Mississippi Lake Today

V 3 April 2015

A document prepared for the Mississippi Lake Plan Project

Mississippi Lake Plan

Mississippi Lakes Association

Mississippi Valley Conservation Authority

Watersheds Canada

Acknowledgements

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- Centre for Sustainable Watersheds – Lake Plan Committee, project management and funding
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- Leeds, Grenville and Lanark District Health Unit - Technical Advisory Committee
- Mississippi Valley Conservation Authority- Lake Plan Committee and Technical Advisory Committee, project management and funding
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- Ontario Ministry of Natural Resources - Technical Advisory Committee
- Town of Carleton Place - Lake Plan Committee and Technical Advisory Committee
- Town of Mississippi Mills - Lake Plan Committee and Technical Advisory Committee
- Township of Beckwith- Lake Plan Committee and Technical Advisory Committee
- Township of Drummond North Elmsley- Lake Plan Committee and Technical Advisory Committee

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- RBC Bluewater Project
- TD Friends of the Environment Foundation
- The Ontario Trillium Foundation
- Valley Heartland

Our Partners

Mississippi Lakes Association

Mississippi Valley Conservation Authority

Watersheds Canada

French Planning Services Inc.
www.lakeplan.com

Carleton Place
Meet me on the Mississippi

Beckwith Township
Proud of Our Past
Confident in Our Future

Drummond/North Elmsley Township
Est. 1998
Peace Plenty Progress

Mississippi Mills

Ontario Trillium Foundation
Fondation Trillium de l'Ontario

Valley Heartland
Community Futures Development Corporation

RBC Blue Water Project™

TD Friends of the Environment Foundation

Intent

The intent of this Report on the State of Mississippi Lake and Its Watershed is to provide a summary of the most current and relevant environmental information of this area. This report is part of the lake planning process, which will result in a detailed report used to guide stewardship action and land use policy for long-term protection, maintenance and restoration of the lake environment.

Acronyms

CSW - Centre for Sustainable Watersheds
MLA - Mississippi Lakes Association
MNR - Ontario Ministry of Natural Resources
MOE - Ontario Ministry of the Environment
MVCA - Mississippi Valley Conservation Authority

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History of the Mississippi Lake Association

The Mississippi Lake Association was first established in 1944 to act as the guardian of the lake. The association became incorporated in Ontario in 2002 and continues to act as a voice for lake residents in matters concerning the lake.

The MLA represents the lake and its residents by working with local governments and other groups on issues concerning the lake. Currently, the MLA provides several additional services to the lake and its residents. They are responsible for:

- Maintaining navigational hazard buoys
- Annual meetings regarding current topics and issues
- Lake stewardship in conjunction with MVCA
- Publishing annual newsletter

The MLA has worked on several projects regarding the health of the lake, such as:

- Shoreline Visit Program
- Mississippi River Water Management Program
- Source Water Protection
- Shoreline Naturalization

The Lake Planning Process

In 2011 the Mississippi Lakes Association (MLA) partnered with Mississippi Valley Conservation Authority (MVCA) to initiate the Lake Planning Process to help improve and preserve the condition of Mississippi Lake. Following the partnership, the Mississippi Lake Planning Committee was formed.

The Lake Planning Process uses a community-based approach, designed to present multiple opportunities for everyone with an interest in Mississippi Lake to provide their input, collaborate, and discuss issues pertaining to the lake. This approach involves community consultations, surveys and meetings, with participation from individual community members and representatives from community groups, non-governmental organizations, and various levels of government. All partners are invited to contribute expertise, data and information, and share in decision making and overall ownership. Communication among these partners will strengthen relationships and improve understanding of the issues affecting the lake community.

During the Lake Planning Process, two documents are produced: a Report on the State of Mississippi Lake (*Mississippi Lake Today*) and the Mississippi Lake Plan (the end result of the planning process). The first report is a technical document summarizing the known information about the various environmental characteristics of the lake and its subwatershed, while the second report is a stewardship document intended to guide actions towards the protection and management of the environmental characteristics identified in the first document.

The target community for both documents is defined as anyone who works, lives, or plays within the Mississippi Lake watershed, including but not limited to:

- Permanent and seasonal waterfront and watershed property owners;
- Commercial operation owners and users (i.e., camps, rental cottages, marinas);
- Day users (i.e., anglers, boaters, picnickers, tourists); and,
- Interest groups and government and non-government agencies that have an interest in the state of the lake.

A work plan for this planning process was completed in March 2012, and the Centre for Sustainable Watersheds (CSW) was invited to the Mississippi Lake Planning Committee to provide project management. Additional members of the committee include representatives from the following organizations:

- Mississippi Lakes Association;
- Mississippi Valley Conservation Authority;
- Township of Drummond/North Elmsley; and,
- Township of Beckwith.

A survey was circulated to lake residents in order to gain a better understanding of waterfront property owners' and stakeholders' current values, issues, and considerations regarding the present and future states of Mississippi Lake. The survey questions are summarized in Appendix 1. A summary of some of the results of the

survey are presented below. Following the collection of survey responses, volunteers and supporting agencies began collecting information and data to compile into this Report on the State of Mississippi Lake.

The subsequent report, the Mississippi Lake Plan document, will be a long-term plan of action developed by the community and affiliated partners to protect the health and special characteristics of the lake. It can address issues from water quality and pollution to development and boat traffic. This Lake Plan is a voluntary, non-regulatory document that will:

- Identify and protect the characteristics valued by the lake community;
- Promote community discussion, education, action, and unity;
- Set goals and objectives for the protection and enhancement of the lake environment;
- Recommend land use policies that influence development on and around the lake; and,
- Recommend stewardship action- ways to better care for your lake so it can be enjoyed by future generations.

A Lake Plan is not a government-produced document, nor is the implementation of the recommendations contained in it mandatory or legally binding.

Mississippi Lake Plan Community Survey Summary

The Mississippi Lake Planning Committee conducted a survey of the Mississippi Lake community and users from May 2012 to January of 2014. The purpose of the survey was to get an understanding of how the lake is used, the values people hold regarding the lake and their identified issues impacting those values. A total of 367 survey responses were recorded during the time frame; they were received both electronically and in hard copy.

Respondent Demographics

Ownership Status		Dwelling Type		Proximity to Lake	
Owner	93	House	62	Fronting	89
Renter	2	Seasonal Cottage	32.5	Within 200 metres	9
Visitor	2	Rental Cabin	0	Between 200 m and 1 km	1.5
Day User	0.5	Trailer/Camp site	0.5	More than 1 km	0.5
Other	2.5	Other	5		

Survey Results

Survey respondents were asked to identify and rank the activities they most often engage in while at the lake, the values that add the most enjoyment to the lake, and the issues and concerns that impact their enjoyment of the lake.

Top 10 Recreational Activities

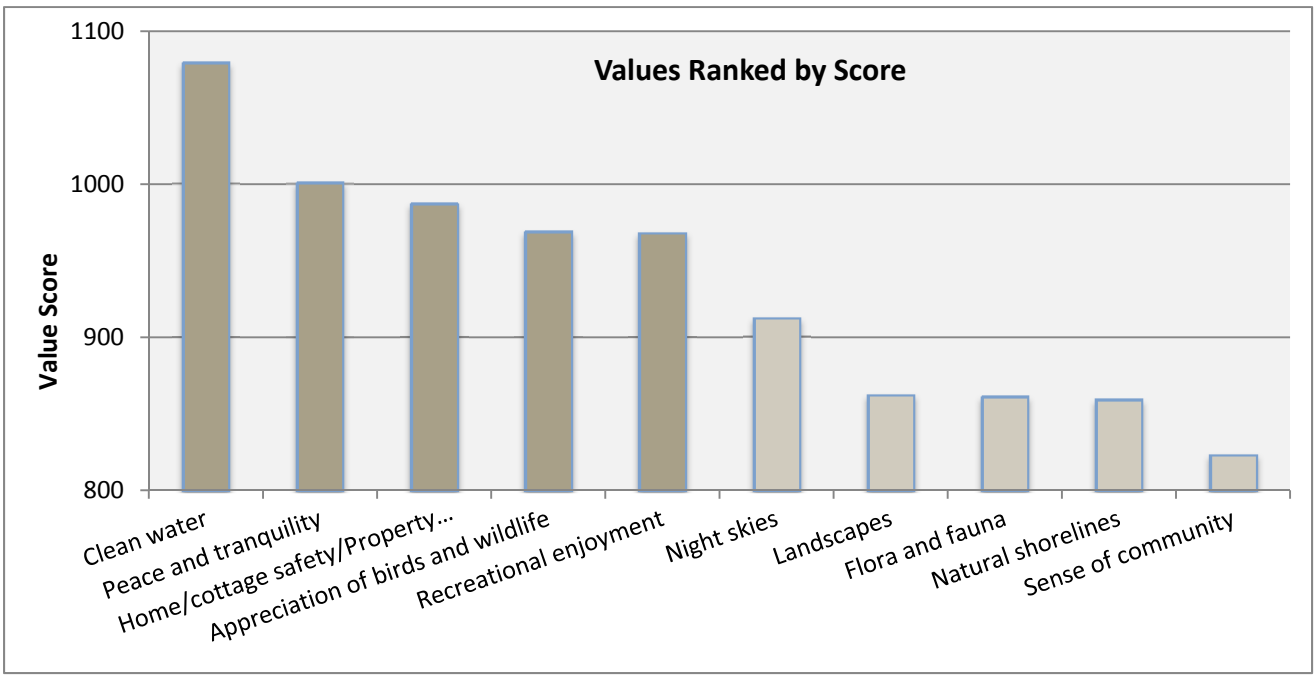
Swimming (83%)	Nature Appreciation (65%)
Motor Boating (77%)	Canoeing (55%)
Reading (76%)	Fishing (53%)
Socializing (74%)	Kayaking (48%)
Walking/Hiking (66%)	Water Skiing (32%)

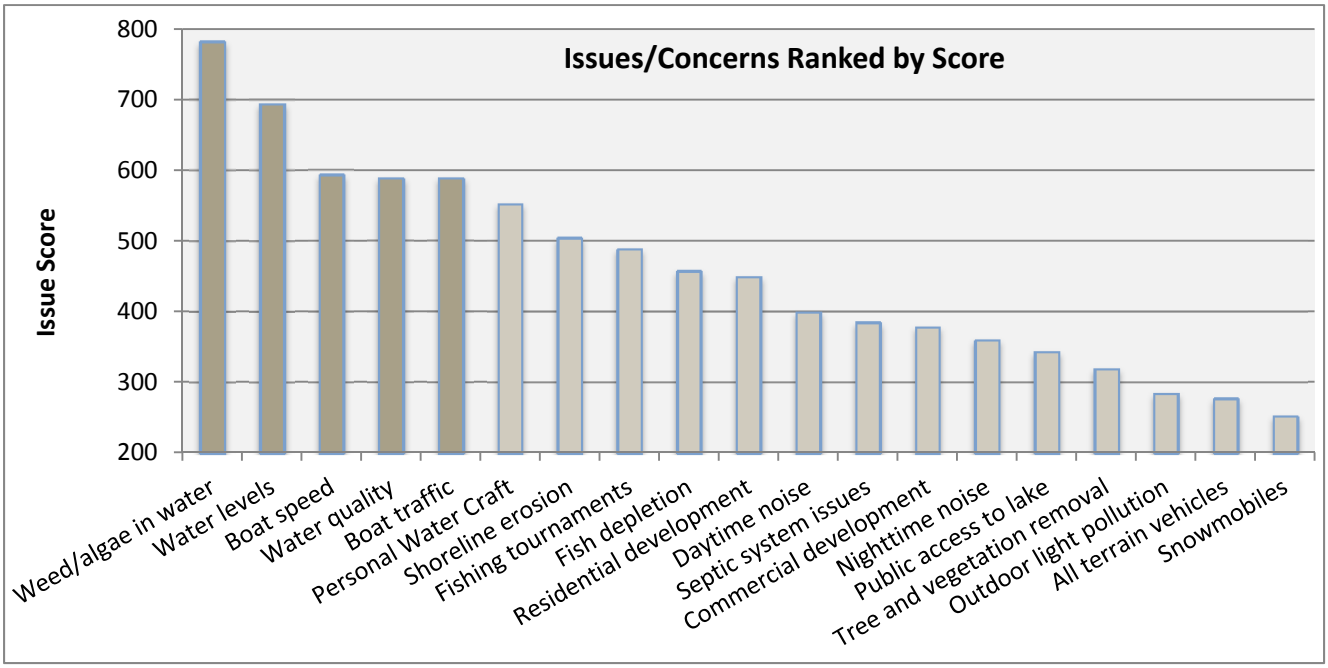
Top 5 Values

1. Clean Water
2. Peace and Tranquility
3. Safety/Property Security
4. Appreciation of Birds and Wildlife
5. Recreational Enjoyment

Top 5 Issues/Concerns

1. Weeds/algae in the water
2. Water Levels
3. Boat Speed
4. Water Quality
5. Boat Traffic





Executive Summary

The Mississippi Lake Today Report provides a snapshot of the state of the lake's environment, land uses and development levels, and its boating and recreational conditions. This report is a key building block in the Mississippi Lake planning process, a process to develop a detailed plan that will guide stewardship action and land use policy for the long-term protection of the lake environment. Another important building block for the lake plan is a survey that was circulated to lake residents in 2012 and 2013 in order to gain a better understanding of the community's current values, issues, and considerations regarding the present and future states of Mississippi Lake.

Mississippi Lake Today was prepared by a consortium of the Mississippi Lakes Association (MLA), Mississippi Valley Conservation Authority (MVCA), and the Centre for Sustainable Watersheds (CSW). The intent of this report is to:

- Provide a summary of what is currently known about the health of the lake and its watershed;
- Identify trends and changes in lake health over time;
- Discuss how that information relates to the issues and concerns identified by the lake community; and
- Improve the understanding of how our current activities presently, or could potentially, impact the lake and its surrounding environment.

The Lake Planning Process

The Lake Planning Process uses a community-based approach, designed to present multiple opportunities for everyone with an interest in Mississippi Lake to provide their input, collaborate, and discuss issues pertaining to the lake. Through 2014 and into early 2015 several public forums will take place to gain the community's ideas and perspectives at key stages in the development of the plan, which is to be finalized in spring, 2015.

Get Involved

The Mississippi Lake Today Report will be posted on the Mississippi Lakes Association website (www.lakemississippi.ca), along with all other plan-related material and information. Check the website for more information, and please provide your feedback and insights on any aspect of the process.

To get involved, please contact our Planning Committee chair Rob Bell at misslakeplanorg.rb@gmail.com.

The Mississippi River Watershed

- Mississippi Lake is the largest lake in the Mississippi River watershed;
- Has a total upstream watershed area of 2577 km^2;
- 92% of the upstream drainage area is forest covered, 3.8% is wetland cover, 3.8% is agricultural land;
- The upstream drainage area is primarily underlain by Canadian Shield, with thin sandy soils;
- Water quality of the upstream drainage area scored an A (excellent) grade;
- The riparian vegetation of the upstream area also scored an A (excellent) grade.

The Mississippi Lake Plan Watershed

- Is located in the lower portion of the Mississippi River watershed, from the western boundary of Drummond/North Elmsley Township to Carleton Place;
- Mississippi Lake has a shoreline length of 64km and length of 14km, average depth of 2.7m and maximum depth of 9.2m, and surface area of 24.5km^2;
- The lake has 2 Provincially Significant Wetlands located on the shoreline;
- The lake watershed is within the jurisdiction of 3 townships, and directly upstream of a 4th;
- Is located on the geologic boundary of the Canadian Shield and Paleozoic sedimentary plain.

Surface Water Quality

- Surface water quality sampling results indicate Mississippi Lake is moderately nutrient enriched, classifying it as a mesotrophic lake;
- Dissolved oxygen and temperature profiles indicate that there is sufficient oxygen in the water most of the year to support the lake ecosystem;
- Recent data (2006 to 2011) suggest that phosphorous levels may be rising in the lake, potentially leading to increased growth in weeds and algae;
- The pH is consistently within the Provincial Objective range for protecting aquatic life, with an average level of 7.5;
- The relatively high alkalinity of the lake means it is suitable habitat for the Zebra Mussel.

Aquatic Vegetation

- Growth of weeds and algae has been identified as having the most negative impact on lake enjoyment
- Data on the current state and growth of vegetation in the lake are very limited;
- Invasive Eurasian Milfoil has been documented in Mississippi Lake.

Water Levels

- The Mississippi River is a managed system, meaning Mississippi Lake is influenced by dams and water control structures that are managed according to operation ranges set out in the Mississippi River Water Management Plan (2006).
- Water levels are maintained by Mississippi Valley Conservation Authority to minimize flooding as much as possible.
- Mississippi Lake is the last in a series of lakes along the Mississippi River; the dam at Carleton Place controls lake water levels under normal flow conditions;
- Outflows from the lake are also impacted by the narrowing of the river at the outlet and again at the canoe club and the capacity of the Bridge

Street bridge upstream of the dam.

- The upstream drainage includes a controlled watershed area above the Crotch Lake Dam, and an uncontrolled watershed area between Crotch Lake and the lake;
- The timing and magnitude of spring flooding on the lake is influenced by the rate and timing of runoff (snowmelt and rainfall) from the uncontrolled upstream watershed area;

Flooding and Floodplain Mapping

- Minor flooding in the spring often occurs on Mississippi Lake, due to its location in the watershed and the natural constriction of the river as it flows through Carleton Place;
- Highest recorded flood occurred in the spring of 1998, when the lake reached an elevation of 135.73 m.a.s.l;
- Low lying areas considered 'Floodplain' are regulated by Mississippi Valley Conservation Authority through floodplain mapping.

Fishery

- Mississippi Lake supports a mainly cool and warm water fishery, such as Walleye and Northern Pike, as well as Largemouth and Smallmouth bass;
- The fish community is managed by the Ministry of Natural Resources as a self-sustaining fishery (i.e. no stocking is taking place);
- Netting index surveys indicate that Bass populations are increasing; Northern Pike populations have dropped, but the average size has increased;
- The recent surveys have indicated that the Walleye fishery is healthy, though there are expressed concerns about overharvesting;
- Several Walleye spawning rehabilitation projects have been completed in Innisville to support the Walleye population;
- Very little monitoring of the fish population has been done since 1999.

Natural Environment

- There are 2 Provincially Significant Wetlands located on the shore of the lake (Mississippi Lake Wetland and McEwen's Bay Wetland), as well as one "Area of Natural and Scientific Interest" and one National Wildlife Area;
- A large portion of the lake shoreline is natural area providing habitat for a diverse collection of wildlife;
- Surveys conducted by lake volunteers indicate that there are on average 12 mated pairs of loons on the lake in recent years;
- McEwen Bay is used extensively by waterfowl during fall migration, with as many as 10,000 birds passing through in a day;
- There is little current data available for the health and abundance of mammals, reptiles and amphibians in and around the lake;
- There are 15 species at risk that have been documented in the National Wildlife Area, located at the lake inlet.

Land Use and Development

- Population estimates for the surrounding municipalities indicate that Mississippi Lake may see increased development pressure as the surrounding population grows;
- The current development around the lake is a mix of seasonal dwellings and permanent residences (estimated 1200 shoreline properties in total).

Boating and Recreation

- Mississippi Lake is a popular destination for boating and recreation;
- A boating census was conducted by volunteers in the August of 2013, which documented 1370 moored boats on the lake;
- Boating can cause shoreline erosion from the wake, drown bird nests close to the water, and pollute water through the release of fuel and oil;
- Recreational activities draw people to the lake from the surrounding regions, with ample fishing opportunities, wildlife viewing and beaches;
- Fishing is a popular activity on Mississippi Lake, and includes several bass tournaments each year.

Groundwater

- Groundwater monitoring data in the Mississippi Lake area is intermittent, though available records indicate the water is of overall good quality;
- The majority of the aquifers within the Mississippi watershed have been classified as highly vulnerable due to the thin soils overlaying the bedrock aquifers, which provide little protection to the groundwater.

Carleton Place Water Intake

- The Town of Carlton Place Water Treatment Plant draws its water from the Mississippi River immediately downstream of Mississippi Lake, treating and providing water for over 9400 people
- The Mississippi-Rideau Source Protection Plan, approved in 2013, sets out policies to protect the drinking water supply at its source
- The plan identifies three levels of Intake Protection Zone (IPZ) around the water supply based on: proximity and the amount time it would take surface water to reach the intake
- Vulnerability scores are used to determine the level of land use restriction applied in areas within each IPZ.

Climate Change

- Average annual temperature increases are predicted to continue in the future, most noticeably in the winter;
- Stream flows are expected to be higher from September to January and lower from April to September;
- This could impact fisheries, water quality and recreational activities

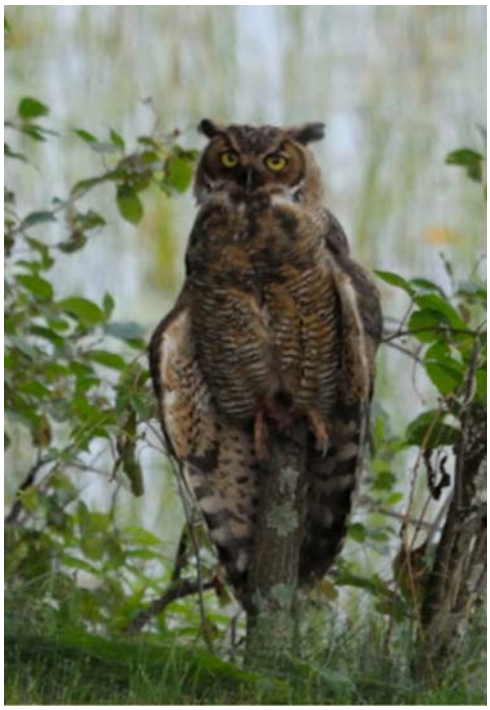


Photo 1: Great Horned Owl (photo courtesy of Jo Ellen Beattie)

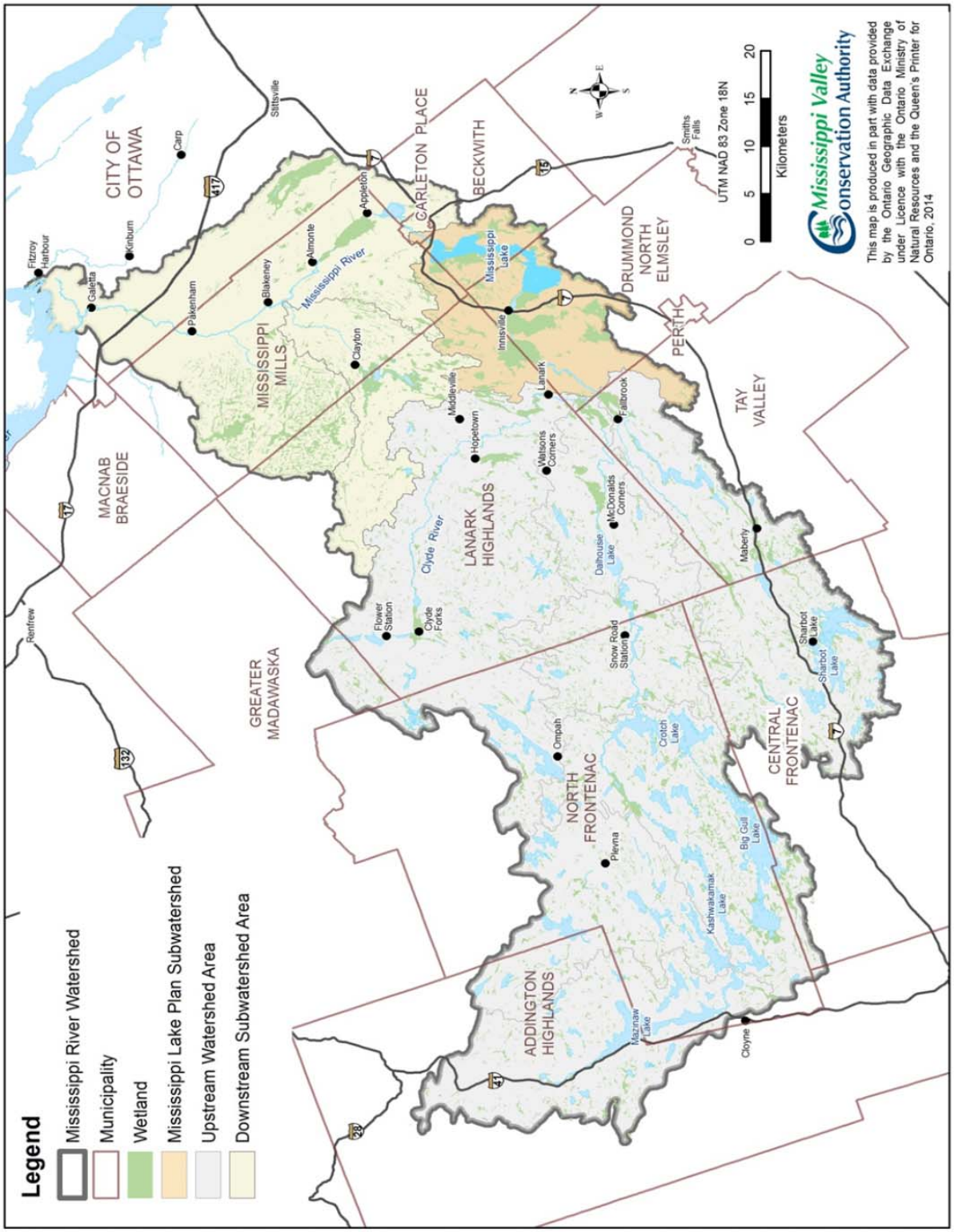
Layout of the Report

The information contained in this report has been compiled by volunteers and staff from the Mississippi Lake Planning Committee and supporting partner organizations. Copies of the original data and information are held at offices of the Mississippi Lakes Association, the Mississippi Valley Conservation Authority, and the Centre for Sustainable Watersheds.

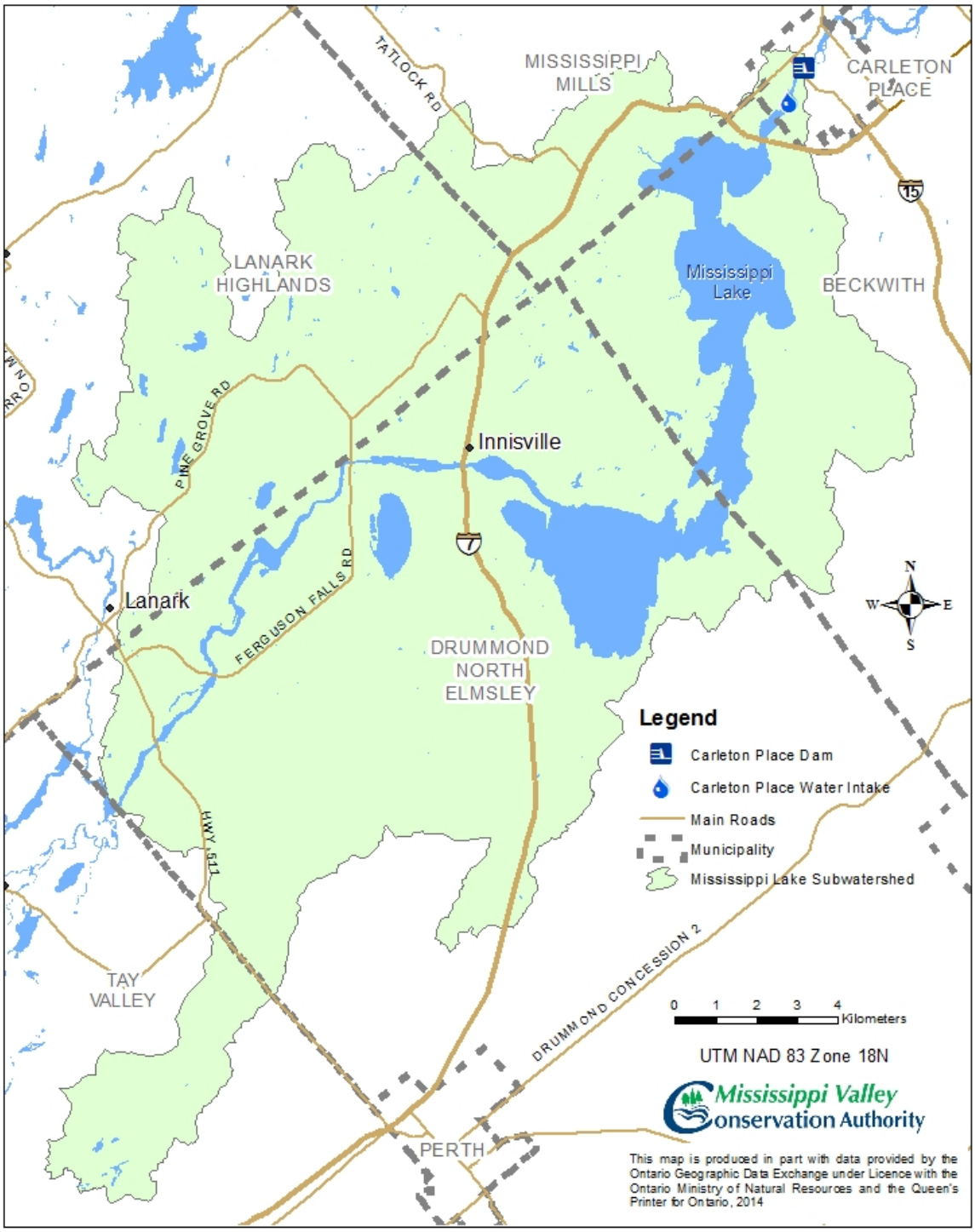
Unlike most lakes that are located at the upstream end of a river system, Mississippi Lake is in the unique position of sitting at the receiving end of a very large upstream drainage area. The lake lies in the middle of the Mississippi River Watershed, a 3750 sq. km drainage system that encompasses a vast network of lakes, rivers and streams that feed into the Mississippi River (**Map 1: Mississippi River Watershed**). Because Mississippi Lake is part of such a large and complex watershed system, the report begins by providing general information on the Mississippi River and its watershed as a whole; then provides additional, more specific information about the area surrounding Mississippi Lake and the lake itself. The information about the Mississippi River Watershed as a whole is presented in Section A of the Report. This section includes general information about the landscape, climate, geology and soils, land cover, etc. at a broad watershed scale.

Section B presents the more detailed information about Mississippi Lake and its surrounding area. For this part of the report, we have broken out a section of the full Mississippi Lake Watershed, which is based on the drainage area where the Mississippi River crosses the west boundary of the Township of Drummond North Elmsley at its upstream end to the Carleton Place dam at its downstream end. This area is depicted as the Mississippi Lake Plan Subwatershed on Error! Reference source not found.**.** Section B of the report presents a more detailed look at the lake area and its various environmental and social factors, including: surface water and ground water, hydrology, natural environment, land use and development and boating and recreation.

Map 1: Mississippi River Watershed



Map 2: Mississippi Lake Plan Subwatershed Area



Mississippi Lake Plan Subwatershed

Section A: Mississippi River and Watershed

Location and Watershed Description

A watershed describes an area of land that contains a common set of streams and rivers that all drain into a single larger body of water, such as a larger river, a lake or an ocean. As seen on the Map 1, Mississippi Lake lies in the middle of the Mississippi River Watershed, a 3750 sq. km drainage system that encompasses a vast network of lakes, rivers and streams that feed into the Mississippi River. The entire Mississippi River is over 200 km long, originating from its headwaters north of Mazinaw Lake and Bon Echo Provincial Park. From there, the river flows east for more than 100 kilometers through a number of large lakes before reaching Mississippi Lake. The river then flows north though the settlements of Carleton Place, Almonte, Pakenham and Galetta before out-letting into the Ottawa River near Fitzroy Harbour.

At 24.5 square kilometres, Mississippi Lake has the largest surface area of all the lakes within the Mississippi River Watershed. While Mississippi Lake sits in the middle of the watershed, it is the last lake on the system of approximately 260 lakes of varying shape and size draining into the system upstream. The second largest lake for surface area, Big Gull Lake (24.2 km^2) and third largest Mazinaw Lake (16.2 km^2), are both located at the top (west) end of the drainage system. The remaining lakes range from 15 km^2 to as small as 0.3 hectares in surface area size, with over 200 lakes that are less than 0.5 km^2 in size.

There are 19 dams along the Mississippi River which are owned and/or operated by Mississippi Valley Conservation Authority (MVCA) for a variety of purposes. In addition, there are 4 privately owned hydro generating stations. There are also a number of small private and or derelict water control structures on other various watercourses throughout the watershed (Mississippi Valley Conservation Authority, 2014).

Geology & Soils

The Mississippi River Watershed is located on two significant geological bedrock features. The western two-thirds are dominated by the Precambrian Canadian Shield, which is composed of metamorphic and igneous rock, with pockets of very thin sandy soils. The eastern third of the watershed sits on Paleozoic bedrock formations where shale, limestone and sandstone plains are the dominant feature. The entire area was shaped by the retreating of the glaciers during the close of the last ice age that began 2.6 million years ago.

Many small wetland pockets can be found throughout the area due to the impermeability of the shield, which catches and holds water, eventually turning isolated swamps into wetlands. There are exposed rocks and outcrops, which were once part of the Grenville Mountain Chain that has been subjected to 100’s of millions of years of erosion, resulting in exposure of the Canadian Shield. The Limestone Plain is on the eastern side of the watershed and follows the southwest shore of Mississippi Lake (Carleton, 2008). The recession of the Champlain Sea about 10,000 years ago resulted in a level plain with mostly glacial sandy loam soils (Ontario Ministry of the Environment, June 1977).

Climate

The Mississippi River region experiences a temperate climate. Data collected at Drummond Centre between 1968 and 2006 show that average monthly temperatures have remained relatively constant. The winter season has a minimum average temperature of 15 degrees below zero Celsius and a maximum average summer temperature of 26.1 degrees Celsius. Average precipitation is 860 millimeters with 28% falling in the summer months. Yearly snowfall is approximately 180 centimeters (71 inches). The average frost-free period is 193 days. Ice out on Mississippi Lake usually occurs in April, and in 2013 the ice out date was recorded as April 19th (Carew).

Landscape and Land Cover

The Mississippi River watershed covers a diverse range of landscapes. The west end of the watershed features a more rugged landscape, covering a broad expanse of forested lands dotted by numerous lakes and rivers that make up the head waters of the Mississippi watershed and supports a thriving cottage country. Through the central and east part of the watershed the Mississippi River passes through a number of towns and small villages, crossing a mix of forested lands, farmland, woodlots, rural housing, some commercial development and a rapidly growing urban area in the City of Ottawa.

Land cover within the Mississippi River Watershed includes 83.6% forest, 10.4% agriculture, 5.3% wetlands, and 0.8% development. Table 1 shows the land cover breakdown for the watershed, subdivided into the areas upstream, immediately around, and downstream of Mississippi Lake. The upstream area, typical of a Canadian Shield landscape, is dominated by forest cover with only 3.8% agriculture lands. As it moves to the transition between Canadian Shield and limestone plain, the area around Mississippi Lake (identified as the Mississippi Lake Plan Drainage area), has more agricultural lands at 16%, and the highest concentration of wetlands at 11%. Not surprisingly, in the area downstream of the lake that is dominated by the limestone and sandstone plain, the agricultural lands cover increases to 25%, with higher development at 1.8%.

Table 1: Land Cover of Mississippi River Watershed

	Total Area (km2)	Forest (%)	Agriculture (%)	Wetland (%)	Built Up (%)
Upstream Drainage Area	2577	92	3.8	3.8	0.4
Mississippi Lake Plan Drainage Area	296	72	16	11	0.6
Downstream Drainage Area	875	67	25	6	1.8
Total Watershed	**3748**	(MVCA Geographic Information System, 2014)			

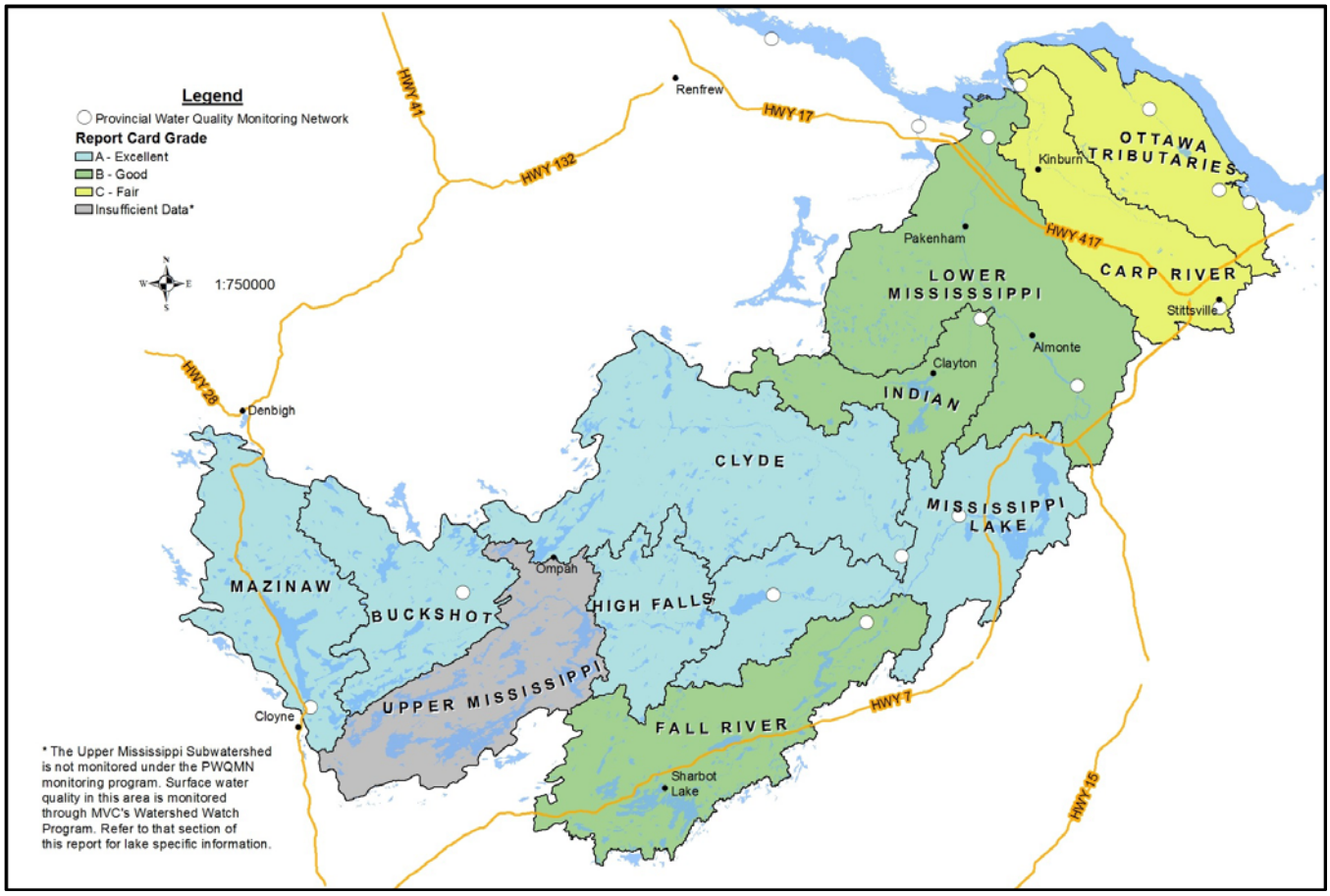
Reflecting trends seen elsewhere in Southern Ontario, the water and natural areas in the watershed face on-going pressure from urban and rural land uses. In the western “cottage country” part of the watershed, there is a growing shift from seasonal small scale use to year round residential use as more commuters and retirees are making the shift to live at the lake year round. The sustained demand for waterfront or near-water properties has caused an increase

in “back-lot” development on the lakes and rivers throughout the watershed. The natural rural areas are also a draw for residents seeking rural estate lot type development.

Watershed Conditions

In 2013, the Mississippi Valley Conservation Authority produced a Mississippi Valley Watershed Report Card for sub-watersheds of the Mississippi, Carp and Ottawa Rivers. The Report Card presents a snapshot of the health of the watersheds based on key environmental indicators including water quality, forest and riparian conditions. Using a provincial scoring system, it looks at water quality monitoring data, percentage forest cover and percent riparian area (the band of natural area along the shores and banks of lakes, rivers and stream) to assess and grade current watershed conditions.

Overall, the Mississippi River sub-watersheds scored high in all of the categories that were assessed. Surface water quality and forest conditions were given a grade of A (excellent) for the sub-watersheds (drainage areas) upstream of and around Mississippi Lake, and the subwatershed (drainage) areas downstream of the lake were given a grade of B (good). Riparian conditions received a grade of A for the subwatershed upstream of Mississippi Lake, and the subwatershed areas around and downstream of the lake received a grade of B. The report card noted that areas with higher populations tend to grade lower, likely because of increased paved urban areas and minimal riparian buffers filtering phosphorus and other nutrients from runoff (Mississippi Valley Conservation Authority, 2013).



Section B: Mississippi Lake Plan Subwatershed

1 Introduction

1.1 Location & Description

As shown on Map 1, Mississippi Lake is located on the eastern side of the Mississippi River Watershed at the southwest end of the Town of Carleton Place, 30 km west of the City of Ottawa. It is also 14 km south of Almonte, 15 km north of Perth and 28 km northwest of Smiths Falls.

