Huffman Lake Shoreline Survey 2015

By Tip of the Mitt Watershed Council

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SUMMARY

Shoreline property management practices can negatively impact water quality and lake ecosystem health. Greenbelts provide many benefits to the lake ecosystem, which are lost when shoreline vegetation is removed. Erosion and shoreline alterations (e.g., seawalls, rip-rap) both have the potential to degrade water quality. Nutrients are necessary to sustain a healthy aquatic ecosystem, but excess inputs from shoreline properties can adversely impact an aquatic ecosystem.

In the spring of 2015, the Tip of the Mitt Watershed Council surveyed Huffman Lake in Charlevoix County, Michigan, to document and assess shoreline conditions. The following parameters were surveyed for all individual properties: *Cladophora* algae as a biological indicator of nutrient pollution, greenbelt status, erosion, alterations (e.g. seawalls, riprap), nearshore substrate types, and stream inlets and outlets. The survey was funded by the Michigan Department of Environmental Quality Nonpoint Source Program as a step in the development of a nonpoint source pollution management plan for the Burt Lake Watershed.

Survey results indicate that there have been improvements in some riparian property management practices, while other practices are potentially degrading the Huffman Lake ecosystem. The occurrence of *Cladophora* growth decreased by 45% since a prior study conducted in 2006, indicating that nutrient pollution from shoreline properties has decreased. Shoreline erosion on Huffman Lake was also well below average for lakes in this region, with no severe erosion observed. Greenbelts, however, were found to be in poor or very poor condition at 57% of shoreline properties. In addition, the percentage of properties with shoreline alterations was high relative to other lakes in the region (>70%), and approximately the same during the 2006 and 2015 surveys.

Numerous best management practices help minimize negative impacts to water quality. Maintaining a buffer of diverse, native plants along the shoreline helps filter pollutants and reduce erosion. Rain barrels, rain gardens, grassy swales, and many other techniques mitigate stormwater runoff impacts. Improving shoreline property management will help protect water quality, strengthen fisheries, and improve the quality of life and recreation on the lakes.

To achieve the full value of this survey, these follow-up actions are recommended: 1) Educate riparian property owners about best management practices that protect water quality; 2) Send survey summaries to all shoreline residents, along with information about what each person can do to help; 3) Confidentially inform property owners of problems observed on their shorelines and encourage them to rectifying problems; and 4) Organize informational sessions to present survey results and best management practices that help protect and improve lake water quality.

INTRODUCTION

Background

Shoreline surveys are an important lake management tool used extensively on lakes in the Northern Lower Peninsula of Michigan. These surveys involve assessing shoreline properties to document conditions or activities that have the potential to affect water quality and the lake ecosystem. Shoreline surveys commonly include an assessment of: *Cladophora* algae growth as a nutrient pollution indicator, erosion, alterations (e.g., seawalls), greenbelts (i.e., shoreline vegetation), emergent aquatic plants, wetlands, and tributary inlets and outlets. Survey results provide the means to carry out follow-up actions that address problems in shoreline areas. Solutions, such as shoreline plantings and rain garden installation are generally simple and low cost. Education and outreach to shoreline property owners is also important, because it encourages the adoption of best management practices that prevent degradation of surface waters.

During late May and early June of 2015, the Tip of the Mitt Watershed Council completed a comprehensive survey of the Huffman Lake shoreline. This survey was funded by the Michigan Department of Environmental Quality Nonpoint Source Program as a step in the development of a nonpoint source pollution management plan for the Burt Lake Watershed. This was the third shoreline survey carried out on Huffman Lake. Periodic repetition of shoreline surveys is important for: identifying both new and chronic problem sites; determining long-term trends in near-shore nutrient inputs, greenbelts, erosion, and shoreline alterations associated with land-use changes; and assessing the success of remedial actions.

Shoreline Development Impacts

Lake shoreline properties are the critical interface between land and water; where human activity has the highest potential for degrading water quality. Developing shoreline properties for residential, commercial or other uses invariably affects the lake ecosystem. During the development process, the natural landscape is altered in a variety of ways: vegetation is removed; the terrain is graded; utilities are 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 negatively impact the lake following shoreline development.

Nutrients are necessary to sustain a healthy aquatic ecosystem, but excess can result in nuisance and potentially harmful algal and aquatic plant growth. Excessive aquatic macrophyte growth (i.e., vascular aquatic plants) and heavy algal blooms that form mats and scum at the lake's surface can become a recreational nuisance. Algal blooms also pose a public health risk as some species produce toxins, including hepatotoxins (toxins that cause liver damage) and neurotoxins (toxins that affect the nervous system). Furthermore, excess algal and aquatic plant growth can degrade water quality by depleting the lake's dissolved oxygen stores. Nighttime respiration, when plants compete with other organisms for oxygen, coupled with the decomposition of dead algae and plant material by aerobic bacteria, reduces a water body's dissolved oxygen stores. This is particularly problematic in the deeper waters of stratified lakes.

Small lakes, such as Huffman Lake, are generally less resilient to water quality impacts caused by nutrient pollution than large lakes because small lakes have less water volume and therefore, reduced capacity for diluting pollutants and storing dissolved oxygen. However, the shallow nature of Huffman Lake reduces stratification, which allows for frequent mixing of the water column and replenishment of dissolved oxygen stores.

Surface waters receive nutrients through a variety of natural and cultural (human) sources. Natural sources of nutrients include stream inflows, groundwater inputs, surface runoff from riparian areas, and atmospheric deposition. Springs, streams, and artesian wells are often naturally high in nutrients due to the geologic strata they encounter and riparian wetlands can discharge nutrients during wet weather. 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., leaking sewer systems and animal wastes) pose a potential health risk due to exposure to bacteria and viruses.

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, water 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 (conductivity measures the water's ability to conduct an electric current, which is determined by the concentration of charged particles). Biologically, nutrient pollution can be detected along the lake shore by noting the presence of *Cladophora* algae.

Cladophora is a branched, filamentous green algae 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. *Cladophora* 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 during the months of May, June, September, and October.

The nutrient requirements for *Cladophora* to achieve large, dense growths are typically greater than the nutrient availability in Northern Michigan lakes. Therefore, shoreline locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake can be identified by noting the presence of *Cladophora*. *Cladophora* growth features are greatly influenced by such factors as current patterns, shoreline topography, size and distribution of substrate, and the amount of wave action on the shoreline. 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 inputs due to changing land use.

