A Shoreline Survey of Paradise Lake

by

Tip of the Mitt Watershed Council

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Introduction

Nutrient pollution resulting from a variety of activities associated with shoreline development is considered the greatest threat to the water quality of Northern Michigan's lakes. In particular, the nutrient phosphorus coming from septic systems, lawn fertilizers, wetland drainage, soil erosion, animal wastes, and stormwater runoff (in addition to natural sources such as springs, seepages, precipitation, and "dryfall"–leaves, pollen, etc.) can increase weed and algae growth and cause a lake to age prematurely.

A shoreline survey for nutrient pollution, or other types of nonpoint-source pollution (pollution originating from diverse, diffuse, often inconspicuous sources) can be a valuable lake management tool. Coupled with follow-up activities such as on-site visits or questionnaires, the source of nutrients to the lake can often be identified. Subsequently, a reduction in nutrient loading can often be achieved by working with homeowners to solve problems. These solutions are often simple and low cost, such as regular septic system maintenance, proper lawn care practices, and similar actions along the shoreline. Prevention of problem situations can also be achieved through the publicity and education associated with the survey.

A shoreline survey to identify locations of nutrient pollution and other types on nonpoint source pollution, as well as other environmentally important shoreline features was conducted on Paradise Lake by the Tip of the Mitt Watershed Council in October and November, 2002. The survey was funded by the Paradise Lake Association.

A shoreline pollution survey was conducted previously on Paradise Lake in 1988. However, the 2002 survey was a more extensive, systematic survey. Periodic repetition of shoreline nonpoint source pollution surveys are important for identifying chronic problem sites as well as recent occurrences. They are also valuable for determining long term trends of nearshore nutrient inputs associated with land use changes, and for assessing the success of remedial actions.

Methods

The Fall, 2002 shoreline survey consisted of several components:

1. Creation of a database using Microsoft Access software for recording, interpreting, and managing the findings of the survey. The database includes fields with information about property characteristics (as observed from the water) and homeowner's names and addresses. This will allow findings about pollution problems and other water resource information to be correlated with specific sites, and eventually facilitate revisiting the sites or contacting property owners.

2. Checking for Cladophora (a type of filamentous green algae), other biological indicators (weed & algae growth) of nutrient pollution, and any other obvious water quality problem situations. At each site where biological indicators were observed, clues or indications about the cause of the growths were assessed.

3. Conducting a septic leachate detector survey using a "homemade" instantaneous readout conductivity meter. This device is different than the device used during a similar survey on Paradise Lake in 1988, but has been shown to be effective during previous projects. However, it is designed to only detect <u>serious</u> problem sites.

4. Documenting other important water resource information:
    A. The presence and condition of a shoreline greenbelt, or vegetated buffer strip (considered one of the most important shoreline management techniques),

    B. Type of nearshore bottom sediments,

    C. The location of all tributary streams,

    D. Sites of accelerated shoreline erosion, and,

    E. Locations of shoreline alterations, principally armoring or hardening constructed by shoreline property owners.

The shoreline survey was conducted using a kayak, which enabled travel very close to the shoreline without trespassing.

Property and Ownership Features
Creation of a database providing a sequential description of shoreline properties (as viewed from the water), coupled with names and addresses of property owners and the results of the shoreline survey provides a good means of managing and reporting the data. It also facilitates contacting selected property owners and conducting repeat shoreline surveys.

The database field containing the property description consists of a sometimes cryptic descriptive phrase up to 50 characters long. Since most properties are developed, and developed properties are those with which nonpoint source pollution is normally associated, individual properties were generally described by the house located there. For example, *Red 2 sty, brn rf, wht trm, fldstn chim, lg pine* means that the property has a red two-story house with a brown roof, white trim, fieldstone chimney, and a large pine tree in the yard.
Besides platted or developed lots, individual properties also included undeveloped (vacant) lots, large undeveloped parcels, parks, preserves, public access sites, and county road endings. However, it was not possible to identify every distinct parcel in this manner.

For the purposes of this survey, developed means the presence of buildings or other significant permanent structures. Included are roadways, boat launching sites, and recreational properties (such as parks with pavilions and parking lots). Properties with only mowed or cleared areas, seasonal structures (such as docks or travel trailers), or unpaved pathways were not considered developed. Additionally, relatively large parcels which may have development in an area far from the water's edge were not considered developed. The length and area of developed vs undeveloped shoreline was not calculated.

