Comparing Frontline Managers' Perceptions of Local Capacity for Implementing Integrated Watershed Management: A Case Study in Cyanobacteria

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Abstract

Watershed management is a complex process, with a myriad of stakeholders that need to work collaboratively in order to achieve desired results. Ontario endorses the use of an integrated watershed management (IWM) approach to address water quality issues. Many water quality issues, including cyanobacteria blooms that are increasingly present in Ontario's inland lakes, represent what is known as wicked problems. Wicked problems are complex and require sufficient local capacity and collaboration to successfully manage. There is a dearth of literature investigating local capacities to implement IWM successfully. This research used cyanobacteria blooms as a vehicle through which to investigate the capacity of regional authorities to implement IWM. Three primary research questions were addressed, 1) how does local capacity compare in different financial, institutional, technical, political, and social contexts. Second, what is the value of regulatory authority for managing bodies implementing IWM. Finally, what are some of the most pressing challenges that managing bodies face while implementing IWM. The Lake Simcoe region employs a holistic ecosystem approach with an emphasis on IWM, which is supported by a legal framework provided through the Lake Simcoe Protection Act (LSPA). This IWM governance structure provides a basis for exploring capacity for IWM implementation in other regions. Callander Bay and Eagle Lake represent regions with varying local capacities for IWM. Semi-structured interviews with local stakeholders and a novel capacity assessment framework were used to show that local capacities vary greatly across Ontario, with financial capacity being the primary hinderance. Local governing bodies relied primarily on less-intrusive means of management, only resorting to regulation when necessary for potentially harmful activities and no stakeholders echoed a need for additional legislation. This research assists in addressing the capability of regional authorities in implementing IWM, something that has been particularly difficult in regions with limited resources.

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1.0 Introduction

Recent studies have shown that Ontario's inland lakes are experiencing a range of water quality issues. Ontario endorses the use of an integrated watershed management (IWM) approach to address water quality concerns. IWM involves collaboration and partnerships, systems approach, science-based, adaptive and mindful of environmental, economics and social interests. Managing water quality using an integrated approach is a complex task, with various actors sharing authority and responsibility for planning, implementing, monitoring, and adopting management plans. Local capacity for management of water quality issues is often a limiting factor for managing complex water quality issues (Butterworth et al., 2010; Ivey et al., 2006). In Central Ontario, cyanobacteria blooms are an emerging threat to lakes of different catchments and limnological conditions. Cyanobacteria blooms are a 'wicked' problem, involving a complex mix of social-environmental issues with uncertainty about future environmental conditions and the potential for contrasting social values. As such, an integrated approach (e.g. collaborative, adaptive, science-based) is an effective way to tackle wicked problems (Patterson et al., 2013; Rogers, 2003). Thus, the 'wicked' problem of cyanobacteria management can serve as a vehicle through which it is possible to compare local capacities to implement IWM.

This research focusses on three different case studies in Ontario (Lake Simcoe, Callander Bay, and Eagle Lake) that are at different stages of IWM implementation; they also have drastically different local capacity for management of water quality issues. The *Lake Simcoe Protection Act* (LSPA) was enacted in December 2008.. The LSPA establishes a legislative framework for protecting and restoring the ecological health of the Lake Simcoe watershed and led to the development of the Lake Simcoe Protection Plan (LSPP). The LSPP and accompanying Phosphorus Reduction Strategy (PRS) provided a model for eutrophication management in Lake Simcoe with an emphasis on implementing IWM (MOE et al., 2009; MOE & LSRCA, 2010). Even though cyanobacteria blooms are rare in Lake Simcoe, there is a

focus on reducing external phosphorus loading, which is a primary method for combatting cyanobacteria, which should prevent blooms from becoming more common. The comprehensive nature of the Lake Simcoe governance structure provides a useful framework for evaluating the capacity to implement an integrated approach in other lakes of different sizes and circumstances in Ontario.

Callander Bay and Eagle Lake are two water bodies in central Ontario that have ongoing water quality concerns. Each of these lakes has different financial, institutional, technical, political, and social contexts and conditions. Callander Bay is protected by the Clean Water Act's Source Water Protection regulation, which is administered by the North Bay Mattawa Conservation Authority (NBMCA) (Scott et al., 2017). Eagle Lake is not a municipal drinking water source and therefore not protected under the Clean Water Act, nor does it fall under the jurisdiction of a conservation authority.

Data collection consisted of a combination of reviewing institutional frameworks and semi-structured interviews with water management agents in each region. A novel framework adapted from Ivey et al. (2001, 2006) and Rizvi et al (2013) discussed in section 3.3.2 below was used to assess local capacity. This framework split capacity into five different categories (Financial, Operational, Technical/Information Management, Social/Community, and Institutional) and outlined indicator questions and indices to help guide capacity assessment.

1.1 IWM

IWM has become a dominant water management paradigm, with an emphasis on adaptive management and strategic partnerships. Conservation Ontario's endorsement of IWM for the management of complex water quality issues allows for a blend of environmental, economic, and societal considerations when approaching water quality management decisions (Figure 1). IWM in Ontario (Conservation Ontario, 2010) is centred around five guiding principles: 1) Watershed-based, informed by science; 2) Requires us to manage natural resources and human activities together; 3) Considers the interests and needs of not just the environment but also the economy and society

because they are connected and impact each other in good and bad ways; 4) Relies on an adaptive management approach which establishes a plan, implements the plan, monitors and reports, and then re-evaluates and updates the plan, if necessary; 5) Needs collaborative governance at many levels for shared decision-making and priority setting. Conservation Authorities serve as primary managing bodies within their jurisdiction at a watershed scale and help implement an integrated approach. While not all regions in Ontario have the local capacity to implement all facets of IWM, it serves as a guiding framework.

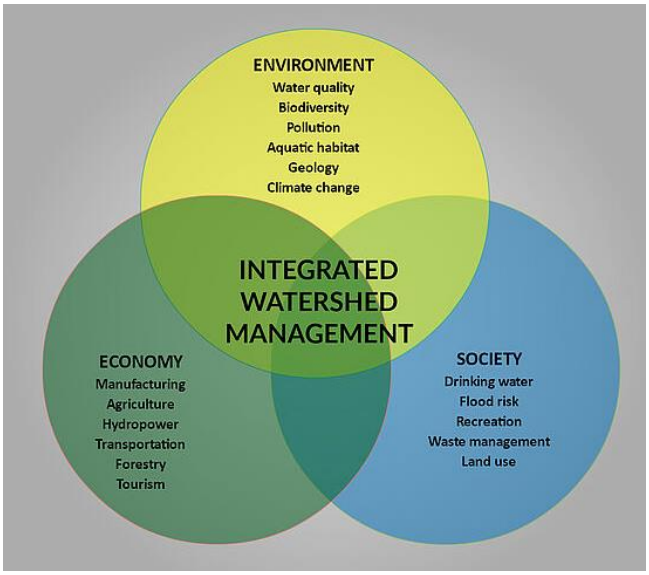

Figure 1: IWM supports the environment, economy, and society (Conservation Ontario, 2010).

1.2 Cyanobacteria Management

Excessive phosphorus is believed to be a primary factor driving the increasing occurrences of cyanobacteria blooms in productive (eutrophic) lakes with high phosphorus concentrations (Pick, 2016) but occurrences are also increasing in unproductive (oligotrophic) lakes with low phosphorus concentrations where excessive phosphorus is not a risk factor (Winter et al., 2011; Reinl et al., 2021). The increase in blooms is also believed to be a climate change indicator, as climate and precipitation patterns are factors in dissolved oxygen (DO) concentration and internal phosphorus loading (Paerl & Huisman, 2009; Molot et al., 2021).

1.2.1 Ontario's 12-Point Plan

In 2014, Ontario released a 12-point plan on blue green algal blooms (cyanobacteria) focussed on protecting drinking water sources (MOE, 2014). The plan follows many of the same principles as IWM, including collaboration across different levels of government and science-based decisions. The 12-points of the plan include: 1) Communicating, engaging and working with partners; 2) Reducing nutrients; 3) Protecting our drinking water sources; 4) Science and innovation; 5) Support; 6) Legislation and regulatory tools; 7) Water quality standards and guidelines; 8) Monitor; 9) Public health; 10) Contingency plans; 11) Analytical laboratory services; 12) Drinking water system courses.

1.2.2 Ontario Context and Circumstances

Collaboration for water governance in Ontario is potentially hindered by Canada's system of federalism (Bakker & Cook, 2011). Jurisdictional fragmentation is a common theme with various levels of government being responsible for different aspects of watershed management (Cook, 2014). For any integrated approach, clearly defined roles are important. This can be especially complex in water quality issues that can span across jurisdictional boundaries. The provincial government of Ontario has primary jurisdiction over most areas of water management and protection. This responsibility is shared among different provincial agencies, such as the Ministry of Environment Conservation and Parks (MECP) , Conservation Authorities and municipal governments. The federal government has responsibility for international waters, such as the Great Lakes shared boundary with the United States; they are also responsible for fisheries, which can be negatively impacted by eutrophication and cyanobacteria blooms. The federal and provincial governments share jurisdiction over agriculture and health (each with their own federal and provincial ministries), both of which are relevant to cyanobacteria management. Given this level of jurisdictional fragmentation, it is important to achieve a high level of collaboration among all levels of government and stakeholders to successfully implement IWM.

1.3 Research Objectives

This research employs a case study approach to answer three primary questions. First, how does local capacity compare in different financial, institutional, technical, political, and social contexts? Second, what is the value of regulatory authority for managing bodies implementing IWM? Finally, what are some of the most pressing challenges that managing bodies face while implementing facets of IWM? Implementing IWM has been particularly challenging in regions with limited resources (Patterson & Bellamy, 2013). This research addresses the capability of regional authorities in pursuing an integrated approach which is timely since there is a dearth of literature assessing capacity at a watershed scale, especially in Canada. This paper will also investigate whether or not varying legal frameworks are a limiting factor for IWM implementation at a watershed scale.

1.4 Thesis Organization

Chapter 2 covers a review of relevant academic literature, presenting the topics covered throughout the paper, including IWM, water quality issues in Ontario, and ending with a review on policy science and capacity assessment literature. Chapter 3 introduces the methods used to collect data and conduct the capacity evaluation between case studies. Chapter 4 introduces the three case studies used in this research, providing background information. Chapter 5 presents an in-depth analysis of the case studies and their local capacity for the implementation of IWM to combat cyanobacteria blooms and related water quality issues. Chapter 6 presents and discusses the implications of the main findings of the research.

2.0 Literature Review

This research includes a review of relevant academic literature to develop a deep understanding of subject material. The following literature review provides a summary of papers and topics covered. First, a brief history of IWM in Canada, including supporters and detractors are explored. Then, a review of watershed governance discusses impacts of good governance and key actors behind IWM implementation in Ontario as well as the need for a 'champion' to maintain interest in watershed health. Next, an exploration of water quality issues that are prominent in this research (eutrophication and cyanobacteria) discusses potential causes and impacts. Finally, literature discussing the theoretical approach towards capacity evaluation is reviewed.

2.1 What is Integrated Watershed Management?

The idea of an integrated approach to water management is continually evolving and there is no universally accepted definition; however, the Global Water Partnership's (GWP) definition is widely cited. The GWP defines Integrated Water Resources Management (IWRM) as, "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (2000, p. 22). While definitions vary, almost all definitions stress the importance of improving efficiency in water use, equity in water access, and achieving sustainability (Butterworth et al., 2010). The principles of integrated resource management are not new, they have been present since at least the 1930's. IWRM received some attention following the 1977 United Nations Water Conference (Jeffrey et al., 2004). In 1992, after the Dublin Conference on Water in the Environment and the United Nations Conference on Environment and Development both featured IWM, the GWP heavily promoted the concept (Shapiro & Summers, 2015). Since its resurgence, IWRM (including adaptive management and strategic partnerships) has become a dominant paradigm guiding watershed management (Grigg, 2014). While water is the emphasis, definitions and approaches have

progressed to taking on a more holistic meaning as the experience and knowledge base grows, and approaches are often represented as IWM, where human activities and all natural resources including water are managed at a watershed scale (Conservation Ontario, 2010).

Different adaptations of IWM have seen some variance among core principles, but the Dublin Conference and UNCED foundational principles outline key concepts of IWM: (1) the recognition that water is a finite resource vulnerable to degradation; (2) broad stakeholder participation in decision making processes; (3) increasing the role of women in water management; (4) the recognition of the social and economic value of water; and (5) the integration of ecologic, economic, and social considerations (GWP, 2000; Schoeman et al., 2014). At its core, IWM aims to enhance social and economic well-being while protecting ecological integrity, with a particular focus on integration (Schoeman et al., 2014). Ramin (2004) provides further insight with discussion of IWM as systems-oriented, placing emphasis on stakeholder involvement and partnerships. Morrison et al., (2004) link integration to collaboration as: (1) stakeholders with varying perspectives create solutions beyond individual interests; (2) interest groups cooperate, create complementary roles, and pool resources; and (3) coordination, including effective communication is vital.

These core ideals of IWM are continually evolving as each adapting organization often modifies them to fit their local context. For example, Conservation Ontario (2012 p. 1) has endorsed IWM, defining it as “the process of managing human activities and natural resources on a watershed basis, taking into account, social, economic and environmental issues, as well as community interests in order to manage water resources sustainably”.

IWM has garnered criticism for a variety of reasons (Blonquist & Schlager, 2005). IWM has been likened to a ‘Nirvana concept’ meaning that it is something that can be an ultimate goal, but may not be altogether achievable (Butterworth et al., 2010; Molle, 2008). This is echoed by Moss’s (2010) assertion

that IWM is too broadly defined and vague to be anything more than a buzzword. This is paired with criticism from Petit (2016) who cites a 2008 United Nations Water survey to suggest that while the principles of IWM may be sound, the level of actual implementation may be lacking. This is alluding to the complex nature of IWM, which makes complete and effective implementation difficult, though even its detractors admit that implementation at smaller scales may be feasible (Biswas, 2008). Others argue that the principles of IWM are beneficial, and that the issue is a lack of local capacity and commitment that would hinder any approach (Mitchell, 1990; Scott et al., 2017).

Ivey et al (2006) uses a novel capacity evaluation framework to emphasize the importance of local capacity and how it is most often the limiting factor in successful watershed management. Another important consideration is the varying contexts in which IWM is practiced. A variety of environmental, economic and social factors persist in each local instance of IWM, so an in-situ, site specific approach is vital (Conservation Ontario, 2010). Despite its criticisms and ongoing debate around its effectiveness, there is general agreement on the principles underlying IWM and the potential it holds for managing complex systems (Anderson et al., 2008; Heathcote, 2009). IWM has been endorsed on a wide scale and is being increasingly accepted by water managers and policy-makers (Davis, 2007).

2.1.2 Watershed Governance

The IWM paradigm is an approach to watershed management with a governance focus and is dependent on good governance practices and allocation of adequate resources in order to be successfully implemented (Grigg, 2008). A good governance model allows for successful watershed management and implementation of policies within a watershed. Watershed management refers to the actual planning processes, policies, decision making and actions taken to protect the health of a watershed. Water governance refers to the complex processes involving individuals, institutions (public, but also private), and civil society that makes social choices. It involves the ability to influence, shape, and execute decisions, and to hold those making them to account (Brandes et al., 2014).

It is important that regional authorities practice tenets of good water governance, including: participation, actor coordination, institutional integration, adaptation and evaluation, transparency, use of science, and funding availability (Melnychuk et al., 2012). Strategic partnerships are an essential component of a successful IWM approach, and a strong governance structure is vital for promoting such partnerships. One such example is the importance of creating opportunities for social learning, where learning networks are defined, and cooperation and reflection are encouraged among strategic partners (Berkes, 2009). The Lake Simcoe Coordinating Committee and the Lake Simcoe Science Committee are two such examples of formal social learning opportunities (MOE et al., 2009). As noted in both the IWM principles and tenets of good water governance, the integration of science is an important consideration. This ranges from adequate historical and contemporary monitoring data to the integration of new approaches towards management. Additionally, the need for a 'champion' or a primary implementing body with clearly defined roles is vital for IWM (Mazmanian & Sabatier, 1989). In Ontario, depending on where you live, the 'champion' or responsible agency might be a conservation authority.

2.2 Conservation Authorities

The Conservation Authorities Act (1946) was drafted for two primary reasons: (1) to provide work for returning WW2 veterans; (2) to address the degradation and rapid consumption of natural resources fueled by a transition to more intensive agriculture and rapid urbanization (Mitchell et al., 2014; Worte 2017). The conservation authorities program is guided by six founding principles: (1) the watershed as the management unit; (2) local initiative; (3) provincial-municipal partnership; (4) a healthy environment for a healthy economy; (5) a comprehensive approach; (6) cooperation and coordination (Shrubsole, 1986).

