2014 MUSKOKA WATERSHED

REPORT CARD

Stewardship works: how healthy is our land and water?

Background Report

May 2014

Muskoka
WATERSHED COUNCIL

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Introduction

As people live and work, they modify the landscape, impact the plants and animals in their watershed, and alter both ecosystem services[1] and ecosystem functions[2]. The Muskoka Watershed Report Card[3] presents the results of monitoring these changes and evaluating the health of the natural features of Muskoka's watersheds[4]. The 2014 Muskoka Watershed Report Card is the fourth report card for the area. The content, level of detail, and accuracy of these reports have evolved and will continue to evolve as new and better data become available.

Goal

The goal of the Muskoka Watershed Council is to achieve a balance between human systems and a wholly functioning ecosystem. This report card is one tool to educate, in the broadest sense, so that people have a positive influence on the ecology of the watersheds. The report card will report on and measure change over time. It will report on ecological conditions, general threats or "drivers" of change, hotspots of special concern, and emerging issues. At the same time, it will identify gaps in our knowledge and research. It will convey the stewardship activities of various groups and offer a pathway for those interested to delve deeper into background information sources.

The report card is intended for a wide array of audiences: from individuals and organizations to planners and policy makers. The document will draw on existing scientific assessments and use other experts' analyses across a range of fields.

[1] **Ecosystem services** are the goods and services which the environment produces, such as clean water, timber, habitat for fisheries, and pollination of native and agricultural plants. From Ecological Society of America, "Ecosystem Services: A Primer," http://www.actionbioscience.org/environment/esa.html

[2] **Ecosystem functions** are the processes by which the environment produces ecosystem services. From Ecological Society of America, "Ecosystem Services: A Primer," http://www.actionbioscience.org/environment/esa.html

[3] **A report card** is a snapshot of the current conditions of our environment.

[4] **A watershed** is an area of land that drains to a river, lake or stream. What happens in one part of a watershed impacts directly on other parts of that watershed regardless of political boundaries.

A variety of indicators[5] will be used to identify present and potential stresses and to evaluate the health of the terrestrial and aquatic resources. The intent is to update the Report Card every four years. Subsequent report cards will document change over time within our watershed. The Report Card is based on water quality and shoreline data collected by The District Municipality of Muskoka, monitoring data from provincial bodies and Geographic Information System (GIS) mapping.

Objective

The mission of the Muskoka Watershed Council is to *Champion Watershed Health*. A minimum ecological standard is required in order to maintain healthy ecological systems, good water quality, and a strong economic base. The objective of the Muskoka Watershed Report Card is to report on the ecological health of the watershed in order to provide some understanding of the success of our collective ability to live within the natural limits set by the watershed. This objective reflects the desire of all watershed municipalities to develop in a manner that is sensitive to the natural environment.

The Report Card examines environmental health at the scale of quaternary watersheds.

The report card evaluation has been completed on a quaternary watershed[6] basis as defined by the Ministry of Natural Resources (Table 1). The Ministry has labelled each quaternary watershed with an alpha-numeric identification tag (e.g. 2EB-07) for easier reference.

A conservative approach has been taken in grading the quaternary watersheds in order to highlight potential issues and raise awareness of the need to be good stewards of our watersheds. This watershed specific analysis will ensure that natural form continues to dominate over built form as development occurs.

Table 1: Quaternary watersheds included in the 2014 Muskoka Watershed Report Card

Watershed	Name
2EB-02	Moon River
2EB-03	Gibson River
2EB-04	Lake Muskoka
2EB-05	Lake Rosseau
2EB-06	Rosseau River
2EB-07	Skeleton River
2EB-08	Dee River
2EB-09	South Muskoka River
2EB-10	Lake of Bays
2EB-11	Oxtongue River
2EB-12	Hollow River
2EB-13	Mary Lake
2EB-14	North Muskoka River
2EB-15	Big East River
2EB-16	Little East River
2EC-14	Lower Black River
2EC-15	Upper Black River
2EC-16	Kahshe River
2EC-17	Severn River

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5 **An indicator** is data that provide information about or predict the overall health of a portion of the natural environment. Examples include total phosphorus as an indicator of recreational water quality or mercury levels in fish as an indicator of toxin levels.

6 **Quaternary Watershed** – a fourth order watershed. Watershed order includes – First order: Great Lakes Basin; Second Order: Georgian Bay; Third Order: Muskoka River; Fourth Order: 19 subwatersheds in Muskoka (Lake of Bays, Lake Rosseau, Big East River, Moon River, etc).

Muskoka Watershed Council supports the **District Council Strategic Priorities**[7] approved in July 2012. The Mission states:

> *"To manage the legacy of a healthy Muskoka by sustaining a functioning natural environment, recognizing the need for a vibrant economy together with a caring community conscience supporting those in need."*

District Council's first goal states:

> *"Manage development and growth in a sustainable manner balancing environmental, economic, social and cultural elements. Recognize that in Muskoka a healthy and vibrant economy depends upon wise stewardship of the environment. Build on the cultural heritage of Muskoka and demonstrate municipal leadership in environmentally sustainable policies, programs and practices."*[8]

Muskoka Watershed Council also supports the **Strategic Vision of The District Municipality of Muskoka** as re-affirmed in Official Plan Amendment #42, recently approved by District Council:

> *"Muskoka will be a place where people can live, work, and play. The overall prosperity of Muskoka will rely on the integration of a vibrant economy and a healthy natural environment along with a caring community that fosters a sense of belonging and supports those in need. Sustainable development will allow for desirable growth and change that respects the small-town, rural and waterfront character of Muskoka. All residents will be valued and community well-being will be promoted."*[9]

The environmental guiding principle states:

> *"The natural environment, especially water, is Muskoka's key asset and it will be protected for the values it provides including support for diverse ecosystems and a vibrant economy."*[10]

All six Muskoka Area Municipalities expressly state in their Official Plans that protection of the natural environment is paramount as development occurs. The Township of Seguin also reflects a desire to protect the natural values of the watershed. The first goal in their Official Plan states that the Township will take an 'Environment-First' approach to development and other decisions.[11]

The Township of Algonquin Highlands Official Plan also recognizes the importance of the natural environment, including wetlands, woodlands, areas of Provincial significance, fish and wildlife habitat, and lakes, rivers and streams, and states that they will proceed on an ecosystem management basis.[12]

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[7] District Municipality of Muskoka, July 2012. *Strategic Priorities*. Unpublished.

[8] ibid

[9] The District of Muskoka Planning and Economic Development Department, Official Plan Amendment #42, adopted February 2013

[10] ibid

[11] Meridian, The Township of Seguin Official Plan, October 22, 2007.

[12] Planscape, The Corporation of the Township of Algonquin Highlands Official Plan, August 29, 2005.

Muskoka Watershed Council recognizes the importance of healthy natural areas to all residents of the watershed and has developed the report card to allow decision makers to monitor the success of policies and whether they are achieving their overall goals of environmental sustainability.

The Report Card is an important management tool because what gets measured gets managed. It provides an evaluation of whether the vision of maintaining a predominantly forested landscape with functioning natural ecosystems is being achieved. It also helps improve the understanding of local degraded areas, focuses management actions where they are most needed and tracks progress over time. The Report Card also defines the forested environment and identifies healthy and ecologically important areas that will allow appropriate management practices to be undertaken and significant areas to be protected for future generations.

Muskoka Watershed

The term Muskoka Watershed refers to all watersheds lying totally or partially within The District Municipality of Muskoka and includes areas in Algonquin Provincial Park and the Townships of Seguin and Algonquin Highlands. Watersheds are the most effective unit for the management of our shared resources; compatible activities and programs should be made available across the watershed, regardless of political boundaries, in order to ensure watershed health.

Unlike some parts of Ontario, Muskoka, in general, is in excellent natural condition: 94% of the watershed is in natural cover; water quality is much better than provincial guidelines for recreational use; and most wetlands are intact. We are in the enviable position of being able to develop our watershed in a sustainable manner. It should be noted, however, that there are already signs of environmental stress: road density in the central core of the watershed is over one (1) kilometre of road per square kilometre of area.[13] Shoreline density on some lakes is as high as 25 lots per kilometre. Only by monitoring and reporting change can we understand the human impact and environmental sensitivities affecting the watershed. In some areas, local stewardship programs are needed to reverse these trends and restore watershed health. Careful monitoring and local benchmarking will assist in understanding the human impact on natural processes and encourage modified behaviour before significant environmental damage is done.

The area covered by the 2014 Muskoka Watershed Report Card is illustrated in Figure 1 and includes all of tertiary watershed 2EB (Muskoka River Watershed) and the northern portion of tertiary watershed 2EC (Black River-Lake Simcoe Watershed).

[13] **Road Densities –** as road densities approach 2 km/km^2 there is a noticeable increase in animal fatality.

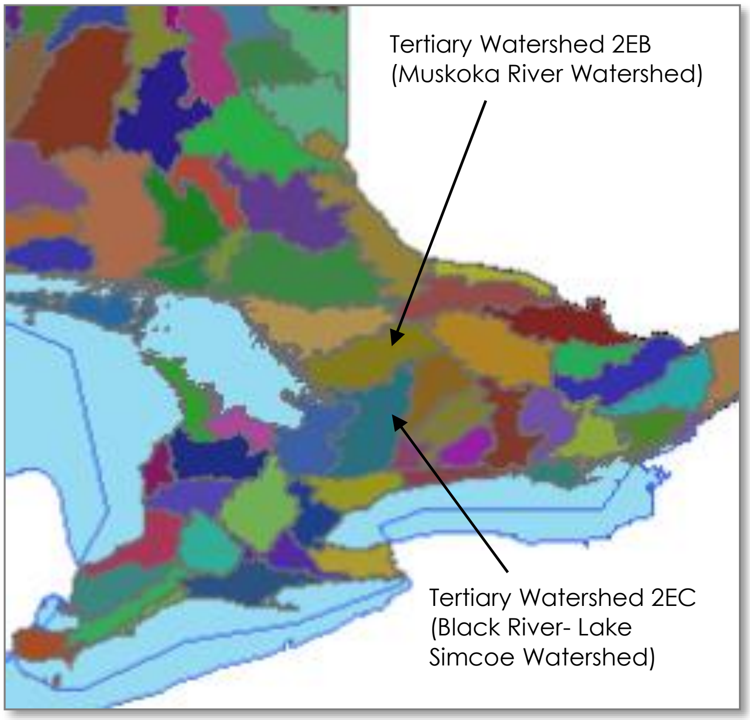

Figure 1: Tertiary Watersheds

These tertiary watersheds can then be subdivided into 19 quaternary watersheds (Figure 2, Table 1).

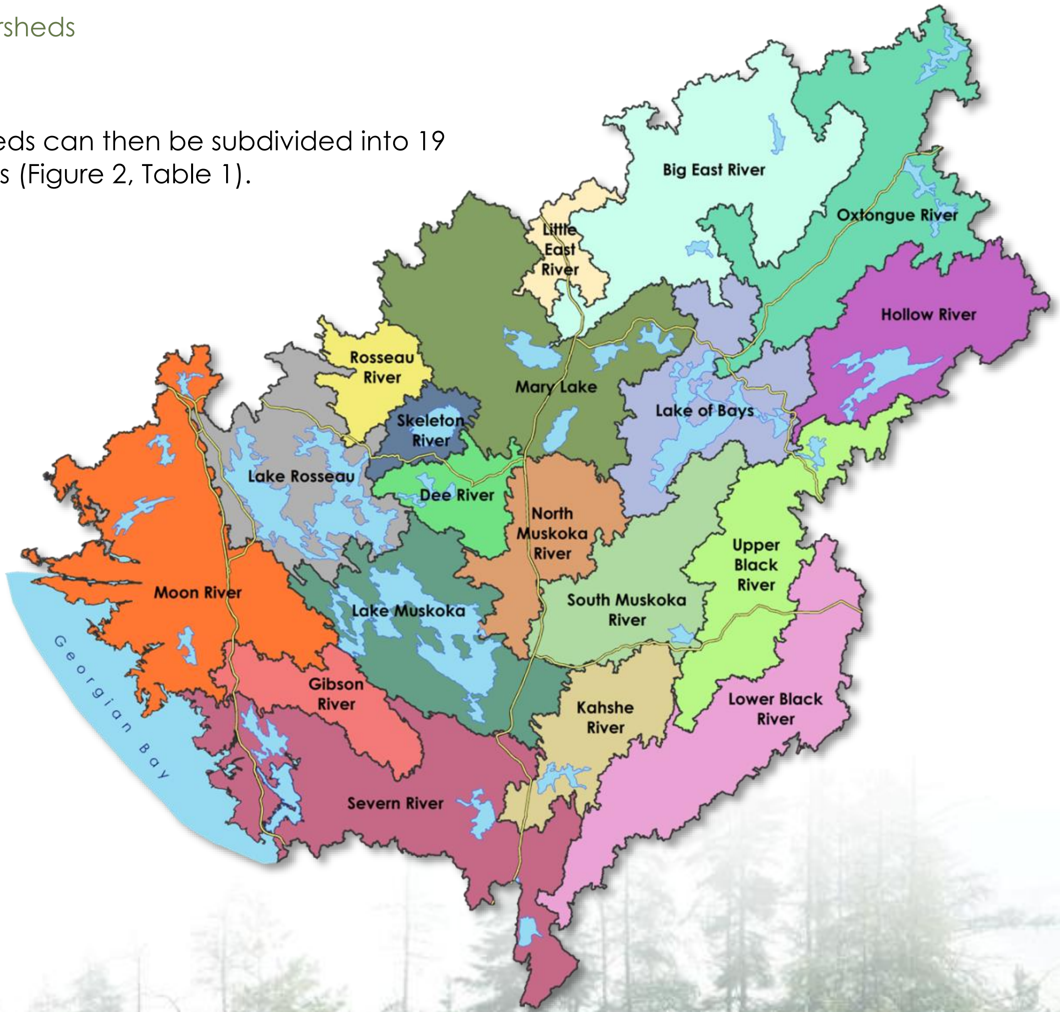

Figure 2: Quaternary watersheds in the 2014 Muskoka Watershed Report Card

The Muskoka River Watershed (2EB)

The Muskoka River Watershed (2EB) is located in central Ontario's lake country. The main population centres are Huntsville, Bracebridge and Gravenhurst. Both Highway 69/400 extension and Highway 11 bisect the watershed in a north/south direction. The physical characteristics of the watershed are provided in Table 2.

Table 2: Watershed Characteristics of the Muskoka River Watershed (2EB)

Characteristic	Value
Watershed Area	7,638 km^2
Approximate Permanent Population	59,000
Approximate Seasonal Population	100,000
Number of Major Towns	3 (Bracebridge, Gravenhurst, Huntsville)
Number of Villages and Hamlets	11
Number of Quaternary Watersheds	16
Number of Lakes	Over 1,000
Number of Municipal Wastewater Systems	8
Number of Control Structures	42
Number of Navigation Locks	3
Number of Hydro Generating Stations	10

From its headwaters in Algonquin Provincial Park, the Muskoka River flows 210 km through a series of connecting lakes to two outlets in Georgian Bay. The watershed is 62 km at its widest point, encompasses an area of approximately 7,638 km^2, and includes about 780 km^2 of lakes. The watershed is divided into three distinct areas: the north and south branches of the Muskoka River, and the lower Muskoka River (Figure 3). The north and south branches of the Muskoka River comprise approximately the eastern two-thirds of the watershed, originating in the highlands of Algonquin Provincial Park. They flow south-westerly until converging in Bracebridge and then flow into Lake Muskoka. The lower portion of the watershed covers approximately the western one-third of the watershed and receives the inflow from the north and south branches of the Muskoka River as well as Lakes Joseph and Rosseau, and Gravenhurst Bay. This combined flow passes through the Moon and Musquash Rivers and discharges into Georgian Bay.

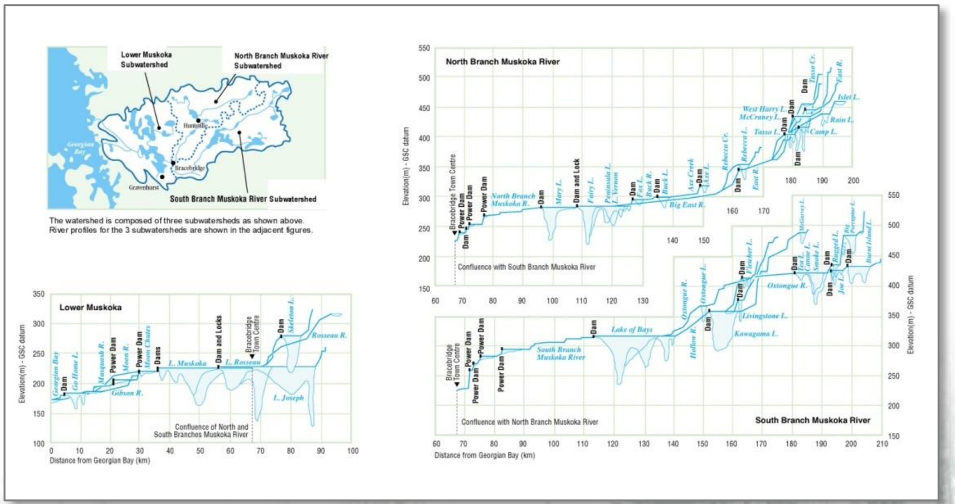

Figure 3: Muskoka River Watershed Elevations (from the Muskoka River Water Management Plan)

The Black River-Lake Simcoe Watershed (2EC)

The Black River-Lake Simcoe Watershed (2EC) encompasses an area from Newmarket in the south to Minden in the north and Honey Harbour in the east. It includes all of Lake Simcoe in addition to the Black and Severn Rivers. The portion of the Black River-Lake Simcoe Watershed that is dealt with in this report card is limited to the northern portions of the Black and Severn River Watersheds only and encompasses 2,538 km^2.

The headwaters of the Black River are in the Township of Algonquin Highlands. From there, the river flows in a south-westerly direction through the southern portion of The District Municipality of Muskoka and northern portions of the Township of Minden Hills, City of Kawartha Lakes, and Ramara Township to Lake Couchiching. From Lake Couchiching it enters the Severn River waterway and flows to Georgian Bay. Most of the land area in the Black River Watershed is Crown land, with the upper reaches being part of the old Leslie M. Frost Centre.

The portion of the Severn River Watershed that flows through the southern portion of Muskoka is the very bottom section of the Trent/Severn Waterway. The water flows from Lake Couchiching into the lower Severn River and out to Georgian Bay at lock 45 at Port Severn. The Kahshe River quaternary watershed flows into the Severn River.

The Black-Severn River Watershed is sparsely populated (less than 54,000 residents) with few large urban or agricultural areas. The land use tends to be a blend of rural residential and crown land settings where population dramatically increases for the summer months as a result of a vibrant tourism industry and seasonal residents. The characteristics of the Black-Severn River Watershed are outlined in Table 3.

Table 3: Watershed Characteristics of the Black-Severn River Watershed (2EC)

Characteristic	Value
Watershed Area	2,769.93 km^2 (only 1,712.71 in study area)
Approximate Permanent Population	54,000 (most of which are located in the subwatersheds south of the study area)
Approximate Seasonal Population	unknown
Upper Tier Municipalities	3
Lower Tier Municipalities	9
Number of Quaternary Watersheds	8 (only 4 in the study area)
Number of Lakes	Over 500

The Black-Severn River Watershed flows through portions of three upper tier municipalities (Simcoe, Muskoka, and Haliburton), one single tier municipality (City of Kawartha Lakes) and nine lower tier municipalities (Gravenhurst, Bracebridge, Lake of Bays, Muskoka Lakes, Georgian Bay, Minden, Algonquin Highlands, Severn and Ramara).

The Black-Severn River Watershed is part of the Trent-Severn Waterway. As such, water levels and water flows throughout the Severn River Watershed, including portions of the Lower Black River Watershed, are managed by Parks Canada, which is an Agency of Environment Canada.

Watershed Use

The Muskoka Watershed supports a wide range of aquatic and terrestrial ecosystems. Numerous human uses, including waterpower generation, swimming, canoeing, boating, angling, hunting and trapping, and tourism operations occur within these ecosystems. There are 42 water control structures (dams and/or dam/powerhouse combinations) on the Muskoka River system and three navigation locks (Figure 3).

All the water in the Muskoka Watershed eventually flows into Georgian Bay through the Moon, Musquash or Severn Rivers.

Quaternary Watershed Evaluation

For the most part, the evaluation has been conducted at a landscape level using remote sensing tools such as air photography and satellite imagery. Results are provided on both a tertiary and quaternary watershed basis. Current data limit the amount of site specific or lake specific analysis that can be done.

As the analysis moves from a tertiary to a quaternary watershed level, the variation in watershed health becomes more evident. The health of each quaternary watershed is important not only because people relate more strongly to their local watershed area, but also because each quaternary watershed has unique stresses and requires specific natural areas to support local processes that serve the needs of local residents for the many ecosystem services and functions they provide.

Development in each of the 19 quaternary watersheds varies resulting in different levels of stress. The more developed watersheds (10% or greater developed) are located in areas that are more accessible by road and tend to be in the areas with a longer history of settlement, for example the Lake Muskoka Watershed. Moderately developed areas (5-10% developed) have good road access but would have been a little more difficult to develop in the early 1900s, for example the Mary Lake Watershed or the Little East River Watershed. Areas with low development are more remote and tend to have more Crown and protected land in the watershed, for example the Hollow River Watershed or Lower Black River Watershed. Each of these classes of watershed will have their own challenges in maintaining good watershed health.

In order to evaluate the health of a watershed or to document change over time, benchmarks[14] can be developed and used. In forested environments such as Muskoka, the province has not established any such benchmarks. Most research addresses more developed environments, such as southern Ontario, where ecological benchmarks have been established. Benchmarks from southern Ontario do not make sense in Muskoka. For example, the provincial guideline for total phosphorus (TP) concentration in rivers and streams is to maintain an average of less than 30 micrograms per litre (µg/L) total phosphorus. The provincial guideline for lakes is to maintain an average concentration of less than 20 µg/L of phosphorus. Most lakes, river and streams in Muskoka have a natural level of phosphorus substantially below these standards.

[14] **A benchmark** is an established guideline against which change in environmental condition can be measured.

In the absence of established benchmarks, the Report Card will rely on one of two methods to analyze the health of the quaternary watersheds. First, where sufficient data exist, an indication of change over time will be undertaken. This method will be used to analyze changes in total phosphorus levels and calcium levels in lakes. Second, where data and research are available, the standards recognized in the scientific literature will be used. Often times these standards were established for more developed watersheds and are not directly applicable to Muskoka. Local benchmarks were established in the 2010 Muskoka Watershed Report Card and represented the average condition in 2010. These benchmarks will be used to temper the published standards to reflect the forested landscape of the watershed. This method will be used for such indicators as large natural areas and interior forest.

In the report *How Much Habitat is Enough?*, Environment Canada identifies the issue of standard ecological targets across Ontario. The report states that any guideline should be a starting point and where local programs can provide more habitat a greater robustness in natural heritage systems can be anticipated.[15] Based on the vision and strategic priorities of all the municipalities within the watersheds, the Report Card assumes that there is a desire to maintain natural systems that are robust and represent more than the minimum areas identified for southern Ontario.