Erosion along the shoreline has the potential to degrade a lake's water quality. Stormwater runoff through eroded areas and wave action along the shoreline carries sediments into the lake and negatively 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.

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 naturally function to control erosion by stabilizing the shoreline with plant root structures that protect against wave action and ice. The canopy of the greenbelt shades near-shore areas, which helps maintain cooler water temperatures and higher dissolved oxygen levels. In addition, greenbelts provide infiltration to reduce overland surface flow carried by stormwater from rain and snowmelt, as well as filtration of pollutants.

Shoreline property development often results in altering or hardening the lake shoreline. Seawalls, riprap, groins, boathouses, and beach sand are among the most common shoreline alterations utilized to control erosion or improve recreational lake access and use. These changes to the shoreline also entail the loss of shoreline vegetation and myriad benefits associated with greenbelts. Of particular concern is the habitat loss in critical shoreline areas brought on by shoreline alterations.

Tributary streams influence a lake's water quality because they are the primary conduit of water and water-borne pollutants. Inlet streams may provide exceptionally high quality waters that benefit the lake ecosystem, but conversely have the potential to deliver contaminants from throughout the watershed and pollute the lake. Outlet streams flush water out of the lake, providing the means to expel contaminants that have accumulated in the lake ecosystem. The relatively higher nutrient levels in streams, relative to lakes, is important when assessing shore survey data because *Cladophora* growth is often heavier in shoreline areas adjacent to inlet tributaries.

Responsible, low-impact, shoreline property development and management is paramount for protecting water quality. Maintaining a healthy greenbelt, stormwater control with rain gardens, correcting erosion sites, and eliminating fertilizer and pesticide application are among many low-cost best management practices that minimize negative impacts of shoreline property management 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

Huffman Lake is located in Hudson Township in southeastern Charlevoix County, Michigan. The lake covers an area of 124 acres and has 1.9 miles of shoreline (Charlevoix County GIS, 2012). A maximum depth of 26’ occurs in the center of the lake (Figure 1). Residential development is found throughout Huffman Lake, but less dense along the western half of the south shore.

Huffman Lake is a glacially formed kettle lake that sits at the headwaters of the Sturgeon River. There are at least two small inlet streams; a stream flowing into the northwest corner that connects to Kidney Lake to the west and a stream of unknown origin that flows in at a developed property on the west end of the south side of the lake. The only outlet is located in the northeast cove, which starts the West Branch of the Sturgeon River.

The 5,825-acre Huffman Lake Watershed is a sub-watershed of the Sturgeon River watershed, which is, in turn, part of the larger Cheboygan River Watershed. The Huffman Lake Watershed extends approximately 3 miles west to Kuzmik Road and from a half-mile south of the Otsego County border to Studer Road and Wildwood Trail to the north (Figure 2). Based on land cover 2010 data, over 70% of the watershed is forested (Table 1). Of land cover types that typically lead to water quality degradation, there is little agricultural (9.0%) and even less urban/residential (1.2%).

Table 1. Huffman Lake Watershed land cover statistics (NOAA 2010).

Land Cover Type	Acres	Percent
Agriculture	524	9.0%
Barren	3	0.0%
Forest	4,285	73.6%
Grassland/Herbaceous	233	4.0%
Scrub/Shrub	301	5.2%
Urban	72	1.2%
Water	163	2.8%
Wetland	245	4.2%
TOTAL	5,825	100.0%

