2019

Backgrounder Three: Natural Systems

MISSISSIPPI RIVER WATERSHED PLAN

Backgrounder Series

Mississippi Valley Conservation Authority

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Table of Contents

List of Figures

List of Tables

Note about mapping:

All maps in this report that bear the Mississippi Valley Conservation Authority logo were produced in part with data provided by the Ontario Geographic Data Exchange under License with the Ontario Ministry of Natural Resources and Forestry and the Queen’s Printer for Ontario, 2019.

The Mississippi River Watershed Plan

This report is the third in a series of four "Backgrounder Reports" that were prepared to support the development of the Mississippi River Watershed Plan. The reports examine various characteristics of the Mississippi River Watershed, looking at past and current conditions and, where possible, anticipating future changes on the landscape. They provide the basis for consultation and discussion with key stakeholders, and the broader watershed community, who are all partners in developing the Mississippi River Watershed Plan.

Mississippi River Watershed Plan Backgrounders:

One: The Physical Environment
Two: People & Property
Three: Natural Systems (Biotic)
Four: Asset Management

Backgrounder One: The Physical Environment provides a broad picture of the physical landscape of the Mississippi River Watershed. It describes the physiography, geology, hydrogeology and climate. It also describes the rivers and lakes and how water levels are managed.

Backgrounder Two: People & Property, examines man's presence on the landscape. It describes the historic settlement of the watershed and how that has shaped the current cultural landscape. It looks at settlement patterns and land uses, and their connection with the river and other features of the physical environment. It also examines municipal servicing of our urban areas and looks at how the rural areas without municipal water and wastewater services are managed. Key local economies that are reliant on the water resources and natural features of the watershed are also described.

This third backgrounder, Natural Systems, presents information about the natural environment. It looks at natural heritage features such as wetlands, areas of natural and scientific interest (ANSIs), woodlands and natural heritage systems. It also looks at species at risk, the health of our aquatic environment, fisheries and some stressors in the natural environment like invasive species.

These documents are intended to promote discussion about the future pressures that we must consider in determining how to move forward in managing the watershed in a sustainable way.

Watersheds and Subwatersheds

The Mississippi River Watershed Plan project focusses on the full watershed of the Mississippi River. The information presented in this document is also often presented in terms of seven subwatersheds that make up the Mississippi River system (Figure 1[1]). They include the catchment areas for the two largest tributaries, the Clyde River and the Fall River, with the remaining area divided into five "Mississippi River" subwatershed areas: the Upper Mississippi; the Central Mississippi; the Mississippi Lake area; the Lower Mississippi – Shield; and the Lower Mississippi – Lowlands.

Assessing environmental information on a subwatershed basis, helps to measure how conditions are changing in different locations throughout the watershed. Comparisons between the subwatershed areas may also help in determining where certain parts of the watershed are responding to the impacts of more localized stressors such as changes in land use, localized climate impacts, invasive species outbreaks, etc.

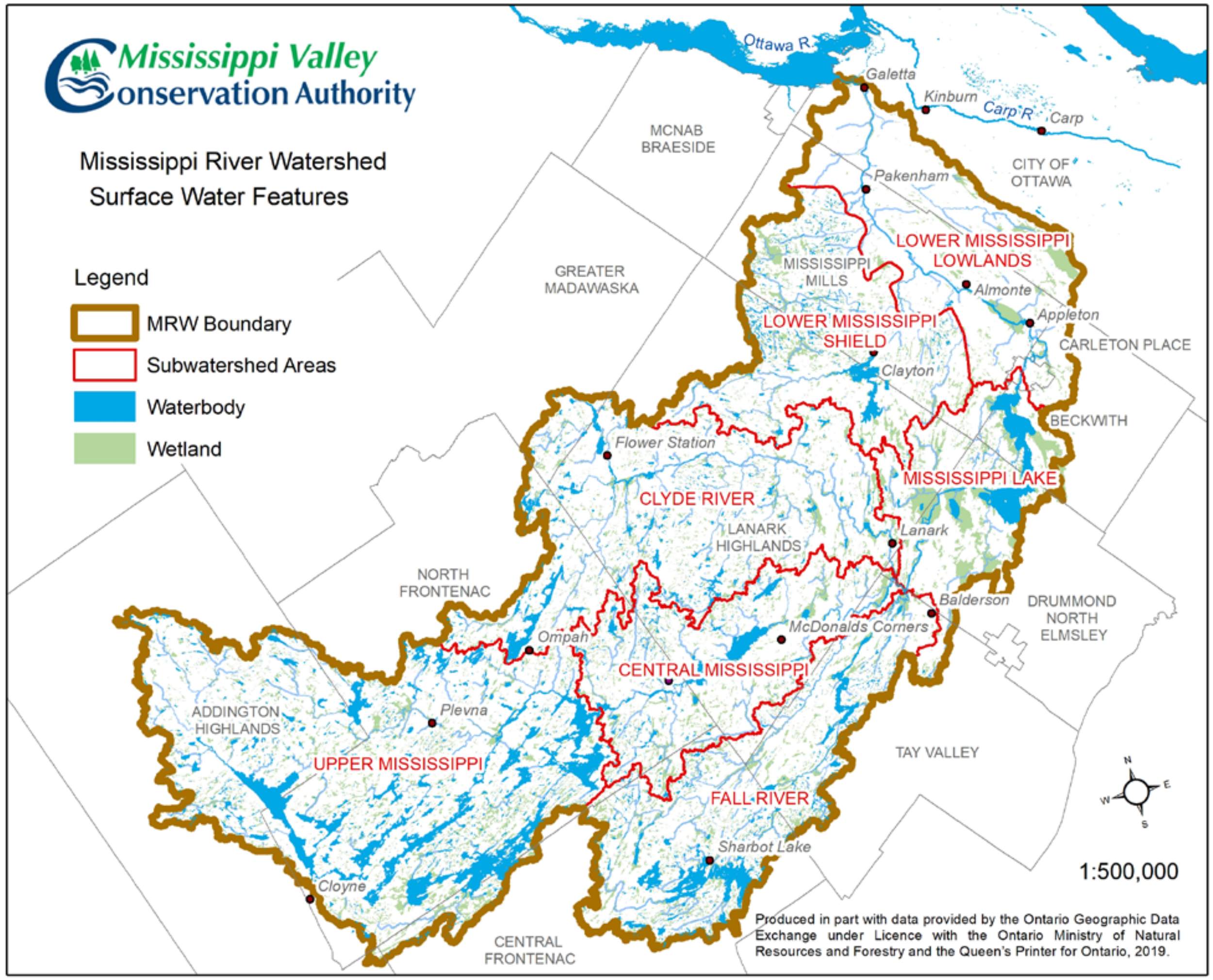


Figure 1: Mississippi River Watershed and Subwatersheds

[1] Source for all mapping features: the Ontario Geographic Data Exchange with the Ontario Ministry of Natural Resources and Forestry and the Queens Printer for Ontario, 2019. The Subwatershed layer generated by MVCA.

Thresholds and Targets

It is a goal of the Mississippi River Watershed Plan to recommend actions and watershed resource management objectives that, wherever possible, include measurable targets. Natural systems and features are an area where many such targets have been researched and quantified. Table 1 summarizes the some of the key thresholds and targets that are used by Conservation Authorities and other environmental agencies throughout the province to assess the state of various environmental features against measurable and comparable objectives.

Table 1: Industry Suggested Targets and Thresholds

	Target/Threshold	Source
Wetland Targets		
Target 1:	Wetland cover: **<u>The greater of</u>** 10% of each major watershed and 6% of each subwatershed, **<u>or</u>** 40% of the historic wetland coverage, should be protected or restored.	Environment Canada (EC). 2013. How Much Habitat is Enough? (3rd Ed. 2013)
Target 2:	Wetland cover grading : Grade A >11.5 %, Grade B: 8.6 to 11.5%, Grade C: 5.6 to 8.5%, Grade D: 2.5 to 5.5%, Grade F: <2.5%	Conservation Ontario. 2011. Guide to Developing Conservation Authority Watershed Report Cards
Target 3:	a) Net loss of wetland area and function be halted by 2025.	Ontario Ministry of Natural Resources and Forestry. 2017. A Wetland Conservation Strategy for Ontario 2017–2030. Queen's Printer for Ontario. Toronto, ON.
	b) By 2030 a net gain in wetland area will be achieved.	
	c) By 2020, establish a broad-scale monitoring framework for the assessment of trends in the quality and function of wetlands.	
	d) The province is committed to developing a wetland offsetting policy, where negative impacts on wetlands are offset by restoration.	
Forest Targets		
Target 3:	a) **Forest cover:** 30% forest cover at the watershed scale (high risk approach); 40% forest cover (medium risk approach); and 50% equates (low risk approach)	Environment Canada (EC). 2013.
	b) **Forest Cover:** Grade A >35 %, B: 25.1 to 35%, C: 15.1 to 25%, D: 5 to15%, F: <5%	Conservation Ontario. 2011.
Target 4:	a) **Forest interior:** a minimum of 10% interior forest should exist within a given watershed.	Environment Canada (EC). 2013.
	b) **Forest Interior:** Grade A >11.5 %, B: 8.6 to 11.5%, C: 5.6 to 8.5%, D: 2.5 to 5.5%, F: <2.5%	Conservation Ontario. 2011.
Target 5:	a) **Riparian forest:** a minimum of 75% of stream length be naturally vegetated with a minimum 30 m wide naturally vegetated adjacent-lands area on both sides of the stream	Environment Canada (EC). 2013. How Much Habitat is Enough? (3rd Ed. 2013)

Table 1: Industry Suggested Targets and Thresholds

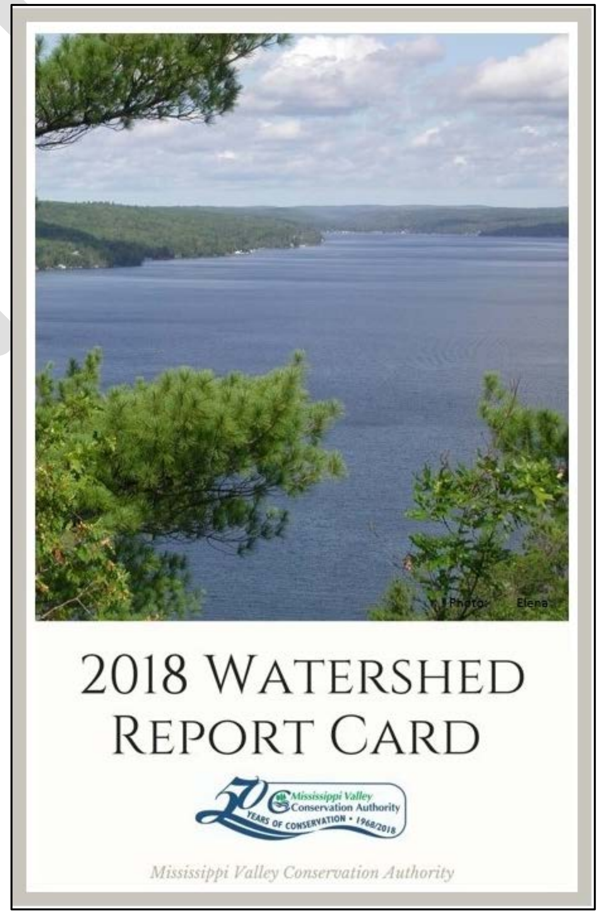
	Target/Threshold	Source
	b) **Riparian forest** Grade A >57.5 %, B: 42.6 to 57.5%, C: 27.6 to 42.5%, D: 12.6 to 27.5%, F: <12.5%	Conservation Ontario. 2011.
Water Quality Targets/Thresholds		
PWQO: Water quality objectives to protect aquatic life. Recreational water quality objectives: for protection of recreational water uses are based on public health and aesthetic considerations.		Ontario Ministry of Environment and Energy (now MECP). 1994. Provincial Water Quality Objectives
CCME Guidelines: Water quality guidelines for drinking water supplies, recreational use and aesthetics, freshwater and marine life, and agricultural uses (i.e., irrigation and livestock water)		Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life.

Watershed Conditions Reporting

The information presented throughout this report comes from a variety of sources including: mapping products, data collected through monitoring programs and initiatives, and various lists and inventories. The MVCA collects a vast amount of its own data, largely water quality data, and also makes use of data collected by other agencies and groups, such as natural heritage and species data and mapping. The information is used to assess current conditions and changing trends in various natural features across the watershed. The findings of those assessments are presented in the standardized formats described below.

Watershed Report Card

The Watershed Report Card is based on Conservation Authority (CA) Watershed Report Card Guidelines that were developed in 2012 to assist the 36 CAs across the province, in developing a set of standardized watershed report cards. The Report Cards are produced on a five-year cycle (2007, 2012 and 2017) to provide a snapshot of the health of the entire watershed based on four key environmental indicators: surface water quality, groundwater quality, forest conditions and wetlands. The reporting is presented on a subwatershed scale using a standardized grading system developed by Conservation Ontario. Each subwatershed receives a grade for each of the four indicators, plus an overall grade based on the total scoring of the four indicators. It provides a practical way to report on data and information that covers a large and varied watershed area, to indicate the current state of the watershed and to track changes over time. It also allows for comparison between all Conservation Authorities across the Province.



Lake Reporting - State of the Lake Reports

Integrated Monitoring Reports are produced annually to present an overview of the monitoring that MVCA undertook throughout the year. The reports are presented on a subwatershed basis following a five year rotation. They focus on presenting data collected through the Lake Monitoring Program, but also include water level and flow, snow pack, and stream monitoring data. They are intended to provide both lake specific assessments and a more holistic review of conditions at the subwatershed scale.

Natural Heritage Features

Preface – Ecoregions and Area Specific Policies

Provincial protection of Natural Heritage features falls under Section 2.1 of the Provincial Policy Statement (PPS, 2014). Under the PPS, the Province uses both the boundaries of the Precambrian Shield, and the boundaries of Ecoregions, to differentiate the level of protection for various natural heritage features. See Table 2.

An **Ecoregion** is a unique area of land and water nested within an ecozone that is defined by a characteristic range and pattern in climatic variables, including temperature, precipitation, and humidity. The climate within an ecoregion has a profound influence on the vegetation types, substrate formation, and other ecosystem processes, and associated biota that live there.

Figure 2[2] shows the Ecoregions in the Mississippi River Watershed, which falls on the boundary between Ecoregions 5E and 6E. Ecoregion 5E generally represents the Precambrian Shield area in the southwest part of the watershed and Ecoregion 6E generally represents the St. Lawrence Lowlands area in the northeast. Backgrounders One and Two highlighted the differences in landscape and land use between these two physiographic regions. The shield area makes up 83% of the watershed and the remaining 17%, mostly on the east side of the Mississippi River, is lowlands.

Table 2: Natural Heritage Feature Policies - Location Criteria

Feature	Location Criteria	PPS Policy
Natural Heritage System	Ecoregions 6E and 7E	Must be identified (2.1.3)
Significant Wetland	Ecoregions 5E, 6E & 7E	Development and site alteration not permitted (2.1.4)
Significant Woodland	Ecoregions 6E and 7E	Development and site alteration not permitted unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions. (2.1.5)
Significant Valleyland	Ecoregions 6E and 7E	
Significant Wildlife Habitat	everywhere	
Significant ANSI	everywhere	
Fish Habitat	everywhere	Development no permitted except in accordance with provincial and federal requirements. (2.1.6 and 2.1.7)
Habitat of Endangered & Threatened Species	everywhere	
Note: Ecoregion 7E is located in southwestern Ontario.		

[2] Source for all mapping features: the Ontario Geographic Data Exchange with the Ontario Ministry of Natural Resources and Forestry and the Queens Printer for Ontario, 2019.

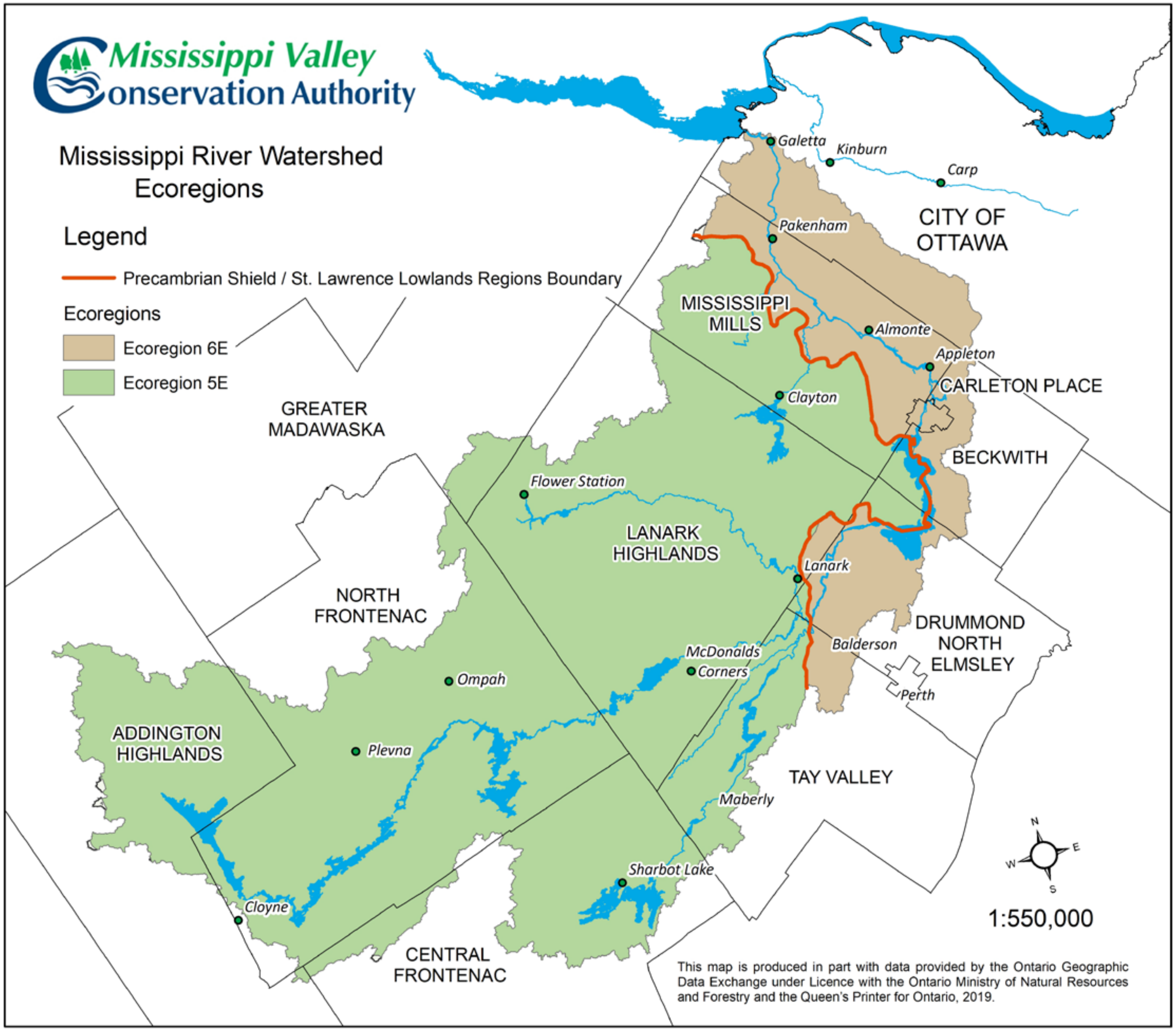


Figure 2: Ecoregions in the Mississippi River Watershed

Wetlands

Wetlands are an essential part of a healthy ecosystem. They play a critical role in regulating the movement of water within our watersheds and in doing so they provide numerous benefits to the surrounding area and ecosystem. Wetlands:

- Improve water quality by providing natural filtration systems;
- Process nitrogen, produce oxygen and have a high capacity to sequester and store carbon;
- Help regulate water levels, storing water in wet periods and releasing it in dry periods, easing flood and drought impacts;
- Regulate the movement of water between the surface and underlying aquifers by recharging and discharging groundwater;
- Enhance biodiversity and provide habitat for numerous species including more than 1/3 of Canada's species at risk;
- Provide important wildlife passageways between their different habitats.

Wetlands are regulated under the *Conservation Authorities Act (S.28)* where they meet all four of the following conditions:

a) is seasonally or permanently covered by shallow water or has a water table close to or at its surface;
b) directly contributes to the hydrological function of a watershed through connection with a surface watercourse;
c) has hydric soils, the formation of which has been caused by the presence of abundant water; and
d) has vegetation dominated by hydrophytic plants or water tolerant plants, the dominance of which has been favoured by the presence of abundant water, but does not include periodically soaked or wet land that is used for agricultural purposes and no longer exhibits a wetland characteristic referred to in clause (c) or (d). 1998, c. 18, Sched. I, s. 12.

KEY CONSIDERATIONS

Wetlands provide significant environmental benefits including reducing flooding and easing drought impacts.

Studies suggest that the east part of the watershed has experienced a 65% loss in pre-settlement wetland cover.

Present wetland cover meets the accepted minimum targets at the subwatershed level, but the eastern area would fall short if measured relative to historic loss.

A vulnerability assessment predicts that most wetlands in the watershed will be at risk of shrinking or drying as a result of climate change.

Wetlands are vulnerable to pre-development activities such as vegetation clearing and site grading.

Wetlands not evaluated as Provincially Significant Wetland (PSW) are not protected under the PPS 2014 but are regulated through the MVCA regulation.

There are no enhanced protection measures for sensitive wetlands which include fens and bogs.

Status of Wetlands in the Mississippi River Watershed

Figure 3 shows wetland cover throughout the Mississippi River Watershed. Wetlands cover 489 km^2 or 13% of the total watershed area. Large wetlands are located around Mississippi Lake, and in parts of the lower watershed near Appleton and Manion Corners. There are also large areas made up of numerous smaller pockets of wetland (known as wetland complexes) in the Pakenham Hills area. Provincially Significant Wetlands (PSWS), described on Page 12, make up 28% of the total wetland area, the remaining 72% are not evaluated and/or not classified as Provincially Significant.

Table 3 presents wetland cover by subwatershed area. The wetland coverage within each subwatershed meets with the Wetland Target 1 (pg. 3) minimum recommendation of 6% at the subwatershed level, but may fall short of the second component related to wetland loss. The estimated losses over time, described below, suggest that many parts of the watershed have considerably less than 40% of the historic wetland cover recommended by EC.[3] Under Target 2, Conservation Ontario Report Card assessment, the subwatershed areas would achieve A and B grades for wetland cover.

Wetlands and Flood Attenuation

Studies show that wetlands left in their natural state can reduce the cost of flood damage by 29% in rural areas and 38% in urban areas. The University of Waterloo Intact Centre on Climate Adaptation (ICCA) assessed the potential for wetlands to affect the financial impacts associated with flooding in both rural and urban scenarios. Using models to simulate a major fall flood, it compared flood damages under conditions where wetlands were maintained in their natural state and where they were replaced with agricultural land use. . (Moudrak, et.al. 2017)

Table 3: Wetland Cover by Subwatershed

Sub Watershed	Subwatershed Area sq.km.	Wetland Area* sq.km.	Percent of Watershed %
Upper Mississippi	1028	105	10.2%
Central Mississippi	395	54	13.7%
Clyde River	664	72	10.9%
Fall River	486	73	15.1%
Mississippi Lake	294	71	24.0%
Lower Mississippi - Shield	425	73	17.1%
Lower Mississippi - Lowlands	432	41	9.5%
Total	3724	489	13.1%

*Derived from PSW 2016, Non-Evaluated Wetland, and Evaluated as Other GIS shape files.

[3] Little is known about the differences in how wetlands function under different physiographical conditions. It may also be appropriate to consider different targets for wetland area on the Precambrian Shield and wetland area off the Precambrian Shield.

Wetland Loss

Despite their numerous benefits, much wetland area has been drained and filled to accommodate various land uses such as agriculture, development and peat extraction. It's estimated that 65% of the original wetlands in the eastern half of the watershed have been lost (Ducks Unlimited, 2010). Invasive species, alterations to natural water levels, and the impacts of climate change also pose serious threats. Recent attention has focused on the protection of wetlands as a critical asset in building resiliency for a changing climate. See Appendix A: Note 1 and Table 1 for more information about the Ducks Unlimited wetland loss study.

A 2014 climate change vulnerability assessment of aquatic ecosystems in the Mississippi and Rideau Conservation Authority watersheds[4] rated the wetland vulnerability[5] in terms of expected responses to predicted changes in climate (Chu, 2014). The study projects that by the 2080's most wetlands in the Mississippi watershed may have a mid or high vulnerability to shrinking or drying due to increases in air temperature and decreases in precipitation.

These findings reinforce the importance in striving to achieve the Wetland Target 3 goals of halting loss of wetland, working toward a net gain and establishing a monitoring framework to assess trend in the quality and function of the wetlands.