Conservation authorities are local, community-based environmental agencies, who represent municipalities on a watershed basis, and promote municipal-provincial partnership, and strategic

coordination in order to manage their respective watersheds (MOE et al., 2009). The primary role of conservation authorities has shifted consistently since 1946. When each new conservation authority was founded, they immediately undertook a watershed scale study of natural resources and created initial plans, referred to as 'conservation reports' (Mitchell et al., 2014). These plans were integrated in nature, addressing both water and land resources, and formed the basis for preliminary actions. These plans were generated by provincial staff with little local input, but upon completion, the conservation authority worked with local municipalities towards implementation (Worte, 2017). Beginning in the 1950's, after the flooding impacts of Hurricane Hazel on the Toronto area, the primary initiative for conservation authorities became flood control (Shrubsole, 1986; Worte, 2017). In the 1970's the role of conservation authorities, and agencies with similar mandates such as the MOE and MNR became blurred, as jurisdiction over water resources was split, and roles were not clearly defined. At the time, conservation authorities primarily focused on water quantity concerns (i.e., flood control and erosion) via the National Flood Reduction Program (Watt, 1995). The MNR focused on fisheries and wetlands, and the MOE focused on water quality concerns (Worte, 2017). In the 2000's the focus on IWM and watershed-based management approaches become more dominant. Conservation Authorities were contracted to coordinate source protection programs as part of the *Clean Water Act* (2006) on a watershed basis and source protection areas were delineated in reference to contemporary conservation authority jurisdictions. The members of conservation authority boards of directors, most of whom are appointed by municipalities in the respective watersheds, form the basis of the source protection authorities, and are actively involved in the implementation or source protection plans (NBMCA, 2015). As outlined in the *Clean Water Act* (2006) some conservation authorities were amalgamated to serve one source protection region. This was deemed necessary for conservation authorities with a smaller population base (and therefore a lesser capacity). In total, there are 19 source protection authorities versus 36 conservation authorities.

Initially, conservation authority funding was a 50-50 provincial-municipal split, which served to increase incentive for municipalities to pursue the foundation of a conservation authority (Mitchell et al., 2014). However, beginning in the 1990's, the provincial funding commitment significantly decreased, ceasing funding for all non-core functions, at one point resulting in a 70% decrease in conservation authorities' funding over a two year period (Mitchell et al., 2014). Provincial funding is still available for project-specific operations, but the majority of conservation authorities' funding is from municipal levies, and self-generated revenue (Worte, 2017). Municipal cost sharing ensured that conservation authorities did not undertake activities that municipalities were not ready to contribute to financially. It has also resulted in conservation authorities being hindered financially in regions with low populations or modest economies (Shrubsole, 1997). Another consequence of the municipal cost sharing funding model is that conservation authorities are rare in catchments where much of the land is government owned or where population is sparse. The level of funding varies considerably year-to-year, reflecting the current responsibilities, and provincial willingness to pay for conservation authority services. This funding variability requires flexibility on the part of conservation authorities, providing a significant challenge to adapt their focus to mesh with shifting priorities of senior levels of government (Shrubsole et al., 2017)

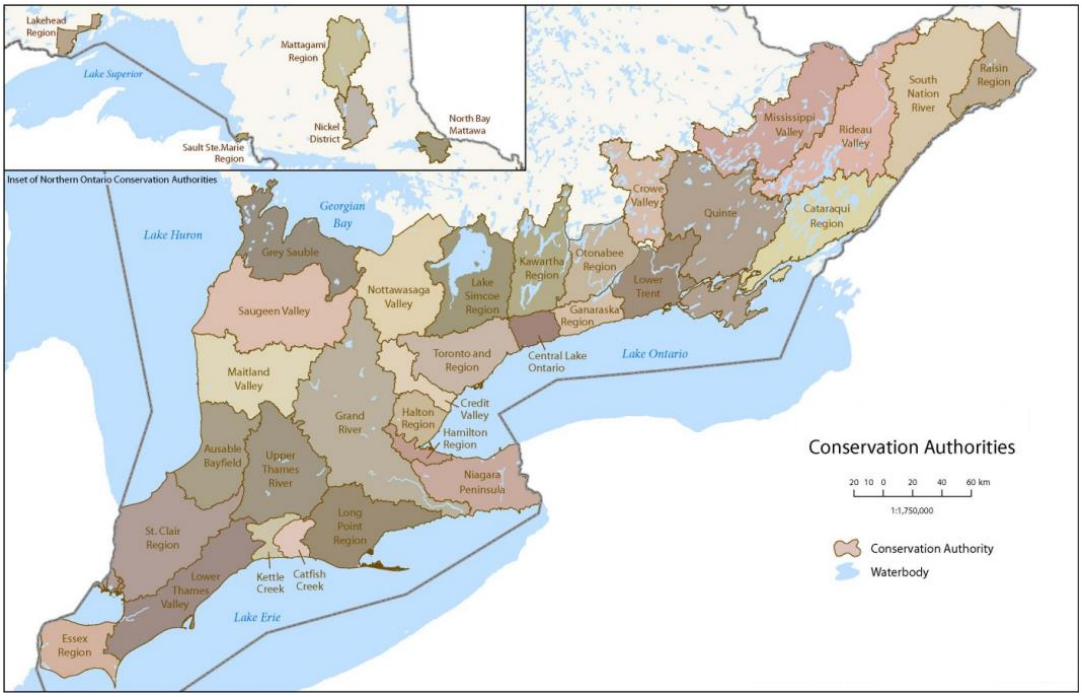

Figure 2: Conservation Authorities of Ontario (Conservation Ontario, 2015)

There are currently 36 conservation authorities, with jurisdictional areas ranging from 500 km^2 to 7000 km^2. The majority of conservation authorities are located in Southern Ontario (Figure 2), where there are moderately sized watershed management units and an adequate municipal tax base to provide necessary funding (Worte, 2017). This is problematic given the recent increase of eutrophication and cyanobacteria in Canadian Shield Lakes in central Ontario (Palmer et al., 2011) where conservation area jurisdiction is largely absent. This is especially concerning given recent speculation of the connection between climate change and increasing occurrences of cyanobacteria blooms in oligotrophic lakes which are a prominent feature of landscapes in regions lacking a conservation authority (Winter et al., 2011; Verschoor et al., 2017; Molot et al., 2021).

2.3 Lake Associations

In areas where Conservation Authorities are not present, it often falls to local lake associations to advocate for the protection of their lake and contributing watershed. In many cases, such as in the

Eagle Lake case study, these associations work closely with the local municipal government who hold regulatory authority (primarily via the *Municipal Act* and *Building Code Act*). Lake Associations operate with no regulatory authority and their financial capacity is closely tied to membership fees and number of cottages on the lake (Gabriel & Lancaster, 2004). Beyond advocacy, lake associations serve as a means to organize stewardship activities and to provide education and outreach to local residents about watershed health. While they do not have the ability to regulate, they do give their members a voice to raise concern over any potentially harmful activities within the watershed. Lake associations represent a potential increase in social/community capacity via collaboration and volunteer participation. The level of expertise associated with any one lake association varies dependent on the members of the board and the local residents. Strategic partnerships between lake associations and experts and/or academics is one way to increase local capacity to address issues of concern.

2.4 Eutrophication

Eutrophication is the excessive richness of nutrients in a waterbody that can cause dense phytoplankton (microscopic photosynthetic algae and cyanobacteria) growth and reduced dissolved oxygen (DO) concentrations (Harper, 1992). It has significant negative impacts on waterbodies, including an increased likelihood for harmful cyanobacterial blooms. It has become the primary water quality issue for many freshwater ecosystems in the world (Zamparas & Zacharias, 2014). The primary nutrients involved in eutrophication are phosphorus (P) and nitrogen (N), but globally, P is far more important as a driving factor of cyanobacteria blooms in eutrophic lakes (Molot et al., 2021). P inputs can be from external sources such as agricultural runoff and wastewater treatment plants (WWTP), or it can be internal through a process known as internal P loading. This is a process in which bound P is released as highly soluble phosphate (PO_4^{-3}) from sediment during conditions of DO depletion (anoxia) and therefore mobilized into water above sediments, contributing to total phosphorus (TP) concentrations and cyanobacteria growth (Orihel et al., 2017). This process occurs in the deeper waters of stratified

lakes, where the water column is separated into distinct layers; the epilimnion, the metalimnion, and the hypolimnion (the lowest layer of water in a stratified lake) but also occurs episodically in shallow polymictic lakes (lakes that are too shallow to form a hypolimnion) during warm periods with very low wind speeds. As a result of temperature and density differences, the hypolimnion is insulated from exchange with, and consequential re-oxygenation from, the atmosphere, the epilimnion, and the metalimnion (Boehrer & Schultze, 2008). Stratification in eutrophic lakes leads to anoxic conditions in the hypolimnion, phytoplankton bloom formation, and cyanobacterial dominance of blooms (Persuad et al., 2015). Oxygen levels in the hypolimnion are a key factor governing internal P loading. In the presence of oxygen in surficial sediments, P is adsorbed to iron hydroxides in sediments and internal P loading cannot occur. Noll (2011) found during a study that increasing hypolimnetic oxygen reduces P concentration and movement from sediment to the water column. Another study by Persaud et al., (2015) showed that peaks in cyanobacteria biomass, which rely heavily on available P, were negatively correlated with hypolimnetic oxygen. Internal P loading is an important element in determining the trophic status of a lake and can increase the lag time for recovery after efforts to reduce external P loading (Petterson, 1998). Trophic status of lakes is assessed using a variety of factors, including TP, Chl-A, Secchi, and DO, but TP is the most useful estimate and the Canadian Council of Ministers of the Environment (2004) developed a system to classify a lake's trophic status based on TP ranges (Table 1).

Table 1: TP trigger ranges for Canadian lakes and rivers (Canadian Council of Ministers of the Environment, 2004)

Trophic Status	TP Trigger Ranges (µg/L)
Ultra-oligotrophic	< 4
Oligotrophic	4 - 10
Mesotrophic	10 - 20
Meso-eutrophic	20 - 35
Eutrophic	35 - 100
Hyper-eutrophic	> 100

Eutrophication's two major impacts are reduced DO and increased biological activity. Reduced DO can result in strains on fish life, especially cold water species which are confined to the hypolimnion during the summer, with potential for massive fish die-offs (Crossman et al., 2013). Increased biological activity means production of more organic matter which acts as a positive feedback cycle for DO reduction, as decomposition of organic matter leads to low DO concentrations in bottom waters (Zamparas & Zacharias, 2014). Eutrophication also leads to reduced water clarity.

2.5 Cyanobacteria

Cyanobacteria are potentially harmful phytoplankton associated with the production of liver and nerve toxins, and unpleasant taste and odour compounds and surface scum (Watson et al., 2008). These impacts cause significant damage to the economic, ecological, and social value of affected waterbodies. They are especially damaging when affected waterbodies are used as sources of drinking water, such as Callander Bay and Lake Erie (Makarewicz et al., 2006; Steffen et al. 2017).

Cyanobacteria are complex microorganisms and challenging to manage since many limnological (e.g., fetch, depth), meteorological (e.g., wind, rain), and anthropogenic (e.g., point source and non-point source pollution) factors can contribute to development of sediment anoxia and bloom development (Verschoor et al., 2017; Molot et al. 2021). Principal drivers of cyanobacteria blooms include high water temperature, low wind speeds leading to thermal stratification or gradient, and high phosphorus concentration (Paerl 1988; Persaud et al., 2015; Molot et al., 2014, 2021). Since the mix of factors contributing to sediment anoxia and bloom formations is heterogeneous from lake to lake, there is a need for place-based approaches to better understand the mechanisms contributing to blooms in individual lakes (Persaud et al., 2015).

The non-point source water pollution that can result in eutrophication and cyanobacteria represents what is deemed a 'wicked problem.' A wicked problem is highly multi-actor, multi-scalar, dynamic, uncertain, and unclear (Patterson et al., 2013) and therefore difficult to manage. Wicked problems are

further complicated by uncertainty about future environmental conditions and contrasting social values. This is certainly the case for non-point source water pollution. Changing climate could produce longer periods of warm, dry, calm days, producing a sustained duration of optimal conditions for cyanobacteria development and dominance. Cyanobacteria dominance is defined as >50% phytoplankton biomass (Downing et al., 2001). Additionally, changing precipitation patterns will affect timing and intensity of runoff, therefore altering non-point sources of water pollution all of which can potentially shift species composition (O'Neil et al., 2012).

Contrasting social values can complicate approaches to solving eutrophication problems. The agricultural sector represents a vivid example. Agricultural operations, specifically runoff of fertilizer and manure, are a significant source of non-point water pollution. Measures to reduce this pollution are supported by most but are often resisted by some in the agricultural sector, who see them as economically taxing (Sproule-Jones et al., 2008). Due to their complexity, wicked problems are especially dependent on an integrated approach for successful management (Rogers, 1993).

2.5.1 Drinking Water Treatment/Advisory

Ingestion of the cyanotoxins such as microcystin LR (one of more than 200 closely-related microcystin variants) (Johannson et al., 2019) can result in gastrointestinal impacts such as nausea, vomiting, and diarrhea and can be fatal to pets and/or livestock (CDC, 2018). Municipal governments are responsible for the maintenance of WWTPs and in areas where cyanobacteria have occurred historically or in areas where growth conditions are present for sustained periods, many WWTPs install activated carbon filters to prevent breakthrough of cyanobacteria toxins in drinking water. Health Canada has set a maximum allowable concentration of 1.5 µg/L for total microcystins in treated drinking water and advises that bottled water be used to mix infant formula when total microcystins exceed 0.4 µg/L (Health Canada, 2021). When drinking water exceeds these levels a drinking water advisory is in place.

This is particularly concerning because simply boiling water is not sufficient as is often the case with other contaminants, hence, removing cyanotoxins requires more technologically dependent methods.

2.5.2 Recreational Advisory

Exposure to cyanobacteria can result in dermatitis, an acute inflammation of the skin (United States Environmental Protection Agency, 2014). When a bloom is detected, a recreational advisory is posted at beaches, warning against recreational use of the water. The beach is not closed, but residents are to use the water at their own risk. Residents are advised that it is safe to continue recreational use of the water only after the bloom is no longer present (NBPSDHU, 2019). When a bloom is detected, the recreational advisory remains in place for the duration of the summer. This is because blooms can reoccur and because testing for cyanotoxins is only done after a bloom has been reported to the Spills Action center.

2.6 Policy Science and Evaluative Frameworks

The study and evaluation of watershed management requires an understanding of complex frameworks within which policies are implemented. As a policy scholar, it is important to consider not only the scientific aspects but political factors that are deep-rooted in any policy approach. They must have a firm understanding of governance, actors and issues, as well as the phenomena over which governance is being directed. Thus, an interdisciplinary knowledge base and approach is necessary (Farr, Hacker, & Kazee, 2008).

Due to the complexity of any policy evaluation, it is important first to identify key variables. These include participants, perspectives, situations/context, capacities, strategies employed, and outcomes/impacts surrounding any policy decision (Laswell, 1970). This is a substantial amount of data that must be considered. Beyond simply analyzing the data, the policy scholar must also choose how to best present said data, especially to those in governance positions who may not necessarily have a firm grasp of the scientific elements of the phenomena being managed. Therefore, it is important to choose

the best methods for representing data, whether that be utilizing maps and charts to convey messages, or supplementing numerical material with physical examples (Laswell, 1970). Effective communication of data is important in order to bridge the apparent science-policy gap (Cvitanovic & Hobday, 2018). Finally, the policy scholar fulfills an important role in research in that they not only have a responsibility to accurately convey the scientific aspects but to promote social responsibility as well (Farr et al., 2008). Therefore, they must simultaneously play the roles of academic and advocate. Also of note is the complexity of evaluating capacity, for which triangulation, or the comparison of multiple data sources is vital. The use of a capacity evaluation framework (Ivey et al., 2006; Ivey et al., 2002; Rizvi et al., 2013) is necessary for a structured approach that allows for reproducibility in other contexts.

2.6.1 Existing Frameworks

The three primary guiding frameworks used in policy science today are: 1) Context, process, output, outcome; 2) Principles or normative values; 3) Capacity.

The context, process, output, outcome framework focusses on getting a thorough understanding of all elements relating to policy creation, implementation, and results. It recognizes that in each individual situation, specific context plays a fundamental role. As Mickwitz (2003) emphasizes, if evaluation of environmental policy is undertaken without due consideration of the specifics involved there is a risk of identifying only minor impacts. It is vital that the key characteristics of both the problems and our knowledge of them should impact the evaluation of policy used to address them. The principles or normative values evaluation framework assesses policy based on its adherence to a set of normative values (Gasper, 2017). In this context, policies would be evaluated based on their adherence to IWM principles. Finally, the capacity approach.. This approach creates capacity indicators (and collects data on said indicators (via policy review and semi-structured interviews) to reach conclusions about local capacity (Dany et al., 2015; Ivey et al., 2002; Ivey et al., 2006; Rizvi & et al., 2013; Timmer et

al., 2007). Policies are evaluated on their contribution to local institutional capacity within varying contexts. A novel framework is presented below in section 3.3.2.