Using these methods, it is possible to see smaller changes in the health of our quaternary watersheds and the functioning of our ecosystems and act accordingly before they become more serious ecological problems. Grades have been given based on deviations from these "made-in-Muskoka" benchmarks in order to provide a better understanding of the health of our local quaternary watersheds.

Managed and Protected Areas

There is no natural areas strategy within the watersheds that recognizes and connects actively managed areas; however, the area is blessed with land that is well managed both by the province and by good private land stewards. Eventually a natural areas strategy will be required to ensure natural areas remain connected, key areas remain in a natural state, and significant habitat is protected. Managed areas are lands managed by either the Crown or a private landowner for the natural values they possess. In particular there are:

1. large areas of Crown land managed under the Public Lands Acts,
2. Crown nature reserves managed and administrated under the Provincial Parks and Crown Reserve Act,
3. eleven (11) provincial parks and one national park managed and administered under specific parks acts,
4. an increasing number of nature reserves owned and managed by local land trusts, and
5. private lands managed by individual landowners and associations under such programs as the Managed Forest Tax Incentive Program (MFTIP) and the Conservation Lands Tax Incentive Program (CLTIP).

These areas will serve as a base for a natural areas system in the future but effort to develop connecting corridors and address natural areas protection in the central corridor of Muskoka is necessary to ensure long-term watershed health. It is expected that pressure for development in

[15] Environment Canada, 2013. *How Much Habitat is Enough*? Third Edition. Environment Canada. Toronto. Ontario.

Muskoka will continue to increase in the next few decades and a natural areas strategy will be important to protect some of the natural values of the watershed.

Muskoka still enjoys many areas that are in good condition and have very high ecological significance. These areas should form the base, or core, of a protected areas strategy. Muskoka is a mosaic of Crown and private land and individuals and land managers responsible for both classifications of land ought to work together to develop a comprehensive approach to the management of the area.

Using updated GIS layers, the percent of protected and managed area was determined for each quaternary watershed (Table 4).

Table 4: Managed and Protected Areas by Quaternary Watershed

Quaternary Watershed	% Total Protected	% Crown Land	% Private Stewardship	% Parks & Protected Areas
Moon River	69	49	3	17
Gibson River	70	32	0	38
Lake Muskoka	16	6	4	6
Lake Rosseau	16	12	2	2
Rosseau River	45	29	9	7
Skeleton River	33	16	17	0
Dee River	14	3	11	0
South Muskoka River	27	15	10	2
Lake of Bays	36	24	11	1
Oxtongue River	99	28	2	69
Hollow River	75	61	0	14
Mary Lake	16	5	10	1
North Muskoka River	17	8	9	0
Big East River	80	39	7	34
Little East River	18	9	2	7
Lower Black River	91	41	1	49
Upper Black River	90	76	3	11
Kahshe River	28	6	6	16
Severn River	72	56	2	14
Total	**48**	**26**	**5**	**17**

Past Indicators

Since the first Muskoka Watershed Report Card in 2004, a lot has been learned about our watershed and what makes it healthy. As experience and knowledge have been gained, the indicators that have been reported on have been changed and modified. The objective of the Watershed Report Card is to report on the ecological health of the watershed. Over the years, the Report Card has addressed such issues as human health, municipal action, stewardship, and drinking water. Although all these issues are important, there are other agencies working within the watershed that are better suited to addressing them. For example, the District of Muskoka reports on drinking water quality.

The 2014 Muskoka Watershed Report Card uses the best information available and focuses on a limited number of indicators that will provide an overview of the ecological health of the watershed. Past indicators that will not be reported on include:

1. *E. coli* – *E. coli* is a bacterium that is commonly found in the lower intestine of warm-blooded organisms. Most *E. coli* strains are harmless, but some can cause serious health effects in humans. When *E. coli* is found in recreational waterbodies, it is an indicator of contamination from feces. In some cases, the contamination can be a result of a poorly functioning septic system or other waste treatment facility; however, often times it is a natural occurrence from the ducks, geese and other wildlife in the area.

   E. coli contamination is a serious human health matter and should not be taken lightly. Both the Ministry of Environment and the Simcoe Muskoka District Health Unit strongly recommend that all drinking water taken from surface water be treated before ingesting. All drinking water should also be tested on a regular basis to ensure treatment systems are functioning properly.

   The Simcoe Muskoka District Health Unit and several lake associations test swimming areas and other recreational areas for *E. coli* levels on a regular basis. Health Unit data confirm that local beaches have very good swimming water quality, and closures of Muskoka beaches for health reasons are rare. Lake association data are collected using several different protocols. They monitor *E. coli* for human health concerns, and also use *E. coli* levels as an easily measured proxy for other environmental problems that can be caused by faulty septic systems (chiefly nutrification). Generally the data show that *E. coli* levels are very low in cottage areas and although levels may be a little higher in more-developed areas such as marinas, average *E. coli* readings are well below the provincial guideline of 100 cfu (colony forming units) for safe recreational use.

   The Muskoka Watershed Report Card will not continue to report on *E. coli* levels because:
   a. At the quaternary watershed scale, *E. coli* levels are a very weak, indirect indicator of ecosystem health although they may reveal localized instances of excess nutrients entering the water; and
   b. All data collected to date have shown our waterways to consistently hold quite low levels.

   Other criteria are more useful for quaternary watershed or larger-scale assessments of ecosystem health. Specific information on *E. coli* levels can be obtained from the Simcoe Muskoka District Health Unit or individual lake associations that have a monitoring program in place.

2. Drinking Water – Municipal drinking water is the responsibility of The District Municipality of Muskoka. Complete water quality analysis and a comparison to provincial guidelines is available on The District Municipality of Muskoka website at http://www.muskoka.on.ca/content/municipal-water-quality.[16] As drinking water is not an indicator of ecological health it will not be included in the 2014 Muskoka Watershed

[16] The District Municipality of Muskoka website at http://muskokadistrict.iwebez.com/siteengine/activepage.asp?PageID=317

Report Card.

3. Air Quality – Air quality is a human health issue and is the responsibility of the Simcoe Muskoka District Health Unit. Air quality is not an indicator of ecological watershed health and so it will not be included in future Muskoka Watershed Report Cards.

   The impacts of poor air quality, or atmospheric deposition, like acid precipitation, do impact watershed health and have been included in the background documentation as it impacts both water quality and terrestrial health.

4. Mercury – In inland lakes on the Canadian Shield, mercury in fish is the most significant contaminant with the most warnings for consuming fish. Mercury in fish is tested by the Ministry of the Environment. Results of the testing are widely available in the *Guide to Eating Sport Fish in Ontario*.

5. Managed and Protected Areas – With the exception of local land trusts, managed and protected areas are the responsibility of the Province and Federal Government. The amount of land that is protected or actively managed is not expected to substantially change.

Trends and Benchmarks

What isn't measured isn't managed. Identifying trends and developing benchmarks is necessary in order to measure progress towards the goal of environmental sustainability identified by all watershed municipalities.

For the purpose of the report card, the definition of environmental sustainability that was first proposed by the Brundtland Report, titled Our Common Future in 1987 will be used[17].

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

Understanding trends and establishing benchmarks to monitor and measure the health of the watersheds of Muskoka is challenging because the quality of data is constantly improving and it is important to be able to distinguish between change due to better data resolution and change due to real environmental change as a result of human activity. A prime example is the improvement in wetland data since the early 2000's. Although no new wetlands have been created in the watershed, an improvement in remote sensing techniques has identified approximately 50% more wetlands.

[17] United Nations (1987) report of the World Commission on Development and Environment. Annex to Document A/42?427 Development and International Cooperation: Environment.

Indicators

Land

The following indicators will be averaged to determine the health of the land portion of the watershed.

- Large natural areas support natural ecological processes that provide services such as clean air and water, and nutrient cycling. In addition, large natural areas ensure a diversity of habitats, preserve native biodiversity, protect moisture regimes, maintain microclimates, and reduce the impact from flooding:

    - Size of natural area includes all ecosystems, such as forest, lakes, rock barrens and wetlands. Size of natural areas will be reported as areas larger than 200 hectares when roads, other linear intrusions and urban development are removed. Unlike interior forests, wetlands, rock barrens, agricultural areas, and smaller lakes that form part of the natural or undeveloped landscape are included in the calculation.

    - Interior Forest includes only those areas of the watershed that are forested and are surrounded by a 100-metre undisturbed natural buffer. Interior forest areas do not include agriculture, wetlands, lakes and rock barrens, or human structures. The amount of interior forest is an indicator of the quality of the forest habitat.

      A healthy forested landscape should have a percentage of interior forest in order to support a variety of species that require an undisturbed habitat. Interior forest habitat is one habitat type that is threatened as development occurs. Interior forest will be reported as forested areas larger than 200 hectares after a 100 metre buffer has been applied and all human development including roads, other linear intrusions, urban areas, and non-forested natural areas have been removed.

- Road Density is a measure of the degree of fragmentation on the landscape and is the primary factor in the death of many species, especially local turtles and snakes. As road density increases to about 1.0 km of road per square kilometre of watershed (1.0 km/km^2) an increase in road mortality of a variety of species occurs. Road density will be reported as the length of road per square kilometre.

- Development is a key stress on our watersheds. As development occurs habitats are lost and waterbodies experience chemical and biological changes. How our watersheds are developed will dictate their health in the future and determine the legacy left for future generations. There are three components of development:

    - Change in level of development is a surrogate for the amount of impervious cover and resulting degradation of lake and stream health. Various studies, including Booth and Jackson (1997), indicate that watersheds that have more than 10% developed area tend to be degraded. Development levels will be reported as the percent developed area by quaternary watershed.[18]

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[18] Booth, D. B. and Jackson, C. R. (1997), Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detection, and the Limits of Mitigation. JAWRA Journal of the American Water Resources Association, 33: 1077–1090. doi: 10.1111/j.1752-1688.1997.tb04126.x

- Shoreline buffers are the 20 m wide strip of land bordering a lake commencing at the shoreline. They are commonly thought of as the front yard at the cottage. The interrelationship between a lake and its shoreline is important. The shoreline zone is the last line of defence against both the land-based stresses, such as silt and erosion from stormwater, and the water-based forces, such as wave action, that may otherwise destroy a healthy lake. A naturally-vegetated shoreline filters runoff generated by surrounding land uses, removing harmful chemicals and nutrients. At the same time, shoreline vegetation protects the lake edges from the onslaught of erosion caused by waves and ice. The shoreline zone also provides critical habitat for aquatic insects, microorganisms, fish, and other animals, thereby helping to maintain a balance in sensitive aquatic ecosystems. Shoreline buffers will be reported as the percent (%) of a shoreline left in a natural state.

- Shoreline density is an important indicator of the human stress being place on a waterbody. This stress includes not only the nutrient loading, dealt with in more detail in the water section, but also the crowding, aesthetic and habitat impacts. Shoreline density will be reported as the number of lots per kilometre of shoreline and assumes one single family dwelling per lot.

Water

The following indicators will be averaged to determine the health of the water portion of the watershed.

- Total Phosphorus (TP) is a measure of the amount of nutrient entering the waterbody. Increases in Total Phosphorus increase the likelihood that a waterbody will experience a nuisance algal bloom.

- Algae are photosynthetic organisms that occur in most habitats. They vary from small, single-celled forms to complex multicellular forms. Although they are a natural and important component of any aquatic ecosystem, they may become a nuisance if they develop into a significant bloom. The propensity for algal blooms will be evaluated based on average phosphorus readings greater that 15 μg/L and if the lake is over threshold. In the future, information on the sighting of algal blooms will be reported as data become available from lake residents and lake associations.

- Fish habitat is a measure of the alteration to shorelines where many fish spawn or feed. Loss of near shore fish habitat will significantly impact fish survival rates and the ecological health of the aquatic environment. Fish habitat is reported as the percent of the shoreline and shallow water zone in a lake that has been left in a natural condition. In the future, changes in the macroinvertebrate community will also be reported.

- Calcium is an important nutrient for the development of bones and exoskeletons. As a result of acid precipitation, calcium has leeched out of the forests and is now also in decline in many of the lakes in the watershed. In some cases, reduced calcium levels have resulted in increased stress to *Daphnia*, a small zooplankton at the bottom of the food chain. Calcium levels are reported as the concentration of calcium in the water (mg of Ca/L of water).

Wetland Cover

Wetlands are an important part of the landscape and, among other services, they help clean the water, reduce flooding, provide habitat for many species of both plants and animals, and replenish our groundwater supplies. Since 2012, Muskoka Watershed Council (MWC) volunteers have monitored wetlands and identified change. Wetlands will be reported as the amount of change in wetland cover on a quaternary watershed basis.

Biodiversity

Biological diversity - or biodiversity - is a term used to describe the variety of life on Earth. It refers to the wide variety of ecosystems and living organisms: animals, plants, their habitats and their genes. It is an essential part of our environment, enabling our ecosystems to maintain productive soils, clean water, and fresh air. Biodiversity also confers ecosystem resilience, which can help our environment recover from future shocks and changes.

Data do not exist that provide a direct measure of biodiversity loss. As such, two closely related indicators will be used to report on biodiversity loss. The Report Card will use the number of species at risk as an indicator of change in habitat diversity and alien invasive species as an indicator of change in species diversity.

- Species at Risk Habitat - species at risk is reported as the number of different types of species at risk habitat in a quaternary watershed. Watersheds with habitat for more types of species at risk are more vulnerable to development or other stressors.
- Invasive Species - is reported as the number and type of invasive species in a quaternary watershed. Maintaining the diversity of native species is important to a healthy watershed. Invasive species often out-compete native species and significantly reduce the biodiversity of an area.

Climate Change

Climate change will have a significant impact on the Muskoka watershed over the next 100 years. A more detailed report of the Muskoka Watershed Council's position paper on Climate Change Adaptation in Muskoka can be found on the MWC website at www.muskokawatershed.org. The Report Card will provide up to date observations of weather events in order to track longer term changes in weather patterns.

Environmental Stewardship

Environmental Stewardship is the act of taking responsibility for the well-being of the environment and taking action to manage or protect that well-being. More simply stated, stewardship is the act of enjoying the splendor and values of our watersheds while still passing on a healthy legacy for our children and grandchildren to enjoy. Environmental stewardship is not something that can be graded but stewardship areas that require additional effort are identified.

Watershed Grades

The Watershed Report Card presents the results of monitoring the health of our watersheds. It has established benchmarks that use the best available science to show a snapshot of the current condition of our land, water, and wetland resources, in addition to the biodiversity of the watershed. Muskoka's benchmarks are considerably higher than those used in southern Ontario, to reflect the healthier condition of our watershed.

The longer you look the more change you see; some good and some bad. Long-term data sets are required to identify or understand environmental change. Monitoring across the watershed has identified new stresses that are impacting the health of the area. This year the Report Card has added calcium decline, shoreline density, algae, road density, species at risk habitat and invasive species. By reporting on a broader range of indicators, this Report Card becomes a more sensitive evaluation tool. It makes it possible both to detect changes, and to highlight the need to apply remedial actions sooner, where necessary.

Overall, Muskoka's natural areas are in excellent natural condition. The watershed is 94 percent in natural habitat. We are in the unique position of being able to achieve sustainable development in the watershed, but not all parts of Muskoka enjoy this high level of ecological health. Settlement and development have come with an environmental cost, and local stewardship programs are needed to reverse these trends and restore watershed health.

Our understanding of the health of our watershed is improving as more data become available. Grades are presented as:

- Not Stressed (green)
- Vulnerable (yellow), and
- Stressed (red)

The benchmarks used to evaluate the health of the Muskoka Watershed are outlined in Tables 5 to 8.

Table 5: Benchmarks for the **Land Indicators** used in 2014 Muskoka Watershed Report Card

Indicator	Measurement Tool	
Large Natural Areas		
Size of Natural Area	Not Stressed	>80% of land area in patches >200 ha
	Vulnerable	50% to 80% of land area in patches >200 ha
	Stressed	<50% of land area in patches >200 ha
Interior Forest	Not Stressed	>50% of the watershed is interior forest
	Vulnerable	20% to 50% of the watershed is interior forest
	Stressed	<20% of the watershed is interior forest
Road Density	Not Stressed	<0.5 km/km^2
	Vulnerable	0.5 to 1.0 km/km^2
	Stressed	>1.0 km/km^2
Development		
Change in Development Level	Not Stressed	<5% of the watershed is developed
	Vulnerable	5% to 10% of the watershed is developed

Indicator	Measurement Tool	
	Stressed	>10% of the watershed is developed
Shoreline Density	Not Stressed	<13 lots/km of frontage on lakes (watershed average)
	Vulnerable	13 to 17 lots/km of frontage on lakes (watershed average)
	Stressed	>17 lots/km of frontage on lakes (watershed average)
Shoreline Buffers	Not Stressed	>75% of lakes in the watershed are Not Stressed
	Vulnerable	50% to 75% of lakes in the watershed are Not Stressed
	Stressed	<50% of lakes in the watershed are Not Stressed

Table 6: Benchmarks for the **Water Indicators** used in 2014 Muskoka Watershed Report Card

Indicator	Measurement Tool	
Total Phosphorus	Not Stressed	TP < background +30% increase (watershed average)
	Vulnerable	TP is between background +30% and +50% (watershed average)
	Stressed	TP > background +50% (watershed average)
Algae	Not Stressed	TP <15 µg/L (watershed average)
	Vulnerable	TP >15 µg/L (watershed average)
	Stressed	TP >15 µg/L and Over Threshold (watershed average)
Fish Habitat	Not Stressed	>70% of the lakes in the watershed are Not Stressed
	Vulnerable	50% to 70% of the lakes in the watershed are Not Stressed
	Stressed	>50% of the lakes in the watershed are Not Stressed
Calcium	Not Stressed	>50% of the lakes in the watershed have a calcium concentration >2.0 mg/L
	Vulnerable	>50% of the lakes in the watershed have a calcium concentration >1.5 mg/L
	Stressed	>50% of the lakes in the watershed have a calcium concentration <1.5 mg/L

Table 7: Benchmarks for the **Wetland Indicator** used in 2014 Muskoka Watershed Report Card

Indicator	Measurement Tool	
Wetlands	Not Stressed	No significant development in wetlands
	Vulnerable	Rural and waterfront development with minor loss of wetlands and also an indication that wetlands are being protected
	Stressed	Urban and developing watershed with visual indication that wetlands have been lost

Table 8: Benchmarks for the **Biodiversity Indicators** used in 2014 Muskoka Watershed Report Card

Indicator	Measurement Tool	
Species at Risk	Not Stressed	weighted score of <43 (watershed average)
	Vulnerable	weighted score between 44 and 51 (watershed average)
	Stressed	weighted score of >51 (watershed average)
Alien Invasive Species	Not Stressed	0 invasive species recorded in watershed
	Vulnerable	2 invasive species recorded in watershed (not Zebra Mussel or Spiny Water Flea)
	Stressed	Zebra Mussel or Spiny Water Flea recorded in watershed

Land

Land is an important component of any watershed; as water flows over the land it takes with it nutrients and solids and deposits them in the lake or river. The geology and type of land cover dictate the nutrient level of a lake and the types of plants and animals that inhabit the area. A striking example of the land/water relationship is the spike in phosphorus that was experienced in many lakes during the intense logging era of the late 1800's when many trees were harvested and the land left unprotected[19]. As trees and other vegetation have regenerated, phosphorus levels in lakes have also decreased. The Muskoka Watershed Report Card grades the health of our land using the following indicators:

1. Large Natural Areas
    a. Size of Natural Areas
    b. Interior Forest
2. Road Density
3. Development
    a. Change in Development Level
    b. Shoreline Density
    c. Shoreline Buffer

Large Natural Areas

Size of Natural Areas

In most of Ontario, conservation focus is on forest cover and not total natural area; however, similar principles can be used for all ecosystems found in the watershed to evaluate the health of natural areas. In a forested environment, forest cover is only one component of a healthy watershed. These areas support larger mammals, sequester carbon, create oxygen, provide solitude and are a prime recreational resource. A conservative approach to evaluating large natural areas has been taken in order to provide more options in the future as research provides better information.

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[19] Cornelisse, K.J. and D.O. Evans The Fairy and Peninsula Lakes Study, 1994-1998: Effects of Land Use on the Aquatic Ecosystem, unpublished.

An explanation of factors that will contribute to the evaluation of the health of large natural areas is provided in Table 9.

Table 9: Components of the Evaluation for Large Natural Areas[20]

Parameter	Guideline
Percent Natural Cover	30% natural cover at the watershed scale is a minimal forest cover threshold. This equates to a high-risk approach that may only support less than one half of the potential species richness, and marginally healthy aquatic systems. 40% natural cover at the watershed scale equates to a medium-risk approach that is likely to support more than one half of the potential species richness, and moderately healthy aquatic systems. 50% natural cover or more at the watershed scale equates to a low-risk approach that is likely to support most of the potential species, and healthy aquatic systems. 80% natural cover at the watershed scale will help ensure that large mammals have adequate habitat and that there is minimum conflict with humans.
Area of Largest Forest Patch	A watershed should have at least one, and preferably several, 500-hectare natural patches.
Interior Forest	The proportion of the watershed that is forest cover and 100 metres or further from the forest edge should be greater than 10%.
Fragmented Landscapes and the Role of Corridors	The optimal width of a wildlife corridor depends on the species to be accommodated. Corridors designed to facilitate most species movement should be a minimum of 50 to 100 metres in width. However, corridors designed to accommodate breeding habitat for specialist species need to meet the habitat requirements of those target species and account for the effects of the intervening lands (the matrix).

Large, relatively undisturbed areas are important for a healthy watershed and should remain in natural cover in order to continue to supply goods and services for the health, social, cultural and economic needs of our communities. The natural cover analysis has been completed at a landscape level. This landscape level indicator provides a good understanding of the overall health and function of the watershed. Currently the natural cover across the watershed averages 94%. This includes lakes, wetlands, forests, rock barrens and other natural systems.

Most lakes were included in the calculation of the natural patch size as they form part of the natural landscape used by all species. The watershed is dotted with hundreds of small lakes and to remove them from the analysis would skew the data on large natural areas.

Patch size was determined using a GIS environment. The following features and structures were buffered and clipped out of the watershed area and the remaining patch sizes were calculated:

[20] Environment Canada, 2013. *How Much Habitat is Enough*? Third Edition. Environment Canada. Toronto. Ontario.

- The largest seventeen waterbodies
- Roads
- Building Points
- Building Symbols
- Railways
- Pipelines
- Hydro Corridors
- Communities
- Urban areas
- Agriculture

The seventeen largest lakes were removed from the calculation as they represent a significant break in the natural landscape and have increased shoreline use and road access that negatively impacts the use of the area by many species.

In the opinion of Muskoka Watershed Council, in order to maintain natural cover as development occurs, development needs to be focused in urban areas, while at the same time developing an urban green strategy. Rural and waterfront development will also have to occur within a sustainable framework that supports the maintenance of healthy natural ecosystems. This may be accomplished through municipal land use policy, private land-stewardship initiatives, or land acquisition by local land trusts.