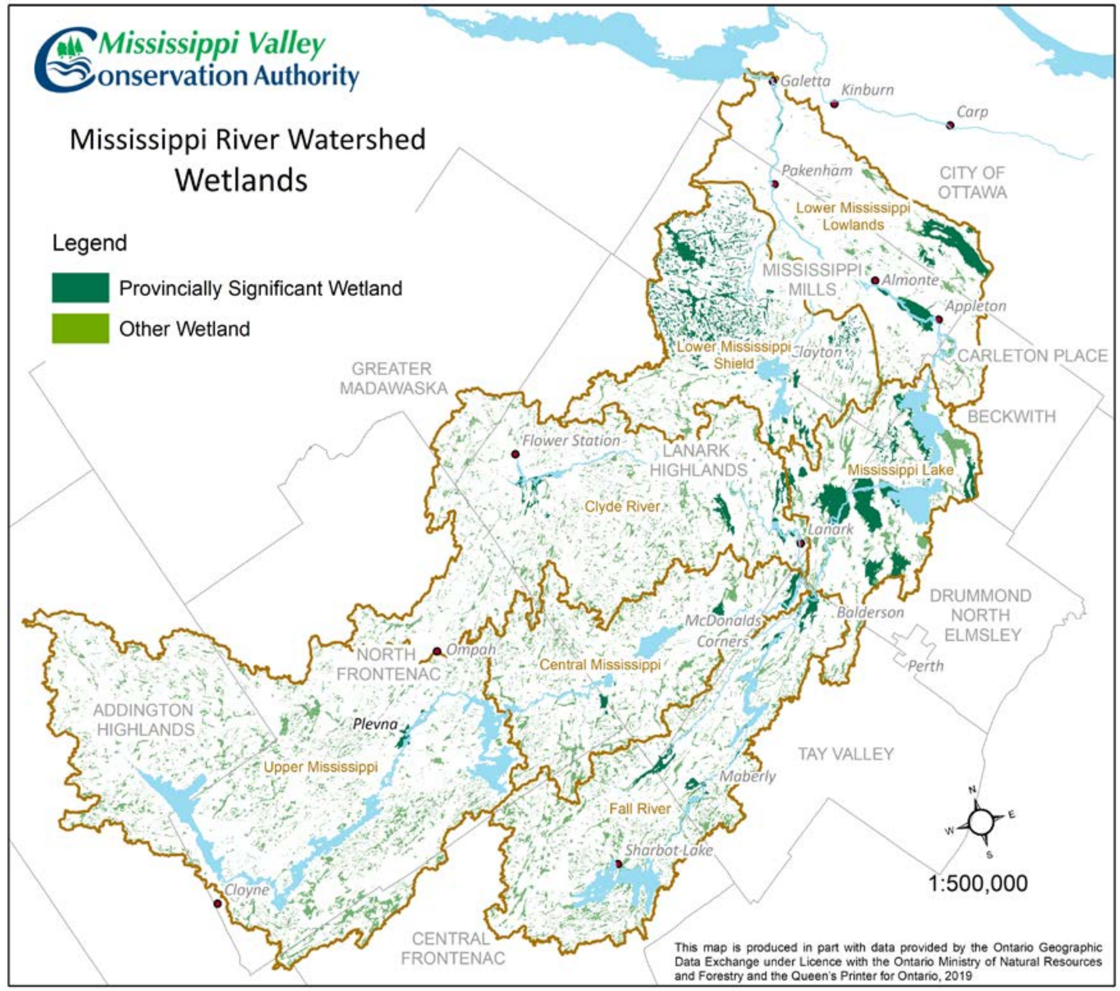


Figure 3: Wetlands across the Mississippi River Watershed[6]

[4] The study only looked at evaluated wetlands which skews the assessment to the east part of the Mississippi River Watershed.
[5] Wetland vulnerability was based on decreased quality, or loss due to drying, that may result from projected changes in air temperatures, precipitation and groundwater inflow.
[6] Mapping source: the Ontario Geographic Data Exchange with the OMNRF and the Queens Printer for Ontario, 2019, and mapping produced by MVCA.

Wetland Protection

The key agencies involved in the protection and regulation of wetlands within the watershed include:

- Ministry of Natural Resources and Forestry (MNRF) - responsible for overseeing the evaluation and mapping of wetlands, and the inclusion of wetland policy in municipal official plans (*Planning Act and PPS, 2014*);
- Municipalities - responsible for protecting PSWs through their planning documents and planning decisions (*Planning Act and PPS, 2014*); and
- MVCA – responsible for regulating development in and adjacent to wetlands (*Conservation Authorities Act and MVCA Regulation O.Reg 153/06*).

Provincial Policy Statement (2014)

The Provincial Policy Statement (S. 2.1.4 and 2.1.5) protects Provincially Significant Wetlands (PSWs) located in Ecoregions 5E, 6E and 7E, which encompasses all of the Mississippi River Watershed. Municipalities are required to identify PSWs and include policies in their Official Plans to prohibit development and site alteration in a PSW. It also prohibits development and site alteration on lands adjacent to (within 120 metres of) a PSW unless "it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions".[7]

The Official Plan and Zoning By-law designations and provisions are not always entirely effective in protecting wetlands from "pre-development" activities such as grading, filling, excavation and vegetation removal which can take place without requirements for approval under the *Planning Act, 1990*. It also does not address protection of wetlands that are not classified as Provincially Significant. It has been demonstrated in other parts of the MVCA jurisdiction (ex. in parts of Ottawa near Stittsville) that the broader protection of wetlands must fall to other policy instruments such as a municipal Site Alteration By-law or the Conservation Authority Regulation.

Conservation Authority Regulation

In 2004 the Province of Ontario passed legislation (O. Reg 97/04) requiring Conservation Authorities (CAs) to amend their regulations to include wetlands, areas within 120 metres of provincially significant wetlands (PSWs), and areas within 30 metres of other wetlands. A distinction is made between the development activities that can be regulated[8] within the wetland itself, and the development activities that can be regulated with the 120 metre and 30 metre adjacent lands. Within the wetland, the regulation applies to any development activity that falls the definition outlined in the supporting policies. Within the 120 metre and 30 metre adjacent areas, the regulation applies to any development activity under the definition **that** may result in impacts to the hydrologic function of the wetland. Starting in 2006 MVCA began to regulate only those wetlands that were designated as PSWs. In 2017, to fulfil its responsibilities under the *Conservation Authorities Act* and regulations, MVCA expanded the implementation of its regulation to cover all wetlands that are greater than 0.5 hectares and that are hydrologically connected to another surface water feature.

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[7] Wetlands can also be identified within Natural Heritage Systems, where certain protective policies would apply. Protection of other, non PSW wetlands, is not addressed through the PPS and is at the discretion of the municipality.

[8] The regulation of wetlands and other features under the *Conservation Authorities Act* applies to areas identified within a mapped "Regulation Limit" or as described in the text of the regulation. Development activities in mapped and/or text described regulated areas may be prohibited or restricted. Where permitted, it requires written permission from the Conservation Authority.

Provincially Significant Wetlands

Provincially Significant Wetlands (PSWs) are wetland areas identified by the MNRF as being the most valuable based on a science-based ranking system known as the Ontario Wetland Evaluation System (OWES). The OWES evaluates and classifies wetlands according to a suite of biological, social, hydrological and special features components. A wetland that has been assessed and scored using the OWES is known as an "evaluated wetland" and is classified as either Provincially, Regionally or Locally Significant. Wetland complexes occur where two or more wetlands separated by a non-wetland area are functionally linked. Functional linkages include wildlife usage (e.g., migration corridors, forage areas), and surface water and groundwater connections. Most wetlands in Ontario are complexes.

The PSWs are shown Figure 3 and listed in Appendix A: Table 2. Thirty (30) wetlands have been evaluated as provincially significant, comprising a total of 135 km^2 and making up 28% of the total wetland area. Most are located in the eastern, lowlands, part of the watershed, primarily around Mississippi Lake and downstream along the river. The upper watershed has only one evaluated PSW (Mud Lake)[9].

The Conservation Land Tax Incentive Program (CLTIP) provides 100% tax exemption for lands that are classified by MNRF as Provincially Significant Wetland and greater than 0.20 Ha in size. The property owner must commit to protection of the wetland and allowing MNRF to inspect the property if requested. The Managed Forest Tax Inventive Program (MFTIP) also protects wetlands and offers a 75% rebate for eligible lands.

Sensitive Wetlands

In Ontario, the four types of wetland include swamp, marsh, fen and bog (see definitions in Appendix A: Note 2). Bogs and fens are rare and are particularly sensitive to subtle shifts in surface water chemistry. There are currently no policy requirements specific to enhanced protection measures for bogs or fens.

While there are no specific policies for wetland type, greater protection and more intensive monitoring programs may be necessary for proposals where the development may impact these wetland types.

A number of larger bogs and fens within the MRW have been identified as Areas of Natural and Scientific Interest (ANSIs). In the PPS (2.1.5) significant ANSIs fall under the “conditional protection” level whereby development and site alteration is not be permitted unless it has been demonstrated that there will be no negative impacts. Appendix A: Table 2 shows the composition of each of the Provincially Significant Wetlands.

The Purdon Conservation Area is a sensitive bog environment with unique characteristics that support Canada's largest native colony of showy lady slipper orchids.

[9] This may reflect resource limitations at the OMNRF District Office level where evaluation of wetlands hasn’t been a priority and/or less priority placed on protecting wetlands in Ecoregion 6E.

Area of Natural and Scientific Interest (ANSIs)

Areas of Natural and Scientific Interest (ANSIs) are sites containing natural landscapes or features which the Ministry of Natural Resources and Forestry (MNRF) has identified as having values important for natural heritage protection, scientific study, or education. They are identified as a life science and/or earth science and are further categorized as Provincially[1], Regionally or Locally Significant.

"Candidate ANSIs", are areas that MNRF has identified and recommended for protection. A Candidate ANSI cannot be officially classified and treated as provincially significant until confirmed. Municipalities may choose to protect Candidate ANSIs. See Appendix A: Note 3 for ANSI definitions.

Figure 4 shows Areas of Natural and Scientific Interest (ANSIs) located throughout the Mississippi River Watershed. Table 4 also provides a listing of the 22 identified ANSIs, which include 4 Earth Science (all Provincially Significant) and 18 Life Science ANSIs (9 provincially significant, 9 regionally sig.) There are also 7 candidate ANSIs. Almost half of the ANSIs are located in the lower watershed. They include fossil features, alvar features, swamps, fens and several unique forests.

KEY CONSIDERATIONS

The watershed has 22 identified ANSIs, 13 of which are classified as provincially significant, 9 as regionally significant.

Only provincially significant ANSIs are fully protected under PPS policy.

There are 7 candidate ANSIs in the watershed that may not be protected under future Official Plan policy.

There is inconsistent protection of Regionally Significant, Locally Significant and Candidate ANSIs across the watershed.

The Appleton Swamp ANSI has been a focus of concern with respect to concern over water level operations.

ANSI Protection

Under the Provincial Policy Statement (PPS 2.1.5), only Provincially Significant ANSI's are officially protected. Municipalities are required to include policies in their Official Plans to prohibit development and site alteration in a Provincially Significant ANSI[10]. Regionally and Locally Significant ANSIs are not subject to the same protection under provincial policy and are not shown in all County Official Plans. Some wetland ANSI's are also classified as Provincially Significant Wetland (PSW) which provides a higher level of protection under the PPS.

MVCA Role with ANSIs

MVCA does not have an official role in identifying and protecting ANSI's, however where the ANSIs is also wetland, MVCA can have an indirect role through the implementation of the wetland component of its own regulation (O Reg. 153/06). The Appleton Swamp ANSI has been a focus of concern with tree die off and concern/speculation that is the result of changes in water levels operations.

[10] Development is prohibited unless it has been demonstrated that there will be no negative impacts on the natural features or their ecological functions (PPS, 2014).

Table 4: ANSIs in the Mississippi River Watershed

ANSI Name	Significance	Area within MVCA (Ha)
Life Science ANSIs		
Appleton Swamp*	Provincial	682
Ardoch Bog	Regional	39
Black Lake Fen	Regional	22
Burnt Lands Alvar	Provincial	2239
Cody Creek Black Maple Forest	Provincial	23
Galetta Black Maple Forest	Regional	55
Harlowe Bog	Regional	234
Hungry Lake Barrens	Provincial	625
Innisville Wetlands*	Provincial	2538
Maberly Bog	Regional	841
Manion Corners Long Swamp Fen*	Provincial	1185
Marathon Forest	Provincial	331
Mississippi Snye Wetland	Provincial	141
Palmerston Lake	Provincial	1604
Panmure Alvar	Regional	725
Perth Blueberry Bog*	Regional	398
Plevna Cedar Swamp	Regional	57
Summit Lake	Provincial	274
Summit Lake	Provincial	29
Earth Science ANSIs		
Highway 17 Fossils	Provincial	4
Marble Lake Stromatolites	Provincial	4
Pakenham Bridge Outcrops	Provincial	1
Snow Road Station Esker	Provincial	239
Candidate ANSI		

*ANSI also evaluated as Provincially Significant Wetland

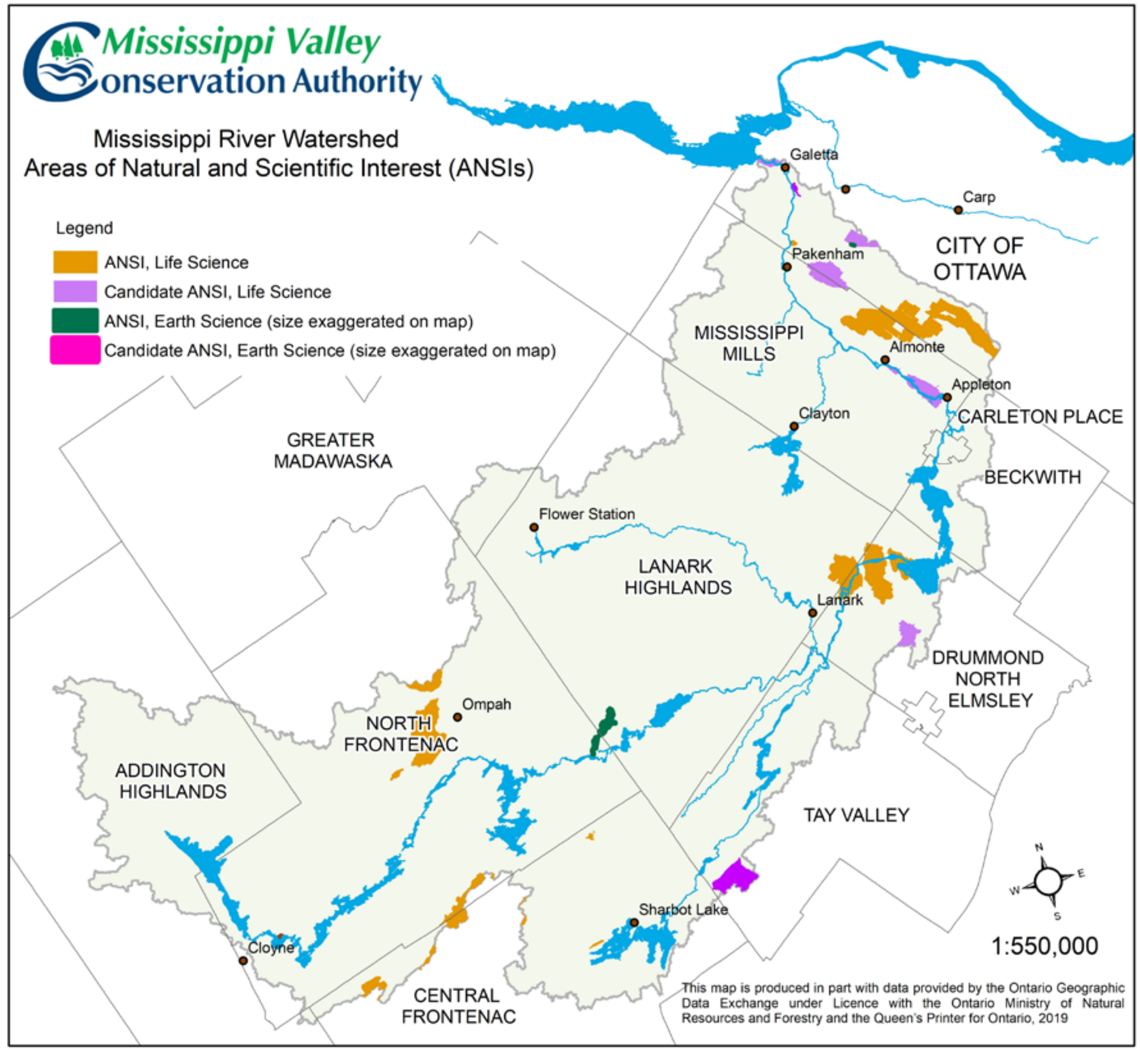

Figure 4: Areas of Natural and Scientific Interest (ANSIs)

Woodland Cover and Significant Woodlands

Woodlands[11] are the predominant land cover throughout the Mississippi River Watershed. Figure 5 shows the distribution of wooded lands which cover 62% of the total watershed area. The Precambrian Shield area in the west has over 72% wooded land cover. In the east, where forests were cleared to make way for farming and development, woodland cover is 31%. Here, many of the larger forested areas are separate isolated patches that are not connected to other forests, a condition referred to as fragmentation. A reduction in connectivity results in barriers to migration for some animals and reduces or limits a species ability to survive changes in its habitat.

Woodlands are treed areas that provide environmental and economic benefits to both the private landowner and the general public, such as erosion prevention, hydrological and nutrient cycling, provision of clean air and the long-term storage of carbon, provision of wildlife habitat, outdoor recreational opportunities, and the sustainable harvest of a wide range of woodland products. Woodlands include treed areas, woodlots or forested areas and vary in their level of significance at the local, regional and provincial levels (PPS, 2014).

Through the Watershed Report Card Program, MVCA assesses forest conditions as a measure of watershed health. The assessment uses three indicators: percent forest cover, percent forest interior, and percent forested riparian zone. Table 5 provides a summary of forest conditions by subwatershed area based on the three indicators and comparing the Precambrian Shield and Lowland areas.

KEY CONSIDERATIONS

The upper (Precambrian Shield) part of the watershed exceeds recommended minimum targets for forest cover and interior habitat (there is no provincial policy guidance for woodland protection in the shield areas).

The Mississippi Lake subwatershed has 40% forest cover which at a watershed scale would be regarded as a medium risk level.

The Lower Mississippi Lowlands area has 29% forest cover which would be regarded as high risk. Part of this area may be lacking sufficient corridors and linkages between wooded areas.

Interior habitat (23%) is good at the watershed scale but the lower subwatersheds are below the 10% watershed target.

There is insufficient mapping information to properly assess vegetated riparian area.

Municipalities are required to identify and protect ‘significant woodlands’ in the areas off the shield (EcoRegion 6E2), requiring specialized interpretation of MNRF mapping products.

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[11] The words “woodland” and “forest cover:” are used interchangeably in this document. The data and mapping presented, was derived by MVCA based on the Ontario Geographic Data Exchange with the OMNRF forest cover information. Woodland describes areas with more than 60% tree cover and greater than 2m in height.

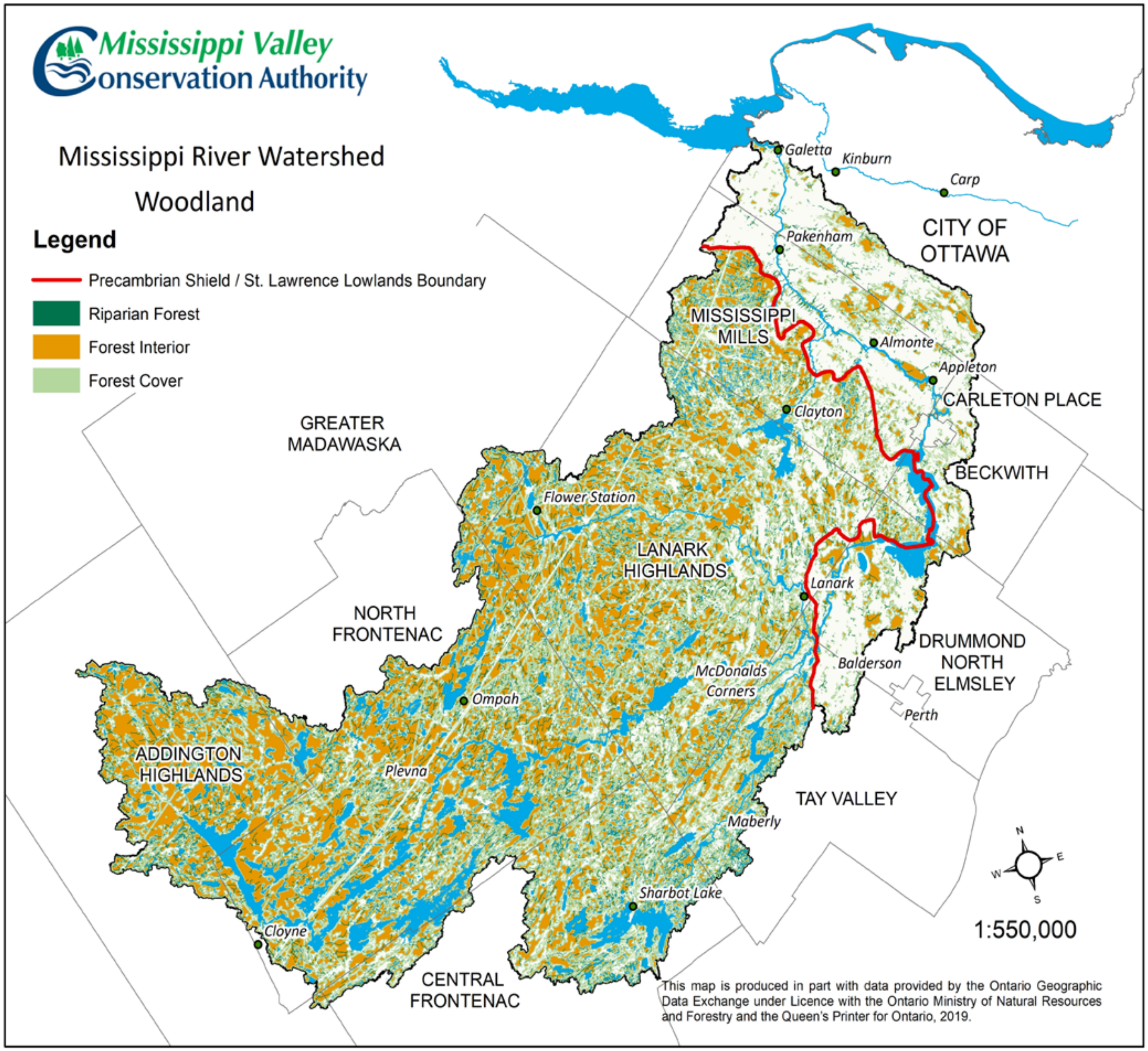


Figure 5: Woodlands

Table 5: Watershed and Subwatershed Forest Conditions

Sub Watershed	Subwatershed	Forest Cover Area	Forest Interior	Forested Riparian
	sq.km.	as a % of subwatershed area		as a % of total potential riparian
Upper Mississippi	1028	74	34	59
Central Mississippi	395	72	24	53
Clyde River	664	76	31	58
Fall River	485	64	16	50
Mississippi Lake	300	40	11	39
Lower Mississippi - Shield	424	68	22	48
Lower Mississippi - Lowlands	464	29	6	30
Total Mississippi River Watershed	**3761**	**64%**	**23%**	**51%**
On Shield	3087	72	27	54.0
Off Shield	634	31	7	31.0

Forest Cover

Forest cover includes all upland and lowland forests, treed swamps, plantations[12] and mature shrub thickets, with a patch size greater than 0.5 hectare (ha). There is 64% forest cover overall which meets with Environment Canada's (EC) low risk approach, where 50% cover at the watershed scale may support most potential species and healthy ecosystems. When broken out by subwatershed the areas in the east have substantially lower forest cover. The Mississippi Lake subwatershed has 40%, and the Lower subwatershed area has 29% forest cover. The forest cover generally falls within the Target 3a medium risk (40% minimum) and low risk (50% minimum) levels, with just the lower Mississippi falling just below the 30% high risk target. Under Forest Cover Target 3b, the Lower Mississippi would receive a B Grade and all the other subwatershed an A Grade.

[12] Pine plantations are common throughout the watershed. There is insufficient mapping data across the Mississippi River Watershed to specifically identify, quantify and separate out the pine plantation sites.

Forest Interior

Forest interior is the core part of the forest that provides important habitat that is required for area sensitive species. For watershed reporting, forest interior is measured as the woodland that remains when a 100 metre buffer is removed from the outer edge[13]. Larger, rounder forest patches are therefore needed to provide sufficient interior habitat. The Mississippi River Watershed has an interior forest cover of 23% overall. At the subwatershed level, the lowlands (off-shield) area with 6% forest interior, is the only area that doesn't meet the Target 4a threshold of 10% forest interior. The Mississippi Lake Subwatershed area is nearing the minimum at 11%. Under Target 4b, the Mississippi Lowlands Subwatershed would revive a C Grade, the Mississippi Lake Subwatershed a B Grade and the remaining subwatersheds an A Grade.