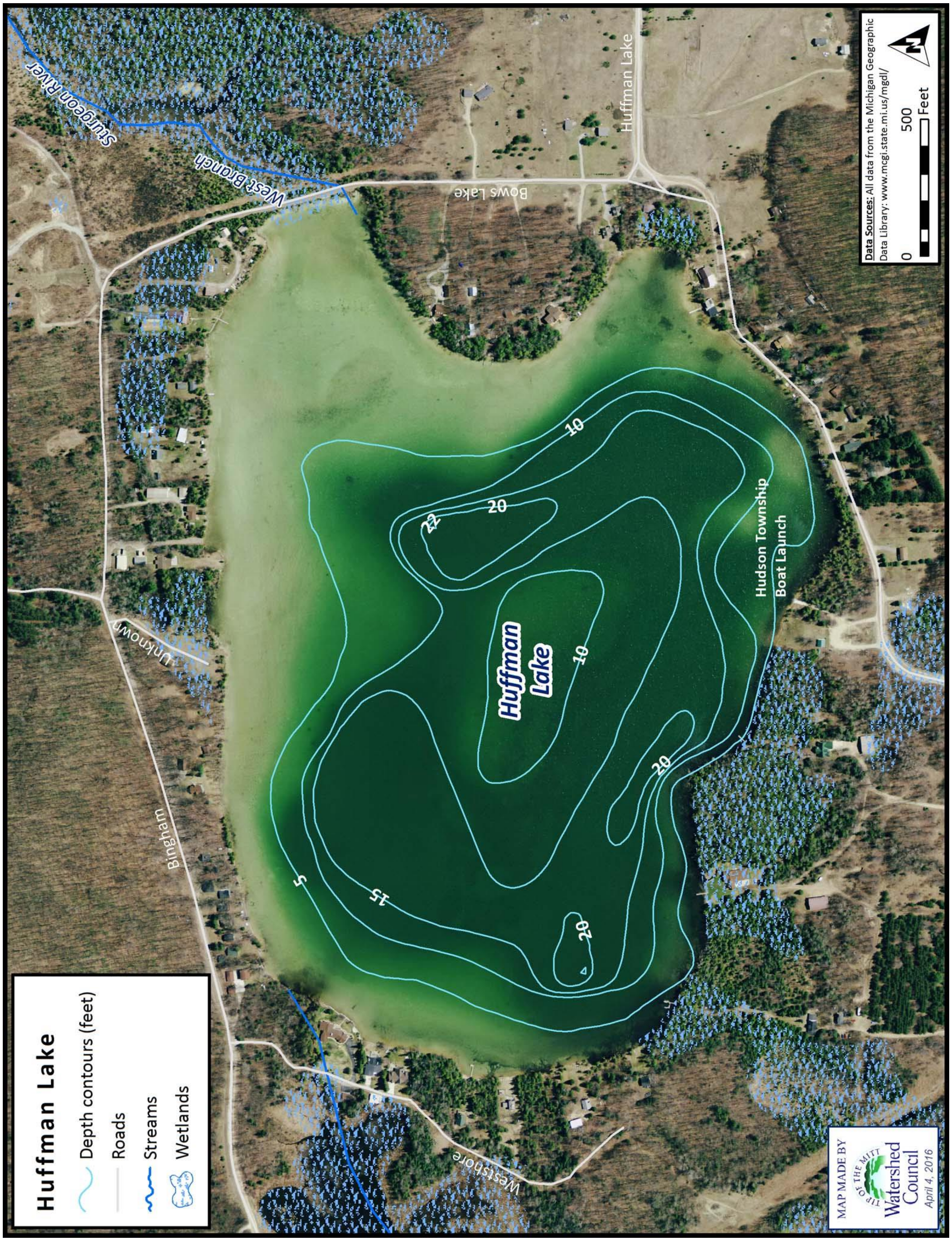


Figure 1. Map of the Huffman Lake features.

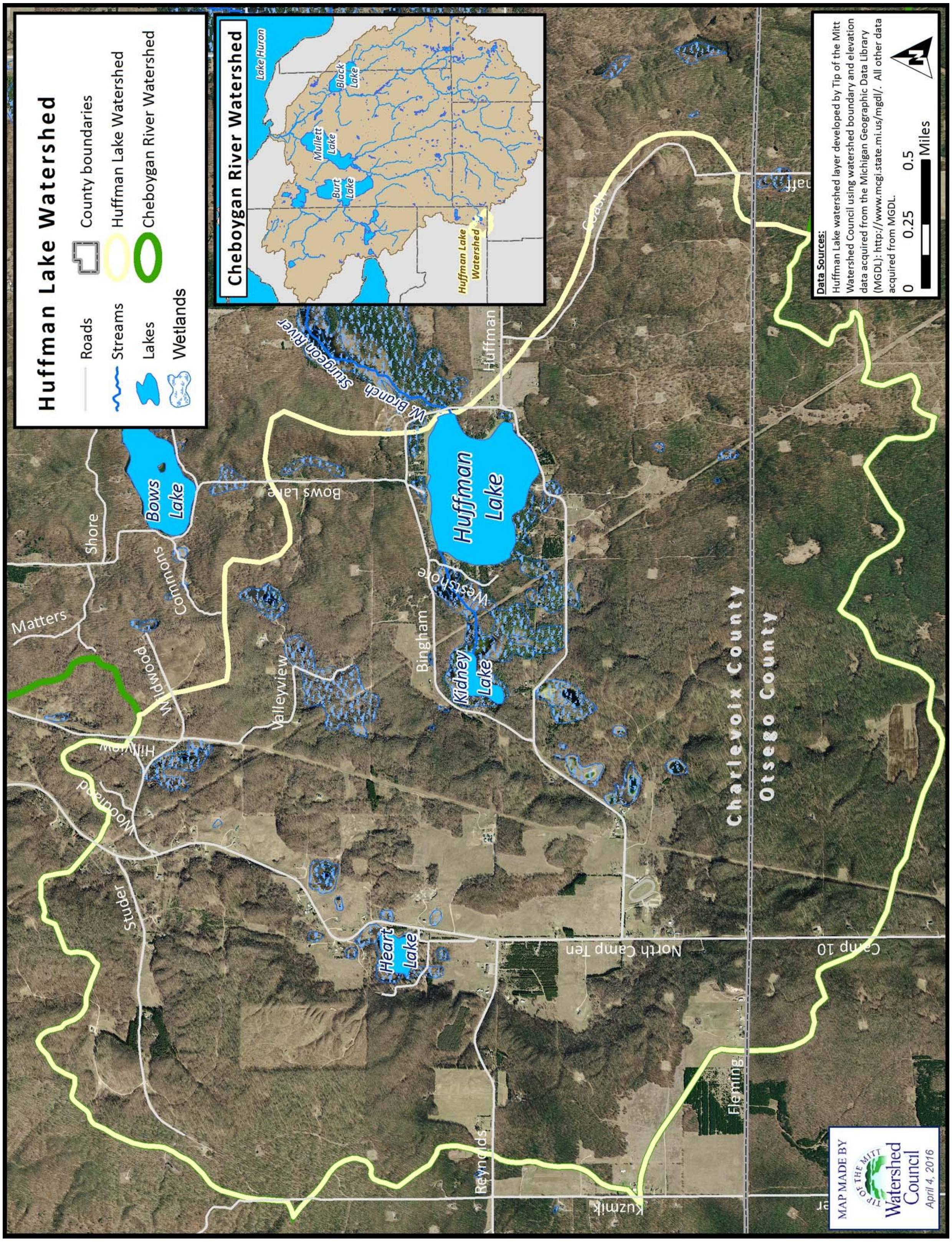


Figure 2. Huffman Lake Watershed.

Water Quality Summary

Based on water quality data collected in programs coordinated by Tip of the Mitt Watershed Council, Huffman Lake contains high quality waters typical for this region. As part of the Watershed Council's Comprehensive Water Quality Monitoring Program (CWQM), numerous parameters have been monitored in Huffman Lake on a triennial basis since 1995. Both dissolved oxygen and pH consistently comply with standards established by the State of Michigan (Table 2). Chloride levels have remained low since monitoring began in 1995, which indicates that there is little impact from urbanization and residential development (Figure 3). Nutrient concentrations are very low on Huffman Lake, with phosphorus levels declining since 1995 (Figure 4). Phosphorus is found in short supply relative to nitrogen and thus, is the limiting nutrient for algae and plant growth in Huffman Lake.

Table 2. Huffman Lake data from the CWQM program, 1995-2013.

	Dissolved Oxygen	**pH**	**Specific Conductivity**	**Chloride**	**Nitrate-Nitrogen**	**Total Nitrogen**	**Total Phosphorus**
Units*	**mg/L**	**Units**	**µS/cm**	**mg/L**	**µg/L**	**µg/L**	**µg/L**
Average£	10.0	8.1	308	3.8	64	265	5.0
Minimum£	6.4	7.6	287	3.0	10	165	2.0
Maximum£	11.7	8.4	353	4.5	88	390	10.0

**mg/L = milligrams per liter, µg/L = micrograms per liter, µS/cm2 = microsiemens per centimeter.*
£Statistics based on measurements from samples collected at mid-depth.