Despite increasing evidence in the literature indicating the significant contribution of forest or natural cover, it is clear that patch size, or size of unfragmented natural areas, is likely more important to many wildlife species. Although there is limited research on the amount and optimum patch size that should be maintained within a forested environment, work on birds undertaken in eastern and southern Ontario recommends that in areas where conifer and deciduous forests are both naturally occurring, forest tracts of 200 hectares for each forest type be maintained to support all or most native interior bird species (used as an indicator of forest health).[21] The 200 hectare standard is seen as a minimum standard that may support native interior birds but is vulnerable to the impacts of new development.

While most work on patch size has focused on birds, they are not the only consideration when determining appropriate natural area patch sizes. Other values of large natural areas have been identified by a number of researchers and summarized by Popatov et al.[22]

- Large natural forest areas are important for the preservation of biological diversity maintaining ecological processes and services like water and air purification, nutrient cycling, carbon sequestration, erosion, and flood control.
- The ability of ecological systems to support the natural diversity of species and communities, and their ability to absorb disturbance (resistance) and recover from disturbance (resilience), is enhanced if they have little or no human interference and the area is large enough to support core ecological processes.
- Forests play a crucial role in mitigating climate change by serving as carbon sinks…containing up to 80% of all above ground and approximately 40% of all below ground terrestrial carbon.

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[21] Environment Canada. "How Much Habitat is Enough?" Second Edition. Minister of Public Works and Government Services Canada. 2004.

[22] Potapov, P., A. Yaroshenko, S. Turubanova, M. Dubinin, L. Laestadius, C. Thies, D. Aksenov, A. Egorov, Y. Yesipova, I. Glushkov, M. Karpachevskiy, A. Kostikova, A. Manisha, E. Tsybikova, and I. Zhuravleva. 2008. "Mapping the world's intact forest landscapes by remote sensing." *Ecology and Society* 13(2): 51. [online] URL: http://www.ecologyandsociety.org/vol13/iss2/art51.

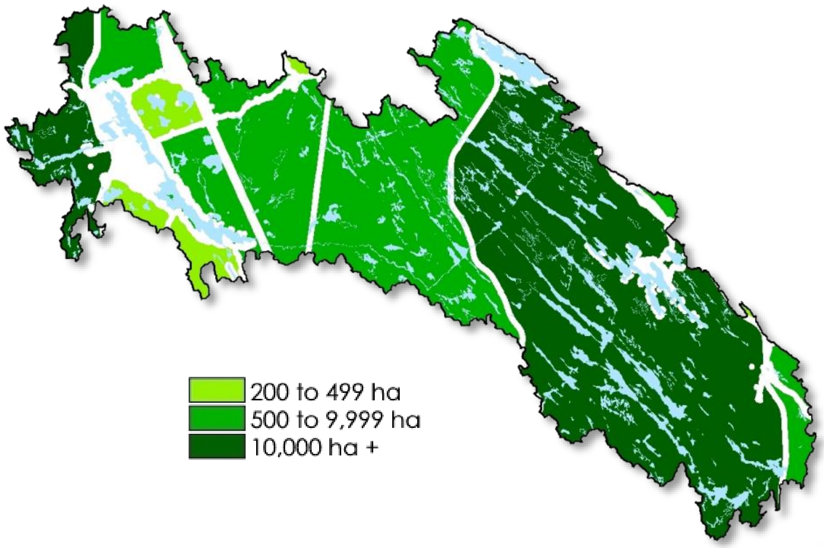
- As the most biologically diverse terrestrial ecosystem, forests provide critical habitats to more than half of all known terrestrial plant and animal species on Earth.
- The basic provisional (timber, food, and forage) and supporting (water purification, climate regulation) ecosystem services provided by forests are essential for human well-being.
- Natural areas serve as important education, research and recreation areas, and are treasured places for spiritual and psychological well-being.

Ecosystems are dynamic, adaptive and resilient living systems, but they cannot withstand the rapid change that results from development or road construction. If the benefits that forests and other natural areas provide are to be maintained, they need to be kept intact. As stated in the Environment Canada document *How Much Habitat is Enough?,* habitat size needs to reflect the values and services it provides to the surrounding community.[23]

The analysis of patch size will track change over time based on the following forest sizes (see Table 10):

1. the area of each quaternary watershed in forest patch sizes of 200 to 499 ha;
2. the area of each quaternary watershed in patch sizes of 500 to 9,999 ha; and
3. the area of each quaternary watershed in patch sizes of 10,000 to 100,000 ha.

This continuum of patch sizes will provide a better understanding of change over time and the impact on forest health. Together with the interior forest indicator, these data provide an understanding of the watershed's ability to both sustain existing wildlife and natural biodiversity (the natural variability in the biological community) and to withstand catastrophic events such as flood, fire, invasive species or disease.



Patches may span more than one quaternary watershed. It is, therefore, possible to have less hectares of a given class size than the class size itself. For example, in the Gibson River Watershed there are only 9,018 hectares of land in the 10,000 to 100,000 hectare class. This would indicate that only a portion of the larger natural area is in the Gibson River Watershed and the remaining portion would be in an adjacent watershed (Figure 4).

Figure 4: Size of Natural Area by Class Size – Gibson River Watershed

[23] Environment Canada, 2013. *How Much Habitat is Enough*? Third Edition. Environment Canada. Toronto. Ontario.

Grades were assigned based on the guidelines provided by the *How Much Habitat is Enough?* document prepared by Environment Canada. Based on the guidelines outlined in Table 9, watersheds were graded as follows:

- **Not Stressed:** >80% of land area in patches >200 ha

  Greater than 80% natural cover at the watershed scale will help ensure that large mammals have adequate habitat and that there is minimum conflict with humans.

- **Vulnerable:** 50% to 80% of land area in patches >200 ha

  Between 50% to 80% natural cover at the watershed scale is likely to support most of the potential species, and healthy aquatic systems, but some losses will have occurred.

- **Stressed:** <50% of land area in patches >200 ha

  Less than 50% natural cover at the watershed scale at best might support one half (1/2) of the potential species richness, and at worst may support less than that and only marginally healthy aquatic systems.

Table 10: Size of Natural Areas by Class and Quaternary Watershed

Quaternary Watershed	Class Size (ha)	Class Area (ha)	Area by Class (%)	Total Area (%)	Grade
Moon River	200 to 499 500 to 9,999 10,000 +	3,300 36,626 16,390	4.61% 51.16% 22.90%	78.67%	Vulnerable
Gibson River	200 to 499 500 to 9,999 10,000 +	710 6,175 9,018	3.82% 33.22% 48.52%	85.56%	Not Stressed
Lake Muskoka	200 to 499 500 to 9,999 10,000 +	2,899 15,015 84	8.21% 42.50% 0.24%	50.94%	Vulnerable
Lake Rosseau	200 to 499 500 to 9,999 10,000 +	3,002 11,747 199	9.67% 37.85% 0.64%	48.17%	Stressed
Rosseau River	200 to 499 500 to 9,999 10,000 +	484 2,663 8,793	3.74% 20.53% 67.80%	92.06%	Not Stressed
Skeleton River	200 to 499 500 to 9,999 10,000 +	0 3,715 963	0.00% 51.64% 13.39%	65.04%	Vulnerable
Dee River	200 to 499 500 to 9,999 10,000 +	1,414 7,730 0	10.10% 55.20% 0.00%	65.30%	Vulnerable

Quaternary Watershed	Class Size (ha)	Class Area (ha)	Area by Class (%)	Total Area (%)	Grade
South Muskoka River	200 to 499 500 to 9,999 10,000 +	1,287 5,331 20,401	3.66% 15.15% 57.98%	76.79%	Vulnerable
Lake of Bays	200 to 499 500 to 9,999 10,000 +	913 12,040 8,412	2.88% 37.98% 26.54%	67.40%	Vulnerable
Oxtongue River	200 to 499 500 to 9,999 10,000 +	259 5,541 48,605	0.43% 9.13% 80.05%	89.61%	Not Stressed
Hollow River	200 to 499 500 to 9,999 10,000 +	728 7,485 22,342	1.93% 19.85% 59.26%	81.04%	Not Stressed
Mary Lake	200 to 499 500 to 9,999 10,000 +	2,797 27,283 13,871	4.50% 43.87% 22.31%	70.68%	Vulnerable
North Muskoka River	200 to 499 500 to 9,999 10,000 +	1,692 3,883 8,265	6.81% 15.64% 33.29%	55.75%	Vulnerable
Big East River	200 to 499 500 to 9,999 10,000 +	1,072 5,104 50,042	1.66% 7.89% 77.36%	86.90%	Not Stressed
Little East River	200 to 499 500 to 9,999 10,000 +	773 1,969 4,113	8.05% 20.50% 42.83%	71.38%	Vulnerable
Watershed 2EB					**Vulnerable**
Lower Black River	200 to 499 500 to 9,999 10,000 +	803 14,803 30,338	1.58% 29.13% 59.70%	90.41%	Not Stressed
Upper Black River	200 to 499 500 to 9,999 10,000 +	149 5,729 29,912	0.38% 14.69% 76.71%	91.78%	Not Stressed
Kahshe River	200 to 499 500 to 9,999 10,000 +	1,014 9,083 7,031	4.26% 38.18% 29.55%	71.99%	Vulnerable
Severn River	200 to 499 500 to 9,999 10,000 +	6,844 27,644 5,513	10.12% 40.89% 8.15%	59.16%	Vulnerable
Watershed 2EC					**Vulnerable**

Interior Forest

Forest interior habitat is a subset of the size of natural areas analysis. Interior forest is defined as the forested area within the larger forest (or patch) with a 100-metre forested buffer from any man-made structure or more open natural area such as roads, development and utility corridors or wetlands and rock barrens that fragment the forested landscape. In addition to large patches of natural area as described above, a healthy forested landscape needs a smaller subset of land that meets the requirements of species that require interior forest habitat. Interior forests are one habitat type that is threatened as development occurs.

Ecological benefits of forest interior habitat are similar to that of all forests but these areas are naturally more protected from outside intrusion and form the base of the watershed's natural ability to function. Benefits include filtering and absorption of water into the system; absorption of large amounts of carbon dioxide that would otherwise be released into the atmosphere; and photosynthesis (plants use the energy from sunlight and nutrients from the soil and air to yield the oxygen that is essential to the survival of living things).

The importance of interior forests is often equated to the health of interior forest birds. Birds are often used as an indicator of forest health, as they integrate biological, physical and chemical conditions required to support healthy populations. Birds are a particularly effective barometer of forest size and shape, since many of our native species need large expanses of interior forest habitat. Many forest-nesting birds shun edges because of the increased risk of predation or nest parasitism, as well as inhospitable temperature and moisture conditions, or insufficient food. Edges are also more susceptible to human disturbance.

Studies in the Severn Sound area directly to the southwest of our watershed indicate that on a scale of a single Breading Bird Atlas square, or 10 000 hectares, there is a strong increase in the number of forest bird species as total forest cover increases. Forest-interior bird species exhibited the greatest increase.[24]

Species diversity typically increases with increasing forest cover, although the size and composition of forests determine what species live there. In the study of birds in Severn Sound, forest interior bird species continued to increase in number until there was at least 35 percent total forest cover. The proportion of interior forest cover was also found to have a slight but significant effect on the number of bird species when combined with total forest cover.[25]

Studies undertaken in southern Ontario indicate that at least 15% of a watershed should have interior forest habitat. These values are considered to be minimum areas within a highly developed landscape and provide only minimal benefits with little ability to withstand any type of natural or man-induced stress. Unfortunately, there is insufficient research to establish interior forest standards in a forested environment; however, the literature does indicate that where the interior forest is located within a forested landscape (as compared to a more urban landscape) the width of the buffer is less important and the area is more useable by various species.

Based on the finding that 15% interior forest cover in a watershed is a minimum standard and recognizing that forest interior ecosystems are at a significant risk at that level, the forest interior indicator was graded as follows (Table 11):

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[24] Environment Canada. "How Much Habitat is Enough?" Second edition. Minister of Public Works and Government Services Canada. 2004

[25] ibid

- **Not Stressed:** >50% of the quaternary watershed is interior forest

  Greater than 50% interior forest at the quaternary watershed scale will ensure that forest interior bird species and sensitive mammals have adequate habitat and that there is minimum conflict with humans. It will also ensure larger areas that are less likely to be impacted by invasive species. This is a local benchmark based on existing interior forest with input from local ecologists.

- **Vulnerable:** Between 20% and 50% of the quaternary watershed is interior forest

  Where 20% and 50% of the quaternary watershed is interior forest there is moderate habitat for most interior species; however, invasive species may pose a greater risk. This is a local benchmark based on existing interior forest with input from local ecologists.

- **Stressed:** <20% of the quaternary watershed is interior forest

  Where there is less than 50% interior forest at the quaternary watershed scale forest interior bird species and sensitive mammals will have reduce and possibly inadequate habitat and there will be more conflict with humans. This is a local benchmark based on existing interior forest with input from local ecologists.

Table 11: Large Natural Areas – Interior Forest

Quaternary Watershed	Interior Forest (ha)	Interior Forest (%)	Grade
Moon River	23,254	37.60%	Vulnerable
Gibson River	5,874	36.03%	Vulnerable
Lake Muskoka	9,099	28.00%	Vulnerable
Lake Rosseau	10,137	35.19%	Vulnerable
Rosseau River	7,680	61.34%	Not Stressed
Skeleton River	3,315	48.72%	Vulnerable
Dee River	5,478	40.22%	Vulnerable
South Muskoka River	17,182	52.90%	Not Stressed
Lake of Bays	15,402	51.76%	Not Stressed
Oxtongue River	36,022	67.66%	Not Stressed
Hollow River	20,177	58.96%	Not Stressed
Mary Lake	29,658	49.68%	Vulnerable
North Muskoka River	9,871	41.60%	Vulnerable
Big East River	36,782	62.10%	Not Stressed
Little East River	4,412	50.32%	Not Stressed
Watershed 2EB	**473,529**	**49.49%**	**Vulnerable**
Lower Black River	17,561	38.53%	Vulnerable
Upper Black River	20,878	58.78%	Not Stressed
Kahshe River	7,586	34.31%	Vulnerable
Severn River	13,773	23.23%	Vulnerable
Watershed 2EC	**162,499**	**36.80%**	**Vulnerable**

Summary of Large Natural Areas

Large natural areas are an important component of the natural system of the watershed. Among other attributes they provide habitat, clean water and air, and sequester carbon. The composite grade for large natural areas is a combination of patch size and amount of interior forest (Table 12). Watershed stressors work together, or cumulatively, and amplify their impact on the land and adjacent lake or river, as each individual stressor increases. Large natural areas have been graded by adding the impact of each individual stress together:

- **Not stressed:** both size of natural area and interior forest are graded as **not stressed**
- **Vulnerable:** both size of natural area and interior forest are graded as **vulnerable,** or both size of natural area and interior forest are graded with some combination of **stressed, vulnerable and not stressed**
- **Stressed:** both size of natural area and interior forest are graded as **stressed**

Table 12: Summary of Large Natural Areas Indicators

Quaternary atershed	Large Natural Areas		Grade
	Size of Natural Areas	Interior Forest	
Moon River	Vulnerable	Vulnerable	Vulnerable
Gibson River	Not Stressed	Vulnerable	Vulnerable
Lake Muskoka	Vulnerable	Vulnerable	Vulnerable
Lake Rosseau	Stressed	Vulnerable	Stressed
Rosseau River	Not Stressed	Not Stressed	Not Stressed
Skeleton River	Vulnerable	Vulnerable	Vulnerable
Dee River	Vulnerable	Vulnerable	Vulnerable
South Muskoka River	Vulnerable	Not Stressed	Vulnerable
Lake of Bays	Vulnerable	Not Stressed	Vulnerable
Oxtongue River	Not Stressed	Not Stressed	Not Stressed
Hollow River	Not Stressed	Not Stressed	Not Stressed
Mary Lake	Vulnerable	Vulnerable	Vulnerable
North Muskoka River	Vulnerable	Vulnerable	Vulnerable
Big East River	Not Stressed	Not Stressed	Not Stressed
Little East River	Vulnerable	Not Stressed	Vulnerable
Watershed 2EB	**Vulnerable**	**Vulnerable**	**Vulnerable**
Lower Black River	Not Stressed	Vulnerable	Vulnerable
Upper Black River	Not Stressed	Not Stressed	Not Stressed
Kahshe River	Vulnerable	Vulnerable	Vulnerable
Severn River	Vulnerable	Vulnerable	Vulnerable
Watershed 2EC	**Vulnerable**	**Vulnerable**	**Vulnerable**

Road Density

Roads, which cover only a small portion of the landscape, can have far reaching effects on wildlife populations and water quality. For instance, in the U.S. roads cover only 1% of the total land area but they have ecological impacts on nearly 20% of the total land area due to wildlife road kill, traffic noise, spread of exotic plants, salt runoff into adjacent waterbodies, wetland drainage, and disruption of wildlife travel corridors among other effects[26]. Roads are also the primary cause for population vulnerability for many threatened and endangered species in Muskoka, such as the eastern Massasauga rattlesnake, due to high road kill rates and segregation of small population units that are less able to reproduce and proliferate.[27]

Studies undertaken over the last twenty-five years indicate that as little as 2–3% additive annual mortality is likely more than most turtle species can absorb and still maintain positive population growth rates.[28] Land areas with 1 km of road/km^2 with traffic volumes of 100 vehicles/lane/day and speed limits of 100 km/hour were predicted to be sufficient to impact turtle populations because of the excess mortality that would result.

Based on these factors road density was calculated using township, district and provincial roadways. Private roads were not included in the calculation as private roads have both lower traffic levels and lower speed limits. While private roads still have an ecological impact by contributing to such stresses as the spread of exotic species and the alteration of wetlands, amongst others, they have not been identified as having a significant impact on animal mortality. The ecological stress of private roads on our watersheds is better determined through the size of natural areas and forest interior indicators.

Within each quaternary watershed, road density was calculated as the total length of township, district and provincial road per total quaternary watershed area, weighted by the standard width of each road classification (Table 13). Although it is recognized that major provincial highways, such as highway 11 and 400, may have a more profound impact on road mortality than municipal roads, there is insufficient information and scientific analysis at this time to undertake a more detailed study of the impact of road density on animal mortality. In light of these concerns, fencing and animal road crossings are being installed in several locations to reduce the impact of major roads.

Grades were based on:

- **Not Stressed:** road density of <0.5 km/km^2

  Less than 0.5 km/km^2 road density at the quaternary watershed scale will not negatively impact wildlife populations. This is a local benchmark reviewed and supported by local ecologists.

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[26] Forman, R.T.T. 2000. Estimate of the area affected ecologically by the road system in the United States. Conservation Biology 14:31-35.

[27] Rouse, J.D., and R.J. Wilson. 2001. Update COSEWIC status report on the Eastern Massasauga Sistrurus catenatus catenatus. Committee on the Status of Endangered Wildlife in Canada. 23pp. http://www.brocku.ca/envi/jm/massasauga/Rouse%20and%20Willson.pdf

[28] Gibbs, J. P and W. G. Shriver. December 2002. Estimating the Effects of Road Mortality on Turtle Populations. Conservation Biology, Pages 1647–1652 Volume 16, No. 6

- **Vulnerable**: road density of 0.5 to 0.99 km/km^2

  A road density of 0.5 to 0.99 km/km^2 will see in increase in wildlife mortality on roads. This is a local benchmark reviewed and supported by local ecologists.

- **Stressed**: road density of >1.0 km/km^2

  Greater than 1.0 km/km^2 road density at the quaternary watershed scale will negatively impact turtle populations. This benchmark is been published in peer review literature.[29]

Table 13: Road Densities by Quaternary Watershed

Quaternary Watershed	Pvt. Road (km/km^2)	Twp. Road (km/km^2)	Dist. Road (km/km^2)	Prov. Road (km/km^2)	Total Road (km/km^2)	Grade
Moon River	0.12	0.06	0.05	0.07	0.18	Not Stressed
Gibson River	0.09	0.06	0.07	0.15	0.28	Not Stressed
Lake Muskoka	0.26	0.55	0.24	0.06	0.85	Vulnerable
Lake Rosseau	0.21	0.23	0.15	0.07	0.45	Not Stressed
Rosseau River	0.01	0.29	0.1	0.02	0.42	Not Stressed
Skeleton River	0.17	0.41	0.14	0.14	0.70	Vulnerable
Dee River	0.16	0.66	0.2	0.15	1.01	Stressed
South Muskoka River	0.17	0.5	0.14	0.15	0.80	Vulnerable
Lake of Bays	0.21	0.35	0.24	0.08	0.66	Vulnerable
Oxtongue River	0.01	0.02	0.01	0.01	0.05	Not Stressed
Hollow River		mostly Crown Land - few roads				Not Stressed
Mary Lake	0.12	0.49	0.2	0.09	0.78	Vulnerable
North Muskoka River	0.16	0.75	0.37	0.17	1.29	Stressed
Big East River	0.07	0.13	0.03	0.03	0.19	Not Stressed
Little East River	0.08	0.37	0.01	0.15	0.52	Vulnerable
Watershed 2EB	**0.13**	**0.30**	**0.13**	**0.08**	**0.51**	**Vulnerable**
Lower Black River	0.05	0.03	0.02	0	0.06	Not Stressed
Upper Black River	0.04	0.08	0	0.04	0.12	Not Stressed
Kahshe River	0.13	0.28	0.09	0.06	0.43	Not Stressed
Severn River	0.67	0.6	0.3	0.29	1.19	Stressed
Watershed 2EC	**0.15**	**0.18**	**0.07**	**0.07**	**0.32**	**Not Stressed**

Each road authority keeps statistics on the volume of traffic on their roads. For example, in the Port Severn area the road density is 1.86 km/km^2 and the average annual daily traffic volume is approximately 700 vehicles/lane/day. Port Severn is an area rich in snakes, turtles and other herpetofauna. The road network is likely having a significant negative effect on the biodiversity

[29] ibid

in the area. With this concern in mind, wildlife underpasses have been installed on some District Roads, for example District Road 48.

The Average Annual Daily Lane Volumes by District Road are provided in Table 14. Although the posted speed on all roads is below the 100 km/h used in the study on the impact of roads on animal migration, the average volumes are quite high which may result in a higher impact on herpetofauna than otherwise expected. Urban area roads have been removed from the table.