Forested Riparian Area

Forested riparian area refers to the long narrow bands of forested area along watercourses. They provide many ecological functions including, erosion protection, nutrient uptake and protection of aquatic life. They also support high numbers of wildlife species and provide a safe movement corridor for wildlife. Forested riparian area is measured as the amount of forest cover within a 30 metre riparian zone adjacent to watercourses and lakes[14]. The forested riparian zone is 51% across the watershed, meaning that 51% of the total available riparian area (lands within 30 metres of watercourses) is forested.

At the subwatershed level, forested riparian zone ranges from 30% to 59% with the Mississippi Lowlands (off-Shield) having the lowest forested riparian zone and the Upper Mississippi having the highest. It should be noted these calculations represent only the forest cover and do not include other valuable natural riparian vegetation types. As such, these values should not be measured against the EC recommended minimum of 75% which captures a broader definition of "vegetated riparian area".

The Hairy Woodpecker is most often found in mature woodlands. There is concern that deforestation will fragment the large forests they rely on and increase competition for nest holes threatening the Hairy woodpecker's population.

Woodland Protection

Under provincial policy (PPS 2014) protection policies apply only to "significant" woodlands in Ecoregion 62E which corresponds to the watersheds off-shield lowlands area[15]. The PPS defines significant woodland as a woodland that is ecologically important in terms of features

[13] Using the Conservation Ontario Watershed Report Card methodology. The outer 100 m is considered "edge" habitat and is prone to high predation, wind damage and is more likely to possess non-native plants.

[14] Forested riparian area is calculated by dividing the area of forest cover within the 30m zone by the total area of the 30m zone. It should be noted that other non-forested permanent cover types such as meadow, thicket or marsh also enhance the riparian habitat and water quality but there is insufficient mapping detail to include assessment of these other riparian vegetation types at this time.

[15] The Provincial Policy Statement (Section 2.1.5) specifies that "development and site alteration shall not be permitted in significant woodlands in Ecoregion 6E and 7E unless it has been demonstrated that there will be no negative impacts on the natural features or the ecological functions.

such as species composition, age of trees and stand history; functionally important due to its contribution to the broader landscape because of its location, size or due to the amount of forest cover in the planning area; or economically important due to site quality, species composition, or past management history (OMNRF, 2010).

The MNRF Kemptville district has produced mapping for the Kemptville District area (includes all of Lanark County) that classifies woodland patches according to a series of categories (ex. interior forest, old growth, rare, and linkages). It doesn't identify "significant" woodlands for municipal planning purposes but is presented as a starting point to assist municipalities in identifying significant woodlands within their jurisdictions. The City of Ottawa has produced their own Significant Woodland mapping based on provincial criteria.

> To support the PPS and good forestry practices, the Municipal Act, 2001 empowers all levels of municipalities (at their discretion) to pass forest conservation by-laws to regulate tree cutting and provide direction to landowners on how to sustainably manage their woodlands for financial and ecological benefits (see section 12.6). Activities associated with the development, management, conservation and sustainability of forests and urban forests are subject to the Professional Foresters Act, 2000.
>
> *Natural Heritage Reference Manual, 2nd Ed. 2005.*

MVCA Role with Woodlands

MNRF is the lead provincial agency responsible guidance with respect to Significant Woodlands (PPS 2.2.15) and the municipalities are responsible for the identification and protection of significant woodlands through the implementation of Section 2.1 of the PPS. While MVCA doesn't have a mandated role in woodland protection, it assesses and reports on forest cover, forest interior and riparian forest as a measure of watershed and subwatershed health through the Watershed Report Card Program.

Through the Natural Heritage Reference Manual (for Policy Statement Section 2.3, 2005) the responsibility for identifying significant woodlands is assigned to planning authorities (the municipality). To date the Province has provided only very general guidance to planning authorities with respect to the identification and protection of significant woodlands. Planning authorities are advised to undertake a comprehensive study to identify significant woodlands for their planning area . Similarly there is little guidance to assist planning authorities in assessing impact. In terms of policy implementation, the onus is on both the developer to demonstrate no negative impact though an Environmental Impact Assessment/Statement, and on the approval agencies (municipality and advisors) to assess the merits of that assessment. Planning authorities are advised to develop and apply a set of evaluation criteria based on factors and characteristics outlined in the Natural Heritage Reference Manual.

Provincial policy does not apply to the protection of woodlands outside of Ecoregion 6E and there is no other policy direction for these areas.

Natural Heritage Systems

Though often described independently, natural features such as wetlands, ANSIs, woodlands, riparian areas and wildlife habitat features are interdependent and must function as a system to maintain biological and geological diversity, ecosystem services, and species populations. The concept of the Natural Heritage System, moves away from a piecemeal approach in treating natural features as isolated units, to an integrated systems approach. The systems approach provides for a more solid foundation in maintaining, restoring and enhancing ecologically sustainable and resilient landscapes to help in maintaining biodiversity and buffering against the impacts of climate change.

A **natural heritage system** is described as an ecologically based delineation of nature and natural function – a system of connected or to be connected green and natural areas that provide ecological functions over a longer period of time and enable movement of species. Natural heritage systems encompass or incorporate natural features, functions and linkages (also referred to as corridors) as component parts within them and across the landscape. They also enable the linking of different landscapes. (MNRF 2010). See Appendix A: Note 4 for PPS definition.

KEY CONSIDERATIONS

The PPS (2014) requires that in their Official Plans, municipalities identify natural heritage systems in Ecoregions 6E and 7E (the off-shield areas in this watershed).

A number of different Natural Heritage Systems type projects have been produced for various parts of the watershed.

There is no comprehensive, consistent mapping product for the Natural Heritage Systems for the EcoRegions 6E part of the Mississippi River Watershed.

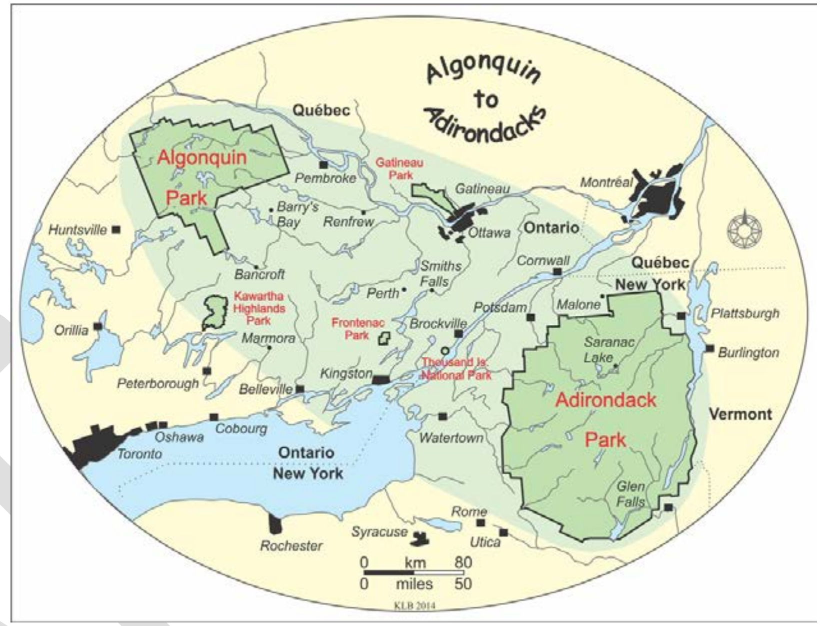
There appears a general lack of universal understanding, appreciation and acceptance of the importance of Natural Heritage Systems.

Status of Natural Heritage Systems in the MRW

There is currently no comprehensive representation of Natural Heritage System (NHS) across the entire Mississippi River Watershed however a number of initiatives have resulted in Natural Heritage System type mapping covering different areas. While they share many of the same broad principles, each had different goals, and used different information and criteria to identify and define the boundaries of the natural heritage systems. Listed below, these initiatives are described in more detail in Appendix A: Note 5.

- A2A (Algonquin to Adirondacks Collaborative)
- County of North Frontenac Natural Heritage Study
- City of Ottawa - Official Plan Natural Heritage System Mapping
- Nature Conservancy of Canada – Great Lakes Blueprint
- Sustaining What We Value (MNRF)
- Town of Mississippi Mills Natural Heritage Concept Plan (Mississippi Valley Field Naturalists)

Within the watershed is the Mississippi Lake National Wildlife Area and a Mississippi Lake Migratory Bird Sanctuary, administered by Environment and Climate Change Canada. These two areas have separate boundaries, but together protect 307 ha of wetland and hardwood forest that provides habitat for migratory birds, Species at Risk, and other wildlife. The NWA designation prohibits activities that interfere with conservation of wildlife, effectively protecting this natural area and it's ecological functions.



Natural Heritage System Protection

MNRF is the lead provincial agency responsible for guidance with respect to Natural Heritage Systems (PPS 2.1) and the municipalities are responsible for the identification and protection of natural heritage systems through the implementation of the PPS. Section 2.1.2 of the PPS states: "The diversity and connectivity of natural features in an area, and the long-term *ecological function* and biodiversity of *natural heritage systems*, should be maintained, restored or, where possible, improved, recognizing linkages between and among *natural heritage features and areas*, *surface water features* and *ground water features*."

The **A2A** project envisions an Algonquin to Adirondacks region that is a resilient, ecologically connected landscape which sustains a full range of native wildlife and enhances people's quality of life into the future. It extends from the southern boundary of Adirondack Park, in New York State, to the northern boundary of Algonquin Provincial Park, in Ontario, and encompasses the area between the two parks and a buffer zone**.** It represents a critical corridor link for wildlife in eastern North America**.**

The PPS (2014) requires that Natural Heritage Systems must be identified in Ecoregions 6E and 7E. Municipalities with lands in the Ecoregion 6E (off-Shield Lowlands area) must include mapping of Natural Heritage Systems in their Official Plans. The City of Ottawa has already done so. The Townships of Drummond/North Elmsley, Beckwith and Mississippi Mills will be required to do so when they next update their Official Plans.

MVCA Role in Natural Heritage Systems

MVCA does not have a specific legislated role with respect to Natural Heritage Systems, but through its advisory capacity in reviewing planning and development applications and policies, has provided the municipalities with significant support regarding natural heritage matters.

The Mississippi River Watershed Plan project has highlighted the need for a comprehensive, watershed wide view of its natural heritage systems and the need for watershed scale natural heritage system mapping as a key component of this planning process. In addition to providing a mapping product that municipalities could use in their planning documents, this would help in directing monitoring, research and stewardship efforts.

Species at Risk and Species of Concern

In Ontario, the protection of Species at Risk and their habitats falls under the *Endangered Species Act, (2007)*. The objectives of the act are:

- To identify Species at Risk (SAR) based on the best available scientific information, including information obtained from community knowledge and aboriginal traditional knowledge.
- To protect species that are at risk and their habitats, and to promote the recovery of species that are at risk.
- To promote stewardship activities to assist in the protection and recovery of species that are at risk.

Species at risk means an extirpated, endangered or threatened species or a species of special concern. (Species at Risk Act, 2002)

Species at risk information is largely classified as sensitive due to concerns about disturbance, capture/harvest and intentional destruction of individuals and/or habitat. As such, the information is presented as general listing of past observations/occurrences within a broad geographic area, such as by municipality.

KEY CONSIDERATIONS

Species at Risk information is largely classified as sensitive to due concerns about disturbance, capture/harvest and intentional destruction.

Generalized listings of Species at Risk are available for the watershed, 30 known species have been listed.

The protection of Species at Risk and their habitat is primarily captured only for activities that are subject to the *Planning Act* application process.

The American Eel is an endangered species that once thrived in the Mississippi River System. Monitoring and research initiatives suggest there is potential for repopulation with the construction of passageways at dam's sites.

Species at Risk in the Watershed

The status of these species has been designated by the Committee on the Status of Species at Risk in Ontario (COSSARO), an independent body that assesses and classifies species at risk, and/or by the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Table 6 identifies *Species at Risk* that have been reported in the watershed. They include a number of plants, reptiles, birds, mammals and fish that are classified as Extirpated (EXP), Endangered (END), Threatened (THR), and Special Concern (SC). The full list of Ontario Species at Risk can be found at Ontario.ca/speciesatrisk .

Table 6: Species at Risk in the Mississippi River Watershed (Confirmed Sightings)

Species	Provincial Status*	Federal Status**
END: Endangered THR: Threatened SC: Special Concern		
VASCULAR PLANTS		
American Ginseng	END	END
Broad Beech Fern	SC	
Butternut	END	END
Eastern Prairie Fringed-orchid	END	END
MOSSES AND LICHENS		
Flooded Jellyskin	recentlly delisted	SC
REPTILES		
Blanding's Turtle	THR	END
Eastern (Gray) Ratsnake	THR	THR
Eastern Ribbon Snake	SC	SC
Five Lined Skink^	SC	SC
Milksnake		SC
Northern Map Turtle	SC	SC
Spotted Turtle	END	END
Stinkpot (Eastern Musk) Turtle	SC	SC
Wood Turtle	END	THR
FISHES		
American Eel	END	THR
Lake Sturgeon	END	THR
Northern Brook Lamprey	SC	SC
River Redhorse	SC	SC
INSECTS		
Monarch Butterfly	SC	SC

^Carolinian Pop'n is END, Southern Shield Pop'n SC,

Species	Provincial Status*	Federal Status**
END: Endangered THR: Threatened SC: Special Concern		
BIRDS		
Bald Eagle	SC	
Barn Swallow	THR	THR
Black Tern	SC	
Bobolink	THR	THR
Canada Warbler	SC	THR
Cerulean Warbler	THR	END
Common Nighthawk	SC	SC
Eastern Meadowlark	THR	THR
Eastern Whip-poor-will	THR	THR
Golden Eagle	END	
Golden Winged Warbler	SC	THR
Henslow's Sparrow	END	END
Least Bittern	THR	THR
Loggerhead Shrike	END	END
Peregrine Falcon	SC	
Rusty Blackbird	SC	SC
Short Eared Owl	SC	SC
Wood Thrush	SC	THR
Yellow Rail	SC	SC
MAMMALS		
Common Gray Fox	THR	THR
* SARA Listing, **COSEWIC Listing		

Table created from Species at Risk in Ontario website list. The list is continually being updated, refer to Ontario.ca/speciesatrisk for current listings. And from information provided by the Canadian Wildlife Service - Onatrio

Species at Risk Protection – MVCA Role

MNRF is the lead provincial agency responsible to the protection of species at risk under the *Endangered Species Act (2007)*. Conservation Authorities (CAs) have no delegated responsibilities with species at risk, their role is primarily in education/awareness and stewardship efforts.

Through the permit process under Ontario Regulation 153/06 (MVCA's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses) MVCA advises the developer/applicant of the need to consult with MNRF regarding obligations under the Endangered Species Act. Through its advisory role in the plan review process and through its own permit process MVCA also consults directly with MNRF when a potential species a risk concern is identified, particularly when a large scale proposal is being considered. In a stewardship capacity, MVCA has supported and/or partnered with MNRF on projects directed at protection and recovery of the American Eel within the Ottawa and Mississippi River systems. It represents one of few aquatic species at risk in the MRW watershed that is classified as endangered.

American Eel

The American Eel, once common in the Ottawa and Mississippi Rivers, it is now listed as endangered under Ontario's *Endangered Species Act*, *2007*. The American Eel as an important traditional food source for First Nations communities and early settlers. It is estimated that it made up 50% of the near shore fish biomass in some inland lakes and rivers. The Lake Ontario and upper St. Lawrence River population suffered a massive collapse attributed to a number of factors including changes in ocean currents, over fishing, contamination, loss of habitat and barriers to migration. Locally, in the Mississippi River Watershed, hydro dams impeding passage to suitable habitat and turbine mortality are the key threats.

Little information is available on current eel populations within the Mississippi River system, though incidental records and some inventories indicate that the eel is still found locally in both the main river channels and upstream lakes in the system[16]. A feasibility assessment of passage of American Eel in the Mississippi River concluded that there is high potential for repopulating the river through removing barriers for upstream and downstream migration and that favourable conditions exist to support the eel without the need for habitat restoration works. This would necessitate the design of site specific passageways at each of the dams and implementation according to priority. New dams should also be designed with appropriate passageways. It also recommended that seasonal flow requirements for critical passageways are incorporated into the Mississippi River Water Management Plan (O'Black, 2009).

[16] Trapnet results in Mississippi Lake showed numbers caught decreasing from a high of 77 in 1985 to 5 in 1998 (Kerr 1999, as cited in O'Black, 2009). Other studies indicate the widespread presence in; Mazinaw L., Dalhousie L., the reach from Playfairville rapids to Ferguson falls, the reach from Ferguson Falls to Innisville Rd., Mississippi Lake, and the reach from Almonte through to the Ottawa River (MRWMP, 2006). Most recently an electrofishing survey caught two eels at the mouth of the Mississippi in 2008. (One was also caught in 2018 in Poole Creek, Ottawa which is in the neighboring Carp River watershed.)

Wild Rice

Wild rice is a tall aquatic grass that grows from seed annually and produces a very valuable grain that has been used by the First Nations people from parts of North America, as food, for thousands of years. It holds enormous cultural importance to First Nations communities. In Ontario, regulations falling under the Ministry of Natural Resources and Forestry prohibit the commercial harvest of wild rice without a permit.

Wild rice is an integral part of shallow lake and river ecosystem, with both the plants and the insects that feed on the plants, providing a rich food source for birds and mammals. The rice stands provide exceptional breeding and nesting areas for an abundance of species. They also filter the water, bind loose soil, protect shorelines from high winds and waves, and provides habitat for species at risk, such as least bittern and black terns. (Plenty Canada, 2018)

The key stressors potentially impacting wild rice are shoreline development, water levels and climate change. Shoreline development is, and continues to be, a major threat to wild rice. People with cottages and houses where the rice is growing tend to uproot the rice plants, apply for chemical control permits, build docks, and use mechanical dredging for the removal of the rice. Water levels are extremely important to maintaining wild rice stands, as high water levels can drown the plants and low water levels can dry them up. In developing the Mississippi River Water Management Plan (2006), wild rice was among the factors considered in setting preferred water level ranges for the system. This process did not consider impacts of climate change and related predicted changes in the scale and frequency of flood and drought conditions.

On the Mississippi River system, wild rice is known to grow in the following locations:

- **Ardoch -** the wild rice growing in this area is of great significance to the local First Nations who harvest the rice each fall.
- **Mud Lake** Provincially Significant Wetland (PSW) and Wild Rice stands at Mud Lake.
- **Dalhousie Lake** - stands are located along the south-western and north-eastern shoreline of the lake.
- **Playfairville Rapids to Fergusons Falls** - wild rice stands cover large areas.
- **Mississippi Lake** - wild rice grows in many of the wetlands and shallow bays throughout the lake.

Plenty Canada, an Indigenous not-for-profit organization located near Lanark, is working on an initiative that helps to replenish and monitor the growth of wild rice in our area in collaboration with Environment Canada's National Wetland Conservation FundIn the fall of 2014. Plenty Canada seeded rice along the Mississippi River at McCulloch's Mud Lake, just outside of their headquarters in Lanark, as well as in Rice Lake in Alderville, ON. Their research involves monitoring the growth conditions of the rice and assessing the overall health of the wetland habitats that the rice supports (https://www.plentycanada.com/wild-rice--aquatic-ecosystems.html).

Surface Water Quality

Water Chemistry and Physical Parameters

The MVCA carries out both a lake and river water quality monitoring throughout the watershed. The **MVCA Lake Monitoring Program** (formerly Watershed Watch) monitors lake sites. The **Provincial Water Quality Monitoring Network (PWQMN)**, which MVCA carries out in partnership with the Ministry of Environment, Conservation and Parks (MECP) monitors river sites. Both of these programs involve the collection water samples for laboratory assessments of chemistry. They also use field equipment to measure associated parameters including pH, conductivity, temperature, dissolved oxygen and water clarity.

The Ministry of Environment, Parks and Conservation (MECP) PWQMN collects water quality data at 10 sites throughout the watershed, shown in Figure 6. The PWQMN is longest running water quality monitoring program in the watershed, with some sites dating back to the 1960's and 70's. In partnership with the MECP, the MVCA samples the sites once a month during the ice free period for analysis at the MECP laboratory. MVCA also collects samples on the Mississippi River at Fergusson Falls, using the PWQMN protocol and sampling rotation. Appendix A: Table 3 also provides a listing and description of PWQMN sites.

KEY CONSIDERATIONS – LAKE WATER QUALITY

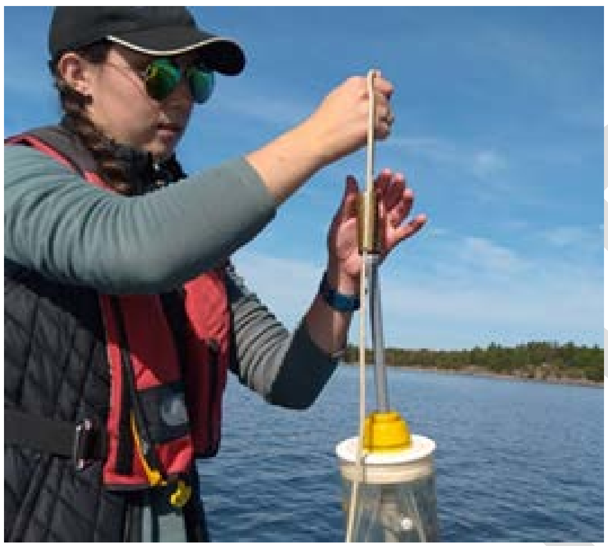
MVCA monitors 44 lakes throughout the watershed on a 2 to 5 year rotation (3 samples collected per sample year). This provides a generalized assessment of conditions, but insufficient data for in-depth analysis and reliable trend analysis.

A generalized assessment of lake Total Phosphorus using 1998 to 2018 data shows good nutrient levels that fall mostly in the oligotrophic and mesotrophic range.

Surface Water quality is also monitored by volunteers through a number of Citizen Science programs. Through the MECP Lake Partner Program, volunteers collect lake water samples in the spring which are sent to the MECP lab for analysis of Total Phosphorus. The volunteers can also undertake monthly water clarity observations (using a sechhi disk) from May to October. Through the Water Rangers Program , volunteers monitor a variety of surface water parameters using a kit that is equipped with easy to use testing equipment. Such programs provide an effective way to monitor generalized conditions and while also offering an effective education and engagement tool.

Lake Water Quality

MVCA's primary lake monitoring initiative, the **Lake Monitoring Program** (formerly Watershed Watch) collects water quality[17] and invasive species data on 44 lakes, at 63 sites throughout the Mississippi River Watershed (Figure 6). The lakes are monitored every 2 to 5 years[18] with three samplings (spring, summer and fall) at each site. The data collected each year is presented in an annual Integrated Monitoring Report.



MVCA Monitoring Staff collecting lake water samples.