Mississippi Lake is the last lake in a series of lakes along the Mississippi River. Shaped like a "J", Mississippi Lake has several basins separated by narrows. It is 14 kilometres in length, with widths of 3.6 kilometres at the big lake, 2.5 kilometres at the second lake, and 3.2 kilometres at the outlet. The lake has a total shoreline length of 64 kilometres and a surface area of 24.5 square kilometres. Characteristics of Mississippi Lake are summarized in Table 2.

Table 2: Characteristics of Mississippi Lake

Characteristic	Measurement
Total Length	14.19 km
Width at Big Lake	3.6 km
Width at Second Lake	2.53 km
Width at Inlet	200 m
Width at Outlet	270 m
Average Depth	2.7 m
Maximum Depth	9.2 m
Shoreline length (perimeter)	68 km
Creeks and Rivers	34
Volume	6.36×10^7 m^3
Flushing Rate	3.5-4 times/year
100 year Flood Plain Elevation	135.73 m.a.s.l.*
Summer Water Elevation	134.35 m.a.s.l.*
Surface Area	24.5 km^2
*Note: Meters Above Sea Level (m.a.s.l.)	

The subwatershed spans four political jurisdictions, including the Township of Drummond/North Elmsley, the Township of Beckwith, the Town of Mississippi Mills and the Town of Carleton Place. Map 2 shows the land included in the subwatershed divided into these political jurisdictions.

1.2 Bedrock & Surficial Geology

Mississippi Lake sits right on top of the boundary between the Canadian Shield of the Precambrian Era and the Limestone Plains of the Paleozoic Era. The Shield underlies the west side of the lake, between Innisville and Montgomery Park. Composed primarily of igneous and metamorphic rock, this area is marked by rock outcrops, steep slopes, hilly terrain, and thin soils. The Precambrian bedrock in this area includes Quartzite, Biotite Migmatite and coarse grained Monzonite, Syenite and Syenodiorite. Poor drainage in low relief areas creates small basins that collect water, forming marshes, bogs and several wetlands.

Underlying the east side of the lake is the Paleozoic Limestone Plain, a relatively flat bedrock area covered by thicker layers of soil. In this area the bedrock is composed of sedimentary rock of the Nepean Formation, described as a yellow and grey fine to course sandstone, and the March and Oxford Formations, described as a blue, very fine crystalline dolomite (Geological Survey of Canada, Surveys and Mapping Branch, 1973).

1.3 Soils

The soils of the Mississippi Lake subwatershed are mostly unsorted glacial till deposited during the recession of the inland glaciers and the Champlain Sea about 10,000 years ago. Over half of the soils (65%) are sandy loam soils and muck complexes, less than a foot deep, unsuitable for agricultural use. Most of the west side of Mississippi Lake, on the Canadian Shield, has sandy loam soils. While the drainage is good, the depth limits its agricultural capability. The remaining soil types within the subwatershed consist of various clay loam mixes, also with poor drainage (Ontario Ministry of the Environment, June 1977). Pockets of organic soils are found in the wetlands surrounding Mississippi Lake.

2 Surface Water Quality

The Mississippi Lake Planning Committee conducted a Community Survey asking respondents to rate a number of features or values that may contribute to their personal enjoyment of the lake. Clean Water received the highest rating, with 94% of respondents ranking it as 'Very Important'. Water quality has a great impact on the recreational and economic uses of the lake, as well as the overall health of the lake ecosystem.

Though natural processes can affect the quality of the lake water, human activities on and around the lake often result in the most significant impacts. Shoreline development, excessive recreational use, faulty septic systems and surface runoff carrying fertilizers or other chemicals can all cause direct impacts to lake water quality. They can also result in indirect impacts. Excess nutrients can cause excessive aquatic vegetation growth and large algae blooms. The replacement of natural vegetated buffers with manicured lawns or other hardened surfaces at the shoreline increases the amount of runoff reaching the lake, while reducing any natural filtration or absorption of the runoff water. It can also lead to soil erosion causing increased sedimentation in the lake.

Over the past 50 years the area around Mississippi Lake has been extensively developed as a popular area for cottagers, campers and others seeking a place to carry out water based recreational activities. More recently the lake has seen many seasonal dwellings being converted to year round homes. This increased development pressure around the lake leads to greater potential for degradation of the water quality.

2.1 How is the Lake Affected?

One way to measure the health of a lake is to assess its trophic status. Trophic status is a measure of the biological productivity of a lake, which represents the amount of living organisms supported by the lake. The trophic scale classifies lakes into three separate classes, Oligotrophic, Mesotrophic and Eutrophic. Oligotrophic represents low biological productivity, mesotrophic represents moderate biological productivity and eutrophic represents high biological productivity. These productivity levels can be estimated by determining the clarity of the water, nutrient availability and dissolved oxygen levels within the lake water. The combination of these parameters determines the amount of suitable habitat for the lake organisms.

Mississippi Lake has experienced changes in nutrient levels over the years, as the phosphorus levels have fluctuated from the mid to high range of the mesotrophic classification. The lake currently exhibits the water quality characteristics of a mesotrophic lake, capable of supporting a moderate to high population of aquatic organisms. Lakes will naturally progress from the Oligotrophic state to the Eutrophic state over a very long period of time. As nutrients build up in the lake water system, and sedimentation in the lakes decreases the depth, the lakes will increase in productivity. This is a natural progression, although human activities and development on and around lakes will accelerate the rate of lake succession. It is this acceleration of lake succession which causes issues within the lake environment, as it has not had time to adjust to the changes over a longer, and much slower natural succession period.

2.2 History

The water quality of Mississippi Lake has been monitored at various times over the years under different programs and projects. Water quality monitoring of the lake began in 1968 with the Ministry of the Environment Cottagers' Self Help Program, and then with the Lake Partner Program in 1996. The Mississippi Valley Conservation Authority then included Mississippi Lake in the Watershed Watch program in 2002. Between these programs there is water quality data for most years between 1968 and 2012.

Concern for the water quality of Mississippi Lake began in the late 1960's when it became apparent the water quality was declining. A report issued in 1979 by J.G Hamilton titled *Mississippi Lake Management Report* stated that, "Mississippi Lake with its large surface area and shallow basin has inherently been eutrophic in nature." (Hamilton, 1979). The report goes on to explain the lake was in a eutrophic state from the late 1960's to late 1970's due to the high Total Phosphorus levels in the water, and the amount of aquatic vegetation growth in the lake. The report states that many of the navigation channels had to be cleared of weeds, and a large amount of energy had been spent on eradicating weeds in the lake. The report also indicated that the increased levels of nutrients and vegetation growth was a result of artificial nutrient input, from shoreline development, seepage from cottage sewage systems, agricultural run-off, near shore road-side erosion, and flushing of other nutrient rich water from lakes in the higher reaches of the watershed. In the decades since that report was released, nutrient levels in the lake have dropped down to levels within the mesotrophic classification.

In 1977 another study was conducted to produce a lake study report. The *Mississippi Lake Study Report* was a collaborative initiative between the Ministry of the Environment, Ministry of Housing, Ministry of Industry and Tourism, Ministry of Natural Resources, Mississippi Valley Conservation Authority and the Leeds, Grenville and Lanark District Health Unit. The purpose of the report was to determine the development pressure around the lake, present the status of the water quality and wildlife populations, highlight concerns of lake users, and determine policies and recommendations regarding lake and land use as a basis for a lake plan.

2.3 Trends

While there is a relatively long and varied record of water quality data available for Mississippi Lake, the field collection methods and laboratory analysis methods have both changed over the years of record. The water quality parameters that were tested and the sampling frequency have also changed. These changes make it somewhat difficult to compare samples from older records to more recent records; however the data does provide a general indication of the lake conditions across the period of record.

The trophic status of a lake is determined based on three measurable water quality parameters: water clarity; Chlorophyll a and Total Phosphorous. Water clarity is measured as a depth expressed in metres (m), using a device called a Secchi disc. Changes in water clarity can be indicative of changes in nutrient levels and algae growth, or the impacts of other factors such as Zebra Mussels. Chlorophyll *a* is measured as a concentration in the water expressed in micro grams per litre (µg/L). Chlorophyll *a,* which is the pigment that is used for photosynthesis, is used to estimate the potential vegetation growth and abundance of algae in the lake water. Total Phosphorus, which is also measured

in micro grams per litre (µg/L), is the level of phosphorus found in the water column of the lake. Phosphorus is one of the most important nutrients for plant and algae growth in a lake.

Table 3 shows the trophic status ranges for each of the three measure parameters. If a lake had Total Phosphorus levels of 21 µg/L or more, Chlorophyll *a* levels greater than 4 µg/L, and Secchi Disc readings of less than 2.9 metres, it would be considered to fall within the eutrophic range. If a lake had Total Phosphorus readings of 18 µg/L, Chlorophyll *a* levels greater than 4 µg/L, and Secchi Disc readings of less than 3 metres, it would be considered to be at the high end mesotrophic and low end of eutrophic. It is normal for a lakes water quality to fluctuate somewhat within these ranges, but when we start to see a trend of increasing eutrophication, that can be indicate that there is a problem.

Table 3: Lake Trophic Status Classification Parameters

Lake Trophic Status	Description	Total Phosphorus (µg/L)	Chlorophyll *a* (µg/L)	Secchi Disc Depth (m)
Oligotrophic	Lakes with low nutrient levels, limiting biological productivity. Water is often clear and cold with sufficient oxygen levels in the entire water column throughout the year; often supporting cool to cold water fisheries.	< 10	< 2 low algal density	> 5
Mesotrophic	Lakes with moderate nutrient levels, resulting in greater biological productivity. Water is often less clear with greater probability of lower oxygen levels in the lower water columns; often supporting cold to warm water fisheries due to a variable range of nutrients.	11 to 20	2 to 4 moderate algal density	3.0 to 4.9
Eutrophic	Enriched lakes with nutrients in higher concentrations. Water has poor clarity, especially in summer months when algae blooms and plant growth peaks. Oxygen levels are greatly reduced in lower water columns throughout the year due to excessive decomposition of aquatic vegetation; often support warm water fisheries.	≥21	> 4 high algal density	< 2.9

The following water quality information has been compiled from data collected through the Ministry of the Environment's Self Help Program and Lake Partner Program, as well as Mississippi Valley Conservation Authority's Watershed Watch program. For the purposes of this report, data up to the year 2013 from the Lake Partner Program and 2014 from the Watershed Watch Program were analyzed, as it was the most recent data available at the time of writing this report.

2.3.1 Water Clarity

Water clarity is determined by measuring how far sunlight can penetrate down into the water (referred to as the *euphotic zone*). It is measured using a Secchi Disc; a black and white disc that is lowered into the water until it can no

longer be seen, at which point a measurement is taken. The Secchi Disc depth indirectly indicates the amount of algae/phytoplankton, suspended soil sediments, and other materials in the water column. The clearer the water is the deeper one can see the secchi disk as it is lowered into the water column. Algae and phytoplankton are important to the life of the lake, as they provide oxygen and food sources for other organisms. The presence of these organisms in the lake only becomes an issue when they become too abundant. If the nutrient inputs into the lake increase, the growth rates of the algae and phytoplankton will increase as well. The amount of light that penetrates to deeper levels of the water column will then be reduced, impacting the photosynthesis rates of aquatic vegetation and organisms living deeper in the water column. Lower photosynthesis rates result in lower oxygen levels in the deeper portions of the lake; coupled with the decomposition of organic matter, the available oxygen at the bottom of the lake can become depleted. For organisms that require oxygen for survival, this type of environment puts additional stress on their bodies, and can cause death if the oxygen depletion becomes severe.

Secchi Disc measurements have been collected at four sites on Mississippi Lake (Big Lake, Second Lake, Inlet and Outlet) for several decades now. The data for Second Lake goes back to 1968; the data for the Big Lake goes back to 1975, while the data for the Inlet and Outlet has only been collected since 2008. Figure 1 displays the average Secchi Disc measurements from 1968 to 2011 calculated as an average of the sites that were sampled in each given year (ex. 1968 represents Second Lake only, 1975 is the average of the Second Lake and Big Lake samples, and 2011 is the average for all four sites). The background colours in the graph represent the trophic status classifications with white indicating oligotrophic conditions, orange indicating mesotrophic, and grey section representing eutrophic conditions (see Table 3).

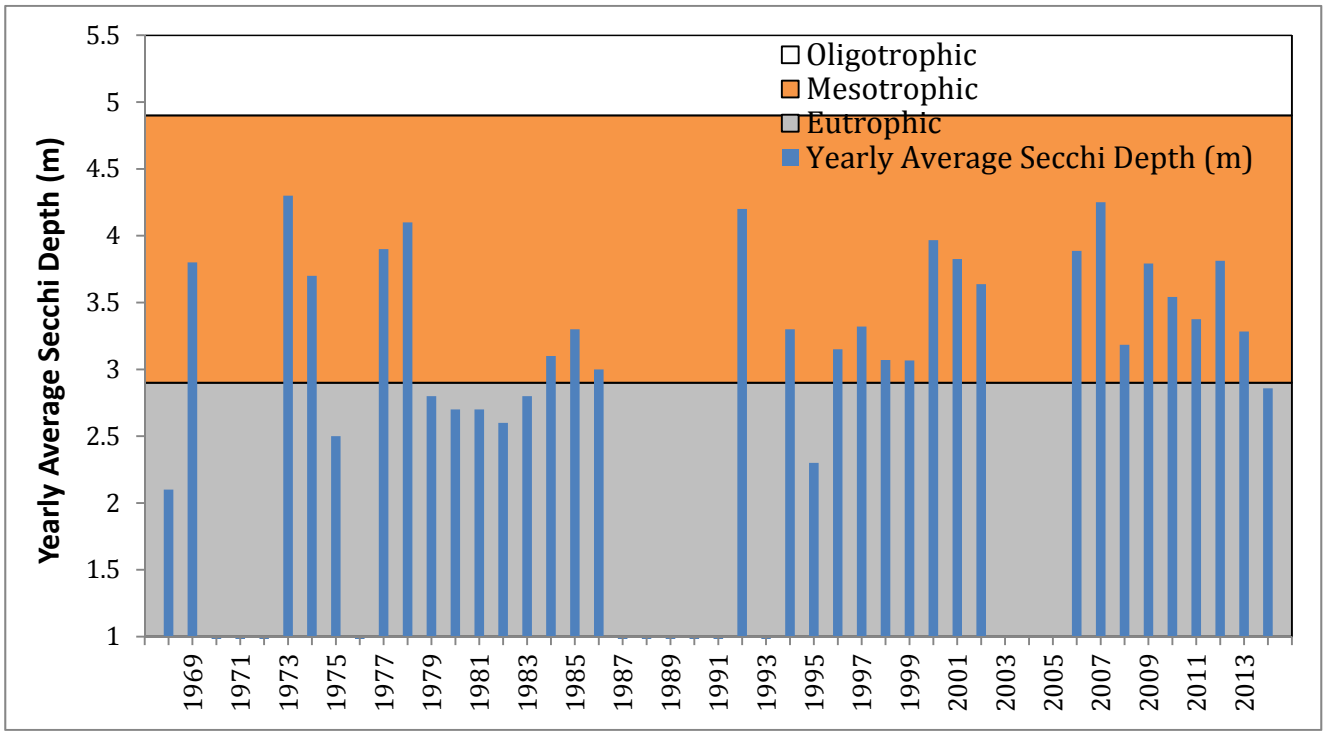


Figure 1: Average Secchi Disc Depths for All Sites Combined

The water clarity (secchi disc) values for the entire range of data vary from 2.1 m in 1968 to 4.3 m in 2007, with the average depth being 3.4 m for all samples. However, when looking at the sample years prior to 1990, 7 of the 15 years have Secchi Disc readings lower than 3 m. This is indicative of the reported eutrophic conditions the lake was experiencing at that time. Since 1995 the water clarity measurements have mostly fallen within the mesotrophic classification, ranging from 3.15 m to 4.3, and dipping below 3 metres only once in 2014.

Water clarity can be affected by a number of variables such as climate conditions or available nutrients. Table 4 compares the sechhi disc measurements to phosphorous levels and chlorophyll *a* concentrations measured in 1975 and 2002, the only two years where secchi disc depths were less than 3 metres and where data was collected at the same time for all three parameters Unfortunately there is not phosphorous or chlorophyll *a* data for the other years the secchi depth was less than 3 m to expand the comparison as it was not until 2002 that all three variables were monitored in unison.

Table 4: Comparison Between Spring Surface Phosphorous Concentration, Chlorophyll *a* Concentration and Secchi Depth at Pretties Island/Second Lake Site, 1975 and 2002

Year	Phosphorous (µg/L)	Chlorophyll *a* (µg/L)	Secchi Depth (m)
1975	26.4	13.7	2.5
2002	14.0	2.1	2.8

Although the data is limited to one sample per year, and the records of phosphorous data and chlorophyll *a* data are not as extensive as the records of secchi depth a basic comparison can be made. First in 1975 when the phosphorous exceeded 20 µg/L, the chlorophyll *a* levels had their highest recorded value of 13.7 µg/L, and the secchi depth was less than 2.9 m, all indicating eutrophic conditions. In 2002 MVCA's Watershed Watch program visited the lake and the spring sample showed that both the chlorophyll *a* and the phosphorous concentrations fall in the range for mesotrophic conditions, however the secchi depth is just less than 3 m indicating eutrophic conditions, suggesting some other cause of the low clarity reading on the sampling date.

2.3.2 Chlorophyll *a*

Chlorophyll *a* is the green pigment contained in algae and aquatic plants that is used for photosynthesis. The chlorophyll *a* concentration is used to measure the abundance of algae and potential plant growth in the water, and is directly related to the amount of nutrients available. If the concentration of chlorophyll *a* is high, then it can be assumed that the nutrient levels in the water are high as well, promoting the abundant growth of the algae. High concentrations of algae and vegetation can cause oxygen depletion in the lake. As the algae and vegetation die off, the decomposition uses up available oxygen; if there are more organisms the amount of oxygen needed for decomposition increases.

Chlorophyll *a* samples have been collected at four different sites on Mississippi Lake (Big Lake, Second Lake, Inlet and Outlet), with each site having been sampled over different time frames. For the Second Lake site, sample data is available from 1973; for the Big Lake site data is available starting in 1975; and for the Inlet and Outlet data started being collected in 2008. Figure 2 displays the chlorophyll *a* concentration from 1973 to 2014 calculated as an average of the sites that were sampled in each given year (ex. 1973 represents Second Lake only, 1975 is the average of the Second Lake and Big Lake samples, and 2011 is the average for all four sites). The orange section of the graph shows the mesotrophic range for chlorophyll *a*; the white depicts the oligotrophic range and the grey depicts the eutrophic range (see Table 3).

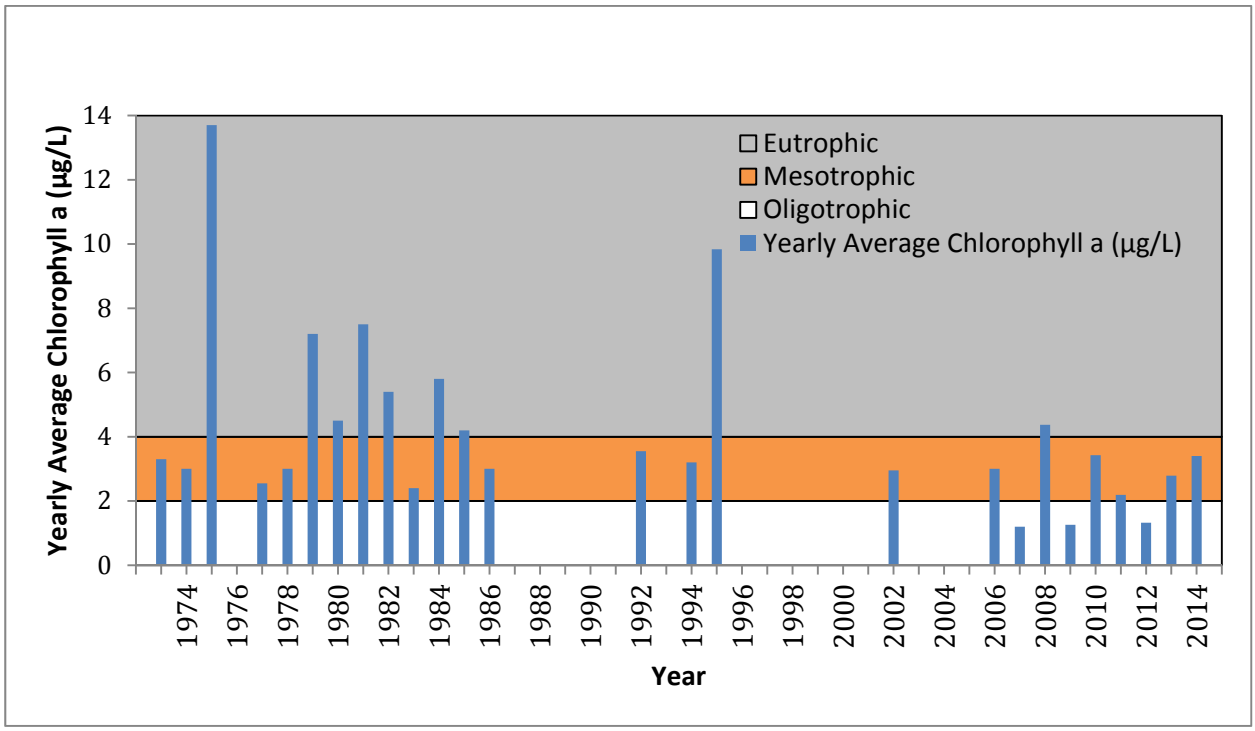


Figure 2: Yearly Average Chlorophyll a Concentration for All Sites Combined

There is variability within the data, with 9 sample years prior to 2008 having values above the mesotrophic average. The samples prior to 1985 have been adjusted to reflect updated lab procedures in sample filtering, resulting in a 35% increase in concentration.

The 1975 chlorophyll *a* result of 13.7 µg/L is noticeably inconsistent with the other data and is likely an outlier which will be excluded in further calculations. The average chlorophyll *a* concentration for the remaining samples from 1973 to 2014 is 3.9 µg/L, which is in the high end of the mesotrophic range. Most samples since 2002 are either within the mesotrophic range or below, consistent with the lake conditions found in other tests. Overall there appears to be a decreasing trend in chlorophyll *a* concentrations in the lake. There are also seasonal fluctuations in the chlorophyll *a* concentration, with higher concentrations in the summer samples than in the early spring or late fall samples; depending on the growing conditions just prior to samples being collected, this may influence the results.

A relationship also exists between water clarity and chlorophyll *a* concentration where higher concentrations of chlorophyll *a* can result in lower water clarity. The higher the concentration of chlorophyll *a*, the more algae are present in the water. If there is an increase in particles in the water there are more opportunities for light rays to be scattered when they penetrate the water surface, which decreases the overall clarity. Figure 3 depicts the average secchi disc depth and average chlorophyll *a* concentrations for the years with available data (the gaps indicate years that data was not available).

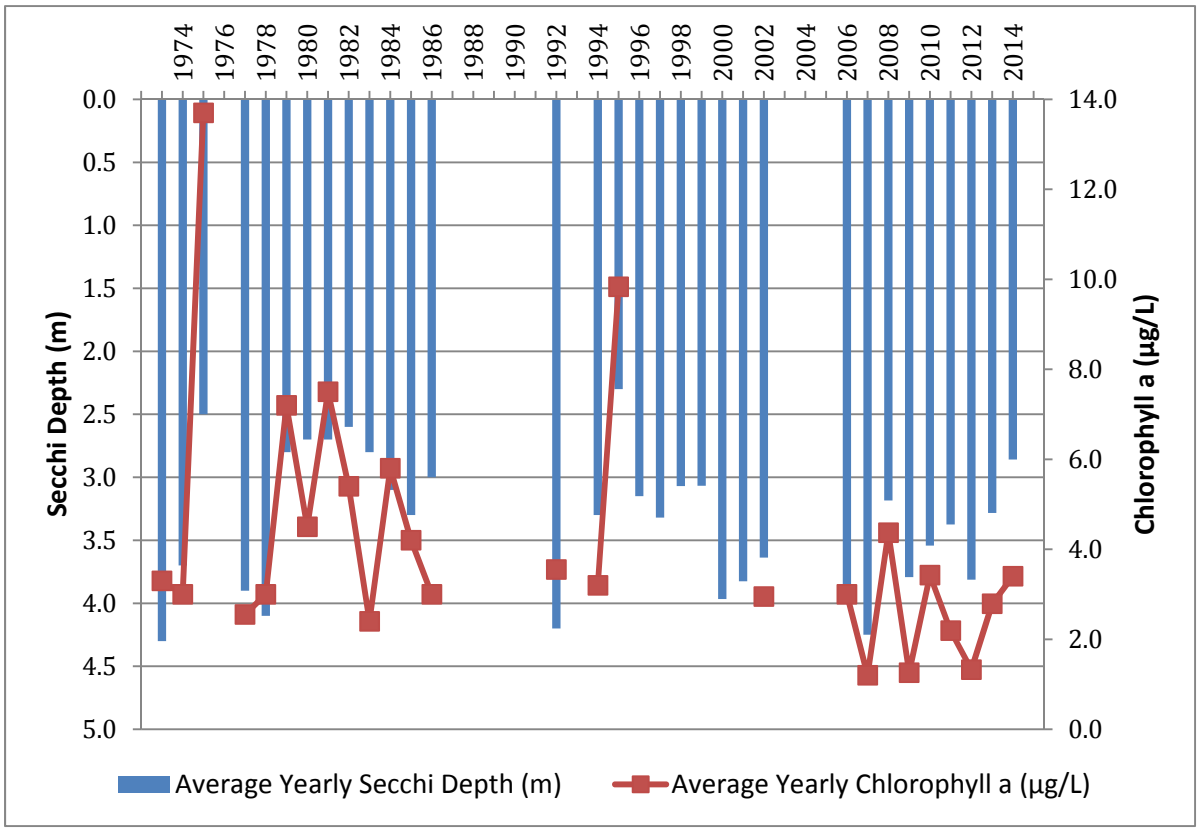


Figure 3: Yearly Average Secchi Disc Depth v. Chlorophyll a Concentration, 1968 to 2014

The trends in the data suggest that the concentration of chlorophyll *a* is strongly related to the water clarity readings, but it is likely not the only variable influencing the clarity. For example, in the years 1975 and 1995 when the chlorophyll *a* peaked we would have expected to a more significant reduction in water clarity. Conversely, in 1983 and 1986, the lower chlorophyll *a* levels are not accompanied by notable improvements in water clarity. For the years following 2002 when monitoring frequency increased there is a stronger correlation between the data patterns. The secchi depths follow the peaks and valleys of the chlorophyll *a* concentration fluctuations more closely than previous years. This trend suggests that the concentration of chlorophyll *a* does have an effect on the clarity of the water, but is not the only influencing factor.

It should also be noted that the presence of Zebra Mussels can affect the concentration of chlorophyll *a* as well as secchi depth. Zebra Mussels are filter feeders, effectively removing phytoplankton and other suspended sediments

from the water column. This removal of phytoplankton from the water column can result in decreased chlorophyll *a* concentrations and also increase the depth of water clarity.

2.3.3 Phosphorus

Phosphorous is a natural part of our environment and is considered to be the limiting nutrient in regard to plant and algal growth. This makes it a very important component in tracking water quality and assessing the condition of the lake to determine the type of habitat it supports.

The Ontario Ministry of the Environment and Climate Change (MOECC) sets Provincial Water Quality Objectives (PWQO) for a number of water quality variables with the goal to ensure that the surface water quality is satisfactory for aquatic life and recreation. TP concentrations are ideally used to interpret lake nutrient status since phosphorus is the element that controls the growth of algae in most Ontario lakes. Increases in phosphorus may decrease water clarity by stimulating algal growth. In extreme cases, algal blooms will affect the aesthetics of the lake and/or cause taste and odour problems in the water.

In terms of nutrient status (Table 3), lakes with TP levels of less than 10 µg/L are considered oligotrophic, described as dilute, unproductive lakes that rarely experience nuisance algal blooms. Lakes with TP between 10 and 20 µg/L are classified as mesotrophic and are in the middle with respect to trophic status. These lakes show a broad range of characteristics and can be clear and unproductive at the bottom end of the scale or susceptible to moderate algal blooms at concentrations near 20 µg/L. Lakes with TP levels that are greater than 20 µg/L are classified as eutrophic and may exhibit persistent, nuisance algal blooms. Based on this, the interim PWQO for the average phosphorous concentration during the ice free season of a lake has been set at 20 µg/L. This level was chosen to avoid nuisance concentrations of algae. Phosphorous levels exceeding 20 µg/L may increase the growth of aquatic vegetation and algae to levels that could result in oxygen depletion and accelerated eutrophication (Source: MOE, December 2013)

In 1975 the MOECC undertook a comprehensive survey of Mississippi Lake where they sampled for a number of parameters including total phosphorous (TP). Based on 8 samples taken from late June through to mid- September, the average TP in 1975 was 26µg/L, placing it above the PWQO of 20 µg/L and within the eutrophic range. Sampling for total phosphorus in Mississippi Lake didn't take place again until 1992 when, under their "Self Help Program" MOECC sampled for total phosphorus at the outlet of the lake for three consecutive years from 1992 to 1995. In those years the average TP concentration ranged from 13 to 18 µg/L, falling within the mesotrophic range.

In 1996 the MOECC Self Help Program was reformatted to the Lake Partners Program and from that time on the lake has been sampled annually, with the exception of a five year period between 2001 and 2005 when Mississippi Lake didn't participate in the program. In 1996 and 1997 the sampling was done only at one site located in Big Lake, and in all other sample years (except 2000) the Lake Partner Program has sampled three sites located in Big Lake; Second Lake; and at the outlet.

The Lake Partner Program sampling is done once a year in May in order to determine the internal load of total phosphorous concentrations before the spring turnover. Lake turnover usually occurs in both the spring and the fall

as the temperature of the water changes. This causes phosphorus held in the bottom zone to be mixed into the water of the euphotic zone. The intent of sampling in May is to obtain a sample that represents the lake after winter's conditions for minimal growth and nutrient uptake by plants, providing a value for the background phosphorous concentration prior to the spring turnover and start of the growing season.

Figure 4 shows the results of the spring sampling of the euphotic zone, from the Lake Partner Program data for 1996 to 2013. The orange highlighted area represents the range of total phosphorus concentrations for mesotrophic lakes; the grey area represents the eutrophic range and the white area the oligotrophic range.

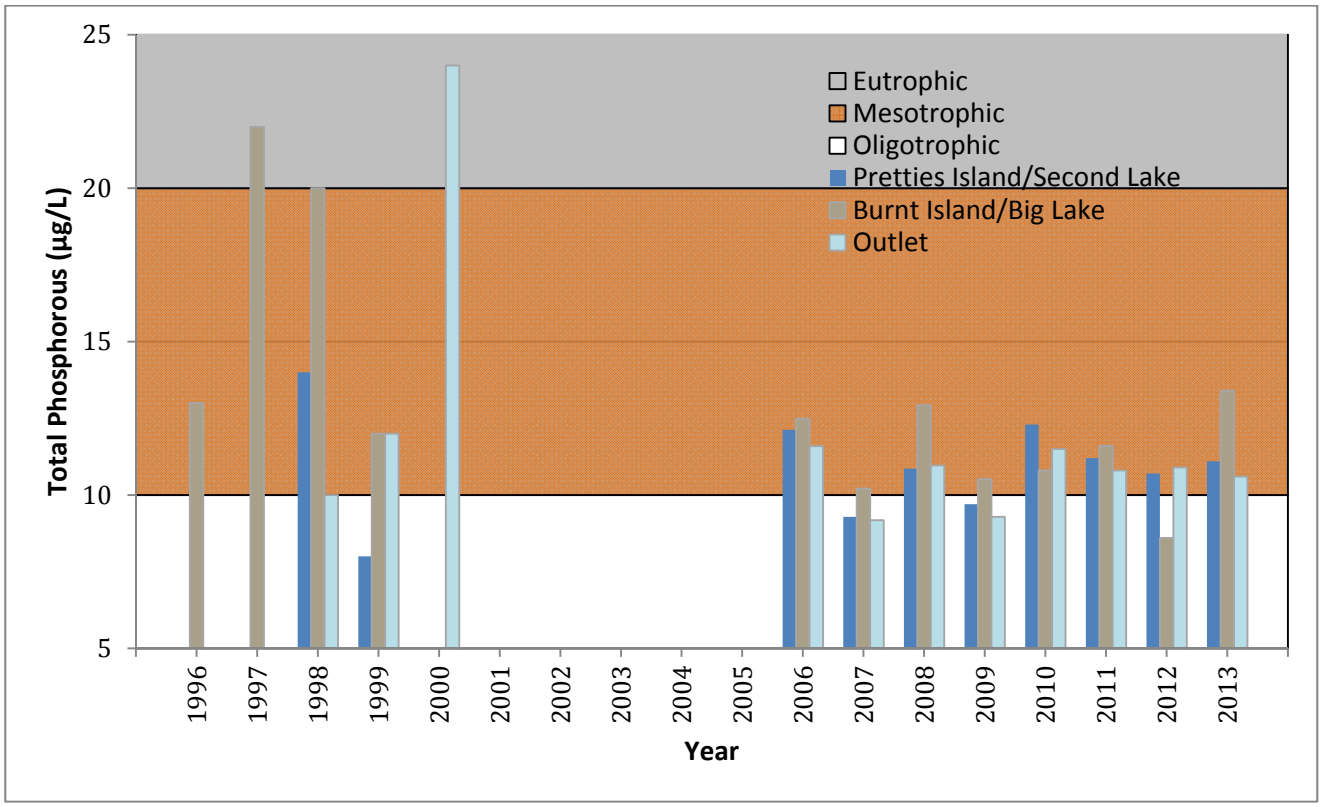


Figure 4: Spring Total Phosphorous Results for Mississippi Lake Euphotic Zone up to 2013 (Lake Partner Data)

While the lake was reported to be in a eutrophic state prior to 1985, there is very limited data for that time period to confirm those reports. Before regular sampling for TP began in 1996, there is just one record taken in 1975, that measured a TP value of 26.2 µg/L. When this is combined with the secchi disk reading (2.5m) and chlorophyll *a* (13.7 µg/L) for that same year, the results point to eutrophic conditions. The more recent data for the spring background TP concentrations show that between 1996 and 2000, a number of the TP readings were somewhat high. When sampling was resumed in 2006 the majority of the samples fall into the range for mesotrophic lakes. It should be noted that in 2002 the Lake Partner Program changed the laboratory methodology they used for analyzing the water samples. In 2003 they also started filtering the samples to remove large zooplankton which can add disproportionate amounts of TP to the sample. Some of the broad variability in TP levels prior to 2003 may be attributed to these differences in sampling and analysis methodologies. For the Lake Partner Program MOE suggests that data collected

prior to 2002 should not be used to examine trends through time but rather could be averaged over several years to describe average concentration of TP prior to 2002.

In 2002, the Mississippi Valley Conservation Authority (MVCA) Watershed Watch Program also started sampling on Mississippi Lake. This provided for increased sampling to a minimum of three times per year at the Burnt Island/Big Lake and Pretties Island/Second Lake sites to represent the lake conditions prior to spring turnover (May), summer (July or August) and lastly before fall turn over (end of August or early September) when the lake would be at its most productive, as well it began sampling the waters 1m above the lake bed at each of these visits. In 2002 seven total phosphorus samples were taken throughout the year, and in 2007 four samples were taken. Starting in 2008 the inlet and outlet sites were added to the Watershed Watch Program.

Water samples are collected at each site in both the euphotic zone and 1 m off the lake bed. The euphotic zone is measured as twice the secchi depth and represents the surface waters of the lake where sunlight can penetrate. As the ice free season progresses into summer this zone becomes affected by temperature stratification making it a sunny, warm and highly productive environment for aquatic plants and algae to grow and use nutrients such as phosphorous. The samples taken from near the bottom of the lake are intended to show what the internal nutrient enrichment is for the lake. Bottom phosphorous concentrations can be significantly higher than surface water concentrations particularly later in the year as organic matter settles to the bottom, is decomposed, and the nutrients are released. This load provides a continuous supply of phosphorous during the peak growing season when flows into the lake are usually at their lowest and the amount of sunshine is at its highest.

Figures 5 and 6 show the average yearly phosphorus concentrations, in the euphotic zone (Figure 5a) and from 1m above the lake bed (Figure 5b), for all of the Watershed Watch sample sites on Mississippi Lake. The number of sampling years and the number of samples per year varies between the sites. Error bars are used to provide an indication of one standard deviation away from the average value within each year's data.

Due to the extreme nature of some of the concentration results they were considered outliers and removed from the calculation of the yearly average. With the records we have it is very hard to tell why the extreme values occurred. It could be due to an actual extreme event occurring upstream or on the lake, or it could be due to a sampling or processing error. We have looked at rainfall data for the days leading up to the date these extreme samples were taken to determine if that could be a cause. In only one case was there a large rainfall event that occurred 6 days prior to the sample being taken, however this is only a possible explanation and not a concrete cause and effect linkage. The results for both the surface and 1m off bottom samples taken by MVCA in May 2010 gave unusually low numbers whereas the spring surface sample that was sent to the Lake Partner Program show more expected numbers for Mississippi Lake. This difference was found to be due to a processing error at the lab the samples to and not reflective of actual lake conditions so they were not included in the calculation of the yearly average value.

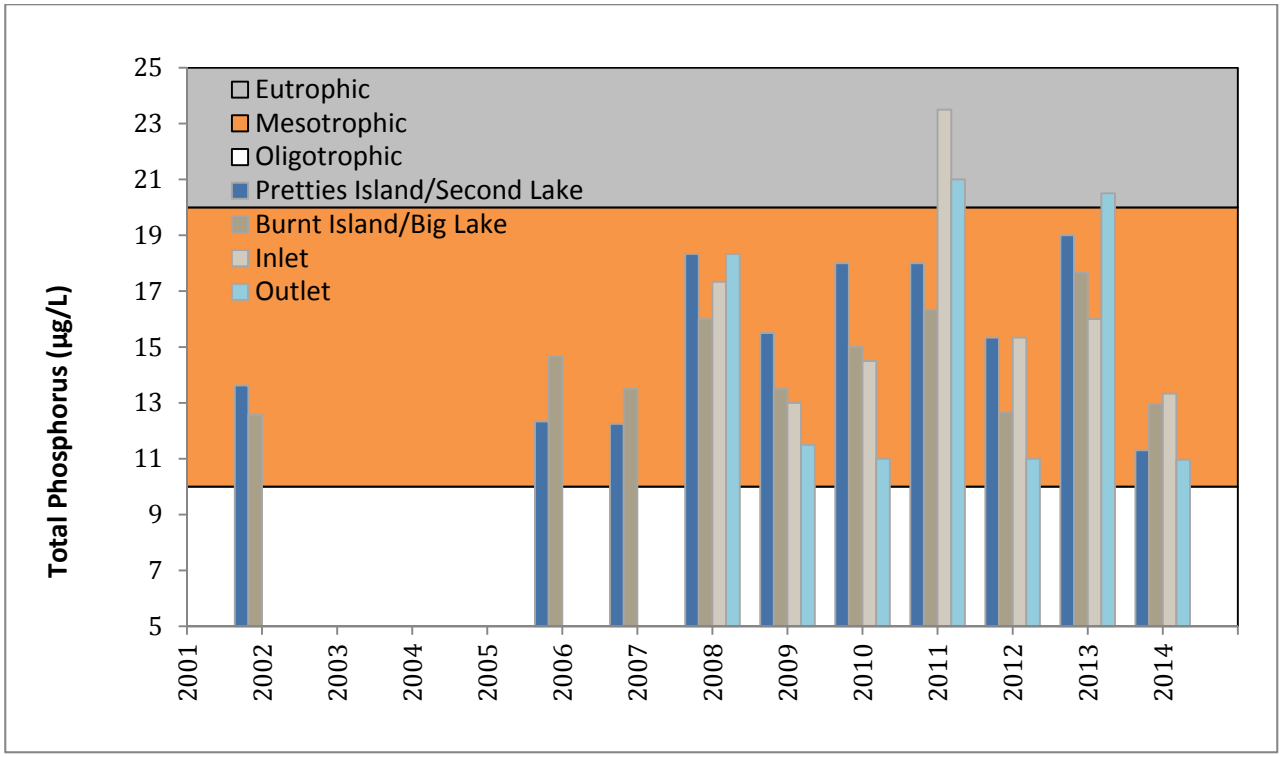


Figure 5: Average Yearly Total Phosphorous Concentration in Euphotic Zone for Mississippi Lake (Watershed Watch data)

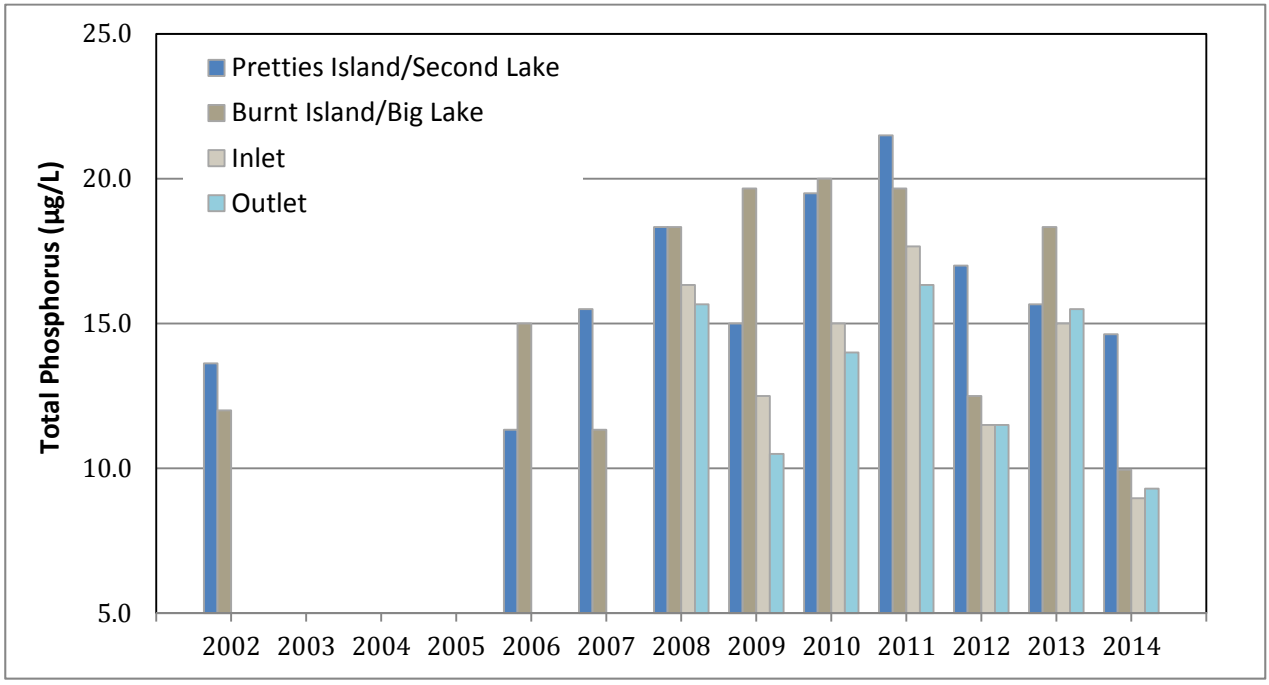


Figure 6: Average Annual Total Phosphorous One Metre off the Bed of Mississippi Lake

(Watershed Watch data)

Figure 5 shows that while there is some variability over the sample years, the average euphotic zone TP concentrations fall mostly within the mesotrophic range of 10 to 20 µg/L. Overall, since 2002 the euphotic zone TP levels were at their highest in 2011 and 2013. In 2011 the yearly average exceeded the 20 µg/L top of the mesotrophic range for the Outlet and Inlet sampling locations and again in 2013 for the outlet site. In 2014 the euphotic zone TP levels were the lowest recorded through the Watershed Watch Program at all sites except for the Inlet which showed a slightly lower level in 2009.