Table 14: Average Annual Daily Lane Volume and Posted Speed Limit (District Roads)

Muskoka Road	Road Name	Average Annual Daily Lane volume	Posted Speed Limit
1	Gravenhurst Parkway (GR)	425	60
2	Brunel Road (HT/LOB)	850	60
5	Honey Harbour Road (GB)	325	80
6	Doe Lake Road (GR)	640	60
7	Peninsula Road (ML)	1515	80, 60, 50
8	Limberlost Road (LOB)	565	60
9	Portage Road (LOB)	190	80
10	Port Sydney Road (HT)	530	60
11	MacTier Road (GB)	865	60
12	Twelve Mile Bay Road (GB)	240	80
13	Southwood Road (GR)	640	60
14	Fraserburg Road (BB)	800	80
15	Santa's Village Road (BB)	700	50
16	Beaumount Drive (BB)	1935	50
17	Old Sands Road (BB/GR)	1640	50
18	Muskoka Road South (GR)	3275	50
19	Beiers Road (GR)	390	80
20	Uffington Road (BB/GR)	215	60
21	Fox Point Road (LOB)	475	80
22	Port Cunnington Road (LOB)	225	60
23	Deerhurst Road (HT)	268	60
24	Windermere Road (ML)	425	80
25	Brackenrig Road (ML)	310	60
26	Mortimer Point Road (ML)	300	80
27	Muskoka Lakes Golf Course (ML)	445	50
28	Minett (ML)	765	50
29	Acton Island Road (ML)	310	60
30	Walkers Point (ML)	565	60
31	Yearly Road (ML)	185	60
32	Go Home Lake Road (GB)	135	60
33	Gibson River Road (GB)	155	60
34	White's Falls Road (GB)	600	80
35	Windermere Corners (BB)	1005	80
36	Beaver Creek Institution (GR)	265	60
37	Entrance Drive (BB)	1290	80
38	Wahta Road (ML)	835	80
41	Bethune Drive (GR)	2945	50
44	South Mary Lake Road (HT)	860	60

Muskoka Road	Road Name	Average Annual Daily Lane volume	Posted Speed Limit
45	Fox Lake Road (HT)	250	60
46	Bonnie Lake Road (BB)	240	60
47	Falkenburg Road (BB)	160	60
48	South Bay Road (GB)	180	60
49	Canning Road (GR)	210	60
50	High Falls Road (BB)	263	60
51	Dickie Lake Road (LOB)	120	60
117	Old Prov. 117	680	80
118	Old Prov. 118 (west of BB)	3550	80, 60
169	Old Prov. 169	2855	80, 60, 50

Source: District of Muskoka, Public Works, AADT data

Development

Change in Development Level

In 2013, the District of Muskoka completed a regional Growth Strategy. The Strategy looks at permanent and seasonal population and housing needs. Projections are also provided to 2031.

The District's permanent population is expected to grow to about 84,000, which represents a 1% growth rate and is consistent with the provincial average. The seasonal population is forecast to reach 94,000, which represents a 0.5% increase by 2031. The combined permanent and seasonal population for the District would then be 188,000. These projections are in the same range as the projections completed in 2008.[30]

Over the past 25 years (1981-2006) Muskoka's permanent population grew at an annual rate of 1.6% per year. Comparatively, over this same time period, the average annual growth rate for the Province of Ontario was 1.4%.

Muskoka's permanent population base has historically been concentrated within the District's largest urban centres. However, in more recent years Muskoka has experienced significant permanent population growth throughout the District's three Townships, largely on privately-serviced waterfront lots. Much of this growth has been the result of conversions of seasonal cottages to permanent housing units - an increasing trend which has been observed over the past decade across Ontario's recreationally-oriented municipalities as a result of the aging baby boom population.

Over the next 30 years, Muskoka District is expected to average 350 new permanent residential buildings per year. Seasonal dwellings are expected to increase by 140 new units per year. Conversion of seasonal residents to permanent residents was not considered in this analysis. The annual rate of housing construction is forecast to decline for Muskoka District in the post-2021

[30] Watson and Associates Economists LTC, The District Municipality of Muskoka Growth Strategy Phase 2 Report. October 2013

period as a result of the aging local and provincial population.[31] It is assumed that development in the rest of the watershed will reflect the same types of trends.

A comparison of lots by property code and year showing an increase in both permanent and seasonal residential lots is provided in Table 15.

Table 15: Change in Number of Lots by Property Code

Class Description	2002	2009	2013	2002-2013 Change (%)
Agricultural Properties	220	225	227	3.18
Commercial Other	9	6	6	-33.33
Commercial Properties	1,025	1,234	1,631	59.12
Government Properties	63	35	36	-42.86
Industrial Properties	331	399	507	53.17
Institutional Properties	41	37	38	-7.32
Permanent Residential Properties	18,681	21,595	22,425	20.04
Special Purpose Properties	323	249	251	-22.29
Seasonal Residential Properties	20,342	21,100	21,412	5.26
Vacant Other Properties	995	1,519	1,562	56.98
Vacant Residential Properties	18,433	17,826	17,683	-4.07
Total number of lots	**60,463**	**64,225**	**65,778**	
Change in number of lots		**3,762**	**1,553**	
Total lots developed	**40,388**	**44,334**	**45,981**	
Change in lots developed		**3,946**	**1,647**	

Source: Municipal Property Assessment Corporation

Waterfront property has been the traditional draw for the seasonal population and as that supply gradually builds out, other seasonal resort-oriented options are being offered across the District. Based on a potential supply of approximately 4,796 existing vacant waterfront lots, plus the potential for an additional 2,034 resort-related seasonal residential units, the District can accommodate 29 years of additional seasonal development without additional development approvals. Given the potential for further resort development in Muskoka, it is anticipated that the seasonal population for Muskoka will continue to grow beyond the identified build-out of waterfront lots.

An overview of the characteristics of each of the 19 quaternary watersheds is provided in Table 16. The more developed lakes (10% or greater developed) are located in areas that are more accessible by road and tend to be in the areas with a longer history of settlement, for example the Lake Muskoka Watershed. Moderately developed areas (5-10% developed) have good road access but would have been a little more difficult to develop in the early 1900s, for example the Mary Lake Watershed or the Little East River Watershed. Areas with low development are more remote and tend to have more Crown and protected land in the watershed, for example the Hollow River Watershed or Lower Black River Watershed. Each of these classes of watershed will have their own challenges in maintaining good watershed health. An estimate of both the Crown and protected lands for each watershed is also provided

[31] ibid

in Table 16 along with the combined total for an estimate of the total provincial holding in the watershed.

Level of development was graded using the following criteria:

- **Not Stressed**: <5% of the quaternary watershed is developed
- **Vulnerable:** 5% to 10% of the quaternary watershed is developed
- **Stressed:** >10% of the quaternary watershed is developed

Watershed Average Development Level

The total average development level for the Muskoka Watershed would be the total area of the watershed (742,560 ha) divided by the total developed area of 39,888.1 ha. Given the level of development, the Muskoka Watershed is 5.4% developed or vulnerable.

Table 16: Development Levels

Quaternary Watershed	Area (ha)	Dominant Land Use	Developed (ha)	Developed (%)	Provincial Lands (%)			Grade
					Total Provincial Holdings	Crown Land	Protected	
Moon River	71,588	Forest, shoreline residential	3,571.7	<5	66	49	17	Not Stressed
Gibson River	18,591	Forest, shoreline residential	928.9	<5	70	32	38	Not Stressed
Lake Muskoka	47,039	2 small urban areas, Forest, shoreline residential	4,654.5	10	12	6	6	Vulnerable
Lake Rosseau	42,583	Portions of 2 small urban areas, Forest, shoreline residential	2,992.2	7	14	12	2	Vulnerable
Rosseau River	12,969	Forest, shoreline and rural residential	661.8	<5	36	29	7	Not Stressed
Skeleton River	9,247	Forest, shoreline residential	460.3	<5	16	16	0	Not Stressed
Dee River	14,869	Agriculture, forest, shoreline residential	2,403.7	16	3	3	0	Stressed
South Muskoka River	35,570	Forest, shoreline residential with urban area at the confluence with the North Branch	1,792.3	5	17	15	2	Vulnerable
Lake of Bays	38,446	Forest, shoreline residential	1,925.7	<5	25	24	1	Not Stressed
Oxtongue River	60,716	Forest, shoreline residential	1,215.7	<2	97	28	69	Not Stressed
Hollow River	40,863	Forest, shoreline residential	815.0	<2	75	61	14	Not Stressed

Quaternary Watershed	Area (ha)	Dominant Land Use	Developed (ha)	Developed (%)	Provincial Lands (%)			Grade
					Total Provincial Holdings	Crown Land	Protected	
North Muskoka River	24,890	1 urban area, Forest, shoreline residential	3,517.2	14	8	8	0	Stressed
Big East River	64,699	Forest, shoreline residential	1,293.6	<2	73	39	34	Not Stressed
Little East River	9,604	Forest, shoreline residential	762.2	8	16	9	7	Vulnerable
Lower Black River	50,816	Forest, shoreline residential	961.7	2	90	41	49	Not Stressed
Upper Black River	38,995	Forest, shoreline residential	786.2	<2	87	76	11	Not Stressed
Kahshe River	24,619	Forest, shoreline residential	1,226.7	5	87	76	16	Vulnerable
Severn River	70,112	Hwy 11 corridor, Forest, shoreline residential	3,930.0	6	67	56	14	Vulnerable
Total	**742,560**		**39,888.1**	**5.4**				**Vulnerable**

Shoreline Density

With the build out of vacant lots and the creation of new lots, the shoreline density of lakes is also increasing. Grading for individual lakes was based on the shoreline lot standard adopted by all local municipalities as 60 m frontages for new lots. This standard would result in a density of 16.67 lots per kilometre if the lake were to build out at that standard. It is recognized that some lakes experienced development prior to the standard being established at 60 m frontages. For that reason, some lakes will have a shoreline density greater than 16.67 lots per kilometre.

The number of lots per lake and the lake perimeter were provided through the District of Muskoka GIS system. Grading for individual lakes is available by visiting: www.muskokawatershed.org/StewardshipWorks and was based on the following criteria:

- **Not Stressed:** <13 lots per kilometre of frontage

  Less than 13 lots per kilometre of frontage represents more than one standard deviation below the mean of the shoreline density data.

- **Vulnerable:** 13.1 to 16.9 lots per kilometre of frontage

  Between 13.1 to 16.9 lots per kilometre of frontage represents a range of one standard deviation on both sides of the shoreline data mean.

- **Stressed:** >17 lots per kilometre of frontage

  Greater than 17 lots per kilometre of shoreline represents more than one standard deviation more than the data mean.

Grading for the quaternary watersheds is based on the following guideline and is provided in Table 17:

- **Not Stressed** >75% of lakes in the watershed have received a grade of ***Not Stressed***
- **Vulnerable** 50% to 74.9% of lakes in the watershed have received a grade of ***Not Stressed***
- **Stressed** <50 % of lakes in the watershed have received a grade of ***Not Stressed***

Table 17: Shoreline Density by Quaternary Watershed

Watershed Name	% of Lakes Not Stressed	Grade
Moon River	97	Not Stressed
Gibson River	100	Not Stressed
Lake Muskoka	78	Vulnerable
Lake Rosseau	76	Vulnerable
Rosseau River	100	Not Stressed
Skeleton River	100	Not Stressed
Dee River	50	Stressed
South Muskoka River	69	Vulnerable
Lake of Bays	91	Not Stressed
Oxtongue River	100	Not Stressed
Hollow River	100	Not Stressed
Mary Lake	86	Not Stressed
North Muskoka River	90	Not Stressed
Big East River	100	Not Stressed
Little East River	69	Vulnerable
Watershed 2EB	**80**	**Vulnerable**
Lower Black River	100	Not Stressed
Upper Black River	100	Not Stressed
Kahshe River	93	Not Stressed
Severn River	90	Not Stressed
Watershed 2EC	**100**	**Not Stressed**

Shoreline Buffer

The shoreline buffer is the area of land adjacent to lakes or rivers and directly influenced by water. It is the front yard at the cottage. Shoreline buffers are the transitional area between land and water and the vegetation and other physical characteristics are visibly influenced by water.[32] Shoreline buffers provide two broad types of ecological function: A buffer between aquatic and terrestrial systems, and resources including woody structure, nutrients and shade. Shoreline buffers also provide habitat in their own right, which may be moderated or enhanced (or possibly diminished) by both the aquatic system on one side and the broader terrestrial systems on the other side.

Figure 5: Property with little shoreline buffer

For the purpose of this Report Card, shoreline buffers are defined as a 20 metre strip of land adjacent to lakes and rivers. The indicator of the health of the shoreline buffer is the percentage of the buffer that has been left in a natural state.

The interrelationship between a lake and its shoreline is important. The shoreline zone is the last line of defence against the forces that may otherwise destroy a healthy lake. A naturally vegetated shoreline filters runoff generated by surrounding land uses, removing harmful chemicals and nutrients.

An overview of the health of the shoreline buffer on a lake and quaternary watershed basis is provided in Table 18. Although the shoreline (where the water meets the land) is often left fairly natural, the 20 metre buffer area, commonly seen as that area between the shoreline and the house or cottage, is often more disturbed with an average of 37% altered and with a range from zero percent to a high of 76% altered.

The combined disturbance of the natural vegetation along the shoreline and in the yard area between the residential structure and the water's edge is an important indicator of the impact shoreline development may have on a waterbody. In the District of Muskoka Official Plan, a minimum target of 75% of the linear shoreline frontage to remain in a natural state to a target depth of 15 meters from the shoreline has been established as the standard for the shoreline buffer, or riparian area. Most Area Municipalities across the watersheds have adopted this standard.

- **Not Stressed:** Less than 15% of the shoreline buffer has been altered

  Where less than 15% of the shoreline buffer has been altered, nutrients and silt are filtered from stormwater before it reaches the lake, wildlife have access to the lake for feeding, and an acceptable level of erosion control remains. This is a local benchmark based reviewed and supported by local ecologists.

- **Vulnerable:** Between 15% and 25% of the shoreline buffer has been altered

  Where between 15% and 25% of the shoreline buffer has been altered the area is likely to support most of the potential species, and healthy aquatic systems, but some losses will

[32] From Biology Online http://www.biology-online.org/dictionary/Riparian_area.

have occurred. This is a local benchmark based reviewed and supported by local ecologists.

- **Stressed:** More than 25% of the shoreline buffer has been altered

  Where more than 25% of the shoreline buffer has been altered there will likely be significant habitat loss, increases in siltation and shoreline erosion.

The health of the shoreline buffer for each lake (Table 18) was determined using the shoreline survey data collected by The District Municipality of Muskoka. Several lakes have been resurveyed with very little change identified between the two time periods. Change on a lake basis occurs slowly and should be monitored.

Table 18: Shoreline Alteration Data for Specific Lakes

Lake	Quaternary Watershed	% Altered	Grade
Bella Lake	Big East River	16	Vulnerable
Lake Waseosa	Little East River	24	Vulnerable
Cardwell Lake	Rosseau River	7	Not Stressed
Go Home Lake	Gibson River	8	Not Stressed
Fox Lake	Mary Lake	24	Vulnerable
Lake Vernon – Hunter's Bay	Mary Lake	61	Stressed
Lake Vernon (Excl Hunter's Bay)	Mary Lake	19	Vulnerable
Mary Lake	Mary Lake	51	Stressed
Rebecca Lake	Mary Lake	16	Vulnerable
Walker Lake	Mary Lake	61	Stressed
Sunny Lake	Kahshe River	28	Stressed
Prospect Lake	Kahshe River	32	Stressed
Riley Lake	Lower Black River	0	Not Stressed
Brandy Lake	Lake Muskoka	18	Vulnerable
Clear Lake (ML)	Lake Muskoka	33	Stressed
Dark Lake	Lake Muskoka	73	Stressed
Gull Lake	Lake Muskoka	52	Stressed
Lake Muskoka - Muskoka Bay	Lake Muskoka	49	Stressed
Leonard Lake	Lake Muskoka	72	Stressed
Long Lake (ML)	Lake Muskoka	45	Stressed
Medora Lake	Lake Muskoka	46	Stressed
Mirror Lake	Lake Muskoka	61	Stressed
Muskoka River - Confluence to Mouth	Lake Muskoka	43	Stressed
Silver Lake (ML)	Lake Muskoka	51	Stressed
Longline Lake	Lake of Bays	26	Stressed
Paint Lake	Lake of Bays	46	Stressed
Pell Lake	Lake of Bays	5	Not Stressed
Tooke Lake	Lake of Bays	51	Stressed

Lake	Quaternary Watershed	% Altered	Grade
Bruce Lake	Lake Rosseau	31	Stressed
Joseph River	Lake Rosseau	7	Not Stressed
Lake Joseph	Lake Rosseau	39	Stressed
Lake Rosseau - Brackenrig Bay	Lake Rosseau	58	Stressed
Lake Rosseau – East Portage Bay	Lake Rosseau	0	Not Stressed
Stewart Lake	Lake Rosseau	26	Stressed
Long's Lake	Dee River	0	Not Stressed
Three Mile Lake (ML)	Dee River	38	Stressed
Flatrock Lake	Moon River	5	Not Stressed
Moon River – Bala Reach	Moon River	61	Stressed
Myers (Butterfly) Lake	Moon River	49	Stressed
Twelve Mile Bay	Moon River	16	Vulnerable
Clearwater Lake (HT)	North Muskoka River	49	Stressed
Brooks Lake	Oxtongue River	34	Stressed
Dotty Lake	Oxtongue River	14	Not Stressed
Bird Lake	South Muskoka River	48	Stressed
Leech Lake	South Muskoka River	40	Stressed
McKay Lake	South Muskoka River	43	Stressed
Pine Lake (BB)	South Muskoka River	44	Stressed
Ril Lake	South Muskoka River	64	Stressed
Spring Lake	South Muskoka River	51	Stressed
Wood Lake	South Muskoka River	76	Stressed
Baxter Lake	Severn River	46	Stressed
Clearwater Lake (GR)	Severn River	30	Stressed
Loon Lake	Severn River	34	Stressed
Muldrew Lake	Severn River	7	Not Stressed
Six Mile Lake	Severn River	21	Vulnerable
South Bay	Severn River	24	Vulnerable
Turtle Lake	Severn River	32	Stressed
High Lake	Skeleton River	46	Stressed
Little Long Lake	Skeleton River	21	Vulnerable
Nutt Lake	Skeleton River	53	Stressed
Skeleton River	Skeleton River	52	Stressed
Clear Lake (BB)	Upper Black River	48	Stressed
Grindstone Lake	Upper Black River	32	Stressed

Source: District Municipality of Muskoka

The health of the shoreline buffer for each quaternary watershed (Table 19) was determined using the results of the lake specific surveys available and supplementing that evaluation with an overlay of Crown land and remote access lakes. Verification was undertaken using the most recent air photos.

Table 19: Quaternary Watershed Grades for Percent Unaltered Shoreline Buffer

Quaternary Watershed	Grade	Comment
Moon River	Vulnerable	Lakes lower in the watershed tend to be on Crown land and have good shoreline buffers. Lakes closer to developed areas are more stressed.
Gibson River	Not Stressed	Large areas of undeveloped Crown land.
Lake Muskoka	Stressed	Highly developed watershed.
Lake Rosseau	Vulnerable	Developing watershed with highly sensitive lakes.
Rosseau River	Not Stressed	Small undeveloped watershed with few lakes.
Skeleton River	Stressed	Small, fairly developed watershed with thin soils.
Dee River	Vulnerable	Three Mile Lake is well developed although other lakes in the watershed are not. As Three Mile Lake is the biggest lake in the watershed it drives the caution for the protection of the riparian zone.
South Muskoka River	Stressed	Many developed cottage lakes.
Lake of Bays	Vulnerable	Large watershed with well developed lakes.
Oxtongue River	Vulnerable	Fairly remote but well developed cottage lakes.
Hollow River	Not Stressed	Large areas of undeveloped Crown land and poor accessibility.
Mary Lake	Vulnerable	Several well developed lakes with poor riparian zones. Headwater lakes tend to be less developed and provide good shoreline buffers.
North Muskoka River	Vulnerable	Few lakes but areas of significant development along the river.
Big East River	Not Stressed	Few developed lakes.
Little East River	Vulnerable	There are both developed lakes with many permanent residents and undeveloped lakes in Arrowhead Provincial Park.
Watershed 2EB	**Vulnerable**	**As development occurs attention is required to protect shoreline buffers around all lakes. Lakes that are currently degraded should be renaturalized.**
Lower Black River	Not Stressed	Mostly Crown land, provincial park, and private nature reserve.
Upper Black River	Not Stressed	Mostly Crown land.
Kahshe River	Vulnerable	Well developed lakes.
Severn River	Vulnerable	Cottage lakes are well developed but there are large areas of undeveloped Crown land.
Watershed 2EC	**Vulnerable**	**Much of this watershed is Crown land and does not receive the same level of development pressure. Attention to the riparian zone is required in the more developed subwatersheds along the Severn River.**

In comparing the shoreline buffer in 2010 to the same area in 2014 there is no significant difference. Although small changes, both increasing natural shorelines and losing native shoreline vegetation, have been reported, based on the length of the shoreline around each lake, no significant difference can be detected.

Development Summary

The composite grade for development is based on the level of development, shoreline buffer and shoreline density indicators. These stressors work together, or cumulatively, and amplify their impact on the land and adjacent lake or river, as each individual stressor increases. Development impact has been graded using an unweighted average of level of development, shoreline buffer and shoreline density. Each indictor was valued as 1. The scores for each indicator were added for each quaternary watershed and divided by the total number of indicators (3). The final classifications are provided below and the indicators are summarized in Table 20.

- **Not stressed**: unweighted average <1
- **Vulnerable**: unweighted average 1-2
- **Stressed**: unweighted average >2.01

Table 20: Summary of Development Stressors

Quaternary Watershed	Development Impact			Grade
	Development	Shoreline Density	Shoreline Buffer	
Moon River	Not Stressed	Not Stressed	Vulnerable	Vulnerable
Gibson River	Not Stressed	Not Stressed	Not Stressed	Not Stressed
Lake Muskoka	Vulnerable	Vulnerable	Stressed	Stressed
Lake Rosseau	Vulnerable	Vulnerable	Vulnerable	Stressed
Rosseau River	Not Stressed	Not Stressed	Not Stressed	Not Stressed
Skeleton River	Not Stressed	Not Stressed	Stressed	Vulnerable
Dee River	Stressed	Stressed	Vulnerable	Stressed
South Muskoka River	Vulnerable	Vulnerable	Stressed	Stressed
Lake of Bays	Not Stressed	Not Stressed	Vulnerable	Vulnerable
Oxtongue River	Not Stressed	Not Stressed	Vulnerable	Vulnerable
Hollow River	Not Stressed	Not Stressed	Not Stressed	Not Stressed
Mary Lake	Vulnerable	Not Stressed	Vulnerable	Vulnerable
North Muskoka River	Stressed	Not Stressed	Vulnerable	Vulnerable
Big East River	Not Stressed	Not Stressed	Not Stressed	Not Stressed
Little East River	Vulnerable	Vulnerable	Vulnerable	Vulnerable
Watershed 2EB	**Not Stressed**	**Vulnerable**	**Vulnerable**	**Vulnerable**
Lower Black River	Not Stressed	Not Stressed	Not Stressed	Not Stressed
Upper Black River	Not Stressed	Not Stressed	Not Stressed	Not Stressed
Kahshe River	Vulnerable	Not Stressed	Vulnerable	Vulnerable
Severn River	Vulnerable	Not Stressed	Vulnerable	Vulnerable
Watershed 2EC	**Not Stressed**	**Not Stressed**	**Vulnerable**	**Vulnerable**

Summary

The terrestrial component of each quaternary watershed can be analyzed based on the Three (3) components outlined above (large natural areas, road density, and change in development). Together, these components provide an indication of the health of the terrestrial component of the watershed. The grading at the quaternary watershed level was based on a weighted average calculation. Any indicator that was scored as Not Stressed (NS) was given a weight of 1. An indicator that was scored as Vulnerable (V) was given a weight of 2. Indicators that we scored as Stressed (S) were given a score of 3. These scores were added for each quaternary watershed and divided by the total number of indicators. The final classifications are provided below and the indicators are summarized in Table 21.