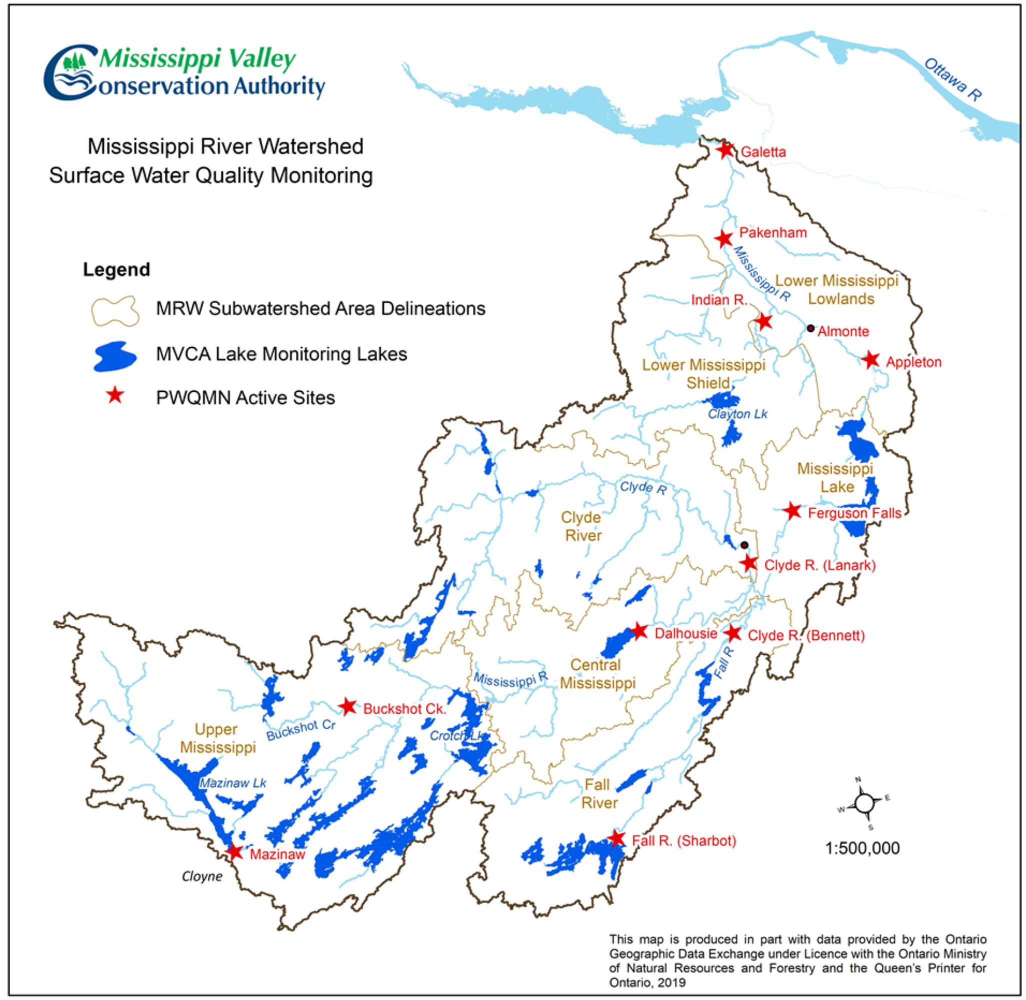


Figure 6: MVCA Lake Monitoring Sites and PWQMN Sites

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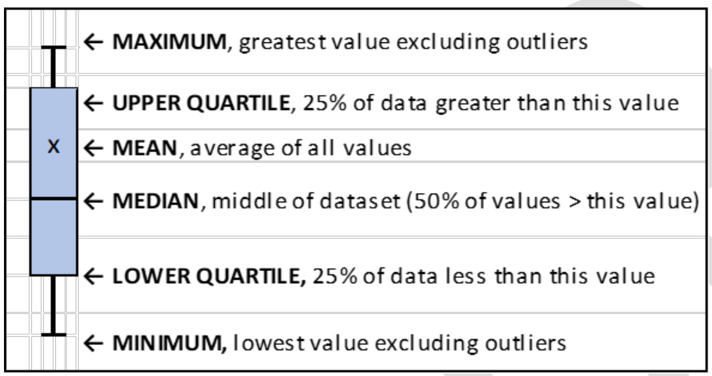
[17] Water quality parameters including dissolved oxygen, water temperature, water clarity, pH, and total phosphorous (TP) concentrations, are monitored 3 times within the sample year (late spring, mid-summer, early fall) to assess seasonal changes in lake chemistry.

[18] Between 1998 and 2015 the lakes were monitored on a five year sampling cycle. In 2016 the monitoring frequency was increased to every 2 or 3 years on highly developed lakes and lakes along the main branch of the river. The 5 year rotation was maintained for most of the other lakes.

Lake Total Phosphorus Assessment

The infrequent sampling (3 times/yr. every 2 to 5 yrs.) makes it difficult to generate a reliable trend analysis of the lake data. Instead the box and whisker plot shown in Figure 7 presents the general range in Total Phosphorus for each lake, grouped by subwatershed area. This format is useful in presenting a dataset when there are significant outliers[19] that can potentially skew the results. The shaded box represents the range within which half of the values fall. For example, for Ardoch Lake half of its 21 samples had a TP between 6.5 and 12 µ/L.

Appendix A: Table 4 provides a summary of the years sampled, number of sample sites and number of samples for each lake that were used for and used for this assessment.



Lake Trophic Status Classifications

Trophic status is a measure of the nutrient richness of a lake. Total Phosphorus (TP) is the parameter most widely used to assess a lakes trophic status, broadly categorized according to three classifications:

Oligotrophic: less than 10 µg/L of TP . These dilute, unproductive lakes rarely experience nuisance algal blooms, and are considered excellent recreational lakes that are highly valued and may support a cold-water fishery, such as lake trout.

Mesotrophic: TP between 10 and 20 µg/L. These lakes can range from clear and unproductive at the bottom (10 µg/L) end of the scale, or susceptible to moderate algal blooms at concentrations near 20 µg/L. They tend to support warm-water fish species and have a more diverse shoreline habitat.

Eutrophic: TP over 20 µg/L. These lakes tend to have naturally higher TP concentrations. They have lower water clarity, especially in summer months when algae blooms and plant growth peaks; and lower oxygen levels throughout the year. Eutrophic lakes may exhibit persistent, nuisance algal blooms.

Source: MOECC, 2015. Lake Partner Report Card 2015 www.desc.ca/programs/lpp

According to this generalized assessment of the 1998 to 2018 data, TP levels in the Upper Subwatershed area would be largely classified as oligotrophic, with several also in the mesotrophic range. In the Central and Lower subwatershed the TP levels are generally more in the mesotrophic range. The Clyde River TP data generally shows both a broader spread for most lakes and a broader range in trophic status, generally centred on mesotrophic. The Fall River TP levels are mostly oligotrophic with just the Bennett and Clear Lake data showing mesotrophic levels.

[19] Outliers are determined as the values that are more than 3/2 times the upper quartile or less than 3/2 times the lower quartile. The outliers are included in the calculation but are not shown on the graphs.

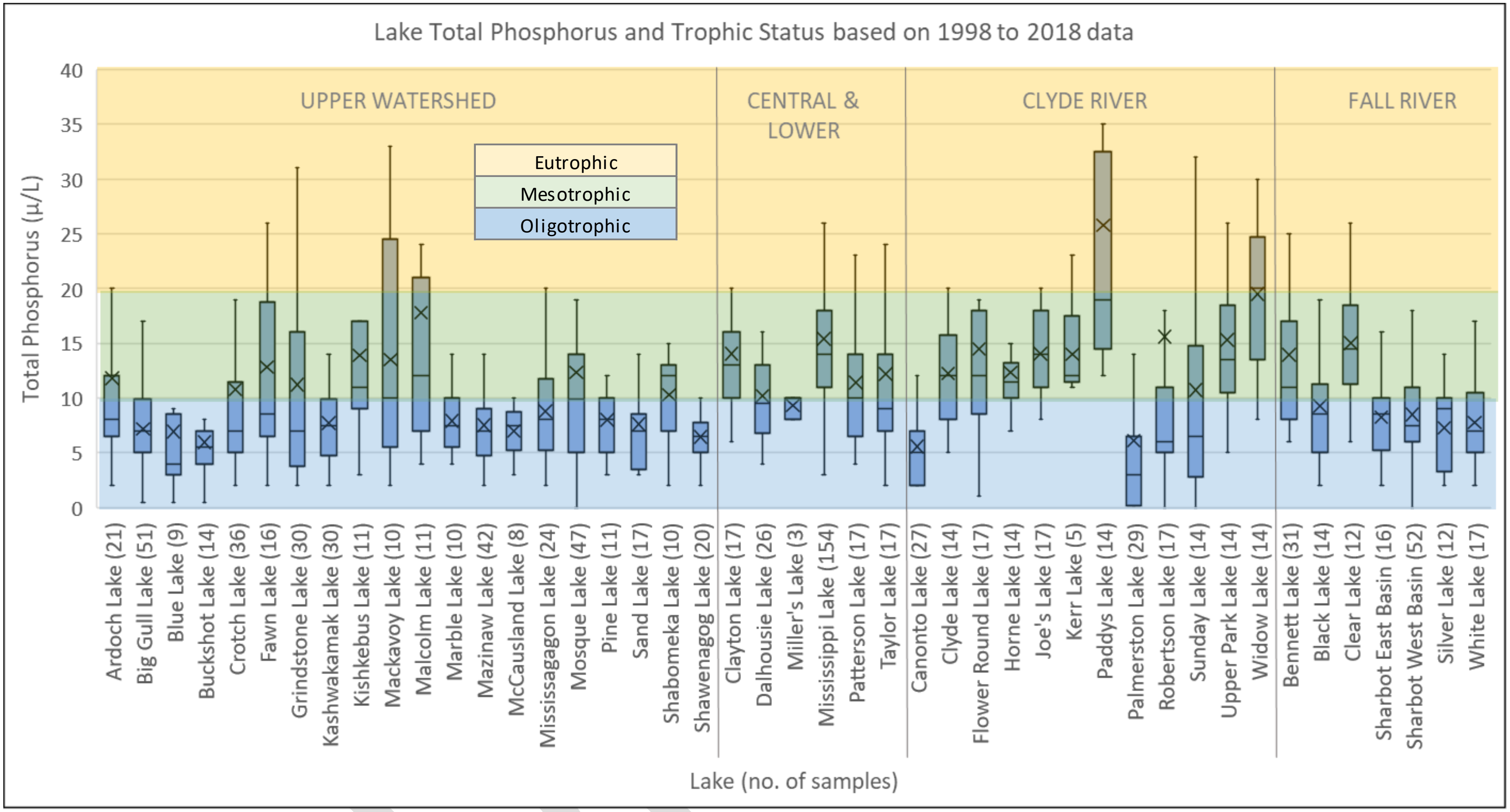


Figure 7: Lake Total Phosphorus and Trophic Status Ranges

It should be noted that while these ranges provide an idea of a lake's trophic status, lakes naturally progress over time from an oligotrophic to eutrophic state, so an 'ideal' trophic status does not exist. Lakes on the bedrock of the Precambrian Shield tend to be naturally more oligotrophic, and off-shield lakes, particularly those already surrounded by a lot of wetland, like Mississippi Lake and Clayton & Taylor Lakes, are naturally more eutrophic.

River and Stream Water Quality

The PWQMN is a primary source of water quality data for the main rivers and streams of the Mississippi River Watershed. It includes 11 sites that are sampled monthly during the ice-free period and are analysed for a broad suite of parameters[20]. The charts and assessment presented in this section represent PWQMN data for the period from 2002 to 2019

The graphs presented in this section present comparisons between two nine year periods: 2002 to 2010 and 2011 to 2019 highlighting six key parameters: Total Phosphorus, Total Nitrogen, Water Temperature, Dissolved Oxygen, Conductivity and Chloride. Where available, the results are assessed relative to the applicable thresholds described on page 7 including: the Provincial Water Quality Objectives (PWQO) and the Canadian Water Quality Guidelines (CWQG) issued by the Canadian Council of Ministers of the Environment (CCME).

The data results for pH are presented in Appendix A: Notes 6 and 7. The metals, including copper, iron, manganese and zinc are consistently well below PWQO and CCME recommended thresholds (Appendix A: Table 6).

KEY CONSIDERATIONS – RIVER & TRIBUTARIES

PWQMN is the main source or river/stream water quality data, collected monthly (ice free period) at 10 sites plus one MVCA site.

Cody Creek, the only main off-shield tributary to the Mississippi , is not part of any monitoring program and therefore has no WQ data.

Nutrients (TP and TN) increase moving downstream but are generally below levels that would cause concern (i.e. <20 µ/L).

In comparing 2002 to 2010 data with 2011 to 2019 data:

- TP appears to have increased slightly in the upper watershed and decreased at the lower end (contrary to what would be expected moving downstream into the agricultural area).
- Total Nitrogen readings have generally decreased everywhere along the river and in the tributaries (potentially reflecting changes in agriculture).
- Average water temperatures show an overall increase with larger ranges in temperature in the past 9 years. Assessment on a seasonal basis would be beneficial.
- Dissolved Oxygen (DO) falls within acceptable levels and shows little overall change.
- Conductivity levels are well within the accepted range of 150 to 500 µ/L and generally show no obvious changes over time. River conductivity levels increase moving downstream. In the tributaries, only the Clyde R. shows an increase and wider range in values over the two 9 year periods.
- Chloride (usually indicative of road salt contamination) increases moving downstream . The nine year comparison shows and increase everywhere except on the Fall River where the levels show an overall decrease.

[20] See Appendix A: Table 4 for a full list of parameters assessed under the PWQMN program and Appendix A: Table 5 for a list of monitoring dates from 2002 to 2019.

Total Phosphorus (TP)

Total Phosphorus (TP), which includes both organic and inorganic types of phosphorus, is one of the most important overall measures of water quality. Phosphorus in small quantities is essential for plant growth and metabolic reactions in animals and plants. It is also the nutrient in shortest supply in most fresh waters, which can result in even small amounts causing significant plant growth including algal blooms. It does not pose a human health risk except in very high concentrations. Sources of TP include animal wastes, sewage, detergent, fertilizer, disturbed land, and road salts used in winter.

Figures 8 and 9 shows the Total Phosphorus data results for the river and its tributaries, presenting a comparison between the two nine year periods of 2002 to 2010 and 2011 to 2019.

General observations – river sites:

- The data shows a general increase in TP from the upstream (Mazinaw) to downstream (Galetta) ends of the river, with Mazinaw frequently at the "non-detect level".[21]
- TP levels were generally between 5 and 25 µ/L, with the downstream sites (Lower Mississippi Pakenham and Galetta) periodically experiencing levels above the PWQO of 20 µg/L.
- The 2011 to 2019 data generally shows less spread than the previous 9 years, and the data and suggests a slight overall decrease in TP at the two downstream sites. This may reflect changes in agricultural uses and practices.

General observations – tributary sites:

- The data for the tributary sites shows TP levels generally meet the PWQO targets of less than 20 µg/L.
- The 2011 to 2019 data generally suggests a slight overall increase in TP at the Fall River and Indian River sites, where there is less spread in the data but higher overall averages..

Conventional Provincial Objectives for Total Phosphorus

The following Provincial Water Quality Objectives (PWQO) for Total Phosphorus (T) apply:

- To avoid nuisance algae, average TP concentrations for the ice-free period should not exceed 20 µg/L;
- To protect against aesthetic deterioration, TP concentrations for the ice-free period should be 10 µg/L or less.
- To eliminate excessive plant growth in rivers and streams, TP concentrations should below 30 µg/L."

[21] Detection Limit: The detection limit for TP is 5 µ/L. All non-detects were included in this analysis at a value of 5 µ/L. .

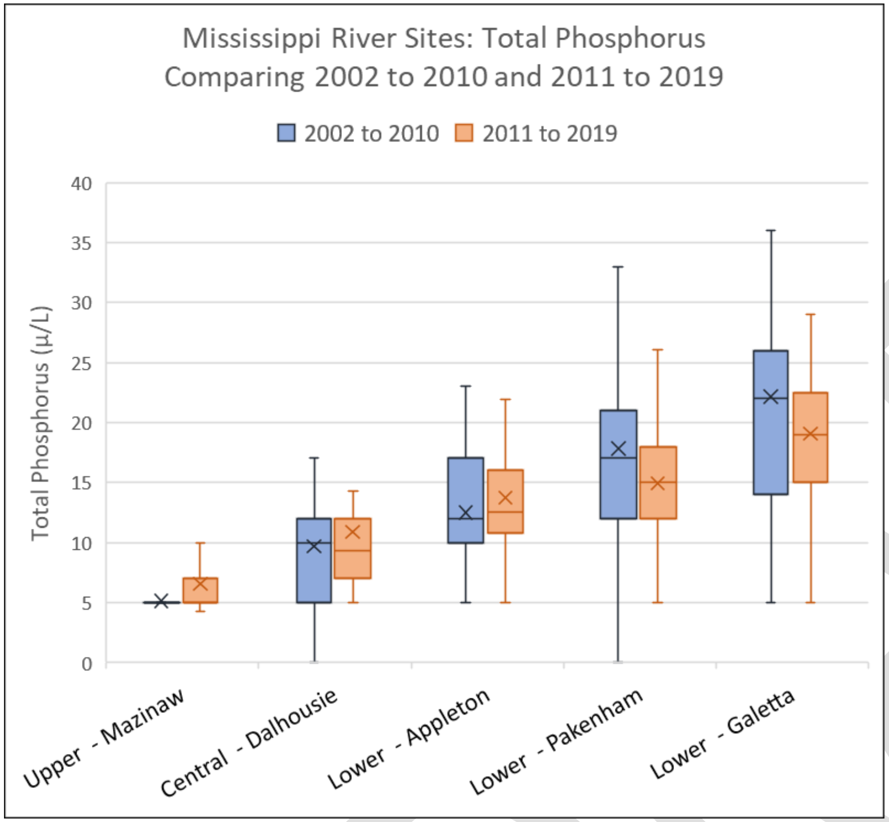


Figure 9: Mississippi River - Total Phosphorus

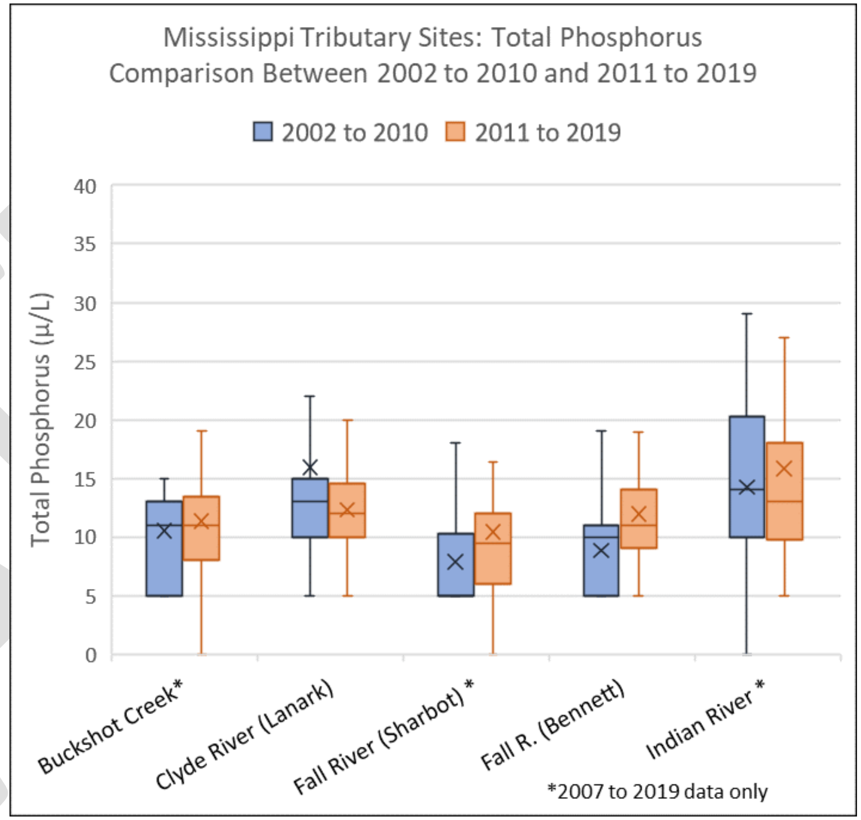
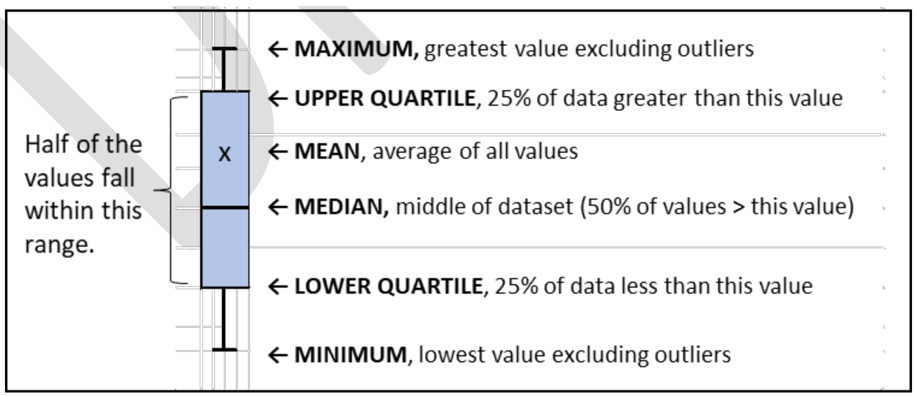


Figure 8: Mississippi Tributaries - Total Phosphorus



Total Nitrogen (TN)

Nitrogen is second only to phosphorus as an important nutrient for plant and algae growth. It does not occur naturally in soil minerals, but is a major component of all organic (plant and animal) matter. Sources vary widely, coming from fertilizer and animal wastes on agricultural lands, human waste from sewage treatment plants or septic systems, and lawn fertilizers used on waterfront property. Nitrogen may enter a river or lake from surface runoff or from groundwater sources.

Figures 10 and 11 shows the Total Nitrogen (TN) [22] data results for the river and the tributaries, presented as a comparison between the two nine year periods of 2002 to 2010 and 2011 to 2019[23]..

General observations – River Sites:

The data shows a general increase in TN levels from upstream (Mazinaw) to the downstream end (Galetta) if the river.

The data shows a marked jump between the Mazinaw and Dalhousie sites (in Precambrian Shield cottage country) and the Appleton, Pakenham and Galetta sites (in lowlands mix of agriculture and development).

The data suggests an overall reduction in TN across all 5 sites between 2002 to 2010 and 2011 to 2019.

Elevated nitrates in drinking water can be harmful to human. health. The CCME sets CWQG for nitrates relative to toxicity but the guidelines do not consider indirect effects due to eutrophication. Provincial Water Quality Guidelines do not set a specific threshold for Total Nitrogen or its compounds. With no official water quality objectives/guidelines for TN.

General observations – Tributary Sites:

Except for the Clyde, which shows little difference over the 9 year datasets, the data suggests an overall reduction in TN across the other tributary sites.

Because nitrogen comes a wide variety of sources and takes a number of different forms, it is difficult to pinpoint the reason the data is showing an overall decrease between 2002 to 2010 and 2011 to 2019. Further assessment by experts in the field of surface water chemistry and water quality would be beneficial.

[22] Nitrogen in surface water appears in several different forms, including nitrite (NO2), nitrate (NO3) and ammonia (NH3). PWQMN laboratory analysis measure for those compounds and for total Kjeldahl Nitrogen, which is a combination of ammonia-nitrogen and organically bound nitrogen but doesn't include nitrite or nitrate. Total Nitrogen (TN) is calculated by adding nitrate and nitrite to total Kjeldahl nitrogen.

[23] The Fergusons Falls site was not included in this analysis because of a lack of data.