As shown in Figure 6, the available data from 2002 to 2014 shows that the average lake bed phosphorus concentrations follow fluctuations similar to the euphotic zone concentrations. The lake bed phosphorous levels at the Inlet site and Outlet are somewhat more consistent from year to year than the levels at the deeper basin sites.

Mississippi Lake's phosphorous concentrations can be influenced by a number of variables including weather related factors such as the rate of snow melt, the frequency of rainfall events in its large upstream catchment area, or a flood event which could each contribute nutrients and sediments from the terrestrial environment to the lake. Other influencing factors include land use, the implementation of stewardship activities, or septic improvements.

2.3.4 pH and Alkalinity

The pH of water is an important indicator of the suitability of the lake environment to support aquatic flora and fauna; since every plant and animal has a pH range they are adapted to living within. Most organisms are adapted to a pH range of 6.5 to 8.0, if the pH of the lake goes outside of that range, either too acidic or too alkaline, the result is loss of species. The pH of the lake is affected by the amount of carbon dioxide (CO_2) that is in the water. If the concentration of CO_2 is high the pH will be lower, as CO_2 binds with water molecules to form carbonic acid. The process of photosynthesis fixes (or removes) CO_2 from the water; so the more productive the lake environment (i.e. the more photosynthetic organisms present) the higher the pH should be. The underlying geology of the catchment basin of the lake can also affect its pH. For lakes that are situated on the Canadian Shield pH tends to be low, because igneous rock is resistant to weathering processes, and the soil that forms is shallow and mainly composed of organic matter. Lanark County, however, is not entirely underlain by the shield; in the eastern and southern parts of the county the underlying bedrock is sedimentary rock, mainly limestone. The soils that form on these types of bedrock are less acidic than the soils found on the shield.

Mississippi Lake is traditionally a more alkaline lake, having a pH above 7. Figure 7 displays the average pH of Mississippi Lake for the years that data was collected. Prior to 2002 the data available is intermittent and collected at different areas of the lake; some of the averages are based on data only from the inlet or outlet, or from the body of the lake. The averages for years 2002 to 2014 are based on the Watershed Watch data; years 2002 to 2007 averages are from Second Lake and Big Lake data, 2008 to 2014 averages include the inlet and outlet. The orange section of the chart outlines the Provincial Water Quality Objective (PWQO) for pH.

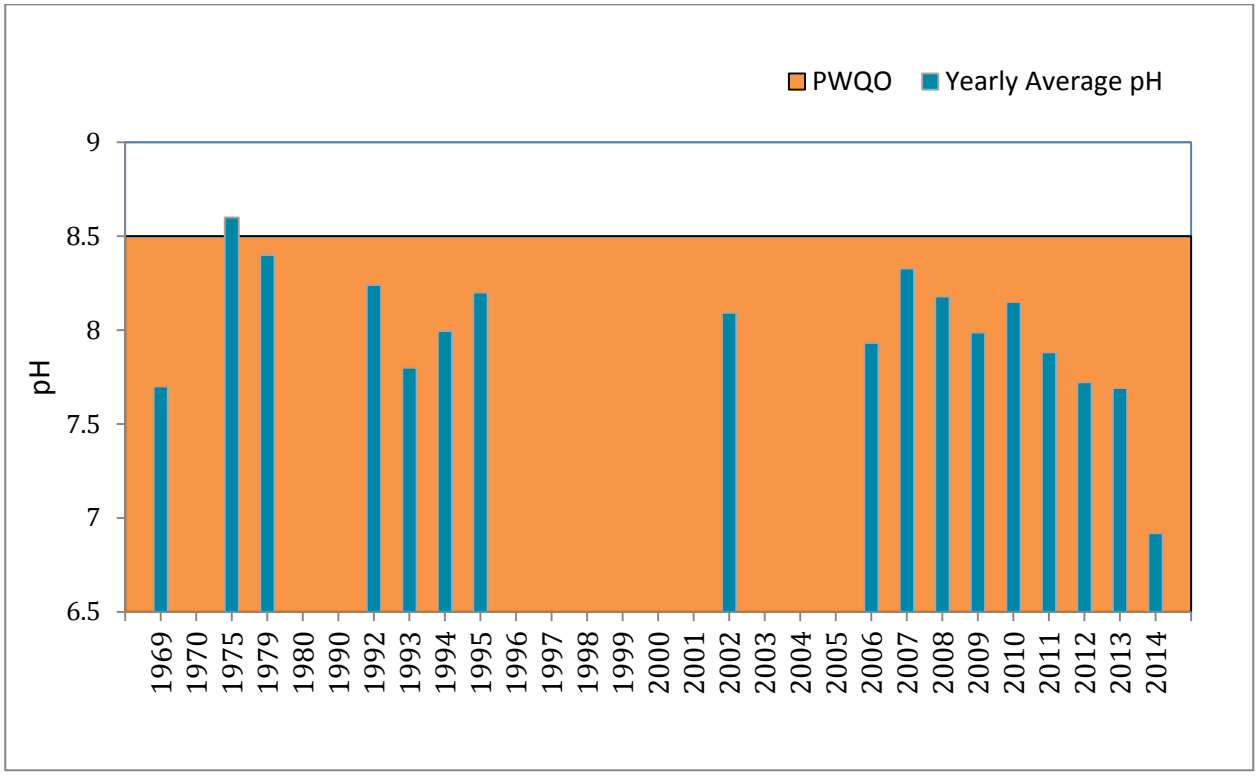


Figure 7: Annual Average pH for All Sample Sites

The average pH for every year of sampling on the lake is above 7.5, with the exception of 2014 which had an average reading of 6.9 this confirming that Mississippi is an alkaline lake. The PWQO for pH, as set out by the MOECC, is in the range of 6.5-8.5. This is considered the ideal range to protect aquatic life, and for recreational activities. Though there is one outlier year, 1975 had an average pH of 8.6, the yearly averages fall into the PWQO range.

The alkalinity of a lake is related to the pH, in that it is a measure of the capacity of the lake to buffer the water against changes in the pH (either from becoming too acidic or too basic). Lakes that have high alkalinity are better able to neutralize acids in precipitation and runoff, protecting organisms that are sensitive to acidic environments.

Lakes mainly obtain their alkalinity from the bedrock geology of the catchment basin, much the same way it affects the pH of the water. Lakes that are located on the Canadian Shield are low alkalinity lakes because the rock does not weather easily, and the soils are acidic. Lakes that are located south or east of the Canadian Shield are situated on sedimentary basins, which contain limestone. Limestone is comprised of calcium carbonate ($CaCO_3$), which is easily weathered and eroded by water, making it readily available in the lake environment. Calcium is the major contributing mineral in water alkalinity, the more calcium that is in the water the more alkaline the water becomes. The MOECC has indicated in the PWQO that the natural alkalinity of a lake should not be reduced by more than 25% of the natural concentration. Lakes with natural high alkalinity are better able to buffer acidification without lasting effects on the lake environment. The *Acid Rain Monitoring Project* conducted by Godfrey et.al. (1996) determined through surveying 4374 water bodies, that lakes with alkalinity greater than 20 mg/L were not sensitive to acidification.

There is limited alkalinity data available for Mississippi Lake; the data that is available was collected through the Lake Partner Program in 2008 and 2010. The 2008 average Calcium concentration for the lake was 25.4 mg/L, and the 2010 average was 29.2 mg/L. Both of these averages are above the 20 mg/L threshold outlined by Godfrey et al. (1996), indicating that Mississippi Lake is currently a non-sensitive lake to acidification from runoff and precipitation.

A high pH and a high calcium concentration can subject lakes to other stresses. Lakes with pH above 7.3 are more sensitive to zebra mussel colonization with optimal growth and reproduction occurring at pH levels greater than 8. A higher pH means there is more calcium available in the water for the mussels to use in forming their shells. Studies have shown that a minimum of 7mg/L of calcium is required for growth of zebra mussels, with infestation intensity increasing when levels are between 10 and 25 mg/L. The calcium data we have for Mississippi Lake shows concentrations well above these required calcium concentration and pH thresholds for optimal growth and reproduction. Mississippi Lake has unfortunately already been invaded by zebra mussels which are now well established in the lake.

2.3.5 Temperature and Dissolved Oxygen

The concentration of dissolved oxygen in the water column is an important indicator for determining the fish species that can be supported in the lake environment. As the temperature of the water rises, the amount of dissolved oxygen in the water decreases, which affects the survivability of fish deeper in the lake. This is particularly important for cold water fish species such as Lake Trout, which spend summer months in the depths of the lakes; Mississippi Lake, however, supports a warm water fishery. Warm water fish species are more tolerant of low oxygen levels than Coldwater fish species. Table 5 outlines the PWQO for dissolved oxygen as set by the MOECC.

Table 5: MOECC Dissolved Oxygen Objective for Warm Water Fish

PWQO Dissolved Oxygen Concentration – Warm Water Biota		
Temperature °C	DO mg/L	% Saturation
0	7	47
5	6	47
10	5	47
15	5	47
20	4	47
25	4	48

Dissolved oxygen concentrations are affected by the temperature of the water, as well as vegetation growth and mixing of the lake water. Decomposing aquatic vegetation at the bottom of the lake will consume available oxygen in the decomposition process. Excess vegetation growth, such as in eutrophic lake conditions, can result in excessive amounts of organic matter sinking to the bottom of the lake and decomposing, consuming oxygen in the process, resulting in depleted oxygen levels in the deeper areas. Lake turnover is a contributing factor to dissolved oxygen, as the process mixes the oxygen depleted bottom lake water with the oxygenated surface lake water in the spring and fall. This process replenishes the oxygen levels in the deep waters, but if the lake does not mix completely or experience full lake turnover, the oxygen levels in the bottom waters will remain low or depleted.

The dissolved oxygen and temperature profiles shown in Figure 8 outline the conditions for two sites, in the spring and mid-summer. The grey shading indicates that for these two periods the entire water column contained dissolved oxygen concentrations suitable for warm water fish habitat. The July 31 profile for Pretties Island shows that at a depth of 4 m the dissolved oxygen content drops to 4.7 mg/L, however, this concentration is still within the PWQO. Typically in the late summer months (August to September) the oxygen concentration will be lowest in the bottom waters, as decaying vegetation increases at the lake bottom. This is when fish usually experience the most stress regarding the amount of suitable habitat available. Unfortunately there are no late summer profiles available for 2011, so a profile from 2012 was used to demonstrate this.

The September profile shown in Figure 9 indicates that below 10 m depth, there is not sufficient oxygen concentration for fish to survive, with limited concentrations in the one metre above the lake bed. Due to the shallowness of the lake, a true stratification of the lake water does not take place in the summer months, so most of the time there is sufficient oxygen in the majority of the water column to provide suitable warm water fish habitat.

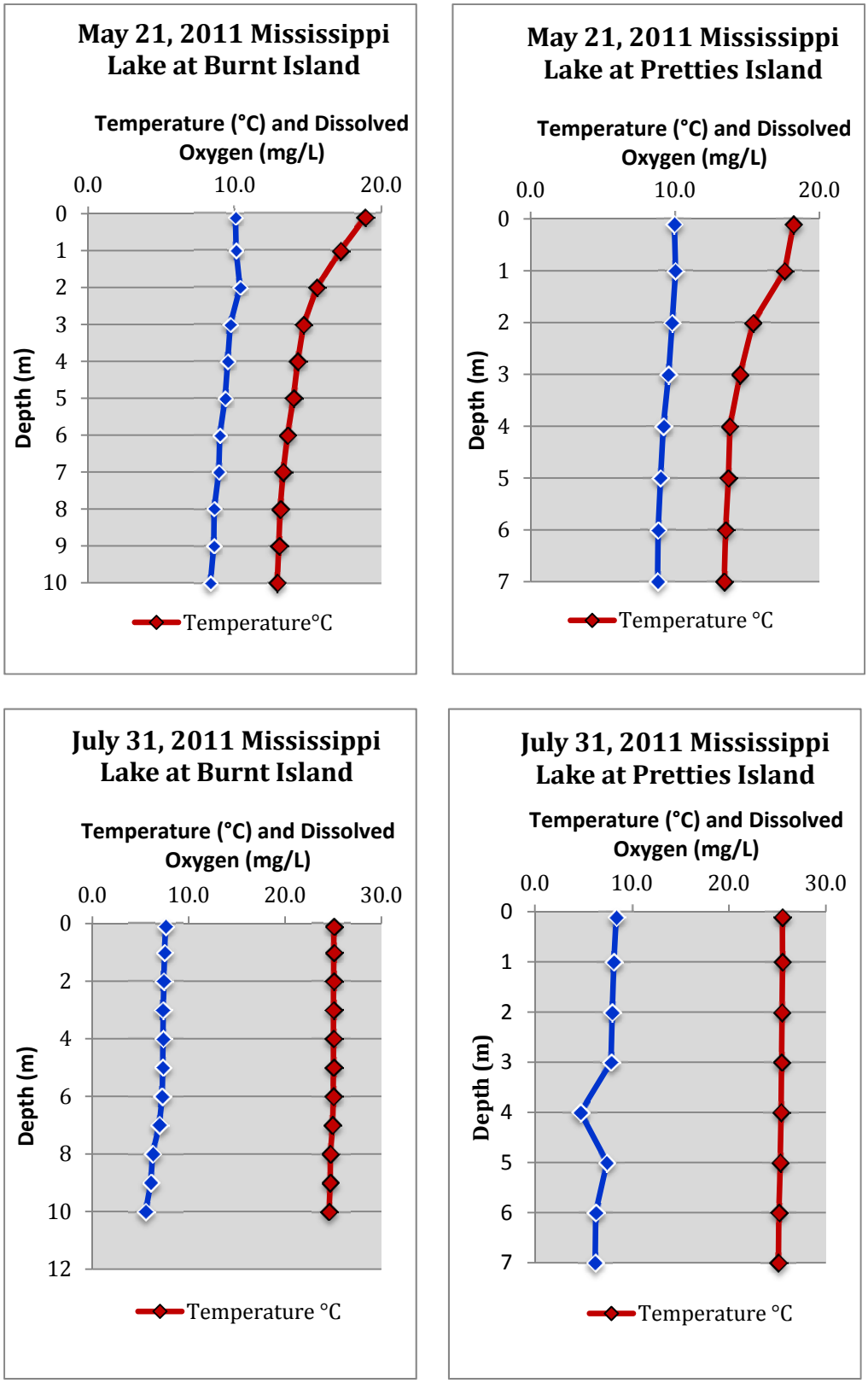


Figure 8: Dissolved Oxygen and Temperature Profiles for Mississippi Lake, May 21 and July 21, 2011

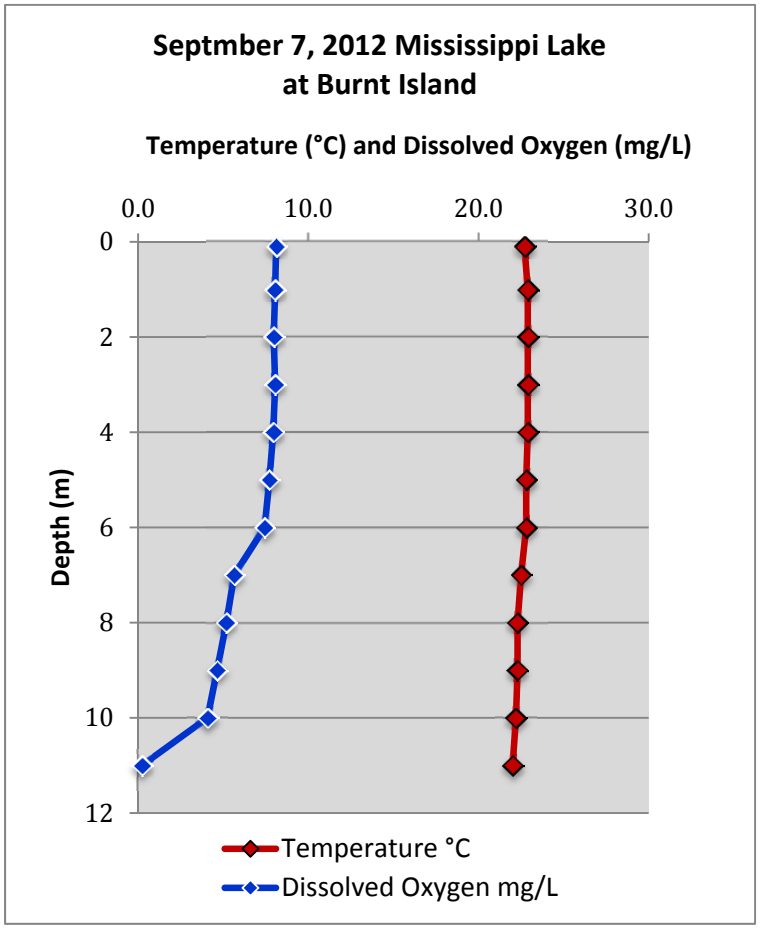


Figure 9: Dissolved Oxygen and Temperature Profile, Mississippi Lake, September 2012

3 Aquatic Vegetation

Aquatic vegetation plays an important role within the ecology of the lake environment, by providing vital food sources and habitat for the lake wildlife. Conversely, aquatic vegetation can also become detrimental to the environment in excessive amounts, and a nuisance to recreational activities. The Mississippi Lake Community Survey identified weeds and algae in the water as having the most significant negative impact on people's enjoyment of the lake.

3.1 Types of Aquatic Vegetation

Aquatic vegetation will grow where there is adequate sunlight, nutrients and water quality. There are several different types of aquatic vegetation, which can be broken down into two categories, algae and vascular plants. Algae can be either single celled or multi-celled species, while vascular plants are those with a true plant structure, having a stem, leaves and roots. Vascular plants can be divided into further subsections; emergent vegetation, submergent vegetation and floating vegetation. Emergent vegetation is rooted in the lake bottom, but has stems and leaves that can rise above the water surface. Submergent vegetation will live entirely under the water surface, although they may have some floating leaves, or flower stems that rise above the surface. Floating vegetation is rooted in the lake bottom, but has leaves and flowers that float on the water surface, and typically grow in areas protected from wave action. Table 6 lists some of the types of aquatic vegetation found in Mississippi Lake.

Table 6: Types of Aquatic Vegetation and Species Found in Mississippi Lake

Vegetation Type	Species Present
Algae	Filamentous Algae
Emergent	Pickerel Weed, Wild Rice, Common Cattail
Submergent	Common Bladderwort, Whorled Water-milfoil, Coontail, Water Celery, Pondweed
Floating	Bullhead Lily, Duckweed, Fragrant Water Lily, Yellow Pond Lily

Aquatic vegetation provides many important services to the lake environment, including; oxygenating the lake water, taking up available nutrients in the water, filtering sun radiation through photosynthesis, and providing food sources. All types of aquatic vegetation provides habitat to fish, amphibians, waterfowl, reptiles and invertebrates, which is critical for the early life stages of many organisms. The presence of aquatic plants also aids in shoreline and lake bottom stabilization by buffering the effects of wave action in the near shore area, and from the network of roots provided by the plants which hold and stabilize the lake's sediment and shoreline soils.

Excessive vegetation growth and algal blooms can be detrimental to the lake ecosystem. As vegetation decays in the water, it uses available oxygen in the decomposition process, which can result in dissolved oxygen concentrations below the required threshold for many organisms to survive. Some algal blooms can also have aesthetic impacts, such as unpleasant odours and altering the taste of the water. Recreational activities can also be affected by excessive growth; channels and shallow bays can become choked with excess vegetation, impairing the ability of lake users to swim and boat on the lake.

3.2 History of Aquatic Vegetation on Mississippi Lake

Historical data regarding aquatic vegetation occurrence and growth rates is not widely available for Mississippi Lake. Inferences can only be made from reports published in the 1970's by various Ontario Ministries and local agencies. The *Mississippi Lake Management Report* (Hamilton, 1979) includes some summaries and observational data regarding the aquatic vegetation patterns of the lake, in the late 1960's and early 19070's. In the report Hamilton explains the incidence of aquatic vegetation and the perceived issues at the time.

"This high oxygen level would suggest that water quality was not limiting at that time, although aquatic weed production had been reported to be continually increasing. As early as 1961, aquatic vegetation was a problem and boating channels had to be constantly cleared in the shallower portions of the lake (Dawson, 1961). The insidious weed problem has presently reached such proportions that a great deal of energy is being expended to remove and control the growth of aquatic vegetation in all parts of the lake." (Hamilton, 1979)

This report indicates that in the era of the 1960's and 1970's, Mississippi Lake was experiencing excessive vegetation growth, affecting recreational activities and boating channels.

3.3 Current State of Aquatic Vegetation

The Mississippi Lake Community Survey revealed that weeds and algae in the water have the most negative impact on lake enjoyment. Many of the comments provided by respondents indicated that; weed growth is inhibiting some boat navigation, extensive wash up of vegetation on shorelines was aesthetically unpleasing, and algal blooms were a problem for some residents as well. There is little data available regarding the current condition of the aquatic vegetation resources. This is an area where future monitoring efforts would be beneficial.

It is acknowledged that there is little data available for current conditions of the aquatic vegetation in Mississippi Lake. More monitoring efforts are required to collect this data, regarding state, health and invasive species, so a proper assessment can be completed.

4 Hydrology and Water Levels

The community survey conducted by the Mississippi Lake Planning Committee identified Water Levels as having the second most significant negative impact on the lake. Many comments left by respondents pertain to better water level management, higher water levels in the late summer months, and water level fluctuation affecting fish habitat.

The water level of the lake affects both the recreational activities that can be carried out on the lake, as well as the habitat for aquatic flora and fauna. Low water levels can expose navigation hazards in the lake that are normally sufficiently under the water; high water levels can hide some hazards below the water surface, and can also lead to shoreline erosion. High water levels can flood out fish spawning areas; low water levels can strand spawning areas, if the species prefer shallow waters for spawning. Water levels on the lake are not static; they are a part of the dynamic system known as the hydrologic cycle, which is constantly moving water through the system. The lake levels are therefore influenced by many different factors. Figure 10, from the *National Oceanic and Atmospheric Administration* (NOAA) website, depicts the hydrologic cycle.

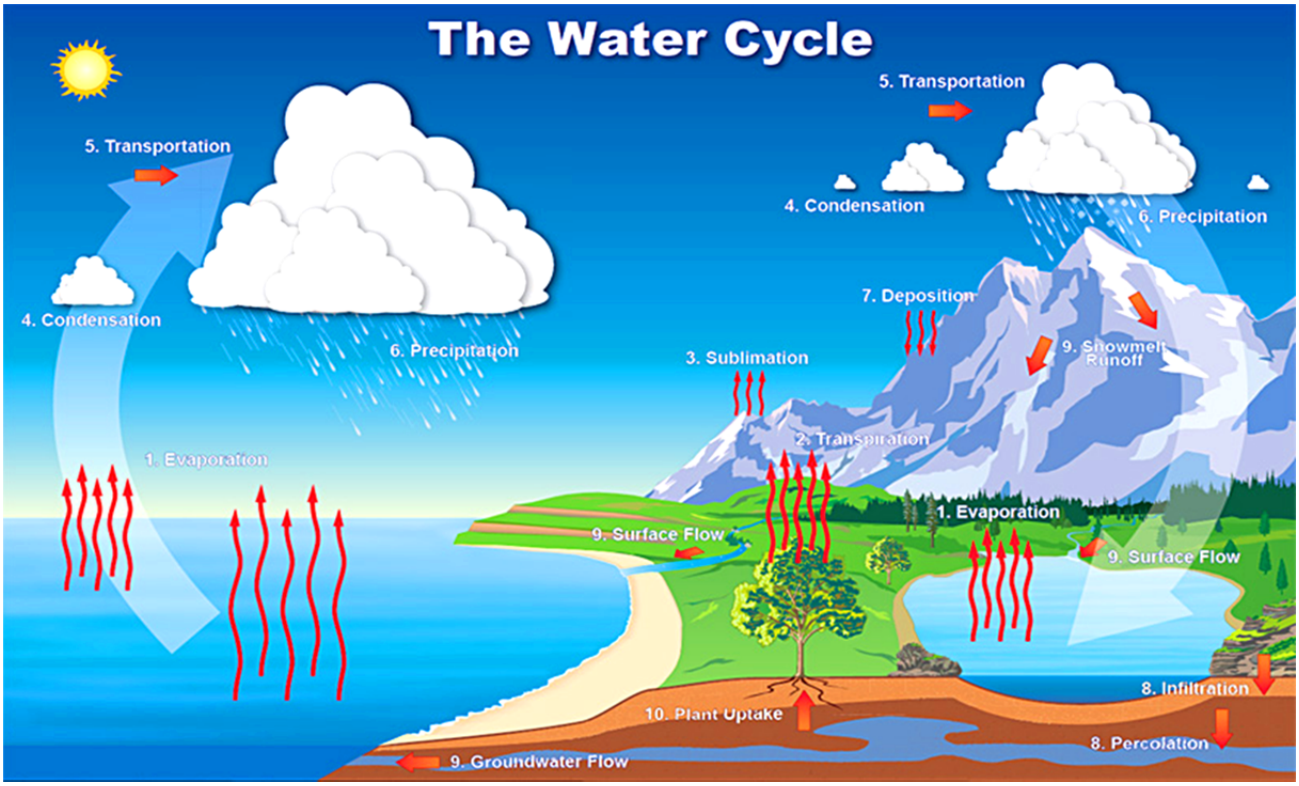


Figure 10: Representative Water Cycle

(National Oceanic and Atmospheric Administration, 2012)

1. Evaporation is the change of state of water (a liquid) to water vapour (a gas). On average about 47 inches (120 cm) is evaporated into the atmosphere from the ocean each year	**2.** Transpiration is evaporation of liquid water from plants and trees into the atmosphere. Nearly all (99%) of all water that enters the roots transpires into the atmosphere.	**3**. Sublimation is the process where ice and snow (a solid) changes into water vapour (a gas) without moving through the liquid phase.	**4**. Condensation is the process where water vapour (a gas) changes back into a water droplet (a liquid). This is when we begin to see clouds.	**5**. Transportation is the movement of solid, liquid and gaseous water through the atmosphere. Without this movement, the water evaporated over the ocean would not precipitate over land.
6. Precipitation is water that falls to the earth. Most precipitation falls as rain but includes snow, sleet, drizzle and hail. On average, about 39 inches (990mm) of rain, snow and sleet fall each year around the world.	**7**. Deposition is the reverse of sublimation. Water vapour (a gas) changes into ice (a solid) without going through the liquid phase. This is most often seen on clear, cold nights when frost forms on the ground.	**8**. Infiltration is the movement of water into the ground from the surface. Percolation is the movement of water past the soil going deep into the groundwater.	**9**. Surface flow is the river, lake, and stream transport of water to the ocean. Groundwater the flow of water unground in aquifers. The water may return to the surface in springs or eventually seep into the oceans.	**10**. Plant uptake is water taken from the groundwater flow and soil moisture. Only 1% of water the plant draws up is used by the plant. The remaining 99% is passed back into the atmosphere.

What is important to note about this figure, for the water level of a lake to stay the same, the amount of recharge must equal the amount of discharge. The points of recharge are precipitation (in the form of rain, snow, sleet or ice), surface water inflow and ground water flow. The points of discharge are surface water outflow, evaporation, transpiration, sublimation and ground water flow. Because there are so many variables in this equation, the water level of a lake will rarely, if ever, be static or stay the same.

Mississippi Lake is the last in a series of lakes that the Mississippi River flows through before reaching the Ottawa River. There is a dam located on the river in the Town of Carleton Place, which is used to control water levels on the lake for most of the year. There are several automated gauges that collect water level and flow data, which is used in the operation of the Carleton Place Dam.

4.1 Water Level Management

The Mississippi River is a managed system, with a total of 19 dams being owned and or operated by MVCA, an additional 4 private hydro generating stations and a number of smaller private structures located in the watershed. Mississippi Lake is the last in a series of lakes along the Mississippi River and the water levels under normal conditions are maintained by the Carleton Place Dam. This dam is owned and operated by MVCA and the management takes into account various (and occasionally competing) interests such as flood / drought mitigation, erosion/ shoreline damage from ice, fish / wildlife habitat, recreation / tourism and occasionally hydro generation.

Flooding is a complex subject but concisely described, will most often occur in the spring on Mississippi Lake but can occur at any time of the year. Flooding results from two distinct scenarios -spring snowmelt usually but not always combined with rainfall, or large rainfall events which can occur at any time of the year. The water flowing into Mississippi Lake comes from a drainage area of approximately 2900 sq km. This can be separated into two distinct basins, a managed watershed above the Crotch Lake Dam of approximately 1000 sq km, and an unmanaged watershed between Crotch Lake and Mississippi Lake of approximately 1900 sq

km. The timing and magnitude of inflows into the lake to produce spring flooding depend on how quickly runoff (snowmelt and rainfall) occurs in the unmanaged section of the watershed. Outflows from the lake are also impacted by the narrowing of the river at the outlet and again at the canoe club and the capacity Bridge Street bridge above the dam. In the spring of 1998, Mississippi Lake experienced its highest recorded flood since water levels began being collected on the lake in the mid 1970's.

4.1.1 History of Water Management and Carleton Place Dam

The history of water management on this section of the Mississippi River, and Mississippi Lake, extends back almost 200 years. The first dam in Carleton Place was constructed in 1820 by Edmund Morphy, since that time the dam has undergone several changes. Around the time of World War I (WWI) the Town of Carleton Place bought the land and the rights to the dam from the Brown's estate. The Town later sold the structure and water rights to the Mississippi River Improvement Company (MRIC). The structure then fell into a state of disrepair until World War II (WWII), at which time the MRIC rebuilt the generators and powerhouse. The dam again fell into disrepair, until 1970 when Hydro was requested to rebuild the structure. Construction of the present dam was finished in 1973, with the understanding that the Mississippi Valley Conservation Authority (MVCA) would assume ownership and operation of the dam.

The present dam is located approximately 0.1 kilometres north (downstream) of the Bridge Street bridge in Carleton Place. It is a concrete structure composed of two sections; the control section and the ogee shaped (round crested) weir. The control section consists of five sluiceways that contain a total of 48 stop logs; there are 10 stop logs in three sluiceways, and 9 stop logs in the other two sluiceways. The ogee crested weir spans the rest of the width of the river, for a distance of 75.15 metres (curved length).

4.1.2 Current Operation

The Carleton Place dam has an operating range of 133.93 metres to 134.50 metres. The dam is operated within this range to achieve a summer target level on Mississippi Lake of 134.35 metres (+/- 0.10 m) by the long weekend in May. The dam is operated to try to remain within the target range of 10 cm above and below the optimum level for Mississippi Lake, from the end of May to the start of the following spring freshet. However, due to natural constrictions in the Mississippi River from the lake to the dam, the dam has minimal effect on flood reduction either upstream or downstream. During the summer months all stop logs are placed in the dam, meaning that the lake level fluctuates wholly on the amount of precipitation it receives. In drought years, lake levels will decrease and increase during heavy precipitation events. Once river flows exceed 150 cubic metres per second and/or once 25 stop logs have been removed from the dam, the dam is no longer a controlling factor. As a result, when river flows are below 150 cms, the lake water levels normally range from 134.9 metres in the spring down to 133.965 metres in the fall.

Dam operations are guided by monitoring stream flow at two stream gauges (one above Mississippi Lake at Ferguson Falls and one below at Appleton), water levels on Mississippi Lake, snow conditions and weather forecasts.

4.1.3 Mississippi Lake Rule Curves

The operation of the Carleton Place Dam to manipulate Mississippi Lake water levels is based on rule curves for the lake. The rule curves for Mississippi Lake are an operating guideline for optimal water levels for the lake, which is outlined in the Water Level Management section of this chapter. There are three rule curves for Mississippi Lake; the first is the black line which is the upper limit of the target range for the lake level. The red line represents the lower limit of the target range for the lake level, and the blue line is the optimal level for Mississippi Lake. Since it is difficult to achieve a precise water level for the lake, there is a target range for the water level, which is usually within 0.1 m of the optimal level.

Figure 11 displays the rule curves for Mississippi Lake, along with the average monthly water level of Mississippi Lake for several recent years. The years chosen for comparison are 2002, 2005, 2008 and 2012; 2005 and 2008 represent years of relatively normal water level conditions for the lake. The year 2002 is displayed because it was a flood year, with high water levels occurring in June; 2012 is included because it is characterized by low water conditions for more than half of the year.

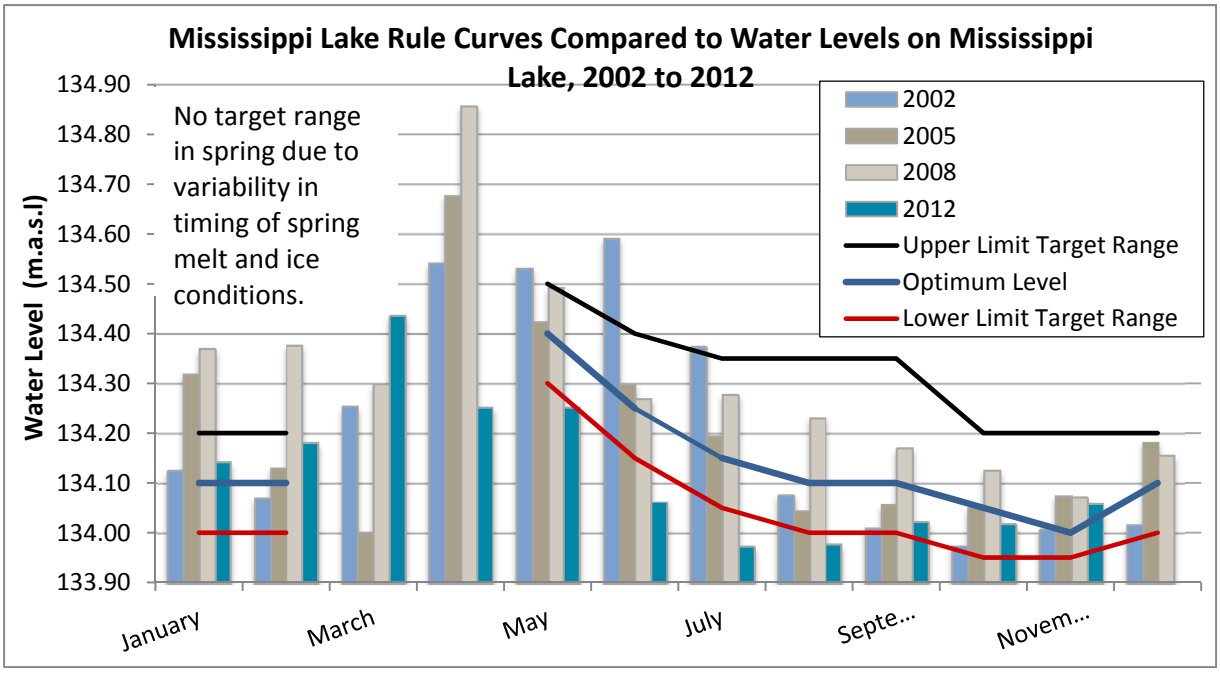


Figure 11: Mississippi Lake Rule Curve

By comparing the monthly averages to the rule curves, it is easy to identify the highs and lows of the water levels on the lake, and by how much they deviate from the target range. As previously indicated 2002 was a

flood year, with heavy rains occurring in mid-June. The Mississippi River at Ferguson Falls reached a peak flow of 158 cms on June 22nd, and Mississippi Lake reached the peak elevation of 134.92 m on June 24th. The graph shows that the peak lake elevation was almost 20 centimetres higher than the upper target range limit. The peak flood level also exceeded the spring freshet peak of that year. The same type of relationship is displayed in the 2012 data. The watershed was in a low water status for more than half of the year, this is reflected in the chart where the monthly averages are at or below the lower limit target range for the lake. This chart also shows how the peak of the spring freshet for 2012 deviates from the lake norm, with the peak being the lowest of the years displayed, and it occurred a month earlier than when the freshet usually peaks. The years of 2005 and 2008 represent years that have normal monthly water levels. These years follow the general trend of peaking in the spring, usually April, and slowly dropping off with a low level usually in October or November.

4.2 Mississippi Lake Seasonal Averages

The MVCA collects daily water level and flow data from gauges located throughout the Mississippi River, Clyde River and Fall River watersheds. This data is used in determining the operation of the dams, including the Carleton Place Dam, to manage water levels on Mississippi Lake, and river flow downstream. The water level analysis of Mississippi Lake is based upon the raw data that has been collected from the Mississippi Lake gauge over the past 12 years. Figure 12 depicts the average water level on Mississippi Lake in the winter, spring, summer and fall.

The winter period was defined as December 1st to February 28/29th (December of the previous year to the January and February data). Spring period was defined as March 1st to May 31st; Summer period was June 1st to August 31st; and the Fall period was September 1st to November 30th. The data shows the general trend of lakes in a climate that experiences winter, the peak water level of the lake in a year occurs in the spring with the freshet; the freshet being the peak of spring runoff when the snow and ice has melted from the lake and upstream tributaries. The graph also shows the low of water levels tend to be in the fall, usually in October. The graph also shows a relationship between low fall water levels and low winter levels, as is demonstrated in the first three years of the chart, and the 2011 to 2012 data.

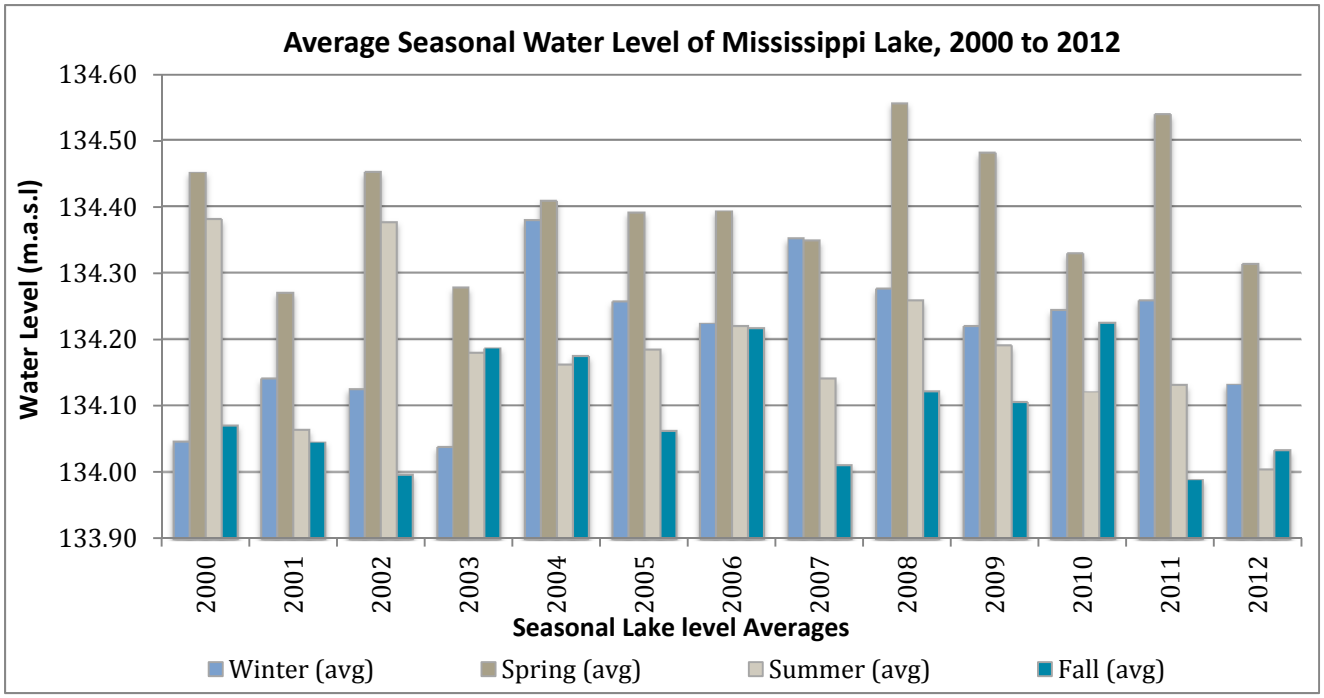


Figure 12: Seasonal Average Water Elevation for Mississippi Lake

4.3 Mississippi Lake Spring Peak

When the peak of the spring freshet occurs, there can be moderate to extensive flooding of the lake depending on the peak elevation of the water level. Figure 13 displays the peak spring elevation (the maximum water level from March 1st to May 31st) of Mississippi Lake from 2000 to 2012.