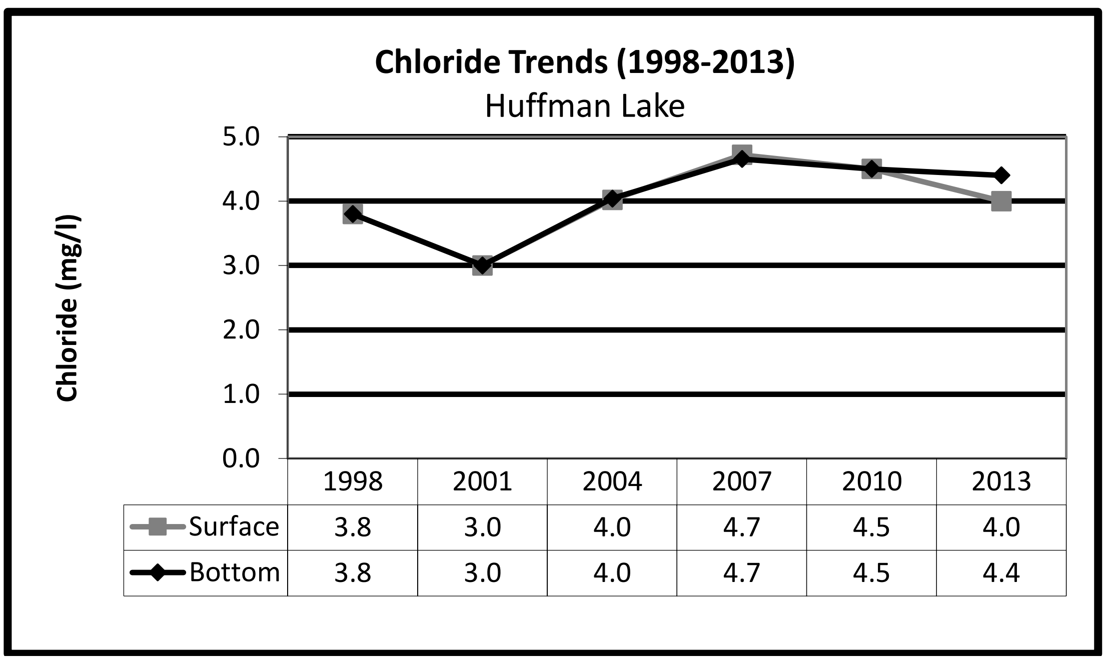
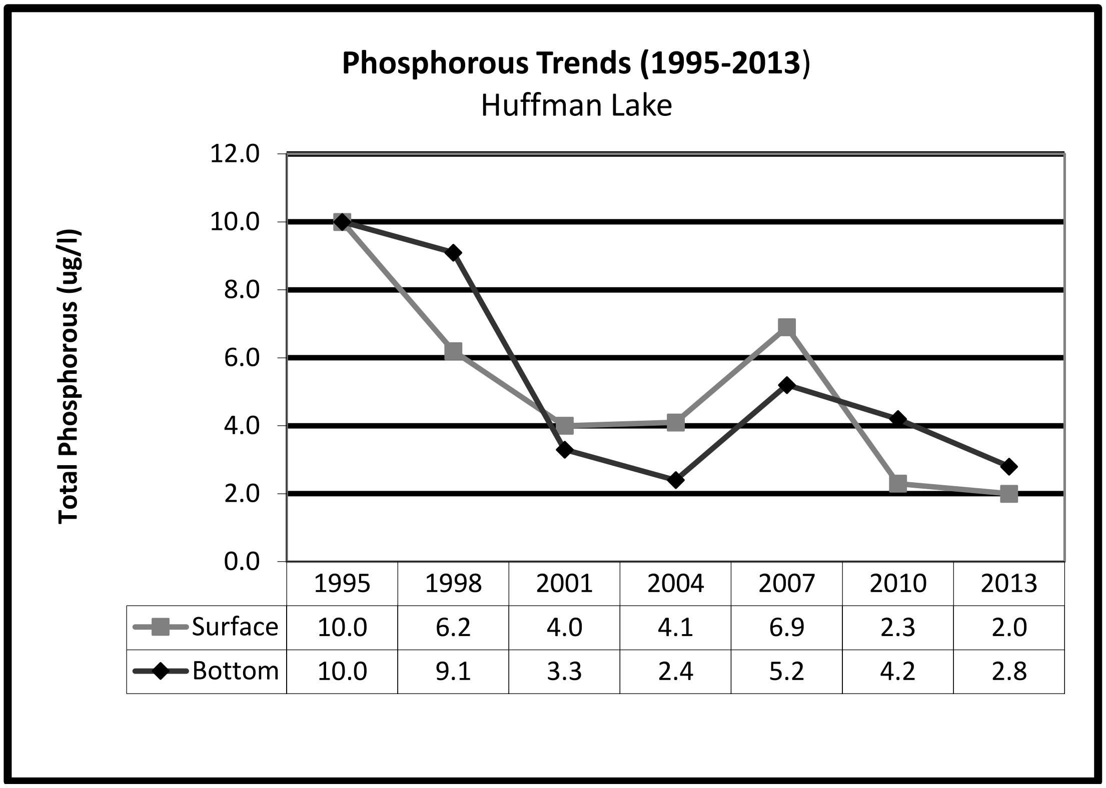


Figure 3. Chloride concentrations in Huffman Lake.



	1995	1998	2001	2004	2007	2010	2013
Surface	10.0	6.2	4.0	4.1	6.9	2.3	2.0
Bottom	10.0	9.1	3.3	2.4	5.2	4.2	2.8

Figure 4. Total phosphorus concentrations in Huffman Lake.