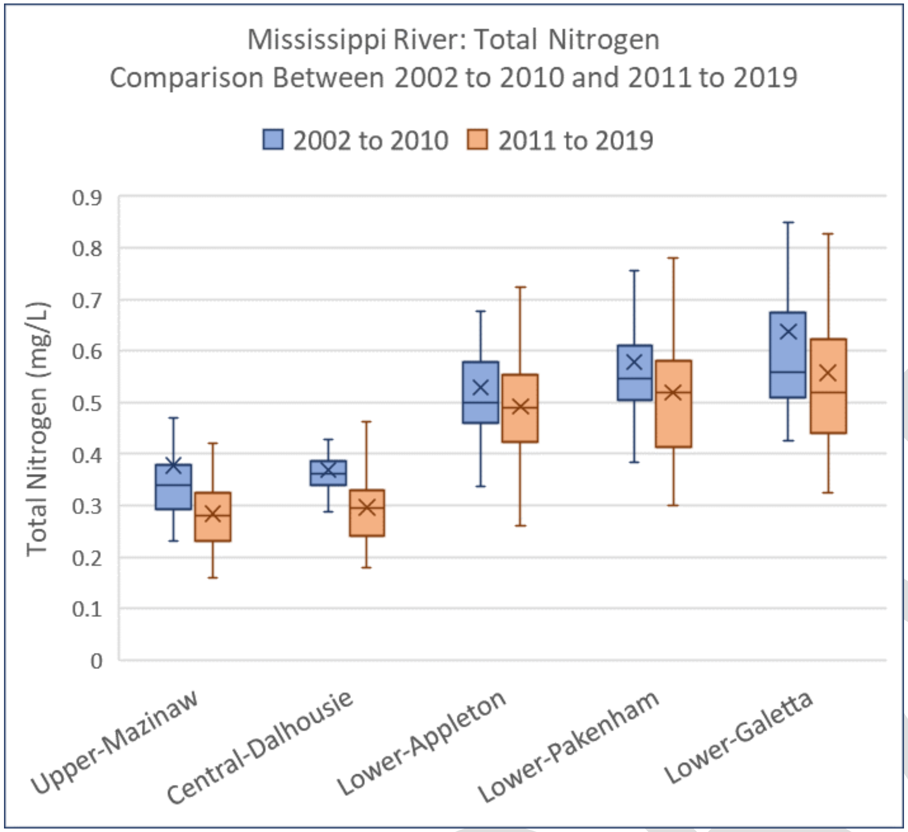


Figure 10: Mississippi River - Total Phosphorus

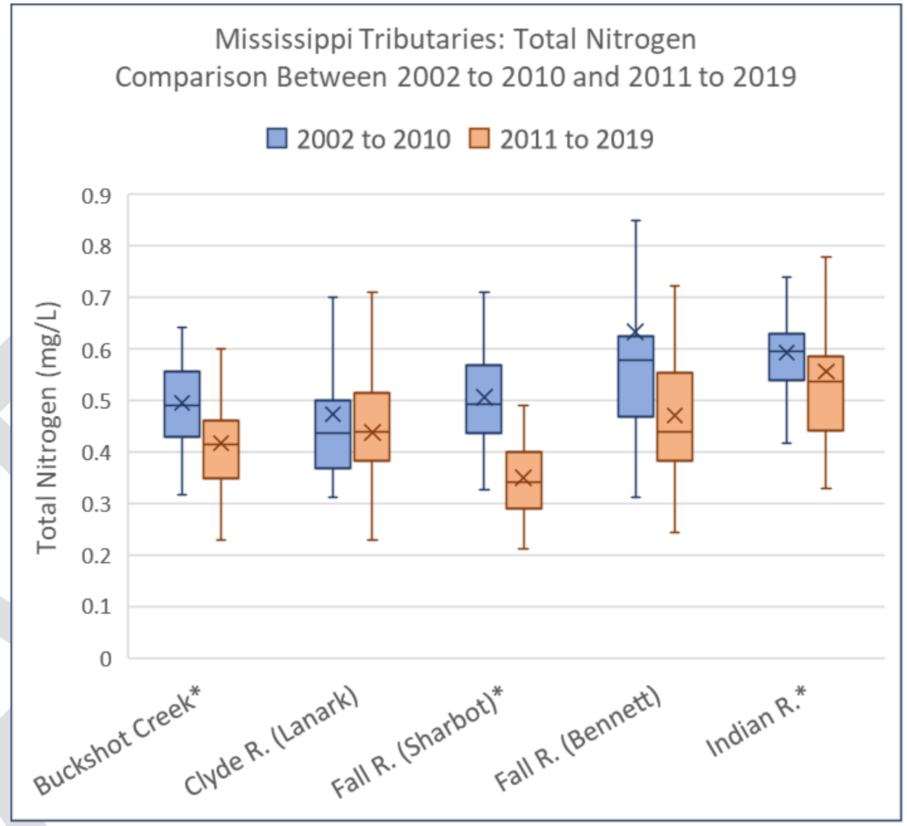
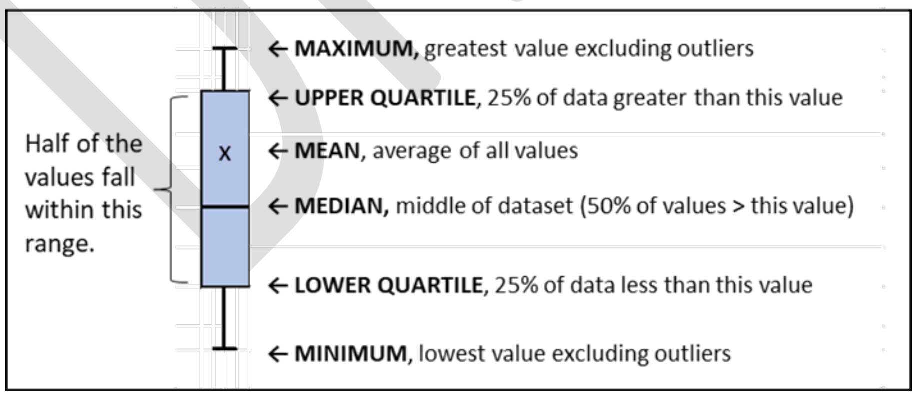


Figure 11: Mississippi Tributaries - Total Phosphorus



Water Temperature

Temperature is an extremely important factor in assessing water condition and health. It can influence the growth rate of plants such as algae, the amount of dissolved oxygen in the water, the rates of chemical reactions, and whether or not compounds remain bound to the sediments or become dissolved or suspended in the water column. Water temperature is affected by air temperature, shading and exposure to sunlight, groundwater inflows, turbidity, and stormwater runoff. In considering the health of organisms, it is necessary to consider both their maximum temperature and their optimum temperature. The maximum temperature is the highest water temperature at which the organism will live for a few hours. The optimum temperature is the temperature at which it will thrive (Behar, 1997).

Figures 12 and 13 shows the average annual water temperature results for the river and the tributaries, presented as a comparison between the two nine year periods of 2002 to 2010 and 2011 to 2019.

Fish Species	Short-term maximum		Optimum for Spawning	
	Celsius	Fahrenheit	Celsius	Fahrenheit
Bluegill	35	95	25	77
Brook trout	24	75	9	48

(Behar, 1997)

General observations – River Sites:

- The data shows the 2002 to 2011 average annual water temperatures (ice free period) generally ranging from about 13 to 17°C and the 2011 to 2019 averages ranging from 14 to 21°C.
- The Central-Dalhousie and the Lower-Galetta sites show the most notable apparent increases in water temperature between the two 9 year periods of records.
- The 2011 to 2019 data also shows a generally wider spread in values.

General observations – Tributary Sites:

- The data shows the 2002 to 2011 average annual water temperatures in the tributaries generally ranging from about 12 to 18°C and the 2011 to 2019 data with generally higher temperature ranging from 14 to 21°C. The 2011 to 2019 data shows a wider spread.
- The Buckshot Creek and the Clyde Rive (Lanark) data show the most notable difference between the two 9 year periods of records.

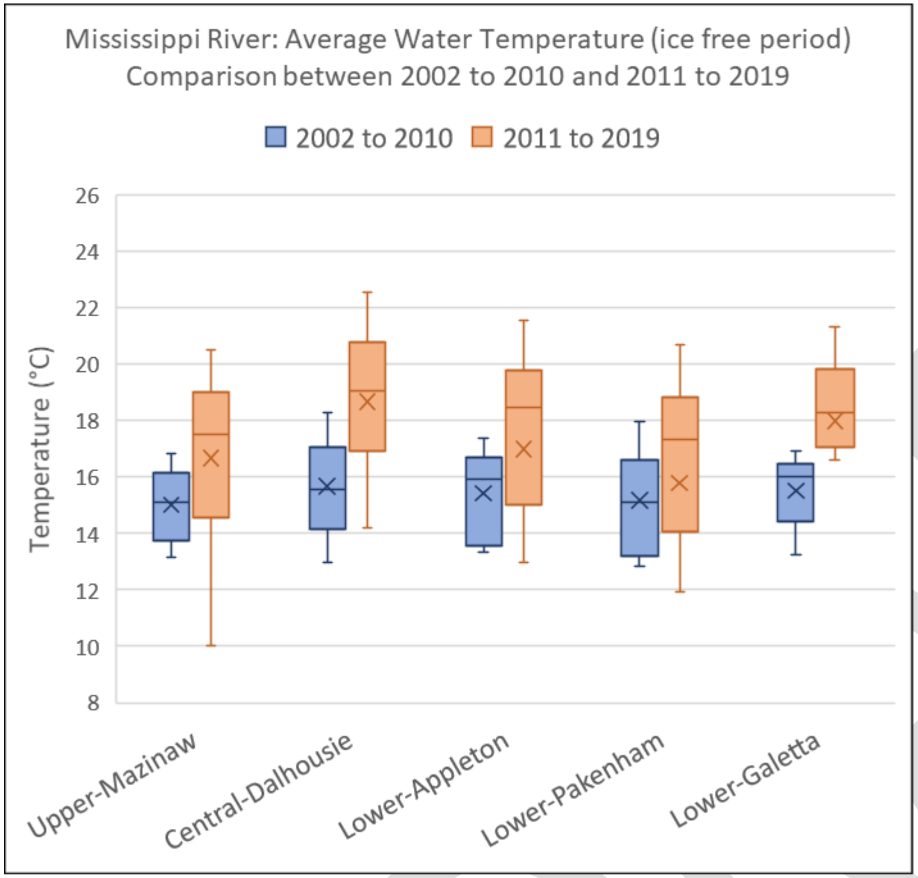


Figure 13: Mississippi River - Average Water Temperature

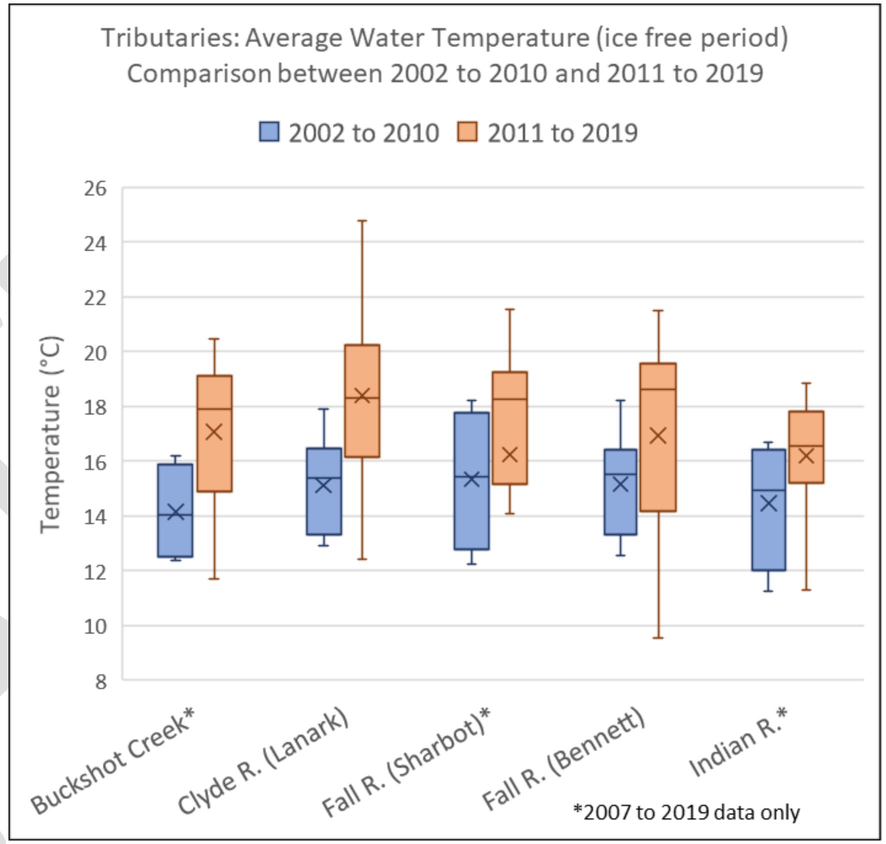
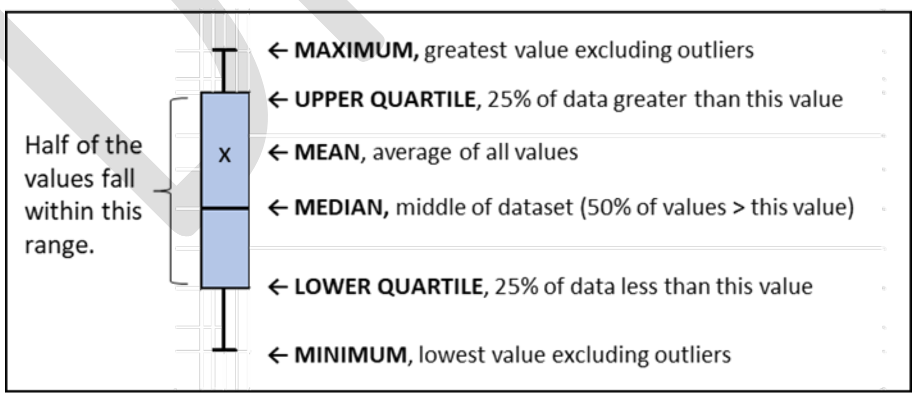


Figure 12: Mississippi Tributaries - Average Water Temperature



Dissolved Oxygen (DO)

Dissolved oxygen (DO) is a measure of the amount of oxygen available in the water for plants and wildlife. It is one of the most important elements, since most aquatic organisms need it to survive. DO levels vary depending on a number of factors including water temperature, time of day, season, depth, and rate of flow. Human factors that can affect dissolved oxygen in streams include: the addition of oxygen consuming organic wastes such as sewage, addition of nutrients (fertilizers, etc.), changes in the flow regime, increased water temperature, and the addition of chemicals.

Excessive nutrients resulting in high aquatic plant growth can cause significant reductions in the amount of dissolved oxygen. Plants consume oxygen during the night, when they respire, and during decomposition. Hypoxia, a depletion of DO under these conditions, can impact aquatic organisms and is often the cause of a fish kill. Consistently high levels of dissolved oxygen are best for a healthy ecosystem.

Appendix A: Figure 1 shows the 2014 to 2018 Dissolved Oxygen levels for the Mississippi River and its tributaries. The data shows the typical seasonal changes in DO, with low levels in the early spring, rising to its high levels in the summer months (Jun to Aug) and decreasing to its lowest levels in the late fall (Oct & Nov) when the aquatic vegetation dies and decomposes.

Figures 14 and 15 show the dissolved oxygen (DO) data results for the river and the tributaries, presented as a comparison between the two nine year periods of 2002 to 2010 and 2011 to 2019.

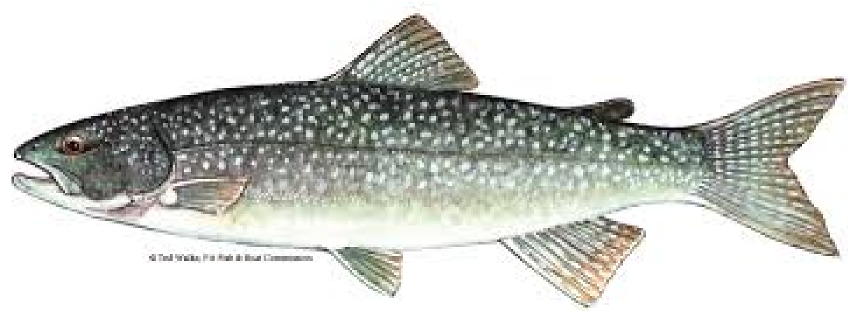
General observations and trends:

- The DO data generally falls in the 7 to 12 mg/L range which is regarded as very good for most stream fish.
- The river sites show no marked trends over the 16 year period, with the exception of Fergusons Falls, which shows an overall decrease in DO over time.
- DO levels in the tributaries have also remained fairly consistent with just the Clyde River showing a slight decline, and Buckshot Creek showing an increase over time.

Dissolved oxygen is measured in mg/L.

- 0-2 mg/L: not enough oxygen to support life.
- 2-4 mg/L: only a few fish and aquatic insects can survive.
- 4-7 mg/L: good for many aquatic animals, low for cold water fish
- 7-11 mg/L: very good for most stream fish

(Behar, 1997)



Source: https://www.fws.gov/
Lake Trout: both cold water temperatures and dissolved oxygen levels in the lower water layer, are critical components of lake trout habitat.

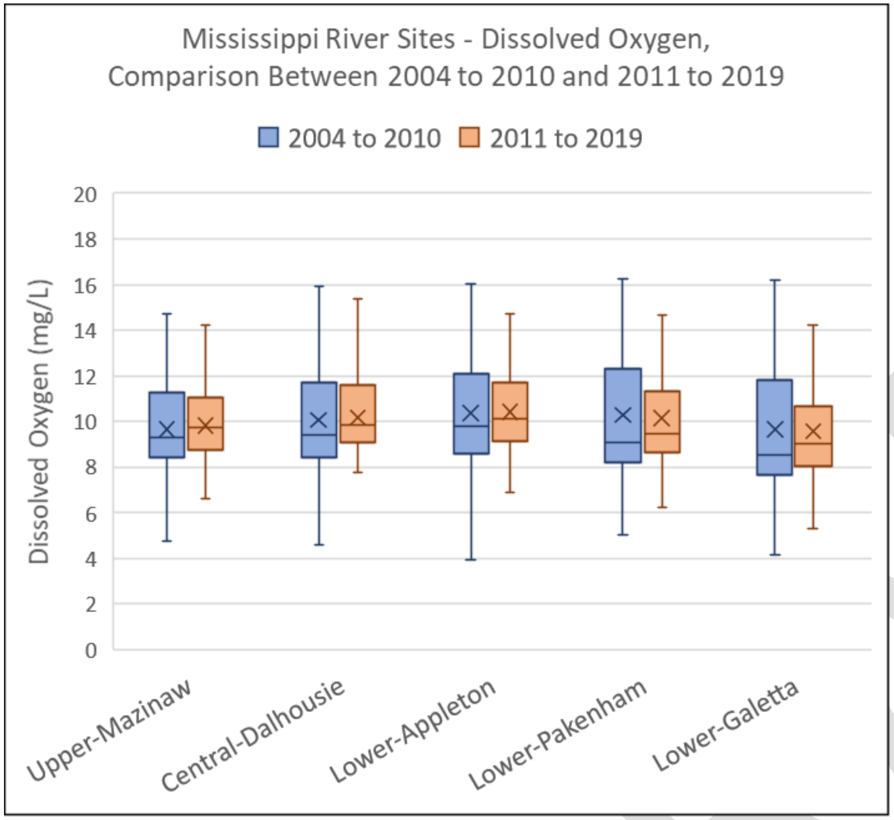


Figure 14: Mississippi River- Dissolved Oxygen

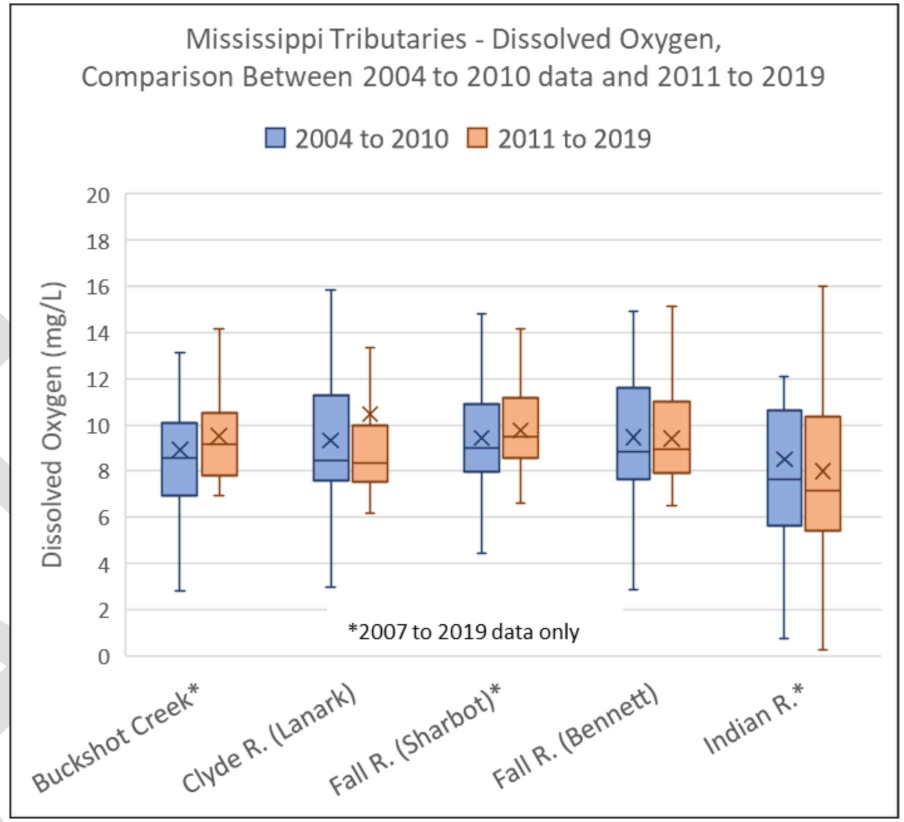
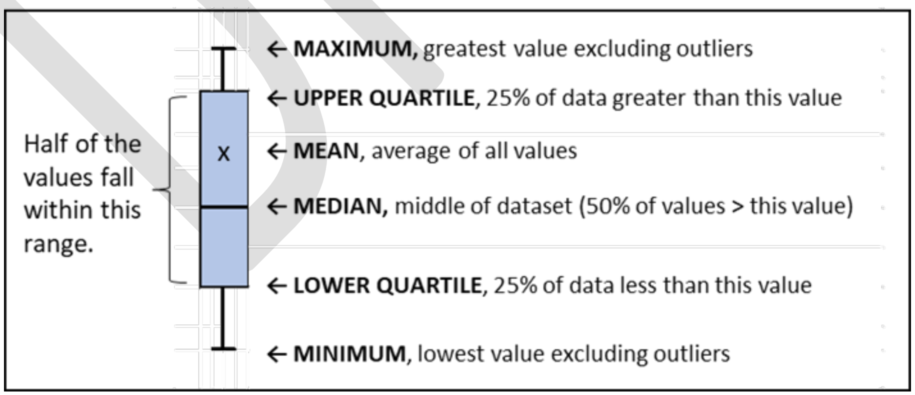


Figure 15: Mississippi Tributaries - Dissolved Oxygen



Conductivity

Conductivity is a measure of the water's ability to conduct electricity. A higher conductivity value indicates that there are more chemicals dissolved in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. Conductivity measurements do not identify the specific ions however significant increases in conductivity may indicate that polluting discharges have entered the water, and it is usually an indicator of road salt runoff.

Every watercourse will have a baseline conductivity depending on the local geology and soils. For example, limestone leads to higher conductivity because of the dissolution of carbonate minerals. Higher conductivity will result from the introduction of various other ions including nitrate, phosphate, and sodium.

Figures 16 and 17 show the conductivity data results for the river and the tributaries, presented as a comparison between the two nine year periods of 2002 to 2010 and 2011 to 2019.

The basic unit of measurement for conductivity is micro Siemens per centimeter (µS/cm).
There are no PWQO or CWQG for conductivity.
Research suggests that freshwater streams ideally should have a conductivity between 150 to 500 µS/cm to support diverse aquatic life.
(Behar, 1997)

General observations – River sites:

- Measured conductivity in the river and tributaries generally falls within a range of 75 to 250 µS/cm, on the low end of the recommended range. With little change between the two nine year periods

- The data shows increasing conductivity levels moving from the upstream to the downstream end of the river.

- Mazinaw and Dalhousie sites both are consistently below 150 µS/cm, the lower end of the preferred range for aquatic diversity. This may reflect baseline conditions related to the bedrock influence of the Precambrian Shield, where the dissolution of carbonates would be lower than the off-shield part of the watershed.

General observations – Tributary sites:

- The Indian River measures the highest conductivity levels and the Clyde River the lowest, with Buckshot Creek and the Fall River levels in between. Again, this may reflect the bedrock geology.

- The graphs show the conductivity levels to have remained relatively consistent between the two nine year periods of record. .