The average spring peak for the period 2000 to 2012 is 134.79 m.a.s.l, which is shown by the black arrow on the graph; however, there is great variability across the thirteen years depicted on the graph. The highest spring peak occurred in 2008 at 135.28 m and the lowest peak was in 2003 at 134.49 m, almost a metre lower than 2008. There is natural variation in water levels from year to year; however, milder winters may lead to less precipitation falling as snow and less ice cover. With less water trapped as snow and ice through the winter there will be less water to enter the system in the spring when temperatures rise. Precipitation that falls as rain through the winter months will enter and leave the system within a few days or weeks depending on the amount of rain and depth of snow pack.

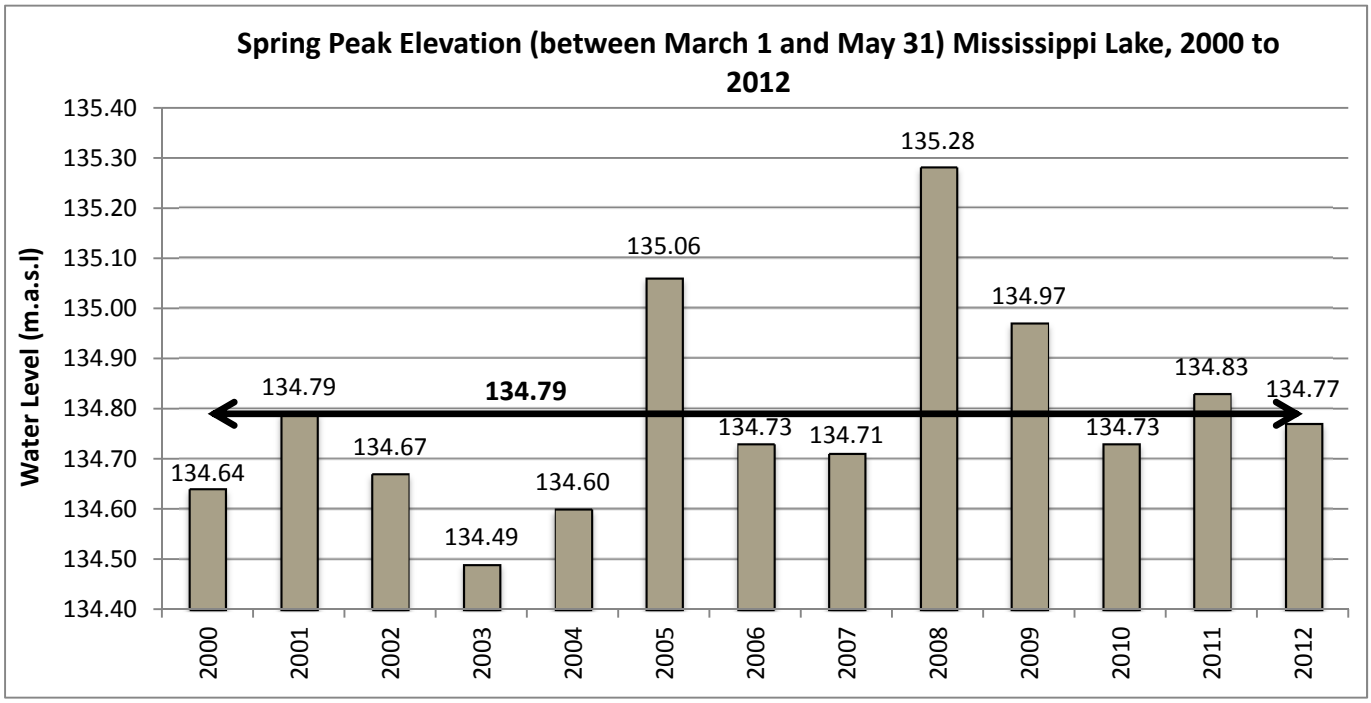


Figure 13: Spring Peak Elevation on Mississippi Lake, 2000 to 2012

4.3.1 Mississippi Lake Water Level Trends

In order to better understand the water level trends of Mississippi Lake, a comparison can be made of the recent level data to the lake rule curves. By comparing the lake levels over an extended period of time, it is easier to see how the water level fluctuation will follow approximately the same pattern each year (in years when the water levels are relatively normal i.e. within the target range). Figure 14 displays the average monthly lake levels from 2000 to 2012 (the blue columns) and the lake rule curves.

The trend in water level fluctuation can be identified quite easily when the data is presented in this fashion. The trend of this lake is for water levels to stay relatively constant from January to March and to peak with the spring freshet in April. The levels then decline after April reaching the low point in the fall around October or November, with a rise in water level occurring in late November and December. The majority of water level data displayed in this chart fits into the target range for Mississippi Lake, as is shown by the yellow line representing the total average for all years combined.

The water levels on Mississippi Lake are controlled mainly by the Carleton Place dam, which has an operating range for the lake level. Recent water level data collected from the Mississippi Lake gauge for the years of 2000 to 2012 was used to analyze the water level trends of the lake. The analysis reveals that although the level of the lake fluctuates throughout the year, the average water level follows the target operating range for the lake. There are, however, instances when the lake level either far exceeds the upper limit of the target

range, or is below the bottom limit. These flood and drought events can cause property damage, erosion of the lake shore, habitat disturbance, and inconvenience recreational activities. These events are naturally occurring in the dynamic system of the lake environment (but can be magnified by human activity, ex. filling within the natural floodplain causing high water levels downstream).

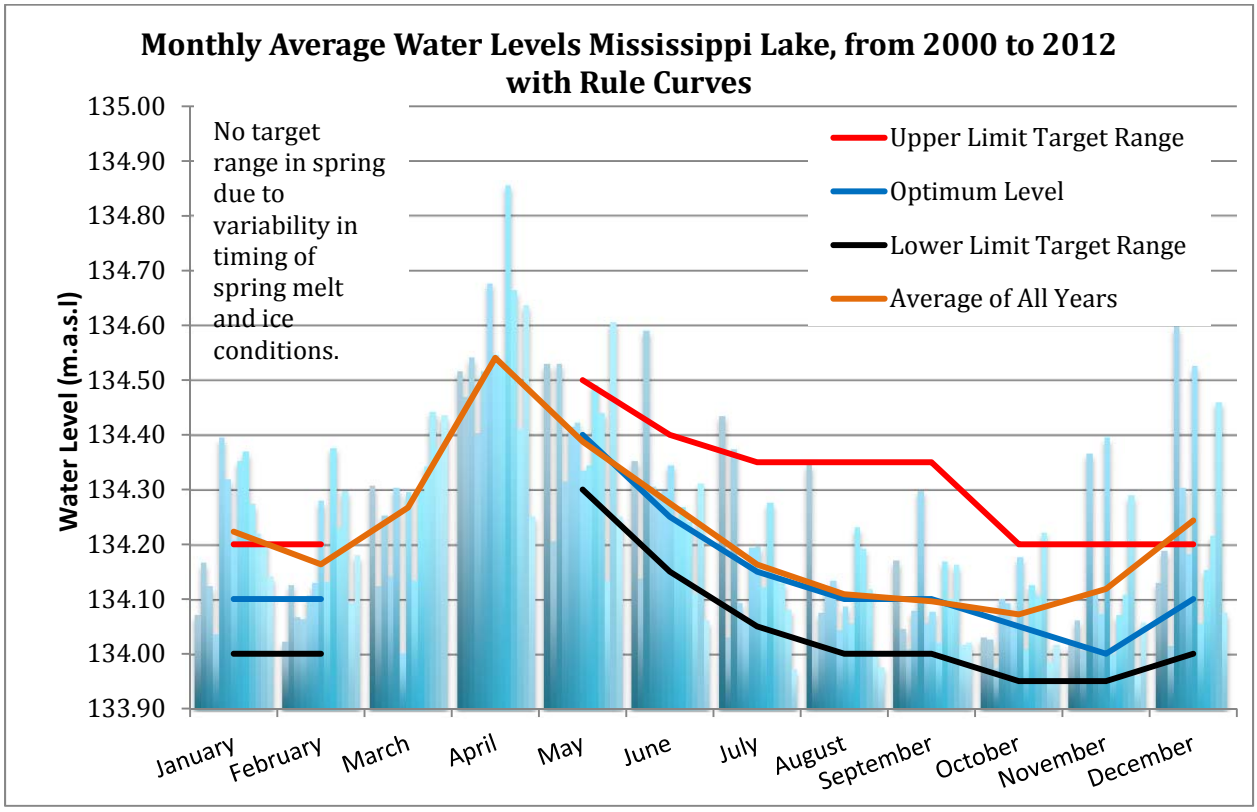


Figure 14: Monthly Average Water Levels on Mississippi Lake, 2000 to 2012

5 Flooding and Floodplain Mapping

5.1 Flooding

Mississippi Lake water levels have been a concern of the cottagers and lake residents for many years; water levels were ranked as the second most significant negative impact to enjoyment of the lake by survey respondents. Flooding around Mississippi Lake results from two distinct scenarios: spring snowmelt often combined with rainfall; or large rainfall events which can occur at any time of the year as observed over the last several years. The water flowing into Mississippi Lake comes from a drainage area of approximately 2900 sq km that can be separated into two distinct basins: a controlled watershed above the Crotch Lake Dam of approximately 1000 sq km; and an uncontrolled watershed between Crotch Lake and Mississippi Lake of approximately 1900 sq km. The rate and timing of runoff (snowmelt and rainfall) from the uncontrolled section of the watershed influences the timing and magnitude of spring flooding on Mississippi Lake. Outflows from the lake are also impacted by the narrowing of the river at the outlet and again at the canoe club and the capacity of the Bridge Street bridge upstream of the dam. In the spring of 1998, Mississippi Lake experienced its highest recorded flood since water levels began being collected on the lake in the mid 1970's.

Flooding usually occurs in the spring with the water rising 60 to 80 centimetres above normal summer lake levels, temporarily submerging shorelines and low lying roads. In years when above average snow melt and/or precipitation contributes to the spring freshet, flooding can be more severe and cause damage to properties, homes, and roads.

The highest recorded flood on Mississippi Lake occurred in the spring of 1998, following the winter of the famous Ice Storm that crippled parts of Eastern Ontario. On Mississippi Lake, the 1998 flood peaked on April 5th, when the flood water reached an elevation of 135.73 metres above sea level (asl); almost one metre higher than the average spring peak level of 134.79 metres asl. During the 1998 flood many homes, cottages and roads around Mississippi Lake were flooded; boats, sheds, docks and other things that weren't anchored to the ground floated away, and property was damaged. The community spent many months recovering from and repairing the damage that was caused by the 1998 flood (Mississippi Valley Conservation Authority, 2014).

Photo 2: 1998 Flood of Mississippi Lake (MVCA)

5.2 Floodplain Mapping

Low lying areas around the lake that are vulnerable to flooding, particularly during the spring runoff season or storm events, are called '**floodplains**' or '**flood hazard lands**'. There is substantial development in the low lying floodplain areas around Mississippi Lake. Many of these areas were developed before development regulations came into effect. With the conversion of a large number of these properties from seasonal to year round use, exposure to the impacts of flooding has increased.

In 1978, Mississippi Valley Conservation Authority (MVCA) produced floodplain mapping to identify the areas around Mississippi Lake that would be susceptible to flooding during a 1:100 year flood event. The 1:100 year flood is a standard that is used in the Province of Ontario and other parts of the country to predict a potential major flood event, based on an analysis of flow and precipitation and/or snow melt records. It represents a flood that on average would occur once every 100 years, or that has a 1% chance of occurring or being exceeded in any given year.

The floodplain mapping was updated in the spring of 2014 using current mapping, climate and flow data to produce more accurate flood lines. This project identifies the 100 year flood elevation for Mississippi Lake as 135.73 metres above sea level, with the wetlands and low lying areas being most susceptible to flooding.

The mapping is used in the flood forecasting and warning program to identify the areas that can be expected to have problems when flood events occur. The mapping is also used in MVCA regulations and in the municipal land use planning process to ensure that new development does not add to the risk of flood damages or public safety risks associated with flooding. The use of floodplain mapping for regulating development activities is discussed in more detail in **Section 8: Land Use and Development**.

6 Mississippi Lake Fishery

The Mississippi Lake Community Survey identified that approximately 53% of the respondents engage in fishing as a recreational activity on the lake. The Mississippi Lake fishery is a vital attribute that makes the lake a popular recreational area, for both the residents and day users. It has economic value, as the fishery brings tourists to the surrounding area, as well as intrinsic value to the people who enjoy the nature of the lake environment. It is therefore critical to protect, maintain and enhance the fish habitat of the lake in order for the fishery, and wildlife that depends upon it, to remain healthy and diverse.

Fish species are classified into guilds based upon what water temperatures they need to carry out their life functions, such as; feeding, resting, hiding and spawning. Using these characteristics, fish species can be placed into three different guilds; Warm Water fishery, Cool Water fishery or a Cold Water fishery; Mississippi Lake is classed as a **cool water fishery**. Though Mississippi Lake is classified as a cool water fishery, it supports a wide range of warm and cool water fish species. The main sport fish species the lake supports are, Walleye (Yellow Pickerel), Northern Pike, Smallmouth and Largemouth Bass. A complete list of all documented species in Mississippi Lake can be found in Appendix 2.

Monitoring of the state and health of the Mississippi Lake fishery was done extensively through the 1960's to the 1990's. However, there is little monitoring data available for the period post 1999. There is a need for current monitoring programs, to properly assess the current condition of the fishery. All Historical fishery data is available in Appendix 3: History of the Mississippi Lake Fishery of this report.

6.1 Current State of the Mississippi Lake Fishery

6.1.1 State of the Habitat

Mississippi Lake is classified as a cool water fishery, supporting both cool and warm water species. The optimal habitat for many of these species is water temperatures from 18 to above 25°C, and dissolved oxygen content of 4 mg/L or higher. Analysis of the temperature and dissolved oxygen profiles for the lake determined the lake does not currently experience oxygen depletion in the summer months, one of two times of the year when it is most likely to occur. This means that in Mississippi Lake there is sufficient fish habitat in the water column throughout the year. It is also important that critical habitat for sport fish species is protected, such as spawning and nursery grounds.

Walleye are one of the primary sport fish species in Mississippi Lake, they are highly sought after, and as a result, protection of their spawning habitat is very important. Walleye typically prefer to spawn in rivers, tributaries, or rocky lake shoals where the water has a swift current and clean rocky substrate, to provide abundant levels of oxygenated water and prevent suffocation of the incubating eggs by sedimentation. Mississippi Lake experiences a spectacular Walleye spawning run in the Mississippi River just as it enters the lake.

This section of the river and lake is optimal habitat for spawning, as it has clean rock substrate and fast moving water. There is a smaller spawning run in the McEwen Creek as well. Several enhancement and rehabilitation projects have been carried out regarding these Walleye spawning sites. In the summer of 1980 an enhancement project was conducted in the Mississippi River at Innisville. The spawning grounds were enhanced through the addition of clean rock and reinforced concrete, to replace natural substrate that had been lost to strong currents and ice. After this project was completed, another was undertaken in McEwen Creek, to clean the existing substrate of sediment, and enlarge the area by adding suitable rock substrate to the creek bottom. There have also been community efforts in rehabilitation and enhancement of the spawning sites. Through the Community Fisheries Involvement Program (CFIP), projects were carried out in 1988 and 1995, where Walleye spawning beds were cleaned of silt and enhanced (Kerr, Mississippi Lake and its Fishery, 1999). These projects were felt to be largely successful, and contribute to the Walleye productivity of the lake. The Lanark Fish and Game Club have recently conducted several Walleye spawning bed rehabilitation projects, including two sites in the Mississippi River just below Innisville.

Much of the spawning habitat that Walleye utilize is protected by the provincial government. The Walleye spawning grounds at Innisville are classified as a Fish Sanctuary by the OMNR, the area 240.8 metres west of Main St. bridge to Mississippi Lake. Fishing is prohibited in this stretch of the river from March 1st to the Friday before the 2nd Saturday in May, in order to protect the vulnerable spawning Walleye.

Northern Pike, also a cool water species, is a popular sport fish in Mississippi Lake. Pike prefer to spawn in shallow vegetated areas, which include intermittent streams which may only carry water for part of the year. Typically pike do not migrate far from spawning areas, as they prefer warm, slow water that is heavily vegetated (Fisheries and Oceans Canada, 2010). There are several areas in Mississippi Lake that have been identified as pike spawning habitat; Code Bay, Kings Bay, Hunters Bay, McEwen Bay, McGibbon Creek, and McCreary's Creek. Largemouth Bass share the same type of spawning habitat as Northern Pike, also spawning in Code Bay, Kings Bay, Hunters Bay, and McEwen Bay. Smallmouth Bass prefer spawning grounds which are somewhat deeper and less vegetated than that of Largemouth Bass, with a rocky bottom. Identified Smallmouth Bass spawning areas in Mississippi Lake are Brown's Point, Rocky Point, and Cooke's shoreline.

6.1.2 Current Inventory

The current fishery inventory for Mississippi Lake was summarized from the Near Shore Community Index Netting (NSCIN) projects that have been completed on the lake for the years of 2003, 2007 and 2009. These netting projects estimate the trend through time analysis for the species using; the fish round weight, fork and total length (length from tip of mouth to the tail fork), and age (determined through scale analysis). The estimated catch-per-unit-of-effort (CUE) for each species represented in the catch is calculated as well. The following information was obtained from the Ontario Ministry of Natural Resources (OMNR), *Mississippi Fisheries Assessment 2009*, in a report summarizing the most recent NSCIN projects (2003, 2007 and 2009).

The most common species captured in the trap netting surveys were; Bluegill, Black Crappie, and Pumpkinseed, respectively. From 2003 to 2007 there was a shift in fish species abundance from Bluegill to Black Crappie. The average length of the sampled sunfish populations was just over 18 cm. The mean age, fork length, and round weight for Pumpkinseeds was similar across the three sampling years, despite the differences in sample size. However, the mean age, round weight, and fork length for Bluegills decreased from the initial netting project in 2003. New fishing regulations introduced in 2010 limiting the number of perch and other panfish (sunfish) that can be harvested, should aid in increasing and sustaining healthy populations, with a higher frequency of adult fish. It is not surprising that the most prevalent species in the catch were panfish, as the assessment protocol targets near-shore fish communities dominated by warm water species, and the panfish population has been rising over the past few decades.

The CUE for the majority of fish species in the lake did increase from 2003 to 2007, but dropped in 2009, whilst still remaining above the 2003 CUE. Both Largemouth and Smallmouth Bass species exhibit an increase in mean age consecutively from 2003 to 2009 in the NSCIN projects; an indicator of healthy bass populations. Both species of bass have also shown an increase in mean weight and mean fork length from 2003 to 2007, followed by a slight decrease in 2009. Smallmouth Bass have experienced an overall increase in mean age, weight, and fork length since the initial netting project in 2003, the sample size has also increased substantially. The combination of these factors suggests the Smallmouth Bass population in Mississippi Lake is healthy and continuing to improve.

The two remaining traditional sport fish species in the lake are Northern Pike and Walleye. The Northern Pike CUE has dropped substantially since the 2003 project, while it dropped from 2003 to 2007; it remained constant from 2007 to 2009. Analysis of age, fork length, and weight shows increasing growth rate of pike from 2003 to 2009. Walleye in Mississippi Lake appear to be healthy and stable, with the age, weight, and fork length progressively increasing from 2003 to 2009. The growth rate of Walleye does not appear to have changed over the sampling periods, but all factors point to a healthy and improving Walleye population in Mississippi Lake.

Coarse fish species in Mississippi Lake include, White Sucker, Brown Bullhead, and Yellow Bullhead. Analysis of White Sucker age, length, and weight increased since the 2003 netting project, with the CUE remaining

relatively constant throughout, indicating the population is healthy and stable. The Brown Bullheads sampled showed a slight increase in mean weight and length from 2003 to 2009, while the CUE doubled from 2003 to 2007, and remained constant to 2009. The sample size of Yellow Bullhead is too small to make inferences about the population; the specimens that were sampled showed an increase of mean and total weight from 2003 to 2009.

The last species represented in the trap netting projects is the American Eel, which is of particular importance due to its status as an Endangered Species in Ontario. The American Eel does not reproduce in Ontario waters; they migrate up the St. Lawrence River and into tributaries as young fish, it is in these waters where they grow and mature, at which point they will migrate back to the ocean to reproduce. Barriers in the waterways, such as hydroelectric dams, have caused the decrease in eel population in Ontario, as the dams impede movement and cause increased mortality. This is evident in Mississippi Lake as the CUE has been steadily dropping for eel; six eel were caught in the 2003 project, none in 2007, and two in 2009.

Figure 15 displays the total catch for each of the NSCIN netting projects, 2003, 2007 and 2009. Each species is displayed by the percentage of the total catch for each particular year. The data was obtained from the OMNR report summarizing the NSCIN netting program on Mississippi Lake. An outline of the MNRF Broad Scale Monitoring Program is presented in Appendix 4

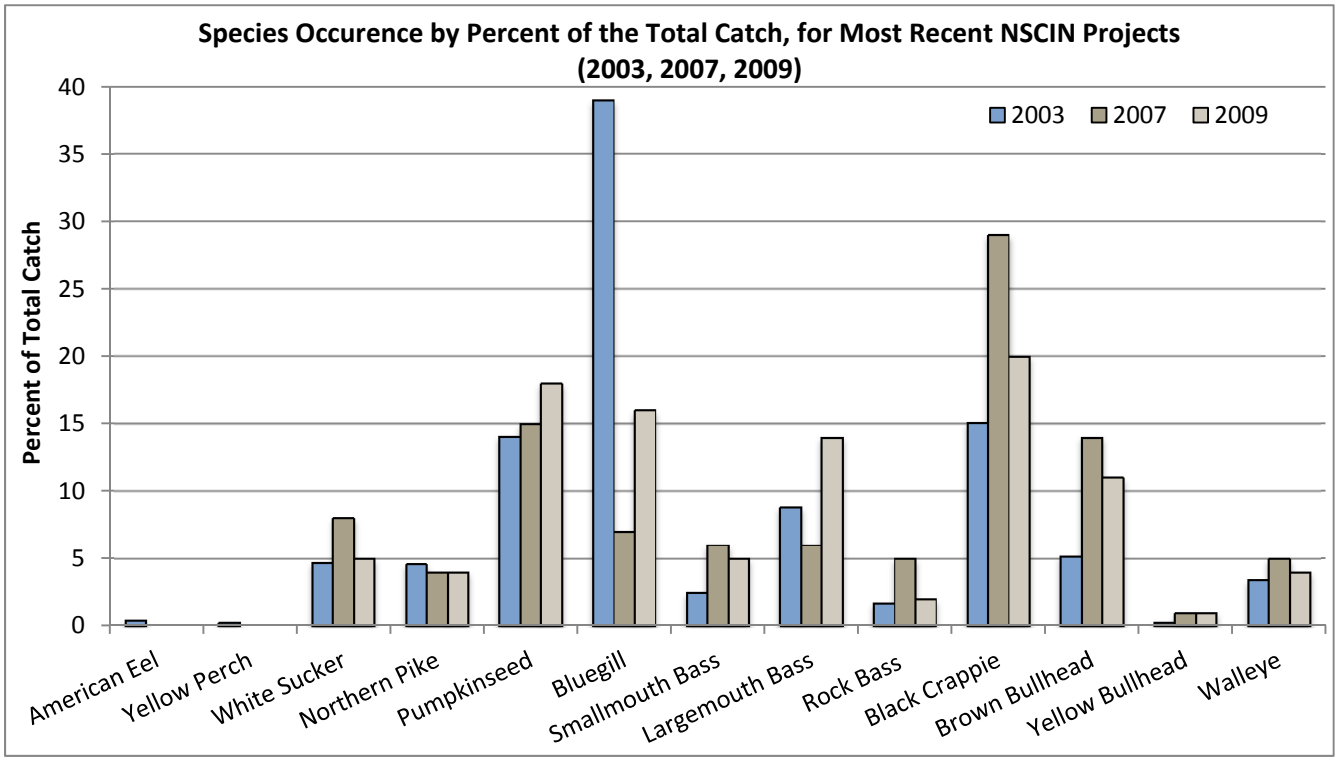


Figure 15: Total Catch Numbers for NSCIN Projects from 2003 to 2009

6.1.3 Contaminants in Fish

The Ontario Ministry of the Environment (MOE) publishes the *Guide to Eating Ontario Sport Fish* every two years, to provide updated information about consuming Ontario fish. Fish is a healthy food source low in saturated fat; however, wild fish can contain high levels of contaminants such as Mercury or Polychlorinated Biphenyls (PCBs). Samples are collected from sport fish out of Mississippi Lake, and analyzed to determine the levels of some contaminants. Consumption guidelines are then set based on the level of fish contamination, to allow for safe consumption of the fish.

Contaminant testing has been conducted on the following fish species from Mississippi Lake; Black Crappie, Bluegill, Brown Bullhead, Largemouth Bass, Northern Pike, Pumpkinseed, Rock Bass, Smallmouth Bass, Walleye, White Sucker and Yellow Perch. The recommended number of meals per month of fish is based on the fish length, as the contaminant concentration generally increases with fish length. The guideline is also separated into two consumption groups, the general population and the sensitive population; the latter being women of child-bearing age and children under 15 years of age.

The MOE *Guide to Eating Sport Fish* summarizes Mississippi Lake consumption rates, which can be found in Appendix 5. The test results determined that there are no species of fish in the lake that should not be consumed; however there are restrictions for the sensitive population. It is not recommended that people in the sensitive population consume; Bass species over 30 cm in length, Yellow Perch over 25 cm in length, or Walleye over 35 cm in length. There are fewer consumption restrictions for the general population; the number of meals per month does decrease with increasing fish length.

6.1.4 Fishery Management Strategy

The Mississippi Lake fishery is managed by the Ontario Ministry of Natural Resources (OMNR), which regulates the seasons and catch limits. The OMNR divides the province into 20 distinct Fisheries Management Zones (FMZs), based on ecological factors such as; watersheds, climate zones, angling pressure and existing road networks. Mississippi Lake is located in FMZ 18, the most easterly zone in the province. The lake is managed as a self-sustaining fishery, meaning there are no fish stocking programs for the lake. To maintain a naturally reproducing population there are catch limits in place for the highly sought after sport fish, such as: Walleye, Bass (Largemouth and Smallmouth), Northern Pike, Yellow Perch, Crappie and Sunfish. Table 7 outlines the MNR Fishery Management Strategy for Mississippi Lake. The catch limits for fish are based on the type of fishing license that anglers possess, there are two types, Sport fishing or Conservation fishing. Sport licenses allow higher catch limits, Conservation licenses, as the name suggests, has a lower catch limit.

Table 7: MNRF Fishery Management Strategy

Species	Open Season	Sport Fishing License Limits	Conservation License Limits
Walleye	January 1 to March 1; 2nd Saturday in May to December 31	4--Must be between 40 to 50 cm	2--Must be between 40 to 50 cm
Bass (Largemouth and Smallmouth)	3rd Saturday in June to December 15	6	2
Northern Pike	January 1 to March 31; 2nd Saturday in May to December 31	6	2
Yellow Perch	Open All Year	50	25
Crappie	Open All Year	30	10
Sunfish	Open All Year	300--Only 30 may be greater than 18 cm	15

The Mississippi River at Innisville and the head of the lake is designated a fish sanctuary. This stretch of the river is a no-fishing zone from March 1st to the Friday before the 2nd Saturday in May. This part of the river, and lake, is a closed fish sanctuary due to the Walleye spawning run that takes place every spring.

6.2 Issues/Concerns Regarding the Mississippi Lake Fishery

There are many factors that are currently putting the Mississippi Lake fishery under increased pressure, and factors that have potential in the future to cause a fundamental shift in the fishery. The following sections outline the present and future issues that could impact the lake fishery.

6.2.1 Shoreline Development/Loss of Habitat

Also known as the Ribbon of Life, the lake shoreline is an important habitat for aquatic flora and fauna. The shoreline acts as a nursery for young fish, providing shelter in the vegetation, and prey to feed upon. When lake shores are developed, or “cleaned”, the natural vegetation is removed and replaced by hardened surfaces like lawns and retaining walls. This change in the shoreline, though it may be more aesthetically appealing to property owners, has negative effects on the ecosystem. Activities in back lots of the lake (lots that are not directly fronting on to the lake) can also impact this shoreline zone. Agricultural development can cause increased sediment in runoff through tilling land, and increased nutrient and chemical input with the application of fertilizers and pesticides.

These development activities can alter the shoreline through increased sedimentation in the water, as the natural buffer that removes most sediment from runoff is no longer available. The gills of fish can be damaged by sediment laden water as it passes through, which can reduce the amount of oxygen fish can absorb. The sediment can also smother spawning areas and nurseries, covering eggs and filling in depressions young fish occupy. Increased sediment can decrease visibility, making prey less visible for fish, as well as decrease benthic productivity, a food source for fish, by filling in areas used by benthic invertebrates, and

vegetation. The combination of these factors decreases the habitat suitability for fish, which can cause a shift in the fish populations and ecosystem structure.

There are examples of this type of shift already evident in Mississippi Lake. There used to be a population of shoal spawning Walleye in the lake that utilized areas in the mid-section of the lake and around Grieg Island. These areas of the lake became heavily silted in the late 1960's and 1970's; during the time the lake was experiencing eutrophic conditions. This population of Walleye has since disappeared, due to the unsuitable conditions of the shoals for spawning.

6.2.2 Overharvesting

The comments many respondents left with the Community Survey revealed they are concerned about fish stock depletion, through over harvesting of the fishery. Respondents were concerned that fishing tournaments and the winter fishing season result in an increased fish harvest. Mississippi Lake is a very popular recreational fishery, and is fished very heavily. Many residents are concerned the highly sought after species are harvested in excess of the natural reproduction and replacement rates.

The popularity of fishing tournaments in Ontario has been increasing over the past 20 years. The Ontario Ministry of Natural Resources published the report, *A Survey of 2012 Competitive Fishing Events in Ontario*, which compiled a list of known competitive fishing tournaments on Ontario lakes and rivers. The total number of known events held in 2012 was 1,068; this is double the recorded number of events in 1999. Twelve of these events were on Mississippi Lake, ranking it in the top 22 lakes that hosted more than 10 tournaments. The same survey conducted in 2004 identified 8 tournaments on the lake. As the number of fishing tournaments increases, so too does the number of boats/participants. Though there are catch limits on the lake and many fishermen practice catch and release, the harvest rate will increase as anglers on the lake increases. This can lead to increased harvesting of the fishery, and stock depletion.

The survey recorded information about the tournaments, such as species sought, time of year and the details of the event. For the 2012 events on Mississippi Lake, 2 events were held in the spring, 8 in the summer, and 1 in the fall. Five of the tournaments were specifically for Bass, all of these tournaments were held in the summer. Five others were specifically for Walleye and occurred in all seasons. One event was for all species, though the time of year it was held is unknown. An additional tournament for Walleye and Northern Pike was held in the spring.

6.2.3 Water Quality

The water quality of the lake has a profound effect on the health of the lake fishery. Fish populations can be used as an indicator of water quality; as poor water quality results in fish kills and population declines, and healthy fish stocks reflect good water conditions. Oxygen content of the water is the most limiting factor of habitat for fish species. Cool and cold water species typically require waters that have high dissolved oxygen

content in combination with low water temperatures. Increased nutrient levels will cause more algae blooms and excessive vegetation growth, which will result in oxygen depletion as the organic matter decomposes. This process usually takes place in the mid to late summer, fall and late winter, when the cool and cold water species are living in the lake depths in the cooler water. The oxygen depletion in these water layers reduces the amount of available habitat for species such as Walleye and Northern Pike, resulting in decreased survivability of the fish. A reduced population of Walleye is detrimental to the lake, as it is a popular recreational and sport fishery. This is why it is important to engage in practices that reduce sediment and nutrient loading, to aid in increasing dissolved oxygen levels in the lake.

6.2.4 Water Level Fluctuation

The water level of Mississippi Lake affects fish species, through habitat availability and survivability. Water level fluctuation on the lake has been an expressed concern by residents, regarding the impact on fish populations. Low water levels can affect spawning success. There is a dam located in Carleton Place that does act as a controlling mechanism for the lake most of the year. However, due to natural constrictions in the Mississippi River from the lake to the dam, the dam has minimal effect on flood reduction either upstream or downstream. The lake fisheries are incorporated into the operating regime of the Carleton Place dam as much as possible however. During the summer months all stop logs are placed in the dam, meaning that the lake level fluctuates wholly on the amount of precipitation it receives. In drought year's lake levels will decrease and increase during heavy precipitation events. The fishery is then essentially affected by natural highs and lows on the lake.

6.2.5 Invasive/Non-Native Species

Invasive and non-native aquatic species can have profound effects on the indigenous fish populations in a lake. Mississippi Lake is affected by two invasive species in particular; the Zebra Mussel and the Black Crappie. Zebra Mussels have been present in the lake for over 10 years, having first been introduced into Canadian waters in the late 1980's. The Black Crappie was introduced to the lake in late 1980's and first recorded in index netting in 1990.

The Zebra Mussel is a filter feeder, meaning it feeds by filtering nutrients and plankton from the water. This process increases the clarity of the lake water by removing suspended particles and organisms. Increased water clarity is detrimental to some aquatic species, such as the Walleye. Walleye prefer murky water, water with suspended sediments, because they are photosensitive and it allows them to hide from prey. As the water clarity increases, the amount of suitable habitat for the Walleye decreases. The presence of the Black Crappie also has a negative impact on Walleye recruitment.

The population of Black Crappie in Mississippi Lake has exploded since it was first recorded in 1990. Though it is a non-native species, it has not been viewed as negatively as other invasive species in the lake. This is largely due to the fact that crappies are a desirable species to some anglers, being viable pan fish and

sporting species. However, Crappies are known to vigorously feed on Walleye fry, which is detrimental to the species as it has been declining over the past 20 to 30 years. Both of these invasive species put increased pressure on the Walleye fishery, which has been the dominant sport fishery on the lake since recreational fishing became popular.

6.2.6 Climate Change

A change in water temperature, no matter how small, can create a big change in aquatic ecosystems. Temperature change trends are reflected in fish populations, as most species require specific temperature ranges to carry out their life processes; this makes them excellent indicators of a changing environment. Mississippi Lake is located at the southern edge of the range for cold water species and the northern edge of the warm water species range, this location means there will be major changes in the fishery as the lake water warms.

A report was published in 2008, *From Impacts Towards Adaptation, Mississippi Watershed In a Changing Climate*, a joint initiative by Natural Resources Canada, Mississippi Valley Conservation and Queen's University. The goal of this report was to identify the effects that climate change has had on the watershed's aquatic ecosystems, and identify the future effects. Data used to produce the report was attained from records for the St. Lawrence River, Great Lakes Basin, the Ottawa weather station, Bay of Quinte, and the Mississippi Valley Watershed. Workshops were held in Almonte, Ontario for the public, local agencies and municipal governments to determine the implications of climate change in the Mississippi Watershed. The following is a list of the identified potential impacts associated with climate change variables that were identified in the report.

- Temperature increase of only a few degrees will increase recruitment success of warm water species by double in 2020 and increase 15 times by 2050; with decrease of cold water fish recruitment by similar amounts.
- Water temperatures have increased over the past 20 years, resulting in an increase of warm water species, and decline in cold water species.
- Warming conditions allow for the expansion of less favourable competitors that negatively impact the existing fishery; i.e. the Black Crappie
- Growth rates of mature fish will increase with temperature for Warm Water species, but decrease for Cool/Cold Water species.
- A decrease in winter fish kills due to less ice cover and warmer water temperatures, but more summer fish kill incidents associated with toxin-producing bacteria that colonize in warmer waters; i.e. *Colmunaris*.

These changes are a result of climate change factors;

- Warmer temperatures throughout the seasons, causing a decrease in cold water populations because optimal spawning conditions require cold fall and winter temperatures.
- Lower lake levels and river flow rates and reduction in wetland flooding, causing lower and earlier spring freshets that result in a decline in cool water species that depend on strong freshets for spawning.
- Increased precipitation; more rain events in the winter, summer months will be dominated by more and longer dry periods with periods of short heavy rain events, causing increased sedimentation of stream and lake beds, increased flushing of pollutants into water bodies, water level fluctuation may become too extreme for some aquatic species.

Some of the changes described above can already be observed in Mississippi Lake. Over the past 20 years there has been a shift in the recreational fishery of the lake from Walleye to Bass species. This shift has occurred as the warm water Bass species have become more successful in the lake than the cool water Walleye, making them more available to anglers.

7 Natural Environment

Mississippi Lake sits on the boundary between the Canadian Shield granite bedrock and the Paleozoic sedimentary bedrock. The position of the lake on this boundary creates the conditions for great biodiversity through the convergence of these ecosystem types. The area supports both coniferous forest and deciduous forest systems, providing a wide array of habitat opportunities for organisms of different ecological niches. The combination of these ecosystem types with the various natural features around the lake (such as wetlands), create conditions for great diversity in flora and fauna, providing excellent recreational opportunities such as fishing and wildlife viewing and appreciation.

The Mississippi Lake Community Survey revealed that 64% of respondents enjoy nature appreciation as an activity and 53% enjoy fishing. Appreciation of birds and wildlife was the fourth most important value to those people who responded as well. The natural environment of the lake contributes to the qualities that people enjoy about these activities.

7.1 Natural Features

Natural features are interdependent and function as a system to maintain biological and geological diversity, ecosystem services, and species populations. Natural features include areas such as; significant wetlands, fish habitat, endangered and threatened species habitat, wildlife habitat, and areas of natural and scientific interest (ANSI).

Mississippi Lake and the surrounding land have diverse natural features integral to the healthy functioning of the Mississippi Lake system as a whole. The presence of fish and wildlife provide recreational opportunities and contribute to ecological biodiversity. Shoreline vegetation and wetland areas provide value to both wildlife and humans, through; stabilizing shorelines from erosion and loss of property, providing fish and wildlife habitat, minimizing the impacts of flooding, reducing carbon dioxide from the atmosphere and water, filtering contaminants, and creating privacy.

The natural features are important to maintain, protect, or restore both for human and wildlife benefit. However, human related pressures such as shoreline development, faulty septic beds, use of fertilizers, and removal of shoreline vegetation can contribute or cause adverse effects to the natural environment. Increased vegetation and algae growth has negative impacts to wildlife depending on good water quality and clarity, and can reduce the recreational enjoyment of people who want to swim fish and play in the water. Fish and wildlife can be displaced by development that alters or destroys available habitat, and this can affect biodiversity and limit recreational activities like fishing and hunting. For these reasons, it is important to understand the presence and interrelatedness of natural features.

7.1.1 Wetlands

Wetlands provide various environmental services for the surrounding area and ecosystems, including: maintaining ground water quantity, filtering contaminants, maintaining lake water levels, reducing erosion and sedimentation rates, and providing resources for fish and wildlife. Wetland soils have high moisture content, which reduces soil respiration, limiting the amount of carbon dioxide released back into the environment. They also provide habitat for over species of wildlife, including more than one-third of Canada's species at risk. Wetlands are used for breeding areas, spawning, rearing young, shelter, and protection. As biodiversity decreases, the function of these cycles begins to slow, and in some cases completely fail. Wetlands also provide important wildlife passageways between their different habitats.

The Ontario Ministry of Natural Resources (MNR) maintains the Ontario Wetland Evaluation System (OWES), a system used to evaluate and rank the relative value of wetlands for land use planning purposes. Through OWES a wetland can be classified as Provincially Significant (PSW), meaning that it has features and functions that warrant special protection policies under development/land use planning processes. Municipalities can also designate and zone wetlands that are not evaluated as PSW's so that they too are protected from certain development activities.

As shown in Map 3, there are a number of wetlands within the Mississippi Lake Plan subwatershed area. They include both Provincially Significant Wetlands, as listed in Table 8, and wetlands that are not classified as Provincially Significant. Roughly 19 kilometres, or one-third, of Mississippi Lake's shoreline is composed of wetland. This includes two Provincially Significant Wetlands: the Mississippi Lake PSW, 633 hectares located on the northwest shore of the lake; and the McEwen Bay PSW, 231 hectares located at the inlet of the lake. There are another five PSWs located within Mississippi Lake Plan subwatershed that make up an additional combined area of 2693 hectares.