- **Not Stressed:** weighted average <1.49
- **Vulnerable:** weighted average of 1.5 to 2.49
- **Stressed:** weighted average >2.5

Table 21: Summary of Land Indicators

Quaternary Watershed	Large Natural Areas		Road Density	Development Impact			Overall Grade
	Size of Natural Areas	Interior Forest		Development	Shoreline Density	Shoreline Buffer	
Moon River	V	V	NS	NS	NS	V	Vulnerable
Gibson River	NS	V	NS	NS	NS	NS	Not Stressed
Lake Muskoka	V	V	V	V	V	S	Vulnerable
Lake Rosseau	S	V	NS	V	V	V	Vulnerable
Rosseau River	NS	NS	NS	NS	NS	NS	Not Stressed
Skeleton River	V	V	V	NS	NS	S	Vulnerable
Dee River	V	V	S	S	S	V	Stressed
South Muskoka River	V	NS	V	V	V	S	Vulnerable
Lake of Bays	V	NS	V	NS	NS	V	Vulnerable
Oxtongue River	NS	NS	NS	NS	NS	V	Not Stressed
Hollow River	NS	V	NS	NS	NS	NS	Not Stressed
Mary Lake	V	V	V	V	NS	V	Vulnerable
North Muskoka River	V	V	S	S	NS	V	Vulnerable
Big East River	NS	V	NS	NS	NS	NS	Not Stressed
Little East River	V	V	V	V	V	V	Vulnerable
Watershed 2EB	**V**	**V**	**V**	**V**	**V**	**V**	**Vulnerable**
Lower Black River	NS	V	NS	NS	NS	NS	Not Stressed
Upper Black River	NS	NS	NS	NS	NS	NS	Not Stressed
Kahshe River	V	V	NS	V	NS	V	Vulnerable
Severn River	V	V	S	V	NS	V	Vulnerable
Watershed 2EC	**V**	**V**	**NS**	**V**	**NS**	**V**	**Vulnerable**

Water

Water quality is one of the fundamental components of a healthy watershed. As people live and work around lakes, they impact and change the lake ecosystem. Some of these changes may be beneficial, while others may degrade the natural systems upon which both humans and other species rely.

Background

Lake Size

There are over 1,000 lakes in the Muskoka River and Black/Severn River Watersheds and they range in size from very large and deep to very small and shallow. Figure 6 illustrates the range in lake size across the watersheds. Each lake has its own characteristics and natural healthy equilibrium; therefore, in evaluating the health of a lake it can only be compared to itself as it changes over time and should not be compared to other lakes.

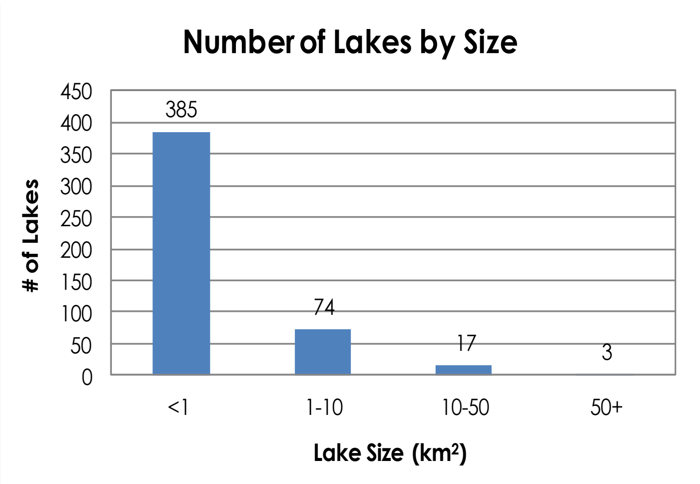

Figure 6: Distribution of Lakes by Size in the Muskoka River and Black/Severn River Watersheds

Lake Nutrient Status [33]

People use lakes and rivers for a variety of recreational pursuits such as swimming, boating, fishing and aesthetic enjoyment. Change in phosphorus concentration is an indicator of the likelihood of a lake having an algal bloom, which is considered a degradation of water quality by many. Phosphorus concentration is used across Ontario as an indicator of lake health and has been adopted as an indicator for the Muskoka Watershed Report Card.

[33] Hutchinson Environmental Science Limited – this section is a paraphrase of the analysis undertaken by HESL as part of the 2012 review of the District of Muskoka Water Quality model.

Phosphorus is a nutrient that is in limited supply in most Ontario lakes and therefore generally controls the growth of algae. For this reason, a change in phosphorus concentration in a lake can impact the types of algae and the potential for algal blooms. Algal blooms detract from the recreational use of water and, in some cases, affect the habitat of coldwater fish species such as Lake Trout.

The District Municipality of Muskoka has monitored over 160 lakes across the District for over thirty (30) years, assessing both Secchi depth and phosphorus levels. The Provincial Lake Partner program has monitored additional lakes within the watersheds but outside Muskoka for many years. Even with these long-term data sets, it is difficult to understand changes and trends that might be occurring. Phosphorus levels in a lake will naturally vary between years as a result of factors such as precipitation, wind, and levels of sunlight. Scientists are also starting to understand that climate change is affecting phosphorus levels. In order to understand trends in phosphorus concentration, detailed studies that relate all these factors to variables such as development, invasive species and other human impacts are necessary. These issues are starting to be addressed through the Muskoka River Watershed Consortium, funded under the Canadian Water Network.

In any watershed, there is also a natural variation in phosphorus concentration from lake to lake as a result of such variables as lake size, amount of wetlands, and flow characteristics. Figure 7 indicates the variation in trophic status[34] or productivity of a lake by lake size. Lakes are generally classified into three categories:

- Oligotrophic or low phosphorus level, usually less than 10 µg/L;
- Mesotrophic or moderate level of phosphorus, usually between 10 and 20 µg/L; and
- Eutrophic or high phosphorus levels, usually greater than 20 µg/L.

The variation in trophic status across the watershed should be maintained as development and other changes occur.

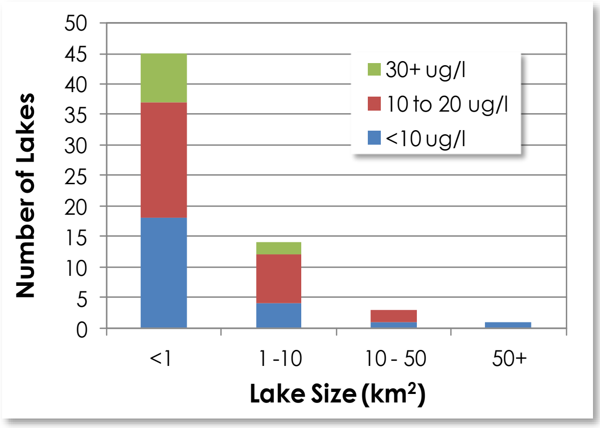

Figure 7: Trophic Status by Lake Size

In order to determine the state of water quality in the watersheds of Muskoka, the ten-year mean spring turnover total phosphorus (TP) concentration for each lake was calculated for the years 2003 to 2013. Mean total phosphorus concentrations in the 194 monitored Muskoka lakes and basins ranged from 3.8 to 28.3 µg/L, with an average of 9.4 µg/L and a standard deviation of 3.7 µg/L. This nutrient distribution demonstrates the excellent water quality in Muskoka's lakes in general. In 2005, using data collected from 1990 to 2000, the average TP was 10 µg/L, indicating that the overall nutrient level of lakes has not changed significantly since the 1990s.

[34] Trophic status refers to the amount of productivity in a lake; commonly equated to the amount of phosphorus. The higher the phosphorus level the more aquatic vegetation there will be in the lake.

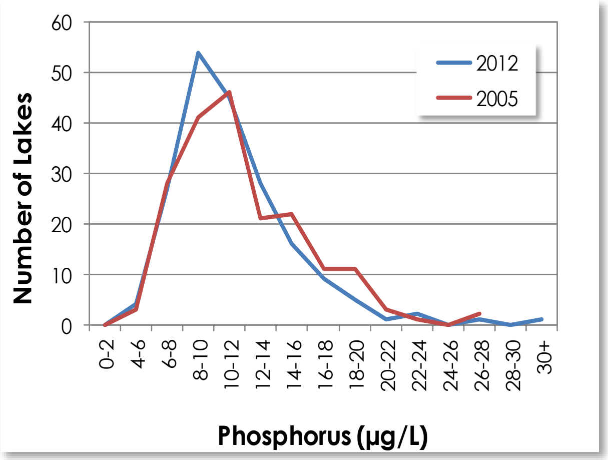

Figure 8: Distribution of Mean Total Phosphorus by Lake in Muskoka's Watersheds

Figure 8 compares the 10-year mean distribution of TP in lakes across the watersheds for 1995 to 2005 and 2002 to 2012. Once again, the graph does not show a significant change in lake water quality. If TP in all lakes had increased over the 7 year interval the blue curve would have shifted to the right. Some individual lakes, however, do show trends over time, as discussed in the following section.

As illustrated in Figure 9, thirty-four percent (34%) of lakes in the watershed are oligotrophic, or nutrient poor, with phosphorus concentrations of less than 10 µg/L.[35] These lakes are considered excellent recreational lakes and are highly valued for cottage development. Sixty-four percent (64%) of the lakes are considered mesotrophic, or moderately enriched, and have phosphorus concentrations between 10 and 20 µg/L. These lakes tend to be smaller and support warm-water fish species and more diverse shoreline habitat. Two percent (2%) are considered eutrophic, or enriched, and have phosphorus concentrations over 20 µg/L. These lakes have naturally elevated levels of phosphorus based on watershed inputs and include Barron' s, Brandy, Three Mile, Bass, and Ryde Lakes.

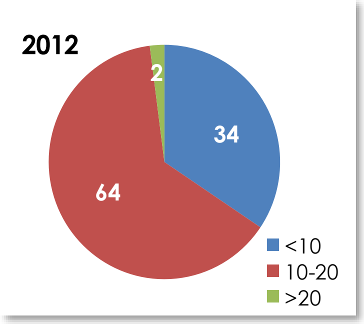

Figure 9: Distribution of Mean Total Phosphorus by Percentage

Total Phosphorus (TP) Trends on a Lake Basis[36]

Detection of long-term TP trends for an individual lake can be undertaken by a visual assessment of the District of Muskoka Lake Data Sheets, available on the Muskoka Water Web (www.muskokawaterweb.ca). These data are updated annually.

On a watershed basis, statistical testing was conducted using the annual means of measured phosphorus concentrations in all lakes or lake basins in the Muskoka data set for the years 2000-2013. There are 197 lakes for which measured concentrations exist but for 9 of these[37], the data record was 2 years or less and so they were excluded from the analysis.

There was a statistically significant ($p<0.10$) trend in total phosphorus concentrations in 28 of the 188 lakes tested. Phosphorus concentrations increased in four lakes over the period of record: Gull Lake, South Nelson Lake, Nine Mile Lake and Solitaire Lake. The remaining 24 lakes displayed decreasing phosphorus concentrations.

[35] µg/L means micrograms per litre and is equivalent to parts per billion (ppb).

[36] HESL paraphrased from 2013 District of Muskoka review of the Water Quality model.

[37] Go Home Bay, Cognashene Bay, Little Go Home Bay and Wah Wah Taysee of Georgian Bay, The South Basin of Lake Muskoka, North Basin of Lake Rosseau, McLeans Bay of Sparrow Lake , Rogers Cove of Fairy Lake and Barrons Lake.

Decreasing phosphorus concentration is a general trend that has been observed across lakes in Ontario since the 1990s. Data collected by the Ministry of Environment over a wide series of lakes across all of Ontario indicate that many lakes are experiencing a decrease in phosphorus. The mechanism for this decrease is not completely understood, but the multiple stresses of climate change[38] and acid deposition[39] are considered to be contributing factors. Long-term studies are required to truly understand the complex nature of such trends.

Although 24 lakes in Muskoka have decreased in phosphorus concentration and 4 lakes have increased in phosphorus concentration, 160 lakes appear to be stable in their nutrient level and fewer show the variability of earlier data. This change is likely due to better data collection methods and analysis.

Because sediments are laid down in lakes over years, analysis of a sediment, or paleo, core can be used to reconstruct the lake environment throughout geologic time, looking especially at changes associated with such events as climatic change, acidification and other human impacts. Paleo core analysis of local waterbodies indicates that in some cases, the present day concentration of phosphorus in lakes in Muskoka is below that experienced before European development on the lake.[40]

This long-term variability in data makes it difficult for lake managers to develop effective programs and to predict the impact of management decisions. Further monitoring of lake system changes is required to fully understand many of these trends.

Additional Lake Stresses

Recent studies have seen an increase in Dissolved Organic Carbon (DOC), a decrease in calcium, an increase in lake temperatures, and a shorter ice cover season. As noted below, some indices suggest signs of improvement while others indicate deterioration. It is generally agreed that environmental stress, as a result of human activities, is affecting natural processes. Muskoka prides itself on having relatively robust and functioning natural ecosystems. Maintaining these natural systems will be challenging in the face of increased environmental stressors.

Report Card Grading

The Report Card will report on the change in the ten-year average Total Phosphorus (TP) concentration and the trend in Total Phosphorus (TP) for each lake and each quaternary and tertiary watershed.

For each of the three (3) tertiary watersheds and the nineteen (19) quaternary watersheds, the trend in TP will be determined by comparing the ten-year average phosphorus concentration of lakes in the watershed from 1995 to 2005 and from 2003 to 2013 (Table 23).

The Province of Ontario has established a water quality guideline for TP for lakes on the Precambrian Shield that allows a 50 percent increase in phosphorus concentration from a

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38 Climate change is a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events).

39 Acid deposition is rain, snow, fog and other forms of precipitation with extremely low pH (acidic).

40 Cornelisse, K.J. and Evans, D.O. "The Fairy and Peninsula Lakes Study, 1994-1998: Effects of Land Use on the Aquatic Ecosystem."

modeled baseline of water quality in the absence of human influence (commonly referred to as background +50).

This threshold was established based on the relationship between increased phosphorus and water clarity. As phosphorus concentration increases water clarity decreases. This relationship is made more complicated because the amount of Dissolved Organic Carbon (DOC) or lake colour will also decrease water clarity.

By studying the change in water clarity with increases in both DOC levels with phosphorus concentrations it was determined that a 50% increase in phosphorus concentration resulted in an average loss of 25% in water clarity (Table 22).[41]

A 50% increase in phosphorus concentration protects the clearest and most desirable water clarity and allows a greater proportional change only in those lakes with high DOC where DOC (rather than the phosphorus/chlorophyll relationship) is the limiting factor in recreational water quality.

Table 22: Average loss in Secchi depth with a 50% increase in total phosphorus concentration as a function of dissolved organic carbon (DOC) concentration

DOC (mg/L)	Increase in TP (%)	Loss of Water Clarity (%)
2	50	14
4	50	18
6	50	27
7	50	41
	Average	25.3

Change in water clarity occurs gradually as TP concentrations increase. For that reason, the Report Card has established three broad categories for grading individual lakes:

- **Not Stressed:** Total Phosphorus level is less than background level plus 30%

  Where the Total Phosphorus level is less than background level plus 30% it will protect the aquatic health of the lake. This is a local benchmark.

- **Vulnerable:** Total Phosphorus level is between background level plus 30% and background plus 50%

  Where the Total Phosphorus level is between background level plus 30% and background plus 50% the water clarity may be impaired and increased nutrients may impact water quality.

[41] Ministry of the Environment, Ministry of Natural Resources, Ministry of Municipal Affairs and Housing. 2010. Lakeshore Capacity Assessment Handbook. Protecting Water Quality in Inland Lakes on Ontario's Precambrian Shield. May 2010. PIBS 7642e. Pg A-19

- **Stressed:** Total Phosphorus level is over threshold (greater than background level plus 50%)

  Where the Total Phosphorus level is over threshold (greater than background level plus 50%) there will be a twenty-five percent (25%) decrease in water clarity and a noticeable decrease in water quality. This benchmark was established by the District of Muskoka based on provincial standards.

Phosphorus readings and trends for individual lakes are available on the Muskoka Water Web at www.muskokawaterweb.ca.

Similar to individual lakes, quaternary watersheds have been graded based on the stress level of lakes within each watershed:

1. **Not Stressed:** Less than 30% of the lakes in the watershed are over threshold
2. **Vulnerable**: Between 30% and 50% of the lakes in the watershed are over threshold
3. **Stressed**: More than 50% of the lakes in the watershed are over threshold

Table 23: Summary of TP Concentrations 1995-2005 and 2003-2013

Watershed	1995 - 2005						2003 - 2013					
	Not Stressed	Vulnerable	Stressed	% >Bg+30%	# of Lakes or Bays	Grade	Not Stressed	Vulnerable	Stressed	% > Bg+30%	# of Lakes or Bays	Grade
Watershed 2EB Lakes	**73**	**27**	**29**	**43**	**129**	**Vulnerable**	**101**	**28**	**48**	**43**	**169**	**Vulnerable**
Moon River Watershed	4	3	2	56	9	Vulnerable	12	4	5	43	21	Vulnerable
Gibson River Watershed	3		1	25	3	Not Stressed	5	2	0	29	7	Not Stressed
Lake Muskoka Watershed	7	4	8	63	19	Stressed	7	5	9	67	21	Stressed
Lake Rosseau Watershed *	6	3	6	60	15	Stressed	8	3	16	70	27	Stressed
Rosseau River Watershed **	1	0	0	0	1	Not Stressed	1	0	0	0	1	Not Stressed
Skeleton River Watershed ***	2	1	0	33	3	Vulnerable	2	1	1	50	4	Vulnerable
Dee River Watershed	3	0	2	40	5	Vulnerable	3		2	40	5	Vulnerable
South Muskoka River Watershed	7	6	4	59	17	Stressed	10	5	4	47	19	Vulnerable
Lake of Bays Watershed	10	2	2	29	14	Not Stressed	11	4	4	42	19	Vulnerable

Watershed	1995 - 2005						2003 - 2013					
	Not Stressed	Vulnerable	Stressed	% >Bg+30%	# of Lakes or Bays	Grade	Not Stressed	Vulnerable	Stressed	% > Bg+30%	# of Lakes or Bays	Grade
Hollow River Watershed +					0	N/A	9	0	2	18	11	Not Stressed
Mary Lake Watershed ++	9	5	2	44	16	Vulnerable	12	3	1	25	16	Not Stressed
North Muskoka River Watershed	7	1	1	22	9	Not Stressed	8	0	1	11	9	Not Stressed
Big East River Watershed	7	1		13	8	Not Stressed	6	1	1	25	8	Not Stressed
Little East River Watershed	5		1	17	6	Not Stressed	4	0	1	20	5	Not Stressed
Watershed 2EC Lakes	**20**	**5**	**7**	**38**	**32**	**Vulnerable**	**26**	**3**	**11**	**35**	**40**	**Vulnerable**
Lower Black Watershed ~	1	0	0	0	1	Not Stressed	1	0	0	0	1	Not Stressed
Upper Black Watershed	3	1	2	50	6	Vulnerable	7	0	2	22	9	Not Stressed
Kahshe River Watershed	8	2	1	27	11	Not Stressed	9	1	1	18	11	Not Stressed
Severn River Watershed	8	2	4	43	14	Vulnerable	9	2	8	53	19	Stressed

* This grade reflects the several bays in Lake Joseph that exceed the background + 50% standard
** Cardwell Lake is the only lake of any size in this watershed
*** Skeleton River, High Lake and Young Lake are the only lakes of any size in this watershed
+ This watershed is comprise primarily of Crown land
++ The Mary Lake Watershed includes Lakes Vernon, Fairy, Peninsula and several smaller lakes
~ This watershed is comprised mostly of Crown land, provincial park, and a privately owned and undeveloped township

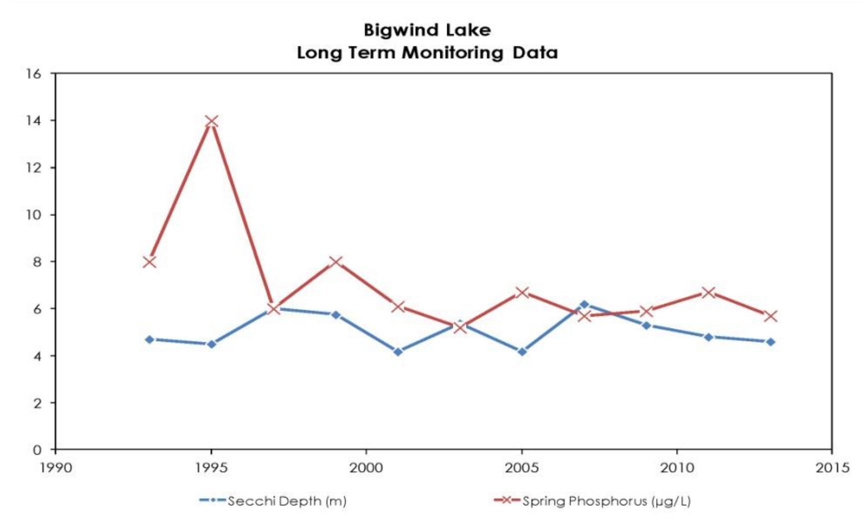

Figure 10: Example of Long-Term Monitoring Data

In addition, on individual lakes, phosphorus has been tracked for up to 30 years, depending on the lake. The Report Card will provide individual lake graphs that track the entire phosphorus record (see figure 10).

Algae

Algae are free-floating (phytoplankton) or attached (periphyton) plants found in all lakes and rivers. They contain chlorophyll, which allows them to sustain themselves through photosynthesis. They are at the base of aquatic food webs and a vital part of the lake's ecology. They also occasionally become very abundant and form visible algal blooms. The types of algae found in Muskoka include diatoms, chrysophytes, green algae, pigmented flagellates, and blue-green algae.

In most cases, the concern with algal blooms is focused on the occurrence of blue green algal blooms because they have the ability to produce toxins. However, other species of algae can bloom and create taste and odour problems with the water. One study carried out on seven local lakes demonstrated that there was a significant increase in chrysophytes that resulted in blooms with declines in the number of diatom algae. The long-term changes in algal species composition are believed to be attributable to multiple human stressors acting at a regional scale, such as climate change, invasive species and industrial emissions. The results of the study, coupled with paleoecological studies, indicate that increases in chrysophytes are connected with water chemistry changes associated with industrial activity since the mid-1900s and physical changes linked to climate change.[42]

Currently there is minimal long-term data to report on the number or type of algal blooms across the watersheds. Where anecdotal information is available, it suggests that there has not been a significant increase in algal blooms[43], although there are more reports of increased attached algae on rocks, docks and boats.

It is possible to gain an understanding of the propensity for algal blooms to occur by considering the long-term average Total Phosphorus (TP) and the recent increase of TP to a lake. In most situations, higher phosphorus levels that support algal blooms are natural and a result of the natural nutrients coming from the specific lake watershed. In general, where the long-term TP average is above 20 µg/L, nuisance algal blooms are more likely to occur. Using a conservative approach, lakes are considered vulnerable when the TP value is above 15 µg/L.