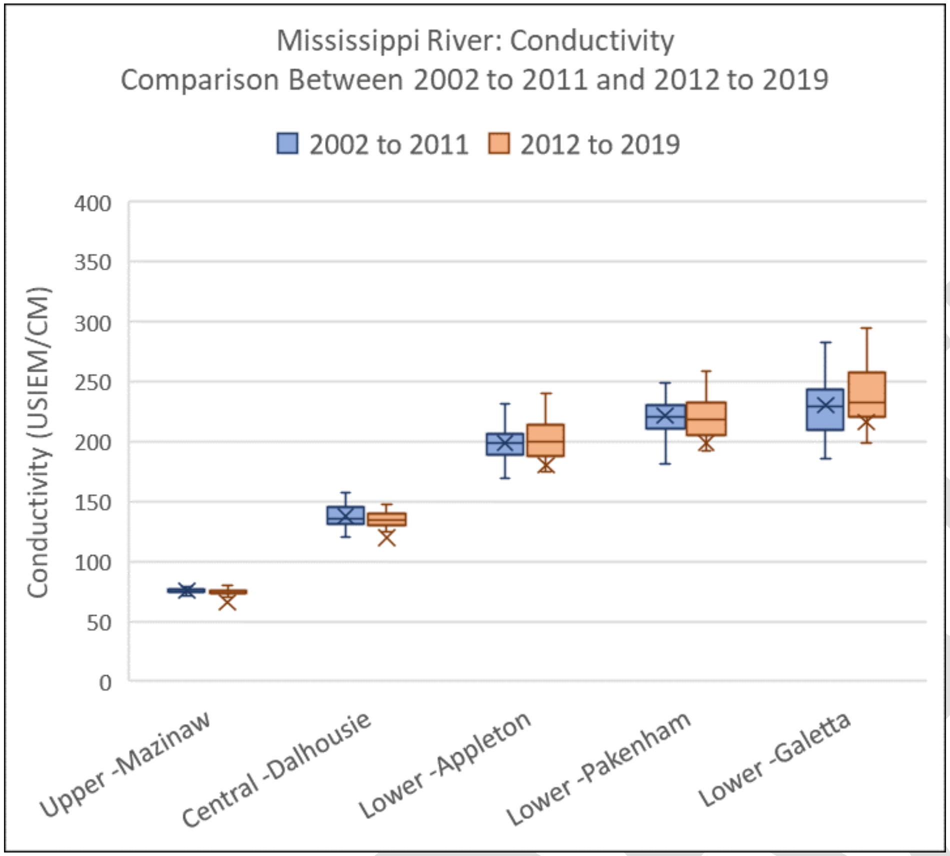


Figure 16: Mississippi River - Conductivity

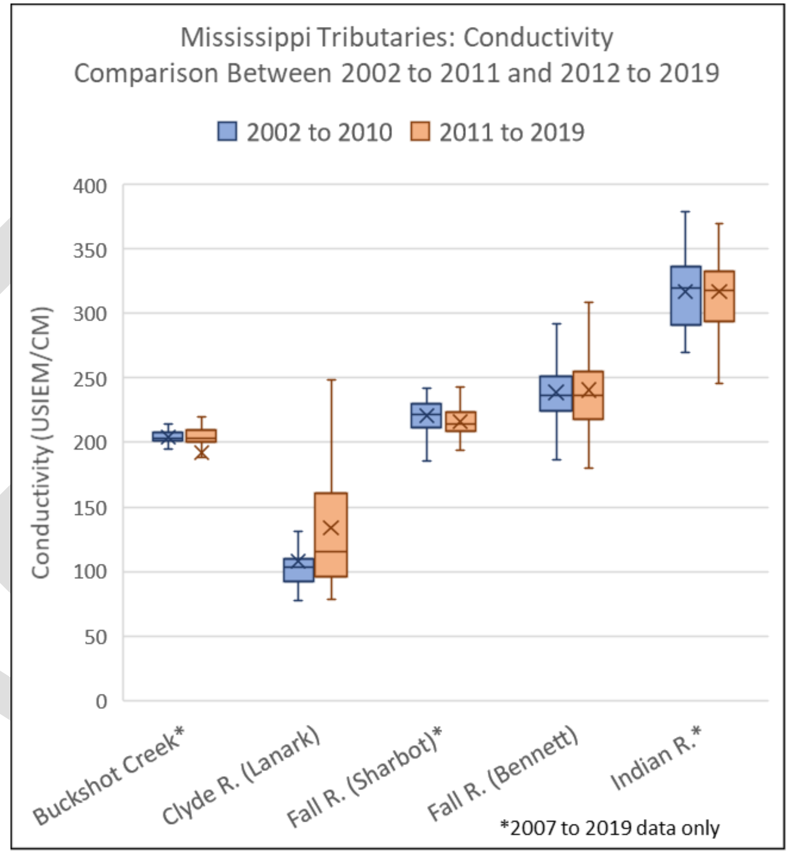
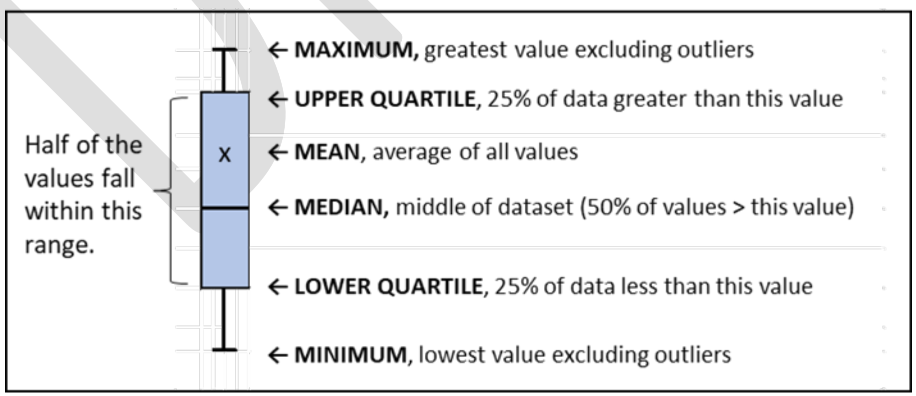


Figure 17: Mississippi Tributaries - Conductivity



Chloride

The presence of chloride (Cl) where it isn't naturally occurring indicates possible water pollution from human activity and land use. Road salt, agricultural chemicals, and human and animal wastes are the main sources of chloride in surface water. Increases in chloride, either seasonally or over time, can mean that one or more of these sources is impacting the waterbody. Since waterbodies vary in their natural chloride content, it is important to have background data or a long term database to document changes.

Figures 18 and 19 show the chloride data results for the river and the tributaries, presented as a comparison between the two nine year periods of 2002 to 2010 and 2011 to 2019.

General Observations - River Sites

- The chloride concentrations measured throughout the river generally fall within a range of 2 mg/L to about 13 mg/L, well within acceptable limits.
- The data shows a general increase in Cl concentrations moving from the upstream end to the downstream end of the river, though Dalhousie shows lower levels than the Mazinaw site upstream, possibly a dilution factor.
- The data suggests an overall consistent increase in river Chloride levels between the two nine year periods.

There is no PWQO for Chloride, however increased chloride in surface water results in increased salinity which can affect the health of some aquatic organisms. The CWQG for the protection of aquatic life has as a guideline for chloride: 120 mg/L for long-term exposure and 640 mg/L for short-term exposure

(CCME, 2011).

General Observations – Tributary Sites

- Buckshot Creek and the Clyde River show the lowest concentrations with the Fall River and the Indian River showing notably higher concentrations.
- Buckshot, the Clyde and the Indian River each show increased Chloride levels between the two nine year periods, and the Fall River shows a decrease[24].

[24] The Fall River is the only tributary that is crossed by Highway 7, changes in road salt application practices may have an impact on Chloride levels.

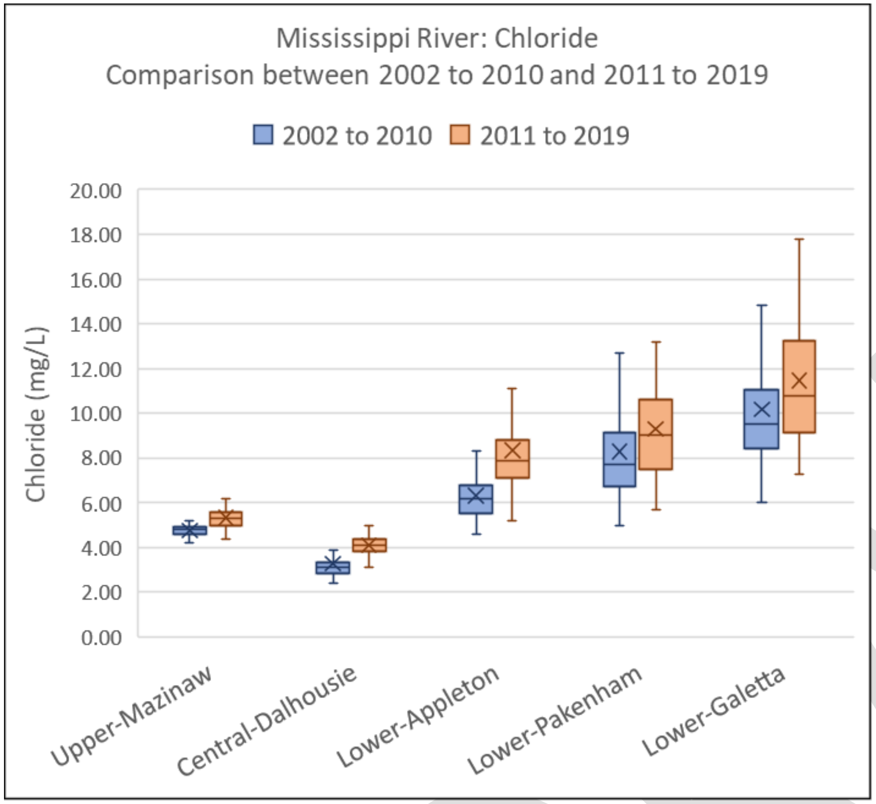


Figure 18: Mississippi River - Chloride

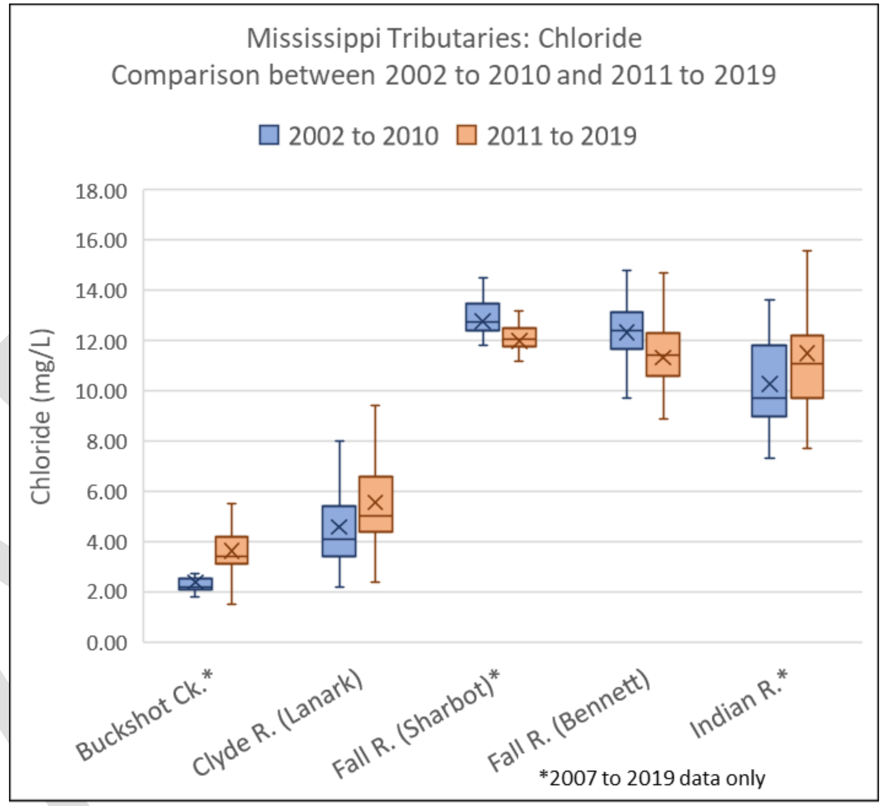
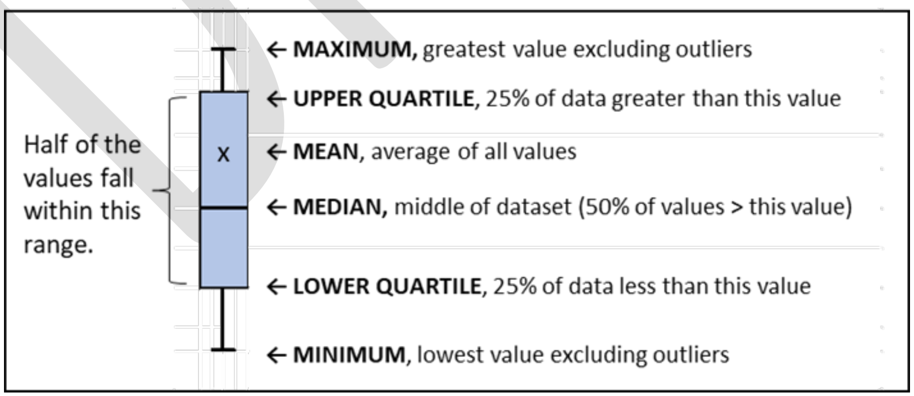


Figure 19: Mississippi Tributaries - Chloride



Algae

Algae are naturally occurring aquatic organisms, similar to plants, which contain chlorophyll and produce their own food through photosynthesis. They appear in many different varieties and are often difficult to properly identify without a microscope or other laboratory techniques. In moderate levels algae are part of a healthy aquatic system and are a fundamental base of the aquatic food chain. A proliferation of algae, however, can be indicative of a change in the lake environment and a resulting impairment of ecological and aesthetic conditions. Algae is difficult to monitor because it is so spatially variable and the various species are difficult to identify. As such, there is very little documented information about algae types and distribution throughout the watershed.

Blue Green Algae and Harmful Algae Blooms (HABs).

Although many different algae species can experience rapid growth resulting in a bloom, of significant concern for water users are blooms of blue-green algae. Blue-green algae, which is actually a form of bacteria rather than an algae and is scientifically referred to as Cyanobacteria because it is typically cyan blue in colour. It may produce a variety of toxins called microcystins, two of which are neurotoxins (brain toxin) or hepatotoxins (liver toxin), and which can cause serious illness (Huynh and Serediak, 2006).

Identifying HABs

Laboratory testing is needed to confirm the presence and concentration of mycrocystins in order to determine whether the bloom exceeds the threshold for classification as a public health risk. In Ontario, the Ministry of Environment, Conservation and Parks (MECP) is responsible for the testing of suspected blue-green algae blooms and the local Public Health Unit is then responsible for public outreach and education in the event of a HAB.

KEY CONSIDERATIONS

There is little documentation of algae in the watershed and it is difficult to monitor.

Moderate amounts of algae are a healthy part of the aquatic ecosystem.

A proliferation in the form of a bloom may indicative of deterioration in ecosystem health.

Harmful Algae Blooms (HABs) of the Blue-green algae/cyanobacteria strain produce toxins that are harmful to humans and other living creatures.

Confirmed HAB occurrence on the Mississippi system were first officially documented in 2016 on Mississippi Lake some occurrences in subsequent years.

Research suggest that temperature, particularly sharp rise in temperature, is a key factor in activating an algae bloom.

In the Mississippi River Watershed, Blue green (cyanobacteria) Harmful Algae Blooms (HABs) were first officially documented and confirmed by the Ministry of Environment, Conservation and Parks (MECP) in 2014, with occurrences Mississippi Lake and Dalhousie Lake. HABs were again confirmed on Mississippi Lake in 2015, 2016 and 2018. In all cases, the confirmed HABs occurred in mid to late September and early October.

The conditions that typically produce an algae bloom include calm water, warm sunny conditions, shallow warm water and, usually, high nutrient levels (although this does not always seem to be necessary). These conditions usually occur in late summer and early fall; however, due to the effects of climate change this window may be shifting.

Algae Research in the Mississippi River Watershed

In 2016, MVCA, Queen's University and the Mississippi Lakes Association (MLA) collaborated in undertaking a research project to study factors affecting algae bloom occurrences on Mississippi Lake. The modelling exercise assessed predicted algae growth relative to changes in nutrient inputs, temperature and spatial impacts (inflows, water depth, location on the lake, etc.). It found a high correlation between predicted peaks in algae growth and sharp increases in air temperature. It also demonstrated a strong the localized impact of nutrient inputs from the smaller tributaries flowing directly into the lake, compared to the impact of nutrient loading from the river itself.)

Blue- Green Algae Bloom, Mississippi Lake Sept 25, 2014

Lake Temperature

In 2016 MVCA also began a program to undertake continuous (hourly) lake temperature on several representative lakes throughout the MRW. The lakes include Canonto, Dalhousie, Kashwakamak, Mississippi, and Sharbot Lakes. The hourly data is collected annually from May to October. It will be used in conjunction with information on algae occurrences in order to better understand the relationship between temperature and algae blooms and to support related ecological modelling projects.

Fish & Fish Habitat

Fish are a critical component of the watershed ecosystem, providing a range of ecological, social, cultural and economic benefits. The Mississippi River system support both warmwater and coldwater fisheries. Protecting the habitat of these species is important to maintaining a healthy aquatic ecosystem. The MNRF oversees the management of the recreational fishery, whereas MVCA's fish monitoring effort is focused on the collection of baseline stream population data to identify any threats to these fisheries.

Recreational Fishery and Habitat

The Ministry of Natural Resources and Forestry (MNRF) oversees the management of recreational fisheries throughout the province. The Mississippi River Watershed lies within the MNRF Fish Management Zone (FMZ) 18[25]. Through its Broad-scale Monitoring (BsM) Program the MNRF monitors recreational fish populations by collecting information on a representative number of lakes in each FMZ, generally following a 5 year rotation. The first sampling cycle of the BsM program occurred from 2008 to 2012. Appendix A: Tables 7 and 8 list the lakes that have been monitored and the species composition.

The species that make up the highest percent of overall composition are the panfish, including Rock Bass, Yellow Perch, Pumpkinseed and Bluegill, and Smallmouth Bass. These species spawn in generalized locations that are widely distributed throughout the watershed. Other species such as Walleye, Lake Trout, and Brook Trout have more specialized spawning habitat requirements that result in these species returning to specific very localized spawning sites year after year. Mapping of these known specialized spawning locations, shown in Figure 20, has been produced to assist in protecting these areas from the impacts of water management and planning/development activities and decisions[26].

Fish Sanctuaries

The MNRF identifies fish sanctuaries where fishing is restricted during certain times of year. They include locations on:

KEY CONSIDERATIONS

Fisheries management is the responsibility of the MNRF. MVCA undertakes monitoring of fish species on streams to track stream health.

Most fish species have relatively general, more commonly available habitat requirements. Specialized fish habitats include walleye spawning locations, cold water streams and cold water lakes (Lake Trout Lakes).

Cold water streams and lakes that are of special importance because of their sensitivity to environmental stressors and the specialized species they support (i.e. brook trout, lake trout).

Lake Trout lakes are afforded special protection under provincial policy and guidelines because of their sensitivity to development impacts.

These features will be particularly vulnerable to climate change impacts.

The current Lake Capacity Assessment model is limited in its applicability and scope and is undergoing revision.

[25] Fish populations and fishing regulations are managed according to Fisheries Management Zones (FMZs). There are 20 FMZs across the province.
[26] Mapping prepared by MVCA based on in-house data and knowledge.

- Crotch Lake and Mississippi River - from Sidedam Rapids
- Dalhousie Lake and Mississippi River – at bridge crossing the Mississippi River where it enters Dalhousie Lake
- Indian River where it enters Clayton Lake
- Mississippi River - Innisville to Mississippi Lake
- Mississippi River – Almonte falls and upstream side of bridge on Lanark County Road 20.

Coldwater Systems

The Mississippi River Watershed has several historically recognized cold and cool stream systems which include Bolton Creek, Long Sault Creek, Paul's Creek, Easton's Creek, and the Clyde River. These are especially important as they serve to cool down their systems and provide habitat for a number of highly valued and specialized fish species including brook trout.

Coldwater streams are also the most susceptible to impacts from climate change. In 2015, MVCA began collecting water temperature data from a number of streams throughout the watershed that were either known or suspected to be cool/cold water systems. This data will become increasingly valuable over time.
Appendix A: Note 8 and Table 9 provide monitoring information for these streams.

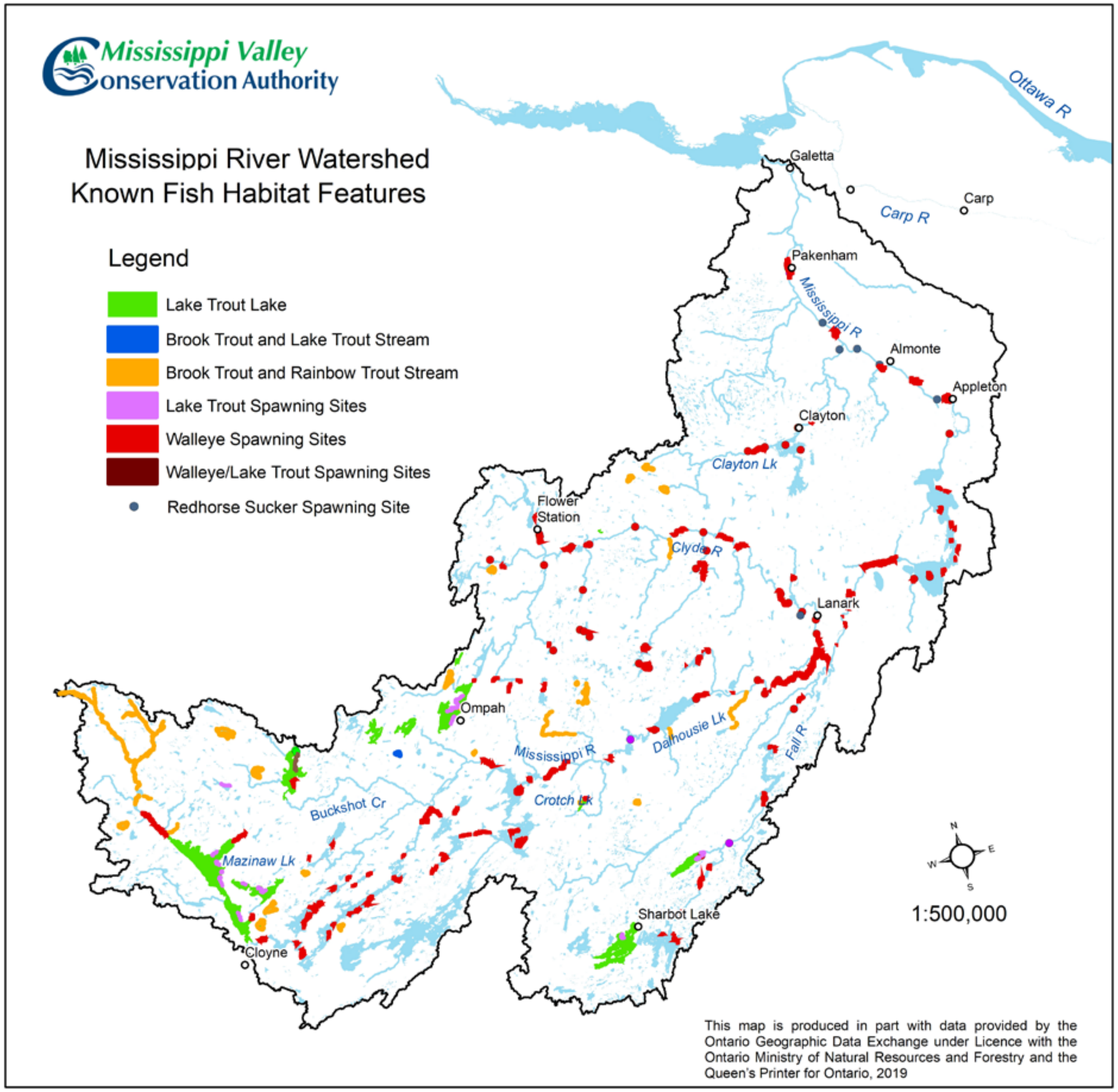


Figure 20: Known Fish Habitat Features

Lake Trout and Cold Water Lakes

Lake Trout is a highly specialized species that has adapted to a narrow range of environmental conditions. It is also valued among anglers making it an important fishery resource. Both cold water temperatures and dissolved oxygen levels in the lower water layer, are critical components of lake trout habitat. They spawn in the autumn in water between 8.9°C and 13.9°C, over lake areas with a boulder or rubble substrate. They also occasionally spawn in rivers. During summer they remain in the deeper waters in water temperatures of around 10°C.

There has been a general decline in both the quality of the sport fishery for Lake Trout and in Lake Trout habitat in many lakes. Lake Trout lakes are particularly vulnerable to the impacts of human activities, including fishing stresses, enrichment from cottage septic systems, acidification, species introductions, and habitat destruction. Because of these vulnerabilities, MNRF has specifically identified “lake trout lakes” and their drainage basins as a special fisheries resource to be considered when making land use planning decisions.

Status of Lake Trout Lake in the Mississippi River Watershed

MNRF maintains a formal list of lakes designated for lake trout management (Inland Ontario Lakes Designated for Lake Trout Management, 2015), dividing the lakes according to two classifications:

- “Natural” Lake Trout lakes - represent lakes that naturally support Lake Trout or have the capacity to be restored to support lake trout; and
- “Put-Grow-Take” lakes - represent lakes that are stocked to provide a recreational fishery, but may not have originally supported Lake Trout and may not support natural reproduction.

In the Mississippi River Watershed, six lakes are classified as “Natural” Lake Trout and four lakes classified as “Put-Grow-Take” lakes. See Appendix A: Table 10. There are also known “Cold Water“ lakes within the watershed that are not officially recognized or managed by MNRF as lake trout lakes but that may have either supported lake trout populations in the past or may continue to have some lake trout and/or other cold water species present. These lakes are managed as warm water lakes and are not afforded the same special protection measures as the MNRF classified lakes.

Appendix A: Table 11 lists six lakes known to have had lake trout population that have since been extirpated because of changes in the lake environment. The changes included negative impacts to their spawning success resulting from draw down of water levels in the fall on the lakes that are managed as reservoirs (Big Gull, Crotch, Kashwakamak and Mississagagon), and competition from the introduction of other species (i.e. Walleye). In the case of Murray Lake, it is thought that impacts to the inflow from the Tatlock Quarry resulted in deterioration of habitat conditions.

Lake Capacity and Lake Trout Lake Protection

The Ministry of Environment, Conservation and Parks (MECP) and MNRF are the lead agencies responsible for technical support to municipal planning authorities with regard to lake capacity and lake trout habitat protection. The MECP Lakeshore Capacity Assessment Handbook (2010) was developed as a tool to help protect the water quality of Precambrian Shield inland lakes by preventing excessive development along shorelines[27]. The capacity model primarily assesses predicted increases in phosphorus levels to determine the level of development that can be sustained without exhibiting any adverse effects to water quality (i.e. increased aquatic vegetation and algae growth, and depletion of oxygen). The handbook recommends a 300 metre development setback for lake trout lakes deemed to be at capacity.

Lake trout lakes in the Mississippi River Watershed deemed to be at capacity include:

- Buckshot Lake
- Kishkebus Lake
- Mosque Lake
- Little Green Lake
- Shabomeka Lake
- Silver Lake

Mississagagon Lake is not classified as a lake trout lake by the Province of Ontario. In 2016, the Ministry of Environment, Conservation and Parks (MECP) designated Mississagagon Lake to be 'at capacity' for new development. See Appendix A: Table 12 for full list of lake trout lakes.