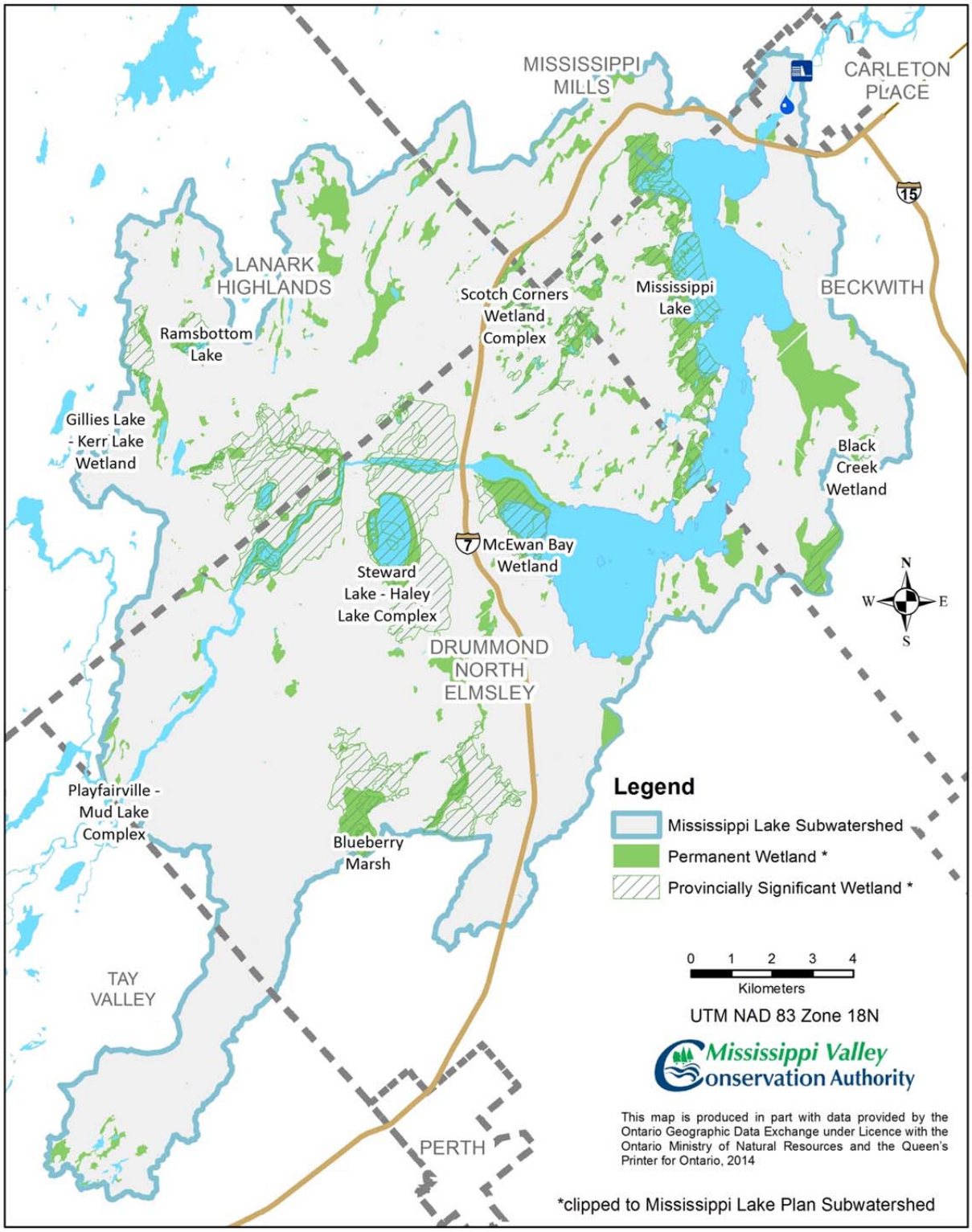
Table 8: Provincially Significant Wetlands within the Mississippi Lake Watershed

	Location	Wetland Name	Area (ha)
Within Mississippi Lake Subwatershed	Directly on Lake	Mississippi Lake	633
		McEwen Bay Wetland	231
	Not Directly on Lake	Blueberry Marsh	216
		Gillies Lake - Kerr Lake Wetland	337
		Ramsbottom Lake	66
		Scotch Corners Wetland Complex	202
		Steward Lake - Haley Lake Complex	1,872
		TOTAL	**3,557**

The McGibbon Creek Wetland, on the south side of Mississippi Lake in Beckwith Township, is classified as "locally significant". Wetlands within the Mississippi Lake subwatershed are regulated by three bodies: the Ministry of Natural Resources, the Mississippi Valley Conservation Authority (MVCA) and the local municipalities. The regulation of wetlands is discussed in more detail under **Section 8: Land Use and Development**. All three municipalities include policies in their Official Plan that are aimed at protecting the Provincially and Locally Significant wetlands.

Wetlands

Map 3: Location of Wetlands within the Mississippi Lake Subwatershed



Wetlands Within Mississippi Lake Plan Subwatershed

7.1.2 National Wildlife Area

The Mississippi Lake National Wildlife Area (NWA) is 264 hectares in size and located at the southwest end of Mississippi Lake, it provides important refuge and breeding habitat for a variety of bird and fish species. The NWA was first established as a Migratory Bird Sanctuary in 1959, to protect the staging waterfowl, before becoming the NWA. In 1968, Environment Canada's Canadian Wildlife Service began purchasing the land around McEwen Bay in order to conserve the habitat, and the NWA was established in 1977 under the *Canadian Wildlife Act* (1973) as the first NWA in Ontario. The NWA is comprised of McEwen Bay and its surrounding wetlands, along with some drier, forested upland habitat west of McEwen Bay and a small wetland and forested area along the north shore of the Mississippi River, east of Innisville. This NWA was designated in order to protect habitat for staging migratory waterfowl.

The wetlands in McEwen Bay provide important staging habitat for significant numbers of waterfowl during migration. Ten thousand ducks can pass through the NWA in a day during fall migration, with American Black Duck, Blue-winged Teal, Green-winged Teal, Hooded Merganser, Mallard, Wood Duck, and Ring-necked Duck being the most common. The wetlands are important breeding habitat for water birds such as the Common Loon, Marsh Wren, and Pied-billed Grebe. The shallow waters of McEwen Bay provide habitat for amphibians such as American Bullfrog and spawning areas for fish such as Largemouth Bass, Northern Pike and Walleye.

A number of species at risk, listed under the federal *Species at Risk Act,* have been reported at the Mississippi Lake NWA, including the endangered Butternut, threatened Least Bittern, Golden-winged Warbler, Canada Warbler, and Easter Musk Turtle, and special concern Rusty Blackbird, Red-shouldered Hawk, Snapping Turtle, Monarch, and Broad Beech Fern. In addition, five bird species (Barn Swallow, Bobolink, Eastern Meadowlark, Wood Thrush, and Easter Wood-pewee) designated at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and the Bald Eagle and Black Tern, classified as special concern under the Ontario *Endangered Species Act, 2007*, have been reported at this site.

Public Access to the NWA is permitted for day use only, via the entrance on Drummond Concession 9A, from December 16th to September 14th. Recreation activities allowed include: hiking, skiing, snowshoeing, picnicking, and wildlife viewing on designated trails, and seasonally recreational boating from boat launch and sport fishing. To provide a safe, undisturbed refuge for staging migratory waterfowl, recreational boating and sport fishing, in McIntyre Creek and McEwen Bay is prohibited September 15th through December 15th, except to directly access Mississippi Lake (outside NWA) and a portion of the Mississippi River (within the NWA), from the NWA boat launch to McIntyre Creek. There is no other water access elsewhere in the NWA. Hunting is not permitted within the boundaries of the NWA, in accordance with the *Canada Wildlife Act* and *Wildlife Area Regulations*, and *Migratory Bird Sanctuary Regulations*.

The preceding is an excerpt from the *Mississippi Lake National Wildlife Area Management Plan (Proposed)* Environment Canada-Canadian Wildlife Service, 2014.

7.1.3 Area of Natural and Scientific Interest

Areas of Natural and Scientific Interest (ANSI) are areas of land and water that represent significant geological or biological features. The Ministry of Natural Resources (MNR) designates ANSI's that are provincially significant, by surveying regions and identifying sites with the highest value for conservation, scientific study and education (Ontario Ministry of Natural Resources, 2009). The area around McEwen's Bay, and upstream to Ferguson's Falls has been designated an ANSI by the MNR, referred to as the Innisville Wetlands. This wetland provides habitat for many different fish and wildlife species. Wild rice stands attract hundreds of waterfowl species on their migration south. The flooded shrub thickets and wooded upland terrain provide many songbird species with a safe stopping or nesting area. Even the marshes created by the wetland play an important role as fish nurseries and spawning beds. This area also falls under the boundary of the Mississippi Lake NWA.

7.2 Wildlife

The protection of wildlife and wildlife habitat is important for the sustainability of the lake environment. Each species of flora and fauna plays an important role in the ecosystem, from the primary producers like the terrestrial and aquatic vegetation, to the tertiary consumers like the Bald Eagle and Northern Pike. A diverse natural environment is often what draws people from urban areas to rural lakes such as the Mississippi. It is important to protect these natural places both for the ecological services they provide, as well as the intrinsic value they hold for society.

7.2.1 Mammals

There are a variety of small and large mammals present in the Mississippi Lake area. As a part of the NWA *Management Plan (Proposed)* a small mammal trapping study was conducted; the study revealed five species living within the boundaries of the NWA; Short-tailed Shrew, Masked Shrew, Meadow Vole, Deer Mouse and the Eastern Chipmunk. Larger furbearers are also present with in the NWA, as the combination of wetlands, upland forest, and meadow areas provides ample habitat opportunities. Species include, North American beaver, River Otter, Muskrat, Black Bear, Red Squirrel, Raccoon, White-tailed Deer, Eastern Cottontail, Snowshoe Hare and Porcupine. The preceding is an incomplete list of species, it is possible there are species missing and they may also occur in other locations in and around Mississippi Lake.

There is little known about the current health and abundance of the mammals that reside around Mississippi Lake. Continued monitoring and surveying is required to complete this list of species.

7.2.2 Birds

The diverse habitat around Mississippi Lake provides home to numerous bird species. Some bird species occupy the lake for the entire year, while others are seasonal occupants, either during their breeding season or migration. Wetlands provide exceptional habitat for waterfowl, during migration staging, molting and breeding. Wetlands and open water are also good habitat for other water or near shore birds, providing nesting locations and food sources to species like the Osprey, Bittern and Swamp Sparrow.

Mississippi Lake, specifically the NWA, is well known for its extensive use by many different species of waterfowl, for breeding and migration purposes. The *Management Report (Proposed)* for the NWA states that up to 10,000 ducks can pass through the NWA in a day during the fall migration, this is vitally important habitat for the waterfowl and the main reason it received federal protection. The most commonly seen waterfowl species during migration are; American Black Duck, Blue-winged Teal, Green-winged Teal, Hooded Merganser, Mallard, Wood Duck and Ring-necked Duck. The Mallard, American Black Duck, Wood Duck, Blue-winged Teal and Canada Goose are also the most common species seen breeding in the NWA.

Table 9: Bird Species Documented in the NWA or Observed on Mississippi Lake

Species Family	Common Name and Scientific Name
Waterfowl Species Found in the NWA	American Black Duck *Anas rubipes*
	Blue-winged Teal *Anas discors*
	Green-winged Teal *Anas crecca*
	Hooded Merganser *Lophodytes cucullatus*
	Mallard *Anas platyrhynchos*
	Wood Duck *Aix sponsa*
	Ring-necked Duck *Aythya collaris*
	Canada Goose *Branta canadensis*
Water Bird and Marsh Dependent Species Identified in the NWA	American Bittern *Botaurus lentiginosus*
	Black Tern *Chilidonias niger*
	Common Loon *Gavia immer*
	Common Tern *Sterna hirundo*
	Least Bittern *Ixobrychus exilis*
	Marsh Wren *Cistothorus palustrisi*
	Pie-billed Grebe *Podilymbus podiceps*
	Virginia Rail *Rallus limicola*
	Swamp Sparrow *Melospiza georgiana*
	Sora *Porzana Carolina*
Other Observed Water Birds	Bald Eagle *Haliaeetus leucocephalus*
	Belted Kingfisher *Megaceryle alcyon*
	Great Blue Heron *Ardea herodias*
	Osprey *Pandion haliaetus*

There are also a variety of other water birds that utilize the wetland areas for migration and breeding. These can include marsh dependent birds or fishing birds, which are dependent upon the fish stocks for food and nest upland. Marsh dependent birds that have been identified in the NWA include; American Bittern, Virginia Rail, Swamp Sparrow, Sora and Least Bittern. Several of these species, and others, have been recorded as

breeding within the NWA; Common Loon, Marsh Wren, Virginia Rail, Black Tern, Pie-billed Grebe and Common Tern. Table 9 provides a listing of bird species documented on TWA or observed on Mississippi Lake.

The Common Loon is intrinsically connected to a natural lake environment; it is often the first species thought of when describing a lake ecosystem. Loons can be thought of as a keystone species, due to their sensitivity to human interaction and disturbance and the effect environmental contamination can have on the population. The effects of bioaccumulation of chemical substances can have profound effects on Loon reproduction. Due to their physical structure, maneuvering on land is quite difficult, so they nest close to the water's edge, any changes in water levels can drown eggs or make it too difficult to access the water. Volunteers around Mississippi Lake have been participating in the annual Canadian Lakes Loon Survey sponsored by Bird Studies Canada for a number of years. As summarized in Table 10, the survey documents the number of adult loons on the lake, and their relative breeding success by the count of surviving chicks.

Table 10: Summary of Recent Loon Surveys on Mississippi Lake

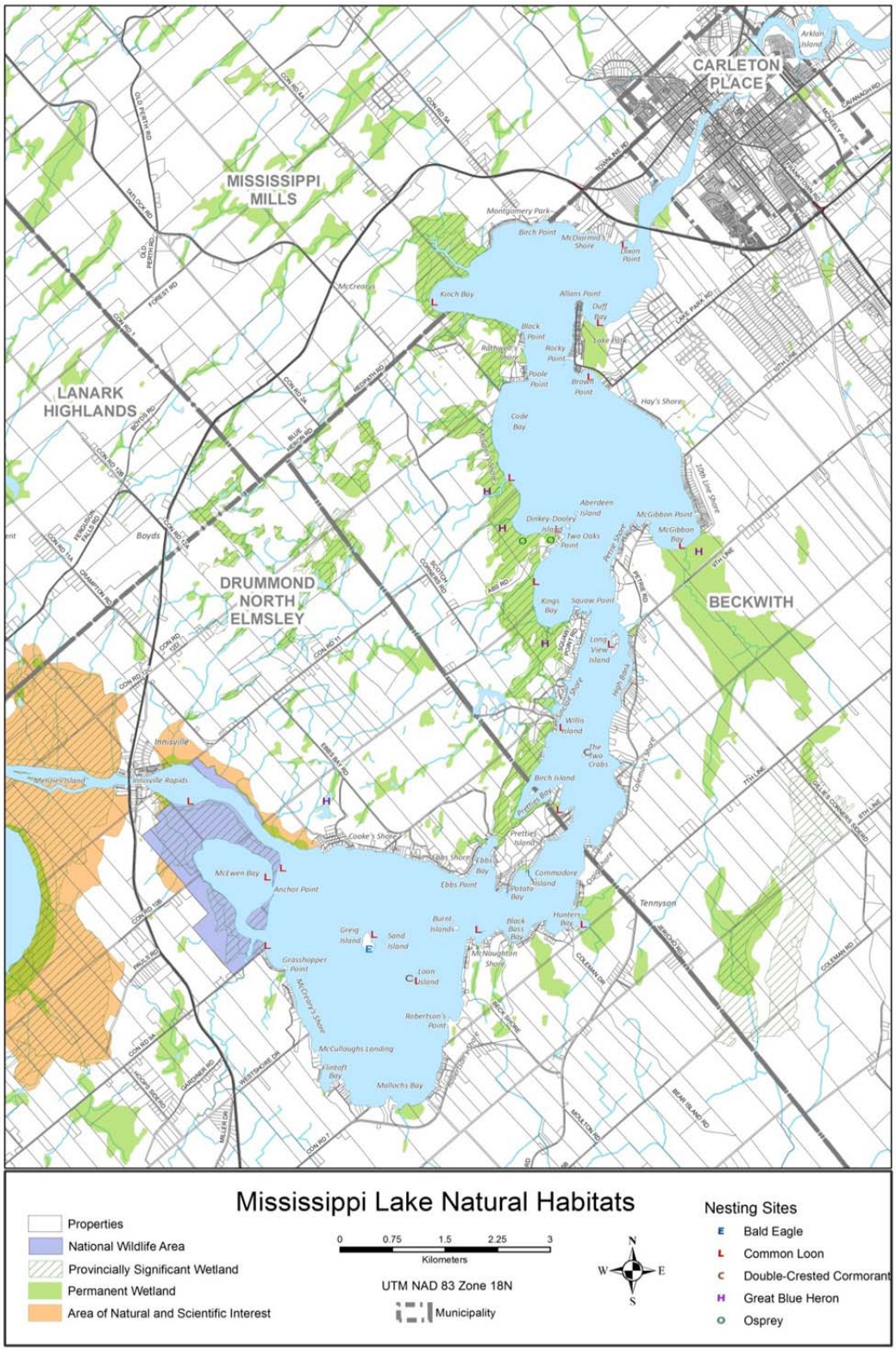
Number of Loons	2007	2010	2011	2012	2013
Maximum Number of Adults	24	35	35	39	40
Maximum number of mated pairs	10	12	11	12	13
Number of surviving young	8	7	5	8	8

Larger predatory species of birds have been observed around the lake during their breeding season, or the nest sites have been confirmed on the lake. Species such as the Great Blue Heron, Osprey and Bald Eagle all have observed nests on Mississippi Lake. Map 4 shows the locations of the known nesting sites of Bald Eagle, Common Loon, Double-crested Cormorant, Great Blue Heron and Osprey in the Mississippi Lake area (Loon survey and bird nesting sites courtesy Jo Ellen Beattie, 2013).

There is need for continued monitoring, and surveys of bird species that reside around Mississippi Lake, to better understand the current state of their health and abundance.

Bird Nesting Sites

Map 4: Locations of Known Bird Nesting Sites on Mississippi Lake



This map is produced in part with data provided by the Ontario Geographic Data Exchange under Licence with the Ontario Ministry of Natural Resources and the Queen's Printer for Ontario, 2014

Mississippi Valley Conservation Authority

7.2.3 Reptiles and Amphibians

The diverse habitat around the shores of Mississippi Lake, from wetland areas to upland and forest, provide suitable habitat for a number of reptile and amphibian species. Several amphibian species are considered keystone species, because of their sensitivity to suitable habitat indicating the relative health of the ecosystem. The NWA *Management Plan (Proposed)* has documented thirteen species of reptiles and amphibians within the NWA; the documented species are listed in Table 11.

Table 11: Reptile and Amphibian Species Identified in the NWA

Species Family	Common and Scientific Name
Frogs and Toads	Green Frog *Rana clamitans*
	Tetraploid Gray Tree Frog *Hyla versicolor*
	American Bullfrog *Rana catesbeiana*
	Northern Leopard Frog *Rana pipiens*
	Wood Frog *Rana sylvatica*
	Northern Spring Peeper *Pseudacris crucifer crucifer*
	Eastern American Toad *Bufo americanus americanus*
Snakes	Eastern garter Snake *Thamnophis sirtalis*
	Northern Water Snake *Nerodia sipedon sipedon*
Turtles	Midland Painted Turtle *Chrysemys picta marginata*
	Eastern Musk Turtle (a.k.a Stinkpot) *Sternotherus odoratus*
	Snapping Turtle *Chelydra serpentine*
Salamander	Northern Redback Salamander *Plethodon cinereus*

Photo 3: Gray Treefrog (www.ontarionature.org)

Photo 4: Midland Painted Turtle (www.ontarionature.org)

There is little known about the current health and abundance of reptiles and amphibians that reside around Mississippi Lake. Continued monitoring and surveying is required to complete this list of species.

7.3 Species at Risk

Species at Risk (SAR) are flora and fauna that have been identified as being at risk of disappearing from Canada, by Provincial and/or Federal legislation, through either loss of suitable habitat or population decline. The Canadian Government established the *Species at Risk Act* (2002) (SARA) to provide protection to wildlife at a national level. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established in 1977, to provide a scientifically sound classification of wildlife species at risk of extinction (Government of Canada, 2009). With the establishment of SARA, COSEWIC was designated as the independent body of experts responsible for identifying and assessing wildlife species considered at risk, for the federal government to consider for protection under SARA. The Ontario Provincial government also has legislation in place to protect at risk species; the *Endangered Species Act* (2007) (ESA) identifies species at risk, protects the species and their habitats, and promotes stewardship activities aimed at the protection and recovery of the listed species (Government of Ontario, 2007).

The legislation and committees involved in the protection of species at risk, classify the species into categories; extinct, extirpated, endangered, threatened, and special concern. Listed species may have a different status in different areas of the country, depending on population size and habitat. For the purposes of this report, species that have been listed under federal or provincial legislation have been included, as well as those listed under committee assessments.

Table 12 lists the species that have been identified in the National Wildlife Area (NWA), through the *Mississippi Lake National Wildlife Area Management Plan (Proposed)*. Though these species were only noted in the report as to their presence in the NWA, they may also appear in other locations on or around Mississippi Lake.

Photo 5: Canada Warbler

Photo 6: Eastern Musk Turtle

Photo 7: Broad Beech Fern

(Source of photos: http://www.ontario.ca/environment-and-energy/canada)

Table 12 is not to be considered a complete list of Species at Risk for Mississippi Lake. There may be other species present in the lake that are not included in this table. Continued monitoring and research is required to complete this list.

Table 12: Species At Risk identified at Mississippi Lake NWA

Common and Scientific Name	Status		
	SARA[1]	COSEWIC[2]	ESA[3]
Vascular Plants			
Broad Beech Fern *Phegopteris hexagonoptera*	Special Concern	Special Concern	Special Concern
Butternut *Juglans cinerea*	Endangered	Endangered	Endangered
Invertebrates			
Monarch *Danaus plexippus*	Special Concern	Special Concern	Special Concern
Reptiles			
Eastern Musk Turtle *Sternotherus odoratus*	Threatened	Special Concern	Threatened
Snapping Turtle *Chelydra serpentina*	Special Concern	Special Concern	Special Concern
Birds			
Bald Eagle *Haliaeetus leucocephalus*	No Status	Not at Risk	Special Concern
Barn Swallow *Hirundo rustica*	No Status	Threatened	Threatened
Black Tern *Chlidonias niger*	No Status	Not at Risk	Special Concern
Bobolink *Dolichonyx oryzivorus*	No Status	Threatened	Threatened
Canada Warbler *Cardellina canadensis/Wilsonia canadensis*	Threatened	Threatened	Special Concern
Eastern Meadowlark *Sturnella magna*	No Status	Threatened	Threatened
Eastern Wood-pewee *Contopus virens*	No Status	Special Concern	Not Classified
Golden-winged Warbler *Vermivora chrysoptera*	Threatened	Threatened	Special Concern
Least Bittern *Ixobrychus exilis*	Threatened	Threatened	Threatened
Red-shouldered Hawk *Buteo lineatus*	Special Concern	Not at Risk	Not Classified
Rusty Blackbird *Euphagus carolinus*	Special Concern	Special Concern	Not Classified
Wood Thrush *Hylocichla mustelina*	No Status	Threatened	Not Classified

[1]SARA (*Species at Risk Act*)-Extinct, Extirpated, Endangered, Threatened, Special Concern, Not at Risk (assessed and deemed not at risk of extinction), or no status (not rated).
[2]COSEWIC (Committee on the Status of Endangered Wildlife in Canada): Extinct, Extirpated, Endangered, Threatened, Special Concern, not at risk (assessed not at risk), or data deficient (available information is insufficient to resolve eligibility for assessment or permit an assessment of the wildlife species' risk of extinction).
[3]ESA, 2007 (*Endangered Species Act, 2007*): Ontario Ministry of Natural Resources (Species at Risk in Ontario (SARO) List): Extirpated, Endangered, Threatened, Special Concern, or not classified.

7.4 Invasive and Non-Native Species

Flora and fauna species that have been introduced to the area, but originate from other parts of the world, can be detrimental to the health of an ecosystem. Some non-native species can become well established in the new environment, and disrupt the native species, at which point they are classified as invasive species. Invasive species can out-compete native species for resources, such as food and habitat, and introduce new diseases and parasites. Some species, such as Eurasian Milfoil, can form colonies so thick they disrupt recreational activities, such as boating and swimming, by choking navigation channels and popular swimming areas. Invasive organisms reduce the biodiversity of an area, by crowding out native species through predation, parasitism, disease, and competition.

The *Mississippi Lake National Wildlife Area Management Plan (Proposed)* has outlined the various aquatic and terrestrial invasive flora and fauna species currently found in the NWA. Table 13 lists the observed invasive species; this should not be considered a complete list of invasive species. Of the species listed, Zebra Mussels have had a great impact on the lake ecosystem. Since they are filter feeder, they will remove sediment and suspended particles from the water column, in the process increasing water clarity. Increased water clarity will mean that sunlight will penetrate deeper into the water, increasing vegetation growth in the lake.

The Mississippi Lake Plan Community Survey ranked residential development 10th, for the most significant negative impact on respondent's enjoyment of the lake. Septic system issues were ranked 12th and commercial development was ranked 13th. However, many of the comments left by survey respondents related to development on the lake, in both positive and negative connotations as related to the lake environment.

Table 13: Invasive Species Found in the Mississippi Lake NWA

Species Type	Common and Scientific Name
Terrestrial Plants	Common Buckthorn *Rhamnus cathartica*
	Common Lilac *Syringa vulgaris*
	Purple Loosestrife *Lythrum salicaria*
	Scots Pine *Pinus sylvestris*
	Tartarian Honeysuckle *Lonicera tatarica*
Aquatic Plants	Eurasian Milfoil *Myriophyllum spicatum L.*
	European Frogbit *Hydrocharis morsus-ranae*
	Flowering-rush *Butomus umbellatus*
Invertebrates	Zebra Mussel *Dreissena polymorpha*
Birds	Double-crested Cormorant *Phalacrocorax auritus*
Fungus	Butternut Canker *Ophiognomonia clavigignenti-juglandacearum*

Of significant concern is the Emerald Ash Borer, a non-native insect that has made its way to Lanark County. The emerald ash borer is a green beetle native to Asia and Eastern Russia. Outside its native region, the emerald ash borer is an invasive species and is highly destructive to ash trees in its introduced range. The

Canadian Food Inspection Agency has reported confirmed finds of the Emerald Ash Borer in Pakenham and in the Carleton Place close to Mississippi Lake. The presence of Emerald Ash Borer could have a significant impact on the natural features around the lake given that ash trees are a popular ornamental tree in the cottage areas (since they are moisture tolerant) and are also a predominant species in in lowland hardwood ecosystems including our shoreline wetland areas. The expected loss of ash trees could provide opportunity for other invasive species such as buckthorn to take their place.

Photo 8: Emerald Ash Borer (Image from: www.nrcan.gc.ca)

This is not to be considered a complete list of Invasive Species for Mississippi Lake. There may be other species present in the lake that are not included in this table. Continued monitoring and research is required to complete this list.

8 Land Use and Development

8.1 Settlement History

Prior to European settlement of the Mississippi Lake area, the lake and its watershed existed in relative ecological harmony. Following the War of 1812, the British Government settled Crown lands in Lanark County with discharged soldiers. At the turn of the 19th century, the land was cleared for logging and agriculture. Carleton Place (Morphy's Falls until about 1829) was a mill town, and Morphy built the first Carleton Place dam in 1820. As early as the 1840s, there were lumber drives on the Mississippi River, and lumber barons claimed public rights for navigation of logs along its length.

Farming was one of the first forms of settlement on Mississippi Lake. In 1816, the first farms were settled on the southeast shore's 7th Concession, the original 6 farms on this shore were founded by the; McDonnells, McNaughtons, Robertsons, Hunters, Flintoffs and O'Neills. Pioneering families with farms abutting the shoreline had the privilege of naming the bays, islands, and points of Mississippi Lake. The names given to some of these landmarks by the families are; Willis, Brown, McCreary, McCullough, Coleman, Hay, and McCann.

Information Gap:
We are looking for information about cottage lot development around the lake; when was Mississippi Lake first developed as a cottaging area? Where did it start? How did it grow and change over time, until now?

As the largest lake within an easy commute of Ottawa, Mississippi Lake is seeing a significant change in the amount and type of development around the lake. The recent twinning of Hwy 7, the major road linking the City of Ottawa and Carleton Place, has improved the commute from the city. The area is becoming more attractive as a bedroom community and as a recreational get-away. The Mississippi Lake area is undergoing a shift, from seasonal properties to permanent homes; there is also increased development pressure in back lot areas.

8.2 Population

Mississippi Lake is bordered by three municipalities, the Township of Beckwith, the Township of Drummond/North Elmsley, and the Town of Mississippi Mills, and is immediately upstream of the Town of Carleton Place. As shown in Table 14 these municipalities have shown varying rates of growth in population between 2006 and 2011, with Beckwith showing the largest growth at 9.4% and Carleton Place the lowest at 3.8%. Table 14 also shows population projections produced by each municipality for the purpose of planning for growth and development. Beckwith is projecting growth that would result in a 62 % increase between 2011 and 2026; Drummond/North Elmsley's projected growth would result in 34% increase between 2011 and 2028; Mississippi Mill's projections would mean 49% growth between 2011 and 2026; and Carleton Place

projected a low growth scenario that would result in a 13% increase between 2011 and 2031 and a high growth scenario resulting in 38% growth over the same period.

Table 14: Population Statistics for Surrounding Municipalities

Municipality	Population 2006	Population 2011	% Change	Avg. Annual Increase %	Projected Population (year)	% change	Avg. Annual Increase %
Beckwith	6567	6986	9.4	1.8	11,230 (2029)	62	4.1
Drummond-North Elmsley	7118	7485	5	1-1.5	10,000 (2028)	34	2.0
Mississippi Mills	11704	12385	5.5	1.1	18,500 (2026)	49	3.3
Carleton Place	9437	9809	3.8	0.76	11,132 to 13,571 (2031)*	13 to 38	0.7 to 1.9

(Source: Statistics Canada, 2011 Census Data)
(Source for Populations Projections – Municipal Official Plans)

While these populations and projected growth in population are spread throughout each municipality and would not translate to the same levels of growth around Mississippi Lake itself, they are indicative of the overall growth of the area. As the local populations grow, Mississippi Lake will likely see more development within surrounding areas accompanied by more overall recreational use by day users that live nearby.

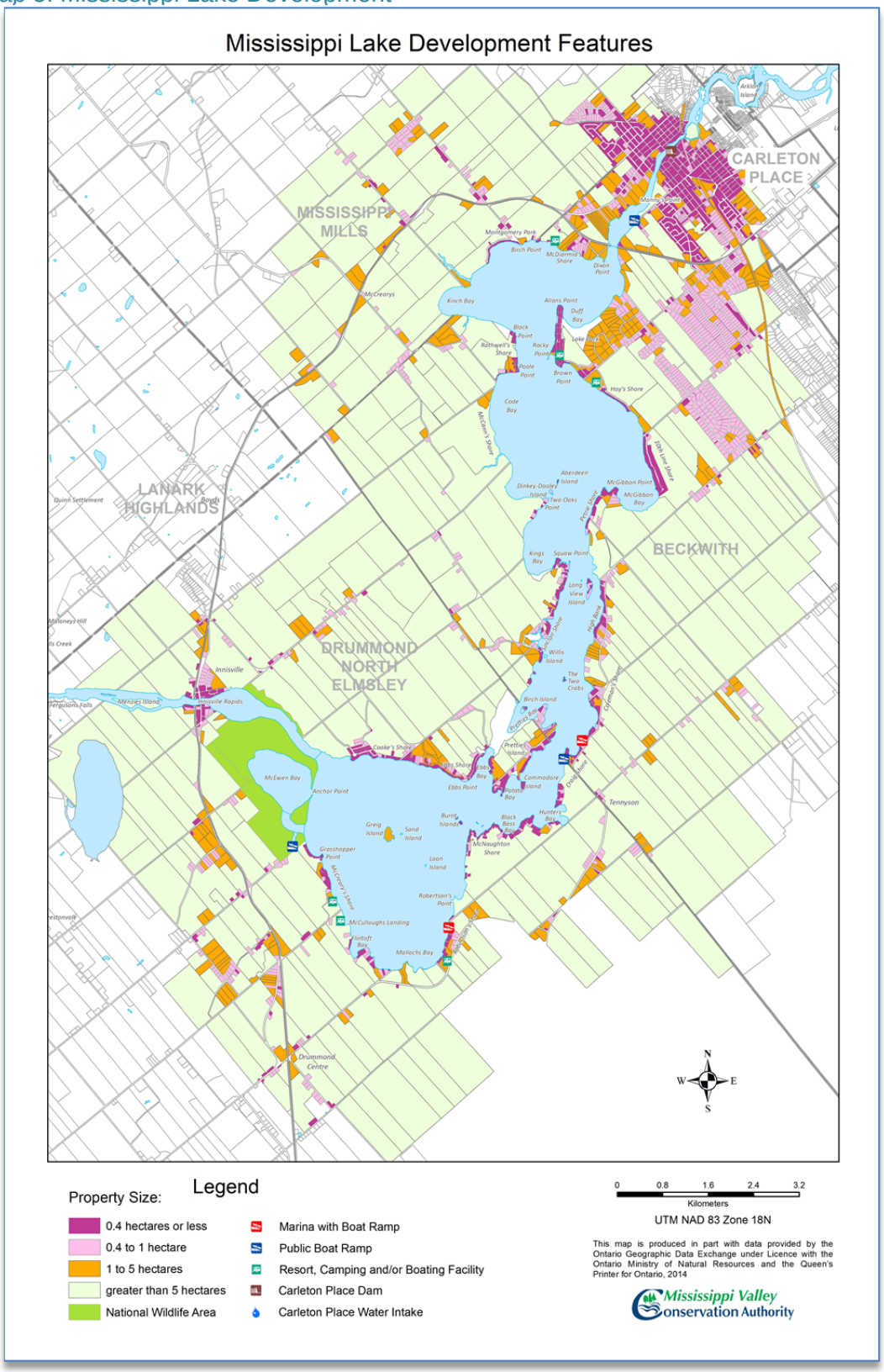
8.3 Current Land Use and Development

The four municipalities around Mississippi Lake share a mix of residential, both permanent (year round) and cottage (seasonal), and commercial development (resort, campgrounds, marinas). Map 5 shows the distribution of development around Mississippi Lake including residential land use, resorts and marinas. Park lands and public and private (commercial scale) boat ramps are also shown.

For Map 5, properties are colour coded according to size to provide a representation of the density of development within a 2.5 km area around the lake. The colour coding represents the following property size ranges: 0.4 hectares (1 acre) or smaller, 0.4 to 1 hectare, 1 to 5.hectares, and greater than 5 hectares.

Map 5 highlights the fact that while there are many areas of concentrated smaller properties (1 acre or 0.4 ha or less) along the shores of the lake (shown as dark pink), there are also concentrations of 0.4 to 1 hectare properties (shown as light pink) representative of rural estate lot type development around the lake, particularly in the Township of Beckwith at the east the lake. Small concentration of larger scale rural estate residential made up of 1 to 5 hectare properties (orange) are seen closer to the lake and along some of the major roadways.

Map 5: Mississippi Lake Development



The large tracts of properties greater than 5 hectares in size (pale green) right around the lake are representative of low density/undeveloped areas that either have physical characteristics that make them unsuitable for development or are protected because of special environmental features. Further away from the lake these larger properties are representative of the predominantly rural character of the surrounding landscape.

Table 15 presents a summary of the number of waterfront and back lot properties shown on Map 5, categorized by size, as either high density or low density. The numbers properties and numbers presented in Map 5 and Table 16 were derived from 2014 Assessment Parcel mapping. There are an estimated total of 983 properties that have direct frontage on Mississippi Lake. Of those properties 796, or 81 percent, are 04. Ha (1 acre) or less in size. There are another 2006 properties that are within 2.5 km of the shoreline of Mississippi Lake, without direct frontage on the water. About 30% of those properties are also 0.4 Ha (1 acre) or less in size. Many of the small and rural estate type lots are concentrated around the shoreline, close to the Town of Carleton Place, and in parts of Beckwith that are within the Black's Corners Community Development Area.

Table 15: Summary of Properties Shown on Map 5

	Property Size	Beckwith	Drummond/ North Elmsley	Mississippi Mills	Lake Totals	Carleton Place
Waterfront	1 acre or less	425	330	41	**796**	62
	1 acre to 1 ha	54	27	1	**82**	5
	1 ha to 5 ha	54	37	2	**93**	9
	greater than 5 ha	4	2	6	**12**	2
	Total Waterfront Properties	537	396	50	**983**	78
Backlot (within 2.5 km of lake)	1 acre or less	310	249	41	**600**	2924
	1 acre to 1 ha	585	168	100	**853**	168
	1 ha to 5 ha	131	62	33	**226**	35
	greater than 5 ha	115	157	55	**327**	7
	Total Backlot Properties	1141	636	229	**2006**	3134
Total Properties		**1678**	**1032**	**279**	**2989**	**3212**

Source: 2014 Assessment Parcel Mapping Layer

Table 16 presents an approximation of the number of permanent, seasonal and vacant properties with frontage directly onto Mississippi Lake. This information was derived from assessment information and property counts. With most roads around the lake having year round maintenance it's often not known whether property owners are living at the lake year round. This makes it difficult for the municipalities to

determine accurate counts of the number of dwellings that are used as permanent residences as opposed to seasonal cottages.

Table 16: Mississippi Lake Waterfront Properties

Municipality	Permanent	Seasonal	Vacant	Total
Beckwith	314	217	N/A	531
Drummond-North Elmsley	117	245	30	392
Mississippi Mills	41	15*	?	56
*number of dwellings in campground				
(Municipal Staff): info in table to be verified by municipal staff				

Note: There is a discrepancy in the total number of water front between what is shown in Table 15 and what is shown in Table 16. This reflects the different sources of data for that were needed to derive the different information presented. The Map 5 and Table 15 data was derived from 2014 Assessment Parcel Mapping and the counts of permanent, seasonal and vacant properties presented in Table 16 were provided by the municipalities.

Shown in Map 6 are the features that pose a constraint to development, which include:

- **Provincially Significant Wetlands (PSW):** Provincial Policy prohibits or restricts new development in PSWs and on "adjacent lands" within 120 metres of the wetland boundary (see section 7.1.1Wetlands). Those policies are reflected in the policies of the municipal Official Plans. PSW's and their adjacent lands are also regulated by MVCA;

- **Locally Significant Wetlands:** The municipalities include policies in their Official Plans to restrict development in locally significant wetlands. McGibbon Creek Wetland on the south side of the lake in Beckwith Township is classified as locally significant;

- **Other permanent wetland areas:** potentially unsuitable for development due to environmental features and/or drainage and soils stability issues. Development is only restricted where they have been identified in the Official Plan. There are wetlands at Hunters Bay, Mallochs Bay, Lake Park and several other small wetland areas that are not protected through the OP's but fall within the regulated floodplain area where development is restricted;

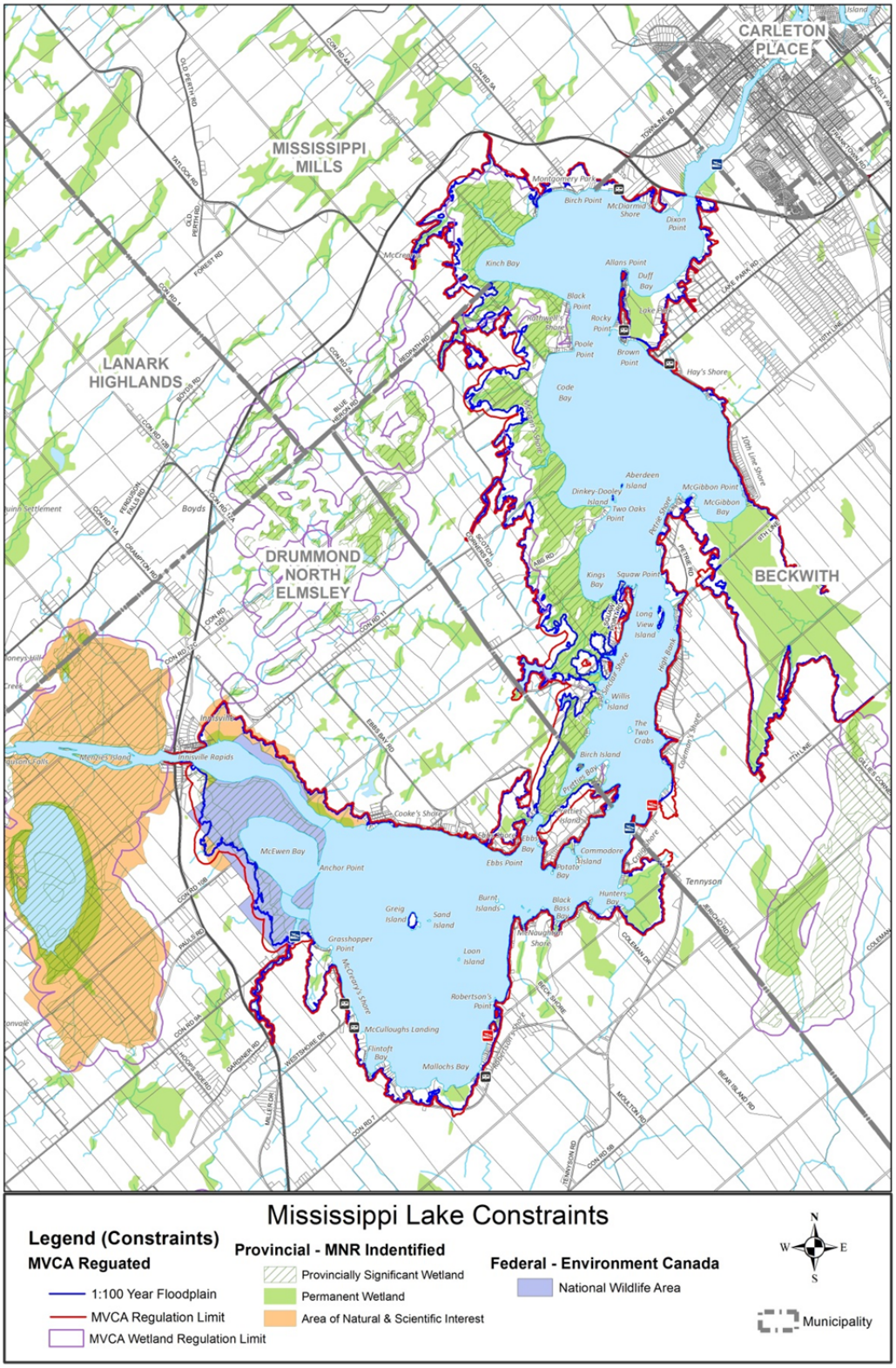
- **Areas of Natural and Scientific Interest (ANSI):** The ANSI areas at the southwest end of the lake were identified by Ministry of Natural Resources to apply special status to the Innisville Wetlands. Under Provincial Policy development is not permitted within an ANSI unless it has been demonstrated though an Environmental Impact Study that there will be no negative impacts on the natural features or their functions;

- **Mississippi Lake National Wildlife Area:** This federally owned property at McEwen Bay is managed by Environment Canada. Under the Canada Wildlife Act, Environment Canada enforces Wildlife Area regulations aimed at the protection and conservation of wildlife and their habitat. (see section 7.1.2National Wildlife Area)

- **1:100 year floodplain and associated regulation limits:** In these areas development is restricted or limited subject to Mississippi Valley Conservation Authority (MVCA) Regulations (see section 5.2 Floodplain Mapping)

Private roads (not shown map): also present a constraint to development as many municipalities no longer permit development in areas that can be accessed only through private road.