Lakes with TP averages greater than 15 µg/L include:

- Ada Lake (2EB-05 – Lake Rosseau Watershed) Natural
- Bass Lake (2EC-16 – Kahshe River Watershed) Natural
- Black Lake (2EB-04 – Lake Muskoka Watershed) Natural
- Brandy Lake (2EB-04 – Lake Muskoka Watershed) Natural
- Barron's Lake (2EC-17 – Severn River Watershed) Natural
- Fawn Lake (2EB-14 – North Muskoka River Watershed) Natural
- Riley Lake (2EC-14 – Lower Black River Watershed) Natural
- Ryde Lake (2EC-16 – Kahshe River Watershed) Natural

Where a lake has both an average TP reading greater than 15 µg/L and its average TP reading is more than 50% above the background level for that lake, the lake is considered stressed for algal blooms. A more conservative TP level has been used to define a stressed lake as the lake is also experiencing considerably higher than natural TP levels.

[42] Paterson, A.M., J.G. Winter, K.H. Nicholls, B.J. Clark, C.W. Ramcharan, N.D. Yan and K.M. Somers. 2008. Long-term changes in phytoplankton composition in seven Canadian Shield lakes in response to multiple anthropogenic stressors. Can. J. Fish. Aquat. Sci. 65: 846-861. Dorset Special Issue.

[43] Personal Communication, Michelle Palmer, MOE.

Lakes that are currently stressed include:

- Three Mile Lake - Main Basin (2EB-08 – Dee River Watershed) Natural
- Doeskin Lake (2EC-16 – Kahshe River Watershed) Natural
- Penfold Lake (2EB-13 – Mary Lake Watershed) Natural
- Silver Lake (ML) (2EB-04 – Lake Muskoka Watershed) Human Activity
- Weismuller Lake (2EB-09 – South Muskoka River Watershed) Natural

Watersheds can also be evaluated for the propensity to experience algal blooms. Generally watersheds within the Muskoka and Black/Severn Tertiary Watersheds do not experience significant numbers of algal blooms. Lakes not specifically noted above have a low probability for nuisance algal blooms since their TP concentration is below 15 µg/L. However, this does not mean that they will not experience an algal bloom from time to time. Continued monitoring of algal blooms should occur and trends noted in future report cards. On the few lakes that experience blooms, stewardship programs and development controls should address specific situations.

Fish Habitat

Fish inhabit all parts of a lake but the sensitive spawning and nursery areas are generally located along the shore where young fish can find food and hide from predators. Near shore areas provide cover in the form of woody debris or aquatic plants, food in the form of algae and zooplankton, and warmer waters preferred by some fish species. When residents 'improve' their shoreline they often remove woody debris and aquatic vegetation, or add sand which covers spawning areas. In some cases, they add structures such as crib docks or hardened shorelines that create barriers to the movement of fish.

Across the watersheds, municipalities, lake associations and conservation groups have done significant work to encourage landowners to maintain or renaturalize shorelines and shoreline buffers. The Towns of Bracebridge, Gravenhurst and Huntsville and the Township of Muskoka Lakes have undertaken local projects to renaturalize the shoreline in public parks. Recent policy of many watershed municipalities requires the maintenance of shoreline vegetation through the development approval process or through a tree-cutting and site alteration bylaw. The Township of Lake of Bays has also implemented a development permit system that requires a permit to remove shoreline vegetation.

The Report Card looks at the amount of human disturbance along a shoreline. In future report cards it is hoped that it will be possible to also report on the impact of development on the benthic community.

There is a direct correlation between the quality of fish habitat and disturbance to natural shorelines. The District Municipality of Muskoka undertakes shoreline land use surveys that identify shoreline alteration. Where no shoreline surveys have been conducted, the 2008 air photos were used to estimate the shoreline condition. The standard established by the Department of Fisheries and Oceans is to limit shoreline disturbance to a maximum of 25% of the lot's shoreline or a maximum of 50 feet on a 200 foot lot. This standard has been accepted by all municipalities within the watershed and will be used to grade shoreline alteration in the Report Card. Table 21 provides an evaluation of the health of fish habitat by subwatershed. The level of stress on the watershed due to shoreline alteration will be determined using the following scale:

- **Not Stressed:** more than 70% of the subwatersheds are not stressed
- **Vulnerable:** between 50% and 70% of the subwatersheds are not stressed
- **Stressed**: more less than 50% of the subwatersheds are stressed

Where there is specific data for individual lakes, the amount of shoreline alteration will be reported. The level of stress on the lake due to shoreline alteration will be determined using the following scale (Lake data are available on the Muskoka Water Web at www.muskokawaterweb.ca.

- **Not Stressed:** more than 90% of the shoreline has been left in a natural state
- **Vulnerable** between 75% and 90% of the shoreline has been left in a natural state
- **Stressed:** less than 75**%** shoreline has been left in a natural state

Table 24: Comparison of Shoreline Habitat 2010 to 2014

Quaternary Watershed	2010	2014
Moon River	Not Stressed	Not Stressed
Gibson River	Vulnerable	Not Stressed
Lake Muskoka	Vulnerable	Vulnerable
Lakes Rosseau	Vulnerable	Vulnerable
Rosseau River	Not Stressed	Not Stressed
Skeleton River	Vulnerable	Not Stressed
Dee River	Vulnerable	Not Stressed
South Muskoka River	Vulnerable	Vulnerable
Lake of Bays	Vulnerable	Not Stressed
Oxtongue River	Not Stressed	Not Stressed
Hollow River	Not Stressed	Not Stressed
Mary Lake	Vulnerable	Vulnerable
North Muskoka River	Vulnerable	Vulnerable
Big East River	Not Stressed	Not Stressed
Little East River	Not Stressed	Not Stressed
Lower Black River	Not Stressed	Not Stressed
Upper Black River	Not Stressed	Not Stressed
Kahshe River	Vulnerable	Vulnerable
Severn River	Not Stressed	Not Stressed

In 2010, Watershed 2EB had 6 'not stressed' and 9 'vulnerable' quaternary watersheds. As a result the fish habitat in the watershed was determined to be 'vulnerable' to negative impacts. In 2014, Watershed 2EB had 10 'not stressed' and 5 'vulnerable' quaternary watersheds and was determined to be not stressed with respect to fish habitat. This shift in status is likely due to a more robust data set and not to improvement in shoreline fish habitat. Watershed 2EC had 3 'not stressed' and 1 'vulnerable' quaternary watershed in both 2010 and 2014. The watershed has been graded as 'not stressed' in both years.

As was found in the review of shoreline buffers, there has been little change in shoreline structures between 2010 and 2014. This is especially true on smaller lakes. However, as more and larger docks and boathouses are built on lakes, care is required to protect fish habitat. The use of bubblers is also becoming an issue with larger areas of near shore water not freezing during the winter. The ecological impacts of this development are not well understood and new research is needed.

Calcium Decline

The causes of lake calcium decline are varied and represent an active area of scientific research in Ontario and around the world. The main source of available calcium to lakes is the bedrock and soils within their watersheds. As acid rain intensified in the mid 1900s it caused calcium to move from watershed soils into lakes faster than it could be replenished through weathering, or through inputs from the atmosphere such as dust.

As a result, calcium levels initially increased in lakes because of the increased transfer of calcium from the watershed to lakes. However, with continuing acid rain, the available pool of calcium in soils was slowly depleted. As happens with our money when we withdraw more from our bank account than we deposit, less calcium was available for transfer, and in some lakes this has resulted in noticeable declines in calcium concentrations.

Acidic deposition is not the only stressor affecting calcium levels in softwater lakes, like those in Muskoka. Both the removal of calcium-rich timber, and the re-growth of forests following harvesting, can place pressure on the available pool of calcium in soils. Declines in the deposition of calcium-rich dust in some regions may further contribute to lake calcium declines.

Scientists are just now beginning to understand the consequences for the aquatic biota of declining calcium. In lakes with less than 1.5 milligrams of calcium per litre (mg/L), *Daphnia* die. *Daphnia* are keystone herbivores in lake food webs. Across the Muskoka Watershed, 62% of lakes have a calcium concentration approaching or below the threshold of 2.5 milligrams of calcium per litre at which laboratory *Daphnia* populations suffer reduced survival. The ecological impacts of environmental calcium loss are likely to be both widespread and pronounced.

In the Muskoka River Watershed, 57% of the lakes have a calcium concentration below 2.0 mg/L. Most of these lakes are in the headwater region of the watershed. The headwater area is particularly sensitive to reduced calcium because the lakes in this area were more sensitive to acid precipitation and therefore they had low calcium levels to start. They are also likely to have the smallest pools of watershed calcium, and thus are the most easily depleted. In the Hollow River Watershed, all 16 lakes have a calcium concentration below 1.5 mg/L.

Lakes that are located in the Black-Severn River Watershed are off the Shield and do not suffer from a loss of calcium because the limestone soils have buffered the effect of acid deposition.

There are insufficient data to determine any trends in calcium levels at a tertiary watershed level at this time. The level of stress on the watershed due to decreased calcium levels will be determined using the following scale:

- **Not Stressed:** 50% or more of the lakes have a calcium concentration above 2.0 µg/L
- **Vulnerable:** 50% or more of the lakes have a calcium concentration greater than 1.5 µg/L
- **Stressed:** 50% or more of the lakes have a calcium concentration less than 1.5 µg/L

Similar to the watershed analysis, level of stress on an individual lake due to decreased calcium levels will be determined using the following scale (detail listing is available on the website):

- **Not Stressed:** lake calcium concentration above 2.0 µg/L
- **Vulnerable:** lake calcium concentration between 1.5 and 2.0 µg/L
- **Stressed:** lake calcium concentration less than 1.5 µg/L

The number of lakes by quaternary watershed that fall into the Not Stressed, Vulnerable, and Stressed grading based on the scale provided above is presented in Table 25.

Table 25: Level of Calcium Stress by Quaternary Watershed

Quaternary Watershed	Not Stressed	Vulnerable	Stressed	Averaged Grade
Moon River	24	9	8	Not Stressed
Gibson River	7	5	2	Not Stressed
Lake Muskoka	24	7	3	Not Stressed
Lake Rosseau	31	9	6	Not Stressed
Rosseau River	2	0	1	Not Stressed
Skeleton River	3	1	1	Not Stressed
Dee River	4	3	0	Not Stressed
South Muskoka River	21	14	1	Not Stressed
Lake of Bays	11	22	7	Vulnerable
Oxtongue River	2	28	7	Vulnerable
Hollow River	0	7	9	Stressed
Mary Lake	14	12	11	Vulnerable
North Muskoka River	6	3	2	Not Stressed
Big East River	9	16	20	Vulnerable
Little East River	3	2	0	Not Stressed
Watershed 2EB	**161**	**138**	**78**	**Vulnerable**
Lower Black River	1	0	0	Not Stressed
Upper Black River	2	0	2	Vulnerable
Kahshe River	6	3	2	Not Stressed
Severn River	22	0	0	Not Stressed
Watershed 2EC	**31**	**3**	**4**	**Not Stressed**

Source: District of Muskoka Water Quality Program and Yan: 300 Lake Study

Summary

The aquatic component of each subwatershed can be analyzed based on the four indicators outlined above (total phosphorus, occurrence of algal blooms, fish habitat, and calcium decline). Together these components provide an indication of the health of the aquatic component of the watershed. The grading at the quaternary watershed level was based on a weighted average calculation. Any indicator that was scored as Not Stressed (NS) was given a weight of 1. An indicator that was scored as Vulnerable (V) was given a weight of 2. Indicators that were scored as Stressed (S) were given a score of three. These scores were added for each quaternary watershed and divided by the total number of indicators (4). The final classifications are provided below and the indicators are summarized in Table 26.

- **Not Stressed:** weighted average <1.25
- **Vulnerable:** weighted average 1.26 to 3.0
- **Stressed:** weighted average >3

Table 26: Summary of Water Indicators

Quaternary Watershed	Total Phosphorus		Algal Blooms		Fish Habitat		Calcium Decline		Total Grade	
	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
Moon River *	V	V	NS	NS	NS	NS	N/Avail	NS	Not Stressed	Not Stressed
Gibson River	NS	NS	NS	NS	V	NS	N/Avail	NS	Not Stressed	Not Stressed
Lake Muskoka	S	S	V	V	V	V	N/Avail	NS	Vulnerable	Vulnerable
Lake Rosseau	S	S	NS	NS	V	V	N/Avail	NS	Vulnerable	Vulnerable
Rosseau River	NS	NS	NS	NS	NS	NS	N/Avail	NS	Not Stressed	Not Stressed
Skeleton River	V	V	NS	NS	V	NS	N/Avail	NS	Vulnerable	Not Stressed
Dee River	V	V	S	S	V	NS	N/Avail	NS	Vulnerable	Vulnerable
South Muskoka River	S	V	NS	NS	V	V	N/Avail	NS	Vulnerable	Vulnerable
Lake of Bays *	NS	V	NS	NS	V	NS	N/Avail	V	Not Stressed	Vulnerable
Oxtongue River +	V	NS	NS	NS	NS	NS	N/Avail	V	Not Stressed	Not Stressed
Hollow River+	NS	NS	NS	NS	NS	NS	N/Avail	S	Not Stressed	Not Stressed
Mary Lake	V	NS	NS	NS	V	V	N/Avail	V	Vulnerable	Vulnerable
North Muskoka River	NS	NS	NS	NS	V	V	N/Avail	NS	Not Stressed	Not Stressed
Big East River+	NS	NS	NS	NS	NS	NS	N/Avail	V	Not Stressed	Not Stressed
Little East River	NS	NS	NS	NS	NS	NS	N/Avail	NS	Not Stressed	Not Stressed
Watershed 2EB	**V**	**NS**	**NS**	**NS**	**V**	**NS**	**N/Avail**	**V**	**Not Stressed**	**Not Stressed**
Lower Black River	NS	NS	NS	NS	NS	NS	N/Avail	NS	Not Stressed	Not Stressed
Upper Black River	V	NS	NS	NS	NS	NS	N/Avail	V	Not Stressed	Not Stressed
Kahshe River	NS	NS	NS	NS	V	V	N/Avail	NS	Not Stressed	Not Stressed
Severn River	V	S	NS	NS	NS	NS	N/Avail	NS	Not Stressed	Not Stressed
Watershed 2EC	**V**	**NS**	**NS**	**NS**	**NS**	**NS**	**N/Avail**	**NS**	**Not Stressed**	**Not Stressed**

* identified as vulnerable because of the introduction on the calcium indicator
+ although the watershed is identified as bring not stressed, the decline in calcium is a significant issue that will have a major impact on the watershed health

Wetlands

Wetlands have been recognized by all levels of government as important components of a healthy environment. The Federal government signed the North American Waterfowl Management Plan with the United States and Mexico in 1986. The plan outlines the scope of the conservation and protection work to be done on a continental basis and provides broad guidelines for habitat protection and management actions. The Provincial government has taken many steps to identify and protect large, provincially significant wetlands, the most notable being the adoption of a protective policy statement under the Planning Act in the mid 1990's. The Province has also developed a system (Ontario Wetland Evaluation System: Northern Manual) to allow the evaluation and classification of wetlands in order to secure their protection through municipal planning documents such as Official Plans and zoning bylaws.

Wetlands are defined as:

...lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens. [44] Wetlands also include beaver ponds.

A **swamp** is a wetland type with woody vegetation such as White Cedar, Black Spruce, Red Maple, Tamarack and White Pine. Some swamps may also include tall shrubs, dominated by Alder, Winterberry, and Mountain Holly. Swamps are the most common wetland type in Muskoka. A **marsh** is a wetland type without woody vegetation. Under the Ontario Wetland Evaluation System (OWES), marshes can have up to 50% coverage of low shrubs (<1 m in height or less), species such as Sweetgale, Leatherleaf, Spirea etc., and feature grasses, rushes, reeds, sedges, and other herbaceous plants. A **bog** is a wetland type that accumulates acidic peat and has no flow of water through it. A **fen** is a wetland type that accumulates peat deposits. Fens are less acidic than bogs and may have some flow through of water.[45]

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[44] Government of Ontario, Provincial Policy Statement, Queen's Printer, 2005.

[45] Wikipedia, wetland definitions. http://en.wikipedia.org/wiki.

Wetland Values

Wetlands are both essential individual ecosystems and parts of larger, more complex ecosystems. They do not function in isolation and require the physical and biological interaction with the surrounding land to continue to function and provide benefits. Wetlands and the area that surrounds them provide continuous, sustainable environmental, economic and social benefits that contribute to the high quality of life in Muskoka.

Most species at risk native to Muskoka rely on wetlands for all or a portion of their life cycles. Many also rely on the surrounding land. Therefore, in order to protect these species and to ensure that wetlands continue to function, both the wetland and the surrounding land should be protected as changes occur. As development occurs, it is often the surrounding lands that are impacted and habitat is lost.

For convenience, wetland values are generally grouped into biological, hydrological and socio-economic benefits; however, many of the values contribute to all three broad categories. Wetlands and their surrounding area generally provide the following functions:

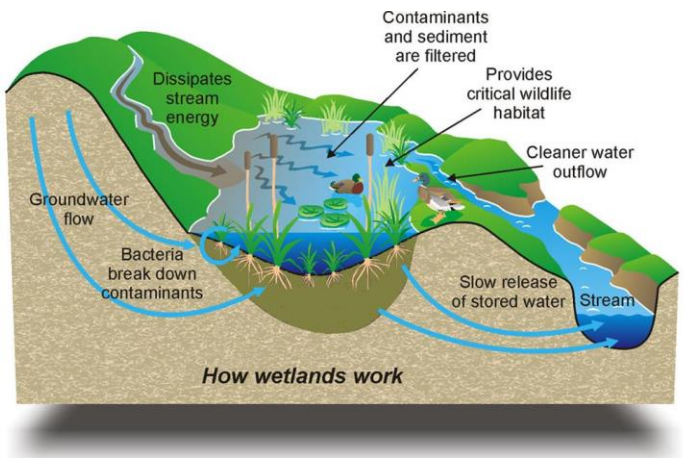

Figure 11: Function of a Wetland

- Recharge and discharge of groundwater;
- Maintenance and improvement in water quality;
- Aid in flood control;
- Protection of shorelines from erosion;
- Trapping sediments that would otherwise fill watercourses;
- Supporting and initiating complex food chains that are ultimately essential for a broad spectrum of living organisms, including humans;
- Providing important habitat for a wide variety of plant and animal species;
- Immobilizing some contaminants and nutrients;
- Reducing other contaminants to less-damaging compounds;
- Assisting in maintaining water quality in adjacent lakes and streams that support fish populations;
- Providing valuable resource products such as timber, fish and wild rice on a sustainable basis;
- Contributing substantial economic and social benefits to the municipality through trapping, hunting, fishing and outfitters; and
- Providing active and passive recreational opportunities, including canoeing, bird watching, hunting and fishing.

Although all wetlands have importance, it is broadly recognized that larger wetlands that support regional hydrological systems or are home to rare, threatened and endangered species require an extra level of protection.

Value of Beaver

Beaver ponds are wetlands and an important component of the ecology of all watersheds in Muskoka. The North American beaver population was originally estimated to be 100 to 200 million before the days of the fur trade.[46] The population in the early 19th century declined drastically, due to extensive hunting for fur and for the glands used as medicine and perfume, and because the harvesting of trees and flooding of waterways by beaver interfered with other human land uses.[47] With protection in the late 19th and early 20th centuries, the current beaver population has rebounded to an estimated 10 to 15 million[48] which represents only 1/10 of the original population.

The beaver works as a keystone species in an ecosystem by creating wetlands that are used by many other species, including many species at risk. Beaver also regulate the hydrology of the watershed. Next to humans, no other animal appears to do more to shape its landscape.[49]

A keystone species is a species that has a disproportionately large effect on its environment relative to its abundance.[50] Such species play a critical role in maintaining the structure of an ecological community, affecting many other organisms in an ecosystem and helping to determine the types and numbers of various other species in the community.

The role that a keystone species plays in its ecosystem is analogous to the role of a keystone in an arch. While the keystone is under the least pressure of any of the stones in an arch, the arch still collapses without it. Similarly, an ecosystem may experience a dramatic shift if a keystone species is removed, even though that species was a small part of the ecosystem by measures of biomass or productivity.[51]

The beaver has many functions in an ecosystem. Perhaps most significantly, it increases biodiversity. As wetlands are formed and riparian habitats enlarged, aquatic plants colonize newly available watery habitat. Insect, invertebrate, fish, mammal, and bird diversity are also expanded. Beaver ponds also increase stream flows in seasonally dry streams by storing run-off in the rainy season, which raises groundwater tables via percolation from beaver ponds. Beaver ponds, and the wetlands that succeed them, remove sediments and pollutants from waterways,

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[46] Seton-Thompson, cited in Sun, Lixing; Dietland Müller-Schwarze (2003). The Beaver: Natural History of a Wetlands Engineer. Ithaca, NY: Cornell University Press. p. 98. ISBN 0-8014-4098-X. pp. 97–98; but note that to arrive at this figure he assumed a population density throughout the range equivalent to that in Algonquin Park

[47] Nowak, Ronald M. 1991. pp. 364–367. Walker's Mammals of the World Fifth Edition, vol. I. Johns Hopkins University Press, Baltimore. (as quoted in Wikipedia)

[48] Alice Outwater (1997). Water: A Natural History. New York, NY: Basic Books. p. 89. ISBN 0-465-03780-1.

[49] Beaver. In Animals. Retrieved June 15, 2009, from http://animals.nationalgeographic.com/animals/mammals/beaver.html

[50] Paine, R.T. (1995). "A Conversation on Refining the Concept of Keystone Species". Conservation Biology 9 (4): 962–964. doi:10.1046/j.1523-1739.1995.09040962.x

[51] Mills, L.S.; Soule, M.E.; Doak, D.F. (1993). "The Keystone-Species Concept in Ecology and Conservation". BioScience (BioScience, Vol. 43, No. 4) 43 (4): 219–224. doi:10.2307/1312122. JSTOR 1312122

including total suspended solids, total nitrogen, phosphates, carbon and silicates.[52, 53] Beaver and their ponds, dams and wetlands are an essential component of a healthy watershed.

Wetland Area

There are over 688 square kilometres of wetlands in the Muskoka Watershed which represents 9.27% of the total watershed area.

- Evaluated wetlands – 6,554 ha or 12% of the total wetland area
- Provincially Significant Wetlands – 6,154 ha or 11.4% of the total wetland area
- Increase in evaluated Provincially Significant Wetlands – 154 ha (2010 – 2012)

It is expected that additional Provincially Significant Wetlands (PSWs) will be identified as more wetland evaluations are completed.

Protection of these significant systems is important in order to ensure that wetlands continue to function and provide ecosystem services in the long term. Currently, 33.67% of known PSWs are protected either because they are part of a provincial or national park, a provincial Conservation Reserve, or a land trust property, or because they are located on Crown land. An additional 3.73% of PSWs located on private land are part of the Conservation Land Tax Incentive Program, a voluntary program that allows property owners to be exempt from paying property taxes on the portion of their property that is PSW. In total, 37.4% or 2,200 ha of PSWs are protected by these tools.