Huffman Lake has been determined to have moderate to high biological productivity. Although there is a gap spanning eight years, data from the Tip of the Mitt Volunteer Lake Monitoring Program show low water transparency, which is typically the result of abundant phytoplankton (i.e., unicellular algae) in the water column (Figure 5). Trophic status index scores from Huffman Lake border between mesotrophic and eutrophic (Figure 6). Depending upon variables such as age, depth, and soils, some lakes are naturally eutrophic. However, nutrient and sediment pollution caused by humans can lead to the premature eutrophication of a lake, referred to as “cultural eutrophication.” Cultural eutrophication can lead to nuisance plant growth, problematic algal blooms, water quality degradation, and fish and invertebrate mortality. Because data show that Huffman Lake ranked in the mesotrophic category throughout much of the 1990s, the trend of increasing TSI scores points to cultural eutrophication.

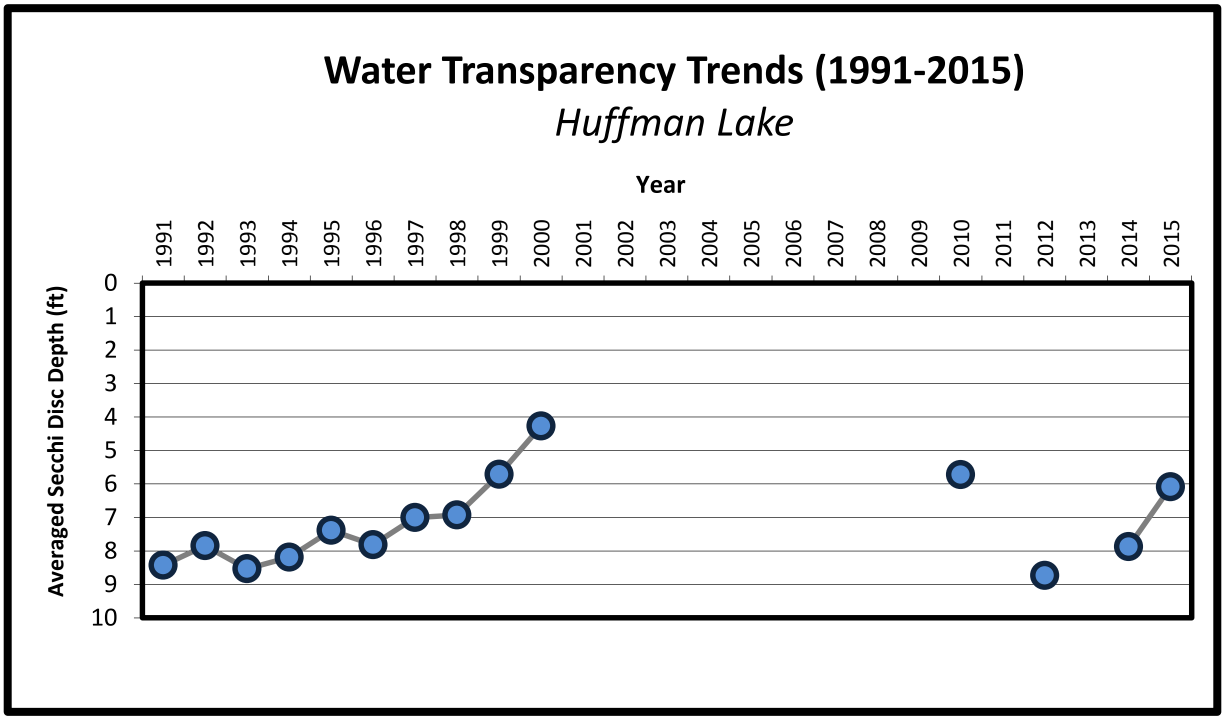
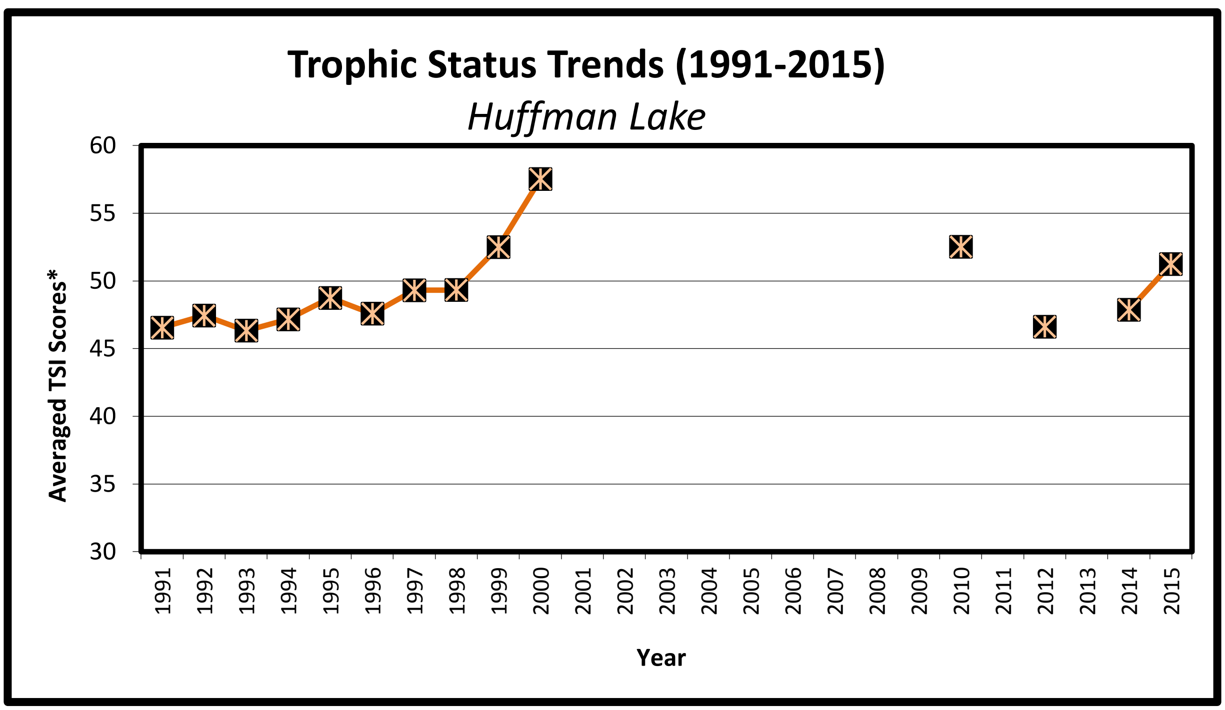


Figure 5. Water clarity in Huffman Lake.