2.7 Knowledge Gap

Cyanobacteria represent a 'wicked' problem that has been increasing in frequency in Ontario's inland lakes (Patterson et al., 2013; Palmer et al., 2011). They are a threat to local aquatic environments, local economies, and to public health. Given the complexity involved in addressing the issues around cyanobacteria, an integrated approach is important. Ontario's 12-point plan provides a general framework for preventing and mitigating cyanobacteria blooms; however, implementation of the action plan takes place at the local level and is reliant upon local capacity. There is a dearth of literature investigating the local capacity of watershed managers to implement the type of integrated approach that is required to adequately deal with the emerging threat of cyanobacteria blooms. This research contributes to the literature by providing a case study approach, evaluating local capacity in three different case studies in Ontario. In addition, it addresses the value of regulatory authority wielded by frontline managers, and provides insight into their perceptions on pertinent issues surrounding IWM. Finally, it provides a novel framework for assessing local capacity for implementation of IWM, specifically for the management of cyanobacteria and eutrophication.

3.0 Methods

3.1 Case Study Approach

Bromwell (1990) defines a case study as a "systematic inquiry into an event or a set of related events which aims to describe and explain the phenomenon of interest" (p. 302). In this instance, the phenomenon of interest is the capacity for IWM implementation in three different case studies with an array of different contextual factors. A case study approach is particularly effective here as it provides a means to explore complex settings to advance understanding (Barth & Thomas, 2012). For the purpose of this research, using a case study approach allows for a blend of both qualitative data (semi-structured interviews, and policy review) and quantitative data (monitoring data) to reach conclusions. It also allows for the integration of stakeholders' perspectives while providing the necessary information to utilize the novel framework (see section 3.3.2) to complete a comparison of capacity for IWM implementation.

This paper uses the capacity approach for evaluating current institutional arrangements (i.e., legislation and policy documents), where capacity indicators are selected, and institutional arrangements are evaluated on whether they contribute to or hinder the capacity for IWM implementation.

3.2 Data Collection

3.2.1 Document Collection and Review

The data collection took place over a year, beginning in summer 2019. Document collection for each case study was the initial step, which highlighted major activities, policy developments, and key stakeholders. Documents collected included technical reports and studies (e.g. Reports on external phosphorus loads), management and policy documents (e.g. Source protection plans), watershed health reporting documents (e.g. Watershed report cards) and legislation (e.g. Clean Water Act). Document review was guided by a framework for real-time policy analysis (Table 2). The framework aids policy evaluation, serving as a checklist for gathering data (Hanberger, 2003). This allowed for a more focused

approach to data collection and for a structured comparison of the policy context for each case study. The framework is split into the following four components: (1) Provides the structure and direction of the evaluation, with a focus on the surrounding context, key stakeholders, the problem at hand, and variables to consider; (2) focuses on the aims and direction of the subject policy, investigating the goals, the plans of action, and the method of policy evaluation; (3) focuses on the actual implementation, analyzing the line of action used in practice, how the implementing organization works, whether or not resources are used effectively, and whether or not unexpected problems occur; (4) focuses on results and consequences, detailing the extent to which intended goals are reached, whether there are unexpected results, what the effects are, and who benefits from the policy. It is important to note that policy evaluation is a continuous process and that the four categories were not analyzed sequentially, but concurrently. Review of legislation was less rigorous, following previous works by Bruce Mitchell, in which legislation was not examined in detail, but in terms of implications for an integrated approach to watershed management (Mitchell et al., 2014).

Table 2: Framework for Real-Time Evaluation of Public Policy (Hanberger, 2003)

Problem/Situation	**Policy**	**Implementation**	**Results/Consequences**
Context	Goals	Line of action	Attained goals
Actors /stakeholders	Policy theory	Organization, competence	Unintended results
Problem definitions	Policy means	Resources	Effects
Relevant variables	Evaluation intervention	Unexpected Problems	Values and order promoted

3.2.2 Semi-Structured Interviews and Survey

The next step was semi-structured interviews with representatives from each case study area. Purposive sampling (Bradshaw and Stratford, 2005) was used to identify potential interview participants. Participants with affiliations to specific organizations relative to the study (Tongco, 2007) were selected from a combination of document analyses and a review of organizational governance structures. Interviews ranged from 35 minutes to one hour and 45 minutes, averaging approximately one hour. A

total of fourteen interviews were conducted (Table 3). Due to the complexity surrounding an integrated approach to watershed management, semi-structured interviews were used to delve into and attempt to understand the variety of different experiences and opinions (Longhurst, 2003). The purpose of the interviews was two-fold: (1) to allow participants to identify areas of success and weakness in their experiences regarding watershed management, including actions that either enhanced, or were limited by local capacity and (2) to document the perception of current legislative and policy frameworks. The majority of interviews took place in person, while some were conducted over the phone. All interviews were digitally recorded and transcribed for further analysis. Participants were guaranteed confidentiality, helping to reduce interviewee response bias (Koebele, 2015). Interview schedules (Appendix A) were similar, but adjusted slightly for each interview to remove any irrelevant questions. Member checking (Bryman & Burgess, 2002) was used to give participants an opportunity to confirm the credibility of interview transcripts. Member checking, paired with triangulation (Bryman & Burgess, 2002) using multiple sources of information (i.e., document collection, semi-structured interviews, and survey data) were compared to help to ensure data validity. The research used informed consent procedures (Lipson, 1994) as participants were placed in a potentially vulnerable position, where to speak candidly could mean being critical of employers or colleagues. The purpose of the research was clearly conveyed to participants and caution was taken to not be deceptive in anyway about said purpose (Creswell, 2007). The use of semi-structured interviews allowed for a comparison of local capacity using the perceptions of frontline managers.

Table 3: Interview Participants

Case Study Area	Participant Organization (# of Participants)
Callander Bay	North Bay-Mattawa Conservation Authority (2) North Bay-Mattawa Source Protection Committee (1) North Bay Parry Sound District Health Unit (1) Municipality of Callander (1)
Lake Simcoe	Lake Simcoe Region Conservation Authority (1) Rescue Lake Simcoe Coalition (1) Ministry of Environment, Conservation and Parks (1)
Eagle Lake	Eagle Lake Conservation Association (1)* Machar Township (1)*
Severn Sound	Severn Sound Environmental Association (3)
Muskoka	Muskoka Watershed Council (1)** District of Muskoka (1)**

* Participant included input from other members

** Participant represented both organizations

In addition to semi-structured interviews, a survey was completed by attendees of ELCA's Blue-Green Algae Workshop as part of the previously mentioned collaborative research project involving Machar Township, ELCA, York University, and Nipissing University. The survey asked lake residents questions regarding their use of the lake, participation in stewardship efforts, and perception of water quality threats. This information assisted in the capacity evaluation component and in making suggestions towards an integrated approach to watershed management in regions with limited capacity.

3.3 Data Analysis

3.3.1 nVivo

All interviews were digitally recorded, transcribed, and analyzed in nVivo qualitative data analysis software. Interview transcripts were thematically coded to assist in comparison of common categories across case study areas (Azeem, Salfi & Dogar, 2012). Additionally, the use of nVivo allowed for easy access to coded data during the writing phase (Leech & Onwuegbuzie, 2011). The use of nVivo software to organize interview transcripts streamlined the process of using the novel framework to compare local capacity for IWM implementation across case studies.

3.3.2 Capacity Evaluation Framework

This research uses a novel framework for the evaluation of capacity for an integrated watershed management approach (Table 4). The framework was designed based on a combination of work done by Ivey et al. (2001) on evaluating Conservation Authorities' capacity for groundwater management, research by Ivey et al. (2006) on evaluating capacity of existing institutional arrangements for source water protection, and an investigation by Rizvi and Adamowski (2013) on First Nation capacity for integrated water resources management. The framework guided the creation of interview schedules.

Table 4:Capacity Evaluation Framework

Capacity Heading	Indicator Questions	Indices
Financial Capacity	What is the organization's budget and expenses?	Organizational budgets
		Organizational expenses
	What are the sources of the budget?	Sources of organization funding
		Do sources of funding impact organizational goals/directions
		Year-to-year stability of funding
		Elligibility for external funding sources for various organizations (and whether they are pursued)
Operational Capacity	How many staff are involved in cyanobacteria and eutrophication management?	Full and part time staff are working directly or indirectly in cyano/eutroph management
		Type/level of staff training
		Number of summer students/co-ops/internships
	How are organizations regarded by community members and partners?	Organization viewed as or views a 'Champion' for cyano/eutroph management
Technical Capacity and Information Mangement	What monitoring programs are operating and what data is collected?	Types of monitoring progams
		What limnological and chemical paramaters are being measured
		Level of available historical data (variety and quantity)
		Level of algae data
		Data gaps
		Fundamental guiding data/reports
	To what extent is adaptive mangement practiced?	How often management plans are renewed (formally or informally)
		Planning for future threats (i.e., Climate change)
	How is information shared/communicated?	How data is communicated to decision makers
		Opportunities for social learning (committees, etc.)
		Horizontal and Vertical linkages of data sharing
Social/Community Capacity	To what extent are strategic partnerships taken advantage of?	Partnerships with different communities and stakeholders
		Partnerships with academic institutions
		Conflicts/strained relations with different communities and stakeholders
		Relations with FN (if applicable)
	To what extent are stakeholders committed to cyanobacteria and eutrophication management?	Municipal government commitment to watershed health
		Local business' commitment to watershed health
		Level of compliance for non-regulated guidelines/organizational requests
		Level of public concern around watershed health and cyano/eutroph
	What is the level of education and outreach?	Stakeholder awareness of water quality threats
		Variety/Quantity of education and outreach regarding water quality threats
	How are data and decisions commuicated to the public?	How data is communicated to the public
		Online/Social Media presence
	What is the level of public participation?	Level of public participation when opportunties are present
		Level of opportunity for public participation
	To what extent are stewardship activities present and successful?	Stewardship Activities
		Participation in stewardship (ex., Restore Your Shore)
Institutional Capacity	Does the legislative framework adequately protect from potentially harmful activities?	Applicable Legislation
		Authority to regulate potentially harmful activity
		Geographic limitations of regulatory authority
		Potential legislative gaps
		Need (or lack thereof) for additional legislation
		Role of Municipal By-laws
	To what extent is mangement of land and water reources integrated?	Level of integration for water and land use management
		Attention paid to economic and social factors in management plans/decisions
	Does the policy framework account for cyanobacteria and eutrophication adequately	What relevant plans/policies are present
		Are subwatershed plans present
		By-laws and community planning strategies
	Does each stakeholder have clearly defined roles and responsibilities?	Organizations have clearly defined roles
		Jurisdictional overlap
		Level of on the ground implementation
		Policies have an implementing body/organization

The framework is based on five capacity dimensions: financial capacity, operational capacity, technical capacity and information management, social/community capacity, and institutional capacity. Each dimension has corresponding indicator questions and indices. The selection of capacity dimensions, as well as indicator questions and indices, was based on the previous work listed above and a review of literature specifically related to watershed management, harmful algal blooms, and community capacity (Bakker & Cook, 2011; Butterworth et al., 2010; Cohen & Davidson, 2011; Foulon et al., 2020; Imperial, 2005; Patterson et al., 2013; Shrubsole et al., 2017).

While the evaluative framework was used in this case to evaluate capacity for integrated watershed management in various organizations across three case studies, the intent was for it to serve as a framework that could be easily altered to aid in the evaluation of capacity for any type of resource management of any organization.

3.4 Limitations

The research is limited in scope to three case studies. However, it was important to ensure that the research was not so narrowly focused on each individual region so that any claims or suggestions made were general enough to achieve the goal of providing a framework for exploring similar concepts in other watersheds. Therefore, a certain degree of generalization was required.

The reach of the study was primarily limited by data availability. Data were collected via policy/document analysis, semi-structured interviews, and a voluntary survey, but field-sampling and monitoring data were not collected. Therefore, the level of already available monitoring data in each case study partially dictated the extent to which capacity evaluation could be performed and suggestions could be made. Additionally, while an effort was made to seek out and engage with key stakeholders from each region, it is possible that not all perspectives on each situation were included. Of particular note, the LSPP was created in partnership with the Chippewas of Georgina Island First Nation, and the North Bay Mattawa Source Protection Committee has a seat available for a representative

member of Nipissing First Nation. These perspectives would have been valuable but contact for an interview was not successful.

It is beyond the scope of the research to pursue any form of policy creation. The intent of the work is simply to provide suggestions based on in-depth research for improving/advancing watershed management with a focus in areas with limited capacity. The current legislative framework was analyzed, discussed in interviews, and commented on, but anything further is outside of the project's scope.

4.0 Case Studies

4.1 Eagle Lake

Eagle Lake (Figure 3) is a small headwater lake of the Magnetewan River (Georgian Bay) watershed located west of South River, within the Township of Machar south of North Bay (N 45.833 W 79.501). The lake is split into distinct northern and southern basins with a narrow channel allowing for limited interchange with water flowing from the north to the south basin. While the mean depth is 6 m, the northern basin is smaller and shallower, and the southern is larger with a max depth reaching 21 m. The lake has a total surface area of 9.4 km², a morphometric index of 2.0 and a comparatively small catchment of 32.5 km². With a shallow mean depth of 6 m, intermittent periods of stratification and isothermal conditions are expected. Land cover in the catchment is primarily forest (79%) and cleared land including a golf course (15%) (Hutchinson Environmental Sciences Ltd., 2013).

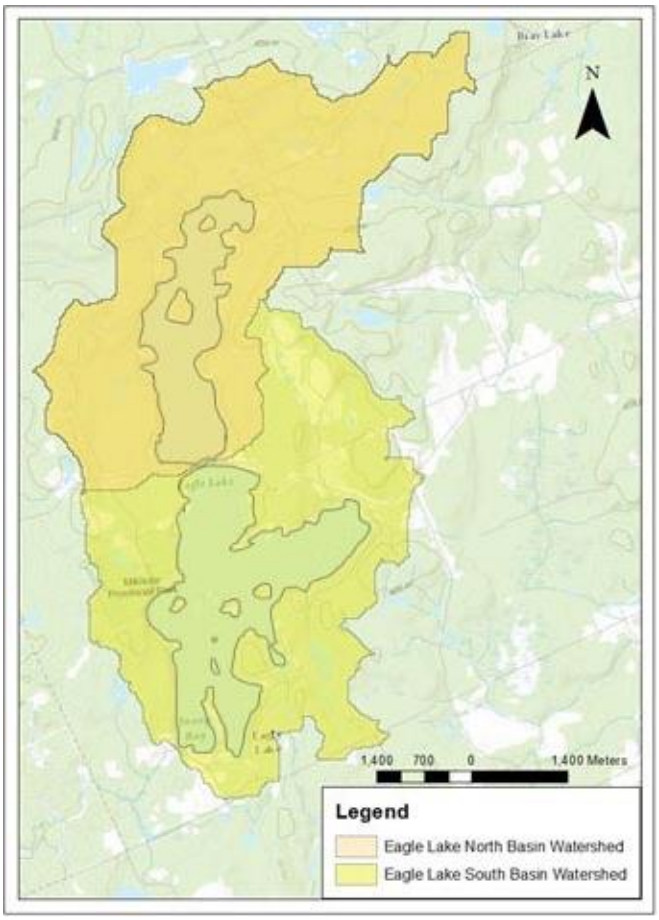

Figure 3: Eagle Lake Watershed

Historically, phosphorus levels have been representative of an oligotrophic lake, with average total phosphorus (TP) values of 8.0 µg/L from 2002-18 (Table 5). However, TP levels in both the north and south basin have been increasing slowly with the northern basin reaching mesotrophic levels (13.1 µg/L) starting in 2015. In 2017 the North Bay Parry Sound District Health Unit (NBPSDHU) issued a warning about a potential harmful algal bloom (HAB) in Eagle Lake. Although the bloom species composition was confirmed to be a diatom, it could be indicative of increasing TP and longer ice-free seasons which are also more favourable conditions for cyanobacteria. Additionally, over the last three years, invasive phragmites have appeared in over 25 locations on the lake. In 2019, as part of a collaborative research project involving a partnership with the Eagle Lake Conservation Association

(ELCA), Machar Township, York University, and Nipissing University, temperature probes at 1 m intervals and dissolved oxygen sensors 0.5 m above the sediment-water interface were deployed at two stations in the southern basin. One sensor string was deployed at the deepest point in the lake, and the other was deployed in semi-secluded Angus Bay where the 2017 bloom originated.

