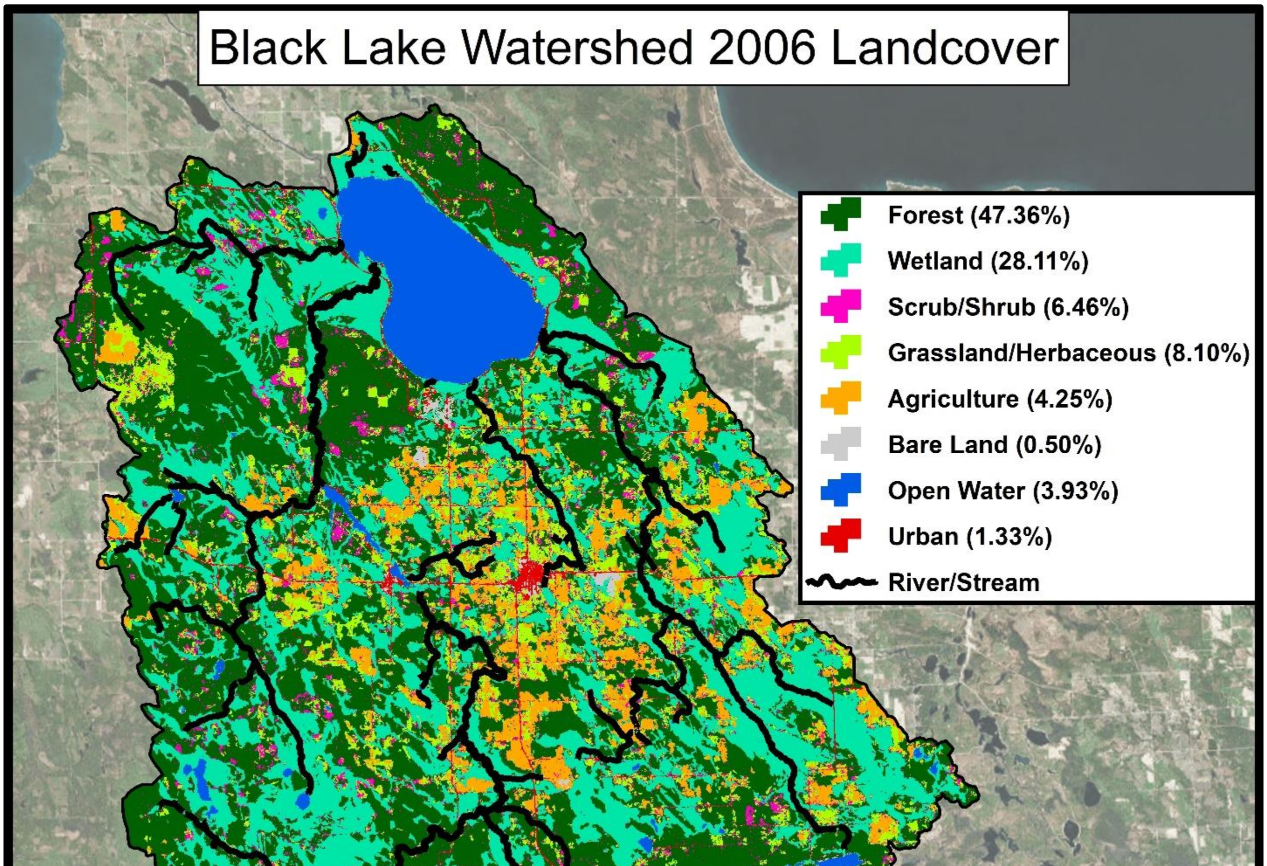

Figure 17 Watershed land cover statistics, 2006