**TSI=Trophic Status Index. Scores of 0-38 = oligotrophic or low productive system, 39-49 = mesotrophic or moderately productive system, and 50+ =eutrophic or highly productive system.*

Figure 6. Trophic status index values for Huffman Lake.

Prior Surveys

A prior shoreline survey, sponsored by the Huffman Lake Property Owners Association, was conducted by Tip of the Mitt Watershed Council on Huffman Lake in 2006. All residential shoreline areas were surveyed for nutrient pollution and shoreline alterations. Survey results showed moderate to heavy-density *Cladophora* growth at 24 shoreline properties (Table 3) and strong septic leachate detector readings at another 6 properties. Nutrient pollution indicators were concentrated in four lake areas, including embayments in the northeast and southeast corners, the northern part of the west shoreline, and the western side of the southern shoreline. Shoreline alterations were noted at 76% of properties, over 90% of which consisted of riprap. Follow-up actions to identify and address specific nutrient pollution sources was not carried out.

Table 3. *Cladophora* statistics from the 2006 shoreline survey.

***Cladophora* Density Category**	**Number of Properties**	**Percent of Properties***
Light	16	39%
Moderate	16	39%
Heavy	8	22%
TOTAL	40	100%

**Percent of total properties where Cladophora was found (40%).*

METHODS

The Huffman Lake shoreline was comprehensively surveyed in May of 2015 to document conditions and activities that potentially impact water quality. All individual properties were surveyed by traveling in kayak as close to the shoreline as possible (usually within 10 feet) and noting *Cladophora* growth, substrate type, erosion, greenbelt health, shoreline alterations, emergent aquatic plants, and tributary streams. Information for each property was recorded on field datasheets and subsequently, inputted into a database. Shoreline properties were also photographed with a GPS camera; these photographs were used to link field data with property owner data from county equalization records.

Field Survey Parameters

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

Developed parcels were noted on field datasheets and included as a separate column in the database. Properties described as developed indicate the presence of buildings or other significant permanent structures, including roadways, boat launching sites, and recreational properties (such as parks with pavilions and parking lots). Properties with only mowed or cleared areas, seasonal structures (such as docks or travel trailers), or unpaved pathways were not considered developed. Additionally, 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.

Cladophora algae growth observed in the nearshore area was noted on field datasheets. Many species of filamentous green algae are commonly found growing in the nearshore regions of lakes and positive identification of these species usually requires the aid of a microscope, but *Cladophora* usually has an appearance and texture that is quite distinct. Surveyors were trained to recognize these traits, which 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 datasheets and described the same as those of *Cladophora*.

Cladophora was described in terms of the length of shoreline with growth, the density of growth, and any observed shoreline features potentially contributing to the growth. For example, "MHx30' – seeps" denotes an area of moderate to heavy *Cladophora* growth along approximately 30 feet of the shoreline with groundwater seeps in the vicinity suspected of contributing to the growth. Both shoreline length and growth density were subjective estimates. Growth density was determined by estimating the percentage of substrate covered with *Cladophora* (Table 4).

Table 4. 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 both high percentage of substrate coverage and long filamentous growth.*

Nearshore substrate types were noted during the survey because, among other things, the distribution and size of each *Cladophora* growth is dependent on the amount of suitable substrate present. Therefore, the extent of suitable substrate has to 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 types suitable for *Cladophora* growth include *g, r, b,* and *w*. The extent of suitable substrate along the shoreline of individual properties in terms of distance (i.e., linear footage) was not documented.

Erosion was noted based on shoreline areas exhibiting areas of bare soil, leaning or downed trees, exposed tree roots, undercut banks, slumping sod, or excessive deposits of sediments. Similar to *Cladophora*, shoreline erosion was recorded on field datasheets with estimates of its extent and relative severity (minor, moderate, or severe). For example “Mx20’” indicated 20 feet of shoreline with moderate erosion. Additional information about the nature of the erosion, such as possible causes, was also noted.

Greenbelts 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:

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

Length and depth ratings were summed to produce an overall greenbelt score that ranged from 0 to 7. Scores represent greenbelt status or health with 0 considered very poor (no greenbelt), 1-2: poor, 3-4: moderate, 5-6: good, and 7: excellent (pristine).

Shoreline alterations were documented with the following abbreviated descriptions:

SB = steel bulkhead (i.e., seawall)	BB = boulder bulkhead
CB = concrete bulkhead	RR = rock rip-rap
WB = wood bulkhead	BR = Mixed boulder/rock riprap
BH = permanent boathouse	BS = beach sand
G = groin	DP = discharge pipe

Abbreviations were sometimes mixed or vary from what is listed above.

Tributary streams were noted on the field datasheets and included in a separate column in the database. Additional information regarding shoreline property features or shoreline conditions recorded on field datasheets was included in the database in a “comments” column. Emergent aquatic plants in nearshore areas, such as bulrush and cattail, were also noted in the comments column of the field datasheet.

Data Processing

Upon completing field work, all field data were transferred to a computer. Information from field datasheets was inputted into a Microsoft Excel® workbook. Digital GPS photographs were uploaded to a computer at the Watershed Council office and processed for use.

Field data were linked to county property data in a GIS with the aid of GPS photographs. The linked field and equalization data allows shoreline conditions documented during the survey to be referenced by property identification number or property owner name. In order to display survey results without pinpointing specific parcels, a new map layer was developed, which consisted of a narrow 100-meter 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 survey display maps.

Final products include a database with all field survey data, a complete set of GPS digital photographs, GIS data layers of shoreline parcels that include both county equalization and shore survey data, and maps displaying results. The shoreline survey database contains a sequential listing of properties beginning at the Hudson Township boat launch and traveling counter-clockwise around the entire perimeter of the lake. Identification numbers in the database correspond to those in GIS data layers and on hard-copy maps. GPS photographs were renamed using the same identification numbers, and are also linked to a separate GIS data layer.

RESULTS

This survey documented shoreline conditions at 70 properties on Huffman Lake. Approximately 52 shoreline properties (74%) were considered to be developed. The length of shoreline per parcel varied from less than 20 feet to over 1000 feet.