.

Palmerston Lake is a Lake Trout Lake

[27] The MECP Lake Capacity Assessment Handbook was developed for lake on the Precambrian Shield and does not transfer well to lakes that are not on the shield. The province is working on a new model that is expected to encompass a broader range of factors.

Invasive Species

Invasive species are plants, animals, and micro-organisms introduced by human action outside their natural past or present distribution whose introduction or spread threatens the environment, economy, or society, including human health. Invasive species can out-compete native species for resources, such as food and habitat, and introduce new diseases and parasites. Some species, such as Eurasian Milfoil, can form colonies so thick they disrupt recreational activities, such as boating and swimming, by choking navigation channels and popular swimming areas. Invasive organisms reduce the biodiversity of an area, by crowding out native species through predation, parasitism, disease, and competition.

Changes in climate, such milder winters and longer warm periods, can create conditions favorable to the introduction of invasive species. There is growing concern over the potential impacts of introduced species and the effect they will have on our ecosystems and quality of life. An expanding list of invasive species are impacting the Mississippi River Watershed. Most concerning at this time include aquatic species like the Zebra Mussels and Eurasian Water Milfoil in its lakes, Phragmites in wetland areas, and forest invasive species like the Butternut Canker. Emerald Ash Borer, Beech Bark Disease.

Other forest invasive species not yet present but pose a threat of spread into the watershed include: Asian Longhorned Beetle, Oak wilt, Hemlock Woolly Adelgid and Spotted Lanternfly.

MVCAs monitoring efforts have largely focused on aquatic invasive species. Look at Appendix A: Table 13 for a full list and Note 9 for a list of Invasive Species initiatives.

KEY CONSIDERATIONS

Invasive species are a growing concern in all jurisdictions.

MVCA has partnered with the Ontario Federation of Anglers and Hunters in monitoring for Zebra Mussels and several other aquatic invasive.

The increased incidence and proliferation of Eurasian Water Milfoil, and aquatic plant, is a growing concern throughout the watershed.

Eurasian Water Milfoils is a fast-growing perennial, that forms dense underwater mats that shade other aquatic plants. When large stands begin to die off in the fall, the decaying plants can reduce oxygen levels in the water. It is easily spread when water currents, boat propellers, trailers or fishing gear carry plant fragments to new areas. Source: http://www.invadingspecies.com/

Invasive Species Monitoring Program:

MVCA has partnered with the Ontario Federation of Angles and Hunters (OFAH) to implement an Invasive Species Monitoring Program throughout the watershed, focused on monitoring for Zebra Mussels, Spiny Water Flea and Rusty Crayfish. See Appendix A: Table 14.

Zebra Mussels were first recorded in the parts of the MRW in the late 1990's. Once established, they can have enormous impacts on the health of the characteristics and ecosystem. They out-compete native species of food sources. They also cause clearer water, which allows sunlight to penetrate deeper, encouraging the growth of aquatic vegetation including invasive plants such as Eurasian watermilfoil. Zebra mussels also avoid eating certain types of plankton which can cause increasing occurrences of toxic algal blooms.

Zebra Mussels
http://www.invadingspecies.com/

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Town of Mississippi Mills Natural Heritage Concept Plan

Appendix A

For Backgrounder Three: Natural Systems

Mississippi River Watershed Plan

List of Figures

List of Notes

List of Tables

Note 1: Ducks Unlimited Study on Wetland Loss

Building on a study done by Environment Canada in 1987, Ducks Unlimited analyzed historic wetland conversions throughout Southern Ontario to measure wetland loss since pre-settlement (c.1800) up to 2002. They measured an overall reduction of approximately 1.4 million hectares (Ha) or 72% of the pre-settlement wetlands, with 3.5% loss occurring as recently as the 20 years between 1982 and 2002. Parts of eastern Ontario were listed among the areas showing the most drastic decline, where over 85% of the original wetlands have been converted to other uses (Ducks Unlimited, 2010).

In the Mississippi River watershed wetland losses have been greatest in the more populated and good agricultural areas and least in the Precambrian (Canadian Shield) area where the rugged topography and shallow soil cover are generally not suited to farming. It is estimated that 65% of the original wetlands in the eastern half of the watershed have been lost.

Table 1 presents the results for the municipalities within the Mississippi River Watershed that were included in the Ducks Unlimited study, showing estimated losses of between 41 and 98%, with most showing losses greater than 75%. The data also shows that in parts of the watershed, substantial loss has continued to occur more recently in the 20 years between 1982 and 2002. Due to gaps in available data, North Frontenac, Addington Highlands and parts of Lanark County, were not assessed.

Table 1: Wetland Losses in Mississippi River Watershed Municipalities

Municipality	Former Ward	Pre Settlement (c 1800) Wetland Amount		1967 Wetland Amount		2002 Wetland Amount		Wetland Lost by:		
								1967	1982	2002
		Ha	% of Twp.	Ha	% of Twp.	Ha	% of Twp.	% Lost	% Lost	% Lost
Beckwith*		13854	53.4	8752	33.8	8138	31.4	36.8	29.6	41.3
Carleton Place		65	10.8	3	0.5	4	0.7	95.6	93.3	93.9
Drummond/ N. Elmsley	Drummond*	13576	53.5	8414	33.1	7896	31.1	38	32.5	41.8
Lanark Highlands	Dalhousie	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Darling**	4764	17.6	3335	12.3	N/A	N/A	30	N/A	N/A
	Lanark*	8063	29.8	5872	21.7	648	2.4	27.2	19.6	92
	Lavant	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	North Sherbrook	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mississippi Mills	Pakenham*	3829	14.8	2136	8.2	63	0.2	44.2	41.1	98.4
	Ramsay*	4934	18.7	2447	9.3	1230	4.7	50.4	41.7	75.1
Tay Valley Township	Bathurst *	7817	31.2	3543	14.1	1557	6.2	54.7	53.4	80.1
	South Sherbrooke**	3618	21.1	2172	12.7	N/A	N/A	40	99.5	N/A
Ottawa	March	4575	34	1296	10.6	1103	8.2	71.7	68.8	75.9
	West Carleton	27567	44.1	6944	12.2	6725	10.8	74.8	72.3	75.6

*partial or missing 2002 coverage **partial or missing 1982 and 2002 coverage

Table 2: Provincially Significant Wetlands within the Mississippi River Watershed

Wetland Name	Subwatershed	Area (km^2)	Wetland Type (%)			
			Bog	Fen	Swamp	Marsh
Mud Lake Wetland	Upper Mississippi	3.1		2	50	48
McCullochs Mud Lake Wetland	Central Mississippi	2.9			60	40
McDougall's Mud Lake Wetland	Central Mississippi	0.9	n/a	n/a	n/a	n/a
Stump Lake	Central Mississippi	1.0			15	85
Hopetown Wetland	Clyde River	2.6			85	15
Joes Lake	Clyde River	3.1			35	65
Bennet Lake	Fall River	1.2			50	50
Bolton Creek	Fall River	2.7			79	21
Little Mud Lake Wetland	Fall River	1.1			20	80
Lower Fall River	Fall River	0.2	n/a	n/a	n/a	n/a
Silver Lake Wetland	Fall River	0.9	10		80	10
Upper Fall River	Fall River	1.1			88	12
Black Creek Wetland	Mississippi Lake	0.7	3		95	2
Blueberry Marsh	Mississippi Lake	5.5	14		83	3
McEwen Bay Wetland	Mississippi Lake	2.3			50	50
Mississippi Lake	Mississippi Lake	6.3			60	40
Ramsbottom Lake	Mississippi Lake	0.7	35		13	52
Scotch Corners Complex	Mississippi Lake	2.0			42	58
Steward Lake - Haley Lake Complex	Mississippi Lake	18.7			42	58
Gillies Lake - Kerr Lake Wetland	Mississippi Lake / Clyde River	4.7	n/a	n/a	n/a	n/a
Playfairville - Mud Lake Complex	Mississippi Lk/Fall / Clyde/Central	6.5			70	30
Appleton Wetland	Lower Off Shield	6.7			75	25
East Burnt Lands	Lower Off Shield	1.1	n/a	n/a	n/a	n/a
Lower Mississippi River Marsh	Lower Off Shield	0.3	n/a	n/a	n/a	n/a
Manion Corners Complex	Lower Off Shield	10.4	8	1	87	4
Clayton-Taylor Complex	Lower On Shield	10.6			15	85
Wolfe Grove Complex	Lower On Shield	2.6			30	70
Pakenham Mountain Complex	Lower On Shield / Lower Off Shield	35	n/a	n/a	n/a	n/a
	Total Area:	135				

Note 2: Wetland Types

There are four types of wetland:

- Swamp: the most common and diverse type, largely dominated by trees and shrubs, large diversity of vegetation and wildlife;
- Marsh: have open areas of water with floating plants (ex. water lilies) and emergent plants (i.e. cattails), critical habitat for migratory birds, breeding habitat for amphibians, and wide variety of other plant and animal species;
- Bog: extremely rare in Southern Ontario, very old wetlands that are peat covered with a carpet of sphagnum moss, low in nutrients and strongly acidic and receive water only from rainfall and surface water;
- Fen: rare in Southern Ontario, less acidic and more nutrient rich than bogs allowing for a higher diversity of plant life including sedges, grasses and reeds.

In addition to being rare, bogs and fens are particularly sensitive to subtle shifts in surface water chemistry. There are currently no policy requirements specific to enhanced protection measures for bogs or fens.

While there are no specific policies related to wetland type, greater protection and more intensive water-quality sampling programs may be necessary for proposals relating to development that may affect these wetland types. Such an assessment would need to consider both chemical concentrations and chemical loadings using a mass balance approach. There just five PSWs in the MRW that are officially identified as containing areas of bog: Silver Lake, Black Creek, Blueberry Marsh, Ramsbottom Lake and Manion Corners Complex. Mud Lake PSW in the Upper Mississippi subwatershed is the only wetland where an area of fen is identified.

A number of larger bogs and fens within the MRW have been identified as Areas of Natural and Scientific Interest (ANSIs) - See Section X for more detail. In the PPS (2.1.5) significant ANSIs fall under the “conditional protection” level whereby development and site alteration is not be permitted unless it has been demonstrated that there will be no negative impacts.

Note 3: Areas of Natural and Scientific Interest (ANSIs)

Life science ANSIs are significant representative segments of Ontario's biodiversity and natural landscapes, containing relatively undisturbed vegetation and landforms, and their associated species and communities. They include specific types of forests, valleys, prairies, and wetlands. Provincially significant life science ANSIs include the most significant and best examples of the natural heritage features in the province. Many ANSIs coincide (overlap) with other significant natural heritage features and areas such as significant wetlands, significant valley lands, and significant woodlands. Earth Science ANSIs contain natural heritage values that are representative of the province's geological diversity and natural landscapes, including the best representations of bedrock, fossils and glacial landforms.

Note 4: Natural Heritage Systems

A natural heritage system is defined by the Province of Ontario as: "A system made up of natural heritage features and areas, and linkages intended to provide connectivity (at the regional or site level) and support natural processes which are necessary to maintain biological and geological diversity, natural functions, viable populations of indigenous species and ecosystems. These systems can include natural heritage features and areas, federal and provincial parks and conservation reserves, other natural heritage features, lands that have been restored or have the potential to be restored to a natural state, areas that support hydrologic functions and working landscapes that enable ecological functions to continue. The Province has a recommended approach for identifying natural heritage systems, but municipal approaches that achieve or exceed the same objectives may also be used" (Provincial Policy Statement 2014).

Note 5: Natural Heritage System Type Projects

Sustaining What We Value:

Headed by MNRF in partnership with a number of organizations, it identifies a Natural Heritage System using the Marxan model (a conservation planning decisions support software). It was designed to provide a tool to prioritize stewardship, land securement and conservation efforts, and to support municipalities land use planning efforts with a focus on providing a link between health ecosystems to healthy human communities. The mapping is at a regional landscape scale. In the Mississippi River Watershed, the project area extends into the southeast part of the watershed. It follows the boundaries of EcoDistrict 6E-11 which covers an area that extends just west and north of Mississippi Lake and north of Almonte and the Burnt Lands Alvar.

A2A (Algonquin to Adirondacks Collaborative):

A mapping project that builds on the Sustaining What We Value's mapping, it identifies connected natural habitat between the Adirondack Park in New York State and Algonquin Provincial Park in Ontario. The goal was: to create a habitat connectivity mapping tool that will support land conservation, stewardship activities, land use planning, and other conservation efforts by planning authorities, conservation groups, community organizations, and residents in the A2A region. It undertook a connectivity mapping project (2013-2014) with the OMNRF, expanding on the Sustaining What We Value maps, with the same methodology, to include the entire A2A region. The mapping is at a regional landscape scale. In the Mississippi River Watershed the A2A covers the entire area within Ecoregion 6E which generally corresponds with the area that lies Off-Shield.

County of North Frontenac Natural Heritage Study:

The study includes evaluation and mapping of OMNRF identified natural heritage features such as wetlands, forest cover, and wildlife habitat at a regional scale across all of Frontenac County. It also include some generalized connections between these features. The mapping is accompanied with policy recommendations that can be used by planners to protect significant natural features from development. It was developed to set a foundation for the natural heritage policies of the first draft of the County Official Plan (2014). In the Mississippi watershed it includes all of the lands that are within Central and North Frontenac Townships.

City of Ottawa

Ottawa has identified a natural heritage system comprised of a variety of significant natural features, associated contributing features and connecting linkages. This Natural Heritage System was defined as part of a comprehensive Official Plan Review process that was finalized in 2009. The NHS is now officially identified as part of the Schedules of the Official Plan and its protection is supported through associated OP policies.

The Natural Heritage System mapping provides for a relatively fine scale of mapping that covers all lands within the City and thus covers all Ottawa parts of the Mississippi River watershed.

Nature Conservancy of Canada – Great Lakes Blueprint

Identifies a network of high quality natural sites that can guide conservation efforts to sustain and further enhance biodiversity in Ontario. It also lists species targeted for protection. Two blueprints were produced, one for Aquatic Biodiversity and one for Terrestrial Biodiversity. The aquatic blueprint uses a watershed scale to identify Parks and Protected Areas, Designated Natural Heritage Areas, and Priority Stewardship Areas that are further categorized as Natural and Non-natural. The Terrestrial Blueprint uses EcoDistricts to identify those same features. The Mississippi watershed falls under Smith Falls EcoDistrict 6E-11 and Bancroft EcoDistrict 5E-11. See map below.

Table 3: Active PWQMN Sites across the Mississippi River Watershed

Waterbody/Subwatershed	Location	Agency	Year Started	Site ID
Buckshot Creek	Hwy 509 at gauge	MECP	2007	18343000102
Clyde River	Dam d/s of Lanark	MECP	1970	18343052002
Fall River	Sharbot Lake outlet	MECP	2005	18343000302
Fall River	Bennett Lake outlet	MECP	1981	18343061002
Indian River	Concession Road 8	MECP	2007	18343002002
Upper Mississippi River	Mazinaw Lake	MECP	1970	18343023002
Central Mississippi River	Dalhousie Lake outlet	MECP	1970	18343017502
Mississippi Lake	Ferguson Falls bridge*	MVCA	2005	18000020
Lower Mississippi River	Appleton bridge	MECP	1970	18343006102
Lower Mississippi River	Dam below Pakenham	MECP	1970	18343003402
Lower Mississippi River	Galetta Railroad trestle	MECP	1966	18343003002

*MVCA site monitored using PWQMN scheduling and protocols

Table 4: PWQMN Paramaters

Parameter	Min Detection Limit	Units
Aluminum	1	ug/L
Aluminum	2	ug/L
Antimony	0.5	ug/L
Arsenic	1	ug/L
Barium	0.5	ug/L
Barium	0.1	ug/L
Beryllium	0.5	ug/L
Beryllium	0.1	ug/L
Bismuth	5	ug/L
Boron	10	ug/L
Cadmium	0.5	ug/L
Cadmium	0.8	ug/L
Calcium	0.05	mg/L
Chromium	5	ug/L
Chromium	1	ug/L
Cobalt	1	ug/L
Cobalt	1	ug/L
Copper	0.5	ug/L

Parameter	Min Detection Limit	Units
Hardness	1	mg/L
Iron	30	ug/L
Iron	3	ug/L
Lead	0.5	ug/L
Lead	7	ug/L
Lithium	5	ug/L
Magnesium	0.01	mg/L
Manganese	0.5	ug/L
Manganese	0.5	ug/L
Mercury	5	ng/L
Molybdenum	0.5	ug/L
Molybdenum	2	ug/L
Nickel	2	ug/L
Nickel	2	ug/L
Nitrogen; total	0.05	mg/L
Phosphorus; total	0.005	mg/L
Potassium	0.02	mg/L
Selenium	5	ug/L

Parameter	Min Detection Limit	Units
Silver	0.5	ug/L
Silver	9	ug/L
Sodium	0.02	mg/L
Strontium	1	ug/L
Strontium	0.3	ug/L
Thallium	0.5	ug/L
Tin	9	ug/L
Titanium	5	ug/L
Titanium	0.5	ug/L
Uranium	0.5	ug/L
Uranium	3	ug/L
Vanadium	0.5	ug/L
Vanadium	0.5	ug/L
Zinc	2	ug/L
Zinc	2	ug/L
Zirconium	1	ug/L

Table 5: PWQMN Monitoring Dates, 2002 to 2019

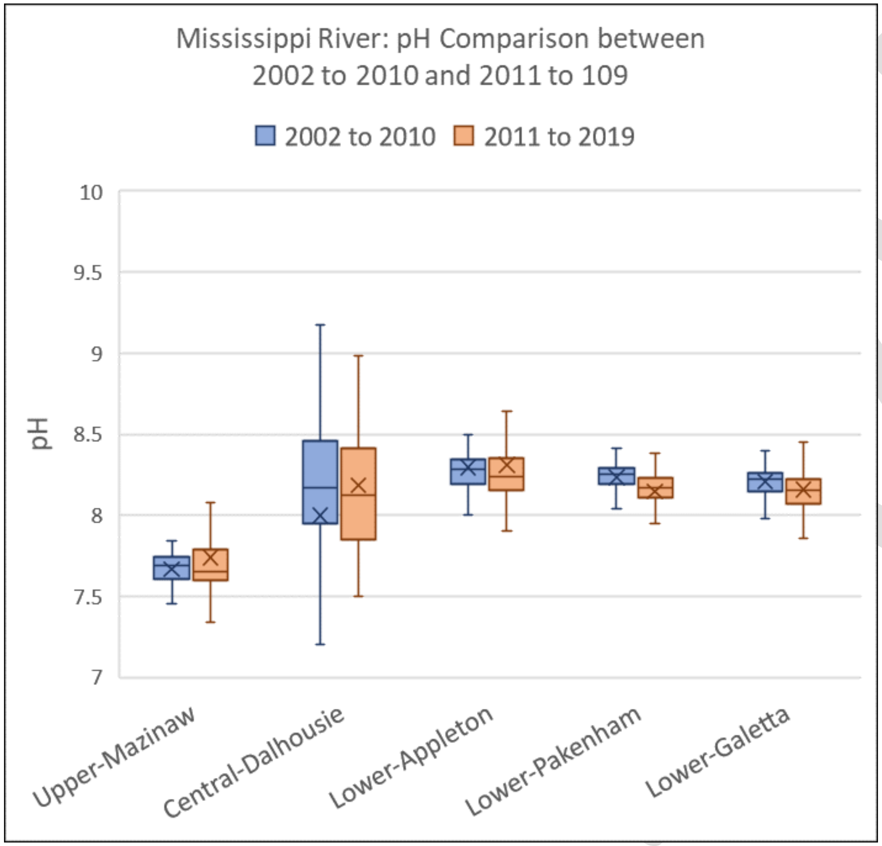
Year	April	May	June	July	Aug	Sept	Oct	Nov
2002		27/28		22/23	26/27	23/24	28/29	25/26/27
2003	28/29/30	26	23/24/25	28/29	25/26	29/30	27/28/29	24/25
2004	26/27	31		5/6 26/27	24	27/28	25/26	29/30
2005	25/26	30/31	27/28	25/26		6/7 26/27	31	1 28/29
2006			19/20	17/18	28. 29	25/26	30/31	27/28
2007			4/5 25/26	30	27/28	24/25	29/30	26/27
2008	28/29		2/3 23/24	28/29	25/26		6/7 27/28	24/25/26
2009	20/21	25/26	29/30	27/28	24/25		5/6 26/27	
2010	19/20	31	1 28/29				4/5 25/26	29/30
2011		30/31	27/28	25/26	29/30	19/20		
2012	30	1 28/29	25/26	30/31	27/28		1/2 29/30	
2013	27/28	24/25				30	1 28/29	25/26
2014		26/27	23/24		25/26	29/30	27/28	
2015		25/26	22/23	27/28	24/25	28/29	26/27	
2016	25/26	30/31	27/28	25/26	29/30	26/27	24/25	28/29
2017		1/2 29/30	26/27	24/25	28/29	25/27	30/31	28/29
2018	23/24	28	25	30/31	27/28	24,25	29	
2019	29/30	27	10/24	3 29/30	26/27	30	1 28/29	25/26

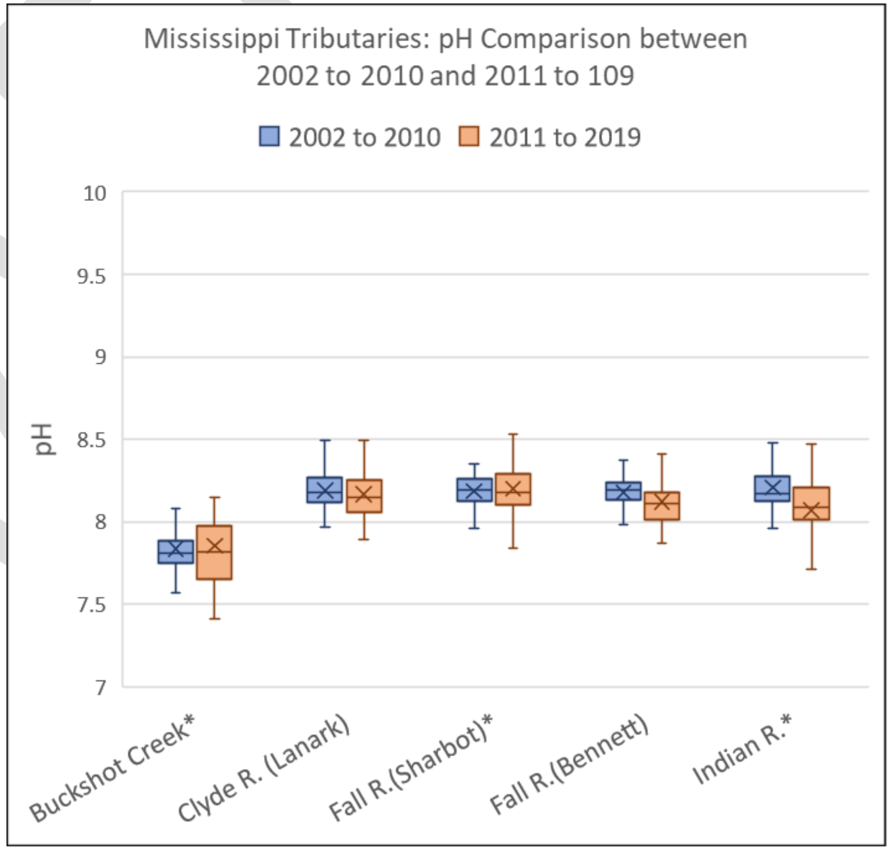
*the 11 PWQMN sites across the watershed are generally sampled over a two day period each month. Where a month is missed, that sample was usually collected early in the next month.

Note 6: PWQMN pH

pH is a measure of a solution's acidity. A pH measurement of "7" is neutral, below "7" is acidic and above "7" is alkaline. The acidity of a water body affects all chemical reactions within the water. Even small changes in pH can have a large influence on the solubility of some nutrients, including phosphorus, which in turn can influence plant growth. The largest variety of freshwater aquatic organisms prefer a pH range of 6.5 to 8.0.

Appendix B3: Figures 12 & 13 present the 2002 to 2018 pH concentrations and trend lines for the PWQMN sites located on the Mississippi River and its main tributaries.





Note 7: PWQMN Metals

The PWQMN also samples for a series or metals. Many metals are already naturally occurring in surface water, others are introduced through human activity. Since waterbodies vary in their natural content of certain metals, it is important to have background data or a long term database to document changes.

This assessment focusses on the four metals most commonly used as an indicator of water quality: copper, iron, manganese and zinc.

Copper: Copper is an essential element that can be toxic to aquatic flora and fauna when concentrations are either too high or too low. It can enter a waterbody through natural weathering of the soil and atmospheric deposition, and it can also be introduced through human activities such as wastewater treatment. Low levels can harm mosses and other microorganisms while high levels may affect the growth, reproduction and brain function of other species such as fish.