As development pressure increases, it is important to identify and evaluate wetlands in those quaternary watersheds most at risk from development pressure to ensure that appropriate consideration is given to the protection of significant wetlands so that we continue to benefit from the ecosystem services they provide.

Reasons for Wetland Habitat Destruction

Many wetlands in Muskoka have already been lost or altered as development occurred. However, it is assumed that the wetland coverage in the large undeveloped portion of Muskoka today is at a natural level as forests and other natural areas have regenerated since the full scale logging operations of the late 1800s. Major causes of wetland loss in Muskoka today include:

- Hydrologic alteration such as drainage, dredging, stream channelization, ditching, deposition of fill material, and stream diversion;
- Development including community development, rural and waterfront residential, industrial and commercial operations;
- Marinas/Boats;

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[52] David L. Correll, Thomas E. Jordan, Donald E. Weller (2000-06). "Beaver pond biogeochemical effects in the Maryland Coastal Plain". Biogeochemistry 49 (3): 217–239. JSTOR 1469618.

[53] Sarah Muskopf (October 2007). The Effect of Beaver (Castor canadensis) Dam Removal on Total Phosphorus Concentration in Taylor Creek and Wetland, South Lake Tahoe, California (Thesis). Humboldt State University, Natural Resources. Retrieved 2011-03-05.

- Agriculture; and
- Timber harvest.

Degradation of wetlands results in changes to water quality, quantity, and flow rates; increases in pollutant inputs; and changes in species composition as a result of the introduction of non-native species and disturbances. The major pollutants associated with urbanization are sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, hydrocarbons, bacteria, and viruses. These pollutants may enter wetlands from point sources or from non-point sources. Construction activities are a major source of suspended sediments that enter wetlands through urban runoff.

Impervious surfaces decrease groundwater recharge within a watershed and can reduce water flow into wetlands. Significant increases in stormwater peakflow rates, and longer-term changes in wetland hydrology as a result of stormwater discharge, can cause erosion and channelization in wetlands, as well as alteration of species composition and decreased effectiveness in removing pollutants. Changes in frequency, duration, and timing of the wetland cycles may adversely affect spawning, migration, species composition, and thus the food web in a wetland as well as in associated ecosystems.

Urban and industrial stormwater rich in nitrogen and phosphorus can lead to algal blooms. Algal blooms deplete dissolved oxygen, leading to mortality of both sensitive fish like Lake Trout and benthic organisms.

As a result of disturbance and habitat degradation, wetlands can be invaded by aggressive, highly-tolerant, non-native vegetation, such as Purple Loosestrife (*Lythrum salicaria*) or can be dominated by a monoculture of cattails leading to a decrease in wetland diversity and function.

Historically, agriculture has been a major factor in wetland loss and degradation as land was drained and turned into farmland. Much of that farmland has now been abandoned and wetlands have re-established through natural processes like beaver activity.

Currently, cranberry production impacts several wetlands in western Muskoka. Although the area remains wet, the water fluctuation of the wetland is controlled and biodiversity is lost. Most species that rely on wetlands are not compatible with cranberry production and are lost from the wetland.

Forestry activity such as drainage, clearing, road construction, rutting, and ditching of forested wetlands all may affect wetlands in some way, although the impact may only be temporary. Since timber removal generally occurs in 20-50 year rotations, careful harvest may not be a permanent threat to wetlands. By using best management practices such as those required when a forest is certified under the Forest Stewardship Council, hydrology and biogeochemical processes of wetlands may be altered for only one to three years following timber harvest.

Peat mining occurs on a relatively small scale in Muskoka. However, where it has occurred, the wetland undergoes significant modification, often being transformed into open water habitat. These activities destroy the portion of the wetland selected for harvest and degrade adjacent areas.

Wetland Grades

In southern Ontario, ecologists recommend that 10% of a watershed should remain as wetland in order to provide the ecosystem services and functions necessary for a healthy watershed. However, on the Canadian Shield this figure is less applicable. In Muskoka, many quaternary watersheds are naturally comprised of less than 10% wetlands. Therefore, for the purpose of the Report Card, it is assumed that the wetland area in existence in 2010 in each quaternary watershed is close to its natural level, unless the review of historic air photos indicates differently (Table 27). For example, Skeleton River Watershed has only 6.27% wetlands and the Lake Rosseau Watershed has only 4.61% wetlands. On the other hand, the Rosseau River Watershed has 15.42% wetlands and the Severn River Watershed has 17.85% wetlands. These areas have lakes with higher DOC and typically more nutrients in the lakes and rivers.

Table 27: Wetland Coverage by Quaternary Watershed

Quaternary Watershed	Watershed Area (ha)	Wetland Area (ha)	Wetland Area (%)	1% Wetland Loss (ha)
Moon River	71,588	7,909	11.05	79.09
Gibson River	18,591	3,180	17.11	31.80
Lake Muskoka	47,039	3,781	8.04	37.81
Lake Rosseau	42,583	1,961	4.61	19.61
Rosseau River	12,969	2,000	15.42	20.00
Skeleton River	9,247	580	6.27	5.80
Dee River	14,869	1,564	10.52	15.64
South Muskoka River	35,570	4,329	12.17	43.29
Lake of Bays	38,446	2,402	6.25	24.02
Oxtongue River	60,716	2,939	4.84	29.39
Hollow River	40,863	1,527	3.74	15.27
Mary Lake	66,344	7,175	10.82	71.75
North Muskoka River	24,890	2,164	8.69	21.64
Big East River	64,699	3,114	4.81	31.14
Little East River	9,604	716	7.45	7.16
Lower Black River	50,816	5,214	10.26	52.14
Upper Black River	38,995	2,885	7.40	28.85
Kahshe River	24,619	2,907	11.81	29.07
Severn River	70,112	12,512	17.85	125.12
Total	**742,560**	**68,859**	**9.27**	**688.59**

An objective of no net loss of wetlands from the 2010 level will be used as the benchmark; however, it is very difficult to measure wetland loss on the landscape. In a large and well forested watershed with widely distributed wetlands, such as the watersheds in Muskoka, it is difficult to track wetland changes. Air photos and satellite imagery have been used at a strategic level to identify larger wetland areas and they can be used to track major shifts and changes in wetland coverage, but they are not very efficient for determining local level changes. A landscape level analysis does not provide the detailed information on wetland loss that is required to understand very local shifts in wetland coverage and function.

In 2012, volunteers with the Muskoka Watershed Council began to identify wetland loss at a local level. By identifying where fill was being deposited, where small wetlands were being altered or drained for development, and road, culverts or other structures were changing wetlands it is possible to begin to develop a sense of the impact of people on local wetlands.

Wetland loss is small and cumulative in Muskoka. It is also associated with areas that are being developed. For the most part, municipalities require that development occur outside defined wetland areas. Where filling does occur, it is generally not directly associated with a planning approval and often occurs without the knowledge of the regulatory body. Due to the small area of wetland being lost it is not possible to provide a percent of wetland loss. A qualitative evaluation of the changing wetland mosaic across the quaternary watersheds, using the following guidelines, is provided in Table 28:

- **Not Stressed**: No significant development in wetlands
- **Vulnerable**: Rural and waterfront development with minor loss of wetlands and also an indication that wetlands are being protected
- **Stressed:** Urban and developing watersheds with visual indication that wetlands have been lost

Table 28: Grades for the Wetlands Indicator

Quaternary Watershed	% Wetlands	Comment	Grade
Moon River	11.05	The Moon River Watershed is experiencing development at the top end of the watershed in the Bala Reach. Bala was one of the first areas of settlement in Muskoka and historic development has defined the development envelope for the community. As such, conflict with wetlands arises from time to time. Filling of wetlands has been noted in the wetland associated with Carr Lake and, although some areas seem to fill naturally with woody plants, the northwest segment has been filled with rock blasted to create a basement for a house being built on River Street. The Bala Sports Park has been built on what was once a wetland. The Sports Park is a raised rectangle of earth with ditching/drainage on the north, east and south sides. The remains of the wetland are easily seen on the eastern side. Bits of wetland remain in the drainage area on the north and south sides. The lower portions of the watershed are a mix of Crown land and large private land holdings with minimal development pressure. The wetlands in the upper watershed, in the Bala reach area, are in fair condition. The wetlands in the lower portion of the watershed are in good condition.	Not Stressed

Quaternary Watershed	% Wetlands	Comment	Grade
Gibson River	17.11	The Gibson River Watershed is approximately 70% Crown and protected lands with less than 5% development. Wetlands in this watershed are in good condition.	Not Stressed
Lake Muskoka	8.04	The Lake Muskoka Watershed is limited to that area that flows directly into Lake Muskoka. It includes part of the urban areas of Gravenhurst, Port Carling, MacTier, and Bala. This central part of Muskoka is the oldest settled area in the District; as a result, many wetlands would have been impacted by development at the time of first settlement. Today, as in the past, as development occurs wetlands tend to get filled in, especially along the edges of the wetland. Port Carling is restricted in the area it has to develop by both roads and lakes. Wetlands in the area are particularly at risk because of the potential conflict in use. For example, recent observations note that fill has been added to several wetland areas along Highway 118 on the west side of the community. Fill has also been added to lots along Foreman Road as development proceeds. Golf course development in the last twenty years in Port Carling has also seen the filling and manipulation of wetlands. In MacTier, the railway was built through a swamp and several pockets of wetland area continue to exist between the railway and roads. Many of these pocket wetlands get filled in as the community continues to grow. In addition, filling has occurred in the Conger Marsh at the edge of the built up area. Cranberry development in the Bala area also impacts wetlands. Although the area remains wet, many of the hydrological and ecological functions of the wetland have been lost. As a key economic generator in the area a balance between cranberry production and wetland function is required. The Lake Muskoka Watershed continues to experience an elevated level of development pressure. Once again, in the Port Carling area, several new developments have been approved in areas that are bordering on or encompass wetlands. Wetlands in this watershed are vulnerable as there is constant pressure to develop.	Vulnerable

Quaternary Watershed	% Wetlands	Comment	Grade
Lake Rosseau	4.61	The Lake Rosseau Watershed is approximately 14% Crown and protected lands with approximately 7% development. Development is predominantly on the shore of the lakes where near-shore marshes are prone to destruction as property owners 'tidy' their shoreline. This near-shore habitat is important fish habitat. Significant development is not planned for the area, but steady shoreline development can be expected. The wetlands in this watershed are in fair condition. They are an important aspect of the landscape, but as there are very few, and they are prone to development, there is a risk of loss.	Vulnerable
Rosseau River	15.42	The Rosseau River Watershed is approximately 36% Crown and protected lands with less than 5% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed
Skeleton River	6.27	The Skeleton River Watershed is approximately 16% Crown and protected lands with less than 5% development. It is not close to a developing community and significant development is not planned for the area. Small wetlands areas adjacent to Skeleton River may be subject to filling by property owners. Wetlands in this watershed are in good condition.	Not Stressed
Dee River	10.52	The Dee River Watershed is approximately 3% Crown and protected lands with approximately 16% development. Development is predominantly on the shore of the lakes. Near-shore marshes are prone to destruction as property owners 'tidy' their shoreline. This near-shore habitat is important fish habitat. Three Mile Lake is the principal waterbody in this watershed and, while significant development is not planned for the area, steady shoreline development can be expected. Wetlands in this watershed are in fair condition.	Vulnerable

Quaternary Watershed	% Wetlands	Comment	Grade
South Muskoka River	12.17	The South Muskoka River Watershed is approximately 17% Crown and protected lands with approximately 5% development. Except for Muskoka Falls on Spence Lake at the very southern portion of the watershed, there is little community-type development within the watershed. Spence Lake was formed with the building of the dam at South Falls. At that time wetlands also developed. At this point development does not appear to be impacting these wetlands. Elsewhere in the watershed, development is focused on shoreline development in a series of smaller lakes. Some filling of wetlands in the shore area has occurred as residences were developed. Wetlands in this watershed are in good condition.	Not Stressed
Lake of Bays	6.25	The Lake of Bays Watershed is approximately 25% Crown and protected lands with less than 5% development. It is not close to a developing community and significant development is not planned for the area. Shoreline development has impacted some wetland areas. Wetlands in this watershed are in good condition.	Not Stressed
Oxtongue River	4.84	The Oxtongue River Watershed is approximately 97% Crown and protected lands with less than 2% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed
Hollow River	3.74	The Hollow River Watershed is approximately 75% Crown and protected lands with less than 2% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed

Quaternary Watershed	% Wetlands	Comment	Grade
Mary Lake	10.82	The Mary Lake Watershed is a large watershed with significant areas of development, including the urban area of Huntsville, Port Sydney, Deerhurst and the Highway 11 corridor. Although wetlands in the large rural area do not appear to be under significant development pressure, wetlands in areas adjacent to roads and in the urban areas are vulnerable to filling. In the Big East delta of Lake Vernon, the Town of Huntsville has taken some steps to protect the vast and provincially significant wetland. However, a review of current and past air photos indicates that several residential structures have been allowed in the margins of the wetland. As Hidden Valley developed, large areas of wetlands were filled or significantly manipulated. The original golf course south of Highway 60 was built primarily in a wetland. Today only remnant wetland pockets remain. It is encouraging, however, that when the Champion golf course was built on the north side of the highway, most of the wetlands were preserved and designed into the course. More recently, along Highway 60 toward Dwight, filling has occurred on the north side of the highway. The air landing strip was once a wetland and several properties have filled in small portions of wetlands to have a developable lot. The wetland east of Grandview Drive at Brook Lane has also been filled in as development has occurred. Wetlands in this watershed are in fair condition.	Vulnerable

Quaternary Watershed	% Wetlands	Comment	Grade
North Muskoka River	8.69	The North Muskoka River Watershed is approximately 8% Crown and protected lands with 14% developed area. The urban area of Bracebridge is within this watershed. Although the wetlands in the large rural area do not appear to be under significant development pressure, areas adjacent to roads are vulnerable to filling in the margins of wetlands. The wetland complex south of Bracebridge and terminating at Henry's marsh has a major development approved for the area that will likely impact a series of wetlands that flow from Highway 11 to the Muskoka River. If this area is eventually developed, steps to protect the functionality of the wetland are required. Wetlands in this watershed are in fair condition.	Vulnerable
Big East River	4.81	The Big East River Watershed is approximately 73% Crown and protected lands with less than 2% development. Development in the delta at the bottom of the watershed is impacting wetlands in that area, however, for most of the watershed wetlands are in good condition.	Not Stressed
Little East River	7.45	The Little East River Watershed is only 16% Crown and protected lands and is approximately 8% developed. Although there is no significant development planned for the watershed, the expansion of Highway 11 north of Huntsville has significantly impacted the provincially significant wetland at Novar. Generally the wetlands in the large rural area do not appear to be under significant development pressure, although some development has occurred in the wetlands along North Waseosa Lake Road. As with other rural areas, properties adjacent to roads are vulnerable to filling in the margins of wetlands. Wetlands in this watershed are in fair condition.	Vulnerable

Quaternary Watershed	% Wetlands	Comment	Grade
Watershed 2EB	**8.13**	**The Muskoka River Watershed is comprised of small urban centres and large areas of rural and waterfront development. Quaternary watersheds that are primarily in the rural and waterfront designations have healthy, intact wetlands that do not appear to be experiencing significant stress. Wetlands in quaternary watersheds with more development in communities and rural areas close to good roads are being filled. Planning policy and development approvals do not appear to be effective in curbing the slow degradation of locally and regionally significant wetlands. Consideration of fill by-laws may be appropriate.**	**Vulnerable**
Lower Black River	10.26	The Lower Black River Watershed is approximately 90% Crown and protected lands with less than 2% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed
Upper Black River	7.40	The Upper Black River Watershed is approximately 87% Crown and protected lands with less than 2% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed
Kahshe River	11.81	The Kahshe River Watershed is approximately 87% Crown and protected lands with less than 5% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed
Severn River	17.85	The Severn River Watershed is approximately 67% Crown and protected lands with less than 6% development. It is not close to a developing community and significant development is not planned for the area. Wetlands in this watershed are in good condition.	Not Stressed
Watershed 2EC	**12.74**	**The Black/Severn River Watershed is comprised of a high percentage of Crown and protected lands. It does not include any major developing urban areas and significant development is not planned for the area. Wetlands in this watershed are in good condition.**	**Not Stressed**

As illustrated in Table 28, above, the objective of no net loss of wetlands is not being met in the quaternary watersheds of Muskoka. Where development is occurring, wetlands are being filled and drained. A program that includes both regulatory and stewardship approaches is required to protect local wetland values that are critical to the ecological, social and economic well being of Muskoka.

Biodiversity

Muskoka is blessed with biologically diverse terrestrial and aquatic ecosystems. Their biodiversity has provided them with the resilience necessary to withstand environmental change and continue to function normally and provide the environmental goods and services on which we and other species depend. The local watersheds have always undergone change, initially in response to relatively gradual patterns of climatic change following the retreat of the last Pleistocene glaciation in this region about 10,000 BP. There were, nonetheless, profound changes in which the composition of the forest ecosystem was altered radically from an early boreal to a later mixed pine and hardwood forest seen today. With the arrival of aboriginal populations and then Europeans, the nature and the pace of change quickened. Human activities altered terrestrial ecosystems profoundly and aquatic ones substantially. The health of the watershed's biological diversity can be measured through the health of its aquatic and terrestrial species and the occurrence of invasive alien species.

Species at Risk

Over 200 native Ontario species are at risk of becoming extinct. In Muskoka there are over 30 species at risk (Table 30). As habitats are lost to development and additional invasive species are introduced; native species will experience additional stress.

Table 29: Species at Risk Classifications

Status Classification	Definition
Special Concern	Lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats.
Threatened	Lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening it.
Endangered	Lives in the wild in Ontario but is facing imminent extinction or extirpation.

Table 30: Species at Risk in Muskoka

Species	Status
Peregrine Falcon	Special Concern
Cerulean Warbler	Threatened
Barn Swallow	Threatened
Bobolink	Threatened
Eastern Meadowlark	Threatened
Least Bittern	Threatened
Chimney Swift	Threatened
Whip-poor-will	Threatened
Henslow's Sparrow	Endangered
Grass Pickerel	Special Concern
Lake Sturgeon	Threatened
Rust-Patched Bumble Bee	Endangered
Broad Beech Fern	Special Concern
Branched Bartonia	Threatened
Butternut	Endangered
Engelmann's Quillwort	Endangered
Forked Three-awed Grass	Endangered
Eastern Ribbonsnake	Special Concern
Eastern Milksnake	Special Concern
Common Five-lined Skink	Special Concern
Eastern Fox Snake	Threatened
Eastern Hognose Snake	Threatened
Massasauga Rattlesnake	Threatened
Northern Map Turtle	Special Concern
Snapping Turtle	Special Concern
Blanding's Turtle	Threatened
Eastern Musk Turtle	Threatened
Spotted Turtle	Endangered
Little Brown Bat	Endangered
Northern Bat	Endangered

Although endangered species may be found in all quaternary watersheds, the watersheds in the Georgian Bay, Gravenhurst and south Muskoka Lakes areas tend to support more species habitats that are recognized as being endangered. As such, those watersheds are identified as stressed for species at risk (Table 31).

Table 31: Species at Risk Grades by Quaternary Watershed

Quaternary Watershed	Grade
Moon River	Stressed
Gibson River	Vulnerable
Lake Muskoka	Stressed
Lake Rosseau	Vulnerable
Rosseau River	Vulnerable
Skeleton River	Vulnerable
Dee River	Stressed
South Muskoka River	Stressed
Lake of Bays	Vulnerable
Oxtongue River	Not Stressed
Hollow River	Not Stressed
Mary Lake	Vulnerable
North Muskoka River	Stressed
Big East River	Vulnerable
Little East River	Vulnerable
Watershed 2EB	**Vulnerable**
Lower Black River	Not Stressed
Upper Black River	Vulnerable
Kahshe River	Not Stressed
Severn River	Stressed
Watershed 2EC	**Vulnerable**

Alien Invasive Species

Invasive species are plants, animals, both aquatic and terrestrial, and micro-organisms that out-compete native species when introduced outside of their natural environment and threaten Canada's ecosystems, economy and society. They can come from across the country or across the globe. Invasive species will be reported as the number of species on a quaternary watershed basis.

The number of non-native species impacting our watersheds is increasing with foreign species coming from other parts of the country or the world often having hitched a ride with human travelers, in cargo, on the bottom of boats and in the ballast of ships.

These types of species are called “alien species”, and while many of these species do not pose any immediate risk, and may even provide important benefits, many others, such as the reed, *Phragmites*, the Emerald Ash Borer and the Giant Hogweed, can cause very significant ecological, economic and environmental damage. These species are known as “invasive” alien species.

Invasive alien species are the second most significant threat to biodiversity, after habitat loss. In their new ecosystems, invasive alien species become predators, competitors, parasites, hybridizers, and diseases of our native and domesticated plants, animals and aquatic life. The impact of invasive alien species on native ecosystems, habitats and species is severe and often irreversible, and can be a significant cost to property owners and local governments attempting to control it.

The Ontario Federation of Anglers and Hunters, in conjunction with the Ministry of Natural Resources, created an Invasive Species Hotline in 1992. Since that time, people across the province have been reporting occurrences of alien invasive species. The Ministry of Natural Resources has identified twenty-four (24) invasive alien species of concern in Ontario, seven (7) of which are found locally (Table 32).

Table 32: Alien Invasive Species of Concern in Ontario

Species Type	Species Name	Present in Muskoka?	Comment
Fish	Asian Carp	No	
	Goldfish	Yes	
	Rainbow Smelt	Yes	
	Round Goby	No	In the Great Lakes
	Rudd	No	In the Great Lakes
	Ruffe	No	
	Sea Lamprey	No	In the Great Lakes
	Tubenose Goby	No	
Fish Parasites & Diseases	Asian Fish Tapeworm	No	In the Great Lakes at Detroit
Tree Parasites & Diseases	Beech Bark Disease	Yes	Just starting; will likely kill up to 90% of Beech trees
	Emerald Ash Borer	No	Likely to be here in 5 years
Invertebrates	Bloody Red Shrimp	No	
	Spiny Water Flea	Yes	
	Fishhook Water Flea	No	
	Rusty Crayfish	No	Severn River Watershed
	Zebra Mussel	Yes	Severn River and Georgian Bay
Aquatic Plants	Eurasian Water Milfoil	Yes	Severn River Watershed
	European Frog-bit	No	
	Fanwort	No	
	Phragmites	Yes	Georgian Bay
	Flowering Rush	No	
	Purple Loosestrife	Yes	
	Water Chestnut	No	
	Water Lettuce	No	
	Water Soldier	No	
	Yellow Iris		

Using the data produced through the Invasive Species hotline, the number, species and year of first sighting is provided on a quaternary watershed basis (Table 33).