Habitat generally considered suitable for *Cladophora* growth was present along at least part of the shoreline at 65 properties (93%). Noticeable growths of *Cladophora* or other filamentous green algae were found along the shoreline at 10 properties, representing 14% of the total or 15% of properties with suitable habitat (Table 5). At properties where *Cladophora* growths were observed, approximately 70% were classified as light or very light growth and six properties had heavy or very heavy growth.

Table 5. *Cladophora* density results.

Cladophora Density	Number of Properties	Percent of Properties*
Very Heavy	0	0%
Heavy	0	0%
Moderate to Heavy	0	0%
Moderate	2	20%
Light to Moderate	1	10%
Light	3	30%
Very Light	4	40%
TOTAL	10	100%

**Percent of properties with Cladophora growth.*

Greenbelt scores ranged from 0 (little to no greenbelt) to 7 (exemplary greenbelt). Approximately 21% of greenbelts were found to be in good or excellent condition (Table 6). Conversely, 57% of shoreline property greenbelts rated in the poor or very poor categories.

Shoreline alterations were noted at 49 shoreline properties (70%) on Huffman Lake (Table 7). Riprap accounted for 80% of shoreline alterations, while 16% had seawalls, including seawalls combined with riprap or other structures. Beach sand, whether from fill or vegetation and topsoil removal to expose underlying sand, was documented at 4 properties.

Table 6. Greenbelt rating results.

Greenbelt Rating	Number of Properties	Percent of Properties
0 = Very Poor*	4	6%
1-2 = Poor	36	51%
3-4 = Moderate	15	21%
5-6 = Good	10	14%
7 = Excellent	5	7%
TOTAL	70	100%

**Very poor indicative of a property with no vegetation beyond mowed turf grass at the lake edge.*

Table 7. Shoreline alteration results.

Alteration Type	Number of Properties	Percent of Properties
Riprap	39	80%
Seawall	3	6%
Beach sand*	5	10%
Riprap and seawall	2	4%
TOTAL	49	100%

**Beach sand includes sand fill or exposing sand by removing vegetation.*
†Other includes rock groins, boat ramps, boat houses, or modifications.

Erosion was noted at 39 properties (56%) on Huffman Lake, with over 80% classified as minor in terms of severity (Table 8). No severe erosion was found on the shoreline.

Table 8. Shoreline erosion results.

Erosion Category	Number of Properties	Percent of Properties*
Minor	34	87%
Moderate	5	13%
Severe	0	0%
TOTAL	39	100%

**Percent of properties with erosion.*

Spatial patterns in the occurrence of *Cladophora* growths, erosion, and poor greenbelts were noticeable. *Cladophora* growth was observed at properties throughout the lake, with the densest growth occurring along the south shore. Properties with moderate shoreline erosion were found in isolated clusters along the northwest and southeast shores. Shoreline alterations and poor greenbelts were found at residential shorelines throughout the lake. Poor shoreline health occurred in the densest residential areas (Figure 7).

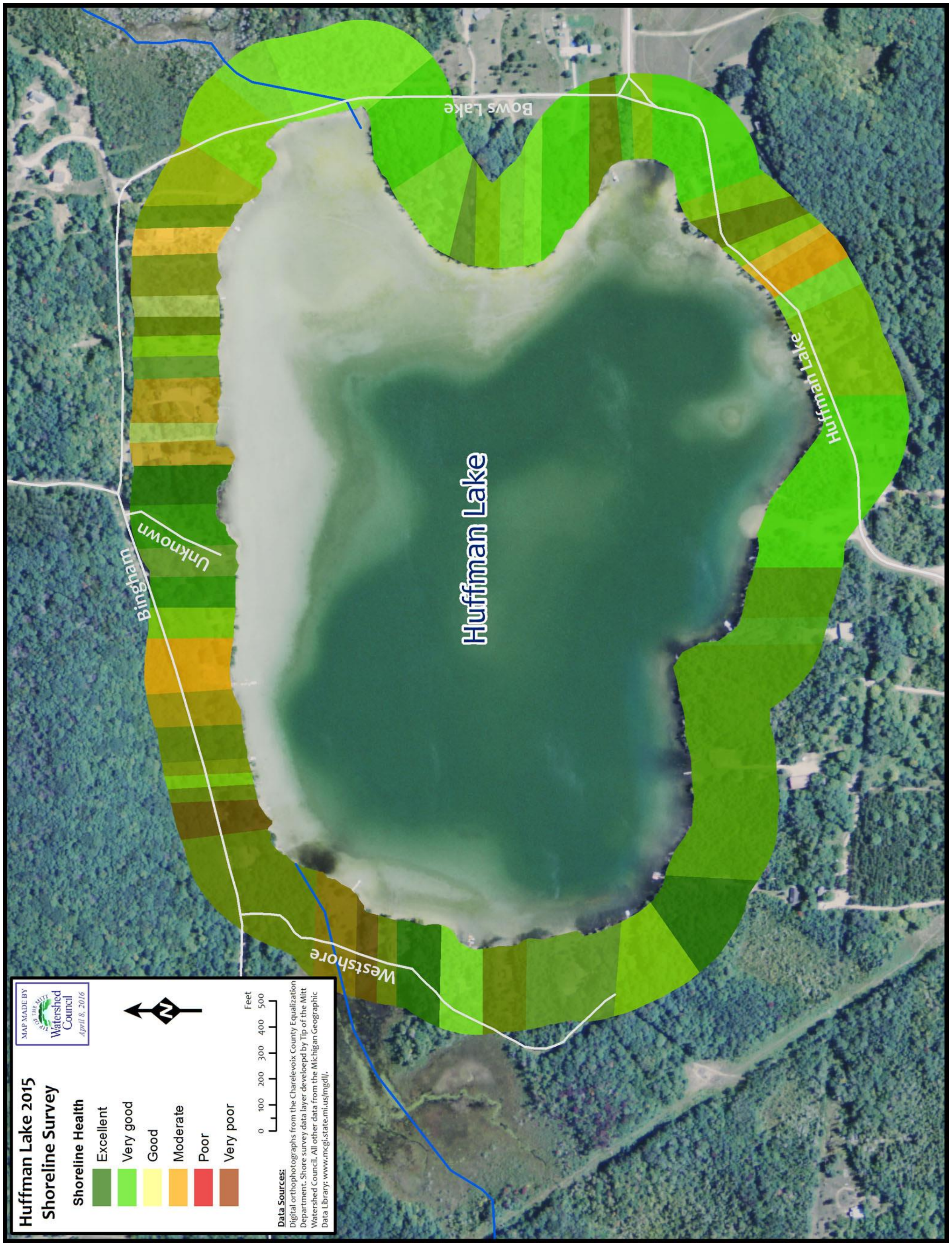


Figure 7. Survey results: shoreline health.