Iron: Iron enters surface water through the weathering of soil and rocks. It may be seen as a dense orange floc settled at the bottom of a river bed or by the orange/brown staining of the river substrate which may negatively impact aquatic organisms.

Manganese: One of the least toxic metals, manganese can be found in rocks, soil and both ground and surface water. Essential for both plants and animals, in excessive amounts it may cause toxic effects in aquatic organisms.

Zinc: Zinc is naturally present in low concentrations in most rocks. Elevated levels can lead to "decreased benthic invertebrate diversity and abundance, increased mortality, and behavioral changes" (Environment Canada, 1998).

Conventional Objectives for Metals

Copper:
PWQO have an interim objective for copper of 5 µg/L.

Iron:
CCME states that the concentration of total iron should not exceed 300ug/L.

Manganese:
There are currently no provincial or federal guidelines for manganese but the CCME is in the process of producing one.

Zinc:
There is an interim PWQO for zinc of 20 µg/L.

Appendix B3: Table 4 presents a summary of the PWQMN results for the Mississippi River based on five year averages for the years 2002 to 2006, 2007 to 2015 and 2012 to 2016. This coincides with the 5-Year reporting schedule used for the Conservation Authority Watershed Report Cards (Page 7). It also presents an overall average for the full 15 years from 2002 to 2016.

The frequent lack of values (n/a) is largely a reflection of a high incidence of non-detect levels being found for each of these parameters in many of the samples. In all cases, the copper, iron and zinc levels fall well below the PWQO and CCME guidelines. The manganese levels are also very low, either at or just above detection limits. The levels for all four of these metals do not present any concern at this time.

Table 6: Summary of PWQMN Metals Results presented as 5 Year Averages (2002 to 2006, 2007 to 2011, 2012 to 2016) and overall 15 year Average (2002 to 2016)

	Catchment					Catchment				
	Upper	Central	Lower			Buckshot Creek	Clyde River	Fall River	Fall River	Indian River
PWQMN Site	**Mazinaw**	**Dalhousie**	**Appleton**	**Pakenham**	**Galetta**	**Buckshot**	**Lanark**	**Sharbot**	**Bennett**	**Indian**
Copper (interim PWQO 5 µg/)										
2002 to 2006	0.45	0.45	0.56	0.53	0.59	n/a	0.48	n/a	0.42	n/a
2007 to 2011	0.9	0.75	n/a	n/a	1.08	0.69	0.75	0.17	0.74	1.02
2012 to 2016	0.47	n/a	n/a	n/a	1.21	0.59	0.88	n/a	0.77	1.12
2002 to 2016	0.47	0.46	0.56	0.53	0.95	0.64	0.7	0.17	0.64	1.07
Iron (CWQG 300ug/L)										
2002 to 2006	30.6	39.5	n/a	123.7	n/a	n/a	66.4	n/a	21.6	78.8
2007 to 2011	51.9	n/a	109.4	201.2	n/a	209.6	75.4	109	19.1	n/a
2012 to 2016	28.7	n/a	80.8	121.4	n/a	202.4	68.4	n/a	28.3	n/a
2002 to 2016	30.3	39.5	42.9	78.8	150.2	206.2	70	109	22.8	95.8
Manganese										
2002 to 2006	3.7	16.2	10.4	15.9	23.4	n/a	34.7	n/a	19.8	n/a
2007 to 2011	6.7	18.4	n/a	n/a	21.6	54.4	33.7	n/a	16.7	36.3
2012 to 2016	3.4	n/a	n/a	n/a	24.6	64.6	38.5	n/a	25.1	32.6
2002 to 2016	3.7	16.2	10.4	15.9	23.2	59.2	35.5	15.4	20.4	34.5
Zinc (interim PWQO 20 µg/L)										
2002 to 2006	1	0.8	2.1	0.8	1.9	n/a	1.2	n/a	1.2	n/a
2007 to 2012	3.13	3.75	n/a	n/a	3.84	4.01	3.23	2.22	2.45	4.43
2012 to 2016	3.5	n/a	n/a	n/a	8	5.2	8.19	n/a	6.36	8.1
2002 to 2016	1.9	0.9	2.1	0.8	4.5	4.6	4.1	2.2	3.2	6.2

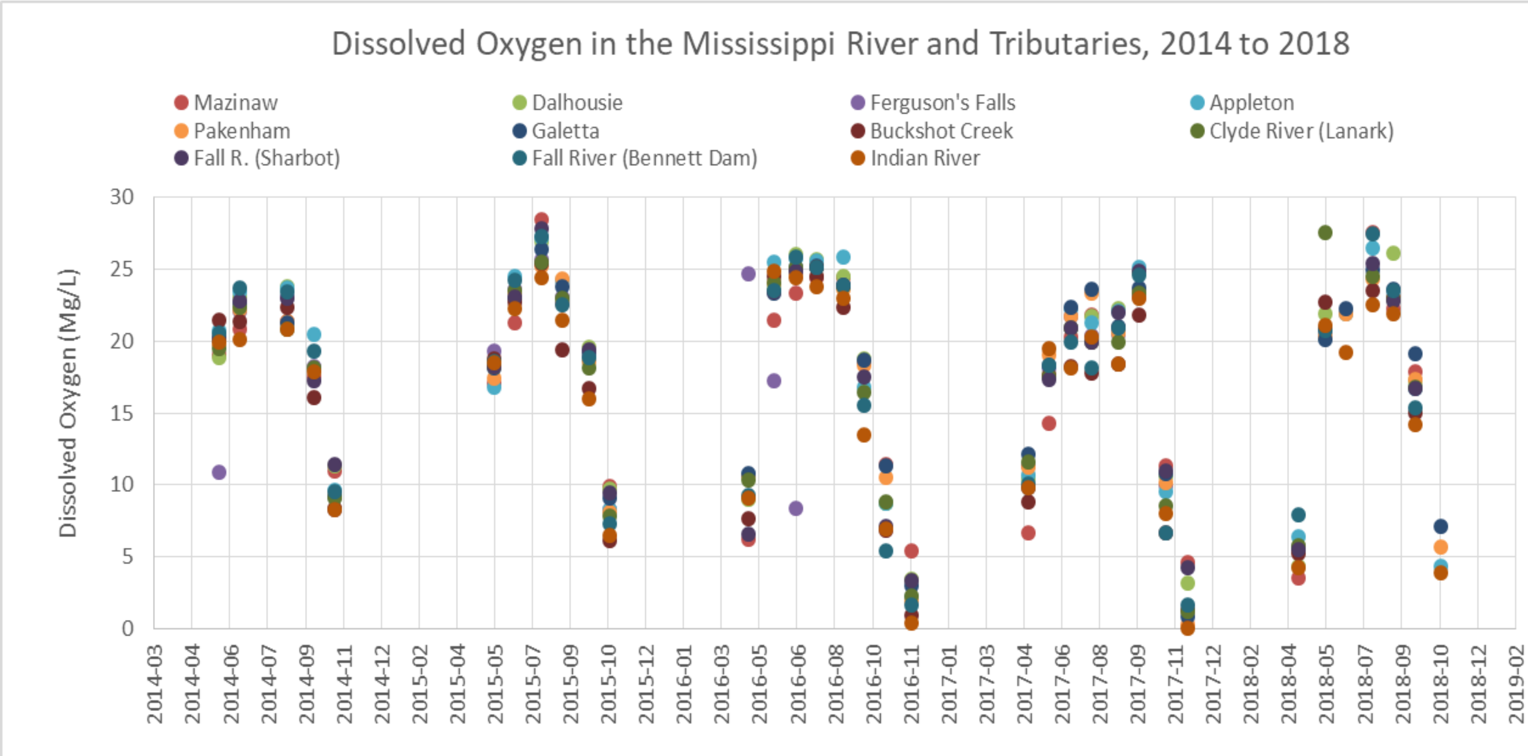


Figure 1: Dissolved Oxygen in the Mississippi River and Tributaries

Table 7: MNRF Broadscale Monitoring Lakes

Mississippi Lake (2009, 2014)
Palmerston Lake (2009, 2015)
Sharbot Lake (2010, 2016)
Shawenegog Lake (2010, 2016)

Big Gull Lake (2010, 2017)
Buckshot Lake (2008)
Crotch Lake (2010, 2017)
Dalhousie Lake (2009, 2015)
Kashwakamak Lake (2008, 2013)

Table 8: Fish Found in the Mississippi River Watershed

Family	Common Name	Scientific Name	Thermal Preference Class *
Catostomidae	White Sucker	*Catostomus commersonii*	cool
Centrarchidae	Black Crappie	*Pomoxis nigromaculatus*	cool
	Bluegill	*Lepomis macrochirus*	warm
	Largemouth Bass	*Micropterus salmoides*	warm
	Pumpkinseed	*Lepomis gibbosus*	warm
	Rock Bass	*Ambloplites rupestris*	cool
	Smallmouth Bass	*Micropterus dolomieu*	warm
Cottidae	Mottled Sculpin	*Cottus bairdii*	cold
	Slimy Sculpin	*Cottus cognatus*	cold
Cyprinidae	Blackchin Shiner	*Notropis heterodon*	cool/warm
	Blacknose Shiner	*Notropis heterolepis*	cool
	Bluntnose Minnow	*Pimephales notatus*	warm
	Brassy Minnow	*Hybognathus hakinsoni*	cool
	Common Shiner	*Luxilus cornutus*	cool
	Creek Chub	*Semotilus atromaculatus*	cool
	Eastern Blacknose Dace	*Rhinichthys atratulus*	cool
	Emerald Shiner	*Notropis atherinoides*	cool
	Fallfish	*Semotilus corporalis*	cool
	Fathead Minnow	*Pimephales promelas*	warm
	Finescale Dace	*Chrosomus neogaeus*	cool
	Golden Shiner	*Notemigonus crysoleucas*	cool
	Hornyhead Chub	*Nocomis biguttatus*	cool
	Longnose Dace	*Rhinichthys cataractae*	cool
	Northern Redbelly Dace	*Chrosomus eos*	cool/warm
	Northern Pearl Dace	*Margariscus margarita*	cool

Table 8: Fish Found in the Mississippi River Watershed

Family	Common Name	Scientific Name	Thermal Preference Class *
	Spottail Shiner	*Notropis hudsonius*	cold/cool
Esocidae	Muskellunge	*Esox Masquinony*	warm
	Northern Pike	*Esox lucius*	cool
	Banded Killifish	*Fundulus diaphanus*	cool
Gadidae	Burbot	*Lota lota*	cold/cool
Gasterosteidae	Brook Stickleback	*Culaea inconstans*	cool
Ictaluridae	Brown Bullhead	*Ameiurus nebulosus*	warm
Percidae	Iowa Darter	*Etheostoma exile*	cool
	Johnny Darter	*Etheostoma nigrum*	cool
	Log Perch	*Percina caprodes*	warm
	Yellow Perch	*Perca flavescens*	cool
Salmonidae	Brook Trout	*Salvelinus fontinalis*	cold
	Brown Trout	*Salmo trutta*	cold/cool
	Rainbow Trout	*Oncorhynchus mykiss*	cold
Umbridae	Central Mudminnow	*Umbra limi*	cool/warm

Thermal Preference Class is based on the Coker et al. (2001) classification which uses preferred summer water temperatures to classify species as either warm (> 25°C), cool (19 – 25°C) or cold (< 19°C). A species can occupy two classes if their preferred temperature overlaps classes. **Seine net hauls*

Note 8: Stream Temperature Classification:

Stream temperature is the most important factor in determining the type of fish species found in a stream. In general, coldwater species prefer summer stream temperatures below 19°C, cool water fish species between 19°C and 25°C, and warm water species above 25°C (Coker et al, 2001). These temperatures can change for different life stages. Coldwater species are of particular interest as they are often much sought after sport fish (i.e. Brown Trout, Brook Trout) and their presence or absence can be indicative of changing thermal conditions within a stream.

A modified version of the Stoneman and Jones method for thermal regression (Chu *et al*, 2009) was used to thermally classify the Mississippi River watershed stream sites based on their maximum air and water temperatures. Stream water temperatures, collected every 15 minutes throughout the summer season (May – September), are compared with local air temperatures. The data points that adhere to the following criteria are plotted against the nomogram (chart to the right), and the thermal classification is determined:

- *Sample occurred between July 1 and August 31.*
- *Sampling date had a maximum air temperature ≥24.5°C and was preceded by two consecutive days with a maximum air temperature ≥24.5°C during which time no precipitation occurred.*
- *Water temperature was measured at 16:00 hr.*

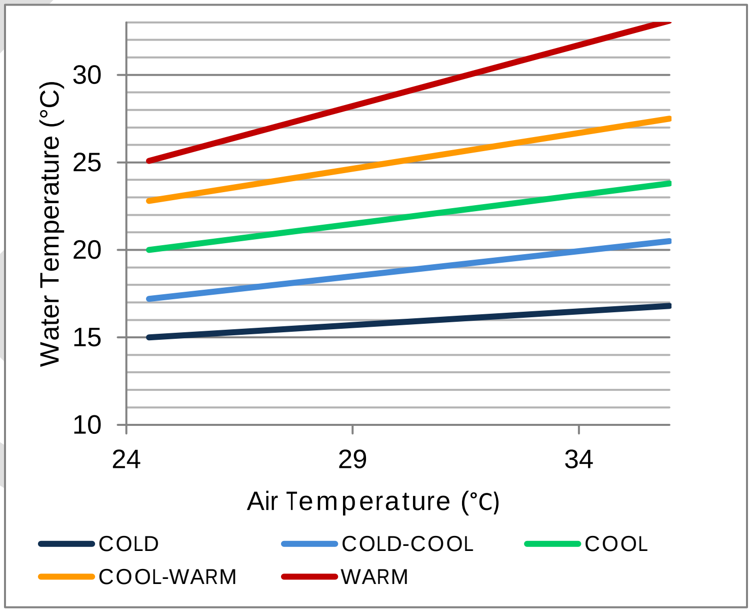


Table 4 presents a summary of the thermal classifications based on the data collected between 2015 and 2018. Since stream temperature can be influenced by a number of factors, the goal is to revisit the sites in order to monitor any changes in the thermal classification over both the short and long term.

Table 9: Mississippi River Watershed Stream Thermal Classifications 2015 to 2018

Watercourse	Location	2015	2016	2017	2018
Black Creek	Shiner Rd			Cool-Warm	Cool-Warm
Bolton	Hunter Side Rd			Cool-Warm	Warm
Buckshot	Streat Gauge Site			Cool-Warm	
Cartwright's	Ivy Acres Rd d/s				Cool
Cody Creek	Hansen Side Rd d/s				Cool-Warm
Cody Creek	Peter Robinson Rd or March Rd u/s				Cool
Conn's Creek	River Rd. d/s				Cool
Donnelly Creek	OSAP site				Cold-Cool
Easton's Creek	Dalhousie 2nd Conc			Cool-Warm	
Easton's Creek	Waddle Ck Rd				Cool-Warm
Fall River	Bennett Lk Outlet			Warm	
Graham Creek	K&P			Cool-Warm	
Gull Creek	4044 Ardoch Road d/s				Cool
Indian River	Ramsay Con 8				n/a
Indian River	Tatlock Road u/s				n/a
Long Sault	Milton Rd d/s	Cool-Warm		Cool	Cool
Long Sault	Dalhousie 9th Con. u/s	Cool-Warm			
Mosquito Creek	Gemmill Rd				Cool
Paul's Creek	Elphin-Maberly Rd		Cool	Cool	Cool-Warm
Wolf Grove	Ramsay 8 d/s	Warm			Cool-Warm
Wolf Grove	Rae Rd u/s	Warm			

Table 10: MNRF Classified Lake Trout Lakes

Lake Name	Township(s)	Official Plan Designation
Natural Lake Trout Lakes		
Buckshot	North Frontenac	At Capacity
Kishkebus	North Frontenac	At Capacity
Mazinaw - Lower	North Frontenac	Not at Capacity
Mazinaw - Upper	Addington Highlands/N. Frontenac	Moderately Sensitive/Not at Capacity
Mosque	North Frontenac	At Capacity
Palmerston	North Frontenac	Not at Capacity
Put and Grow Lakes		
Little Green	North Frontenac	At Capacity
Long Mallory	North Frontenac	Highly Sensitive
Shabomeka	North Frontenac	At Capacity
Silver Lake	Central Frontenac/Tay Valley	At Capacity/Highly Sensitive

Source: MNRF, 2015, Inland Ontario Lakes Designated for Lake Trout Management

Table 11: Former Lake Trout Lakes with Population Now Extirpated

Lake Name	Township	Notes
Big Gull	North Frontenac	Extirpated due to fall drawdown and competition with Walleye
Canonto	Lanark Highlands	Extirpated due to competition with Walleye. Brook Trout, Brown Trout, Rainbow Trout also found.
Crotch	North Frontenac	Extirpated due to fall drawdown.
Kashwakamak	North Frontenac	Extirpated due to fall drawdown. Brook Trout found.
Mississagagon	North Frontenac	Extirpated due to fall drawdown and competition with Walleye
Murray Lake	Lanark Highlands	Inflow from Tatlock Quarry impacting Trout survivability. Brook Trout, Rainbow Trout, Splake also found.

Table 12: Other Cold Water Lakes that have and may still support some cold water fish species.

Lake	Township	Lake Trout Status	Notes
Blue	North Frontenac	no official record	Splake found.
Duncs	Lanark Highlands	no official record	Brook Trout found.
Georiga	North Frontenac	no official record	Brook Trout found.
Gibsons	North Frontenac	no official record	Brook Trout found.
Green	Lanark Highlands	no official record	
Grindstone	North Frontenac	recorded recently	Lake Trout population stressed due to exploitation and marginal habitat / Brook Trout, Rainbow Trout, Splake found.
Kate	Lanark Highlands	no official record	Brook Trout found.
Lavant Long	Lanark Highlands	recorded recently	
Machesney	Addington Highlands	recorded recently	Rainbow Trout, Splake found.
McCausland	North Frontenac	recorded recently	Brook Trout, Rainbow Trout, Splake found.
Paddy's	Lanark Highlands	no official record	Introduction of N. Pike impacted stocking of Rainbow Trout / Brook Trout, Rainbow Trout found
Pennick	Central Frontenac	no official record	Brook Trout, Rainbow Trout, Splake found
Perch	Lanark Highlands	no official record	Brook Trout, Rainbow Trout, Splake found
Peterwhite	Lanark Highlands	no official record	Brook Trout found.
Pine	North Frontenac	no official record	Impacted by introduction of Walleye
Shoepack	North Frontenac	no official record	Brook trout population impacted by introduction of Smallmouth Bass and Perch. Reintroduction efforts unsuccessful.
Summit	North Frontenac	no official record	Brown Trout, Rainbow Trout found.
Tate	Lanark Highlands	no official record	Brook Trout found.
Wolfe	North Frontenac	no official record	Brook Trout, Rainbow Trout found.

Table 13: Reported Invasive Species in the Mississippi River Watershed

Invasive species most frequently reported in the MVCA on the EDDMaps website:

Banded mysterysnail *Viviparus georgianus* (I. Lea, 1834)

Common St. Johnswort *Hypericum perforatum* L.

Dog-strangling vine, European swallowwort *Vincetoxicum rossicum* (Kleopov) Barbarich

Eurasian water-milfoil *Myriophyllum spicatum* L.

European buckthorn *Rhamnus cathartica* L.

European common reed *Phragmites australis ssp. australis* (Cavanilles) Trinius ex Steudel

European frog-bit *Hydrocharis morsus-ranae* L.

Garlic mustard *Alliaria petiolata* (Bieb.) Cavara & Grande

Glossy buckthorn *Frangula alnus* Mill.

Helleborine *Epipactis helleborine* (L.) Crantz
Purple loosestrife *Lythrum salicaria* L.
Rusty crayfish *Orconectes rusticus* (Girard, 1852)
Spiny waterflea *Bythotrephes longimanus* Leydig, 1860
Wild parsnip *Pastinaca sativa* L.
Zebra mussel *Dreissena polymorpha* (Pallas)

Note 9: Invasive Species Initiatives

EDDMapS Reporting of Invasive Species: The EDDMapS[1] (Early Detection & Distribution Mapping System) program provides a key platform for reporting and mapping invasive species occurrences. It is a web-based mapping and data entry tool used to document the distribution of invasive species and to help identify leading edges of new infestations.

Mississippi Lake: Starting in 2016, MVCA, the Mississippi Lakes Association (MLA) and the Mississippi Valley Field Naturalists (MVFN) have partnered to undertake aquatic invasive species surveys on Mississippi Lake. The surveys are targeted at monitoring for the presence of some of the more common and easily identified invasive aquatic plants such as curly-leaf pondweed, European frogbit, purple loosestrife and phragmites. Occurrences are documented and mapped for the purpose of ongoing monitoring and to identify patches that may be targeted for removal.

Malcolm and Ardoch Lakes: Eurasian Water Milfoil (EWM) is an aquatic invasive plant that is of growing concern in the Mississippi River Watershed. In 2017, the Malcolm Ardoch Lakes Landowners Association identified EWM as a problem in their lakes. They have since undertaken extensive monitoring as well as the testing of removal techniques to try to control its spread.

Phragmites Mapping: Phragmites is an aggressive invasive plant that is rapidly spreading along roadsides and wet areas throughout the watershed. The Mississippi Valley Field Naturalists developed a program to map Phragmites occurrences throughout the watershed.

[1] EDDMapS is a program developed by the University of Georgia Centre for Invasive Species and Ecosystem Health. It has an Ontario version of the on-line app that has been widely adopted as the key platform for reporting and mapping invasive species occurrences.

Table 14: OFAH Program - Zebra Mussel and Spiny Water Flea Sampling Results 1998 to 2016

Lake	Years Record	Last Record	Zebra Mussel Veligers	Spiny Water Flea	Ca+ Value Range
Ardoch Lake	9	2016	Not Present		40-56
Bennett Lake	8	2014	Present		32-48
Big Gull Lake	12	2015	Not Present	Present	16-24
Big Lake	1				
Black Lake	12	2016	Present		32-56
Blue Lake	7	2016	Present		40-56
Bottle Lake	2	2008	Not Present		
Bowers Lake	1	2008	Not Present		
Buckshot Lake	14	2016	Not Present		16-24
Canonto Lake	11	2016	Present - Not Present		32-40
Clayton Lake	7	2014	Present		24-56
Clear Lake	5	2015	Present		32-56
Clyde Lake	3	2012	Present - Not Present		24-32
Constance Lake	5	2014	Present		40-88
Crotch Lake	8	2016	Not Present	Present	16-24
Dalhousie Lake	12	2016	Present		24-48
Fawn Lake	7	2014	Not Present		16-24
Flower Round Lake	6	2016	Present - Not Present		32-40
Green Lake	3	2010	Not Present		
Grindstone Lake	8	2015	Present		16-32
Horne Lake	5	2012	Not Present		32-48
Joes Lake	7	2016	Present - Not Present		24-48
Kangaroo Lake	6	2011	Present - Not Present		
Kashwakamak Lake	12	2015	Present	Present	16
Kerr Lake	3	2016	Not Present		40
Kishkebus Lake	3	2008	Not Present		16-40
Little Green Lake	2	2008	Not Present		
Mackavoy Lake	5	2014	Not Present		16-24
Malcolm Lake	7	2016	Not Present		32-48
Marble Lake	5	2016	Not Present		16-24
Mazinaw Lake			Not Present		8, 24
McCausland Lake	3	2008	Present		8
McGowan Lake	1	2011	Not Present		
Millers Lake	1	2014	Present		24-32

Table 14: OFAH Program - Zebra Mussel and Spiny Water Flea Sampling Results 1998 to 2016

Lake	Years Record	Last Record	Zebra Mussel Veligers	Spiny Water Flea	Ca+ Value Range
Mississagagon Lake	7	2014	Present - Not Present		32-56
Mississippi Lake	12	2014	Present		32-48
Mosque Lake	7	2014	Not Present		16-24
O'Reilly Lake	1	2014	Not Present		
Paddy's Lake	3	2012	Not Present		24-32
Palmerston Lake	10	2016	Not Present		32-40
Patterson Lake	11	2016	Not Present		24-48
Pine Lake	6	2014	Not Present		16-40
Robertson Lake	9	2016	Not Present		32-48
Sand Lake	8	2015	Present		24-40
Shabomeka Lake	9	2016	Present		16
Sharbot Lake	8	2014	Present		32-48
Shawenegog Lake	8	2015	Not Present		24-40
Silver Lake	9	2014	Present		32-48
Stump Lake	1	2011	Not Present		
Sunday Lake	8	2016	Present		32-40
Taylor Lake	7	2014	Present		40-64
Upper Mazinaw Lake	6	2016	Not Present		
Upper Park Lake	6	2015	Present		32-48
White Lake	7	2016	Not Present		32-48
Widow Lake	4	2015	Not Present		24-40
Wolfe Lake	5	2011	Present		
Woods Lake		2006	Not Present		
25mg/l Ca+ is optimal for shell growth					