The lake is an angling destination and recreational resource. There are 683 utilized lots on the lake, made up primarily of seasonal cottages, and permanent residences. There are 111 vacant lots. Additionally, Mikiskew Provincial Park borders a portion of the western coast in the southern basin. Residents draw drinking water from the lake, but it is not a municipal drinking water source. A Lakeshore Capacity Assessment was completed in 2013 and concluded that both basins were over capacity for shoreline development with respect to TP concentration under existing conditions (Hutchinson Environmental Sciences Ltd, 2013). As a result, further development on the shoreline has been restricted by Machar Township.

The two primary managing bodies of Eagle Lake are the ELCA and Machar Township. ELCA is the cottager's association formed in the mid 1970's, with approximately 170 properties on the lake as members. ELCA is largely responsible for education and outreach, advocating for the protection of water quality, organizing the public for stewardship activities, and taking annual water samples as part of the Lake Partnership Program. Machar Township works in tandem with the ELCA and can regulate some potentially harmful activities via township By-Laws and Ontario's Building Code. As the lake is not a municipal drinking water source, and does not fall within the boundaries of a conservation authority, it is therefore not protected under the Clean Water Act. Other legislation relevant to managing water quality includes the *Environmental Protection Act*, the *Ontario Water Resources Act*, and the *Nutrient Management Act*.

4.2 Callander Bay

Callander Bay (N 46.213, W 79.389; Figure 4) is a small circular embayment at the eastern end of Lake Nipissing, bordered by the Municipality of Callander. It is a polymictic system that is separated from the main basin of Lake Nipissing by several islands and a provincially significant wetland. It is a shallow bay with a mean depth of 4.5 m and a max depth of 10.5 m. It has a total surface area of 12.1 km² and a comparatively large catchment of 296.1 km². With a low morphometric index of 1.3 (defined by Osgood (1988) as the mean depth (m) over the square root of surface area (km^2)), stratification does not usually persist throughout the summer and intermittent mixing events with isothermal conditions occur. A higher index value is associated with stronger stratification in temperate lakes (Nurnberg et al., 2013). Land cover in the catchment is primarily forest (59%), wetland (12%), and cleared land including agricultural areas (12%) (NBMCA, 2015).

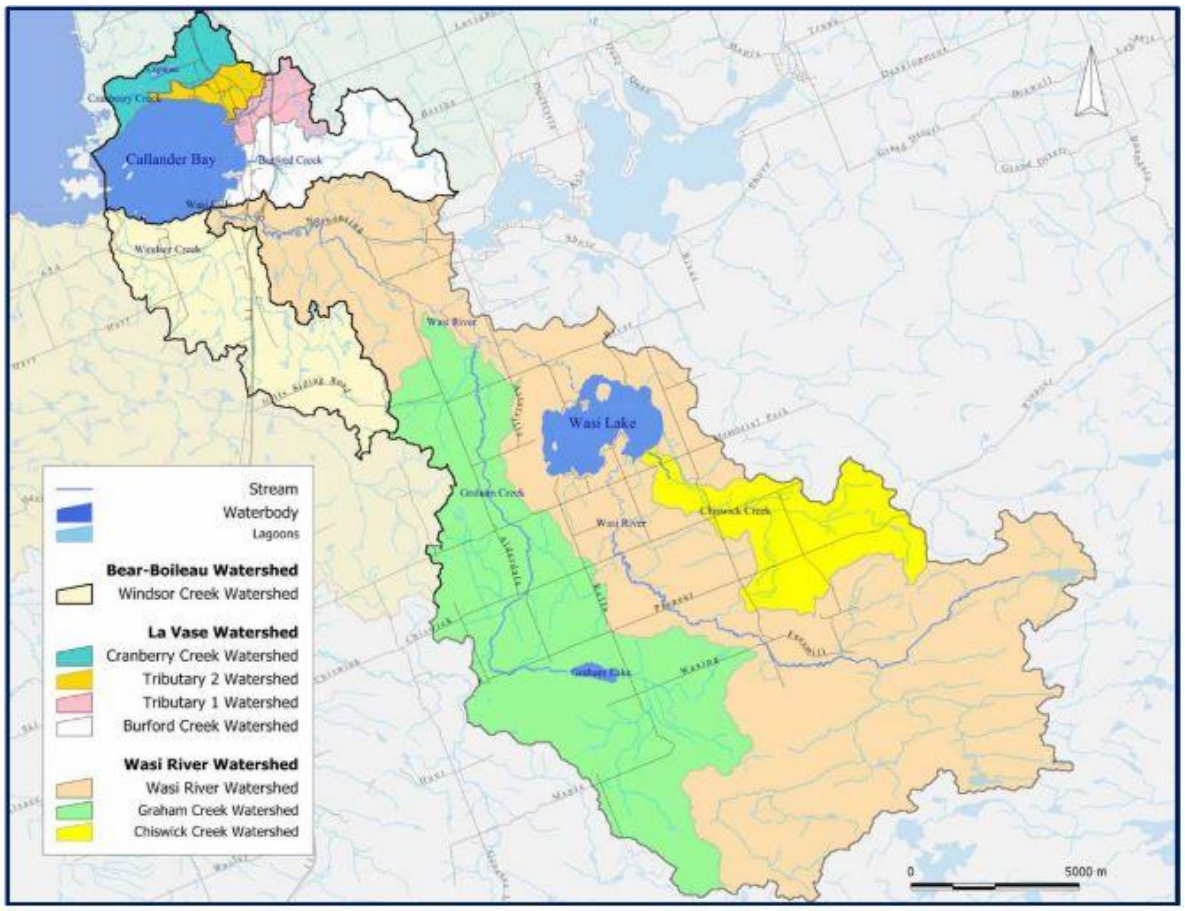

Figure 4: Callander Bay Watershed (Source: Karst-Riddoch 2010)

Phosphorus levels indicate a meso-eutrophic waterbody, with TP values averaging 20.6 µg/L from 2002-18 (Table 5). TP levels have been stable over the last decade despite efforts to reduce external loading to mitigate the occurrence of harmful algal blooms that have become a seasonal event in the bay (NBPSDHU, 2019). In 2013, Nipissing University began monitoring temperature and dissolved oxygen profiles in the bay over the ice-free season to address a monitoring need outlined in the Callander Bay Subwatershed Phosphorus Budget report (Karst-Riddoch, 2011). Subsequent research has shown evidence of stratification, hypolimnetic anoxia, and internal P loading (Prescott 2015, Lavigne 2019, Jones 2020). Given the relatively stable trophic status, it is likely that the recent increase in

harmful algal blooms is at least partially a climate change indicator (Winters et al. 2011, Pearl & Huisman 2008; Molot et al., 2021).

Callander Bay is a drinking water source for the Municipality of Callander, with a population of 3,863. It is also a significant recreational resource and a popular tourism destination. As a municipal drinking water source, Callander Bay is protected under the *Clean Water Act* and Source Water Protection regulation. The North Bay Mattawa Conservation Authority (NBMCA) delivers the protection program on a watershed basis and acts as the primary managing body for Callander Bay (NBMCA 2015). Through the *Clean Water Act*, a source protection plan (SPP) began development in early 2013 and was finalized in 2015 and is overseen through a partnership involving the NBMCA, Source Protection Authority, Source Protection Committee, municipalities, and key stakeholder representatives. The Municipality of Callander is designated as the implementing body for numerous source protection plan policies and is able to regulate potentially harmful activities via township By-Laws and Ontario's Building Code. The North Bay Parry Sound District Health Unit (NBPSDHU) is the 'first-responder' when cyanobacteria blooms are present. Citizens call the NBPSDHU or the MECP Spills Action Centre when they suspect a bloom. Upon confirmation of a bloom via MECP testing, the NBPSDHU issues a media release warning the public of a potential hazardous algae bloom. They also focus on education and outreach in order to protect public health from the threat of harmful algal blooms (i.e., consumption and exposure to skin). Other relevant legislation includes the *Environmental Protection Act*, the *Ontario Water Resources Act*, the *Safe Drinking Water Act* and the *Nutrient Management Act*.

4.3 Lake Simcoe

Lake Simcoe (N 44.462, W 79.3554; Figure 5) is largest inland lake in southern Ontario, excluding the Great Lakes; some of the fastest growing urban centers in the province (MOE et al. 2009) surround it. The lake consists of a main basin and two large bays, Kempenfelt Bay in the west, and Cook's Bay at the southern end of the lake. Cook's Bay and the Main Basin are shallower with a mean depth of 7.4 m

and 15.3 m, respectively, while Kempenfelt Bay is deeper with a mean depth of 25.7 m. The Main Basin is large with a surface area of 641.5 km² while Cook's Bay and Kempenfelt Bay have comparatively small surface areas of 45.1 km² and 35.7 km², respectively. Cook's Bay and the Main Basin are polymictic systems with limited episodic thermal stratification and low morphometric indexes of 1.1 and 0.6, respectively. Kempenfelt Bay has a higher morphometric index of 4.3 and undergoes summer stratification. The lake has a total surface area of 722 km² and a small contributing source area (catchment) of 3572 km². Intensive urban development paired with agricultural expansion in the watershed have resulted in major land use changes and degraded water quality (Jin et al., 2013).

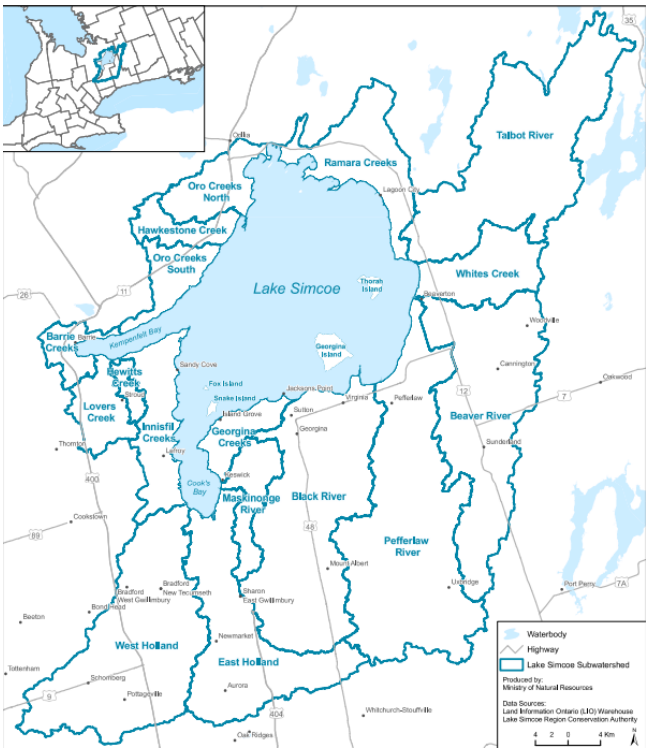

Figure 5: Lake Simcoe Watershed (Dodds, 2016)

Lake Simcoe is among the most studied inland lakes in Ontario and water quality concerns have been documented since the 1970s. Eutrophication, invasive species, land use change, and climate change have been noted as particularly concerning (LSSAC 2008) although cyanobacteria blooms are rare. As

Wood (2008) outlines, anthropogenic phosphorus inputs have been managed since the 1990s and improvements have been made, but with increasing pressure from development, further steps were deemed necessary. As part of a commitment to address long-term environmental issues, the Government of Ontario approved the *Lake Simcoe Protection Act* (LSPA) in 2008. A portion of LSPA funds was directly related to long-term monitoring and directed research (Palmer et al., 2011). As the most recently published Minister's report indicates, TP levels (Table 5) have been decreasing and hypolimnetic dissolved oxygen has been increasing in the lake (MECP, 2019), possibly due, in part, to invasive Dreissenid mussels (Li et al., 2018). While these are encouraging signs of recovery, TP loads are still high and TP loading targets set in the Lake Simcoe Protection Plan (LSPP) have not yet been met (LSRCA 2019).

Table 5: Morphometry, TP, and Secchy transparency of study sites

	Eagle Lake	**Callander Bay**	**Lake Simcoe**
Catchment Size (Km^2)	32.5	296.1	2898.6
Surface Area (Km^2)	9.4	12.1	722.4
Max Depth (m)	21.9	10.5	41.0
Mean Depth (m)	6.0	4.5	15.3
Morphometric Index	2.0	1.3	0.6
Avg TP (µg/L)	8.0	20.6	7.5
Secchi Depth (m)	4.1	2.0	4.9

Lake Simcoe is the most intensely fished inland lake in Ontario, and provides a tremendous economic asset with seasonal tourism and year-round recreational opportunities (MECP 2019). The lake also serves as a drinking water source for eight municipalities (Young et al., 2010). The Lake Simcoe Protection Plan (LSPP) was published in 2009 as part of the LSPA and serves as a guiding framework for

watershed management in the region with an emphasis on IWM. The Ministry of Environment Conservation and Parks (MECP) is responsible for administering the LSPA and implementing the LSPP, and has a Lake Simcoe Project Team that works in partnership with key regional stakeholders (Peat, 2016). One key stakeholder is the Lake Simcoe Region Conservation Authority (LSRCA) formed in 1951, which acts as a primary managing body for Lake Simcoe and provides leadership to the two Lake Simcoe advisory committees, municipalities, and key community stakeholders to implement policies laid out in the LSPP (MOE et al., 2009). Additionally, as a municipal drinking water source within the jurisdiction of a conservation authority, it is protected under the Clean Water Act (2006). As part of the Clean Water Act, source protection authorities were created (consisting of boards of directors from existing conservation authorities) to establish and support a source protection committee. The source protection committee is made up of 21 appointed local citizens representing economic, municipal, and public sectors as well as one chair and one member from Rama First Nation (LSRCA et al., 2015). The committee was responsible for preparing the terms of reference and assessment reports preceding the publication of the South Georgian Bay Lake Simcoe Source Protection Plan and continues to spearhead public consultation. There are numerous independent organizations within the Lake Simcoe watershed that are operating to protect the watershed. One such organization is the Rescue Lake Simcoe Coalition (RLSC), that acts as a coordinating body for numerous local non-government organizations, providing leadership and advocating for the protection of Lake Simcoe. Other relevant legislation includes the Greenbelt Plan, which protects 1.8 million acres in the Greater Golden Horseshoe from development, the Growth Plan for the Greater Golden Horseshoe, which provides strategic direction for managing growth in the area, the *Environmental Protection Act*, which primarily addresses point sources of water pollution, the *Ontario Water Resources Act*, which is a general water management statute applying to both groundwater and source water, the *Safe Drinking Water Act*, which legislates drinking water testing in municipal systems, the *Nutrient Management Act*, which requires farm operators to develop nutrient

management systems, and finally the *Ontario Planning Act*, through which the restriction of potentially harmful activities can be overridden via a Minister's Zoning Order.

5.0 Evaluating the Capacity for Integrated Watershed Management in Three Different Contexts

5.1 Financial Capacity

Within the context of the novel framework, financial capacity refers to the ability of key stakeholders in a region to generate, maintain, and responsibly make use of available funds. It is important to make a distinction between internal and external funding. Internal funding refers to financial capital that is generated from within the case study (i.e., municipal levies, membership fees, etc.). Internal funding also includes provincial funding that is non-project specific or renewed annually (i.e., funding through the Conservation Authorities Act). External funding refers to financial capital that is generated from outside the case study (i.e., project specific provincial funding, grants, etc.)

An absence of financial capacity is a hinderance on watershed management activities (Rizvi, 2013; Patrick et al., 2008; Brandes & O'Riordan, 2014). It is also a primary factor in addressing different types of capacity concerns (Walters et al., 2012, Cervoni et al., 2013). A region with a limited financial capacity and a dependence on external funding could struggle to move beyond project-specific mitigation techniques. A region with a comparatively larger and more stable financial capacity is able to collect necessary data (especially long-term data), engage in large-scale stewardship, and make informed management decisions regardless of external funding eligibility.

5.1.1 Eagle Lake

Interview results for Eagle Lake show a limited financial capacity that has been adequate for initial actions but has limited the ability to take additional steps. The Eagle Lake Conservation Association (ELCA) had an operational budget of $27,348.43 in June of 2019 with an annual revenue of slightly more than $10,000.00. This funding is primarily internal, generated through membership fees and fundraising events such as the annual calendar sale. Members pay a fee of $25.00/year or $100.00 for five years. External funding includes a $920.00 grant from the Federation of Ontario Cottager's

Association (FOCA) to help combat invasive phragmites and an $8000.00 restricted investment from Fisheries and Oceans Canada. While not completely project specific, this investment is only applicable towards a lake restoration project. Machar Township works in tandem with ELCA towards watershed management, and they have an operational budget of approximately $3.5m, though they do not have funding specifically allocated for watershed management at this point.