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 provide habitat and food in nearshore areas, absorb and filter pollutants in stormwater runoff, and stabilize shoreline areas to 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. Results from the 2015 survey indicate that poor greenbelts, and shoreline alterations pose the greatest threats to the water quality and nearshore health of Huffman Lake.

Relative to shore surveys conducted on other lakes in the region, Huffman Lake was well below the average in terms of the percentage of properties with *Cladophora* growth and heavy *Cladophora* growth (Table 9). Moderate-density growth was found at just two locations, which coincide with the 2006 survey. The tributary stream entering the lake in the northern end of the west shoreline is probably the source of nutrients contributing to Cladophora growth in that area. The moderate-density growth in the northeast corner of the lake corner, however, may be the result of nutrient pollution from human sources. On-site assessments by trained personnel can help determine if the algae growth is the result of human-caused nutrient pollution. Once the source of nutrient enrichment has been identified, actions can be taken to address the problem.

The percentage of properties with poor greenbelts on Huffman Lake (57%) was above the average for lakes in this region (Table 9). Lakeshore vegetation removal and the consequent loss of nearshore habitat and food sources impacts aquatic fauna ranging from minute crustaceans to top predator fish. Furthermore, the lack of vegetation leads to greater amounts of shoreline erosion and less filtration of pollutants. Although the percentage of properties with poor greenbelts was high, large parcels along the western half of the south shore that make up approximately 20% of the lake shoreline received good or excellent greenbelt ratings. Properties such as these, with healthy, intact greenbelts, provide a model for improvement for other shoreline properties. Improvements in the quality of greenbelts throughout the shoreline will invariably have positive impacts on the lake's water quality and ecosystem in general.

Table 9. Shore survey statistics from Northern Michigan lakes.

Lake Name	Survey Date	*Cladophora**	Heavy Algae*	Erosion*	Poor Greenbelts*	Alterations*
Black Lake	2005	20%	21%	ND	ND	ND
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	2008	59%	50%	7%	64%	58%
Pickerel Lake	2012	27%	33%	15%	52%	64%
Round Lake	2014	21%	0%	27%	44%	44%
Silver Lake	2014	3%	0%	70%	53%	65%
Six Mile Lake	2008	14%	5%	5%	34%	30%
Thumb Lake	2007	4%	0%	ND	ND	39%
Walloon Lake	2010	46%	24%	7%	36%	75%
Wildwood Lake	2014	5%	0%	22%	45%	50%
AVERAGE	NA	22%	12%	16%	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.*

Shoreline erosion on Huffman Lake was also well below average for lakes in this region (Table 9). Moderate erosion was found at locations on the north and south shores, in developed shoreline areas. The properties with moderate erosion also had poor greenbelts, indicating a relationship between the two. Corrective actions to address existing erosion, preferably using bioengineering techniques, as well as preventative measures, such as improving greenbelts, will benefit the Huffman Lake ecosystem.

The percentage of properties with shoreline alterations on Huffman Lake was above the regional lake average (Table 9). Most shoreline alterations (87%) consisted of riprap, which is one of the least damaging types in regards to lake ecosystem health (Table 7). However, the majority of the remaining alterations (10%) were seawalls or seawalls mixed with other alteration types, such as riprap or beach sand. Seawalls are now frowned upon by water resource managers due to negative impacts that range from near-shore habitat loss to iceinduced erosion in neighboring shoreline areas. Reducing the length of altered shoreline, particularly in terms of seawalls, will improve the water quality and bolster the ecosystem of Huffman Lake.

Comparisons with the shoreline survey conducted on Huffman Lake in 2006 showed positive changes in shoreline conditions. Cladophora occurrence decreased by 45%, the majority of this decrease occurring in the moderate and heavy density categories. The percentage of properties with shoreline alterations was roughly equivalent between surveys. Greenbelt status and shoreline erosion were not documented in the 2006 survey.

Numerous best management practices have been developed to minimize water quality and aquatic ecosystem degradation, which can be utilized during, or retroactively after shoreline property development. A buffer of diverse, native plants can be maintained along the shoreline to filter pollutants and reduce erosion. Impacts from stormwater runoff generated from roofs, roads, and driveways can be reduced using rain barrels, rain gardens, grassy swales, and many other techniques. Mulch can be composted far from the shoreline and fertilizers applied sparingly, if at all. Improving shoreline property management will help protect water quality, strengthen the fisheries, and improve the quality of life and recreation on Huffman Lake.

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. Send a <u>general</u> summary of survey results to all shoreline residents, along with information about best shoreline property management practices. Also, provide practical, feasible, and effective action options to protect water quality. Keep the specific results of the survey confidential (e.g., do not publish a list or map of sites where shoreline erosion was found) as some property owners may be sensitive to publicizing information regarding their property.

2. Confidentially inform lakeshore property owners of shoreline survey results specific to their properties. The survey information can be made available via Watershed Council and partner web sites, with confidentiality ensured by randomizing the survey database and providing property owners with a code number specific to their property. This full report and a separate summary can be posted on web pages

because they do not contain any property-specific information.

3. Encourage riparians property owners with moderate *Cladophora* growth, moderate to severely eroded shorelines, and poor or very poor greenbelt scores to work with the Watershed Council to identify and correct problems. Send these riparians a questionnaire to fill out and return (or make available electronically) to help interpret causes of the growth and provide recommendations for addressing problems. The Watershed Council or other qualified organizations or businesses can be contracted to perform site assessments to identify any problems and provide solutions.

4. Organize and implement informational sessions 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 lake water quality.

5. Repeat some version of the survey periodically (ideally every 3-5 years), coupled with the follow-up activities described previously, in order to promote water quality awareness and good management practices on an ongoing basis, as well as identify chronic problem areas.

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