Map 6: Mississippi Lake Development Constraints



This map is produced in part with data provided by the Ontario Geographic Data Exchange under Licence with the Ontario Ministry of Natural Resources and the Queen's Printer for Ontario, 2014

8.3.1 Beckwith

The Township of Beckwith has the highest number of Mississippi lake waterfront properties, with 314 Single Family Detached Dwellings and 217 Seasonal Recreational Dwellings. The Township does not have information on the number of vacant properties along the shoreline. The majority of development around the lake has taken place on private roads, which are roadways that are not maintained by the municipality. As the Township's Official Plan no longer permits creation of lots on private roads, it is unlikely the number of lots around the lake will increase significantly.

There are nine (9) properties around the lake subject to a form of commercial zoning. A number of these parcels are developed with businesses, including a marina, 2 restaurants and a campground. Future commercial activities on the remaining parcels containing commercial zoning would have to be relatively small-scale to reflect the size of these parcels.

The Township of Beckwith requires development in a variety of zones to receive site plan approval from Council prior to construction. This process involves making an application to the Township that outlines the proposed development. The Township circulates this application to public agencies to seek technical input on the proposed development. The Township also provides notice of a public meeting to property owners within 60 metres of the subject application. This process helps to minimize the impact of development in sensitive areas. The Township implements site plan approval if development is proposed within the following zones: Flood Plain, Residential Limited Services, all Commercial, all Industrial, Institutional, Mobile Home Park and Wrecking Yards. The majority of development around Mississippi Lake is required to obtain Site Plan approval prior to initiating construction.

The preceding was provided in part by the Township of Beckwith (Niall Oddie, Planner Beckwith Township 2014).

8.3.2 Drummond North-Elmsley (DNE)

The Township of Drummond/North Elmsley has 117 Permanent homes, 245 seasonal cottages and 30 vacant potentially buildable lots on Mississippi Lake. Most undeveloped shoreline in the Township is protected as either locally or provincially significant wetland. Areas of concentrated development include Cookes Shore/Ebbs Bay Drive where there is a greater portion of year round residences. In areas such as Pretties Island, seasonal residences prevail.

Regular and ongoing redevelopment of seasonal properties into larger seasonal or year round properties will likely continue at a rate of 10-15 a year. Any future development would have to occur on existing private or new public roads, as the Official Plan does not allow new or extended private roads.

There are 2 major commercial areas in DNE on the lake: McCreary's Beach and McCullough's Landing. McCreary's is a fractional ownership cottage/RV campground with over 120 sites. McCulloughs Landing has about 180 RV and cottage sites. These 2 parks are situated close together and are both accessed off of Westshore Drive. A mobile home park is proposed near an existing one on Concession 7 that will not front on the lake but will overlook it (Grenke, 2014). The potential for new commercial uses on the lake is quite limited, constrained by private road and lot size requirements.

The Township of Drummond/North Elmsley also uses Site Plan Control to implement site specific development conditions (i.e. Shoreline vegetation, permeable paving stones for patios, etc.) to implement good shoreline planning and specific shoreline development provisions of their Official Plan. Site Plan Control allows the township to work on a case by case basis with property owners, respecting the individual conditions of each lot. In Drummond/North Elmsley Site Plan Control is required for all uses within natural heritage areas or adjacent to a waterbody, where the proposed development may have an impact on the ecological function of the waterbody.

8.3.3 Mississippi Mills

A small portion of the Town of Mississippi Mills is located on the north end of Mississippi Lake. Currently there are a total of 41 permanent dwellings on Mississippi Lake including the Birch Point campgrounds. The campgrounds have 15 seasonal dwellings, bringing the total to 56 dwellings on the lake. It is not known how many lots are developed on the lake per year or how many developable lots of record exist. It is also not known at what the rate of cottage conversions occurs. There are no commercial properties in the Mississippi Mills portion of the Mississippi Lake shoreline.

8.3.4 Carleton Place

The current development along the Mississippi River downstream of the lake is a mix of public and private lands. Approximately half of the land on either side of the river within the town is publicly owned, including Roy Brown Park and Riverside Park. Presently there are 17 residential buildings along the river, 1 large commercial development, and 3 commercial buildings. Some of the lands bordering the river are restricted to development by wetlands and flood plains. No new development is underway in this area but there are several undeveloped parcels of land. It is not known how many developable lots of record exist on this portion of the river.

Carleton Place has municipal water and sewage treatment. It is estimated that there is enough sewage capacity for at least another 10 years of development. Carleton Place draws its drinking water from the Mississippi system. The Mississippi and Rideau Source Water Protection Plan has determined that influences to this drinking water source can extend up to 3 km from the intake. The report recommends the use of good stewardship practices by all land users upstream to ensure good drinking water quality be maintained.

8.4 Policies for Managing Growth and Development

8.4.1 Municipal Official Plans

Each municipality is responsible for the guiding growth and development within its area of jurisdiction through the adoption and implementation of their Official Plan (OP) and Zoning By-Law documents. The Official Plan is the primary planning document, providing goals, objectives and policies, that guide where and how various types of development should take place throughout the municipality. The OP outlines how land can be used in accordance with broad land use designations (ex. residential, industrial, commercial, wetland). It also sets out policies to guide the process (ex. requirements for Site Plan approval and/or supporting studies such as Environmental Impact Statement). The Zoning By-law is an implementation tool for the Official Plan. It sets out the detailed regulations to control specific land uses and the form of development at the property level. It includes specifics about permitted uses, setbacks from features and lot lines, lot sizes and building sizes.

8.4.1.1 General Policies for Mississippi Lake and other Waterbodies

Official Plan land use designations and policies form the primary basis for guiding future growth and development throughout the municipality. The Beckwith, Drummond/North Elmsley and Mississippi Mills Official Plans each contain goals, objectives or assumptions that specifically recognize Mississippi Lake and other waterbodies as important features in their planning framework:

Beckwith Official Plan

- Section 3.2: *"It is recognized that there will be a need to provide for limited development within the rural areas including development and redevelopment around Mississippi Lake. The policies of the Plan are based on such development taking place under controlled conditions so that it does not become a financial burden to the Township. The Township will manage redevelopment around Mississippi Lake to ensure that impacts to water quality, the lake environment and public health and safety are mitigated."*

Drummond North Elmsley Official Plan

- Section 2.2.2 *"Development is expected to continue to take place along the major waterways and other lakes of the Township, in the hamlets, and in the rural areas of the Township. As a consequence, the policies of this Plan must address a wide range of issues related to the impact of future development."*

- *2.2.3 "Development potential in the Township will be affected by the numerous natural heritage features and areas, renewable and non-renewable resources, and environmental constraints*

such as the Rideau Canal, the Mississippi River, lakes, floodplains and wetlands, all of which must be protected."

- *2.2.4 "The numerous lakes and rivers in the Township provide considerable potential for recreation and tourist development…."*
- *2.2.5 "The numerous recreational waterbodies in the Township have created a municipality which caters to both permanent and seasonal resident."*
- *2.2.6 "Many seasonal and permanent residential dwellings have been constructed along the lakes and rivers in the Township, with access by private roads. It is expected that some additional waterfront development on private roads and conversions from seasonal to permanent dwellings will continue, as residents continue to choose waterfront properties."*
- *2.2.7 "It is expected that future development in the Township will take place on private water supply and septic systems. As a result, development will take place at relatively low densities."*

Mississippi Mills Official Plan

- Section 3.1.1 Goal to: *"Recognize Mississippi Lake, Clayton Lake, White Lake, Madawaska River and the Mississippi River and its tributaries as major recreational, social and economic assets within the community."*
- Section 3.7.11 *"The Mississippi Lake and River, Clayton Lake, White Lake and Madawaska River represent important areas of open space and are defining features of the physical landscape of Mississippi Mills. This Plan shall strive to maintain and enhance public access to these water bodies. The Town shall undertake a program to clearly identify public access points along its water bodies."*

The Official Plans also contain goals, objectives and policies that are more broadly aimed at managing growth and development on all lakes and waterfront areas throughout the municipality.

Beckwith:

- Section 4.19 - Setback from Water Policies requiring implementation of a 30 metre setback from water for development. A decrease is only considered on an existing lot of record which cannot meet a 30 metre setback and must ensure the greatest setback possible is achieved.
- Section 4.20 - Policy allowing the implementation of Site Plan Control on all waterfront properties and designated wetlands. Provides municipality with greater control in managing various aspects of the development including design and appearance, landscaping, parking and drainage.

- Section 5.5.1(xi) - Under policies for the dedication of park land as a condition on division of land, indicates the intention to obtain, wherever possible and practical, waterfront lands around Mississippi Lake".

Drummond/North Elmsley (DNE) Official Plan

- Section 6.11.2 - Policy supporting Lake Plans indicating that consideration will be given to planning recommendations and policies in Otty Lake Management Plan, and that "s*hould other similar watershed studies be prepared by qualified professionals and/or under the supervision of the appropriate public agencies, Council shall also be guided by the planning recommendations and policies contained therein which are consistent with the policies of this Plan..."*
- Section 6.9.1 - Waterfront Development policies to guide new development and redevelopment adjacent to water. Require implementation of a 30 metre setback from water for all new development and require an *"Environmental Impact Study to demonstrate there will be no negative impact".* For redevelopment of existing structures within the 30 metre setback, no further reduction in the deficient setback permitted.
- Section 6.9.2 - Applicants required to submit a plot plan which illustrates the location buildings and structures on the lot, shoreline access, shoreline vegetation and mitigation measures to be implemented where the shoreline and shoreline vegetation within the setback have been previously altered or are disturbed
- Section 6.9.3 - Large development proposals (i.e., greater than 5 lots, resort/condominium development, etc.) shall be supported by a site evaluation report prepared in consultation with the Ministry of the Environment to determine the impact on the water quality of the water body.

Mississippi Mills:

- Section 4.1.1 - Surface and groundwater protection policies aimed at identification and mapping of water resources, coordinated watershed planning and the establishment of site specific development review criteria.
- Sets zoning by law requirements for a minimum setback of 30 metres from water. Reduction in the setback requires an amendment to the zoning by-law along with requirements for a vegetated buffer between the development and the water.

8.4.1.2 Official Plan Land Use Designations and Policies around Mississippi Lake

In terms of specific land use designations for Mississippi Lake waterfront and backlot areas, all three municipalities identify:

- Floodplain or Environmental Hazard designation - to identify and restrict development in floodplain areas (see Section 8.4.3).
- Wetland or Environmental Protection designation - to identify and restrict development in the Provincially Significant Wetlands. New development is not permitted within the wetland designation and development within 120 metres of the wetland must be supported by an Environmental Impact Study demonstrating no negative impact to the features or functions of the wetland.
- Rural areas designations – designations that apply to most remaining lands not designated floodplain or wetland.

Apart from the lands that are unsuitable for development because they are designated wetland and/or floodplain, most waterfront and backlot areas around Mississippi Lake fall under the "Rural" (Drummond/North Elmsley and Mississippi Mills) and "Rural Lands" (Beckwith) designations. Future development around Mississippi Lake will therefore be governed primarily by the applicable Rural/Rural Lands designation policies contained in each Official Plan. As listed in Table 17, each of the three municipalities permit a broad range of uses within their Rural/Rural Lands designations, including various types and scales of residential, commercial and industrial uses. The OPs set specific policies for each permitted use that may differ from one municipality to another.

Table 17: Uses Permitted in the "Rural Lands" and "Rural" Official Plan Designations for Each Municipality

Beckwith Township "Rural Lands" Designation:	Drummond/North Elmsley "Rural" Designation:	Mississippi Mills: "Rural" Designation:
Rural residential Commercial Industrial Outdoor recreation Plus, uses permitted in Agricultural designation as described below	Agriculture Hobby farms Residential Limited Services Residential Commercial Tourist Commercial Industrial	Agriculture and related businesses Forestry Conservation and Management of Natural Environment Residential Dwellings and Accessory Uses Rural Commercial Uses (small scale) Resource based or Resource-related Industry Tourist Commercial

The Beckwith Township Official Plan identifies a special "Rural Residential – Special Policy Area" designation for the Gardiner Shore properties near the 10th Line. The Plan of Subdivision process was used to transition this area from a historic "unplanned cottage area" into a "lake-oriented rural residential community". This planning exercise included the phasing out of some of the original dwellings. Site plan control is used to regulate development in this area.

The Beckwith Township Official Plan also designates several large areas to the southeast of Mississippi Lake as "Agricultural". Land uses permitted under the Agricultural designation include: agricultural uses; agriculture-related commercial and agriculture-related industrial uses that are small scale and directly related to the farm operation and are required in close proximity to the farm operation; and secondary farm occupations, including home occupations, home industries, bed and breakfast operations, agri-tourism uses and uses that produce value-added agricultural products from the farm operation on the property. These uses are also permitted within the "Rural Lands" designation.

The Drummond/North Elmsley Official Plan identifies a "Hamlet" designation around Innisville at the west end of the lake. The policies for the Hamlet designation provide for expansion of the existing development, allowing for a mix of uses including: a variety of residential uses (single and multi -residential), institutional uses, commercial uses, and industrial uses. Where residential development is proposed next to a waterbody, the applicant is required to submit a plot plan in accordance with the Waterfront Development policies.

McCreary's Beach Resort and McCullough's Landing Resort both fall within the Rural designation of the DNE Official Plan and are both zoned Tourist Commercial in the Zoning By-law. The Official Plan identifies a "Mobile Home Development" designation around a Mobile Home Park that is located off of Drummond Conc. 7.

8.4.1.3 Lot Creation, Subdivision and Multi-Residential Development Policies

In the Rural designation, the Beckwith Township Official Plan (Section 6.5.1) permits the creation of lots by severance and by Plan of Subdivision to a maximum of 25 lots. A proposal to expand beyond 25 lots requires an amendment to the Official Plan and will be subject to an assessment of the availability of undeveloped land within the Community Development Areas, actual growth rates in relation to growth projections, and demand. Council will also consider proposals for multiple residential development (ex. condominium) in the Rural area, "for exceptional circumstances" such as one related to a major recreational facility or public and private senior citizens projects, and subject to various supporting studies and reports.

The Drummond North Elmsley Official Plan (Section 6.3) indicates that Hamlets will be the primary focus of development and outside of the Hamlets, lot creation shall occur on a limited basis, where Council will take into consideration the number of existing lots of record in the Township. The OP also sets out detailed consent and subdivision policies. It directs that division of land by consent (severance) is intended for the creation of a limited number of lots. Generally, where more than three lots have been severed from an original parcel of land since January 1st 1979, further development must occur by plan of subdivision. Plans of subdivision are generally to be limited to no more than 30 lots through larger subdivisions can be permitted subject to phasing requirements to assess the overall and cumulative impacts of development.

In the Rural designation, the Mississippi Mills Official Plan (Section 3.3.5) permits the creation of up to two lots per land holding by severance subject to a number of specific policies including a minimum lot size of one hectare. The OP also sets out policies for "Cluster Lot Development" which allows for the creation of a grouping of three to five lots by consent, subject to a set of very specific requirements. This concept is being tested as a pilot project, whereby once a

maximum of 40 lots have been created throughout the municipality using this approach, the policies will be assessed to determine if policy changes are required. In Mississippi Mills, rural estate lot subdivisions are not a permitted use in the Rural designation.

8.4.1.4 Mobile Home Development

In Beckwith Township, the Mobile Home Parks policies under Section 6.6 of the Official Plan state that the establishment of a new mobile home park will require amendments to the Official Plan and the Zoning By-law. The requirement for an OP amendment brings with it a more rigorous planning approval process that triggers requirements for a variety of supporting justification, studies and assessments. Section 6.6 also sets out access, servicing and design requirements specific to mobile home park development.

In the Drummond/North Elmsley Official Plan, Mobile Home Parks are not specifically identified as a permitted use in the Rural designation. Mobile Home Parks fall under their own designation, separate from the Rural designation. The Mobile Home Designation applies only to existing mobile home parks. Section 4.5 of the OP outlines policies guiding the establishment of a new mobile home development including the requirement for an amendment to the Official Plan along with a host of specific requirement for access, servicing and design. A new Mobile Home Park would have to be considered through the Official Plan Amendment and Zoning Amendment process and subject to identified studies.

The Mississippi Mills Official Plan does not have policies specifically permitting Mobile Home Parks.

8.4.1.5 Tourist Commercial Development

The Beckwith Official Plan directs commercial development to specific areas within the community development areas, but also anticipates a need for small scale commercial development in the rural area, as well as resort commercial development associated with Mississippi Lake and River or with other significant recreational facilities. Commercial uses will be allowed in the Rural Land designation in accordance with policies regarding the nature of the use relative its location, access, parking, also set out requirements to minimize impact to environmental features, natural resources and the rural character of the surrounding area, along with requirements regarding lot size, access, traffic studies, and other design and servicing requirements. Tent and trailer parks will be permitted in the Rural designation. New tent and trailer parks will require an amendment to the Zoning By-law and the site development standards such as lot area, density, campsite area, frontage and others, will be established in the Zoning By-law.

In the Rural designation, the Drummond/North Elmsley Official Plan (Section 4.3.7) permits a variety of tourist commercial uses including: hotels, motels, resorts, recreation facilities such as golf courses, ski centres, facilities related to boating such as marinas, tent and trailer parks, campgrounds, summer camps, hunting and fishing camps, restaurants and similar uses that directly serve tourists. Institutional uses such as museums and an accessory dwelling or dwelling unit are also permitted. New tourist commercial uses will require an amendment to the Zoning By-law and will be subject to Site Plan Control. The Official Plan also sets out a number of specific requirements pertaining to design, servicing, access, parking, and so on.

In the Rural designation, the Mississippi Mills Official Plan (Section 3.3.2) also permits a variety of tourist commercial uses including: tourist lodging facilities (such as hotels, motels, resorts, country inns, rental cottages), summer camps, clubs, places of entertainment, recreational facilities (such as hunt camps, marinas and existing ski hills and golf courses and existing tent and trailer campgrounds); retail commercial establishments catering to the day-to-day needs of the tourist; cultural uses and maple syrup related uses. Under the Tourist Commercial Policies (Section 3.3.8.2) new tent and trailer campgrounds, golf courses and ski hills are only permitted through and amendment to the Official Plan and would be subject to Site Plan Control. The policies also set out requirements to minimize impact to environmental features, natural resources and the rural character of the surrounding area, along with requirements regarding lot size, access, traffic studies, and a host of design and servicing requirements.

8.4.2 Municipal Zoning By-law Provisions around Mississippi Lake

Where the Municipal Official Plans are intended to provide a vision for future growth and generally guide where new homes, schools, businesses and parks should be located, the Zoning By-Laws guide the specifics of how the development can take place within the property**.** Table 18 presents a summary of the Zoning By-law provisions that apply to the residential zoning categories identified by each of the four municipalities for properties around Mississippi Lake. The two most common zoning categories used by Beckwith, Drummond North Elmsley and Mississippi Mills for rural and waterfront development are “Limited Services Residential” and “Rural”. Mississippi Mills also uses a “Rural Residential” category. Carleton Place uses “Residential” and “River Corridor” for its residential zoning along the river. The “Limited Services Residential” zoning for Drummond/North Elmsley, Beckwith and Mississippi Mills applies to properties accessed by private roads.

A review of Table 18 shows that while some zoning requirements, such as the minimum lot size requirements, are generally quite similar between the four municipalities, there are some differences. Carleton Place permits much smaller frontages on its waterfront properties. This likely reflects standards used for development on full municipal services where additional area is not required to accommodate on-site septic systems and wells.

There is also variability in the maximum permitted lot coverage which is the amount of structural footprint that can cover the property, calculated as a percent of the property’s total area. The average around the lake, where properties are on private services, is 15%, with Beckwith permitting 30% and Drummond North Elmsley and Mississippi Mills permitting 15% in the LSR zone. Carleton Place permits 60%, again most likely a reflection of the standards for development on full municipal services.

The zoning requirements that vary the most between the four municipalities are the setbacks. The setback that has the most impact on waterfront properties is the shoreline setback, measured as a setback from the high water mark (hwm). Drummond North Elmsley applies a standard 30 metre setback, whereas the other municipalities use different setbacks either depending on when the lot was created or depending on various physical or environmental features on the site. Beckwith uses 30 metre for all lots created after June 1, 1999 and 20 metres for lots created before. Mississippi Mills the greater of a 30 metre setback from the hwm or a 15 metre setback from the floodline. Carleton Place uses a 30 metre setback from a natural shoreline and 15 metres from a hardened shoreline.

Table 18: Zoning By-Law Requirements for Residential Uses around Mississippi Lake

Township	Beckwith		Drummond/ North Elmsley		Mississippi Mills			Carleton Place	
Zone	**LSR**	**Rural**	**LSR**	**Rural**	**LSR**	**Rural Resid.**	**Rural**	**Resid. (SFD)**	**River Corridor (SFD)**
Lot Size									
Lot Area (min.)	0.4 ha	0.4 ha	0.4 ha	0.4 ha	0.4 ha	0.4 ha	1 ha	Nil	Nil
Lot Frontage (min.)	45 m	45 m	50 m	45 m	60 m	45 m	45 m	10.6 m	10.6 m
Lot Coverage (max.)	30%	10%	15%	20%	15%	15%	15%	60%	60%
Building Height (max.)	9 m		11 m		11 m			11 m	
SETBACKS (minimum, unless otherwise stated)									
Front Yard	9 m	15 m	30 m	30 m (waterfront) 7.5. m non-waterfront	7.5 m	15 m	9 m	4.5 m min, 7.5m max	4.5 m min, 7.5m max
Exterior Side Yard	9 m	15 m	7.5 m	7.5 m	7.5 m	15 m	9 m	4.5 m	4.5 m
Interior Side Yard	3 m	3 m	3 m	3 m	3 m	6 m	6 m	1.2 m	1.2 m
Rear Yard	6 m	15 m	7.5 m	7.5 m	7.5 m	25 m	9 m	7.5 m	8.0 m
Setback from High Water Mark	lots created prior to 06/01/1999: 20 m; lots created after 06/01/1999: 30 m		30 m		Buildings: greater of 30 m from hwm or 15 m from flood line. Septic tank /tile field: greater of 30 m from hwm or 23 m from flood line.			30 m from natural shoreline; 15 m from hardened shoreline	

LSR: Limited Services Residential zone
SFD: Single Family Dwelling (Carleton Place has slightly different zoning provisions for Residential/River Resid. semi-detached dwellings and duplexes)
Sources: (Township of Beckwith, 1991) (Township of Drummond/North Elmsley, 2012) (Town of Mississippi Mills, 2000) (Town of Carleton Place, 2008)

The zoning by-laws also set out other general provisions that apply to all properties regardless of their zoning category. Table 19 presents a summary of other zoning requirements that would be of interest for waterfront development. There is substantial variability in other waterfront zoning provisions among the four municipalities.

Table 19: Other Zoning Provisions (apply in all zones that permit residential or commercial use)

	Beckwith	Drummond/ North Elmsley	Mississippi Mills	Carleton Place
Shoreline Occupancy Provisions	none	Except for a marina, the lesser of 25% or 15 m of lands within 3 m of shoreline may be used for marine facilities and accessory structures.	none	Permitted in 30 m setback: Boathouse/Boatport/Dock (max. length 8 m): stairs/landings (max width 2.5 m), shed (max. 10 sq.m.)
Decks	can encroach 1.5 m into front and rear yard setbacks	Uncovered terraces or patios permitted with 2.5 m to interior side lot line, cannot encroach into 30 m setback	a) not higher than 0.6 m above adjacent grade – min. 3 m to front lot line b) all other cases – projection not more than 2 m, plus a front and exterior side yard setback of 3 m and 1 m from other lot lines.	No maximum into any side yard and 3.0 metres (9.8 feet) into any required front of rear yard
Marine Facilities	permitted, no setback from water	Permitted (except in an Environmental Protection (EP) Zone), no setback from water	permitted, no setback from water	permitted in Open Space zone
Shoreline Vegetated Buffer	none	none	Vegetated buffer extending 15 m from high water mark req'd. Allows water access area of a maximum of 9 m in width.	No vegetation removal within 30 m unless Environmental Impact Statement demonstrates no impact
Provincially Significant Wetland	Environmental Impact Assessment required for new development within 120 m of the wetland boundary			not applicable (no PSWs)

LSR: Limited Services Residential zone
SFD: Single Family Dwelling (Carleton Place has slightly different zoning provisions for Residential/River Resid. semi-detached dwellings and duplexes)
Sources: (Township of Beckwith, 1989) (Township of Drummond/North Elmsley, 2012) (Town of Mississippi Mills, 2000) (Town of Carleton Place, 2008)

8.4.3 Development in the Floodplain

In Ontario the management of development in the floodplain falls under the jurisdiction of the Ministry of Natural Resources and Conservation Authorities. The province has floodplain policies that are implemented under the Planning Act through the Provincial Policy Statement (2014), a document that provides policy direction on matters of provincial interest related to land use planning and development.

The Official Plans and Zoning By-laws for the Township of Beckwith, the Township of Drummond/North Elmsley, the Town of Mississippi Mills and the Town of Carleton Place, all include “floodplain” or “hazard land” designations and zoning to identify the floodplain areas around and downstream of Mississippi Lake. The floodplain policies are implemented when a property owner is proposing to build, renovate or undertake other development activity in the floodplain that requires municipal approval of a building permit or planning application.

8.4.4 Mississippi Valley Conservation Authority Regulations

Mississippi Valley Conservation Authority also has regulations and supporting policies made under the Conservation Authorities Act for regulating development activities in floodplain areas, wetland areas, and areas along watercourses and shorelines (MVCA's "Development, Interference with Wetlands and Alterations to Shorelines and Watercourses" Regulation).

These regulations apply to lands in and adjacent to the floodplain and Provincially Significant Wetland (PSW) areas around Mississippi Lake. To identify the regulated areas, MVCA has mapped a Regulation Limit (**Map 6: Mississippi Lake Development Constraints**) that is based on a setback of 15 metres from the 1:100 Year flood line and 120 metres from the boundary of the PSW. Along some shore and river bank areas the regulation limit also includes steep slopes that are greater than 3 metres in height. Here within the regulated areas, the Regulation Limit is based on a 15 metre setback from the stable top of slope.

A permit is required from MVCA for certain development activities including construction, renovations and lot grading. Provincial floodplain policies contained in the Provincial Policy Statement (2014) are also used by MVCA in considering applications for development activity in floodplain areas.

8.5 Septic Systems

The properties around Mississippi Lake are serviced by private water and sanitary sewage disposal systems (wells, individual water intakes, and septic systems). Much of the concern about water quality is related to either phosphorus loading, which can cause a proliferation of aquatic plant and algae growth, or bacterial contamination which can be harmful to animals and humans, causing a swimming and consumption risk. Improperly functioning septic systems can be a source of both of these elements.

Older septic systems, privies and grey water pits often do not meet current health and building codes and are prone to malfunction. Renovations or conversions of cottages can also lead to higher demand on the system (through the installation and use of dishwashers, showers and baths, laundry facilities) which can also cause the malfunction or failure of the septic system. Alternatively, a major renovation of a home or cottage often triggers a requirement for replacement of a substandard system with a new upgraded properly functioning system. Even with new systems, proper maintenance and water conservation is required to ensure the system works properly. Improper maintenance can lead to the malfunctioning or failure of a septic system.

8.5.1 Septic System Approvals, Placement and Replacement

The permitting and regulation of private residential septic systems around Mississippi Lake is administered by Leeds, Grenville and Lanark District Health Unit (LGLDHU) under authority of the Building Code Act (BCA) (1992). The Ontario Building Code (OBC) regulates the design, construction, operation and maintenance of sewage systems with

design flows of less than 10,000 Litres/day that serve no more than one lot. Larger scale developments with larger sewage systems having a design flow greater than 10,000 Litres/day are regulated by the Ministry of the Environment (MOE), under the Ontario Water Resources Act.

The LGLDHU issues permits for new and replacement septic systems and they enforce the provisions of Division B Part 8 of the Ontario Building Code 350/06 for malfunctioning or failed systems. The permit to install a sewage system is required before the municipalities can issue their building permit. Depending on the type of redevelopment, a septic inspection may be required prior to building permits being issued to ensure the existing system can handle the additional living space, or a new septic system may be required. The LGLDHU reviews planning applications for municipalities to determine requirements for a new sewage treatment system, or for maintenance or upgrades to an existing system. With the redevelopment trend occurring along the shoreline, septic system information is becoming more abundant.

The LGLDHU has provided a summary of the number of permits and planning application reviews around Mississippi Lake from 1974 to 2015. As presented in Table 20, they have presented the information for three levels of buffer zones around the lake: the area within 60 metres of the lake; the area within 1 km of the lake; and the area within 2.5 km of the lake. The numbers of permits are broken down by type including sewage permits, and the four types of planning application that they review (Minor Variance, Severance, Site Plan and Zoning). Also presented in Table 20 is a breakdown of the total number of permits and planning application reviews by decade.

Table 20: Summary of Sewage System Related Permits and Reviews, 1974 to 2015

	Distance From Lake		
	Within 2.5 km	**Within 1 km**	**Within 60 m**
Total Permits/Reviews	**1436**	**846**	**559**
Sewage	1172	664	432
Minor Variance	38	34	32
Severance	94	39	16
Site Plan	99	85	64
Zoning	32	24	15
Range 1974-2015			
1970's	29	24	20
1980's	259	152	101
1990's	439	231	146
2000's	383	238	154
2010's	326	201	138

(LGLDHU, based on existing database information)

Since 1974 the LGLDHU has recorded a total of 1436 permits and planning application reviews within 2.5 km of Mississippi Lake; 846 of those were within 1 km of the lake, and 559 were within 60 metres of the lake. Out of those

totals, sewage permits make up the bulk of those numbers, representing 1172 of the total 1446 records. For the planning applications, most of the severance application reviews (78 of 94) were beyond 60 metres of the lake. Whereas almost all of the Minor Variance reviews (32 out of 38), and about two thirds (64 out of 99) of the Site Plan reviews were located within 60 metres of the lake. This distribution of planning applications is not surprising given that most waterfront lot creation took place around Mississippi Lake before the 1970's. With little waterfront land left to subdivide, since the1970's most severances have taken place in the backlot areas. Minor Variance applications primarily deal with the expansion or redevelopment of existing structures, where they cannot meet with setback and lot coverage requirements set out it the municipal zoning by-law, and Site Plan applications are now required for most types of waterfront development.

The municipalities also regulate the placement of septic systems through their zoning by-law, which sets out the required setback from the high water mark. The Township of Drummond/North Elmsley considers septic systems to be "structures", which means they are subject to the same zoning standards as other structures; any requested reduction in setbacks would need to be addressed through the minor variance process.

While we have information about septic systems where a permit or planning application review was required, there is currently little information regarding the actual number and condition of existing septic systems around the lake. Municipalities have the power to implement either a voluntary or mandatory septic re-inspection program within their municipality. Under such a program, a licensed septic system inspector undertakes a visual inspection of existing septic systems to determine their condition and whether they are functioning properly. A report of any findings is prepared for the property owner along with reference material on proper system maintenance. Currently there is no septic re-inspection program on Mississippi Lake.

Information Gap:
We are looking for information regarding septic systems around the lake, how many? Types of system installed? Etc.

8.6 Waterfront Regulatory Agencies and Roles

Waterfront development activities within the Mississippi watershed are regulated by several provincial and federal agencies, as well as municipal government bodies. The type and nature of the development activity determines the number of agencies involved, and the degree of to which they are involved. The regulatory agencies within the Mississippi River watershed include; Municipalities, Lanark County, Mississippi Valley Conservation Authority (MVCA), Health Unit, Ministry of Natural Resources (MNR), Ministry of the Environment (MOE), Ministry of Municipal Affairs, Department of Fisheries and Oceans (DFO) and Transport Canada. Table 21 presents a listing of each regulatory agency, the legislation they administer, and the waterfront development activities they regulate.

A more detailed account of each agencies role in regulating waterfront development, and the applicable legislation, is presented in Appendix 6.

Table 21: Governing Bodies for Specific Waterfront Development Activities

Project Type	Municipality	Lanark County	Conservation Authority	LGLDHU	MNRF	MOECC	MMA	DFO	Transport Canada
Planning Applications/Minor Variance, Site Plan, Zoning	✓		*	*					
Severance	✓	✓	*	*					
Subdivision Approval	*	✓	*	*					
Official Plan Amendments	*	✓	*	*	*	*	✓		
Septic Permit Approval			**	✓					
Shoreline Stabilization/Erosion Control - New			✓		✓			wsa	
Shoreline Stabilization/Erosion Control - Maintain, repair or replace existing			r/p		wsa			wsa	
Relocate rocks on shore lands			r/p		wsa				
Dock			✓*		✓□			wsa	wsa
Boathouse (below high water mark)	✓		✓		✓□			wsa	
Boat Launch/Boat Ramp	□		r/p		□			wsa	
Fill placement (on shore lands and/or lake or river bed)	□		r/p		✓			wsa	
Dredging - new dredge or expansion of existing dredge			r/p		✓			wsa	
Dredging - of shore lands previously dredged (no expansion)					wsa			wsa	
Aquatic Plant Removal - by hand or mechanical					wsa	□		wsa	
Aquatic Plant Removal - chemical/herbicide						✓			
Floating Raft / Mooring Buoy									✓
Spills, Water Contamination, suspected Blue-Green Algae Bloom						✓			

LGLDHU: Leeds, Grenville & Lanark District Health Unit **MNR**: Ministry of Natural Resources and Forests, MOECC: Ministry of the Environment and Climate Change **MMA**: Ministry of Municipal Affairs DFO: Department of Fisheries and Oceans

✓	approval agency (permit required) and/or primary reporting agency
*	review agency ** MVCA reviews septic applications for waterfront and/or floodplain properties only
✓*	MVCA permit or letter of clearance may be required dependant on the design, size and nature of alteration to shoreline (i.e. installation of permanent abutments on shore, excavation or fill placement to at shore)
✓□	MNRF Work Permit required for dock or boathouse that has a supporting structure, such as pipes or cribs, that occupies more than 15-square metres on the bed of a water body
r/p	MVCA review required, permit may be required depending on design and scope of project
wsa	(website self-assessment): consult agency website, if project meets with stated criteria and/or specified measures are followed review and/or permit not required. Otherwise, review and/or approval or permit required

Fish Timing Window (MNR): The MNR has established timing window guidelines to restrict in-water work related to an activity during certain periods in order to protect fish from impacts of works or undertakings in and around water during spawning migrations and other critical life stages. **No in or near water works are permitted between March 15th and June 30th inclusive.**

MNR and DFO have recently moved to a self-assessment and/or registration approach for some shoreline or in-water activities that they regulate. Property owners/proponents are directed to visit an online service to determine whether a permit is required.

8.7 Light and Sound Pollution

Pollution in all its forms can have detrimental effects on a lake or river environment. It can have a significant impact on the ability for the human population (resident or touring) to enjoy the environment for living and recreation, and the ability for the ecosystem to sustain a variety of flora and fauna. Whereas water and air pollution are by far the most common and most dangerous forms of pollution, the impact of light and sound pollution can become significant, depending upon the intensity and frequency of occurrence.

8.7.1 Light Pollution

This is defined as the use of artificial light for the purposes of safety, security, recreation, and business. Whereas these are legitimate reasons for producing artificial light, the impact can nevertheless be significantly negative.

There are two basic forms of light pollution:

a. Sky Glow - indirect light from nearby communities, businesses, etc. that illuminate the lake via reflected light from clouds and airborne particles (smog, fog, etc.). Sizeable urban communities can produce particularly invasive sky glow pollution as a result of the combined effect of numerous shopping centers, highway illumination, and high rise buildings; and

b. Direct Light - produced by residents and businesses on the lake shore, and therefore directly visible from the lake surface or from adjacent shores. This form of light is also produced by commercial sites and farms that use floodlights for security and safety reasons. Microwave and cell phone towers are additional sources of direct artificial light.

8.7.1.1 Impact on Humans

The impact on humans is a loss of quality of life and enjoyment of a natural habitat. Waterfront property has always been considered valuable, not only for its ready access to water for recreation, but also for the enjoyment of nature, away from the comparatively noisy and busy urban areas. As ease of access to a rural region increases, there is a

corresponding increase in the permanent human population, leading to a noisier and brighter environment – degrading the very qualities which initially made the region attractive and valuable.

8.7.1.2 Impact on the Ecosystem

The effects of light pollution on plants and animals in the environment are numerous, and are becoming more known. In general, the most common action is that light pollution alters and interferes with the timing of necessary biological activities. Nocturnal species that begin their daily activities at sundown can be negatively impacted by artificial lights at night. It can confuse animal navigation, alter competitive interactions, change predator-prey relations, and cause physiological harm. The rhythm of life is orchestrated by the natural diurnal patterns of light and dark, so disruption to these patterns impacts the ecological dynamics. This would include disruption to nesting grounds, changes to spawning habits and timings, and changes (nearly always averse) to the behavior of predators and prey alike. It is not well appreciated that, although humans are mainly a day-time species, a large majority of the ecosystem (for both plants and animals) is in fact more active at night.

8.7.1.3 Current State (2013)

a. Sky Glow - Although Mississippi Lake is surrounded by a largely rural region where the population density is fairly low, the nearby communities of Smiths Falls (30km Southeast, pop: 8,800), Perth (15 km South, pop: 5,800), Carleton Place (immediately North on the lake shore, pop: 9,800), Almonte (15km North, pop: 4,700), and the city of Ottawa (50km Northeast, pop: 880,00) all contribute significantly to sky glow during periods of partial cloud or overcast. In general, however, the Mississippi Lake region still enjoys a comparatively dark night-time environment.

b. Direct Light - Of the 1,200 estimated residents on the lakeshore, almost all will have lights on in the evenings during the summer, with a slight drop in the off-season (when cottages are not being occupied). Of these, a portion will have their lights on all night (dusk to dawn). Additionally, various businesses and farmyards use flood lights dusk-to-dawn. The cumulative effect of the direct lighting varies along the lake shore, with the greatest impact being felt along the narrow portions at third lake.

8.7.2 Sound Pollution

The main source of sound pollution is from pleasure craft such as speed boats and snowmobiles. The ability of sound to carry great distances over water further amplifies the impact of loud engines. In the winter, the ice and snow cover provides some degree of attenuation thereby reducing the effect of snowmobile engines. Nevertheless, loud engines do disrupt the tranquility of the lake, both for humans and wildlife.

Mississippi Lake has a large surface area, but most of that surface consists of very shallow regions, often rife with weeds. Therefore, the navigable portion of the lake is restricted to a narrow channel aligned roughly with the main water course for the Mississippi River. Whereas there are wider sections of the lake where waterskiing, tubing, and generally fast speeds can be safely undertaken, much of the main water course is close to the eastern shore of the

lake, and in any case much of the lake is fairly narrow. In these regions, sound from loud motors can be particularly detrimental.