Eagle Lake's current expenses are quite low for three primary reasons: 1) they have just taken initial steps and are still collecting data before investing in a more capital intensive management effort; 2) the vast majority of work is done on a volunteer basis; 3) strategic partnerships with organizations such as Nipissing University have vastly reduced data collection costs. Their primary expenses include insurance, their annual general meeting, and the mailing of tri-annual newsletters. However, with TP trending up, the emergence of invasive phragmites, and increasing occurrences of algal blooms (none of which have been classified as cyanobacteria-dominant yet), and a vigilant group of stakeholders, it is clear that management efforts and associated costs are likely to increase. The continued nurturing of strategic partnerships can help reduce this cost, but without increased financial capacity, the amount to which management efforts can increase will be hindered. It is important to note that being outside the jurisdiction of a conservation authority, Eagle Lake does not receive sustained provincial funding through the *Conservation Authorities Act*.

ELCA's internal funding is consistent year-to-year as there has been little turnover in terms of membership and the participation in calendar sales, fundraising, and donating is reliable. As one interviewee stated, 'The membership group is vigilant and cares deeply about the environment.' External funding varies on an annual and project basis. Neither ELCA or Machar Township have someone that is applying to project specific grants full-time. However, there have been instances of project specific funding in the past, including the $8000.00 restoration grant, the FOCA phragmites funding, and previous funding from the Trillium Foundation towards the development of a Lake Plan. This variability

in year-to-year funding hinders the ability of key stakeholders to plan management activities in advance. It can also sway management approaches towards activities that are eligible for external funding. To date, this has resulted in project-specific mitigation approaches, whereas the most pressing need is to expand data collection, which can be prohibitively expensive.

5.1.2 Callander Bay

Interview results for Callander Bay show a financial capacity that is meeting current needs but is lacking in year-to-year stability. The North Bay Mattawa Conservation Authority (NBMCA) had a 2019 budget of approximately $3.7m. However, the funding varies, depending on the possibility of funding cuts (via the provincial government) and the availability of project specific grants. In the NBMCA Source Protection Plan, cyanobacteria in the Callander Bay Issue Contributing Area (ICA), which is considered a significant threat and phosphorus contribution related to the toxin Microcystin LR, is given specific consideration (NBMCA, 2015). NBMCA's 2019 budget (NBMCA, 2019) allocated $253,000.00 or approximately 7% to source protection. The conservation authority gets the majority of its funding via municipal levies. It also receives provincial grants through the MECP for source water protection, flood forecasting, and water and erosion control infrastructure. Additionally, it collects certain fees that help offset operating costs in some instances and is eligible for various grant programs for project-specific funding. The majority of these grant programs focus on stewardship activities. The Municipality of Callander works in partnership with NBMCA and is also designated as the primary implementing body for a number of source protection policies. Watershed management is not a budget item for the municipality, but it is responsible for maintaining a WWTP and drinking water treatment facility. In 2019, the water and wastewater budget totalled $1,085,398.00. The vast majority of the municipality's budget comes via municipal taxes. The local source protection committee (SPC) receives provincial funding as well to fulfill its role of drafting documents for the source protection plan and helping to oversee policy

implementation. This funding is very specific, giving it limited flexibility in terms of where to allocate funds. The North Bay Perry Sound District Health Unit (NBPSDHU) is responsible for issuing media releases when there is potential for a harmful algal bloom and educating the public about exposure risks. While they do not have a specific budget for work involving hazardous algal blooms, their funding is a 70/30 provincial/municipal split. There are 31 municipalities serviced by NBPSDHU that contribute to their funding.

NBMCA's two major sources of expenses are staffing and watershed monitoring. They have also paid a portion of a graduate stipend for a student at Nipissing University as part of a strategic partnership, where they receive relevant data from the research. The expenses fluctuate based on the budget (i.e., the quantity of monitoring data is an element of the available budget), so a limited budget means a restriction on monitoring capability. As one interviewee stated, "We would love to have constant monitoring devices similar to what Nipissing University has on Callander Bay, but expenses are a limiting factor there to be sure." The primary method for reducing expenses while maintaining the quality of service/data is strategic partnerships. For example, Nipissing University routinely monitors Callander Bay for a variety of water quality metrics, including total phosphorus (TP). The Municipality of Callander's water and wastewater expenses in 2019 amounted to $786,666.00.

The municipal levies collected by NBMCA are consistent year-to-year but the provincial funding and project-specific funding have a high degree of variance. As previously mentioned, provincial funding is dependent on shifting political ideologies. Project-specific funding comes from two sources; external grants that are applied for, and directly from the province. This too varies significantly year-to-year based on the availability of external grants and provincial priorities. Funding instability can hinder any long-term management, stewardship, or monitoring programs. As one interviewee states, "This can make it hard to maintain things like long-term monitoring programs that require a certain level of

annual funding for maintenance and upkeep. Project-specific funding often provides start-up capital but rarely provides sustained funding". SPC funding is even more unstable than that of NBMCA, as their funding is solely from the provincial government and entirely vulnerable to shifting priorities. The Municipality of Callander's funding is stable, as there is little change in the municipal tax base year-to-year. The provincial portion of NBPSDHU's funding varies depending on the current government, and their current funding/operating structure is subject to change. The current government is looking to merge certain health units, reducing the total from 35 to 10. There have also been significant funding cuts for public health under the Ford government (Ontario Health Coalition, 2019).

It is important to consider that, for NBMCA and the SPC, sources of funding can impact organizational direction. To a certain extent, funding is tied to the provincial government, and available actions or programs are an element of available provincial funding. This can be problematic, as taking on any long-term program comes with a degree of risk given the variance in funding. One participant voiced concern over the longevity of funding availability, "One of the concerns that I would have for the program going forward is that the province will see fit to cap the resource allocations and just flatline them out to infinity and whether or not that will be adequate over the long term." It is this type of uncertainty over access to necessary financial capacity that can make impactful change hard to achieve.

5.1.3 Lake Simcoe

The Lake Simcoe region has a comparatively healthy financial capacity, with contributions from provincial, municipal, and external sources that allow for extensive management considerations. However, a lack in provincial funding stability is a hinderance towards long-term projects. The Lake Simcoe Region Conservation Authority (LSRCA) had a total budget of $21m for 2019, which is separated into different core services, including Water Risk Management and Watershed Studies & Strategies, which had 2019 budgets of $3.5m and $2.3m, respectively (LSRCA, 2020). The majority of LSRCA's

funding comes via municipal levies, but they also receive significant provincial funding through the Lake Simcoe Protection Plan (LSPP). The MECP manages and administers provincial funding for Lake Simcoe. An initial $20m was contributed to assist with the first four years of LSPP implementation. Since then, the province has invested approximately $50.1m to further support LSPP implementation. In addition, LSRCA is eligible for numerous project-specific grants related to watershed management and has received project-specific federal funding in the past, such as the Lake Simcoe Clean-Up Fund. The Rescue Lake Simcoe Coalition (RLSC) focusses on advocacy for the protection of Lake Simcoe, and relies on a limited budget of approximately $100,000.00. The majority of their funding is from personal donations, but they have received project specific funding as well.

The primary expense for LSRCA is monitoring activities and staffing. The extent of monitoring activities varies annually based on cost-benefit analysis of continued monitoring of certain parameters and on availability of project-specific funding. In 2019, $2.6m was spent on Water Risk Management and $2.1m was spent on Watershed Studies & Strategies. Total gross expenses for LSRCA in 2019 amounted to $18.3m. MECP expenses revolve primarily around supporting LSPP implementation. They have also co-funded the development of sub watershed plans for each of the major tributaries to Lake Simcoe and have funded municipalities' work on aging wastewater infrastructure. RLSC expenses are almost entirely project specific, with a lot of annual variance. The majority of their work is on a volunteer basis so staffing costs are minimal.

LSRCA funding via municipal levies has a high level of stability, but project-specific and provincial funding sees a high degree of variance. Similar to the experience of NBMCA, this can make longer term projects difficult to justify/maintain, as one interviewee states, "People are often good at helping fund initial capital for monitoring set up, but not always the longer term costs." The LSPP does aim to incorporate long-term monitoring and directed research (Palmer et al., 2011) but a lack of funding stability from provincial sources can deter management bodies from undertaking the type of long-term

monitoring necessary to identify trends (Burt et al., 2008). It is also important to note that monitoring and management approaches are dependent on the provincial government's attitude towards environmental protection, which varies from administration to administration. This concern was articulated by multiple participants, as one states, "Year-to-year stability of funding depends on the provincial government. You likely have four years of stability under certain governments. Then under governments with less of a mindset towards environmentalism, the funding is much less stable." Given the previously mentioned actions of the Ford government to cut conservation authority funding, this concern is well-validated. MECP funding is even more dependent on provincial government ideologies.

5.2 Operational Capacity

In this context, financial capacity refers to the number of staff and level of staff training. It also refers to the perception of the organization from local stakeholders. As previously mentioned, it is important for each case study to have a 'champion' organization for effective watershed management (Mazmanian & Sabatier, 1989). As one interviewee states, "You sometimes need that guy on that soapbox yelling at the world and advocating for the cause." Therefore, it is essential to discuss whether or not each case study region is home to a watershed management 'champion' or primarily implementing body. The number of staff in each organization is presented below using the metric of full-time staff allocations. That number includes full-time staff, part-time staff, summer students/internships, and contract/project specific staff. This number does not include volunteer work. Adequate operational capacity is essential for effective watershed management (Forster, 1997). Additionally, inadequate operational capacity limits the ability to develop the other facets of capacity presented in this framework.

5.2.1 Eagle Lake

Interview results for Eagle Lake shows low operational capacity that is a hinderance to expanding management activities. ELCA works in tandem with Machar Township to protect Eagle Lake.. It is important to note that ELCA does not have any regulatory authority, but is a volunteer advocacy group that takes action to protect the lake. There are 170 properties that are members of the organization, which represents between 300 and 350 lakefront residents. A Lakeshore Capacity Assessment in 2013 shows that at the time there were 413 active residential properties on the lake (Hutchinson Environmental Science Ltd., 2013). This includes both seasonal and permanent properties and does not include Mikisew Provincial Park or Rainbow Resort, both of which are also on the lake. ELCA has three executive board members and 16 total board members. These members help organize activities to protect the lake. When activities take place (such as phragmites removal), it is on a volunteer basis and it is not uncommon for non-member residents to volunteer for such tasks. The level of training for these volunteers is minimal and informal. To date, there have been two workshops hosted by ELCA in partnership with Nipissing University. One workshop focussed on phragmites, and one focussed on HABs, but both were aimed at informing the general public, not designed to provide management or mitigation training.

Machar Township's council consists of three councillors, the deputy mayor, and the mayor. One councillor is consistently and directly involved in partnership with ELCA for watershed protection. The township includes a public works department and administration staff that are all indirectly involved with watershed management and general ecological protection. To date, there has been no specific training for managing occurrences of HABs.

5.2.2 Callander Bay

Interview results for Callander Bay show a relatively strong operational capacity given the limited financial resources available. NBMCA is recognized as the 'champion' organization or primary implementing body. As of 2019, NBMCA had 1⅔ full time staff devoted to water quality management, including a full-time water resource scientist, a part-time technician, and a summer student who assisted the technician. Relevant staff training was peer-to-peer with the water resource scientist providing in-house training. Staff have accessed workshops through the Provincial Water Quality Monitoring Network (PWQMN) pertaining to a range of water quality topics. When new monitoring equipment is acquired, specific training for the proper use of said equipment is provided. Additionally, there is one full time position for source water protection. There are approximately 9 staff who serve smaller, indirect roles for source water protection as part of their duties. Finally, there are two full time staff who are responsible for organizing and implementing stewardship activities (such as Restore Your Shore).

The SPC (Figure 6) consists of 13 total positions (the position of First Nations Representative at the time of writing was vacant). The majority of operational capacity required for project specific work is 'borrowed' from the hosting conservation authority. There have been instances where the SPC has gone to specialists outside of the conservation authority for project specific activities, when the level of training or specific expertise was not available from within.

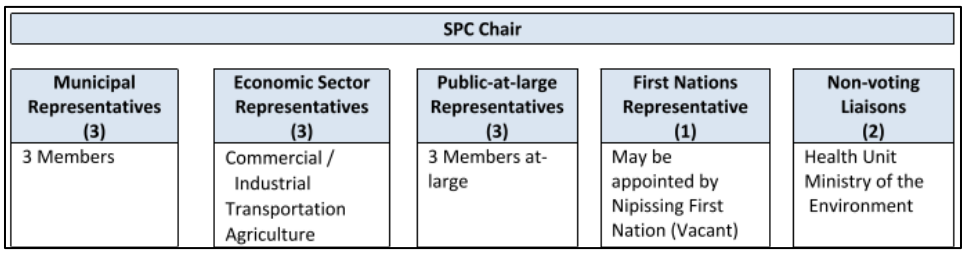

Figure 6: Source Protection Committee Structure

The NBPSDHU has one senior inspector responsible for the water portfolio (including drinking water, small drinking water, and recreational water). The primary activity regarding HABs for NBPSDHU is creating media briefs and answering calls from concerned citizens when HABs are present locally. There is a rotation of staff that answer calls and all staff receive training to ensure that the messaging is consistent.

5.2.3 Lake Simcoe

Interview results for Lake Simcoe show a comparatively high operational capacity. The LSRCA is the primary watershed management organization in the region. Between environmental monitoring and watershed planning, LSRCA boasts approximately 20 full time staff. LSRCA routinely fills summer student positions to further boost operational capacity and provide valuable experience for students. There is some annual variance as staffing numbers are impacted by budget and what projects are being undertaken during a calendar year. LSRCA new hires often have a certain level of expertise and/or training (i.e., related university education or prior experience), so training is primarily peer-to-peer and site specific as opposed to a more formal training structure. Staff have access to numerous workshops and professional development opportunities.

The MECP Central Region is the primary partner for LSRCA for the protection of the Lake Simcoe watershed. The MECP office in Newmarket has 6 full time staff that are actively engaged in different facets of local watershed management (primarily regarding the implementation of the 119 policies that make up the LSPP). Staff are also responsible for managing site-specific environmental issues within the watershed, managing grant payments, and broader policy/program discussions. Additionally, the MECP provides a field response when there is a report of a potential HAB, which includes initial testing for the presence of cyanobacteria. The staff have a high level of training and have had access to professional development opportunities. The MECP laboratory is capable of analysing phytoplankton samples.

The RLSC's staff consists of one full time worker, as well as one part time bookkeeper and one part time communications specialist. They rely on significant volunteer work, including a volunteer who operates and maintains the website. Most of the advocacy, education and outreach work performed by the RLSC is completed on a volunteer basis.

5.3 Technical Capacity and Information Management

Technical capacity and information management refers to data availability (and potential gaps in data) as well as how data is used/shared within and among key stakeholder organizations. This includes both contemporary and historical data. Without sufficient data, making informed and efficient management decisions is impossible (Kraff & Steinman, 2018; Orihel et al., 2017; Palmer, 2013; Scott et al., 2017). Data gaps have been recognized as one of the primary factors inhibiting the success of IWM implementation in Ontario (Conservation Ontario, 2010; Palmer et al., 2011; Kraff & Steinman, 2018).

5.3.1 Eagle Lake

Eagle Lake's technical capacity is in its infancy as continuous data collection began recently in 2019. The vast majority of contemporary data come from two sources; participation in the Lake Partner Program, and a strategic partnership with Nipissing University. The Lake Partner Program is a volunteer-based water quality monitoring program for Ontario's in-land lakes that is overseen by MECP's Dorset Environmental Science Centre (DESC) in partnership with the Federation of Ontario Cottagers' Associations (FOCA) (DESC, 2021). Through the Lake Partner Program, annual TP and secchi depth readings are available dating back to 2002 and 1991 respectively. Nipissing University began continuously measuring temperature at 1 m intervals and placing a DO sensor 0.5 m above the sediment-water interface in Angus Bay and at the deepest point of the lake in the central basin during the ice-free season. While no formal septic testing has taken place on Eagle Lake, residents were given

dye tablets to test their septic system manually. However, no formal mechanism was put in place to ensure that the testing took place or that test results were collected.

Participants felt that the current level of data is insufficient to make informed management decisions. There are also various factors that are not currently being monitored, largely due to fiscal constraints. An example from one interviewee is dissolved organic carbon, "Recent developments suggest that there may be other unidentified factors having a negative effect on Eagle Lake. For example, the consultant who completed the lake capacity study recommended that we begin testing for dissolved organic carbon as part of our annual water testing program." Beyond lacking contemporary data, there is little historic data available which is important for analyzing trends which can be used to determine if water is improving or not (Gatti et al., 2015). Additionally, there is the question of whether once-annual TP readings are adequate. A Machar Township council member further emphasised the need for adequate data, "Of course I can't really overstate the importance of this data, both current and historical. As a council member and as council we need that accurate data to make the proper decision when a problem arises." There are decisions that can be made based on available data and secondary research (i.e., advising about proper septic testing or keeping a natural shoreline) however if a need arises for more complex (and costly) management decisions or a regulatory approach (i.e., mandating septic inspection), then further data will be beneficial.