Database fields were created for names of property owners and shoreline address of properties, however few entries were made. It was intended that this information would be gathered and added at a later time.

Cladophora as an Indicator of Nutrient Pollution
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. 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. Artificial substrates such as concrete or wood seawalls are also suitable. The preferred water temperature is 50 to 70 degrees Fahrenheit. This means that late May to early July, and September and October are the best times for its growth in Northern Michigan lakes.

The nutrient requirements for Cladophora to achieve large, dense growths are greater than the nutrient availability in the waters of most lakes. Therefore, the presence of Cladophora can indicate locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake along the shoreline (although it has less usefulness as an indicator of nutrient pollution in streams).

Sources of these nutrients can be due to natural conditions, including springs, streams, and artesian wells that are naturally high in nutrients due to the geologic strata they encounter; as well as wetland seepages which may discharge nutrients at certain times of the year. However, past experience has shown that the majority of Cladophora growths can be traced to cultural sources such as lawn fertilization, malfunctioning septic systems, poor agricultural practices, soil erosion, and wetland destruction. These nutrients can contribute to an overall decline in lake water quality. Additionally, malfunctioning septic systems pose a potential health risk due to bacterial and viral contamination.

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, climatic factors, and the amount of wave action to which the shoreline is subject. Therefore, quantifying the amount of growth has limited value when making year to year comparisons at a single location or estimating the relative amount of shoreline nutrient input. Rather, the presence or absence of any significant growth at a single site over several years is the most valuable comparison. It can reveal the existence of chronic nutrient loading problems, 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.

In spite of the limited value in quantifying Cladophora growths, when a growth was observed during the Paradise Lake Survey, an attempt was made to describe its relative abundance by ascribing it to one of the following three categories, based on its density or amount of available substrate that was utilized:

Slight (SL)	10 - 40% substrate coverage
Moderate (MOD)	41-60% substrate coverage
Heavy (HVY)	61-100% substrate coverage

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

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

<u>Conductivity as an Indicator of septic system Pollution</u>

Septic leachate detectors (SLDs) were developed in the 1980s, and for a time were popular lake management tools. These instruments typically consisted of a portable fluormeter and conductivity meter. A fluorometer is an instrument for measuring the intensity of flourescense (the emission of a particular type of light by some substances when acted upon by a radiant energy source). Fluorometers in SLDs were calibrated for specific wavelengths to detect both breakdown products of human waste and components of soaps and detergents. A conductivity meter measures the ability of water to conduct electricity, which has a direct relationship to the concentration of dissolved substances in the water.

Commercial production of septic leachate detectors has apparently ceased. However, portable conductivity meters are still produced and widely used for other types of water quality studies. For this survey, a YSI Model 33 Conductivity/Temperature meter was rigged with a small 12 volt water pump fitted to the end of a probe, which provided a continuous, nearly instantaneous reading of conductivity for very shallow, nearshore water.

Septic system effluent is likely to contain high levels of dissolved substances. During very calm periods, leachate plumes can form distinct water masses near shore. If higher-than-normal conductivity is encountered in a small area along the shoreline, it may indicate the presence of septic system leachate. Naturally occurring minerals or other substances can also cause high conductivity readings.

<u>Greenbelts</u>

The preservation or establishment of a shoreline greenbelt (also known as a vegetated buffer strip) is considered one of the most important shoreline management techniques. A greenbelt is a strip of diverse vegetation, either naturally growing or planted, along the shoreline of a lake or stream. It usually consists of a mixture of trees, shrubs, ground cover, and wildflowers. Greenbelts minimize polluted runoff, reduce the need for lawn maintenance (including pesticide and fertilizer applications), remove nutrients from septic systems and other sources, strengthen shoreline soils and help prevent erosion, are attractive, offer privacy and dampen sound, attract wildlife, can help save energy, discourage congregations of waterfowl, and may increase property values. Mowed turfgrass usually stands in stark contrast to a diverse, well-functioning greenbelt.