8.7.2.1 Current State (2013)

Taking the above into consideration, the current (2013) state of sound pollution on the lake is considered to be on average low, with increased activity (particularly in the Summer) producing regions of moderate to high levels on an infrequent basis. The effect of winter activities, such as from snowmobiles, is assessed to be low to minimal.

8.7.3 Trend in Light and Sound Pollution

Although both light and sound pollution are at this time (2013) generally low to moderate, both are bound to increase over time with the advent of a greater population living nearby, and of greater ease of access to the lake via highways. The recent twinning of Highway 7 from Ottawa to Carleton Place has already produced an increase in traffic and tourism to the area, as well as an increase in new home construction, particularly in Beckwith and Carleton Place. Projected further twinning of Highway 7 from Carleton Place to Perth, as well as improvements to Highway 15 to/from Smiths Falls, will further facilitate increases to population and access to this region.

8.7.4 Summary

Noise and light can have a negative impact on fish and wildlife, including humans who live on the lake. However, noise and light levels, at this time, are considered to be of low impact.

9 Boating and Recreation

9.1 Boating

The Mississippi Lake Plan Community Survey identified motor boating as the second most popular recreational activity for residents. Boating is a popular activity, for both residents of the lake and day visitors; due to the close proximity of the lake to the City of Ottawa and other nearby towns, it is readily accessible to a large population. Many comments left by the survey respondents indicated that residents are concerned about boating safety, as well as safety of swimmers, due to the current boat traffic level on the lake. Currently, there is little data available to indicate the true volume of boaters and boating impacts on the lake; this is an area where future monitoring activity would benefit.

9.2 Impacts of Boating

Though boating can be a fun recreational activity, it can also have several detrimental effects on the lake. Boating safety is a major concern; if the number of water craft on the lake increases, the possibility of accidents increases as well. The activity of boats on the lake can also impact the lake shoreline. As boats travelling at high speeds create a wake, the waves can cause increased shoreline erosion, by either being too close to shore, or in proximity to erosion prone areas. The release of sediments through erosion can also cause sedimentation of important fish habitat, such as spawning beds and near shore areas used as fish nurseries.

Increased boating can also contribute to noise, air and water pollution. Watercraft with large motors, or travelling at high speeds, can be very loud, disrupting the atmosphere of the lake. Survey respondents indicated Peace and Tranquility as the second most important value to their enjoyment of the lake, increased noise pollution may impact this value. The emissions released by combustion engines can also affect the quality of the air. The effects on water quality are probably the greatest concern, as leaking engines can release gasoline and oil products in to the lake water. Refueling and maintenance of watercraft near shore can also result in the unintended release of petroleum products through spills.

The movement of boats can also be disruptive to fish and wildlife. Boating activities can impact the activity of fish and their behavior, as it may disturb feeding areas, spawning and nursery habitat. The wake created by boats can also affect near shore nesting birds, as it may drown nests, or result in adults abandoning eggs and chicks if the area is frequently disturbed. Boating activity can also be linked to the introduction of non-native or invasive species. This is mainly through the transfer of boats and fishing equipment from one water body to another, without properly cleaning the equipment between stops.

9.3 Boating Census

In late August of 2013, a group of volunteers undertook a shoreline survey of watercraft on Mississippi Lake. Each team canvassed a portion of the shoreline, by boat, noting the number and type of watercraft at each property.

A number of arbitrarily assigned categories were used to distinguish the vessels:

Power Craft

- Runabouts or utility boats accommodating an outboard motor of less than 10 HP
- Runabouts or utility boats accommodating an outboard motor of more than 10 HP
- Pleasure Craft equipped with an inboard engine or stern drive
- Pleasure Craft equipped with an outboard motor
- Bass Boat: a shallow boat with a platform, specifically designed for fishing
- Pontoon Boat
- Deck Boat: a hybrid boat with conventional hull and a platform similar to a pontoon boat
- Personal Water Craft

Unpowered Water Craft

- Row Boat
- Canoe
- Kayak

Sail Craft

- Sail Boat
- Catamaran
- Other Sail Craft (Windsurfer, Sail Board)

The shoreline of the lake was divided into segments, generally following the pattern of the access roads. The marsh areas, where no development exists, formed natural end-points for shoreline segments. Included in the survey were portions of the Mississippi River, where shoreline residents have direct access to the lake: Innisville, and the section of the river from Highway 7 to Bridge Street in Carleton Place.

The results of each volunteer team's survey were compiled by shore segment, and are presented in Table 22.

Table 22: Watercraft Census August 2013 - Summary Results

	Power Craft								Unpowered				Sail Power		
Watercraft Type	Runabout < 10 HP	Runabout > 10 HP	Pleasure Craft: Stern Drive	Pleasure Craft: Outboard	Bass Boat	Pontoon Boat	Deck Boat	Personal Water Craft	Row Boat	Paddle Boat	Canoe	Kayak	Sail Boat	Catamaran	Other Sailcraft
Total Count	164	89	261	140	6	143	10	98	56	140	123	94	22	6	18
Total: All Watercraft					1370										
Total: Powered Watercraft					911										
Total: Unpowered Watercraft					413										
Total: Sailcraft					46										

9.3.1 Observations

Given the watercraft categories established for the survey, the interpretation was left to the observer. An observed Deck Boat may have been recorded as an outboard-equipped Pleasure Craft. A Bass Boat may have been recorded as a Runabout with more than 10HP engine. A kayak may have been recorded as a canoe.

At the Carleton Place boat launch, on the day that area was surveyed, 16 empty boat trailers were recorded. It could be assumed that these boats were somewhere on the lake at the time, but lacking specific information, they were not included in the count.

One survey team recorded empty boat lifts. Most likely, other teams also observed, but did not count empty boat lifts. Were these boats somewhere on the lake at the time? During the last week in August, when much of the survey was taken, there was very little boat traffic on the lake. Had the boats already been taken out of the water for storage? What type of boat had occupied the lift? No conclusions were drawn regarding the empty boat lifts and they were not included in the vessel count.

During the time of the survey, there were some water craft active on the lake. These vessels were not recorded or included in the count because there was no way of knowing whether they had already been recorded by one or more teams.

For the reasons noted, the count lacks a certain amount of precision, as do enumerations of every level. The survey has produced some tangible numbers that serve as a baseline. A similar census, in future years, will yield information on trends, which may be useful.

The Volunteer Teams

Fiona and Doug Bailey
Jo-Ellen Beattie and Steve Shortt
Cheryl and Vern Runnels
Lawrie Sweet
Pat and Jim Tye
Bonnie and David Wood
Clare & Dave Hands

9.3.2 Conclusions

Since we have no baseline for comparison, it is difficult to draw firm conclusions from the numbers. However, some inferences can be made. From an environmental perspective, all non-motorized craft can be considered to have little or no impact. These account for 33% of the vessels counted in the survey.

Two thirds of the vessels counted were powered by some form of combustion engine. It is these vessels that, potentially, contribute to environmental harm through exhaust, effluent and damage to aquatic plants. Against that, many of these vessels spend the majority of their time moored at docks or resting in boat lifts. The survey gives us no information on the number of seasonal hours of operation.

Of the total 931 powered watercraft counted in the survey, 116 or 12.5% reside at McCreary's Beach Resort and McCullough's Landing.

We understand that there are 1200 cottages and homes on the shoreline. Removing the 116 powered craft at McCreary's and McCullough's, 815 powered vessels are spread along the remaining shoreline or, less than one per address. This choice, on the part of the resident may be based on economic or environmental considerations or, that their particular shoreline topography is unfriendly to a powered vessel.

9.3.3 Recommendations

Volunteers who participated in the 2013 boat census, along with others interested in volunteering in future Lake Plan activities, are invited to make suggestions for improvements and refinements.

The 2013 watercraft census was conceived, designed, volunteers recruited, survey carried out, summarized and reported upon, all during the month of August. It was important to get it done before Labour Day weekend, when boats and docks would start disappearing from the lake. Future studies could be carried out earlier in the summer. This year's project had the advantage of a tight timeline, which focused the efforts of the volunteers.

9.4 Social and Recreational Activities

Mississippi Lake is a popular destination for people seeking abundant recreational opportunities. Because of the lake's close proximity to several communities, such as Carleton Place, Perth and the City of Ottawa, it is accessible to people for activities year round. The Mississippi Lake Community Survey identified the top recreational activities most enjoyed by those who responded shown in Figure 16. The top 5 activities were Swimming (83%), Motor Boating (77%), Reading (75%), Socializing (73%) and Walking/Hiking (65%). Figure 14 provides a summary of the recreational activities and their rank according to the survey respondents; the top 5 activities are highlighted in blue.

9.4.1 Winter Activities

Mississippi Lake is easily accessible in the winter, due to the many municipal roads around the lake that are maintained through the winter months. Ice fishing is becoming an increasingly popular activity on the lake, noticeable by the number of ice fishing shacks that appear on the lake every winter. This is both a social activity as well as an angling activity for many people, drawing people to the lake from the surrounding municipalities. Skating is also a popular activity, with many lakeside residents shoveling and maintaining rinks on the lake ice. Snowmobiling on the lake is also popular, as the shoreline of the lake is over 50 kilometres in length, and contains many natural features in the wetland areas.

9.4.2 Summer Activities

Swimming was rated as the most popular activity people engage in on Mississippi Lake. The lake is quite shallow, so the water temperature can reach 24°C in the summer, making for optimum swimming conditions. There are also several sand beaches located around the lake, including McCreary's beach, Sand Island in Big Lake and at Lake Park Lodge. Boating was the second most popular activity, with a surface area of approximately 24 square kilometers and shoreline length of over 50 kilometers, there are ample boating opportunities. Boating activities also include water skiing and personal watercraft, which offer faster paced ways of enjoying the lake environment. Unpowered modes of boating are also popular, such as canoeing, kayaking and sailing. Fishing is also a very popular recreational activity on the lake, drawing people from all over the world. Mississippi Lake supports a popular bass fishery, with many bass fishing tournaments held on the lake every year. There are several public boat launches located around the lake, offering easy access to anyone wishing to enjoy Mississippi Lake. Some locations of boat launches are; Town of Carleton Place on Lake Avenue, Drummond Concession 9A at the Wildlife Area, McCullough's Landing, Johns Marina on south shore road and Bait Casters on Hardwood Road (du Feu, 2009).

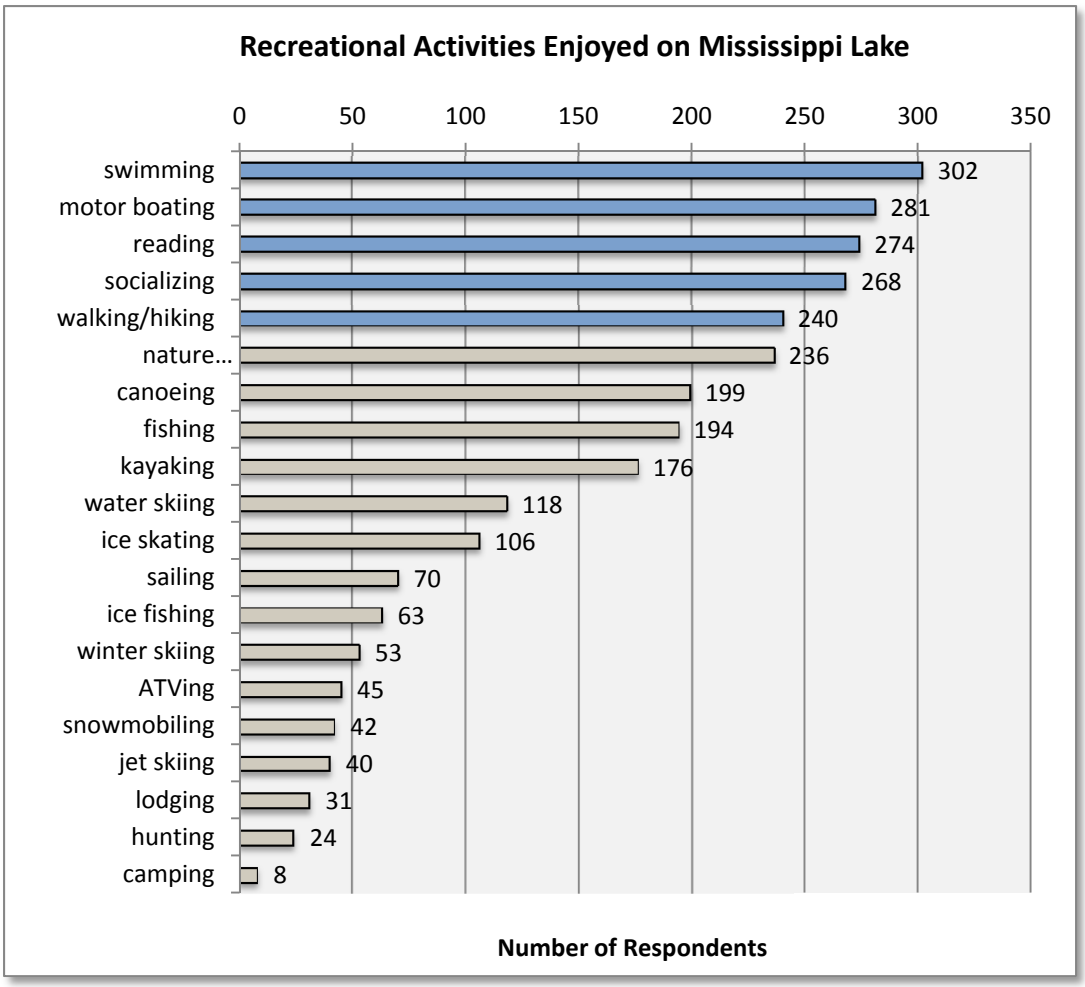


Figure 16: Recreational Activities -Mississippi Lake Community Survey

10 Groundwater – Quality and Quantity

Groundwater is an important resource; many residents of Mississippi Lake rely upon drilled wells for drinking water and other residential purposes. Groundwater is also a critical component of aquatic and terrestrial habitats, maintaining wetlands, lakes, streams and forests.

Water is continuously moving across the Earth, through what is called the Water Cycle. When water falls as precipitation, it will either evaporate back into the atmosphere; be transpired by vegetation; move as runoff or surface water to wetlands, streams or lakes; or it will infiltrate into the soil becoming groundwater. The precipitation that percolates through the ground will move through the pore spaces of sediments (such as clay, sand and gravel) and fractures in the bedrock. The layer of sediment and bedrock that collects the water and becomes saturated is referred to as the **formation**. The geologic unit of rock that produces the water for drilled wells is referred to as an **aquifer**; this is the supply of water that drilled wells access.

Groundwater moves through sediments and bedrock until it eventually reaches the surface as **discharge,** via wells, springs, streams, or areas with a shallow water table, such as a wetland. Groundwater provides the **base flow** for streams and lakes throughout the year, and is the main source of base flow for the summer and winter months. **Recharge** areas are typically upland areas with topographic high elevations, where the bedrock is shallow and overlain by sandy soils. This allows the water to infiltrate into deeper groundwater aquifers, and flow to lower elevations or surface water features. Wetlands can act as both discharge and recharge areas; small isolated wetlands with no surface water connections to lakes or tributaries are likely important to groundwater maintenance.

10.1 Aquifer Vulnerability and Contamination

The *Mississippi-Rideau Source Protection Region Draft Assessment Report* (2010) indicates the majority of aquifers in the Mississippi watershed have been classified as Highly Vulnerable. This is due mainly to the shallow depth of the bedrock, and the shallow layer of sandy overburden common on the Precambrian shield; the shallow overburden offers little protection to the bedrock aquifer. The following is a list of factors that can contribute to the vulnerability of an aquifer:

- Geology of the area (type and thickness of overburden, sediment and bedrock type)
- Hydraulic conductivity of the formation (how fast the groundwater can move through the formation depends upon the size and amount of pores or fractures)
- Proximity of the aquifer to the surface (high or low water table), i.e. bedrock outcrops
- Direction and magnitude of the groundwater flow
- Time of year (most recharge occurs during late spring to early summer and late fall)
- Land use practices

Human activities and development on the ground surface can greatly impact the groundwater quality, by introducing contaminants to the aquifers below; particularly in areas with vulnerable aquifers. The following is a list of contaminants and sources that can impact groundwater supplies:

- Pathogens (surface applications of manure, faulty septic system effluent)
- Nitrates (lawn fertilizers, septic systems, manure, agricultural fertilizer application)
- Pesticides
- Solvents and fuels (hazardous household or farm wastes discharged to septic systems, the ground, or leaking storage tanks)
- Salts (naturally occurring sources, road salt applications, water softeners, septic systems)
- Landfills, pits and quarries
- High-yield water taking operations
- Drilled wells may also pose a risk if they are accessing shallow aquifers with little soil protection; they may introduce pathogens or contaminants if poorly cased, or will tap water already contaminated

Typically surface water features, such as lakes, are associated with discharge of groundwater; however, some surface water features can recharge underlying groundwater systems, where the surface water is situated on top of bedrock with higher permeability. This is the case with Mississippi Lake, as it is situated above the Nepean Sandstone formation, which is highly permeable to surface water infiltration (Mississippi-Rideau Source Protection Region Watershed Characterization Report-Draft, 2008). Though the water quality of the Nepean sandstone aquifer is generally good, the recharge of the aquifer by the surface water of Mississippi Lake does make it more vulnerable to contamination. The Assessment Report also determined the areas around Mississippi Lake to be Significant Groundwater Recharge Areas (SGRA), due to the Nepean Formation sandstone being at the surface (outcropping) near the boundary of the Precambrian bedrock. These outcrops provide a direct path for surface water to the aquifer, resulting in a high vulnerability score as there is little protection for the aquifer from surface contamination.

10.2 State of Groundwater

The Mississippi-Rideau Source Protection Region Draft Assessment Report (2010) identified the major bedrock aquifers within the region. The majority of the Mississippi Lake subwatershed is contained within the Precambrian bedrock aquifer. The groundwater within this aquifer generally moves through a system of bedrock fractures. The western portion of the watershed also contains many recharge areas, for both the Precambrian aquifer, and the aquifers that extend to the eastern portions of the watershed. The area directly around Mississippi Lake lies on the boundary of the Precambrian aquifer and the Nepean Sandstone Formation. The area north and west of the lake lies on Precambrian shield; while the area underneath the lake, south and east is underlain by the Nepean sandstone.

In general, the quality of the groundwater within the Mississippi-Rideau Source Protection Region (MRSPR) is of good quality. The groundwater in the Precambrian aquifer is of lower hardness than aquifers in the eastern parts of the watershed. The general water quality of this aquifer is good, with moderate total dissolved solids (TDS) and high iron concentrations occasionally recorded. The groundwater in the Nepean Formation aquifer is also generally of good quality, with hard water being more common in the eastern portions of Lanark County than the western portions of the watershed; due to limestone strata in the bedrock formations. Sodium concentrations above the Ontario Drinking Water Quality Standard recommended limit for salt restricted diets are naturally occurring within the region. The

Nepean Formation aquifer is the most desirable aquifer in Eastern Ontario because of the quantity and quality of the water in the aquifer (Characterization Report, 2008).

The Nepean Formation generally provides the highest sustainable yield of quality potable water, so is targeted by large commercial and municipal systems. It is also targeted for domestic use, if the bedrock is within an economical depth for drilling. The Precambrian aquifer, however, has variable yield due to the small storage volume afforded by the fractured rock; unlike the sandstone matrix of the Nepean Formation that provides ample pore storage space.

The Renfrew County-Mississippi-Rideau Groundwater Study Summary report outlined the future capability and demands for the aquifer. An evaluation of the sustainability of the groundwater resources was made by comparing the quantity of groundwater pumped, to the estimated infiltration volume that replenishes the aquifer. It was estimated that the total groundwater taken is < 2% of what is potentially available from recharge. There is no indication of depletion of the aquifer from this comparison, at a regional or subwatershed scale. Localized areas of over withdrawal likely occur, due to aquifer mining or interference, but these do not reflect widespread conditions (Golder Associates Ltd., 2003)

10.2.1 Groundwater Monitoring

The Mississippi Valley Conservation Authority (MVCA) is currently involved in the Provincial Groundwater Monitoring Network (PGMN), in partnership with the Ministry of the Environment (MOE), to monitor groundwater quality and quantity at eight chosen well locations in the watershed. Two of the eight wells are in close proximity to Mississippi Lake, one at Blacks Corners and one in Carleton Place. These wells are monitored to establish baseline data regarding the quantity of water and the quality, so trends can be observed and the effects of changing land use and development can be monitored.

The well at Blacks Corners was sampled and analyzed 5 times from 2003 to 2011 for various different water chemistry parameters. The well at Carleton Place was sampled 7 times from 2003 to 2011, also for various water chemistry parameters. A full analysis of the collected data has yet to be conducted, but a summary analysis of a few selected parameters has been completed. Tables 23 and 24 outline the selected water chemistry parameters for the two wells, as well as the Ontario Drinking Water Standards, Objectives and Guidelines (ODWSOG) for each parameter. The summary tables for both local wells indicate that the chemistry of the groundwater, for the sample years available, is below the provincial objectives set for the parameters.

Table 23: Well 1 - Mississippi River at Carleton Place

Parameter	23-May-03 (mg/L)	24-Nov-06 (mg/L)	07-Dec-07 (mg/L)	24-Oct-08 (mg/L)	13-Nov-09 (mg/L)	03-Nov-10 (mg/L)	26-Nov-11 (mg/L)	ODWSOG (mg/L)
Alkalinity	289	321	336	315	300	322	343	**30 – 500** Operational Guideline
Aluminum	0.0005	N/A	N/A	0.00074	0.0004	0.0003	0.0005	**0.1** Operational Guideline
Chloride	33.1	10	187	196	54.6	26.6	89.6	**250** Aesthetic Objective
Fluoride	0.07	N/A	N/A	0.09	0.06	0.07	0.06	**1.5** Maximum Acceptable Concentration
Iron	0.004	0.04	0.18	0.006	0	0	0	**0.3** Aesthetic Objective
Selenium	0	N/A	N/A	0	0.0003	0.0002	0.0003	**0.01** Maximum Acceptable Concentration
Sodium	13.4	9	79	84	35.2	15.9	40.3	**200** Aesthetic Objective

Table 24: Well 2 - Blacks Corners, Beckwith Township

Parameter	22-Jul-03 (mg/L)	24-Nov-06 (mg/L)	28-Nov-08 (mg/L)	09-Nov-09 (mg/L)	01-Dec-11 (mg/L)	ODWSOG (mg/L)
Alkalinity	266	303	276	281	279	**30 – 500** Operational Guideline
Aluminum	0.0005	N/A	0.00042	0.0003	0.0002	**0.1** Operational Guideline
Chloride	43	33	47.4	42.8	46.4	**250** Aesthetic Objective
Fluoride	0.06	N/A	0.04	0.05	0.06	**1.5** Maximum Acceptable Concentration
Iron	0.047	N/A	0.011	0	0	**0.3** Aesthetic Objective
Selenium	0.001	N/A	0	0.0004	0.0005	**0.01** Maximum Acceptable Concentration
Sodium	24.2	24	27.5	28.7	26.5	**200** Aesthetic Objective

Information Gap:
Data regarding local landfill sites, both active and closed is limited; further research into this area and data analysis is required.

11 Carleton Place Water System (Source Water Protection)

11.1 Background

A key feature of Mississippi Lake is that it is immediately upstream of the Town of Carleton Place Surface Water Treatment Plant which supplies drinking water to approximately 9,400 people. Carleton Place draws its water from the Mississippi River approximately 1400 metres downstream of the lake, where it is treated before being supplied to households, businesses and industry throughout the town.

In recent years drinking water source protection plans have been put in place across Ontario to address activities and land uses around municipal wells and intakes to protect existing and future sources of drinking water. These plans are designed to protect existing and future sources of drinking water by creating a set of policies that help ensure activities carried out near municipal wells and surface water intakes do not threaten the quality and quantity of the drinking water supply.

11.2 Source Water Protection

In 2013, the Mississippi –Rideau Source Protection Plan was approved by the Ministry of the Environment to set out policies aimed at protecting ground and surface drinking water resources. The plan was developed following requirements set out by the MOE to address recommendations that came out of the public inquiry led by Justice Dennis O'Connor, into the Walkerton drinking water tragedy that occurred in May 2000. A key conclusion was the need to have multiple layers of protection in place to protect sources of drinking water. The Ontario Government responded to the inquiry recommendations by strengthening existing legislation and introducing new legislation to fill regulatory gaps. A key part of this response was enacting the *Clean Water Act* in 2006 and funding the drinking water source protection program that followed.

The *Clean Water Act* is not designed to protect water resources in general, but to protect those water resources that are used as a source of drinking water. Specifically, it is focused on protecting rivers, lakes and groundwater where they supply municipal drinking water systems (the large systems that serve towns, villages and cities). Under the Act, sources of water for these municipal systems must be studied and policies created to protect them from contamination and depletion. Protecting "the source" is intended to complement the work of water treatment plant operators who ensure municipal drinking water is properly treated, tested and safely distributed to homes and businesses.

Because a source of drinking water often flows through many municipalities before it is drawn into a drinking water system, the Walkerton Inquiry recognized that source protection should be undertaken at the watershed scale. The *Clean Water Act* divided southern Ontario and parts of northern Ontario into 38 Source Protection Areas. Mississippi Lake falls within the Mississippi-Rideau Source Protection Region, which combines the Mississippi and the Rideau Source Protection Areas.

11.3 Carleton Place Intake Protection Zone (IPZ)

An Intake Protection Zone (IPZ) is one of four types of vulnerable areas identified in the Clean Water Act. It is the area upstream of a surface water intake where land use activities have the potential to affect the quality of water that flows into the intake. Appendix 7 provides a fact sheet about the Carleton Place Intake Protection Zone as well as a map showing the IPZ areas.

Intake Protection Zones (IPZ) illustrate where surface water is coming from to supply a municipal intake at a water treatment plant and how fast it is travelling toward the intake. A total of three zone subcategories are identified within the IPZ (see Appendix 7):

- IPZ-1 is a 200 meter radius around or upstream of the intake with a buffer on land
- IPZ-2 is the area within which surface water could reach the intake within two hours
- IPZ-3 is the remaining area within which surface water could reach the intake

The Assessment Reports then looked at how vulnerable the intake was to contamination (in deep or shallow water, far or close to shore) and how easily surface contaminants could get into the watercourse (vegetated or hardened surfaces, sloped or flat). These factors, along with travel time from the intake, were used to assign vulnerability scores in each zone. Scores are highest closest to the intake and where the vulnerability is high.

- IPZ-1 can receive a vulnerability score of 9 or 10 depending on the vulnerability of the intake and the area
- IPZ-2 can receive a vulnerability score of 8, 8.1 or 9 depending on the vulnerability of the intake and the area
- IPZ-3 can receive vulnerability scores of 2 to 8 (scores decrease by one every four hour increment from the intake)

Areas Scored 8 to 10

Activities can only be considered a “significant” drinking water threat in areas scored 8 to 10. The only exception is Dense Non-aqueous Phase Liquids (DNAPLs) which are a significant threat anywhere in WHPA-A, B or C. Under the *Clean Water Act*, Source Protection Plans must include policies to address significant threats and only significant threats can be prohibited or made to require a Risk Management Plan. Since areas scored 8 to 10 cover less than 1.5 percent of the Mississippi-Rideau region, most properties will not be affected by the majority of policies in this Plan.

Areas Scored Less Than 8

No activities (except DNAPLs) can be considered a significant drinking water threat in areas scored less than 8. This means more restrictive policies like prohibition and Risk Management Plans cannot be used in these areas. The only policies in this Plan that apply in these types of areas are:

- Managing waste disposal sites in Highly Vulnerable Aquifers
- Encouraging the wise use of road salt
- Promoting best management practices through education

Appendix 7 shows the Carleton Place Intake Protection Zones areas that scored 8 or higher.

The Mississippi Rideau Source Water Protection Plan sets out policies that address the following 19 specific prescribed drinking water threats within the Intake Protection Zone:

1. Waste Disposal Sites
2. Sewage Works
3. Road Salt and Storage of Snow
4. Dense Non-aqueous Phase Liquids
5. (DNAPLs) and Organic Solvents
6. Fuel
7. Commercial Fertilizer
8. Pesticide
9. Outdoor Livestock Areas
10. Agricultural Source Material (ASM)
11. Non-agricultural Source Material (NASM)
12. Aquaculture
13. Aircraft De-icing

In general, the policies in the Plan that address significant drinking water threats:

- Prohibit future activities that pose too high a risk (e.g., DNAPLs) or are unnecessary to locate in a vulnerable area (e.g., gas station)
- Manage all other future activities and all existing activities (no existing activities are prohibited).

The Plan also includes policies to address moderate and low threats pertaining to:

- Waste disposal sites because their magnitude warrants careful review in a region where groundwater is highly vulnerable to contamination
- Road salt application because this is an emerging issue that could affect regional groundwater
- Aquaculture because this cannot be considered a significant threat but warrants a policy in case a facility was proposed near a municipal intake

There are polices in the pan to also address:

- Transport pathways (wells, pits and quarries, and earth energy systems)
- Transportation corridors (roadways and recreational waterways)

This Plan uses education to raise awareness about all vulnerable areas and drinking water threats. The policies promote awareness about vulnerable area locations, what people can do to help protect their community's source of drinking water, and what funding is available to help them do it.

Source: Mississippi-Rideau Source Protection Plan 2013

12 Climate Change and Lake Impacts

When most people think of climate change, they think of warmer temperatures, longer summers and milder winters. While this may mean a longer season for swimming, boating, and other water activities, warmer temperatures could also lead to more algae and aquatic vegetation growth, increased contaminant levels, and changes in fish populations. Warmer temperatures and changes in rain and snowfall can also result in an increase in drought periods and flooding events.

A recent study of the impacts of climate change on flow conditions in the Mississippi River looked at how conditions have changed over the past years, relative to changes in weather patterns (temperature and precipitation) and how conditions may be expected to change in the next 100 years (Lehman, 2012)

12.1 Past Trends

By looking at stream flow records for the Mississippi River at Appleton, spanning a 93-year period dating back to 1918, the following trends were identified:

- Average annual stream flows have increased marginally
- Minimum summer stream flows are lower over the past 30 years and have greater variability from year to year
- After 1970, low summer stream flows continue to persist and become more pronounced
- Average winter stream flow in the period after 1970 has increased substantially and exhibits greater variability from year to year

12.2 Future Predictions

Natural Resources Canada reports that the average annual temperature in Ontario has increased by as much as 1.4°C since 1948 (Paul Egginton, 2008). This trend is projected to continue, with the most pronounced temperature increases occurring in winter. A 2007 study conducted by MVCA, Queens University and University of Guelph found that observed changes in the Mississippi River stream flows are consistent with projected impacts on water resources across the Great Lakes Basin (Lehman, 2007). In terms of long range impacts the study predicts the following general changes in climatic conditions in the Mississippi River watershed.

- The average temperature increase is predicted to be 4.5° C by 2055.
- For precipitation, the scientific model predicts less snow and more rainfall in winter and spring.
- Over the next 100 years, summer water temperatures are expected to increase 4°C;

The study then looked at how the predicted changes in climate will affect stream flow conditions on the Mississippi River system. To assess how things may be expected to change in the future, three consecutive 30 year periods were modeled (2010 to 2039, 2040 to 2069 and 2070 to 2099) and compared to observed stream flow conditions between 1970 and 2000. Figure 17 shows the average annual stream flow hydrograph for the Mississippi River at Appleton for the four periods that were analyzed.

The overall prediction is for higher stream flows from September to January and lower stream flows from April to September. Spring floods are predicted to occur earlier and have lower volumes and low flows in the summer will be lower. The climate change impact analysis has indicated that by 2099, summer stream flows will be 40% less than present, with periods of intense rainfall, resulting in additional nutrient loading and decreased capacity to assimilate nutrient loads.

The specific predictions are:

- Spring freshets will be 28% lower in volume and will occur 6 to 7 weeks earlier
- Minimum summer flows will be 44% lower and the low flow will persist for 28% longer with greater variability in summer water levels
- Fall and winter flows will be 70% higher, resulting in a greater flood risk in fall and winter, erosion rates will increase and increased ice generation

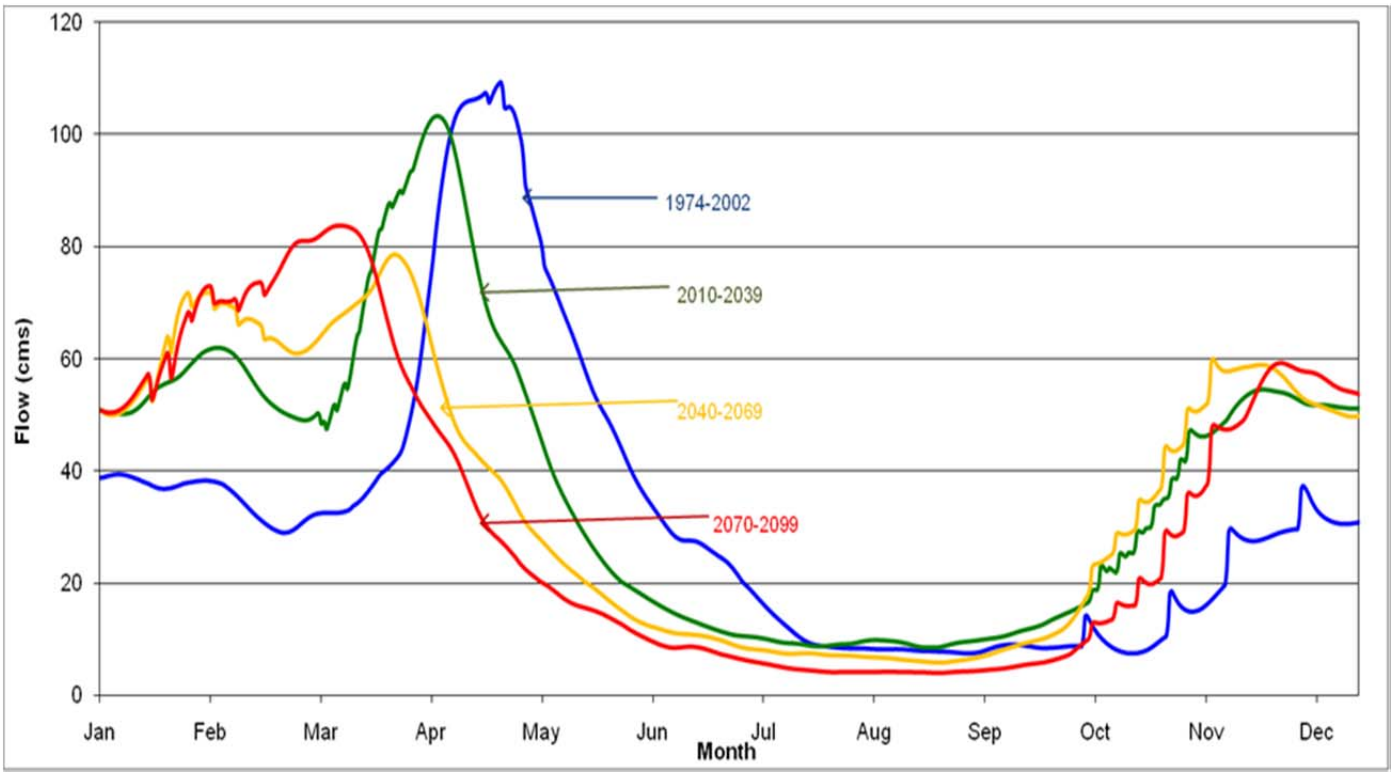


Figure 17: Average Annual Stream Flow Hydrograph for Mississippi River for Four Periods

Note: these represent the average yearly hydrograph for each period modeled and are based on the output from a single climate model and future emission scenario. Within each 30-year period there will continue to be considerable variability from year to year.

12.3 What this Could Mean for Mississippi Lake

As discussed under chapter **6.2.6 Climate Change**, the predicted increase in water temperature will impact fish populations by favouring warm water fish species (e.g. bass) and may be detrimental to the walleye fishery (Casselman, 2007). We may also see impacts to human health with an increase in pathogens such as e coli, Giardia lamblia (Beaver Fever) and schistomatidae (swimmer's itch).

Increased temperatures along with lower flows could reduce the flushing rate of the lake causing a greater buildup of nutrients. Increased air and water temperatures, in combination with the increased nutrient levels will also cause more weed and algae growth, impacting water activities (ex. swimming and boating) as well as the overall aesthetic of the lake.

An overall lowering of water levels could impact boating activities (docking issues, more exposed shoals). Higher fall and winter flows could mean more flooding and shoreline erosion during those periods. Shorter winter ice periods will also impact winter activities such as ice fishing and snowmobiling.

To help determine ways to adapt to the predicted changes, Mississippi Valley Conservation Authority (MVCA) is working on a "Nutrient Budget" project that is focused on measuring the amount and sources of nutrients entering the lake from upstream. The budget will be used to determine how nutrient levels in the lake may be expected to respond to various changes in climate and flow conditions. It will also be used to analyze the impact of changes in upstream land use as a way to identify and target actions and best management practices (ex. increased shoreline vegetation upstream may reduce nutrient loading).

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Appendices

Appendix 1: Mississippi Lake Plan Community Survey

MISSISSIPPI LAKE PLAN SURVEY

Before developing a Lake Plan, we need to identify some of the values you attribute to the lake and any issues or concerns you have as a member of the lake community. Please provide input about the things that ***you*** think are important. If the spaces below are insufficient, please feel free to use Section 12 for additional comments.

If possible, please complete this survey on-line at **https://www.surveymonkey.com/s/mississippilake**
This will facilitate our compilation of results. If this is not possible, please feel free to complete and return this survey using one of the options listed on the bottom of Page 4. If other people in your household would also like to complete the survey separately, it can be downloaded from our website at www.lakemississippi.ca

1. **What is your connection to Mississippi Lake?**

I am/we are:	**of a:**	**which is located:**
☐ Owner (residential)	☐ House	☐ Fronting on Mississippi Lake
☐ Renter	☐ Seasonal cottage	☐ Not fronting lake but within 200 metres
☐ Visitor (ex. overnight guest, camper)	☐ Rental cabin	☐ Between 200 m and 1 km from the lake
☐ Day user (ex. visit with boat)	☐ Trailer site/campsite	☐ More than 1 km from the lake
☐ Owner/operator of a business	☐ Not applicable (ex. visit lake with boat don't stay at specific property)	
☐ Other (specify):_____	☐ Other (specify):_____	

2. **My/our home, cottage, rental, unit, business is located at or near the following part of the lake:**

☐ Area A: Drummond Conc 9A or Westshore Dr
Grasshopper Point, McCreary's Shore, McCullough's Landing

☐ Area B: Drummond Conc 7
Flintoff Bay, Malloch Shore, Robertson Shore, Red Rock, Beck Shore

☐ Area C: Tennyson Rd.
Black Bass Bay, Hunter Bay, Craig Shore

☐ Area D: 9th Line Beckwith
Coleman Shore, High Bank, Petrie Shore, Petrie Point

☐ Area E: Lake Park Rd.
Gardiner Shore, Hay's Shore, Lake Park, Duff's Woods Subdivision

☐ Area F: Hwy 7 at Carleton Place, Townline Rd. or Ramsay 5A
McDiarmid Shore, Nagle Shore, Birch Point, Montgomery Park

☐ Area G: McCann Rd. *Dowdall's and Rathwell Shore*

☐ Area H: Scotch Corners Rd. *Ab's Road, Squaw Point*

☐ Area I: Ebb's Bay Rd.
Pretty's Island, Ebb's Bay, Ebb's Shore, Cookes Shore

☐ Area J: Innisville

☐ Area K
Upstream of Innisville Bridge

☐ Area L
Carleton Place and downstream

☐ Area *M: Other location, (ex. Long View Island)*
Describe:_____

3. **Which municipality is the property located in:**

☐ Beckwith ☐ Carleton Place ☐ Drummond/North Elmsley ☐ Mississippi Mills
☐ Not applicable (ex. visit lake with boat and don't stay at specific property)

4. **How long have you or your family been a resident, renter, visitor, business owner on or near Mississippi Lake?**

Number of years _____ Number of generations _____

5. **When do you stay at/near the lake?** (*check all that apply)* ☐ Spring ☐ Summer ☐ Fall ☐ Winter

6. **On average how many people stay at your residence/location at one time?**

   ☐ 1 to 2 ☐ 3 to 4 ☐ 5 to 6 ☐ 7 to 8 ☐ >9

7. **What recreational activities do you participate in at the lake?** ***(check all that apply)***

   ☐ Boating ☐ Reading ☐ Swimming ☐ Ice Fishing
   ☐ Canoeing/Kayaking ☐ Socializing ☐ Walking/Hiking ☐ Snowmobiling
   ☐ Sailing ☐ Fishing ☐ Camping ☐ Winter Skiing
   ☐ Water Skiing ☐ Hunting ☐ Nature Appreciation ☐ Ice Skating
   ☐ Jet Skiing ☐ ATVing ☐ Lodging

   Other activities (please list):_____

8. **How many boats and/or personal watercraft do you have?** _____ Please list and describe boats below

Type of Boat(s)/Watercraft *(ex: motor boat, pontoon, canoe, sailboat, jetski)*	**Length** (ft.)	**Horsepower** (motor boats only)	**Frequency Used** on average (ex. daily, twice/week, once/2 weeks, once/month, less than 1/month)

Launching arrangements: ☐ boat launch at property ☐ public boat launch ☐ marina
☐ other (describe):_____

Docking arrangements: ☐ dock at property ☐ at marina ☐ other (describe):_____

9. **Values: Please rate how the following values add to your personal enjoyment of Mississippi Lake.**

Personal Values	**Very Important**	**Important**	**Not Important**	**Comments**
Clean Water	☐	☐	☐	
Natural Shorelines	☐	☐	☐	
Recreational Enjoyment (swimming, boating, etc.)	☐	☐	☐	
Landscapes	☐	☐	☐	
Flora and Fauna	☐	☐	☐	
Appreciation of Wildlife & Birds	☐	☐	☐	
Peace and Tranquility	☐	☐	☐	
Night Skies	☐	☐	☐	
Cottage Safety/Property Security	☐	☐	☐	
Sense of Community	☐	☐	☐	

Other (please specify):	☐	☐	☐	
Other (please specify):	☐	☐	☐	
Other (please specify):	☐	☐	☐	

10. **Issues and Concerns: How much negative impact have the following had on the enjoyment of your property or time at the lake?**

	Significant Impact	Moderate Impact	Light Impact	No Impact	Comments
Water Quality	☐	☐	☐	☐	
Weeds/Algae in Water	☐	☐	☐	☐	
Water Level Management	☐	☐	☐	☐	
Boat Traffic	☐	☐	☐	☐	
Boat Speed	☐	☐	☐	☐	
Personal Water Craft	☐	☐	☐	☐	
Residential Development	☐	☐	☐	☐	
Commercial Development	☐	☐	☐	☐	
Septic System Issues	☐	☐	☐	☐	
Shoreline erosion	☐	☐	☐	☐	
Daytime Noise	☐	☐	☐	☐	
Night time Noise	☐	☐	☐	☐	
Outdoor Light Pollution	☐	☐	☐	☐	
Tree and Vegetation Removal	☐	☐	☐	☐	
Public Access to lake	☐	☐	☐	☐	
Fish Depletion	☐	☐	☐	☐	
Fishing Tournaments	☐	☐	☐	☐	
Snowmobiles	☐	☐	☐	☐	
All-Terrain Vehicles	☐	☐	☐	☐	
Other (specify):	☐	☐	☐	☐	
Other (specify):	☐	☐	☐	☐	
Other (specify):	☐	☐	☐	☐	

11. **Identify the top 3 actions you believe should be taken to preserve and enhance our lake.**

1. _____
2. _____
3. _____

12. **Please use this space to provide any additional information or comments.**

_____

_____

_____

_____

What Next?