In 2013, Hutchinson Environmental Sciences Ltd. completed a Lakeshore Capacity Assessment for Eagle Lake and that report has helped guide management/monitoring efforts. Machar Township's Official plan also outlines management efforts, and section B4 specifically focuses on shoreline management, with section B4.9 being dedicated to the shoreline management of Eagle Lake (Machar Township, 2015). This Official plan draws on the Eagle Lake Community Action Plan that was created in conjunction with a consultant in 2008 and focusses on community stewardship (ELCA, 2008).

Data are shared between ELCA and Machar Township who have a positive working relationship. Machar Township does have an Invasive Phragmites Committee and a Blue-Green Algae Control Committee that serve an advisory role. Advisory groups also represent an excellent opportunity for networking and building relationships that are essential for positive collaboration.

5.3.2 Callander Bay

Water quality monitoring in Callander Bay is largely the responsibility of the NBMCA, in partnership with Nipissing University. Current management programs build upon information provided by various assessment reports completed as part of the SPP process that was finalized in 2015. Notably, Hutchinson Environmental completed a phosphorus budget in 2010 that has direct relation to cyanobacteria management (Karst-Riddoch, 2010). As one interviewee states, “There was a whole slew of studies that were done for the original assessment report but the amount of studies related to cyanobacteria management is going to be a much smaller amount than those involved with source protection”.

Callander Bay is part of NBMCA’s monitoring program, as they sample TP and secchi depth for 21 watercourses from April to November. Callander Bay is sampled for TP once in May and once in August by the NBMCA. In June and July NBMCA collects Secchi depth and lowers a sensor-laden sonde to gather a variety of limnological parameters from several depths electronically (temperature, oxygen, conductivity, specific conductance, turbidity, chlorophyll a fluorescence and cyanobacteria fluorescence) but does not collect TP samples which must be sent to a laboratory for analysis. In 2013, Nipissing University began deploying a chain with high frequency temperature sensors positioned at several depths and a high-frequency DO sensor during the ice-free season. Measurements are taken every minute and results retrieved at the end of the summer. Callander Municipality monitors for the presence of cyanobacteria in the water plant when a bloom is reported. Phytoplankton species

composition data were collected in June 2015 and 2016, and August 2017. The WWTP plant does have activated carbon filters installed to prevent breakthrough of cyanobacteria toxins and taste and odour compounds produced by several microbial groups including cyanobacteria. NBPSDHU works in tandem with the MECP to respond to reported blooms. The Provincial Water Quality Monitoring Network (PWQMN) through the MECP provides phosphorus load data for Wasi River, a tributary to Callander Bay. The Dorset Environmental Science Center is an active participant in monitoring and testing as well.

While there are substantially more data available for Callander Bay than for Eagle Lake, there are clear data gaps that largely stem from limited financial capacity. The first question is whether or not a TP reading in May and August each year is sufficient for informed decision making. As one NBMCA participant stated, "In June and July we lower our sonde but we do not collect TP. We should but we don't because we have a set lab load from the Ministry and they do all of our samples." It is worth reiterating here that NBMCA is responsible for varying levels of monitoring across 21 watercourses in the region and that their annual laboratory load (the number of chemical analyses that have been allocated) needs to be distributed across all 21. The COVID-19 pandemic has created further data collection gaps (and highlighted the need for automated monitoring devices) because technicians have been unable to get out in the field routinely for spot sampling. As one interviewee suggests, "Ideally you'd have a chlorophyll sensor and phycocyanin sensor continuously logging and transmitting data so that you know exactly what the water looks like at any time." Participants also highlighted the lack of phytoplankton data specifically, as historical species composition data is limited and routine testing for microcystin and other cyanotoxins does not occur.

Another data gap is present once a bloom has been confirmed. When a bloom is reported, the NBPSDHU samples and the sample is tested by the MECP. If cyanobacteria are present, a media release is issued stating that a bloom is present on the lake. However, if that body of water is confirmed to be positive, it is only sampled once during the calendar year. It is never re-sampled to determine whether

that bloom has dissipated and therefore whether an advisory can be lifted. This is concerning for residents since property values and recreational opportunities can be impacted by such announcements. This is compounded by the fact that a precise location of the bloom is not part of the media release, it is only the name of the lake that is released. As one participant says, “They (the MECP) previously gave us the direct coordinate of where the bloom was, which I think is a bit too specific (for legal reasons), but then they went away from that and gave us a general idea of what part of the lake the bloom was present and that seemed to work for us, now that is not happening anymore.” Of course, winds can dissipate blooms or move them elsewhere from the location where they were spotted.

Regarding formal review of monitoring plans, the NBMCA works through an Integrated Watershed Management Strategy (IWMS) that is a 20 year plan subject for review every 5 years. The NBMCA SPP went through a Section 36 update five years after it’s commencement in 2015. Beyond this formal update, policies in the plan ‘shall be updated as necessary’ (NBMCA, 2015). The 21 watercourse monitoring program that was put in place in 2017 does not have a formal review program, nor does Nipissing University’s monitoring program. In these cases, monitoring is informally reviewed each year, and is largely dependent on varying financial capacity.

Data is shared between NBMCA and MECP as the MECP conducts laboratory analysis of NBMCA TP samples. The NBPSDHU also works closely with MECP for testing of potential blooms. Nipissing University and the NBMCA have a partnership in which data have been shared between the two. They also coordinate to enable spot sampling on the lake as frequently as possible during the ice-free season. There are horizontal data linkages within the NBMCA as well, as the water monitoring team works closely with the Source Protection team and share data.

5.3.3 Lake Simcoe

LSRCA is the guiding force behind water monitoring in the Lake Simcoe watershed and works in close partnership with the MECP and numerous stakeholders to maintain a vast monitoring network that has resulted in Lake Simcoe being one of the most well studied lakes in Canada (Nürnberg et al. 2013; Palmer et al., 2011, 2017). At their disposal is a myriad of limnological data. LSRCA maintains a groundwater monitoring program, a river flow monitoring program, and a stormwater performance monitoring program, along with in-lake monitoring, and tributary monitoring. The bulk of external funding for monitoring comes either through the MECP's PWQMN or through Municipal funds for project specific monitoring activities. There are a variety of constant water quality monitoring devices deployed throughout the watershed and bi-weekly spot sampling takes place in the lake and tributaries. LSRCA partners with MECP on spot sampling of Lake Simcoe to avoid overlap. The Ministry laboratory has capacity to do analysis of phytoplankton samples in house and provides laboratory allocations to partner conservation authorities. While new monitoring programs are commencing often, one interviewee mentioned the challenge of maintaining existing programs, "People are often good to fund capital investment, but not always the resources in the longer term to maintain it and to put the time and effort into keeping the data, that can often be a challenge." This discourse of capital investment vs. funding for upkeep was a consistent trend in interviews.

Specifically in regards to cyanobacteria and relevant limnological parameters, no immediate data gap is present, though it is important to maintain existing monitoring efforts, especially those around phosphorous loads and TP, as the P loading targets set in the LSPP (44 tonnes) has not yet been achieved (LSRCA, 2019). The largest current data gap in the watershed is around stormwater performance monitoring, which is important given the rapid development in the region.

LSRCA maintains a data portal that is publicly available on their site, where anyone can navigate through a large swath of water quality data and download it for free. This is a vitally important tool that helps support not only the actions of the LSRCA but of partnered stakeholders making efforts to protect the lake. The LSPP requires the MECP to produce a technical report every five years regarding monitoring and research outcomes as well as an annual report on progress of plan implementation. The Lake Simcoe Act also requires that the province undertake a review of the LSPP at least every 10 years with the first review released in 2020 (MECP, 2020). Various other reports are produced on a project specific basis, where funding is granted and reports are created to show progress on project objectives.

A large capacity allows LSRCA and partner stakeholders to embrace an adaptive management approach. The majority of plans are not reviewed on a set schedule but major reviews have historically occurred on 5 and 10 year cycles. However, the LSRCA has made an effort to move towards smaller scale informal plan reviews/changes that are not on a mandated schedule. As a participant stated, “We’re trying to find actually a more adaptive approach to keeping the water management plans a more dynamic, updatable over a short timeframe rather than big documents being reviewed every 5, 10, 15 years.” This approach allows for a more adaptive approach in which plans are dynamic and adjusted in smaller increments to ensure optimal monitoring, “So moving away from the traditional static, 5 year, 10 year plans, that’s the vision we have.” Another participant emphasized the benefits of this adaptive approach, “I think that is necessary to achieve plan targets and indicators. That approach recognizes the science that informs policy is evolving is some respects. It recognizes that there are different levels of resourcing, and knowledge about how to change practices to improve environmental outcomes.” This is an approach that while beneficial, may not be practical in regions with limited capacity and data such as Eagle Lake.

As part of the LSPP, a Lake Simcoe Coordinating Committee and a Lake Simcoe Science Committee were established, and they represent the most relied on example of social learning in this

study (MOE et al., 2009). The LSRCA has been able to use these committees to receive additional support/guidance on specific management approaches, “For example, on stormwater management, winter salt, and chloride levels, we’ve been able to come back and get input and advice from the [science] committee on those topics at particular stages.” These committees are a valuable tool for navigating the science-policy interface (Van den Hove, 2007). However, other participants expressed concern over the efficiency with which the committees were operating, “Generally, the science committee and the coordinating committee needed to work more strategically together, as they typically only met once a year together.” Committees such as these are an excellent way for management organizations to access guidance from experts, however, this may not be possible to the same degree in regions that are not as comprehensively studied or distant from pools of expertise.

5.4 Social/Community Capacity

In the context of this study, social and community capacity refers to the involvement and cooperation of local stakeholders. This includes strategic partnerships, the awareness and commitment of the community to watershed health and the level of public participation, especially in stewardship activities. Strategic partnerships are essential for any implementation of an IWM approach, as capacity is finite (Akhmouch & Correia, 2016; Horning et al., 2016; Mitchell, 2005). Stewardship activities, such as the successful Restore Your Shore Program in Callander Bay (Buckle & Walters, 2016) is another way to make positive change without the need for ‘heavy-handed’ regulatory approaches. When asked about where improvements need to be made, the majority of participants referenced a need for enhanced education and outreach programs. Making change at the individual level can have a large impact (ex. Educating lakefront residents about the importance of proper septic maintenance). Education and outreach is a common approach for IWM implementation (MOE et al., 2009; Mitchell et al., 2014; Scott et al., 2017).

5.4.1 Eagle Lake

Eagle Lake boasts a strong social and community capacity built upon a vigilant group of stakeholders and strong strategic partnerships. The primary partner for the ELCA is Machar Township. While no council members from the township live directly on Eagle Lake there is one council member who acts as the intermediary between the two groups and is heavily involved with supporting ELCA's initiatives. The phragmites removal program is an example of this partnership in action, where ELCA took the lead, and Machar provided support where possible. Mikiskew Provincial Park borders the south basin of the lake, and they too have partnered with ELCA, taking responsibility for phragmites removals in their park. They also help with ELCA funding, selling ELCA calendars in park stores, which are a primary source of fundraising for ELCA. A major expense for ELCA is the Annual General Meeting (AGM), and the Highlander Brewery in nearby South River allows ELCA to host their meetings at no cost. The Hockey Opportunity Camp is the largest employer in the area and borders the southern basin of the lake. They store marker buoys for ELCA and allow use of their pontoon boat when required. It is quite clear from the interviews that local businesses are committed to watershed health. Finally, and most important for technical capacity and data management, ELCA formed a partnership with Nipissing University. This partnership is the result of networking at a Regional Economic Development Symposium and has resulted in the deployment of constant monitoring devices on the lake and funding for two separate community workshops.

Education and outreach is one area where ELCA sees room for improvement. As one interviewee stated, "I think public education could be intensified. We have no regular presence on social media and our website is poorly maintained." ELCA has hosted a community workshop on the threat of phragmites and another on cyanobacteria. Both workshops were funded by Nipissing University and academics spoke to concerned citizens about potential impacts and remediation. Both workshops were well attended. Management decisions are delivered through tri-annual newsletter distribution (Machar

Township distributes a newsletter as well) and directly to those that attend the open AGM. ELCA does manage a website, but developing a social media presence and routinely updating the website would provide an easy and cheap means of communication with the public. It is worth noting that a Machar Township participant also recognizes a social media presence as an opportunity, "I do think it is important to get the word out on any changes that are made, and I think social media could help with that." As outlined in the Hutchinson Lakeshore Capacity Assessment (Hutchinson Environmental Sciences Ltd., 2013), septic tanks are a prominent source of external phosphorus and Machar Township sees public education as a priority moving forward to help combat this, "Public education as well, I think we have to reinforce that. We really have to focus, in my opinion on septic health and the proper disposal of household products at point of entry."

The most noteworthy stewardship operation in the watershed is the phragmites removal program that began in 2019, spearheaded by ELCA and supported by Machar Township. Participation in the operation was high among the community, all on a volunteer basis. This program will continue annually until phragmites are completely eradicated and interview participants are confident that the initially high level of participation will maintain throughout. The only form of volunteer recruitment for the program was advertisement via Machar Township and comments in the tri-annual newsletter and that has proved sufficient. When discussing the potential for a stewardship program encouraging lakefront property owners to maintain a vegetative buffer between their property and the lake (instead of having a manicured lawn right to the shoreline) a Machar Township interviewee stated,

> If you are in need of a demonstration property, whether you want to use someone's property for a study or whatever, there will be no trouble finding properties. There are people that are offering already. Whether that be shoreline restoration, demonstrating the types of plants and the type of impact on erosion control and managing run-off, no problem finding people to help out whatsoever.

While public commitment and participation is high, there has been some resistance to changes (albeit limited). Machar Township passed a by-law prohibiting the use of fertilizers containing phosphorous within 20 metres of any waterway, and while resistance (and non-compliance) has been minimal, there were some lakefront residents that were unhappy. Despite the enthusiasm among many for a Restore Your Shore like program, there are still a number of lakefront residents that eradicated native trees and shrubs, replacing them with a fully manicured lawns extending right to the shoreline. This increases runoff of phosphorus into the lake. The Lakeshore Capacity Assessment concluded that Eagle Lake is highly sensitive to TP inputs and that no further shoreline development or lot creation should be approved unless specific criteria are met (Hutchinson Environmental Sciences, Ltd., 2013) and there has been resistance to this among residents looking to further develop the lake. Additionally, a Machar Township representative discussed a potential issue in the near future, "I can see some decisions coming forwards in the next five years, especially regarding things like septic inspections. If we start getting into By-Laws regulating that, I can see some issues arising when it comes to public complaints." Continued education and outreach will be important to stress to residents the importance of a properly maintained septic system.

5.4.2 Callander Bay

Cyanobacteria is not new to Callander Bay, and watershed organizations, their partners, and the public have demonstrated adequate social and community capacity. The primary watershed organization in the region is the NMBCA, who partners with the Municipality of Callander (whose mayor serves as a source protection committee member), NBPSDHU, the North Bay Source Protection Committee, and the North Bay Source Protection Authority to oversee watershed management activities. Additionally, a link with Nipissing University's Integrated Watershed Research Centre provides important limnological data in Callander Bay. The Clean Water Act guides the actions taken around source protection in Callander, involving a partnership with the MECP who oversees the implementation

of the act on a provincial scale. With this partnership comes allotted laboratory access for sampling of phosphorus samples and limnological data through the Provincial Water Quality Monitoring Network (MECP, 2021). NBMCA acts as a host organization for the North Bay SPC and SPA. This partnership is essential for the SPC and SPA to fulfill their role as advisors of source protection plan creation and implementation. As one SPC interviewee states, “80%, 90% of the time we’re going to be looking to capacity from within the host organization, being the Conservation Authority.” The NBPSDHU works in tandem with the MECP to monitor for the presence of cyanobacteria blooms and inform the public of any potential threats when blooms do occur.