Information on the presence or absence of a shoreline greenbelt was also compiled during this survey. The presence and characteristics of a shoreline greenbelt was described using an index with three basic categories:

> **0.0-1.49 (Absent to Poor).** The shoreline has mostly been converted to an urban setting, with little natural or woody vegetation remaining along the shore. These properties are most likely to be contributing nutrients from surface runoff, and could use a lot of improvement.
>
> **1.5-2.49 (Good).** Although significant areas of natural vegetation remain, large areas have also been converted to lawn or other highly altered landscapes, especially along the shoreline. Properties in this category are generally doing a good job of managing their shoreline with respect to water quality protection, but there is room for improvement.
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> **2.5-3.0 (Excellent).** Very little disturbance of the natural vegetation outside the “footprint” of the house, especially along the shoreline (including emergent rushes and other aquatic vegetation). These properties have the appearance of a cottage tucked into the woods, and are often difficult to observe from the water during the growing season. This is the best category, one which property owners should strive to attain to ensure maximum water quality protection.

Bottom Substrate

This category refers to the natural shoreline or nearshore bottom materials. Among other things, the distribution and size of each Cladophora growth is dependant on the amount of suitable substrate present. Information on bottom substrate is especially important relative to the Cladophora findings because Cladophora grows best on rocky shorelines. 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. Bottom substrate also has important implications for fish and other aquatic life (most fish species prefer to spawn on rocky bottoms). The type of substrate present in front of each property was recorded during the survey. The following simplified categories and codes (either singly or in combination) were used to denote substrate type:

MK = a soft mucky or marl bottom
S = Sand
G = Gravel (0.1" to 2.5" diameter)
R = Rocks (2.5" to 10" diameter)
B = Boulders (greater than 10" diameter)
WD = Woody Debris

Shoreline Erosion

The presence or absence of accelerated shoreline erosion and its relative severity (slight, moderate, or severe) can be ascertained by the following clues:

- An area of bare soil on a steep, high shoreline bank,
- Leaning or downed trees, or trees with exposed roots,
- Undercut banks,
- Rapid rate of recession (based on personal knowledge),
- Slumping hunks of sod,
- Excessive deposits of sediments, and,
- Muddy water during wavy times

Additional information about the nature of the erosion, such as height and length of bank, whether it occurs at the toe or the top of the bank, type of soils, rate of recession, obvious causes, etc. may be added during future surveys.

Shoreline Alterations

This category is to describe the obvious changes than people have made to the shoreline, often in response to the severity of shoreline erosion. The following basic categories were used.

SB = steel bulkhead (a.k.a seawall)
CB = Concrete bulkhead
WB = wood bulkhead
BB = boulder bulkhead
RR = rock rip-rap (see substrate categories for boulder vs rock sizes)
G = groin
BH= permanent boathouse
DR = dredged area
DP = discharge pipe

Tributaries
Tributaries are one of the primary conduits through which water is delivered to a lake or river from throughout its watershed. Tributaries also carry and deliver a variety of materials from throughout the watershed to the receiving water. This can include pollutants such as sediment, nutrients, bacteria, and toxins from human activities far removed from a lake or river. Since tributary streams, even very tiny ones, were readily apparent during the survey, their locations were also added to the database.

Results

The attached database query contains a sequential listing of properties (as well as all the other information described) beginning on the west end of the lake at the MDNR public access site, and traveling counter-clockwise around the entire perimeter of the lake.

The survey identified approximately 290 dwellings on the lake on approximately 375 property parcels. These included numerous large parcels, especially along the south and east shores of the lake. These are approximations pending the compilation of detailed parcel maps for the shoreline, which may be done in another phase of the project. This means that about 77% of the property parcels on the lake are developed (although many of the undeveloped parcels are quite large, and could potentially be subdivided into many smaller parcels). Because the large parcels are mostly undeveloped, the length of developed shoreline is less than the 77% figure, but it was not accurately determined.

Habitat generally considered suitable for Cladophora growth was present at 268 properties (71%). Noticeable growths of Cladophora or other filamentous algae were evident at 73 locations, or about 19% of properties. Almost all of these were associated with developed properties. Most of these were slight growths, indicating relatively low levels of nutrient input. Some were associated with tributary streams or masses of rotting aquatic plants washed up on the shore, but many were obviously associated with well-fertilized lawns, erosion sites, or septic system drainfields. Numbers of each type of Cladophora growth are as follows:

Slight	44
Moderate	21
Heavy	8

Conductivity readings were taken along three heavily developed stretches of the shore where rocky substrates needed for good Cladophora growth were not present. The conductivity testing was done in front of 137 properties, and 33 of them (24%) showed higher-than-normal readings.

The actual readings are not provided on the database because conductivity is a function of water temperature and biological activity, and therefore, readings from different dates or even different regions of the lake are not comparable. Instead, a check-box indicates whether a property had a relatively high reading compared to adjacent areas of the shore on a particular day.