Table 33: Alien Invasive Species by Quaternary Watershed

Quaternary Watershed	Species	Location	Year First Sighted	Grade
Moon River	Spiny Water Flea	Go Home Lake	1991	Stressed
		Healy Lake	1991	
		Virtue Lake	1991	
		Crane lake	1991	
		Horseshoe Lake	2007	
		Go Home Lake	1998	
		Crane Lake	1969	
	Zebra Mussel	Horseshoe Lake	1969	
	Rainbow Smelt	Blackstone Lake	1969	
Gibson River	Giant Hogweed	No location	2008	Vulnerable
Lake Muskoka	Rainbow Smelt	Clear	1973	Stressed
		Silver	1975	
		Lake Muskoka	1976	
	Spiny Water Flea	Lake Muskoka	1989	
		Leonard lake	2001	
		Silver Lake	2005	
		Clear Lake	2006	
	Giant Hogweed	No location	2009	
Lake Rosseau	Rainbow Smelt	Sucker Lake	1968	Stressed
	Spiny Water Flea	Portage Lake	1968	
		Stewart Lake	1973	
		Silver Lake	1973	
		Little Lake Joseph	1977	
		Lake Rosseau	1977	
Rosseau River *	No observations			Not Stressed
Skeleton River	Rainbow Smelt	Skeleton River	1968	Stressed
	Spiny Water Flea	Skeleton River	1998	
		Young Lake	2006	
Dee River	Spiny Water Flea	Three Mile Lake	2001	Stressed
South Muskoka River	Spiny Water Flea	Wood Lake	1995	Stressed
		Leech lake	2005	

Quaternary Watershed	Species	Location	Year First Sighted	Grade
Lake of Bays	Rainbow Smelt	Lake of Bays	1969	Stressed
		Paint Lake	1970	
		10 Mile Creek	1972	
	Spiny Water Flea	Lake of Bays	1999	
		Otter Lake	2005	
		Paint Lake	2006	
		Clinto Lake	2006	
Oxtongue River	Rainbow Smelt	Oxbow Lake	1997	Stressed
		Dotty Lake	1999	
	Spiny Water Flea	Oxbow Lake	2004	
		Dotty Lake	2006	
Hollow River	Rainbow Smelt	Hollow River	1994	Stressed
		Livingston Lake	1995	
		Kimball Lake	2005	
	Spiny Water Flea	Hollow River	2004	
		Livingston Lake	2005	
		Bear	2006	
Mary Lake	Giant Hogweed	Huntsville	No date	Stressed
	Rainbow Smelt	Fairy Lake	1969	
		Vernon Lake	1969	
		Mary Lake	1970	
	Spiny Water Flea	Vernon Lake	1991	
		Harp Lake	1993	
		Peninsula Lake	1999	
		Mary Lake	2009	
	Goldfish	Brunnel	2010	
North Muskoka River	Spiny Water Flea	Devine Lake	2004	Stressed
		Clearwater Lake	2006	
	Purple Loosestrife	Monck Twp	2004	
Big East River	Spiny Water Flea	Bella Lake	2001	Stressed
		Rebecca Lake	2005	
		Solitaire Lake	2004	
	Rainbow Smelt	Rebecca Lake	1971	
		Bella Lake	1972	
Little East River	Rainbow Smelt	Bay Lake	1971	Vulnerable
Watershed 2EB				**Stressed**
Lower Black River *	No observations			Not Stressed
Upper Black River	Zebra Mussel	Raven Lake	2006	Vulnerable

Quaternary Watershed	Species	Location	Year First Sighted	Grade
Kahshe River *	No observations			Not Stressed
Severn River	Eurasia Milfoil	Six Mile Lake	1996	Stressed
	Zebra Mussel	Severn River	1996	
		Six Mile Lake	1996	
		Sparrow Lake	No date	
	Spiny Water Flea	Loon Lake	1999	
	Giant Hog Weed	Muskoka	2011	
Watershed 2EC				**Vulnerable**

* No observations may mean that there are no invasive species, or it could mean that no one has reported the species that are there. As these watersheds tend to be more remote, they have been graded provisionally as not stressed.

The Biodiversity component of each quaternary watershed can be analyzed based on the Alien Invasive Species and Species at Risk indicators. Together, these components provide an indication of the health of the biodiversity in the watersheds (Table 34).

Table 34: Summary of Biodiversity Indicators

Quaternary Watershed	Species at Risk	Invasive Species	Grade
Moon River	Stressed	Stressed	Stressed
Gibson River	Vulnerable	Vulnerable	Vulnerable
Lake Muskoka	Stressed	Stressed	Stressed
Lake Rosseau	Vulnerable	Stressed	Vulnerable
Rosseau River	Vulnerable	Not Stressed	Vulnerable
Skeleton River	Vulnerable	Stressed	Vulnerable
Dee River	Stressed	Stressed	Stressed
South Muskoka River	Stressed	Stressed	Stressed
Lake of Bays	Vulnerable	Stressed	Vulnerable
Oxtongue River	Vulnerable	Stressed	Vulnerable
Hollow River	Not Stressed	Stressed	Vulnerable
Mary Lake	Vulnerable	Stressed	Vulnerable
North Muskoka River	Stressed	Stressed	Stressed
Big East River	Vulnerable	Stressed	Vulnerable
Little East River	Stressed	Vulnerable	Vulnerable
Watershed 2EB	**Vulnerable**	**Stressed**	**Vulnerable**
Lower Black River	Not Stressed	Not Stressed	Not Stressed
Upper Black River	Vulnerable	Vulnerable	Vulnerable
Kahshe River	Not Stressed	Not Stressed	Not Stressed
Severn River	Stressed	Stressed	Vulnerable
Watershed 2EC	**Vulnerable**	**Vulnerable**	**Vulnerable**

Summary

The composite grade for the health of the overall watershed is based on the sum of the grades for water, land, wetlands and biodiversity. The overall grade was determined by using a weighted average of each of the indicators detailed in this report.

- Each indictor that was scored as Not Stressed was valued as 1.
- Each indicator that was scored as Vulnerable was valued as 2.
- Each indicator that was scored as Stressed was valued as 3.
- The scores for each indicator were added for each quaternary watershed and divided by the number of categories (4).
- The final classifications are provided in Table 35.

Table 35: Overall Watershed Grades

Quaternary Watershed	Water			Land			Wetlands			Biodiversity			Total	Grade
	NS	V	S	NS	V	S	NS	V	S	NS	V	S		
Moon River	3	1	0	3	3	0	0	1	0	0	0	2	5.50	Vulnerable
Gibson River	4	0	0	5	1	0	1	0	0	0	2	0	4.00	Not Stressed
Lake Muskoka	1	2	1	0	5	1	0	1	0	0	0	2	7.25	Vulnerable
Lake Rosseau	2	1	1	1	4	1	0	0	1	0	0	2	7.00	Vulnerable
Rosseau River	4	0	0	6	0	0	1	0	0	1	1	0	3.50	Not Stressed
Skeleton River	3	1	0	2	3	1	1	0	0	0	1	1	5.50	Vulnerable
Dee River	2	1	1	0	3	3	0	1	0	0	0	2	7.50	Vulnerable
South Muskoka River	2	2	0	2	3	1	1	0	0	0	0	2	6.00	Vulnerable
Lake of Bays	2	2	0	3	3	0	1	0	0	1	1	1	5.50	Vulnerable
Oxtongue River	3	1	0	5	1	0	1	0	0	0	1	1	4.50	Not Stressed
Hollow River	3	0	1	6	0	0	1	0	0	1	0	1	4.25	Not Stressed
Mary Lake	2	2	0	1	5	0	0	1	0	0	1	1	6.00	Vulnerable
North Muskoka River	3	1	0	1	3	2	0	1	0	0	0	2	6.50	Vulnerable
Big East River	3	1	0	6	0	0	1	0	0	0	1	1	4.25	Not Stressed
Little East River	4	0	0	1	5	0	0	1	0	0	1	1	5.50	Vulnerable
Watershed 2EB	**3**	**1**	**0**	**0**	**6**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**6.00**	**Vulnerable**
Lower Black River	4	0	0	5	1	0	1	0	0	2	0	0	3.50	Not Stressed
Upper Black River	3	1	0	6	0	0	1	0	0	0	2	0	4.00	Not Stressed
Kahshe River	3	1	0	2	4	0	1	0	0	2	0	0	4.50	Not Stressed
Severn River	3	0	1	1	4	1	1	0	0	0	1	1	6.00	Vulnerable
Watershed 2EC	**3**	**1**	**0**	**2**	**4**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**5.00**	**Vulnerable**

Climate Change

Climate change will have a significant impact on the Muskoka Watershed over the next 100 years. This section is a synopsis of the Muskoka Watershed Council's position paper on Climate Change Adaptation in Muskoka that can be found on the MWC website at www.muskokawatershed.org.

Although mitigation is necessary to reduce future climate change impacts, even if all carbon emissions ceased today, the climate would continue to warm until the end of the current century. Mitigation is required to address the impact of climate change in Muskoka.

Between 1948 and 2006, Ontario's average temperature increased by 1.3 ^{0}C. Projections made by the Ontario Ministry of the Environment indicate average temperatures over the Great Lakes Basin, including the Muskoka Watershed, are likely to continue to increase between 2 and 4 ^{0}C by 2050. The Ministry of Environment goes on to predict that precipitation may increase by up to 20% by 2050 in all but the summer months, when little or no change is projected. Rising air and water temperatures are already shortening the ice cover season, exposing water to evaporation for more of the year.

Data collected at the Dorset Environmental Science Center indicate that the mean temperature showed a clear and moderate increase or warming from 1978 to 2013 of about 0.35 ^{0}C per 10 years, or a warming of 1 ^{0}C within 30 years. The annual precipitation had a significant decrease during the period of 1978-1998 and then a weak increase during the period of 1999-2013 (Figure 12).

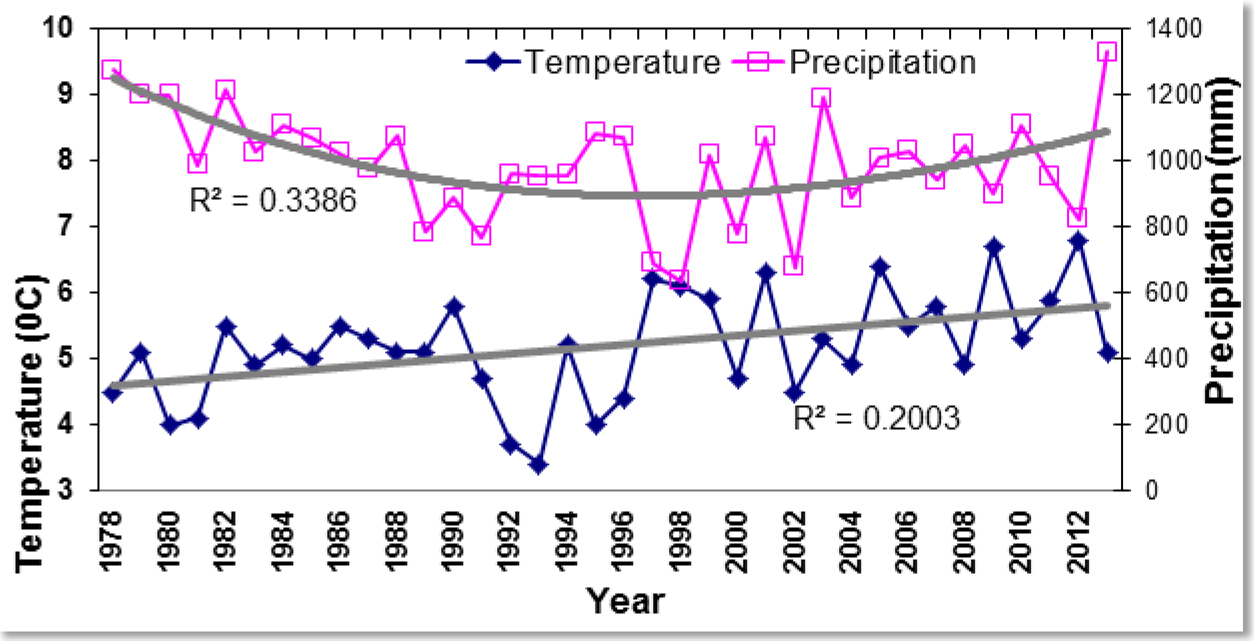

Figure 12: Muskoka Weather Data 1978-2012

Warmer water combined with stronger winds and a longer ice-free period is likely to increase the volume of water evaporating from the surface of lakes. Increased evaporation from the land surrounding the lakes, especially in summer, is likely to reduce the flow in rivers after the spring runoff. In the long-term, the most obvious combined result is likely to be a fall in the average lake levels of the four lower Great Lakes, currently projected to be between 15 and 115 cm over the next 40 years.

More moisture in a warmer atmosphere is expected to cause an increase in extreme weather events – rain, snow, drought, heat waves, wind, and ice storms. There are indications that this trend has already begun. Weather is also likely to be more variable and less predictable.

Both natural areas and socio-economic aspects of the watershed will be impacted by climate change.

Surface Water

Warmer summers will see increased evaporation of water from lake surfaces and increased transpiration of water by wetlands and forests, meaning less runoff, less water and longer periods of drought. As the watershed gets drier, wetlands will dry out and surface water temperatures will become warmer. Ice will form later in the fall and leave earlier in the spring. The longer ice-free season and warmer surface waters will cause the lakes to stratify earlier and be more stable.

Earlier onset and stronger, deeper stratification will mean less coldwater habitat for Lake Trout and an increased risk of total loss of oxygen (anoxia) in lakes leading to an internal phosphorus load and the potential for blue green algae (cyanobacteria).

Water quantity may be the most important integrator of response to climate change and should be monitored. Methods to hold back spring freshet and storm waters and release it slowly, sustaining streams during periods of drought and increasing recharge to groundwater, should be explored. Approaches to active lake management should also be explored with the Province.

Forests and Wetland

Climate change will have three potential impacts on the forests and wetlands in Muskoka:

- Disease and insects – as winters are less severe, more invasive species will survive in local forests.
- Extreme weather – the frequency and intensity of extreme weather and climatic events, such as thunderstorms and windstorms, hailstorms, ice storms, intense precipitation events, drought, heat waves, and abnormally warm winters, are likely to increase and this may be apparent by 2030 according to OMNR. More-frequent storm events will have significant financial implications.
- Drought – will likely not have as significant an impact on forest health as other climate change factors. Muskoka may be lucky due to its location in the lee of the Great Lakes.

Climate change will increasingly make both animal species and local populations of tree species less well adapted to the climate where they occur. For some species, this will reduce growth at the centre of their range and increase growth closer to the northern end of their distribution. Northward movement of the climate is predicted to be +/- 3 km/year; a tree species' ability to migrate is typically <1 km/yr. As a result, habitats will change in unknown ways and reaction to changing climate will be species specific.

Muskoka should be in a position to benefit from production of wood products near to major markets. Ironically, despite the rough time that forest products companies have had recently, future prospects may be much brighter, if climate change-appropriate economic policies are put in place.

Biodiversity

Biodiversity can be defined as the range of plant and animal life in a particular region. These systems in turn depend on a complex and interlinked set of ecological processes, and the physical systems – water, air, soil, and nutrients – on which they depend. It has taken millions of years, through cycles of fluctuating temperatures, precipitation, and atmospheric concentrations of carbon dioxide, for these systems to evolve.

A healthy ecosystem, with high biodiversity, provides important services to human society and a warmer climate will increase the rate of such processes as photosynthesis, plant growth, decomposition, and nutrient cycling. Disturbance regimes, including fire, insect pests, and invasive species, will likely increase in frequency and severity in a warming climate, and will test the ability of existing ecosystems to withstand change. Since much of Muskoka's economy derives from its natural environment, it will be important to build the resilience of those systems as an essential component of adaptation to climate change.

It can be difficult to separate the impact of climate change from other ecosystem stressors such as urban development, alien invasive species, and habitat fragmentation. Careful regional land use planning, creation of buffer zones, and protection of connected wildlife corridors are necessary to ensure that seemingly innocuous changes on the land surface do not have unintended consequences for biodiversity in a changing climate.

Community Infrastructure

Disruptions to critical community infrastructure as a result of climate change – including water treatment and distribution systems, energy generation and transmission, as well as transportation and residential damage – are likely. Periodic assessment of the risks in the light of climate projections, followed by a review of the design standards for new transmission and distribution systems, will be required as trends become clearer, including shifts in the tracking of ice storms.

Human Health

Projections of milder winters suggest that the stresses associated with living in a colder climate will diminish in the years ahead; however, there may be increased risks of illness and premature death as a result of heat waves, smog episodes and ecological changes that support the spread of mosquito and tick-borne diseases such as West Nile Virus, Lyme Disease, and even Malaria as the climate changes.

The results will not only be more serious threats to human health, but increased costs and stresses on existing healthcare services and facilities. Clearly, there will be a need for more attention to long-term planning for healthcare in Muskoka.

Tourism

Muskoka's tourism sector is projected to experience some challenges. Winter recreation, like snowmobiling, may suffer some decline. In contrast, the season for warm-weather activities like golf is expected to increase. Muskoka can anticipate a longer season for recreational water activities such as swimming and boating. However, that may have a negative impact on water quality.

While the total value of tourism and its ancillary recreational equipment suppliers is unlikely to decrease and could even increase, there will be a shift in the balance of outdoor recreation from winter to warm-weather activities.

Agriculture

Warmer summer and winter temperatures will increase the duration of the spring and fall growing season, and expand the range of crops that can be grown. However, the frequency and severity of summer dry periods and droughts will increase the risk of growing these crops. Higher levels of carbon dioxide will promote faster growth, but studies show that nutritional quality may be reduced. Increased winter precipitation will result in faster spring runoff, increasing the risk of soil erosion. Rising temperatures are also expected to increase the potential spread of pests and diseases.

Adaptation to climate change includes the small size and isolation of Muskoka farms, which can be an advantage in slowing the spread of crop and animal pest and disease epidemics. The higher organic matter soils will reduce runoff and erosion due to higher winter precipitation and extreme weather events. The high landscape diversity found on Muskoka's farmland will facilitate the migration of plant, animal and microorganism species to new habitats and provide havens for the evolution of new biodiversity.

Stewardship

Stewardship activities are what people can do to look after the natural values of their property and watershed. The objective of all stewardship programs is to encourage human behaviour to become more environmentally sustainable. Many definitions have evolved for terms "Sustainable Development" and "Sustainability", as well as for various other terms related to the topic.

The 1987 Brundtland Report titled Our Common Future is credited with providing the original definition of Sustainable Development:

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

More simply stated, stewardship is an approach to using the resources of, and enjoying the splendor and values of our watersheds in ways that permit passing on a healthy legacy to our children and grandchildren to enjoy. This is the definition that will be used for this report card to measure the progress toward achieving a more balanced lifestyle in Muskoka.

There are both diffuse and local stressors that impact watershed health. Diffuse stressors include climate change, invasive species and long range transport of pollutants. Local stressors include human inputs and infrastructure effects.

Diffuse stressors are very difficult to address as they require provincial, national and often international agreements and programs to achieve real change. That being said, considerable success has occurred in reducing the impact of such long range pollutants as acid rain, mercury, and other smog creating chemicals. Some programs are beginning to address the issue of invasive species; however, considerable more work is required in that area. Lastly, climate change is a real threat to both local and global sustainability and insufficient work is being carried out on that topic.

While dealing with local stressors is a task over which municipalities and individual residents can have more control, the consequences of decisions that will reduce local causes of

environmental stress are often not acceptable to individuals who may feel that their freedom, or quality of life, is directly impacted. For example, a new access road to a set of otherwise water access properties would increase the property value of the cottages and enable property owners to use the property for a longer period of time. The new road will also fragment habitat, reduce forest interior areas, and possibly lead to increases in soil erosion into a lake. A balance between individual desires, ecological function and social values is required to achieve a balance in these cases.

Many programs exist to encourage people to become informed and participate in stewardship activities. The highlights of many of these programs are provided in Table 36. Stewardship will not be graded but rather a framework for stewardship programs is provided to help guide future improvement in our capacity to become good stewards.

Table 36: Stewardship Programs by Major Stressors

	Stressor	How it is Manifest	Impact	Indicator	
				Awareness	Action
Diffuse Stressors	Climate Change (GHG increase)	Increased Temperature	• Longer ice free period • Change in algal communities and growth • Changes to habitat boundaries • Changes to species migration and food sources	• Number of participants in ice watch programs • Number of participants in a variety of plant and animal watch programs • Number of participants in weather watch programs	• Change in vehicle size • Shift in energy source • Quality of construction • Amount of green infrastructure • Area of land in land trusts or other protected areas program
		More Violent Storms	• More property damage • Increased flooding		
		Change in Precipitation	• Drought • Less TP transport • Water level changes • Effects on water quality		
	Invasive Species	Increased Number of Invasive Species	• Reduced ecosystem integrity • Shift in species composition • Trophic cascades • Effects on water quality	• Number of participants in loon, turtle, frog, bird, invasive species watch programs • Number of bait suppliers with 'invasive species' warnings • Number of public launches with 'invasive species warnings'	
	Long Range Transport	Atmospheric Deposition of Toxic Chemicals	• Effects on water quality • Effects on terrestrial and aquatic biota	• Number of programs that address long range transport of toxic chemicals	• Recovery of acid stressed lakes • Introduction of more stringent regulations

	Stressor	How it is Manifest	Impact	Indicator	
				Awareness	Action
Local Stressors	Human Inputs	• Sewage Plants & Septic Systems • Fertilizers • Vegetation Removal • Stormwater • Golf Courses	• TP load to lakes increases • Change in sediment load • Loss of wetlands • Oil spills in near shore areas	• Number of programs that provide information about the human impacts on natural areas • Septic reinspection programs	Businesses that are certified (golf course, marinas, forestry)
	Infrastructure Effects	New Development	• Loss of habitat • Increase in stormwater flow to waterbodies	• Number of municipalities that require habitat protection • Number of municipalities with 'site alteration' by-laws protecting shorelines	• New parkland or Greenland strategies • Shorelines renaturalized • Amount of green infrastructure built
		Roads	• Fragmentation • Increased levels of sodium in lakes from road salt	• Number of municipalities with a natural areas strategy • Number of municipalities with 'updated' salt management plans	Amount of reduction in the use of road salt
		Poorly functioning septic systems	Poor water quality	• Number of municipalities with septic reinspection programs • Lake associations that provide information on septic system maintenance	Reduce number of faulty septic systems

When all is said and done, the fate of sustainable management of a watershed lies in the hands of grass-roots residents as they go about their day-to-day business. It is the citizens of the watershed who must generate the interest and enthusiasm to create, continue and expand local projects which lead to positive actions and results.

1. **Stop the Spread of Invasive Species**
    a. Purchase non-invasive or native plants
    b. Never dispose of domestic plants or animals into the wild
    c. Inspect and wash your boat, ATV and other equipment and let dry for at least 6 hours before moving to a new lake or area
    d. Do not move species from one area to another

2. **Retain Buffers and Shorelines in a Natural State**
    a. Maintain a wide buffer of native plants and trees
    b. Minimize boat speed (eliminate wake) in all near-shore areas and particularly in areas with known loon nests
    c. Avoid grassed lawns in the waterfront area and minimize use of fertilizers

3. **Protect Wetlands**
    a. Leave wetlands alone
    b. Keep motorized vehicles out of wetlands

4. **Maintain Natural Area**
    a. Limit cleared areas in the rural and waterfront area
    b. Do not create new roads

5. **Reduce Your Personal Impact**
    a. Reduce your use of electricity and fossil fuels
    b. Maintain your septic system
    c. Improve the energy efficiency of your home and vehicle
    d. Reduce waste

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