Numerous participants emphasized the importance of education and outreach and stated that while existing efforts are in place, improvements could be made. NBMCA hosts workshops targeting municipal stakeholders, informing them about various watershed management topics (one example being erosion management). One program that was unanimously praised was the Restore Your Shore stewardship program lead in tandem by NBMCA and Nipissing University (Buckle & Walters, 2016). The program used demonstration properties to encourage waterfront residents to leave a natural vegetative barrier between their property and the water rather than having a manicured lawn stretching right to the land-water interface. Doing so decreases external P input (Blanco-Canqui, 2003). It also reduces shoreline erosion which protects nearshore fish spawning grounds. This program was seen as a resounding success by participants and was impactful on two fronts. First, it helped reduce external P input in a financially manageable manner (participating landowners were provided native vegetation to plant). Second, it took advantage of a community based-marketing approach (McKenzie-Mohr, 2000) to educate at the same time. As one interviewee noted, “with Restore Your Shore, you’re creating multiple benefits. Their property looks nicer or is easier to maintain, potentially benefitting the value of their property. They’re getting education and we’re getting them to pass that on to people. That’s our goal.” Restore Your Shore exceeded its target number of lots, and the approach of providing materials for

participants so they are not financially obligated seems to have gone a long way, “They want to see that doing this isn’t negative on the balance sheet. They ask, how does that benefit me?” There have been other smaller scale stewardship activities in the region, including a partnership between Callander Municipality and Girl Guides to educate residents about storm drainage systems, but Restore Your Shore stands out as largest scale, most impactful stewardship to date.

NBMCA releases a publicly available Watershed Report Card every five years that details monitoring results (NBMCA, 2018). All assessment reports that were part of the original Source Protection Plan creation are publicly available via the NBMCA’s well maintained website as well. Just prior to the interview, NBPSDHU revamped its public communication approach around cyanobacteria. As previously mentioned, MECP does not return to the lake to resample once a cyanobacteria bloom is confirmed, so the water advisory remains posted for the duration of the year. After numerous calls asking why resampling was not occurring so the advisory could be removed, NBPSDHU adopted a three category system used by Peterborough Public Health (Peterborough Public Health, 2019). This system shows different extremities of blooms and more clearly describes appropriate measures to be taken for each category. As one interviewee states, “we instruct our general public to use these classifications and categories to determine what the real risk is for them. So we found this has really helped. It puts the onus on the individual and they are assured that they’re getting the proper information.” NBPSDHU uses its website for the majority of its public communication.

5.4.3 Lake Simcoe

The Lake Simcoe watershed is home to a myriad of strategic partnerships that help maintain a high level of capacity for IWM implementation. The primary management organization in the watershed is the LSRCA, who partners with the provincial and federal government, 20 member municipalities, the Chippewas of Georgina Island First Nation, and a wide array of various organizations to advocate for and

protect the Lake Simcoe watershed. LSRCA's primary partners are their member municipalities, who provide the bulk of their funding and for whom they complete project-specific management efforts. LSRCA also works closely with the MECP to coordinate monitoring efforts in the watershed and has laboratory allocations supported and paid for by the provincial government. Another mechanism for partnership with the province is the PWQMN, through which LSRCA receives funding for monitoring efforts. A unique element of social capacity in the watershed is the partnership LSRCA has formed with the Toronto and Region Conservation Authority (TSRCA) and Credit Valley Conservation (CVC) via the Sustainable Technologies Evaluation Program (STEP). This program minimizes overlap, and focuses on adjacent organizations combining capacity for optimal results. The STEP program has focused on shared interests around stormwater management, salt reduction, and erosion and sediment control. The MECP is responsible for the coordination and implementation of the LSPP and relies on strategic partnerships to meet plan objectives. As one interview states, "The Lake Simcoe Plan and Act rely on a collaborative approach. Each partner contributing in accordance with their mandates." These partners range from small non-profit organizations like the Smart About Salt Council to various academic institutions like York University.

LSRCA has made significant efforts towards an education and outreach approach. The most common target audience is municipalities, "Often municipalities will come to use and bring forward a concern from their residents and ask us to give a presentation, for example, invasive aquatic plants." They also run bus tours for local residents, bringing them to various demonstration sites outlining the benefits of current initiatives and stewardship programs, such as restoring a natural vegetative buffer on shorelines. The aforementioned STEP program offers training to member municipalities as well, particularly on proper application of road salts. While education and outreach efforts are ongoing, the communication surrounding such efforts and management efforts as a whole is a perceived area for growth. As one interviewee confirms, "I would say one of our bigger gaps is communication, and

developing more of a social media presence and more of a dynamic website would be a big step forward." Education and outreach are vital, and are being pursued in all regions of this case study but interviews have made it abundantly clear that adequate communication is essential. While LSRCA handle the majority of education and outreach efforts in the watershed, the MECP's communications are focused on reporting on plan implementation and monitoring results.

There are numerous stewardship activities ongoing throughout the Lake Simcoe watershed. Some more recent initiatives include working with and advocating for developers to adopt green building practices. Both the MECP and LSRA provide project specific funding for stewardship activities for environmental organizations. One example is the MECP funding the Smart About Salt Council to develop educational materials to support commercial contractors to adopt chloride reduction BMPs in the application of road salts. The LSRCA is involved with various restoration programs with an array of partners, including shoreline restoration, tree planting events, and streambank protection.

When asked about public participation when the opportunities present themselves (either via education and outreach opportunities or via stewardship activities) all participants spoke about the importance for a targeted approach. As one participant outlined, "If people don't know what's going on and, it's hard to get them involved. People are busy, this is an area with a high percentage of commutes, and in general volunteerism is going down." General information meetings have seen a far lower attendance than presentations about a specific topic for which there is a target audience that has demonstrated a desire for additional information. This is an important point to consider in all regions when planning education and outreach and stewardship activities.

All participants reported high levels of compliance when regulative authority was wielded, though there have been some instances of resistance. Working closely with developers has been a key point, especially establishing communications in the early stages as opposed to trying to regulate once

development plans have been put in motion. This has been especially important regarding phosphorus loads from new development. Maintaining a vegetative barrier in densely developed shoreline areas has been another challenge, “When you get into kind of denser shoreline areas, it’s a struggle to get people to not go up to the edge.” All participants espoused the benefits of an education and outreach approach here as opposed to a regulatory approach.

5.5 Institutional Capacity

In this context, institutional capacity refers to applicable legislation, potential legislative gaps, the efficacy and reach of current policies/procedures, and organizational role. While the watershed agencies in this study tend to use an education and outreach instead of a regulatory approach, it is important to have adequate legislation available to be able to restrict any potentially harmful activities. When reviewing guiding policies in each case study, it is important to analyze sufficiency as well as the perceived level of implementation. It is also important that each organization within a region has a clearly defined role and that jurisdictional overlap is minimized (Shrubsole et al., 2017). Furthermore, it is important that there is a perceived ‘champion’, advocating for and acting to maintain watershed health, especially in smaller regions that are without a conservation authority (Conrad & Daoust, 2008; Imperial, 2005; Melnychuk et al., 2012)

5.5.1 Eagle Lake

ELCA fills the role of a champion and advocate for the health of Eagle Lake and Machar Township works in partnership with them, while also working with other lakes/organizations in the region. ELCA does not operate with any legislative authority, and would need to request Machar Township to take action if a new By-Law or any form of legislative enforcement were required. Machar Township has published an Official Plan (Machar Township, 2015) that guides their watershed management efforts. They have enacted a by-law prohibiting the use of fertilizers within 20 metres of

Eagle Lake (2018). Mandated inspection of new septic installations falls under the *Municipal Act* (2001) and *Ontario's Building Code* (1992)**.** The Lakeshore Capacity Assessment (Hutchinson Environmental Services Ltd., 2013) concluded that Eagle Lake is at maximum capacity for lot development, and Machar Township has created by-laws included in the Official Plan to limit any future expansion on the lake (Machar Township, 2015). Other relevant legislation includes the *Environmental Protection Act*, the *Ontario Water Resources Act*, and the *Nutrient Management Act* but no interviewees in the region referenced these acts when discussing legislative authority.

All interviewees expressed confidence in the current legislative landscape for dealing with current issues, but recognized that adjustments may be necessary to deal with future challenges. While restrictions have been limited to date, compliance has been high and complaints have been sparse. However, this could change with additional restrictions. Of particular concern is the potential for mandated routine inspection of existing septic systems, the potential for non-compliance and the need for legislative enforcement. One interviewee noted that this may be a necessary shift in the future and that additional by-laws may need to be enacted.

As previously noted, there is no source protection plan for the region, and there are no policies at a sub-watershed level. Education and outreach, guiding voluntary action to sustain the health of the lake has been the primary method of creating change. When restrictions are in place, they are in the form of By-Laws and are enforced by Machar Township.

There is no notable jurisdictional overlap between the two major organizations responsible to watershed health in this region and current policies have been implemented sufficiently. However, as more restrictive policies or more involved management protocols inevitably develop, implementation will need to be monitored.

5.5.2 Callander Bay

Interviews reveal that NBMCA is regarded as the champion for watershed health in the region and is the leading agency protecting Callander Bay water quality. NBPSDHU's role is to protect public health and that intersects with the risk posed by toxic cyanobacteria. The SPC and SPA work in tandem with NBMCA to fulfill their agenda and view NBMCA as a host organization from which they receive the majority of their capacity. Nipissing university serves as a valuable partner for watershed monitoring and limnological data collection.

The *Clean Water Act* (2006) and subsequent Source Protection Plan (NBMCA, 2015) guides the majority of management actions in the region. The *Clean Water Act* gives a myriad of powers to implementing organizations, ranging from prohibition to education and outreach. In the source protection planning process, issues are identified and an approach is decided upon for each issue (Ivey et al., 2006). In the region, education and outreach was the most utilized approach by a wide margin, and more intrusive approaches like prohibition were only used for more serious issues such as containment of certain chemicals (NBMCA, 2015). As one interviewee noted, "The decision was made that the same outcome could be achieved with education and outreach the majority of the time, so the regulatory approach was not utilized, however, when policies are reviewed, these approaches can be changed." Callander is designated as an Issue Contributing Area (ICA) in the Source Protection Plan (NBMCA, 2015), which allows for mandated septic inspections via the *Clean Water Act*. If this were not the case, then it would fall on Callander Municipality to enact a By-Law via the Municipal Act and *Ontario's Building Code*. Of note, this is the same decision that Machar Township is currently deliberating on due to the potential for public backlash. Due to Callander being designated an ICA (primarily due to the presence of cyanobacteria), 500 properties have mandated septic inspection under the Clean Water Act. In addition, 65eveloppment takes place on the water, Callander Municipality

requires a site plan control agreement, which allows for a mandated vegetated buffer to help reduce external P input (Municipality of Callander, 2011).

No interviewees expressed concern over currently existing legislative gaps but all participants did mention the importance of adaptive management in regards to climate change and mentioned doubt about the adequacy of current institutional capacity for dealing with climate change. Of particular note, participants questioned whether the *Clean Water Act* would be adequate moving forward. As one interviewee stated, "Does the legislation account for climate change, I don't think it does. There could be a relationship between climate change adaptation and the CWA but when is it going to get into the CWA explicitly?" This is particularly noteworthy as increasing occurrences of cyanobacteria are estimated to be a climate change indicator (Pearl & Huisman 2008; Molot et al., 2021; Winters et al. 2011).

As previously mentioned, the Source Protection Plan for the region is the primary policy document guiding management decisions. Another fundamental policy document is the Integrated Watershed Management Strategy (NBMCA, 2015) prepared in partnership with Stantec Consulting Ltd. that guides watershed management over a 20 year period with an emphasis on adapting to changing contexts (i.e., development, climate change, changing capacities, etc.).

While there may be some perceived jurisdictional overlap among stakeholders regarding the role of NBMCA vs. the role of the source protection authorities and committees, the perception among participants seems to be that jurisdictional overlap is virtually non-existent. This is likely due to strong working relations between cooperative agencies and a clear perception of NBMCA as the champion advocating for and protecting watershed health in the region. As the watershed report card and source protection annual progress report (NBMCA, 2018) show, there is no serious implementation gap to speak of.

5.5.3 Lake Simcoe

The Lake Simcoe watershed is unique in that it was the first lake in Ontario for which a specific watershed-based legislation was enacted (Davidson, 2013). This has resulted in a uniquely high institutional capacity. While this is beneficial, it also demonstrates a potential for jurisdictional overlap and the importance of clearly defined roles and legislative priorities. As stated in the LSPP (MOE, 2009, p. 10),

> This Plan should be read in conjunction with relevant provincial policies, plans and Acts, including the Provincial Policy Statement, 2005, the *Greenbelt Plan*, the *Growth* Plan for the Greater Golden Horseshoe, the *Oak Ridges Moraine Conservation Plan*, the *Clean Water Act*, 2006, the *Ontario Water Resources Act*, the *Conservation Authorities Act*, *the Environmental Protection Act*, the *Public Lands Act*, and the *Planning Act* ... if a conflict arises between a designated policy in this Plan and a provincial policy of another provincial plan the provision that gives the greatest protection to the ecological health of the Lake Simcoe watershed prevails.

In addition to the funding provided to the region via the LSPA, the LSPP allows for greater legislative authority to regulate potentially harmful activities. One example of this greater control is the Phosphorus Offsetting Policy (LSRCA, 2017) enacted by the LSRCA that mandates that all new development must control 100% of the phosphorus from leaving their property. The LSPP contains 'designated' policies and 'have regard' policies that usually focus on new development or site alteration that raise the minimum standard of protection set out in other legislation (MOE, 2009). This is especially important in Lake Simcoe watershed where continued development is an increasing concern (Oni et al., 2015)**.** The LSPP has also resulted in the creation of sub-watershed plans, including context-specific strategic actions, which are aspirational policies that

municipalities and other stakeholders can receive provincial funding to pursue. Participants lauded the creation of such plans while understanding the high capacity required to do so successfully, “Sub-watershed planning is expensive and resource intensive but a valuable tool to focus common interest and develop local action plans.” One recurring theme in the interviews is the need for proper septic maintenance and inspection of any new septic installation, and this is one area that the plan does not regulate. In the watershed, onsite septic systems are still managed through the *building code* (which is not influenced by the plan) and can be regulated via municipal by-laws.

In addition to the LSPP, the source protection plan (LSRCA et al., 2015) has proved beneficial for the protection of watershed health, as seen in other regions such as Callander Bay. As one interviewee noted, “Within a source protection plan you can get into additional protections around the types of activities that are going on around an [water] intake, and you can regulate them to some degree.” Despite the additional regulative authority granted via the LSPP and source protection plan, all participants continued to emphasize the importance of only using a regulatory approach when necessary. One participant detailed their beliefs succinctly, “I believe you always have to look at it from both ways, you can use the hammer for regulatory when needed but you have to support it with the tools and help people meet their regulatory requirement.” This further illustrates the need for adequate education and outreach and public communication.

When asked about potential gaps in legislation, participants did not point out specific areas where further legislative authority might be necessary. However, the potential for reform of sewage policies under the *Building Code*, in order to require maintenance inspections of on-site septic systems and adoption of new technology was mentioned as a potential area of focus

moving forward. Additionally, participants discussed the possibility to better align policy documents in the future.

In a watershed with a myriad of environmental organizations, it is easy to have jurisdictional overlap, which can result in confusion on the part of the public and stakeholders over who is responsible for what (Woodhouse & Muller, 2017). However, this does not appear to be the case in the Lake Simcoe watershed from the perspective of interview participants. It appears clear that LSRCA is seen as the 'champion' and primary management body in the region and that the MECP and LSRCA have done well to coordinate efforts to avoid as much overlap as possible. This is largely a result of the MECP delegating education and outreach and public communication almost entirely to the LSRCA and themselves focusing on the coordination and implementation of the LSPP. There are numerous smaller organizations though they are working under far more specific mandates and the LSRCA has done a good job of partnering productively with these entities.

While the legislation appears to be adequate, the pitfalls come when considering implementation. The MECP reports on plan implementation and as previously mentioned, great strides have been taken (MECP, 2019) but there are still plan objectives that are far from being met. Most detrimental when considering cyanobacteria, is the failure to meet external phosphorus loading goals. Total phosphorus concentrations have been declining but the reasons are unknown and it is not known if the decline is temporary. One consistent subject in interviews (in all case study regions) was the lack of funding for implementation. One interviewee mentions, "If you looked at the LSPP, it's policy driven, study driven, develop strategies, undertake studies, change our official plans and things like that. And that's great, but very little resources are towards more on the ground restoration and protection." This correlates with the recurring concern that finding initial project funding is often possible, but finding consistent funding to implement and maintain projects is a challenge.

6.0 Discussion and Conclusions

The principles of IWM serve as guidelines for watershed management planning but to achieve adequate implementation, sufficient capacity is essential. This study used a case study approach to address three primary research questions. (1) First, how does local capacity compare in different financial, institutional, technical, political, and social contexts. (2) Second, what is the value of regulatory authority for managing bodies implementing IWM. (3) Finally, what are some of the most pressing challenges that managing bodies face while implementing facets of IWM. The interviews served as a method to measure capacity for implementation of IWM and a means to gather pertinent data about what is required in a successful IWM approach from a variety of experts. Any conclusions made about the value of regulatory authority are based on opinions of local stakeholders in each case study region. While interview topics changed slightly to fit with in-situ context, the general themes were the same and recurring talking points were evident.