Experience has shown that many high conductivity readings and Cladophora growths are associated with human activities along the lakeshores, and indicate sources of nutrients which can be reduced or eliminated through better management practices. However, the high readings and algae growths can also be associated with ground water springs and seepages occurring along the shoreline. These springs and seepages naturally have higher conductivity (and often nutrient levels) than the lake water. They can also help convey wastewater from septic systems toward the lakeshore. Although some of the algae growths and high conductivity readings are undoubtedly associated with septic system leachate or other factors associated with development and human activities, **no individual severe water pollution problems were evident along the Paradise Lake shoreline. However, the cumulative impact of many slight problems can be significant.**

Fifteen percent of properties had greenbelts in the excellent category (very little disturbance of the natural vegetation outside the "footprint" of the house). Another 19% were in the good category (although significant areas of natural vegetation remain, large areas have also been converted to lawn or other uses). Unfortunately, most developed properties on the lake (66%) were in the absent to poor category, meaning the shoreline has mostly been converted to an urban setting, with little natural or woody vegetation remaining along the shore.

A mixture rocks, gravel, and sand was the predominant substrate, covering about 38% of the shoreline. Nearly pure sand was found along about 33% of the shore, and a mixture of gravel and sand along 28%. Muck or mucky sand bottoms in the nearshore zone were present at only a few sites. Suitable Cladophora habitat was present in more areas than rocky substrates were naturally found due to the widespread placement of rock rip-rap.

Accelerated erosion in the form of undercut banks, exposed tree roots, or other obvious indications was present at 73 sites (or along about 20% of the shore). Accelerated erosion is mostly due to woody vegetation removal, and so was predominantly associated with developed properties with extensive lawns. Most of the erosion was judged to be slight, but moderate erosion was judged to be present at 16 sites. No severe shoreline erosion was observed (although there were a few severely eroding sand banks just inland from the shore).

Shoreline armoring structures (a.k.a. shoreline "hardening") have been placed by property owners at 118 locations in an attempt to prevent erosion. These mostly consisted of rock rip-rap, although bulkheads (a.k.a seawalls) of concrete, wood, or steel were present 34 locations. Improperly designed or constructed shoreline erosion control projects can be ineffective, degrade shoreline wildlife habitat, be visually unappealing, and can even cause increased problems on neighboring properties.

Only six tributary streams are present along the shore. Mud Creek at the Lake's east end is the largest (and apparently the only named) tributary, the others being very small in size.

Recommendations

The full value of a shoreline survey is only achieved when the information is used to educate riparians about preserving water quality, and to help them rectify any problem situations. A "follow-up" effort of this nature has occurred on several other lakes where the Watershed Council has conducted shoreline surveys. The following follow-up actions are recommended:

1. Keep the specific results of the survey confidential--in other words, do not publish a list of sites where filamentous algae or high conductivity readings were found.

2. Send a general summary of the survey results to all shoreline residents, along with a packet of informational brochures produced by the Watershed Council and others to provide information

about practical, feasible, effective actions to protect water quality. This would cost approximately $5.00 to $25 per household, depending on complexity and type of materials distributed.

3. Inform those owners of properties with Cladophora growths or high conductivity readings of the specific results for their property, ask them to fill out a questionnaire in a attempt to better interpret causes of the growth, and offer individualized recommendations for water quality protection. Following the questionnaire survey, site visits coupled with ground water testing are sometimes preformed in an effort to gain more insight into the nature of the findings. Again, it should be stressed that all information regarding names, specific locations, and findings be kept confidential to encourage property owner participation in this project.

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

5. Compile more accurate parcel and ownership information for the shoreline database from either the Cheboygan and Emmet County Equalization Departments, or (in the case of simply owner's names) based on the knowledge of Association members or shoreline residents. When this information is added to the database, it will facilitate identifying the locations of Cladophora growths during repeat shoreline surveys and making property owner contacts. It will also be useful for empowering the lake association to monitor shoreline activities and recruit new members, and compiling and managing other water resource information. In particular, obtaining information on property ownership could easily be accomplished by Lake Association volunteers.

6. Create good quality maps showing property parcels, Cladophora locations, and other resource information. Eventually, the shoreline database developed for this survey could be linked with a Geographic Information System to create this type of map. The database could also be expanded to include other shoreline features such as public access sites, shoreline erosion, wetlands, aquatic plants, and type of bottom substrate.