The Lake Planning process will take a few years. The Mississippi Lake Planning Committee is planning a future meeting to present the consolidated responses to the survey and to get more input from local residents and property owners about the Lake Plan. Please indicate your availability and interest in attending future Lake Planning meetings.

I would like to attend a meeting to hear about the results and to learn more about the lake plan:

☐ Yes ☐ No ☐ I would prefer not to attend a meeting but would like to receive updates and information about the project through my email My email address: _____

If yes,

My preference is for a meeting on:

☐ Saturday ☐ Sunday ☐ a weekday

in the: ☐ Morning ☐ Afternoon ☐ Evening

I would prefer to attend a meeting in:

☐ June ☐ July ☐ August ☐ Any month

☐ Other_____

If you have questions or require assistance in completing this survey, please contact: survey@lakemississippi.ca

Thank you very much for completing the survey!

Drop off at:

Beckwith Township Office
1702 9th Line Beckwith

Drummond Township Office
310 Port Elmsley Road

Carleton Place Town Hall
175 Bridge Street, Carleton Place

Or **Email to:** survey@lakemississippi.ca

Or **Mail to**:

Mississippi Lakes Association
P.O. Box 27
Carleton Place, Ontario
K7C 3P3

Contact Information for Mississippi Lake Plan Project

If you wish to maintain the anonymity of the survey but would still like to share historic information, volunteer to help out with the lake plan or receive ongoing information about the lake plan project, please detach this bottom part of the form and mail it to us in a separate envelope, visit our website at www.lakemississippi.ca or send us an email with your preferred contact information and an indication of how you would like to be involved. Otherwise, please complete this section and hand it in with the rest of the completed survey.

☐ I have knowledge about the lake and area that I would like to share
☐ I am interested in volunteering to help with the lake plan
☐ I am not able to help with the lake plan but would like to receive information about it by mail or e-mail

Name:_____ Telephone:_____

Address:_____ email address: _____

_____

The information provided by you will be summarized for lake planning purposes. Personal information will be retained by the Mississippi Lake Planning Committee only based on your specific instructions as noted above.

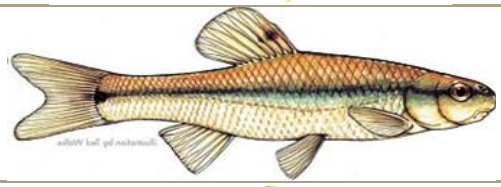
Membership in Mississippi Lakes Association

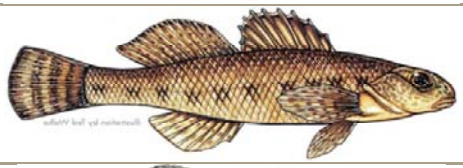
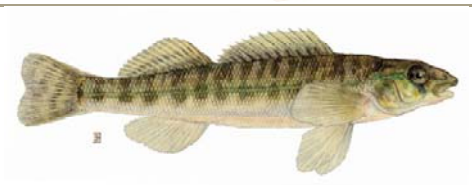
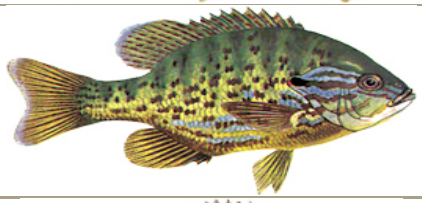
If you are interested in becoming a member of the Mississippi Lakes Association ($10.00 per year) and supporting this initiative and all the other projects and services that the Association provides, please complete and return the form provided below, visit our website at www.lakemississippi.ca or e-mail membership@lakemississippi.ca

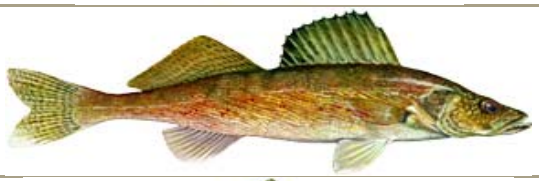
Join us on Facebook at www.facebook.com/MississippiLakeAssociation

Appendix 2: Fish Species Recorded in Mississippi Lake

The following table is a summary of the fish species that have been documented in Mississippi Lake. The list included the common and scientific names, the water temperature preference if available, and a picture of the species appearance.

SPECIES	WATER TEMP. PREFERENCE	APPEARANCE
American Eel (Anguilla rostrata)	Cool	
Black Crappie (Pomoxis nigromaculatus)	Cool	
Blackchin Shiner (Notropis heterodon)	-	
Blacknose Shiner (Notropis heterolepis)	-	
Bluegill (Lepomis macrochirus)	Warm	
Bluntnose Minnow (Pimephales notatus)	-	
Brown Bullhead (Ameiurus nebulosis)	Warm	
Burbot/Ling (Lota lota)	Cold	

Common Shiner (Notropis cornutus)	-	
Fallfish (Semotilus corporalis)	-	
Goldern Shiner (Notemigonus crysoleucas)	-	
Johnny Darter (Etheosoma nigrum)	-	
Largemouth Bass (Micropterus salmoides)	Warm	
Logperch (Percina caprodes)	-	
Mimic Shiner (Notropis volucellus)	-	
Northern Pike(Esox lucius)	Cool	
Pumpkinseed (Lepomis gibbosus)	Warm	
Rock Bass (Ambloplites rupestris)	Cool	

Smallmouth Bass (Micropterus dolomieu)	Warm	
Trout Perch (Percopsis omiscomaycus)	-	
Walleye (Stizostedion vitreum)	Cool	
White Sucker (Catostomus commersoni)	Cool	
Yellow Bullhead (Ameiurus natalis)	-	
Yellow Perch (Perca flavescens)	Cool	

Appendix 3: History of the Mississippi Lake Fishery

HISTORY OF MISSISSIPPI LAKE FISHERY

Mississippi Lake has been a popular recreational fishing area since the lake was first settled. Reports indicate that Northern Pike, Smallmouth Bass and Yellow Perch comprised the early sport fishery of the lake, based on a 1904 5th Annual Report by the Ontario Department of Fisheries. However, Walleye have been the most popular and sought after fish in the lake since their introduction. The recorded management activities of the lake fishery date back to the early 1880's. The details and timing of some of the early management practices on the lake are unclear, though the earliest practices are believed to have been fish stocking.

Stocking

The record of fish stocking on Mississippi Lake extends almost 100 years in length. The first stocking attempt is believed to have taken place in the early 1880's, and the final stocking event occurring in 1979. The first stocking was of an unknown number of Lake Whitefish eyed eggs, which was an attempt to establish the species in the lake. This stocking was followed by another event in 1886, which was an attempt to establish Lake Trout in the lake, by releasing 5 cans of eyed eggs. Both of these early stocking events were unsuccessful in establishing self-sustaining populations of Lake Whitefish and Lake Trout. Largemouth Bass were also introduced into the lake around the turn of the 20th century. Though there is no record of when the fish were introduced to the lake, the number released or life stage; the introduction was successful in establishing a self-sustaining population.

The introduction of Walleye into the lake occurred around the same time as the Largemouth Bass. The Walleye were introduced in 1908, with the release of 100,000 fry. This introduction was also successful, when anglers first reported catching Walleye in the lake in 1911. There is an unconfirmed report that 38 adult Walleye were released into the lake near Innisville in 1913 and 1914. Confirmed record of stocking continued in 1922 to 1927, 1936 to 1954 and 1963 to 1979. From 1908 to 1979 a total of 26,450,000 Walleye were planted into the lake, all of which were eyed eggs except for the initial introduction of fry.

After these initial introductions into the lake, stocking also began for Smallmouth Bass, though they are indigenous to Mississippi Lake. Smallmouth Bass stocking began in 1916 with 50,000 fingerlings, and continued until 1971, with almost yearly stocking. In total from 1916 to 1971, 179,432 Smallmouth Bass were released into Mississippi Lake; they ranged in life stage from fry to fingerlings and adult fish.

Fish stocking was discontinued as a fishery management practice in 1980, and the lake has since been managed as a self-sustaining fishery. The data collected in fish surveys revealed that the fish populations did not seem to respond when more fish were added to the lake. Though stocking and controlled introductions to the lake ceased in 1980, Black Crappie has since become an established species within the lake. This species was introduced into the lake in the late 1980's, and was noted in the 1990 index netting catches for the first time. Since the introduction this species has become very common in Mississippi Lake.

Coarse Fish Removal

Coarse fish are traditionally defined in the United Kingdom as any fish that is not part of the Salmonid family. This is because the Salmonids are the traditional game or sport fishes most sought after. In North America the same type of definition is true of coarse fish, they are the species which are considered under-utilized and less-desirable than the traditional sport fish such as; Northern Pike, Walleye and Bass. Species traditionally recognized as coarse fish in Mississippi Lake were, Bullhead (Brown and Yellow), Burbot (Ling), White Sucker and American Eel.

Several coarse fish removal programs were carried out on the lake, because of their impacts on the more desirable sport fish in the lake. The main concern was the coarse fish eating the fry of the game fish, and out competing the game fish for resources. The first record of Ling impacting the sport fishery was in 1903, when it was reported that fishermen on the lake would pull in night lines to find only the heads of the desired fish, as reported by Brown (undated);

> "For a number of years past, the settlers along the Mississippi River were in the habit of setting out night lines for fishing. When they would lift their lines they were surprised to find only the heads of pike, bass and perch. The secret was made known last week when Mr. Robert Moore of Perth, who has obtained a license for fishing in those waters, lifted his hoop nets and found a great number of large ling. The settlers declare they never before had seen a ling." (Kerr, 1999)

At a later unknown date an early Fish and Game Overseer licensed four hoop nets to remove bullheads and suckers from the lake, because of concern over predation of bass fry. Other documented removals occurred after this, in 1961 and 1962, to reduce competition for the benefit the sport fish species. In 1970 a commercial fisherman from Picton, Ontario was hired to remove coarse fish using hoop nets. The undesirable coarse fish species removed from the lake by these programs were Burbot, Bullheads, Suckers and Eels; panfish were also removed as they also compete with sport fishes.

Coarse Fish Removal Programs on Mississippi Lake

Year	1961	1962	1962-63	1970
Project Dates	April 28-May 12	Sept. 14-Nov. 19	Dec. 24-Feb. 2	October
		Number of Fish Caught		
American Eel	40	-	30 kg	-
Bullheads	199	-	663 kg	-
Burbot(Ling)	3	-	-	-
Largemouth Bass	481	153	-	-
Northern Pike	1077	770	-	27
Panfish	6315	-	1725 kg	-
Smallmouth Bass	526	1385	-	261
Suckers	662	421	-	-
Walleye	2816	288	-	122
Total (All Species)	12119	3017	-	Unknown
Coarse Fish Removed				
No. Fish	7160	-	-	-
Kg (lb) Fish	3084 (6800)	2391 (5271)	2418 (5331)	459 (1013)

(Kerr, 1999)

Creel Census Programs

A Creel census is used to determine many different aspects of a lake fishery, by interviewing anglers and recording the time spent fishing and catches made. This information can then be used to estimate angling pressure on the lake, angling quality, species sought and the species composition of the overall catch. Creels are also useful in determining the effect of fish stocking on the fishery; if stocking improves the fish population over time or has no effect, by the composition and quality if the catch.

Angling Pressure

Angling pressure on the lake is identified by the frequency of fishing (rod hours/hectare) and overall success of the anglers (number of fish caught per hour). From 1960 to 1999 23 creel surveys were conducted on Mississippi Lake, these surveys aid in estimating the angling pressure on the lake over the sample period. Summer angling pressure saw an increase from the initial creel survey in 1961 to 1985. The first creel survey conducted for the summer ice out season was in 1961, from May 13 to September 6. This survey concluded that the angling pressure on the lake was approximately 7.31 rod hours per hectare. The angling pressure steadily increased to 1985, when the summer creel survey from May 11 to September 2 estimated the rod hours to be 22.88 per hectare. From 1985 to 1996 the estimated angling pressure slightly decreased. The last full summer creel survey from May 5 to September 15 1994 estimated rod hours to be 19.59 per hectare. Though the angling pressure decreased from ten years earlier, it is still much higher than the 1961 estimated angling pressure.

The winter angling pressure on the lake also increased over the 1961 to 1999 creel survey sample period. The first winter creel survey was conducted in the winter of 1960 to 1961, and concluded the estimated rod hours to be 0.85 per hectare. The next full winter creel survey was from December 1978 to February 1979, which estimated angling pressure to be 4.17 rod hours per hectare. The estimated angling pressure on the lake increased, by over 3 hours per hectare in this 17 year period. From 1979 to 1997 there were two partial winter surveys conducted, for January to February of 1981 and 1996; the estimated rod hours were 1.69 per hectare and 1.91 per hectare respectively. This is a decrease from the 1979 survey, but the time period of these surveys was shorter than that of 1979, which could account for the decrease. There were two final winter creels conducted in this time period, December 18 to February 28 of 1997 to 1998, and December to March of 1998 to 1999. The estimated angling pressure for these surveys were 8.26 rod hours per hectare and 8.07 rod hours per hectare, respectively. These are double the angling pressure estimated in 1979, suggesting that winter ice fishing has significantly increased in popularity since 1961.

Angling Quality

The angling quality of Mississippi Lake is calculated from creel surveys by recording the species caught and time spent fishing, and is expressed as catch-per-unit-effort (CUE). The larger the value is for the CUE, the better the angling quality is for that fishery. The Mississippi Walleye fishery has fluctuated from 1961 to 1999, with a low of 0.005 to the high of 1.161. The total average CUE for all creels (winter and summer) from 1961 to 1985 was 0.073.

From 1990 to 1999 the average winter CUE for Walleye was 0.016, while the average summer CUE was 0.125. CUE values which are lower than 0.100 are considered only fair quality fisheries, the 1961 to 1985 average and 1990 to 1999 winter average are both below 0.100, indicating a fair quality Walleye fishery. The Smallmouth Bass CUE ranges from a low of 0.004 to a high of 0.217 from 1961 to 1999. The total average CUE from 1961 to 1985 was 0.052, while the average summer CUE from 1990 to 1999 was 0.118. Northern Pike have a CUE range of 0.014 to 0.353 from 1961 to 1999. The 1961 to 1985 CUE total average was 0.165, while the 1990 to 1999 winter CUE average was 0.041 and the summer CUE average was 0.244. The highest catch rate however, was for panfish, which consistently had a CUE above 0.2 from 1970 to 1996.

Species Sought

Many anglers go out on to lakes seeking particular species of fish, while others have no species preference. Between 1972 and 1999 nine creel surveys recorded the species sought by anglers. Walleye were traditionally the most sought after species in the Mississippi Lake fishery; however, over time the focus has shifted towards bass species. The table below summarizes the results of the creel surveys, which recorded angler preference; by percent of anglers seeking a particular species (Bass includes both Smallmouth and Largemouth).

Species sought by anglers as determined by Creel Census

Year/Season	1972(S)	1974(S)	1985(S)	1990(S)	1994(S)	1996(W)	1996(S)	1998(W)	1999(W)
No. Anglers Contacted	354	1145	841	693	1156	202	247	176	189
Walleye	76.3%	35.0%	37.3%	46.5%	25.3%	59.4%	30.8%	79.9%	64.5%
Northern Pike	13.0%	15.0%	25.6%	21.9%	6.5%	14.4%	15.8%	3.4%	5.9%
Bass	9.6%	22.0%	24.5%	24.4%	52.0%	-	27.1%	-	-
Panfish	1.1%	2.0%	12.6%	7.2%	16.1%	-	19.4%	-	-
Black Crappie	-	-	-	-	-	-	-	-	11.8%
Yellow Perch	-	-	-	-	-	20.3%	-	16.7%	17.7%
Anything	0.0%	26.0%	-	-	-	5.9%	6.9%	-	-

(Kerr, 1999)

The percent of anglers seeking Walleye dropped drastically from 1972 to 1996 in the summer surveys. In 1972 over 76% of anglers stated they were seeking Walleye, whereas in 1996 that number dropped to just over 30% of anglers. However, the number of anglers seeking Walleye in the winter season has remained high. Anglers seeking Bass, both Largemouth and Smallmouth, increased from 1972 to 1996. 9.6% of anglers reported they were seeking Bass in 1972, this number increased dramatically to 52% in 1994. The number seeking Bass in 1996 dropped by about half from 1994, but significantly less anglers were interviewed for the 1996 creel than the 1994, which could account for the decrease. Panfish angling also saw a steady increase from 1972 to 1996; likely because the population of Panfish species also rose, creating more opportunities to catch the fish. Northern Pike have seen fluctuation in angling pursuit across the survey period. The percentage of anglers seeking pike rose from 1972 to 1985, and began to drop again after 1990. Northern Pike were never a popular sport fish in Mississippi Lake, many were caught incidentally.

Catch Composition

The species composition of the lake can be estimated from the catch during a creel survey. The catch rates of fish can then be used to estimate the populations of the fish species. The highest catch rates for Walleye occurred in the 1960's ranging from 31% to 45%, and decreased across the sampling years, with the lowest recorded catch rate in 1997/98 at 2.9%. Panfish saw the highest increase in catch rate over the time period, composing around 10% of the catch in the 1960's, and increasing to half or well over half of the catch through the 1970's and 1980's. Bass catch rates increased as well, both Largemouth and Smallmouth, with negligible catch rates in the 1960's for Largemouth Bass. They increased to a steady proportion of the total catch through the 1970's to 1990's. Smallmouth Bass also increased in a similar fashion, though the initial catch rates in the 1960's were higher than those of the Largemouth Bass and Panfish. Northern Pike show a decrease in catch rate from 1961 to 1999, though still maintaining higher levels in the winter season surveys. The shift in the primary fishery of Mississippi Lake from Walleye to Bass is supported by the catch rates, from 1961 to 1999.

Estimated Harvest

The harvest of fish from Mississippi Lake can be estimated from the creel survey interviews. The degree of fishing pressure can then be determined by the harvest, and changes made to regulations if the harvest appears to be excessive. The species which is under the greatest pressure is Walleye, though the number of anglers seeking Walleye has dropped, the number harvested has stayed quite high. The harvest rate for Walleye has regularly been between 50% and almost 90% in some years. The summer 1972 survey indicated 526 of the 591 Walleye caught were harvested, while in the 1999 winter survey 210 of 298 Walleye were harvested. The surveys indicate that the number of Walleye harvested, and the rate of harvesting, increased from 1974 to 1999. This suggests the pressure on the fishery increased despite the shift in angling pursuit to bass species.

The catch and harvest numbers collected through the creel surveys show the fishery has shifted away from Walleye toward Bass species. The number of Bass caught had steadily risen from 1974 to 1994 in the summer surveys. Though the number harvested did not rise in the same manner, suggesting many anglers practice catch-and-release fishing. Panfish also show a drastic increase in catch and harvest numbers from 1974 to 1999, this was likely due to the populations of Panfish increasing over the time period as well. What is interesting to note is that the catch numbers for Northern Pike stayed quite high across the sample periods. Though they were not a popular sport fish, the harvest rates were significantly high as well, only falling in the mid 1990's.

Trap Net and Gill Net Surveys

Trap Net surveys and Gill Net surveys are conducted to provide an indication of the species present and the relative abundance of fish species. The intent of trap nets is to trap fish live, perform biological sampling, and release the fish back into the water. Gill net surveys have high mortality rates, due to the design of the nets used, but allow for more detailed biological surveying of the fish. The biological sampling is used to determine the age and size distribution, as well as the growth and maturation rates of the trapped species. Trap net surveys were conducted in

Mississippi Lake on a regular basis from 1961 to 1998. Gill net surveys have been used much less frequently, with data available only in 1951, 1969 and 1991.

Over the period of time sampling was conducted, the populations of Walleye and Northern Pike declined. The populations stabilized in the 1990's at a lower level than the historical populations, at 2.5% and 3.0% respectively. Bass populations appear to have also declined from 1962, which is unexpected since the catch rate and pressure has increased over that period of time for Bass species. The population levels seem to have levelled in the 1990's, with Largemouth Bass around 1% and Smallmouth Bass just above 3% of the fish community. Panfish made the most significant population jump from 1961 to 1998. Starting at about 52% combined for Pumpkinseed, Bluegill and Rock bass in 1961, the populations increased to 78% of the fish community in 1998. This percentage of the Mississippi Lake fish community increased to 84% when the population of Black Crappie was included with Panfish species.

The table below summarizes some of the Trap Net catches from 1961 to 1998, by the percentage of the total catch, representing relative species abundance.

Summary of Trap net surveys from 1961 to 1998

Fish Species	1961	1985	1990	1994	1998
American Eel	0.3% (40)	0.7% (77)	0.6% (55)	0.2% (12)	0.09% (5)
Black Crappie	0.0% (0)	0.0% (0)	0.01% (1)	0.4% (30)	6.2% (341)
Bluegill	52.1% (6315)[2]	15.2% (1686)	11.9% (1163)	23.5% (1581)	13.7% (752)
Bullheads[1]	1.6% (199)	2.6% (289)	5.5% (537)	3.9% (263)	2.2% (121)
Burbot	0.02% (3)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
Fallfish	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)
Largemouth Bass	4.0% (481)	0.2% (26)	0.9% (85)	1.2% (79)	0.9% (49)
Northern Pike	8.9% (1077)	3.3% (364)	1.7% (166)	3.0% (203)	3.3% (178)
Pumpkinseed	-	52.6% (5836)	47.8% (4688)	51.6% (3465)	54.2% (2963)
Rock bass	-	10.4% (1158)	18.8% (1839)	8.2% (553)	10.6% (579)
Smallmouth Bass	4.3% (526)	3.9% (436)	5.1% (501)	3.3% (223)	3.4% (185)
Walleye	23.2% (2816)	3.4% (380)	2.2% (220)	2.8% (188)	2.3% (127)
White Sucker	5.5% (662)	6.9% (767)	5.0% (493)	1.3% (84)	1.9% (102)
Yellow Perch	N/A	0.7% (74)	0.6% (56)	0.5% (35)	1.2% (66)
Total (all species)	**12119**	**11093**	**9802**	**6716**	**5470**

1. Both Brown and Yellow Bullhead
2. Includes Bluegill, Pumpkinseed and Rock bass

(Kerr, 1999)

The age distribution of sport fish species can be identified through trap net and gill net surveys. Identifying the age distribution aids in determining strong or weak age classes. If the fishery is being over-exploited there will be an over representation of young fish, if spawning success has decreased the older age classes will be over represented. The four main sport fisheries for which the data is available for in Mississippi Lake is Northern Pike, Walleye, Largemouth Bass, and Smallmouth Bass. From 1961 to 1998 there appears to be a good diversity in the age classes of all four species, with adequate distribution among the age classes. Some age classes appear to be stronger than others, such as the 1975 Walleye class which shows as the strongest class for the species from 1977 to 1981; the 1991 class was also strong, as it showed as the largest class in the 1994 survey.

Northern Pike generally had a good distribution of age classes for the sample periods. The 1991 survey revealed no fish in the I and III classes, and few in the II and IV classes. The 1994 survey three years later showed the III class as the strongest, which were the 1991 spawn. The young age classes did recovered in the later surveys, as those age classes appear strong in the 1994 survey. Smallmouth Bass show very good age distribution from 1977 to 1998, with excellent diversity among the age groups from the II class to the XII class in most sample years. Largemouth Bass also had good age diversity among the distribution of age classes. Some sample years from 1977 to 1998 do have empty classes above X, or gaps between older age groups. For the majority of years the Largemouth Bass were well distributed between the III and XI age classes.

Appendix 4: Broad-scale Fisheries Monitoring

Broad-scale Fisheries Monitoring Bulletin

MISSISSIPPI LAKE - ZONE 18

Mississippi Lake Facts

Township(s): Drummond, Beckwith and Ramsay

Surface Area: 2436 ha

Maximum Depth: 9.2 m

Average Depth: 2.7 m

Water Clarity: 4.5 m

Monitoring Activities

- [x] Fish netting
- [x] Fish contaminants
- [x] Zooplankton
- [x] Water chemistry
- [ ] Bathymetry
- [x] Water temperature/dissolved oxygen
- [x] Aquatic invasive species

Netting Summary

Netting period: September 14-18, 2009

Number of net sets: 31

Number of fish species caught: 14

Fish Netting Results

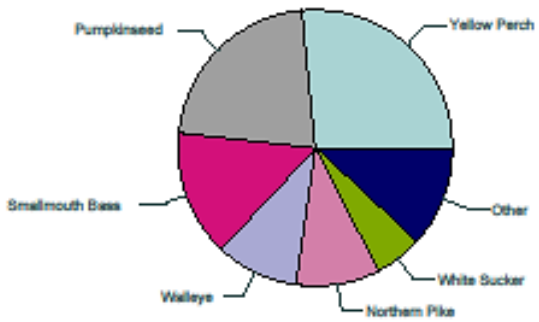
Fish populations were surveyed using large and small mesh nets to provide information on fish species present and their characteristics, such as growth, age and abundance. The catch data below show that 10 species were surveyed in large mesh nets. Additional fish species observed in small mesh nets were Blackchin Shiner, Bluegill, Logperch and Trout-perch.

Fish species	Total Catch %	Maximum Length cm	Minimum Length cm	Average Length cm
Yellow Perch	27	25.3	14.3	17.1
Pumpkinseed	22	28.5	10.4	20.6
Smallmouth Bass	15	43.4	21.7	32.1
Walleye	10	62.3	25.9	37.9
Northern Pike	10	63.0	35.9	51.8
White Sucker	6	54.7	42.0	49.4
Rock Bass	4	21.1	12.0	17.5
Black Crappie	3	25.7	22.0	23.9
Brown Bullhead	3	35.0	31.7	33.6
Largemouth Bass	2	46.5	15.2	32.3

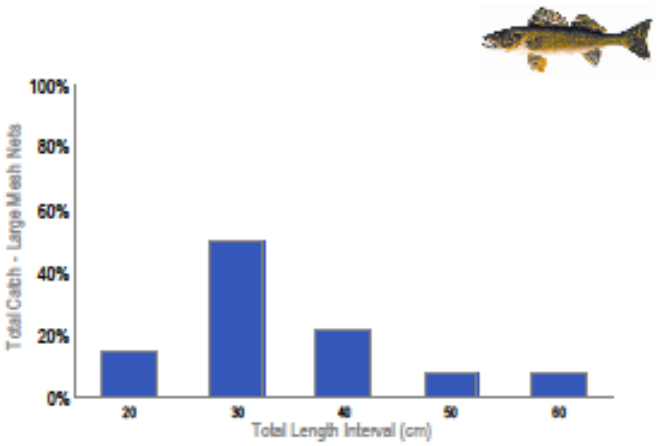
About the Program

The Broad-scale Monitoring Program provides information for managing our fisheries effectively. This bulletin provides a snapshot of the recent monitoring activities and netting results. Netting is conducted using large and small mesh nets to understand the characteristics of fish communities in a lake. Large mesh nets contribute information about fish species and small mesh nets describe the fish community. To learn more about the sampling program visit *Fish Ontario: Monitoring and State of the Resource Reporting*.

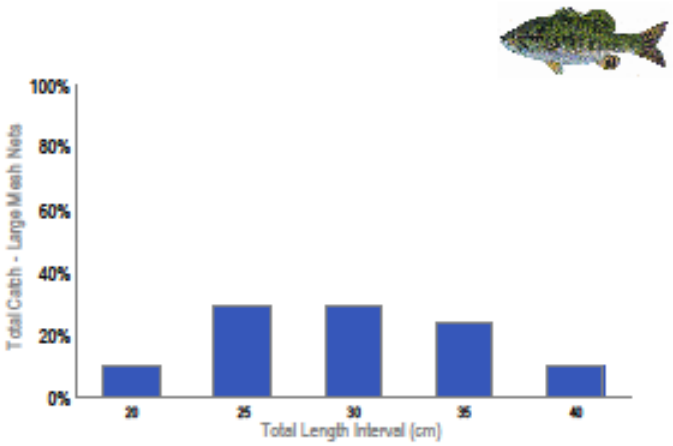
Proportion of Fish Caught in Large Mesh Nets



Length Distribution of Walleye



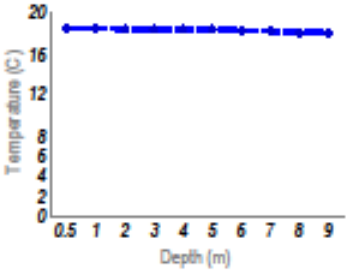
Length Distribution of Smallmouth Bass



The size of Walleye ranged from 25.9 to 62.3 cm and the size of Smallmouth Bass ranged from 21.7 to 43.4 cm in large mesh nets.

Water Chemistry and Temperature

Water samples were collected in April 2009 and sent to the Ministry of Environment for analysis. Water temperature, oxygen levels and water transparency were measured in September 2009. The graph shows the temperature of Mississippi Lake with increasing depth. The temperature at the surface was 18.5 °C and declined to 18.1 °C at the bottom of the lake.



Aquatic Invasive Species

Aquatic invasive species were monitored by field crews. Zebra mussel were observed during monitoring. Samples are currently being processed to determine if any more new invasive species were detected through this sampling program. Any species new to Ontario or an invasive species that is a new record for a waterbody is reported to the Invading Species Hotline (www.invadingspecies.com).

Fish Contaminants

Levels of contaminants in fish flesh (e.g. mercury, PCB's, mirex, organochlorine pesticides and other organic chemicals) will be reported in the *Guide to Eating Ontario Sport Fish*.

For more information please contact Ministry of Natural Resources at 1-800-667-1940, send an email to mnr.nric.mnr@ontario.ca or visit *ontario.ca/fishing*.

ontario.ca/fishing

Ontario

Appendix 5: MOE Guide to Eating Sport Fish

Contaminants

The following table from the MOE *Guide to Eating Sport Fish* summarizes Mississippi Lake consumption rates. General population recommendations are in the G labelled row, and sensitive population recommendations are in the S labelled row. The superscripts that accompany the fish species in the preceding table indicate the contaminants the fish were tested for. The tested contaminants are listed below;

1-Mercury
2-Mercury, PCBs, mirex/photomirex, and pesticides
5-Mercury, other metals, PCBs, mirex/photomirex, and pesticides.

Length (cm) →		15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	>75
Black Crappie [2]	G		8	8	8									
	S		8	4	4									
Bluegill [5]	G	8	8											
	S	8	8											
Brown Bullhead [5]	G		8	8	8	8	8							
	S		8	8	8	8	8							
Largemouth Bass [5]	G		8	8	8	4	4	4	4					
	S		8	8	0	0	0	0	0					
Northern Pike [2]	G			8	8	8	8	8	8	8	4	4	4	
	S			8	4	4	4	4	4	4	0	0	0	
Pumpkinseed [5]	G	8	8											
	S	8	8											
Rock Bass [5]	G	8	8	8										
	S	4	4	4										
Smallmouth Bass [5]	G	8	8	8	4	4	4							
	S	8	8	4	0	0	0							
Walleye [2]	G	8	8	8	8	8	4	4	4	4	4			
	S	8	8	8	4	0	0	0	0	0	0			
White Sucker [1]	G						8	8	8					
	S						8	8	4					
Yellow Perch [2]	G		8	4										
	S		4	0										

Appendix 6: Waterfront Regulatory Agencies and Roles

Mississippi Valley Conservation Authority (MVCA)

The Mississippi Valley Conservation Authority (MVCA) administers Ontario Regulation 153/06: Regulation of Development, Interference with Wetlands and Alterations to Shorelines and Watercourses of the Conservation Authorities Act. Under this legislation MVCA regulates, development (including buildings, grading activities) in and next to floodplains, river banks and steep slopes, and Provincially Significant Wetlands. MVCA also regulates alterations to watercourses and shorelines **including channel realignment; shoreline stabilization or erosion control works shore** (including rip rap installation and removal or installation of other retaining wall types, and **dock attachments at the shore.**

MVCA acts as a review agency for all other activities, such as; planning applications/minor variance, site plans, zoning changes, severances, subdivision approvals, Official Plan amendments, and septic system approval for water front properties. As a review agency the MVCA provides comments to the approval agencies regarding the possible impacts of the proposed activities on natural hazards (flooding, erosion and unstable areas) and natural heritage features, , and suggest mitigating actions to minimize potential impacts.

Leeds, Grenville and Lanark District Health Unit (LGLDHU)

The Leeds, Grenville and Lanark District Health Unit administer Division B Part 8 of Ontario Building Code Regulation 332/12, which gives them the authority to approve **septic system permit applications.** The Health Unit is also a review agency for other development activities; planning applications/minor variance, site plans, zoning change, severances, subdivision approval and Official Plan amendments. As a review agency the Health Unit provides comments to the approval agencies regarding possible impacts of the proposed on-site sewage treatment system, and suggests mitigating strategies for the possible impacts.

Ontario Ministry of Natural Resources (MNR)

The Ontario Ministry of Natural Resources (MNR) administers *Ontario Regulation 239/13 Public Lands Act*. Under this regulation, the MNR is the approval authority for the following activities:

- **shoreline stabilization and erosion control**,
- **boathouse construction** (depending on size), and
- **shoreline dredging**

A work permit is required by this regulation for erosion control structures if the work conducted will result in the structure being a different dimension and location than the original structure. Work permit exemptions exist for shore land dredging if the area was previously dredged under a permit approved on or after January 1 2009, and the subsequent dredging takes place before the 5 year anniversary of the permit or 5 year anniversary of subsequent dredging.

Recently the MNR has changed requirements for some previously permitted work, such as **dock installation and aquatic vegetation removal**. This process is now a self-assessment via the MNR website.

MNR has jurisdiction over **mechanical removal of aquatic vegetation** (i.e. rakes, cutting bars, etc.), if the conditions in the self-assessment are all met by the project proponent (being the landowner), then a work permit for the activity is not required by the MNR. The Fisheries Timing Window, which sets out the guidelines for when in-water work is restricted in order to protect fish during spawning and other critical life stages, is also the product of MNR jurisdiction. The MNR is a review agency for Official Plan amendments, providing comments to municipalities regarding impacts of potential policy changes.

Ministry of the Environment (MOE)

The Ministry of the Environment (MOE) administers the *Environmental Protection Act* with *Ontario Regulation 360 – Spills*. Under this legislation the MOE **regulates all spills and water contamination**. All spills and contaminations must be reported the MOE Spill Action Centre, where the MOE then over sees the proper and timely clean up and disposal of the contaminants by the discharger (responsible party).

In addition to spills, MOE administers the *Pesticides Act Ontario Regulation 63/09*, which regulates herbicides used **for chemical aquatic vegetation removal**, under *Water Exterminations*. The MOE is also as review agency for Municipal Official Plan Amendments, commenting on policy changes and potential impacts.

Department of Fisheries and Oceans (DFO)

The Department of Fisheries and Oceans (DFO) administers the *Fisheries Act*, which requires projects to avoid causing serious harm to fish. DFO is the approval authority for activities such as; **shoreline stabilization/erosion control, dock projects, boathouse construction and dredging**. However, DFO has recently changed their approval process to a web self-assessment and/or registration approach for in-water activities. Proponents are directed to an online service to determine if their project requires a permit, or if specific conditions and mitigative measures apply to eliminate the need for a permit.

Transport Canada

Transport Canada administers the *Navigable Waters Protection Act*, which ensures a balance between public right to navigation and the need to build works, as well as **removing obstructions or hazards** and **prohibiting dumping within waterways**. Transport Canada regulates any obstructions and/or works within a navigable waterway, and as such is an approval agency for **floating rafts and mooring buoys**. Transport Canada also provides self-assessments for **dock projects**; those projects that can meet all of the requirements of the self-assessment can forego the application process.

Lanark County

Lanark County is the upper-tier municipality for the lower portion of the Mississippi Lake watershed. An upper-tier municipality is comprised of two or more lower-tier municipalities, being the townships. Upper-tier municipalities administer the *Planning Act*, making counties the approval authority for **severances, subdivisions and official plan amendments**. The upper-tier is responsible for making sure that severance and subdivisions comply with county Official Plans, municipal zoning by-law and the Provincial Policy Statement.

Lower-tier Municipalities

Lower-tier municipalities include the Townships of Drummond/North-Elmsley, Beckwith, Mississippi Mills, Lanark Highlands and Tay Valley, which combined constitute Lanark County. These municipalities administer legislation under the *Planning Act*, and through zoning by-laws can regulate areas where types of development are permitted or prohibited. These regulations make the municipalities the approval authorities for activities such as; **planning applications, minor variances, site plans, zoning changes, severances and boat houses**. Lower-tier municipalities are also review agencies for subdivision applications and Official Plan amendments, providing comments to the upper-tier municipalities for approval.

It is important to note, that many of these governing bodies act as review agencies for several types of activities. As review agencies, the approval authorities are not required to abide or implement the comments submitted by the agencies. However, in many cases the expertise and knowledge provided by the review agencies carries significant weight with the approval authorities.

Appendix 7: Carleton Place Water Treatment - Intake Protection Zones

DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

Mississippi Valley Conservation
RIDEAU VALLEY CONSERVATION AUTHORITY

Carleton Place
Intake Protection Zone

Municipal Drinking Water

The Town of Carleton Place is serviced by municipal water.

- Their current water treatment plant was built in 1914
- It supplies drinking water to approximately 9,453 people

Where Does the Water Come From?

The water treatment plant draws water out of the:

- Mississippi River

The map on the back side of this fact sheet shows:

- The location where water is drawn out of the river (yellow dot); and
- The upstream area where this water comes from (intake protection zone).

How is the Water Protected?

At the water treatment plant:

- Particles are removed from the water using screens, enhanced coagulation, flocculation and sedimentation, and dual media filtration
- Water is disinfected using chlorine gas
- Water quality is tested regularly and is consistently in compliance with Ontario Drinking Water Standards

? For more information contact the Town of Carleton Place at 613-257-6200 or visit www.carletonplace.ca

In the Intake Protection Zone:

- Policies are being developed to promote good stewardship to protect surface water.
- In areas scored 8 to 10 (see map on reverse side for scores), additional policies may also restrict, or place requirements on, land use activities involving:

→ Waste disposal sites
→ Sewage works and septic systems
→ Nutrients (manure, biosolids)
→ Certain types of chemicals
→ Fuel (minimum 250 litres, includes furnace oil)
→ Pesticides
→ Commercial Fertilizer
→ Outdoor livestock areas
→ Road salt and snow storage
→ Airplane de-icing runoff

- The purpose of these additional policies would be to prevent a spill, a leak or runoff in these areas that could contaminate local surface water supplying the municipal intake.
- These policies are being developed locally, under Ontario's *Clean Water Act*.

? For more information about these policies, please contact the Mississippi-Rideau Source Protection Region at 1-800-267-3504 or visit www.mrsourcewater.ca.

Carleton Place Intake Protection Zone

This network of creeks, ditches and storm sewers that flow into the river upstream of the water treatment plant is called an **Intake Protection Zone**. The zones on this map mean:

- 10 200m upstream & 10m downstream of the intake pipe (plus a buffer on land)
- 9 runoff in this area could reach the intake within 2 hours
- 8 runoff in this area could reach the intake within 2 to 6 hours
- 7 runoff in this area could reach the intake within 6 to 10 hours
- 6 runoff in this area could reach the intake within 10 to 14 hours
- 5 runoff in this area could reach the intake within 14 to 18 hours
- 4 runoff in this area could reach the intake in 18 hours or longer