(3) First, while all elements of capacity are important, it is financial capacity that underpins everything. The four other elements of capacity presented in the framework can be seen as a way to most effectively utilize a finite financial capacity. Without adequate financial support, partner organizations are hampered in data collection (monitoring), education and outreach, planning and implementation.

Watershed management involves complex decisions. When decisions that may receive some resistance deem themselves necessary it is essential that organizations have adequate data to not only justify their stance, but to educate stakeholders on the importance of the actions being taken. Technical capacity and information management (specifically monitoring data) is a key facet for successful IWM implementation. In tandem with data quantity is the importance of most effectively deploying monitoring efforts. This is where a more adaptive approach, with fewer scheduled reviews of monitoring efforts on, say, 5 year timelines and more informal quick adjustments is proving effective.

Another recurring theme was the need for a perceived 'champion' that advocates for the health of the watershed. In Lake Simcoe and Callander Bay this champion is undoubtedly the local conservation authority. Their role is as a primary management body and advocate for watershed health. They also play a role in facilitating collaboration between stakeholders for effective utilisation of limited capacity for IWM implementation. In Eagle Lake, interviews revealed that ELCA serves as the perceived champion, despite not having any regulatory authority. ELCA serves as an advocate for watershed health and organizes stewardship activities, and Machar Township implements any management decisions that require regulatory authority.

(2) When discussing institutional capacity, there was not a single participant that advocated for additional legislation in their region. However, participants in the Lake Simcoe watershed were in support of the LSPA and subsequent LSPP. It is important to note that all experts interviewed advocated for the least intrusive management approach whenever possible. While wielding regulatory authority is a viable option when necessary, all participants emphasized the importance of education and outreach and relying on voluntary action from stakeholders.

(3) Finally, participants were quick to point out that the real key is implementation and that a near-ubiquitous concern is an implementation gap. This primarily stems from an influx of capital investment without consistent funding to maintain management efforts. Interviewees routinely noted that without adequate focus given to on the ground implementation, you could have the best strategies and unlimited capacity, and no real tangible benefits will be seen.

Of important note is the need for expert advice and adequate information when pursuing IWM implementation. In regions like Lake Simcoe, these are abundant, but in areas outside of a conservation authority jurisdiction such as Eagle Lake, expertise and valuable information are less readily available. It is important to consider how to bridge the gap and address water quality issues in those regions with

limited support, mostly located in northern Ontario. Future research could investigate what governance models could be integrated in such regions to best make sure of limited capacity. Additionally, what can be adapted from other regions with more complete governance models and what lessons can be learned from regions such as Lake Simcoe that are in advanced stages of IWM implementation. As climate change continues, it is likely that wicked problems like cyanobacteria will grow as a detriment to water quality in Ontario's inland lakes, and it is important to use what limited capacity is available as efficiently as possible moving forward.

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Appendix A: Interview Schedules

1. North Bay-Mattawa Conservation Authority Interview Schedule, July 24th, 2019

Financial Capacity

1. Can you outline the organization's annual budget? How much is dedicated to source protection and cyanobacteria management?

2. What are the sources of funding for the North Bay-Mattawa Conservation Authority? Are you aware of other sources of funding that could be tapped into that have not been?

Technical Capacity

1. Can you describe current water quality monitoring/reporting activities within the region (i.e., locations, frequencies, variables monitored, etc.)?

2. Can you discuss the level of training for those involved in dealing with source protection and cyanobacteria management (i.e., attending workshops, sampling training, etc.)?

3. Can you discuss the impact/benefit of committees that assist in making management decisions (i.e., source protection committee, scientific committees, etc.)?

4. How often are current management plans and monitoring programs re-evaluated?

Operational Capacity

1. How many staff in your organization are involved (either directly or indirectly) in source protection and cyanobacteria management?

2. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e. Callander, MOEPC, Nipissing University etc.)

Communication and Public Involvement

1. Can you outline the key stakeholders (i.e. management authorities, local companies, local organizations, stewardship groups, public, etc.) that are actively engaged in source protection and cyanobacteria management?

2. How are management decisions or monitoring results communicated to the public?

3. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

4. In your opinion, how would you rate the level of public participation in management decisions (referring to participation opportunities, meeting attendance, outreach, education, etc.)?

5. Do you feel that there are steps that could be taken to increase public participation? If so, can you describe them?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding source protection and cyanobacteria management decisions?

2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority under the Clean Water Act and other guiding legislation is adequate?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and cyanobacteria management that have not already been addressed?

2. North Bay SPC Interview Schedule

Background

1. Can you describe the role of the Source Protection Committee?

2. Can you discuss the selection process for members of the committee?

Financial Capacity

1. How much funding is directed towards actions of the Source Protection Committee? What are the sources of the funding?

Operational Capacity

1. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e. Callander, MECP, Nipissing University etc.)

Communication and Public Involvement

1. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

2. How would you rate the level of public participation in the region (I.e., opportunities to consult, demonstration properties, workshops, etc.)? Do you feel that there are steps that could be taken to increase public participation?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding source protection and cyanobacteria management decisions?

2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority under the Clean Water Act and other guiding legislation is adequate?

Implementation

1. In your experience, what elements of source protection and cyanobacteria management (both the plans themselves and on the ground implementation) have been successful?

2. In your experience, what elements of source protection and cyanobacteria management (both the plans themselves and on the ground implementation) need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and cyanobacteria management that have not already been addressed?

3. North Bay Parry Sound District Health Unit Interview Schedule

Background

1. Can you describe the NBPSDHU's role in protecting the Callander Bay watershed?

Operational Capacity

1. Can you discuss the relationship between the MECP and the NBPSDHU?

2. Can you discuss the relationship between other partnering organizations/municipalities/committees, and the impacts of such relationships?

3. How many staff in your district office are involved (either directly or indirectly) in watershed or cyanobacteria management?

Financial Capacity

1. Can you outline the NBPSDHU budget, and how much is directed towards watershed and cyanobacteria management?

2. What are the sources of funding for the NBPSDHU?

Communication and Public Involvement

1. How are NBPSDHU decisions involving the Callander Bay watershed communicated to the public?

2. Do you feel that there are steps that could be taken to increase public involvement or education? If so, can you discuss them?

Data Availability

1. Can you discuss reports/data that are or have been instrumental in guiding the NBPSDHU's approach to watershed and cyanobacteria management in the region?

2. Do you feel that the current quantity or monitoring data/testing is adequate? Is there additional data that you do not have that would be helpful in guiding future operations?

Challenges, Successes, and Lessons Learned

1. In your experience, what elements of watershed or cyanobacteria management in the Callander Bay watershed have been successful?

2. In your experience, what elements of watershed or cyanobacteria management in the Callander Bay watershed need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding watershed or cyanobacteria management that have not already been addressed?

4. Municipality of Callander Interview Schedule, October 3rd, 2019

Background

1. Can you discuss the municipality's role in source protection and cyanobacteria management?

Financial Capacity

1. Can you outline the municipality's annual budget? How much is dedicated to source protection and cyanobacteria management?

Operational Capacity

1. How many staff are involved (either directly or indirectly) in source protection and cyanobacteria management?

2. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e. Callander, MOEPC, Nipissing University etc.)

Communication and Public Involvement

1. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

2. How are management decisions or monitoring results communicated to the public?

3. How would you rate the level of public participation in the region (I.e., opportunities to consult, demonstration properties, workshops, etc.)? Do you feel that there are steps that could be taken to increase public participation?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority under the Clean Water Act and other guiding legislation is adequate?

Implementation

1. In your experience, what elements of source protection and cyanobacteria management (both the plans themselves and on the ground implementation) have been successful?

2. In your experience, what elements of source protection and cyanobacteria management (both the plans themselves and on the ground implementation) need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and cyanobacteria management that have not already been addressed?

5. Lake Simcoe Region Conservation Authority Interview Schedule, July 25th, 2019

Financial Capacity

1. Can you outline the organization's annual budget? How much is dedicated to source protection and eutrophication management?

2. What are the sources of funding for the Lake Simcoe Region Conservation Authority?

Technical Capacity

1. Can you describe current water quality monitoring/reporting activities within the region (i.e., locations, frequencies, variables monitored, etc.)?

2. Can you discuss the level of training for those involved in dealing with source protection and eutrophication management (i.e., attending workshops, sampling training, etc.)?

3. Can you discuss the impact/benefit of committees that assist in making management decisions (i.e., source protection committee, scientific committees, etc.)?

4. How often are current management plans and monitoring programs re-evaluated?

Operational Capacity

1. How many staff in your organization are involved (either directly or indirectly) in source protection and eutrophication management?

2. Can you discuss the relationship between partnering organizations/municipalities/committees, and the impacts of such relationships?

Communication and Public Involvement

1. How are management decisions or monitoring results communicated to the public?

2. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

3. In your opinion, how would you rate the level of public participation in management decisions (referring to participation opportunities, meeting attendance, outreach, education, etc.)?

4. Do you feel that there are steps that could be taken to increase public participation? If so, can you describe them?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding source protection and eutrophication management decisions?

2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

Legislative Authority

1. Can you discuss the impact of the Lake Simcoe Protection Act, especially pertaining to an integrated approach to management and enforceability?

2. Has there been any resistance to decisions that have been made? If so, can you discuss?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and eutrophication management that have not already been addressed?

6. Rescue Lake Simcoe Coalition Interview Schedule, September 18th, 2019

Background

1. Can you describe your organization's role in protecting the Lake Simcoe watershed?

Financial Capacity

1. Can you outline the organization's annual budget?

2. What are the sources of funding for the Rescue Lake Simcoe Coalition? Are you aware of other sources of funding that could be tapped into that have not been?

Operational Capacity

1. How many staff in your organization are involved (either directly or indirectly) in protecting the watershed?

2. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e. Lake Simcoe Conservation Authority, Ministry of the Environment, Conservation and Parks, etc.)

Communication and Public Involvement

1. In your opinion, how would you rate the level of public participation in management decisions (referring to participation opportunities, meeting attendance, outreach, education, etc.)?

2. Do you feel that there are steps that could be taken to increase public participation? If so, can you describe them?

3. As an organization, how do you publicize your message/findings/activities?

Implementation and Legislative Authority

1. Can you discuss the impact of the Lake Simcoe Protection Act, especially pertaining to enforceability of management plans/policies?

2. In your experience, what elements of the LSPP (both the plan itself and regarding on the ground implementation) have been successful in protecting the watershed?

3. In your experience, what areas of the LSPP (both the plan itself and regarding on the ground implementation) need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding the protection of the watershed that have not already been addressed?

7. Ministry of the Environment, Conservation and Parks Interview Schedule

Background

1. Can you describe the MECP's role in protecting the Lake Simcoe watershed specifically?

2. Can you speak to the MECP's role in watershed management at a provincial scale?

Operational Capacity

1. Can you discuss the relationship between the MECP and the Lake Simcoe Conservation Authority?

2. Can you discuss the relationship between other partnering organizations/municipalities/committees, and the impacts of such relationships?

3. How many staff in your district office are involved (either directly or indirectly) in watershed management or source protection?

Financial Capacity

1. Can you outline the MECP budget, and how much is directed towards watershed management and source protection (Provincially)?

2. Can you discuss ways in which the MECP provides funding specifically for the protection of the Lake Simcoe Watershed?

Communication and Public Involvement

1. How are MECP decisions involving protection of the Lake Simcoe watershed communicated to the public?

Legislative Authority and Implementation

1. Can you discuss the impact of the Lake Simcoe Protection Act, especially pertaining to an integrated approach to management and enforceability?

2. Has there been any resistance to decisions that have been made? If so, can you discuss?

3. In your experience, what elements of the Lake Simcoe Protection Plan (both the plan itself and regarding on the ground implementation) have been successful in protecting the watershed?

4. In your experience, what areas of the Lake Simcoe Protection Plan (both the plan itself and regarding on the ground implementation) need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and eutrophication management that have not already been addressed?

8. Eagle Lake Conservation Association Interview Schedule

Background

1. Can you discuss the ELCA's role in protecting Eagle Lake?

Financial Capacity

1. Can you outline the ELCA's annual budget? How much is dedicated to lake restoration and protection?

2. What are the sources of funding? Are there any sources of funding that you are aware have that have not been pursued at this time?

Operational Capacity

1. How many members are involved (either directly or indirectly) in the ELCA?

2. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e. Machar Township, Nipissing University, Local Businesses etc.)

Communication and Public Involvement

1. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

2. How are management decisions or monitoring results communicated to the public?

3. How would you rate the level of public participation in the region (I.e., opportunities to consult, demonstration properties, workshops, etc.)? Do you feel that there are steps that could be taken to increase public participation?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding the protection of Eagle Lake?

2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority (i.e., By-laws, Ontario Water Resources Act, Environmental Protection Act, and Nutrient Management Act) is adequate?

Implementation

1. In your experience, what activities/actions towards protection of Eagle Lake have been successful?

2. In your experience, what activities/actions are still required or need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and cyanobacteria management that have not already been addressed?

9. Machar Township Interview Schedule

Background

1. Can you discuss the township's role in protecting Eagle Lake?

Financial Capacity

1. Can you outline the township's annual budget? How much is dedicated to lake restoration and protection?

Operational Capacity

1. How many staff are involved (either directly or indirectly) in protecting Eagle Lake and working with the Eagle Lake Conservation Association?

2. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e. Eagle Lake Conservation Association, Nipissing University, Local Businesses etc.)

Communication and Public Involvement

1. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

2. How are management decisions or monitoring results communicated to the public?

3. How would you rate the level of public participation in the region (I.e., opportunities to consult, demonstration properties, workshops, etc.)? Do you feel that there are steps that could be taken to increase public participation?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding the protection of Eagle Lake?

2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority (i.e., By-laws, Ontario Water Resources Act, Environmental Protection Act, and Nutrient Management Act) is adequate?

Implementation

1. In your experience, what activities/actions towards protection of Eagle Lake have been successful?

2. In your experience, what activities/actions are still required or need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and cyanobacteria management that have not already been addressed?

10.Severn Sound Environmental Association Interview Schedule

Background

1. Can you outline the role of the SSEA in watershed management and protection?

Financial Capacity

1. Can you outline the organization's annual budget? How much is dedicated to watershed management and protection?

2. What are the sources of funding for the SSEA?

Operational Capacity

1. How many staff in your organization are involved (either directly or indirectly) in watershed management?

2. Can you discuss the relationship between partnering organizations/municipalities/committees? (i.e Member municipalities, LSRCA, Simcoe Muskoka District Health Unit etc.)

Communication and Public Involvement

1. How are management decisions or monitoring results communicated to the public?

2. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

3. How would you rate the level of public participation in the region (I.e., opportunities to consult, demonstration properties, workshops, etc.)? Do you feel that there are steps that could be taken to increase public participation?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding watershed management in the region?
2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

3. How often are current management plans/projects and monitoring programs re-evaluated?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority (i.e., Clean Water act, By-laws, Ontario Water Resources Act, Environmental Protection Act, and Nutrient Management Act) is adequate?

Implementation

1. In your experience, what activities/actions towards the protection of the Severn Sound watershed have been successful?

2. In your experience, what activities/actions are still required or need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and eutrophication management that have not already been addressed?

11.Muskoka Watershed Council 2019 Interview Schedule

Background

1. Can you outline the role of the Muskoka Watershed Council in protecting and evaluating the health of Muskoka's Watersheds?

Financial Capacity

1. Can you outline the organization's annual budget?

2. What are the sources of funding for the Muskoka Watershed Council?

Operational Capacity

1. How many staff in your organization are involved (either directly or indirectly) in watershed management?

2. Can you discuss the relationship between partnering organizations/municipalities/committees (i.e. District of Muskoka, Friends of the Muskoka Watershed, etc.)?

Communication and Public Involvement

1. How are management decisions or monitoring results communicated to the public?

2. Can you describe any current stewardship programs within the watershed? Can you detail the impacts that these programs have had?

3. How would you rate the level of public participation in the region (I.e., opportunities to consult, demonstration properties, workshops, etc.)? Do you feel that there are steps that could be taken to increase public participation?

Data Availability

1. Can you discuss reports/studies that have been instrumental in guiding watershed management in the region?
2. Do you feel that the current quantity of monitoring data is sufficient to make adequate management decisions? Is there additional data that you do not have that would be helpful in guiding future decisions?

3. How often are current management plans/projects and monitoring programs re-evaluated?

Legislative Authority

1. Has there been any resistance to decisions that have been made? If so, can you discuss?

2. Do you feel that the current legislative authority (i.e., By-laws, Ontario Water Resources Act, Environmental Protection Act, and Nutrient Management Act) is adequate?

Implementation

1. In your experience, what activities/actions towards the protection of Muskoka's watersheds have been successful?

2. In your experience, what activities/actions are still required or need improvement?

Is there anything else you would like to discuss? Are there any notable experiences regarding source protection and eutrophication management that have not already been addressed?